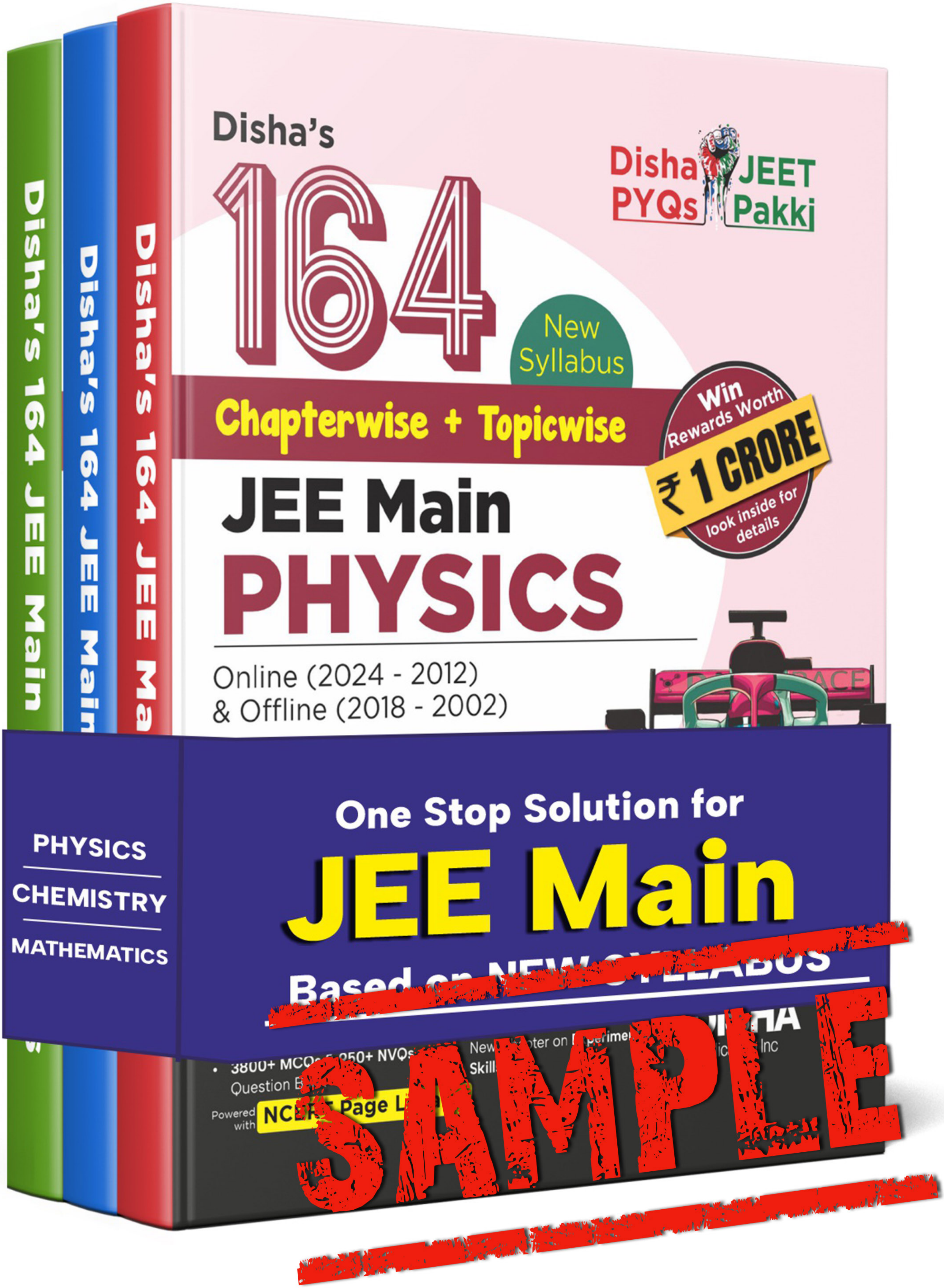
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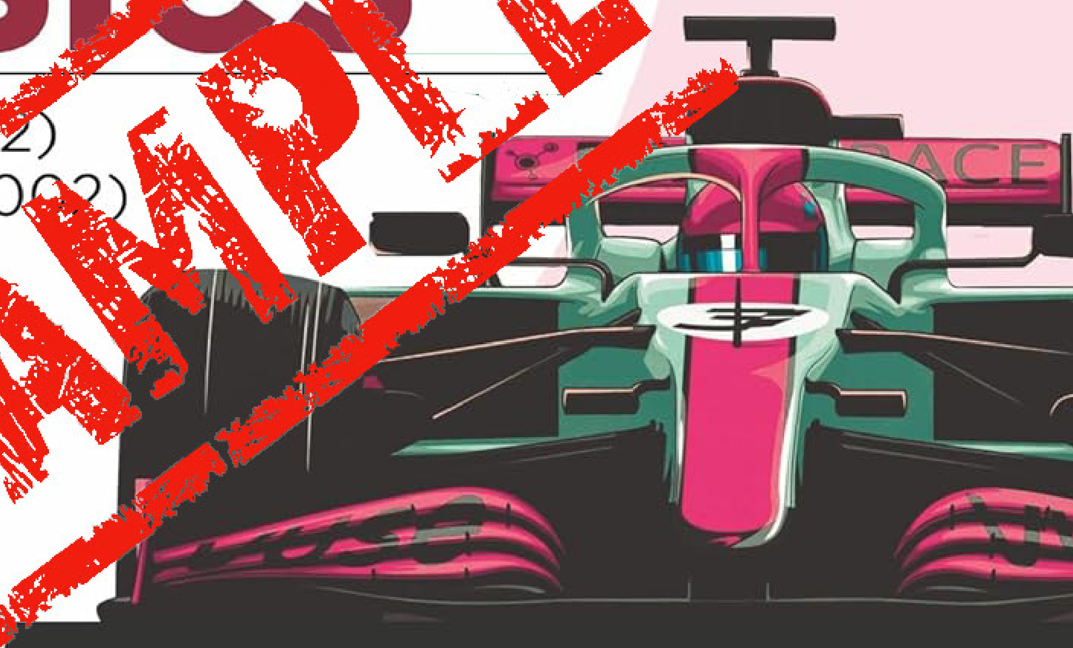

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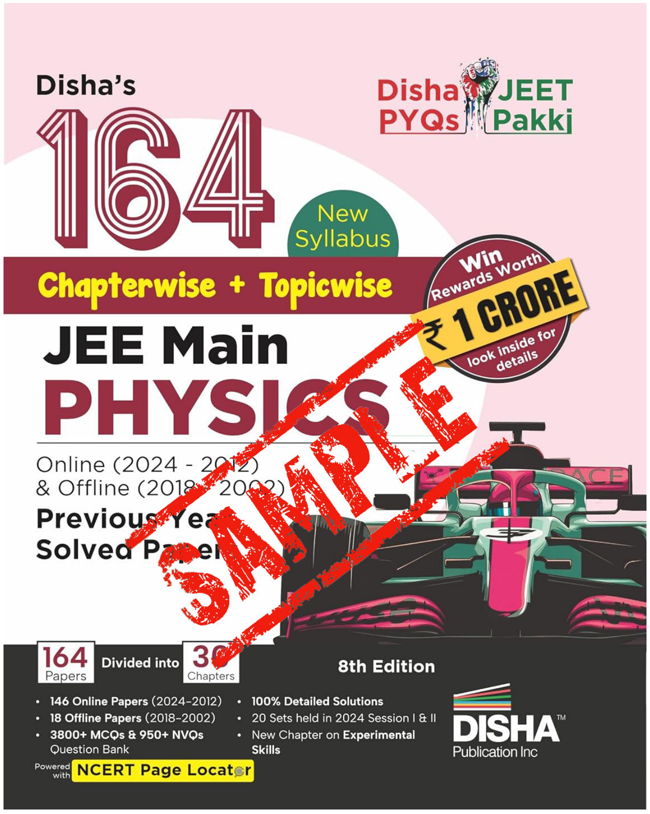

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Chapter 3

Current Electricity

Topic 1 Electric Current, Drift of Electrons, Ohm's Law, Resistance and Resistivity

1. At room temperature (27°C), the resistance of a heating element is 50Ω. The temperature coefficient of the material is 2.4×10^{-4} °C^{-1}. The temperature of the element, when its resistance is 62 Ω, is .... °C.
[NCERT : PL-91 | April 9, 2024 (II)]

2. Resistance of a wire at 0 °C, 100 °C and t °C is found to be 10 Ω, 10.2 Ω and 10.95 Ω respectively. The temperature t in Kelvin scale is ______.
[NCERT : PL-91 | April 8, 2024 (I)]

3. A wire of resistance R and radius r is stretched till its radius became $\frac{r}{2}$. If new resistance of the stretched wire is x R, then value of x is ________ .
[NCERT : PL-84 | April 6, 2024 (I)]

4. The resistances of the platinum wire of a platinum resistance thermometer at the ice point and steam point are 8 Ω and 10 Ω respectively. After inserting in a hot bath of temperature 400°C, the resistance of platinum wire is :
[NCERT : PL-91 | April 4, 2024 (I)]
(a) 2 Ω (b) 16 Ω (c) 8 Ω (d) 10 Ω

5. Two wires A and B are made up of the same material and have the same mass. Wire A has radius of 2.0 mm and wire B has radius of 4.0 mm. The resistance of wire B is 2Ω. The resistance of wire A is _____Ω.
[NCERT : PL-84 | April 4, 2024 (II)]

6. The current in a conductor is expressed as $I = 3t^2 + 4t^3$, where I is Ampere and t is second. The amount of electric charge that flows through a section of the conductor during t = 1s to to t = 2s is ___________ C.
[NCERT : PL-82 | Feb. 1, 2024 (I)]

7. An electric toaster has resistance of 60 Ω at room temperature (27 °C). The toaster is connected to a 220 V supply. If the current flowing through it reaches 2.75 A, the temperature attained by toaster is around : (if $\alpha = 2 \times 10^{-4}$/°C)
[NCERT : PL-91 | Jan. 30, 2024 (I)]
(a) 694 °C (b) 1235°C (c) 1694°C (d) 1667°C

8. The electric current through a wire varies with time as $I = I_0 + \beta t$, where $I_0 = 20$ A and $\beta = 3$ A/s. The amount of electric charge crossed through a section of the wire in 20 s is: **[NCERT : PL-82 | Jan. 29, 2024 (I)]**
(a) 1600 C (b) 800 C (c) 80 C (d) 1000 C

9. Given below are two statements:
Statement I : The equivalent resistance of resistors in a series combination is smaller than least resistance used in the combination.
Statement II : The resistivity of the material is independent of temperature.
In the light of the above statements, choose the correct answer from the options given below:
[NCERT : PL-90 | April 15, 2023 (I)]
(a) Statement I is false but Statement II is true
(b) Both Statement I and Statement II are false
(c) Statement I is true but Statement II is false
(d) Both Statement I and Statement II are true

10. A wire of resistance 160 Ω is melted and drawn in wire of one-fourth of its length. The new resistance of the wire will be **[NCERT : PL-84 | April 12, 2023 (I)]**
(a) 10 Ω (b) 640 Ω (c) 40 Ω (d) 16 Ω

11. The current flowing through a conductor connected across a source is 2A and 1.2 A at 0°C and 100°C respectively. The current flowing through the conductor at 50°C will be ________ × 10^2 mA.
[NCERT : PL-91 | April 12, 2023 (I)]

12. In a metallic conductor, under the effect of applied electric field, the free electrons of the conductor
[NCERT : PL-86 | April 10, 2023 (II)]
(a) drift from higher potential to lower potential
(b) move in the curved paths from lower potential to higher potential
(c) move with the uniform velocity throughout from lower potential to higher potential
(d) move in the straight line paths in the same direction

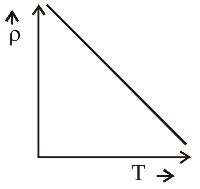
13. A rectangular parallelopiped is measured as 1 cm × 1 cm × 100 cm. If its specific resistance is 3×10^{-7} Ωm, then the resistance between its two opposite rectangular faces will be______$\times^{-7}$ Ω.
[NCERT : PL-84 | April 10, 2023 (II)]

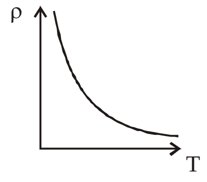
14. A current of 2 A flows through a wire of cross-sectional area 25.0 mm^2. The number of free electrons in a cubic meter are 2.0×10^{28}. The drift velocity of the electrons is _____ × 10^{-6} ms^{-1}
[NCERT : PL-86 | April 8, 2023 (I)]
(given, charge on electron = 1.6×10^{-19} C)

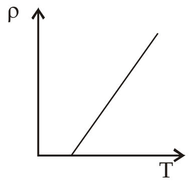
15. The number density of free electrons in copper is nearly 8×10^{28} m^{-3}. A copper wire has its area of cross-section $= 2 \times 10^{-6}$ m^2 and is carrying a current of 3.2 A. The drift speed of the electrons is _______ × 10^{-6} ms^{-1}.
[NCERT : PL-86 | April 8, 2023 (II)]

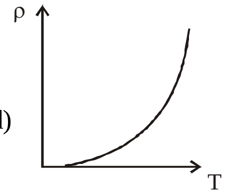
16. The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is _____.
[NCERT : PL-84 | April 6, 2023 (I)]

17. The resistivity (ρ) of semiconductor varies with temperature. Which of the following curve represents the correct behaviour **[NCERT : PL-91 | April 6, 2023 (I)]**

(a) 

(b) 

(c) 

(d) 

18. The drift velocity of electrons for a conductor connected in an electrical circuit is V_d. The conductor in now replaced by another conductor with same material and same length but double the area of cross section. The applied voltage remains same. The new drift velocity of electrons will be
[NCERT : P L-86 | Jan. 31, 2023 (I)]

(a) V_d (b) $\frac{V_d}{2}$ (c) $\frac{V_d}{4}$ (d) $2V_d$

19. The charge flowing in a conductor changes with time as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Where α, β and γ are constants. Minimum value of current is :
[NCERT : P L-82 | Jan. 30, 2023 (I)]

(a) $\alpha = \frac{3\beta^2}{\gamma}$ (b) $\alpha - \frac{\gamma^2}{3\beta}$ (c) $\beta - \frac{\alpha^2}{3\gamma}$ (d) $\alpha - \frac{\beta^2}{3\gamma}$

20. A uniform metallic wire carries a current 2 A. when 3.4 V battery is connected across it. The mass of uniform metallic wire is 8.92×10^{-3} kg. density is 8.92×10^3 kg/m^3 and resistivity is 1.7×10^{-8} Ω–m. The length of wire is :
[NCERT : P L-84 | Jan. 25, 2023 (I)]

(a) l = 6.8 m (b) l = 10 m
(c) l = 5 m (d) l = 100 m

21. The resistance of a wire is 5 Ω. It's new resistance in ohm if stretched to 5 times of its original length will be :
[NCERT : P L-84 | Jan. 25, 2023 (II)]

(a) 625 (b) 5 (c) 125 (d) 25

22. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n \times 10^{-3}$ Ω.
If the resistivity of the material is 2.4×10^{-8} Ω*m*.
The value of n is ______ .
[NCERT : P L-84 | Jan. 24, 2023 (I)]

23. If a copper wire is stretched to increase its length by 20%. The percentage increase in resistance of the wire is ________ %. **[NCERT : P L-84 | Jan. 24, 2023 (II)]**

24. A 1 m long wire is broken into two unequal parts X and Y The X part of the wire is streched into another wire W. Length of W is twice the length of X and the resistance of W is twice that of Y. Find the ratio of length of X and Y.
[NCERT : P L-84 | July 29, 2022 (II)]

(a) 1 : 4 (b) 1 : 2 (c) 4 : 1 (d) 2 : 1

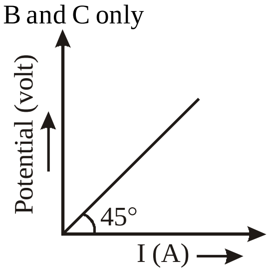
25. A wire of resistance R_1 is drawn out so that its length is increased by twice of its original length. The ratio of new resistance to original resistance is:
[NCERT : P L-84 | July 28, 2022 (I)]

(a) 9 : 1 (b) 1 : 9 (c) 4 : 1 (d) 3 : 1

26. A. The drift velocity of electrons decreases with the increase in the temperature of conductor.
B. The drift velocity is inversely proportional to the area of cross-section of given conductor.
C. The drift velocity does not depend on the applied potential difference to the conductor.
D. The drift velocity of electron is inversely proportional to the length of the conductor.
E. The drift velocity increases with the increase in the temperature of conductor.
Choose the correct answer from the options given below:
[NCERT : P L-86 | July 27, 2022 (II)]

(a) A and B only (b) A and D only
(c) B and E only (d) B and C only

27. The variation of applied potential and current flowing through a given wire is shown in figure. The length of wire is 31.4 cm. The diameter of wire is measured as 2.4 cm. The resistivity of the given wire is measured as $x \times 10^{-3}$ Ω cm. The value of *x* is __________.



[NCERT : P L-84 | June 29, 2022 (I)]

28. Resistance of the wire is measured as 2 Ω and 3 Ω at 10°C and 30°C respectively. Temperature co-coefficient of resistance of the material of the wire is :
[NCERT : P L-91 | June 28, 2022 (II)]

(a) 0.033°C^{-1} (b) –0.033°C^{-1}
(c) 0.011°C^{-1} (d) 0.055°C^{-1}

29. The current density in a cylindrical wire of radius 4 mm is 4×10^6 Am^{-2}. The current through the outer portion of the wire between radial distance $\frac{R}{2}$ and R is ____ πA.
[NCERT : P L-86 | June 27, 2022 (I)]

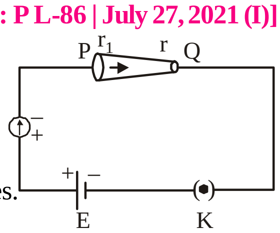
30. The current density in a cylindrical wire of radius r = 4.0 mm is 1.0×10^6 A/m^2. The current through the outer portion of the wire between radial distances r/2 and r is xπ A; where x is ________ .
[NCERT : P L-86 | June 27, 2022 (II)]

31. An aluminium wire is stretched to make its length, 0.4% larger. Then percentage change in resistance is:
[NCERT : P L-84 | June 26, 2022 (I)]

(a) 0.4% (b) 0.2% (c) 0.8% (d) 0.6%

32. The length of a given cylindrical wire is increased to double of its original length. The percentage increase in the resistance of the wire will be ________ %.
[NCERT : P L-84 | June 25, 2022 (II)]

33. In the given figure, a battery of emf E is connected across a conductor PQ of length '*l*' and different area of cross-sections having radii r_1 and r_2 ($r_2 < r_1$).
[NCERT : P L-86 | July 27, 2021 (I)]



Choose the correct option as one moves from P to Q :
(a) Drift velocity of electron increases.
(b) Electric field decreases.
(c) Electron current decreases.
(d) All of these

34. For the circuit shown, the value of current at time t = 3.2 s will be ________ A.

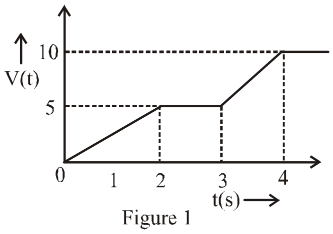


Figure 1

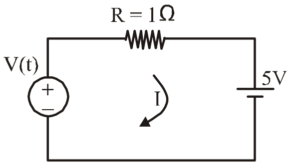


Figure 2

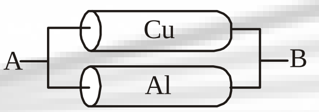
[Voltage distribution V(t) is shown by Fig. (1) and the circuit is shown in Fig. (2)]

[NCERT : P L-83 | NA, July 27, 2021 (II)]

35. A Copper (Cu) rod of length 25 cm and cross-sectional area 3 mm^2 is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.
(Take Resistivity of Copper = 1.7×10^{-8} Ωm Resistivity of Aluminium = 2.6×10^{-8} Ωm)

[NCERT : P L-84 | July 22, 2021 (II)]

(a) 2.170 mΩ
(b) 1.420 mΩ
(c) 0.0858 mΩ
(d) 0.858 mΩ



36. Two wires of same length and thickness having specific resistances 6 Ω cm and 3 Ω cm respectively are connected in parallel. The effective resistivity is ρΩ cm. The value of ρ, to the nearest integer, is _________.

[NCERT : P L-84 | March 18, 2021 (II)]

37. A current of 10 A exists in a wire of cross-sectional area of 5 mm^2 with a drift velocity of $2 \times 10^{-3}\ ms^{-1}$. The number of free electrons in each cubic meter of the wire is _______

[NCERT : P L-86 | March 17, 2021 (I)]

(a) 2×10^{25} (b) 2×10^{23} (c) 625×10^{25} (d) 2×10^{6}

38. A conducting wire of length 'l', area of cross-section A and electric resistivity ρ is connected between the terminals of a battery. A potential difference V is developed between its ends, causing an electric current.
If the length of the wire of the same material is doubled and the area of cross-section is halved, the resultant current would be:

[NCERT : P L-84 | March 16, 2021 (I)]

(a) $4\dfrac{VA}{\rho l}$ (b) $\dfrac{3}{4}\dfrac{VA}{\rho l}$ (c) $\dfrac{1}{4}\dfrac{\rho l}{VA}$ (d) $\dfrac{1}{4}\dfrac{VA}{\rho l}$

39. A current through a wire depends on time as $i = \alpha_0 t + \beta t^2$ where α_0 = 20 A/s and β = 8 As^{-2}. Find the charge crossed through a section of the wire in 15 s.

[NCERT : P L-82 | Feb. 24, 2021 (I)]

(a) 2250 C (b) 11250 C (c) 2100 C (d) 260 C

40. A cylindrical wire of radius 0.5 mm and conductivity 5×10^7 S/m is subjected to an electric field of 10 mV/m. The expected value of current in the wire will be $x^3\pi$ mA. The value of x is _________

[NCERT : P L-86 | Feb. 24, 2021 (II)]

41. In an electrical circuit, a battery is connected to pass 20 C of charge through it in a certain given time. The potential difference between two plates of the battery is maintained at 15 V. The work done by the battery is _______ J. **[NCERT : P L-92 | Feb. 26, 2021 (I)]**

42. A wire of 1 Ω has a length of 1 m. It is stretched till its length increases by 25%. The percentage change in resistance to the nearest integer is

[NCERT : P L-84 | Feb. 26, 2021 (II)]

(a) 76% (b) 56% (c) 12.5% (d) 25%

43. Consider four conducting materials copper, tungsten, mercury and aluminium with resistivity ρ_C, ρ_T, ρ_M and ρ_A respectively. Then : **[NCERT : P L-84 | Sep. 02, 2020 (I)]**

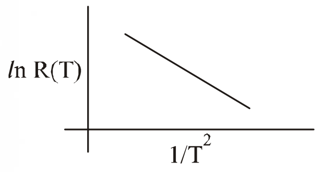
(a) $\rho_C > \rho_A > \rho_T$
(b) $\rho_M > \rho_A > \rho_C$
(c) $\rho_A > \rho_T > \rho_C$
(d) $\rho_A > \rho_M > \rho_C$

44. A current of 5 A passes through a copper conductor (resistivity) = 1.7×10^{-8} Ωm) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is 1.1×10^{-3} m/s. **[NCERT : P L-88 | 10 Apr. 2019 I]**

(a) 1.8 m^2/Vs (b) 1.5 m^2/Vs (c) 1.3 m^2/Vs (d) 1.0 m^2/Vs

45. In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line. **[10 Apr. 2019 I]**
One may canclude that:

(a) $R(T) = \dfrac{R_0}{T^2}$
(b) $R(T) = R_0 e^{-T_0^2/T^2}$
(c) $R(T) = R_0 e^{-T^2/T_0^2}$
(d) $R(T) = R_0 e^{T^2/T_0^2}$



46. Space between two concentric conducting spheres of radii a and b ($b > a$) is filled with a medium of resistivity ρ. The resistance between the two spheres will be :

[NCERT : P L-84 | 10 Apr. 2019 II]

(a) $\dfrac{\rho}{4\pi}\left(\dfrac{1}{a}-\dfrac{1}{b}\right)$ (b) $\dfrac{\rho}{2\pi}\left(\dfrac{1}{a}-\dfrac{1}{b}\right)$

(c) $\dfrac{\rho}{2\pi}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$ (d) $\dfrac{\rho}{4\pi}\left(\dfrac{1}{a}+\dfrac{1}{b}\right)$

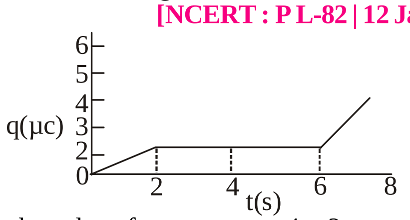
47. In a conductor, if the number of conduction electrons per unit volume is $8.5 \times 10^{28}\ m^{-3}$ and mean free time is 25 *fs* (femto second), it's approximate resistivity is: ($m_e = 9.1 \times 10^{-31}$ kg)

[NCERT : P L-91 | 9 Apr. 2019 II]

(a) 10^{-6} Ω m (b) 10^{-7} Ωm (c) 10^{-8} Ωm (d) 10^{-5} Ωm

48. The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure:

[NCERT : P L-82 | 12 Jan. 2019 II]



What is the value of current at t = 4 s ?

(a) Zero (b) 3 μA (c) 2 μA (d) 1.5 μA

49. Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm^2, is v. If the electron density in copper is $9 \times 10^{28}/m^3$ the value of v in mm/s close to (Take charge of electron to be = 1.6×10^{-19}C)

[NCERT : P L-86 | 9 Jan. 2019 I]

(a) 0.02 (b) 3 (c) 2 (d) 0.2

50. A copper wire is stretched to make it 0.5% longer. The percentage change in its electrical resistance if its volume remains unchanged is: **[NCERT : P L-84 | 9 Jan. 2019 I]**

(a) 2.0% (b) 2.5% (c) 1.0% (d) 0.5%

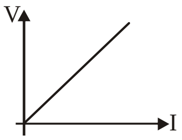
51. A uniform wire of length l and radius r has a resistance of 100 Ω. It is recast into a wire of radius $\frac{r}{2}$. The resistance of new wire will be : **[NCERT : P L-84 | Online April 9, 2017]**

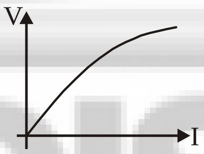
(a) 1600 Ω (b) 400 Ω (c) 200 Ω (d) 100 Ω

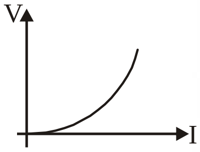
52. When 5V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to : **[NCERT : P L-86 | 2015]**

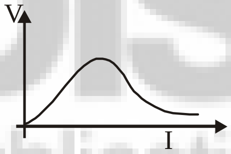
(a) 1.6×10^{-6} Ωm (b) 1.6×10^{-5} Ωm
(c) 1.6×10^{-8} Ωm (d) 1.6×10^{-7} Ωm

53. Suppose the drift velocity v_d in a material varied with the applied electric field E as $v_d \propto \sqrt{E}$. Then V – I graph for a wire made of such a material is best given by : **[Online April 10, 2015]**

(a) 

(b) 

(c) 

(d) 

54. The resistance of a wire is *R*. It is bent at the middle by 180° and both the ends are twisted together to make a shorter wire. The resistance of the new wire is **[NCERT : P L-84 | Online May 26, 2012]**

(a) 2*R* (b) *R*/2 (c) *R*/4 (d) *R*/8

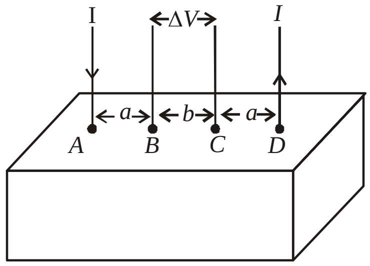
55. If a wire is stretched to make it 0.1% longer, its resistance will : **[NCERT : P L-84 | 2011]**

(a) increase by 0.2% (b) decrease by 0.2%
(c) decrease by 0.05% (d) increase by 0.05%

Directions : Question No. 56 and 57 are based on the following paragraph.

Consider a block of conducting material of resistivity 'ρ' shown in the figure. Current 'I' enters at 'A' and leaves from 'D'. We apply superposition principle to find voltage 'ΔV' developed between 'B' and 'C'. The calculation is done in the following steps:

(i) Take current 'I' entering from 'A' and assume it to spread over a hemispherical surface in the block.
(ii) Calculate field E(r) at distance 'r' from A by using Ohm's law E = ρ j, where j is the current per unit area at 'r'.
(iii) From the 'r' dependence of E(r), obtain the potential V(r) at r.
(iv) Repeat (i), (ii) and (iii) for current 'I' leaving 'D' and superpose results for 'A' and 'D'.



56. ΔV measured between *B* and *C* is **[NCERT : P L-86 | 2008]**

(a) $\frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$ (b) $\frac{\rho I}{a} - \frac{\rho I}{(a+b)}$

(c) $\frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi(a+b)}$ (d) $\frac{\rho I}{2\pi(a-b)}$

57. For current entering at *A*, the electric field at a distance '*r*' from *A* is **[NCERT : P L-86 | 2008]**

(a) $\frac{\rho I}{8\pi r^2}$ (b) $\frac{\rho I}{r^2}$ (c) $\frac{\rho I}{2\pi r^2}$ (d) $\frac{\rho I}{4\pi r^2}$

58. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0°C will be **[NCERT : P L-91 | 2007]**

(a) 3 ohm (b) 2 ohm (c) 1 ohm (d) 4 ohm

59. A material '*B*' has twice the specific resistance of '*A*'. A circular wire made of '*B*' has twice the diameter of a wire made of '*A*'. then for the two wires to have the same resistance, the ratio l_B/l_A of their respective lengths must be **[NCERT : P L-84 | 2006]**

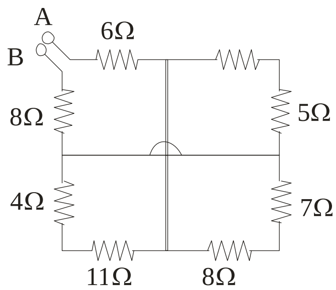
(a) 1 (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) 2

60. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the lengths and radii are in the ratio of $\frac{4}{3}$ and $\frac{2}{3}$, then the ratio of the current passing through the wires will be **[NCERT : P L-84 | 2004]**

(a) 8/9 (b) 1/3 (c) 3 (d) 2

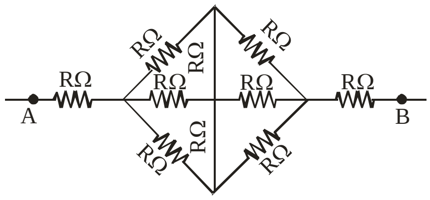
Topic 2 Combination of Resistances

61. The equivalent resistance between A and B is: **[April 9, 2024 (I)]**



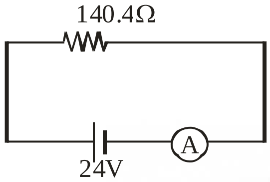
(a) 18 Ω (b) 25 Ω (c) 27 Ω (d) 19 Ω

62. The effective resistance between A and B, if resistance of each resistor is R, will be **[April 9, 2024 (II)]**

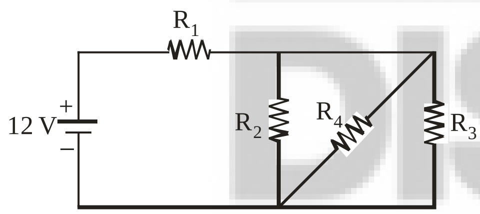


(a) $\frac{2}{3}R$ (b) $\frac{8R}{3}$ (c) $\frac{5R}{3}$ (d) $\frac{4R}{3}$

63. In the given figure an ammeter A consists of a 240Ω coil connected in parallel to a 10 Ω shunt. The reading of the ammeter is ______ mA.
[NCERT : P L-83 | April 6, 2024 (II)]



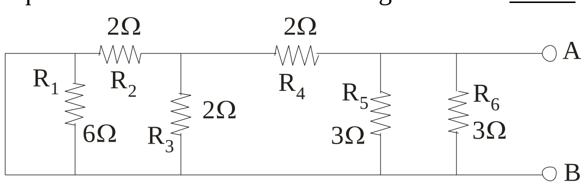
64. In the given figure $R_1 = 10\Omega$, $R_2 = 8\Omega$, $R_3 = 4\Omega$ and $R_4 = 8\Omega$. Battery is ideal with emf 12V. Equivalent resistant of the circuit and current supplied by battery are respectively.
[NCERT : P L-83 | April 5, 2024 (I)]



(a) 12 Ω and 11.4 A (b) 10.5 Ω and 1.14 A
(c) 10.5 Ω and 1 A (d) 12 Ω and 1 A

65. A wire of resistance 20 Ω is divided into 10 equal parts. A combination of two parts are connected in parallel and so on. Now resulting pairs of parallel combination are connected in series. The equivalent resistance of final combination is ________ Ω.
[NCERT : P L-84 | April 5, 2024 (II)]

66. Equivalent resistance of the following network is _____Ω.



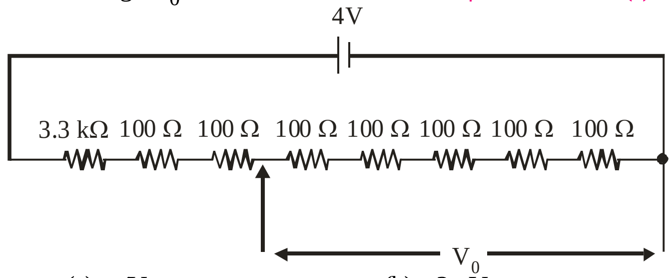
[Jan. 31, 2024 (I)]

67. Two conductors have the same resistances at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients for their series and parallel combinations are :
[NCERT : P L-91 | Jan. 31, 2024 (I)]

(a) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$ (b) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$

(c) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (d) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$

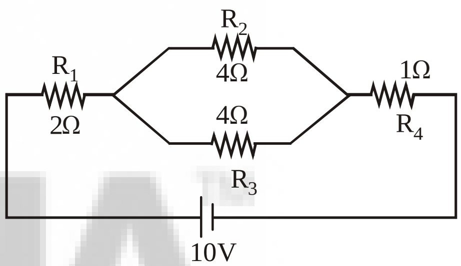
68. A potential divider circuit is shown in figure. The output voltage V_0 is: **[NCERT : P L-83 | Jan. 30, 2024 (I)]**



(a) 4V (b) 2mV
(c) 0.5 V (d) 12 mV

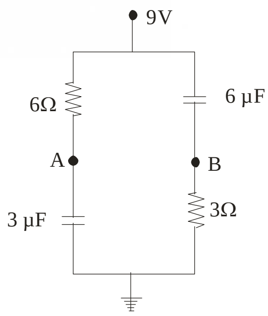
69. A 16Ω wire is bend to form a square loop. A 9V battery with internal resistance 1Ω is connected across one of its sides. If a 4μF capacitor is connected across one of its diagonals, the energy stored by the capacitor will be $\frac{x}{2}\mu J$, where x = ______. **[NCERT : P L-83 | Jan. 29, 2024 (I)]**

70. In the given circuit, the current in resistance R_3 is :
[NCERT : P L-95 | Jan. 29, 2024 (II)]

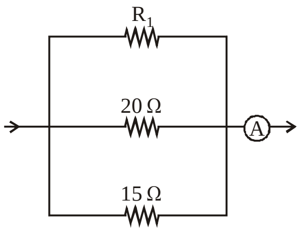


(a) 2.5 A (b) 1 A (c) 1.5 A (d) 2 A

71. In the given figure, the charge stored in 6μF capacitor, when points A and B are joined by a connecting wire is ______ μC. **[NCERT : P L-96, 97 | Jan. 29, 2024 (II)]**



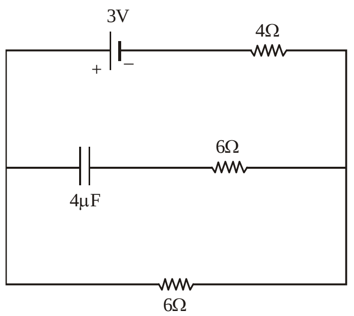
72. In the given circuit, the current flowing through the resistance 20Ω is 0.3 A, while the ammeter reads 0.9 A. The value of R_1 is _____ Ω.
[NCERT : P L-97 | Jan. 29, 2024 (II)]



73. A wire of resistance R and length L is cut into 5 equal parts. If these parts are joined parallely, then resultant resistance will be : **[NCERT : P L-84 | Jan. 27, 2024 (I)]**

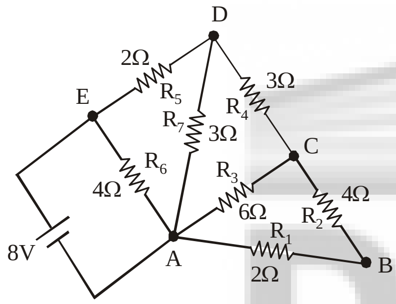
(a) $\frac{1}{25}R$ (b) $\frac{1}{5}R$ (c) 25 R (d) 5 R

74. In the network shown below, the charge accumulated in the capacitor in steady state will be: **[NCERT : PL-83 | April 13, 2023 (II)]**



(a) 7.2 μC (b) 4.8 μC (c) 10.3 μC (d) 12 μC

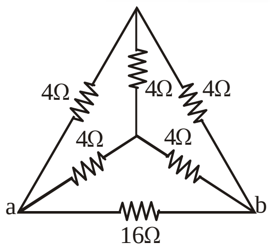
75.



The current flowing through R_2 is: **[NCERT : PL-83 | April 11, 2023 (II)]**

(a) $\frac{2}{3}$A (b) $\frac{1}{4}$A (c) $\frac{1}{2}$A (d) $\frac{1}{3}$A

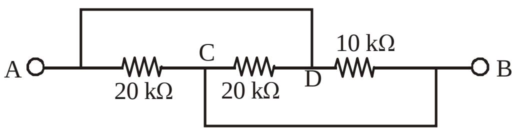
76. The equivalent resistance of the circuit shown below between points a and b is : **[April 10, 2023 (I)]**



(a) 24Ω (b) 3.2Ω (c) 20Ω (d) 16Ω

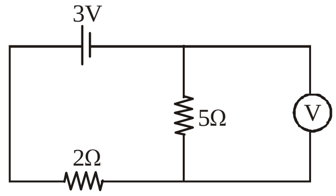
77. 10 resistors each of resistance 10Ω can be connected in such as to get maximum and minimum equivalent resistance. The ratio of maximum and minimum equivalent resistance will be ______ . **[April 10, 2023 (I)]**

78. The equivalent resistance between A and B as shown in figure is: **[April 8, 2023 (II)]**

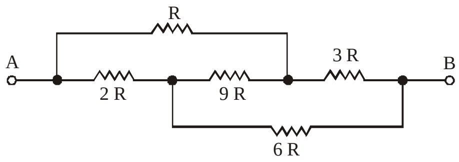


(a) 5 kΩ (b) 30 kΩ (c) 10 kΩ (d) 20 kΩ

79. As shown in the figure, the voltmeter reads 2V across 5 Ω resistor. The resistance of the voltmeter is________Ω. **[NCERT : P L-98 | April 6, 2023 (II)]**



80. The equivalent resistance between *A* and *B* of the network shown in figure: **[NCERT : P L-101 | Feb. 1, 2023 (I)]**

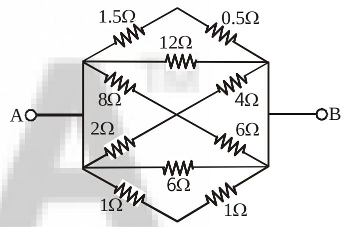


(a) 14 R (b) $\frac{2}{3}$R (c) $\frac{8}{3}$R (d) 21 R

81. Equivalent resistance between the adjacent corners of a regular n-sided polygon of uniform wire of resistance R would be: **[Feb. 1, 2023 (II)]**

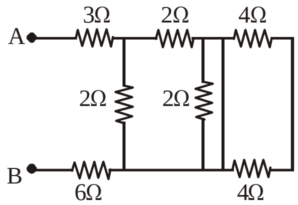
(a) $\frac{(n-1)R}{(2n-1)}$ (b) $\frac{n^2R}{n-1}$ (c) $\frac{(n-1)R}{n^2}$ (d) $\frac{(n-1)R}{n}$

82. The equivalent resistance between A and B is …… **[Jan. 30, 2023 (II)]**

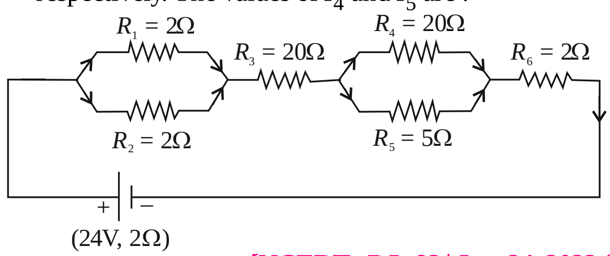


(a) $\frac{2}{3}\Omega$ (b) $\frac{1}{2}\Omega$ (c) $\frac{3}{2}\Omega$ (d) $\frac{1}{3}\Omega$

83. In the given circuit, the equivalent resistance between the terminal A and B is______Ω. **[Jan. 25, 2023 (I)]**



84. As shown in the figure, a network of resistors is connected to a battery of 24 *V* with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are :



[NCERT : P L-83 | Jan. 24, 2023 (I)]

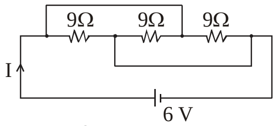
(a) $I_4=\frac{8}{5}$A and $I_5=\frac{2}{5}$A (b) $I_4=\frac{24}{5}$A and $I_5=\frac{6}{5}$A

(c) $I_4=\frac{6}{5}$A and $I_5=\frac{24}{5}$A (d) $I_4=\frac{2}{5}$A and $I_5=\frac{8}{5}$A

85. A cell of emf 90 V is connected across series combination of two resistors each of 100 Ω resistance. A voltmeter of resistance 400 Ω is used to measure the potential difference across each resistor. The reading of the voltmeter will be: **[NCERT : P L-83 | Jan. 24, 2023 (II)]**

(a) 40 V (b) 45 V (c) 80 V (d) 90 V

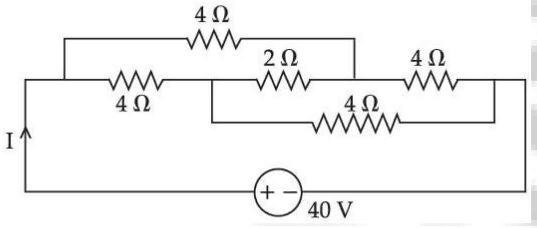
86. The current I flowing through the given circuit will be_______ A. **[NCERT : P L-83 | July 29, 2022 (I)]**



87. Two metallic wires of identical dimensions are connected is series. If σ_1 and σ_2 are the conductivities of the these wires respectively, the effective conductivity of the combination is : **[NCERT : P L-84 | July 29, 2022 (I)]**

(a) $\frac{\sigma_1\sigma_2}{\sigma_1+\sigma_2}$ (b) $\frac{2\sigma_1\sigma_2}{\sigma_1+\sigma_2}$ (c) $\frac{\sigma_1+\sigma_2}{2\sigma_1\sigma_2}$ (d) $\frac{\sigma_1+\sigma_2}{\sigma_1\sigma_2}$

88. The current I in the given circuit will be : **[NCERT : P L-98 | July 26, 2022 (I)]**



(a) 10 A (b) 20 A (c) 4 A (d) 40 A

89. Eight copper wire of length l and diameter d are joined in parallel to form a single composite conductor of resistance R. If a single copper wire of length $2l$ have the same resistance (R) then its diameter will be _______ d. **[NCERT : P L-84 | July 25, 2022 (I)]**

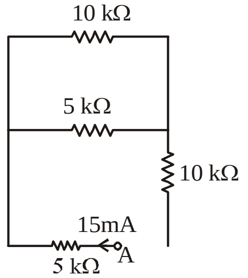
90. A current of 15 mA flows in the circuit as shown in figure. The value of potential differfence between the points A and B will be **[NCERT : P L-98 | July 25, 2022 (II)]**

(a) 50 V

(b) 75 V

(c) 150 V

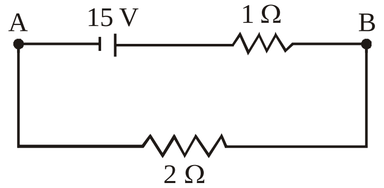
(d) 275 V



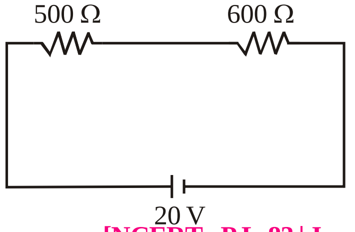
91. An electric cable of copper has just one wire of radius 9 mm. Its resistance is 14Ω. If this single copper wire of the cable is replaced by seven identical well insulated copper wires each of radius 3 mm connected in parallel, then the new resistance of the combination will be: **[NCERT : P L-84 | June 30, 2022 (I)]**

(a) 9Ω (b) 18Ω (c) 28Ω (d) 126Ω

92. For the network shown below, the value $V_B - V_A$ is ________V. **[NCERT : P L-83 | June 29, 2022 (I)]**

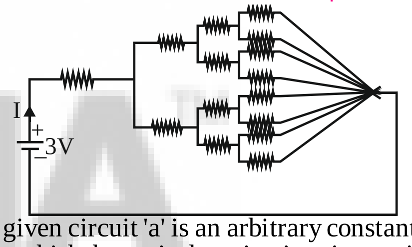


93. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000 Ω is used to measure the potential difference across 500 Ω resister, the reading of the voltmeter will be ____V.

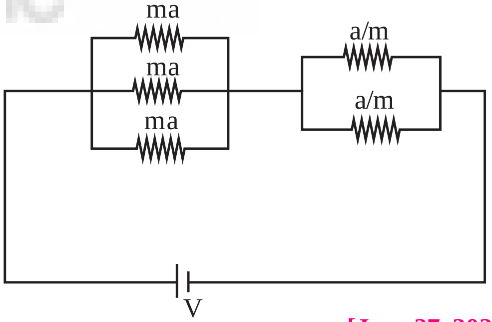


[NCERT : P L-83 | June 29, 2022 (II)]

94. All resistances in figure are 1Ω each. The value of current 'I' is $\frac{a}{5}A$. The value of a is _______. **[NCERT : P L-83 | June 28, 2022 (II)]**

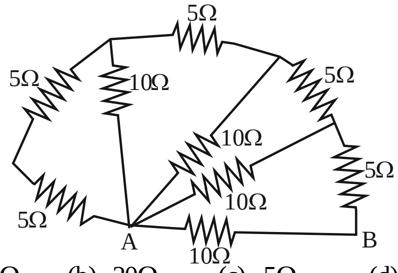


95. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\sqrt{\frac{x}{2}}$. The value of x is _____ .



[June 27, 2022 (II)]

96. The equivalent resistance between points A and B in the given network is : **[June 26, 2022 (II)]**

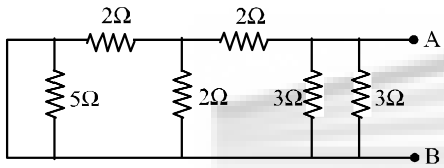


(a) 65Ω (b) 20Ω (c) 5Ω (d) 2Ω

97. What will be the most suitable combination of three resistors $A = 2\Omega$, $B = 4\Omega$, $C = 6\Omega$ so that $\left(\frac{22}{3}\right)\Omega$ is equivalent resistance of combination? **[June 24, 2022 (II)]**
(a) Parallel combination of A and C connected in series with B.
(b) Parallel combination of A and B connected in series with C.
(c) Series combination of A and C connected in parallel with B.
(d) Series combination of B and C connected in parallel with A.

98. A square shaped wire with resistance of each side 3Ω is bent to form a complete circle. The resistance between two diametrically opposite points of the circle in unit of Ω will be ______. **[NA, Aug. 31, 2021 (I)]**

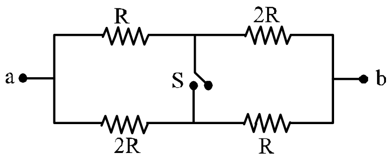
99. The equivalent resistance of the given circuit between the terminals A and B is : **[Aug. 31, 2021 (II)]**



(a) 0 Ω (b) 3 Ω (c) $\frac{9}{2}\Omega$ (d) 1 Ω

100. First, a set of n equal resistors of 10 Ω each are connected in series to a battery of emf 20V and internal resistance 10 Ω. A current I is observed to flow. Then, the n resistors are connected in parallel to the same battery. It is observed that the current is increased 20 times, then the value of n is _________. **[NCERT : P L-83 | NA, Aug. 27, 2021 (I)]**

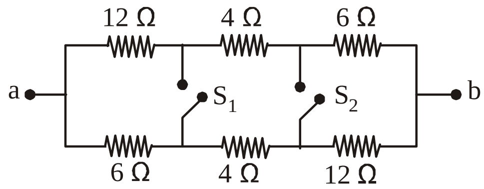
101. The ratio of the equivalent resistance of the network (shown in figure) between the points a and b when switch is open and switch is closed is x : 8. The value of x is _______. **[NA, Aug. 27, 2021 (II)]**



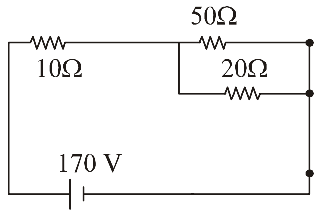
102. What equal length of an iron wire and a copper-nickel alloy wire, each of 2 mm diameter connected parallel to give an equivalent resistance of 3Ω?
(Given resistivities of iron and copper-nickel alloy wire are 12 μΩ cm and 51 μΩ cm respectively)
[NCERT : P L-84 | Aug. 26, 2021 (I)]
(a) 82m (b) 97m (c) 110m (d) 90m

103. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$. **[Aug. 26, 2021 (II)]**
(a) 4Ω and 6Ω are in parallel with 2Ω and 8Ω in series
(b) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series
(c) 2Ω and 6Ω are in parallel with 4Ω and 8Ω in series
(d) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

104. In the given figure switches S_1 and S_2 are in open condition. The resistance across ab when the switches S_1 and S_2 are closed is _________Ω. **[NA, July 20, 2021 (II)]**



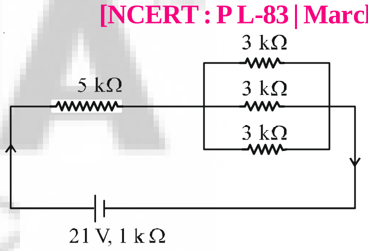
105. The voltage across the 10 Ω resistor in the given circuit is x volt.



The value 'x' to the nearest integer is _______ .
[March 18, 2021 (I)]

106. The equivalent resistance of series combination of two resistors is 's'. When they are connected in parallel, the equivalent resistance is 'p'. If s = np, then the minimum value for n is ________. (Round off to the Nearest Integer)
[March 17, 2021 (I)]

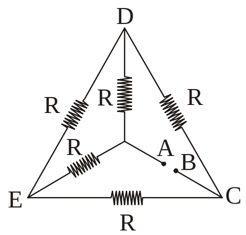
107. In the figure given, the electric current flowing through the 5 kΩ resistor is x mA.
[NCERT : P L-83 | March 16, 2021 (I)]



The value of x to the nearest integer is _____.

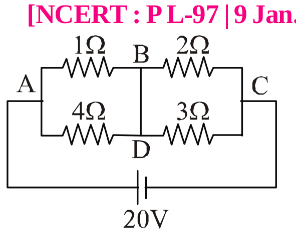
108. Five equal resistances are connected in a network as shown in figure. The net resistance between the points A and B is: **[NCERT : P L-101 | Feb. 26, 2021 (I)]**

(a) $\frac{R}{2}$
(b) $\frac{3R}{2}$
(c) R
(d) 2R



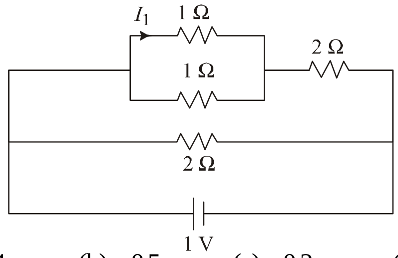
109. In the given circuit diagram, a wire is joining points B and D. The current in this wire is:
[NCERT : P L-97 | 9 Jan. 2020 I]

(a) 0.4A
(b) 2A
(c) 4A
(d) zero



110. The series combination of two batteries, both of the same emf 10 V, but different internal resistance of 20 Ω and 5 Ω, is connected to the parallel combination of two resistors 30 Ω and R Ω. The voltage difference across the battery of internal resistance 20 Ω is zero, the value of R (in Ω) is __________. **[NCERT : P L-98 | NA. 8 Jan. 2020 II]**

111. The current I_1 (in A) flowing through 1 Ω resistor in the following circuit is: **[7 Jan. 2020 I]**



(a) 0.4 (b) 0.5 (c) 0.2 (d) 0.25

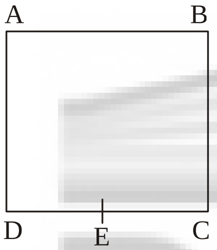
112. A wire of resistance R is bent to form a square ABCD as shown in the figure. The effective resistance between E and C is: (E is mid-point of arm CD) **[9 April 2019 I]**

(a) R

(b) $\frac{7}{64}$R

(c) $\frac{3}{4}$R

(d) $\frac{1}{16}$R



113. A metal wire of resistance 3 Ω is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make a circle. If two points on the circle make an angle 60° at the centre, the equivalent resistance between these two points will be:

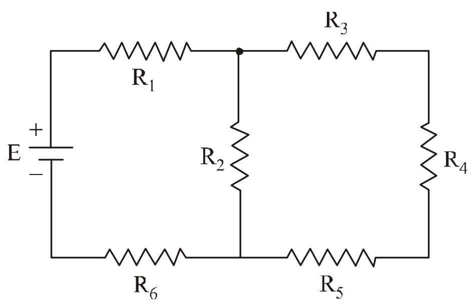
[NCERT : P L-84 | 9 Apr. 2019 II]

(a) $\frac{12}{5}\Omega$ (b) $\frac{5}{2}\Omega$ (c) $\frac{5}{3}\Omega$ (d) $\frac{7}{2}\Omega$

114. In the figure shown, what is the current (in Ampere) drawn from the battery? You are given :

[NCERT : P L-83 | 8 Apr. 2019 II]

$R_1 = 15\ \Omega$, $R_2 = 10\ \Omega$, $R_3 = 20\ \Omega$, $R_4 = 5\ \Omega$, $R_5 = 25\ \Omega$, $R_6 = 30\ \Omega$, E = 15 V

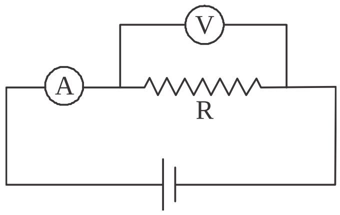


(a) 13/24 (b) 7/18 (c) 9/32 (d) 20/3

115. A uniform metallic wire has a resistance of 18 Ω and is bent into an equilateral triangle. Then, the resistance between any two vertices of the triangle is: **[10 Jan. 2019 I]**

(a) 4 Ω (b) 8 Ω (c) 12 W (d) 2 W

116. The actual value of resistance R, shown in the figure is 30 Ω. This is measured in an experiment as shown using the standard formula $R = \frac{V}{I}$, where V and I are the reading of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is: **[10 Jan. 2019 II]**



(a) 600 Ω (b) 570 Ω (c) 35 W (d) 350 W

117. In the given circuit the internal resistance of the 18 V cell is negligible. If $R_1 = 400\Omega$, $R_3 = 100\ \Omega$ and $R_4 = 500\ \Omega$ and the reading of an ideal voltmeter across R_4 is 5 V, then the value of R_2 will be:

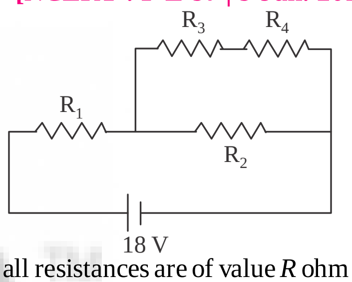
[NCERT : P L-97 | 9 Jan. 2019 II]

(a) 300 W

(b) 450 W

(c) 550 W

(d) 230 W



118. In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is :

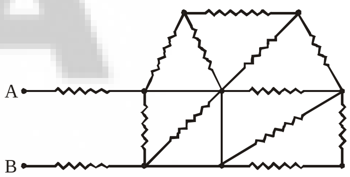
[Online April 15, 2018]

(a) $2R$

(b) $\frac{5R}{2}$

(c) $\frac{5R}{3}$

(d) $3R$



119. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be :

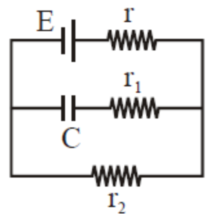
[NCERT : P L-97 | 2017]

(a) $CE\frac{r_2}{(r+r_2)}$

(b) $CE\frac{r_1}{(r_1+r)}$

(c) CE

(d) $CE\frac{r_1}{(r_2+r)}$



120. In the above circuit the current in each resistance is

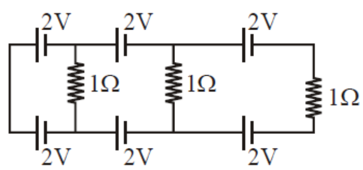
[NCERT : P L-97 | 2017]

(a) 0.5A

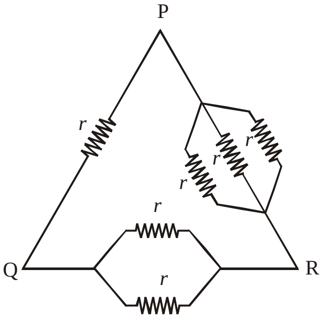
(b) 0 A

(c) 1 A

(d) 0.25 A



121. Six equal resistances are connected between points P, Q and R as shown in figure. Then net resistance will be maximum between : [Online April 25, 2013]



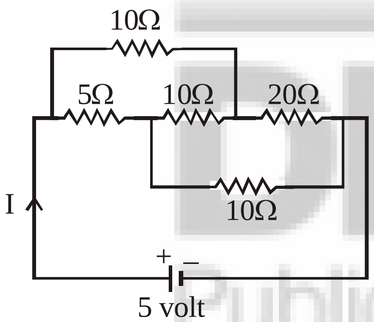
(a) P and R
(b) P and Q
(c) Q and R
(d) Any two points

122. Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly [NCERT : P L-91 | 2010]

(a) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (b) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$

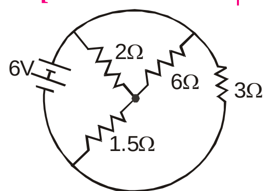
(c) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ (d) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$

123. The current I drawn from the 5 volt source will be [NCERT : P L-101 | 2006]



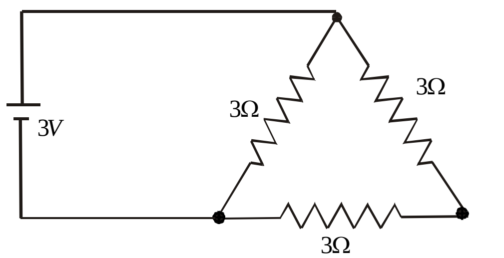
(a) 0.33 A (b) 0.5 A (c) 0.67 A (d) 0.17 A

124. The total current supplied to the circuit by the battery is [NCERT : P L-83 | 2004]



(a) 4 A
(b) 2 A
(c) 1 A
(d) 6 A

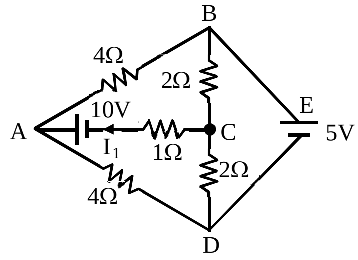
125. A 3 volt battery with negligible internal resistance is connected in a circuit as shown in the figure. The current I, in the circuit will be [NCERT : P L-83 | 2003]



(a) 1 A (b) 1.5 A (c) 2 A (d) 1/3 A

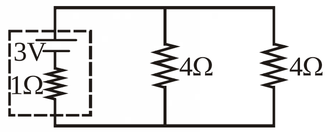
Topic 3 Kircchhoff 's Laws & Cells

126. The current flowing through the 1 Ω resistor is $\frac{n}{10}$ A. The value of n is ______.



[NCERT : P L-83 | April 9, 2024 (I)]

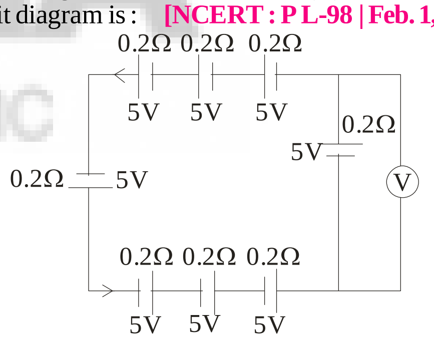
127. In the given circuit, the terminal potential difference of the cell is : [NCERT : P L-95 | April 8, 2024 (I)]



(a) 2V (b) 4V (c) 1.5V (d) 3V

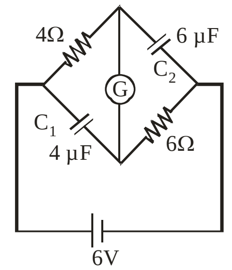
128. The electric field between the two parallel plates of a capacitor of 1.5 μF capacitance drops to one third of its initial value in 6.6 μs when the plates are connected by a thin wire. The resistance of this wire is .... Ω. (Given, log 3 = 1.1) [April 5, 2024 (I)]

129. The reading in the ideal voltmeter (V) shown in the given circuit diagram is : [NCERT : P L-98 | Feb. 1, 2024 (I)]



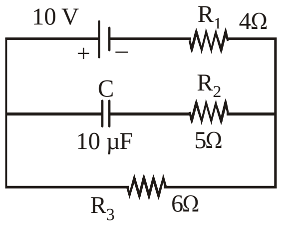
(a) 5V (b) 10V (c) 0V (d) 3V

130. A galvanometer (G) of 2Ω resistance is connected in the given circuit. The ratio of charge stored in C_1 and C_2 is: [NCERT : P L-100 | Feb. 1, 2024 (II)]

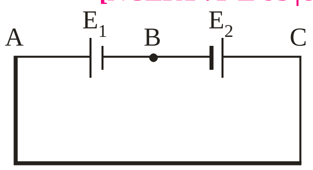


(a) 1
(b) $\frac{2}{3}$
(c) $\frac{3}{2}$
(d) $\frac{1}{2}$

131. In an electrical circuit drawn below the amount of charge stored in the capacitor is _________ μC. [NCERT : P L-97 | Feb. 1, 2024 (II)]

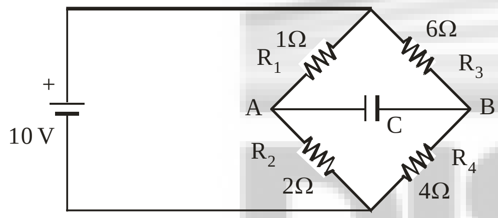


132. Two cells are connected in opposition as shown. Cell E_1 is of 8V emf and 2Ω internal resistance; the cell E_2 is of 2V emf and 4Ω internal resistance. The terminal potential difference of cell E_2 is ________ V.
[NCERT : P L-95 | Jan. 30, 2024 (I)]

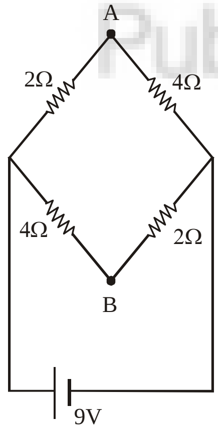


133. The charge accumulated on the capacitor connected in the following circuit is ____μC
[NCERT : P L-97 | Jan. 27, 2024 (I)]

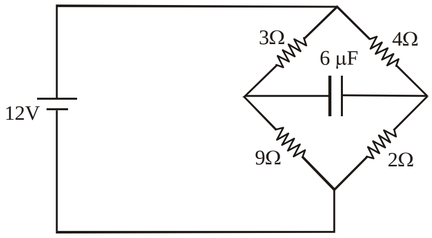
(Given C = 150 μF)



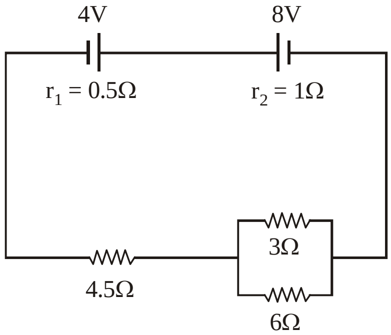
134. A network of four resistances is connected to 9 V battery, as shown in figure. The magnitude of voltage difference between the points A and B is ________ V.
[NCERT : P L-98 | April 15, 2023 (I)]



135. In the circuit shown, the energy stored in the capacitor is n μJ. The value of n is _______.
[NCERT : P L-98 | April 13, 2023 (II)]

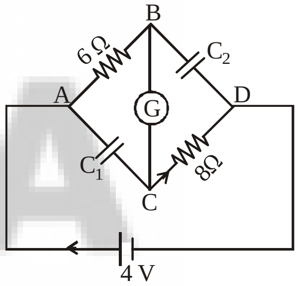


136. In the circuit diagram shown in figure given below, the current flowing through resistance 3 Ω is $\frac{x}{3}$ A. The value of x is _____. **[NCERT : P L-97 | April 11, 2023 (I)]**



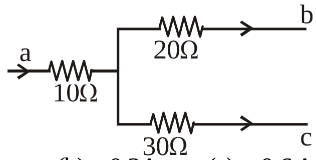
137. Two identical cells each of emf 1.5 V are connected in series across a 10 Ω resistance. An ideal voltmeter connected across 10 Ω resistance reads 1.5 V. The internal resistance of each cell is _______ Ω.
[NCERT : P L-95 | April 11, 2023 (II)]

138. In this figure the resistance of the coil of galvanometer G is 2 Ω. The emf of the cell is 4 V. The ratio of potential difference across C_1 and C_2 is: **[NCERT : P L-98 |]**



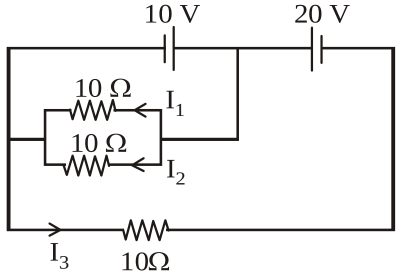
(a) 1 (b) $\frac{4}{5}$ (c) $\frac{3}{4}$ (d) $\frac{5}{4}$

139. Figure shows a part of an electric circuit. The potentials at points a, b and c are 30 V, 12 V and 2V respectively. The current through the 20Ω resistor will be.
[NCERT : P L-97 | April 6, 2023 (II)]



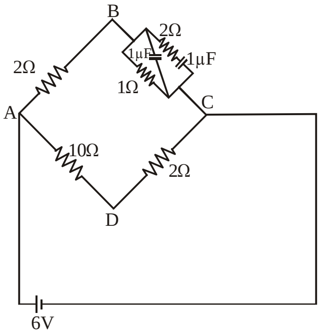
(a) 0.4 A (b) 0.2 A (c) 0.6 A (d) 1.0 A

140. In the given circuit, the value of $\left|\frac{I_1 + I_3}{I_2}\right|$ is _______
[NCERT : P L-98 | Feb. 1, 2023 (II)]

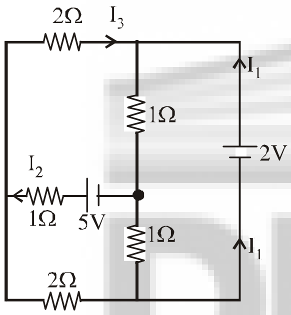


141. Two identical cells, when connected either in parallel or in series gives same current in an external resistance 5Ω. The internal resistance of each cell will be _______ Ω.
[NCERT : P L-95 | Jan. 31, 2023 (I)]

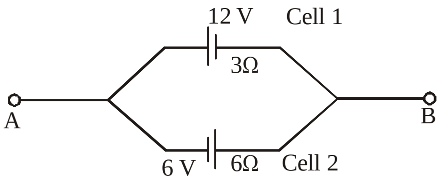
142. For the given circuit, in the steady state, $|V_B - V_D|$ = _______V. **[NCERT : P L-98 | Jan. 31, 2023 (II)]**



143. In the following circuit, the magnitude of current I_1, is _____A. **[NCERT : P L-97 | Jan. 30, 2023 (I)]**



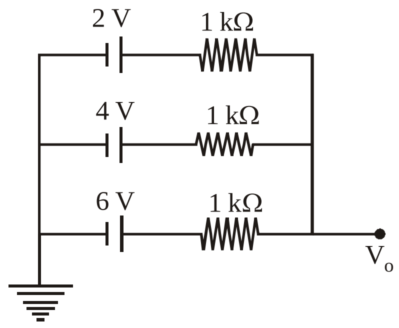
144. Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3Ω. Cell 2 has emf of 6V and internal resistance of 6Ω. An external resistor R of 4Ω is connected across A and B. The current flowing through R will be ______ A.
[NCERT : P L-96 | Jan. 25, 2023 (II)]



145. Two sources of equal emfs are connected in series. This combination is connected to an external resistance R. The internal resistances of the two sources are r_1 and r_2 ($r_1 > r_2$). If the potential difference across the source of internal resistance r_1 is zero then the value of R will be
[NCERT : P L-95 | July 27, 2022 (I)]

(a) $r_1 - r_2$
(b) $\frac{r_1 r_2}{r_1 + r_2}$
(c) $\frac{r_1 + r_2}{2}$
(d) $r_2 - r_1$

146. In the given figure, the value of V_0 will be _______ V.
[NCERT : P L-96 | July 25, 2022 (I)]



147. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2Ω. The value of internal resistance of each cell is :
[NCERT : P L-95 | June 29, 2022 (II)]

(a) 2Ω (b) 4Ω (c) 6Ω (d) 8Ω

148. Two cells of same emf but different internal resistances r_1 and r_2 are connected in series with a resistance R. The value of resistance R, for which the potential difference across second cell is zero, is
[NCERT : P L-95 | June 25, 2022 (II)]

(a) $r_2 - r_1$ (b) $r_1 - r_2$ (c) r_1 (d) r_2

149. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω. A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is
[NCERT : P L-96 | June 24, 2022 (I)]

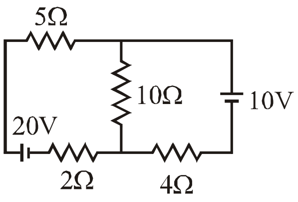
(a) 2.5Ω (b) 4Ω (c) 5Ω (d) 10Ω

150. Five identical cells each of internal resistance 1Ω and emf 5V are connected in series and in parallel with an external resistance 'R'. For what value of 'R', current in series and parallel combination will remain the same ?
[NCERT : P L-96 | Aug. 27, 2021 (I)]

(a) 1 Ω (b) 25 Ω (c) 5 Ω (d) 10 Ω

151. In an electric circuit, a cell of certain emf provides a potential difference of 1.25 V across a load resistance of 5 Ω. However, it provides a potential difference of 1 V across a load resistance of 2 Ω. The emf of the cell is given by $\frac{x}{10}$ V. Then the value of x is ________.
[NCERT : P L-95 | NA, July 22, 2021 (II)]

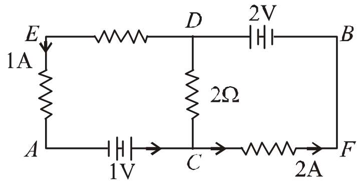
152.



In the figure shown, the current in the 10 V battery is close to : **[NCERT : P L-98 | Sep. 06, 2020 (II)]**

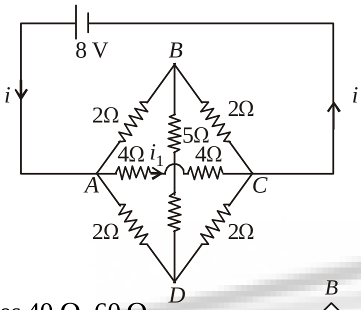
(a) 0.71 A from positive to negative terminal
(b) 0.42 A from positive to negative terminal
(c) 0.21 A from positive to negative terminal
(d) 0.36 A from negative to positive terminal

153. In the circuit, given in the figure currents in different branches and value of one resistor are shown. Then potential at point *B* with respect to the point *A* is :
[NCERT : P L-97 | Sep. 05, 2020 (II)]



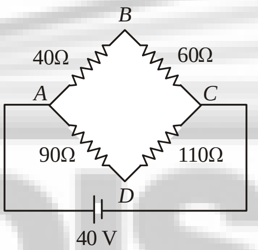
(a) +2 V
(b) –2 V
(c) –1 V
(d) +1 V

154. The value of current i_1 flowing from *A* to *C* in the circuit diagram is : **[NCERT : P L-97 | Sep. 04, 2020 (II)]**

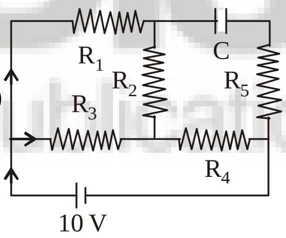


(a) 2 A
(b) 4 A
(c) 1 A
(d) 5 A

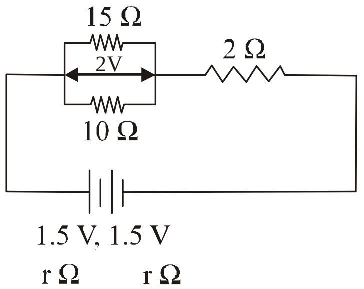
155. Four resistances 40 Ω, 60 Ω, 90 Ω and 110 Ω make the arms of a quadrilateral *ABCD*. Across *AC* is a battery of emf 40 V and internal resistance negligible. The potential difference across *BD* in V is ___________.
[NCERT : P L-97 | NA. Sep. 04, 2020 (II)]



156. An ideal cell of emf 10 V is connected in circuit shown in figure. Each resistance is 2 Ω. The potential difference (in V) across the capacitor when it is fully charged is ___________.
[NCERT : P L-97 | Sep. 02, 2020 (II)]

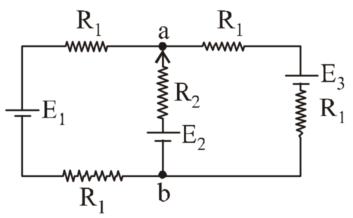


157. In the given circuit, an ideal voltmeter connected across the 10 Ω resistance reads 2V. The internal resistance r, of each cell is : **[NCERT : P L-97 | 10 Apr. 2019 I]**



(a) 1 Ω (b) 0.5 Ω (c) 1.5 Ω (d) 0 Ω

158. For the circuit shown, with $R_1 = 1.0\,\Omega$, $R_2 = 2.0\,\Omega$, $E_1 = 2$ V and $E_2 = E_3 = 4$ V, the potential difference between the points '*a*' and '*b*' is approximately (in V) :
[NCERT : P L-95 | 8 April 2019 I]

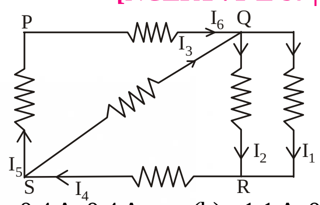


(a) 2.7 (b) 2.3 (c) 3.7 (d) 3.3

159. A cell of internal resistance *r* drives current through an external resistance R. The power delivered by the cell to the external resistance will be maximum when :
[NCERT : P L-95 | 8 Apr. 2019 II]

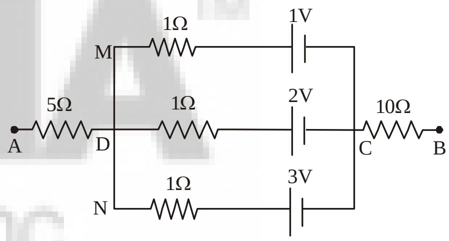
(a) $R = 0.001r$ (b) $R = 1000r$ (c) $R = 2r$ (d) $R = r$

160. In the given circuit diagram, the currents, $I_1 = -0.3$ A, $I_4 = 0.8$ A and $I_5 = 0.4$ A, are flowing as shown. The currents I_2, I_3 and I_6, respectively, are :
[NCERT : P L-97 | 12 Jan. 2019 II]



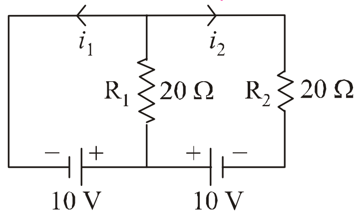
(a) 1.1 A, – 0.4 A, 0.4 A (b) 1.1 A, 0.4 A, 0.4 A
(c) 0.4 A, 1.1 A, 0.4 A (d) –0.4 A, 0.4 A, 1.1 A

161. In the circuit shown, the potential difference between A and B is : **[NCERT : P L-95 | 11 Jan. 2019 II]**



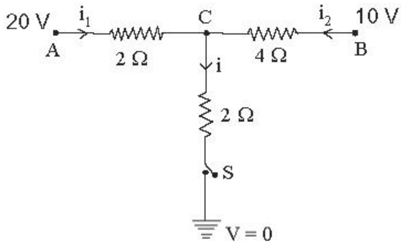
(a) 1V (b) 2V (c) 3V (d) 6V

162. In the given circuit the cells have zero internal resistance. The currents (in Amperes) passing through resistance R_1 and R_2 respectively, are:
[NCERT : P L-97 | 10 Jan. 2019 I]



(a) 1, 2
(b) 2, 2
(c) 0.5, 0
(d) 0, 1

163. When the switch S, in the circuit shown, is closed then the valued of current *i* will be:
[NCERT : P L-97 | 9 Jan. 2019 I]



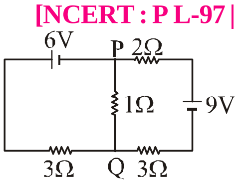
(a) 3A
(b) 5A
(c) 4A
(d) 2A

164. Two batteries with e.m.f. 12 V and 13 V are connected in parallel across a load resistor of 10Ω. The internal resistances of the two batteries are 1Ω and 2Ω respectively. The voltage across the load lies between:
[NCERT : P L-97 | 2018]

(a) 11.6 V and 11.7 V (b) 11.5 V and 11.6 V
(c) 11.4 V and 11.5 V (d) 11.7 V and 11.8 V

165. In the circuit shown, the current in the 1Ω resistor is:
[NCERT : P L-97 | 2015]

(a) 0.13 A, from Q to P
(b) 0.13 A, from P to Q
(c) 1.3A from P to Q
(d) 0A

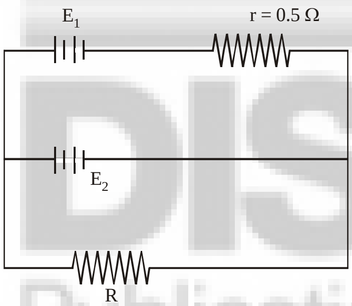


166. A d.c. main supply of e.m.f. 220 V is connected across a storage battery of e.m.f. 200 V through a resistance of 1Ω. The battery terminals are connected to an external resistance 'R'. The minimum value of 'R', so that a current passes through the battery to charge it is:
[NCERT : P L-97 | Online April 9, 2014]

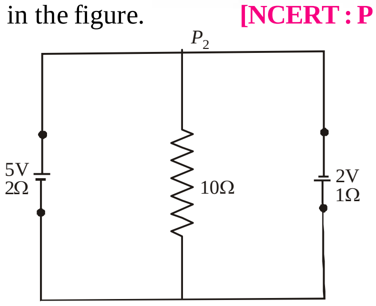
(a) 7 Ω (b) 9 Ω (c) 11 Ω (d) Zero

167. A dc source of emf $E_1 = 100$ V and internal resistance $r = 0.5$ Ω, a storage battery of emf $E_2 = 90$ V and an external resistance R are connected as shown in figure. For what value of R no current will pass through the battery?
[NCERT : P L-96 | Online April 22, 2013]

(a) 5.5 Ω
(b) 3.5 Ω
(c) 4.5 Ω
(d) 2.5 Ω



168. A 5V battery with internal resistance 2Ω and a 2V battery with internal resistance 1Ω are connected to a 10Ω resistor as shown in the figure. **[NCERT : P L-98 | 2008]**



The current in the 10Ω resistor is
(a) 0.27 A P_2 to P_1 (b) 0.03 A P_1 to P_2
(c) 0.03 A P_2 to P_1 (d) 0.27 A P_1 to P_2

169. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be **[2007]**

(a) 1/2 (b) 1 (c) 2 (d) 1/4

170. The Kirchhoff's first law ($\Sigma i = 0$) and second law ($\Sigma iR = \Sigma E$), where the symbols have their usual meanings, are respectively based on **[NCERT : P L-97 | 2006]**

(a) conservation of charge, conservation of momentum
(b) conservation of energy, conservation of charge
(c) conservation of momentum, conservation of charge
(d) conservation of charge, conservatrion of energy

171. Two sources of equal emf are connected to an external resistance R. The internal resistance of the two sources are R_1 and R_2 ($R_1 > R_1$). If the potential difference across the source having internal resistance R_2 is zero, then
[NCERT : P L-95 | 2005]

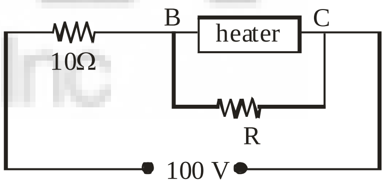
(a) $R = R_2 - R_1$
(b) $R = R_2 \times (R_1 + R_2)/(R_2 - R_1)$
(c) $R = R_1R_2/(R_2 - R_1)$ (d) $R = R_1R_2/(R_1 - R_2)$

Topic 4 Heating Effect of Current

172. Water boils in an electric kettle in 20 minutes after being switched on. Using the same main supply, the length of the heating element should be ………….. to …………. times of its initial length if the water is to be boiled in 15 minutes. **[NCERT : P L-92 | April 8, 2024 (II)]**

(a) increased, $\frac{3}{4}$ (b) increased, $\frac{4}{3}$
(c) decreased, $\frac{3}{4}$ (d) decreased, $\frac{4}{3}$

173. A heater is designed to operate with a power of 1000 W in a 100 V line. It is connected in combination with a resistance of 10 Ω and a resistance R, to a 100 V mains as shown in figure. For the heater to operate at 62.5 W, the value of R should be ………. Ω.
[NCERT : P L-93 | April 8, 2024 (II)]

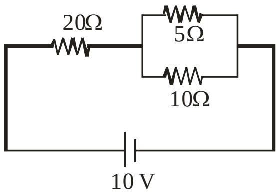


174. The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is :
(Given $e = 1.6 \times 10^{-19}$ C)
[NCERT : P L-92 | April 6, 2024 (II)]

(a) 31.25×10^{17} (b) 6.25×10^{18}
(c) 6.25×10^{17} (d) 1.25×10^{19}

175. The ratio of heat dissipated per second through the resistance 5 Ω and 10 Ω in the circuit given below is :
[NCERT : P L-92 | April 5, 2024 (II)]

(a) 1 : 2
(b) 2 : 1
(c) 4 : 1
(d) 1 : 1



176. An electric bulb rated 50 W – 200 V is connected across a 100 V supply. The power dissipation of the bulb is :
[NCERT : P L-92 | April 4, 2024 (II)]

(a) 12.5 W (b) 25 W (c) 50 W (d) 100 W

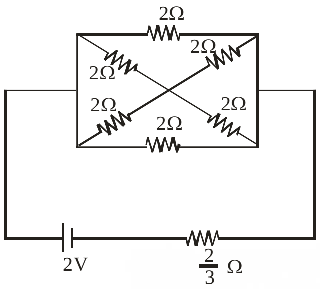
177. By what percentage will the illumination of the lamp decrease if the current drops by 20%?

[NCERT : P L-93 | Jan. 31, 2024 (II)]

(a) 46% (b) 26% (c) 36% (d) 56%

178. In the following circuit, the battery has an emf of 2 V and an internal resistance of $\frac{2}{3}\Omega$. The power consumption in the entire circuit is _______ W.

[NCERT : P L-93 | Jan. 31, 2024 (II)]



179. When a potential difference V is applied across a wire of resistance R, it dissipates energy at a rate W. If the wire is cut into two halves and these halves are connected mutually parallel across the same supply, the energy dissipation rate will become:

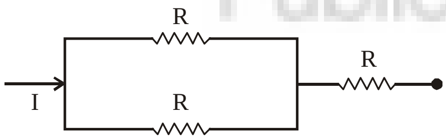
[NCERT : P L-93 | Jan. 30, 2024 (II)]

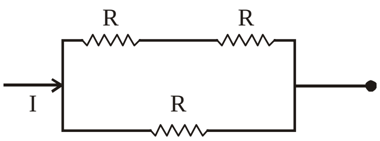
(a) $1/4W$ (b) $1/2W$ (c) $2W$ (d) $4W$

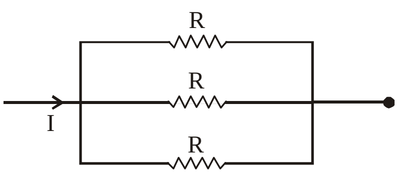
180. Different combination of 3 resistors of equal resistance R are shown in the figures.

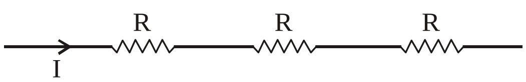
The increasing order for power dissipation is:

[NCERT : P L-93 | April 13, 2023 (I)]

(A)


(B)


(C)


(D)


(a) $P_A < P_B < P_C < P_D$ (b) $P_C < P_D < P_A < P_B$
(c) $P_B < P_C < P_D < P_A$ (d) $P_C < P_B < P_A < P_D$

181. A potential V_0 is applied across a uniform wire of resistance R. The power dissipation is P_1. The wire is then cut into two equal halves and a potential of V_0 is applied across the length of each half. The total power dissipation across two wires is P_2. The ratio $P_2 : P_1$ is $\sqrt{x} : 1$. The value of x is ________.

[NCERT : P L-93 | April 13, 2023 (I)]

182. Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be:

[NCERT : P L-92 | April 11, 2023 (I)]

(a) 4 : 1 (b) 2 : 1 (c) 1 : 2 (d) 1 : 4

183. The H amount of thermal energy is developed by a resistor in 10 s when a current of 4A is passed through it. If the current is increased to 16A, the thermal energy developed by the resistor in 10 s will be:

[NCERT : P L-92 | Jan. 31, 2023 (II)]

(a) H (b) 16 H (c) $\frac{H}{4}$ (d) 4 H

184. Ratio of thermal energy released in two resistor R and 3R connected in parallel in an electric circuit is :

[NCERT : P L-92 | Jan. 29, 2023 (I)]

(a) 3 : 1 (b) 1 : 1 (c) 1 : 3 (d) 1 : 27

185. Given below are two statements: One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Alloys such as constantan and manganin are used in making standard resistance coils.

Reason R: Constantan and manganin have very small value of temperature coefficient of resistance.

In the light of the above statements, choose the correct answer from the options given below.

[NCERT : P L-90 | July 29, 2022 (II)]

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

186. An electrical bulb rated 220 V, 100 W, is connected in series with another bulb rated 220 V, 60 W. If the voltage across combination is 220 V, the power consumed by the 100 W bulb will be about _______ W.

[NCERT : P L-93 | July 28, 2022 (II)]

187. Given below are two statements :

Statement I : A unifrom wire of resistance 80 Ω is cut into four equal parts. These parts are now connected in parallel. The equivalent resistance of the combination will be 5 Ω.

Statement II : Two resistances 2R and 3R are connected in parallel in a electric circuit. The value of thermal energy developed in 3R and 2R will be in the ratio 3 : 2.

In the light of the above statments, choose the most appropriate answer from the option given below

[NCERT : P L-93 | July 28, 2022 (II)]

(a) Both statement I and statement II are correct
(b) Both statement I and statement II are incorrect
(c) Statement I is correct but statement II is incorrect
(d) Statement I is incorrect but statement II is correct

188. Two coils require 20 minutes and 60 minutes respectively to produce same amount of heat energy when connected separately to the same source. If they are connected in parallel arrangement to the same source; the time required to produce same amount of heat by the combination of coils, will be__________min.

[NCERT : P L-92 | June 29, 2022 (I)]

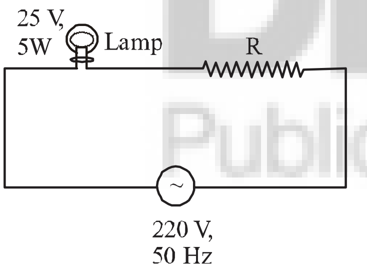
189. Water fall from a 40 m high dam at the rate of 9×10^4 kg per hour. Fifty percentage of gravitational potential energy can be converted into electrical energy. Using this hydroelectric energy number of 100W lamps, that can be lit, is: (Take g = 10 ms^{-2})

[NCERT : P L-92 | June 28, 2022 (II)]

(a) 25 (b) 50 (c) 100 (d) 18

190. A 220 V, 50 Hz AC source is connected to a 25 V, 5 W lamp and an additional resistance R in series (as shown in figure) to run the lamp at its peak brightness, then the value of R (in ohm) will be _______ .

[NCERT : P L-93 | June 27, 2022 (I)]



191. A uniform heating wire of resistance 36 W is connected across a potential difference of 240 V. The wire is then cut into half and potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be 1 : x, where x is ______.

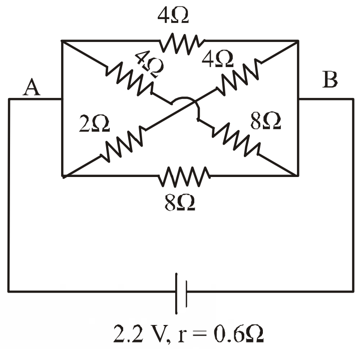
[NCERT : P L-93 | NA, Sep. 1, 2021 (II)]

192. Due to cold weather a 1 m water pipe of cross–sectional area 1 cm^2 is filled with ice at –10°C. Resistive heating is used to melt the ice. Current of 0.5 A is passed through 4 kΩ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required?
(Given latent heat of fusion for water/ice = 3.33×10^5 J kg^{-1}, specific heat of ice = 2×10^3 J kg^{-1} and density of ice = 10^3 kg / m^3 **[NCERT : P L-92 | Sep. 1, 2021 (II)]**

(a) 0.353 s (b) 35.3 s (c) 3.53 s (d) 70.6 s

193. A resistor dissipates 192 J of energy in 1 s when a current of 4A is passed through it. Now, when the current is doubled, the amount of thermal energy dissipated in 5 s in ______J. **[NCERT : P L-93 | NA, Aug. 31, 2021 (II)]**

194. In the given figure, the emf of the cell is 2.2 V and if internal resistance is 0.6Ω. Calculate the power dissipated in the whole circuit : **[NCERT : P L-93 | Aug. 26, 2021 (I)]**



(a) 1.32 W (b) 0.65 W (c) 2.2 W (d) 4.4 W

195. An electric appliance supplies 6000 J/min heat to the system. If the system delivers a power of 90W. How long it would take to increase the internal energy by 2.5×10^3 J?

[NCERT : P L-92 | Aug. 26, 2021 (I)]

(a) 2.5×10^2 s (b) 4.1×10^1s
(c) 2.4×10^3s (d) 2.5×10^1s

196. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.

[NCERT : P L-92 | Aug. 26, 2021 (II)]

(a) 20 Ω (b) 30 Ω
(c) 5 Ω (d) 10 Ω

197. The energy dissipated by a resistor is 10 mJ in 1 s when an electric current of 2 mA flows through it. The resistance is ______Ω. (Round off to the Nearest Integer).

[NCERT : P L-93 | March 16, 2021 (II)]

198. An electrical power line, having a total resistance of 2 Ω, delivers 1 kW at 220 V. The efficiency of the transmission line is approximately: **[Sep. 05, 2020 (I)]**

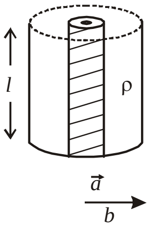
(a) 72% (b) 91%
(c) 85% (d) 96%

199. Model a torch battery of length l to be made up of a thin cylindrical bar of radius '*a*' and a concentric thin cylindrical shell of radius '*b*' filled in between with an electrolyte of resistivity ρ (see figure). If the battery is connected to a resistance of value *R*, the maximum Joule heating in *R* will take place for :

[NCERT : P L-92 | Sep. 03, 2020 (I)]

(a) $R = \frac{\rho}{2\pi l}\left(\frac{b}{a}\right)$

(b) $R = \frac{\rho}{2\pi l}\ln\left(\frac{b}{a}\right)$



(c) $R = \frac{\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(d) $R = \frac{2\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

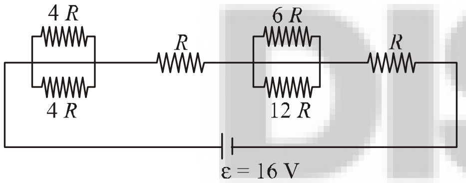
200. In a building there are 15 bulbs of 45 W, 15 bulbs of 100 W, 15 small fans of 10 W and 2 heaters of 1 kW. The voltage of electric main is 220 V. The minimum fuse capacity (rated value) of the building will be:

[NCERT : P L-92 | 7 Jan. 2020 II]

(a) 10 A (b) 25 A (c) 15 A (d) 20 A

201. The resistive network shown below is connected to a D.C. source of 16 V. The power consumed by the network is 4 Watt. The value of R is :

[NCERT : P L-93 | 12 Apr. 2019 I]



(a) 6Ω (b) 8Ω (c) 1Ω (d) 16Ω

202. One kg of water, at 20°C, is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20 Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully, is close to :

[Specific heat of water = 4200 J/(kg°C), Latent heat of water = 2260 kJ/kg] **[NCERT : P L-93 | 12 Apr. 2019 II]**

(a) 16 minutes (b) 22 minutes
(c) 3 minutes (d) 3 minutes

203. Two electric bulbs, rated at (25 W, 220 V) and (100 W, 220 V), are connected in series across a 220 V voltage source. If the 25 W and 100 W bulbs draw powers P_1 and P_2 respectively, then: **[NCERT : P L-93 | 12 Jan. 2019 I]**

(a) P_1=16 W, P_2=4 W (b) P_1=16 W, P_2=9 W
(c) P_1=9 W, P_2=16 W (d) P_1=4 W, P_2=16 W

204. Two equal resistances when connected in series to a battery, consume electric power of 60 W. If these resistance are now connected in parallel combination to the same battery, the electric power consumed will be :

[NCERT : P L-93 | 11 Jan. 2019 I]

(a) 60 W (b) 240 W (c) 120 W (d) 30 W

205. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11 V is connected across it is:

[NCERT : P L-93 | 10 Jan. 2019 II]

(a) 11×10^{-5} W (b) 11×10^{-3} W
(c) 11×10^{-4} W (d) 11×10^{5} W

206. A constant voltage is applied between two ends of a metallic wire. If the length is halved and the radius of the wire is doubled, the rate of heat developed in the wire will be:

[NCERT : P L-93 | Online April 15, 2018]

(a) Increased 8 times (b) Doubled
(c) Halved (d) Unchanged

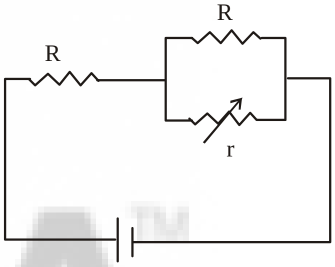
207. In the circuit shown, the resistance r is a variable resistance. If for r = fR, the heat generation in r is maximum then the value of f is : **[NCERT : P L-93 | Online April 9, 2016]**

(a) $\frac{1}{2}$

(b) 1

(c) $\frac{1}{4}$

(d) $\frac{3}{4}$

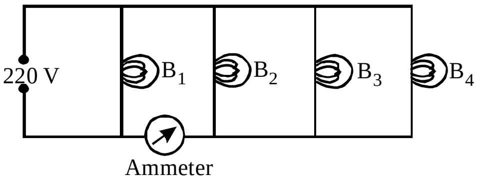


208. In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of electric mains is 220 V. The minimum capacity of the main fuse of the building will be: **[NCERT : P L-93 | 2014]**

(a) 8 A (b) 10 A
(c) 12 A (d) 14 A

209. Four bulbs B_1, B_2, B_3 and B_4 of 100 W each are connected to 220 V main as shown in the figure.

[NCERT : P L-93 | Online April 19, 2014]



The reading in an ideal ammeter will be:

(a) 0.45 A (b) 0.90 A
(c) 1.35 A (d) 1.80 A

210. The supply voltage to room is 120V. The resistance of the lead wires is 6Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb?

[NCERT : P L-93 | 2013]

(a) zero (b) 2.9 Volt
(c) 13.3 Volt (d) 10.04 Volt

211. Two electric bulbs rated 25W – 220 V and 100W – 220V are connected in series to a 440 V supply. Which of the bulbs will fuse? **[NCERT : P L-93 | 2012]**

(a) Both (b) 100 W (c) 25 W (d) Neither

212. Three resistors of 4 Ω, 6 Ω and 12 Ω are connected in parallel and the combination is connected in series with a 1.5 V battery of 1 Ω internal resistance. The rate of Joule heating in the 4 Ω resistor is **[NCERT : P L-93 | Online May 12, 2012]**

(a) 0.55 W (b) 0.33 W (c) 0.25 W (d) 0.86 W

213. The resistance of a bulb filmanet is 100Ω at a temperature of 100°C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of **[NCERT : P L-91 | 2006]**

(a) 300°C (b) 400°C (c) 500°C (d) 200°C

214. An electric bulb is rated 220 volt - 100 watt. The power consumed by it when operated on 110 volt will be **[NCERT : P L-93 | 2006]**

(a) 75 watt (b) 40 watt
(c) 25 watt (d) 50 watt

215. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be **[NCERT : P L-92 | 2005]**

(a) four times (b) doubled
(c) halved (d) one fourth

216. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use ? **[NCERT : P L-93 | 2005]**

(a) 20Ω (b) 40Ω (c) 200Ω (d) 400Ω

217. The thermistors are usually made of **[NCERT : P L-90 | 2004]**

(a) metal oxides with high temperature coefficient of resistivity
(b) metals with high temperature coefficient of resistivity
(c) metals with low temperature coefficient of resistivity
(d) semiconducting materials having low temperature coefficient of resistivity

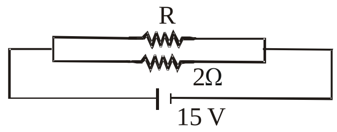
218. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is **[NCERT : P L-92 | 2004]**

(a) 150 s (b) 100 s (c) 50 s (d) 200 s

219. A wire when connected to 220 V mains supply has power dissipation P_1. Now the wire is cut into two equal pieces which are connected in parallel to the same supply. Power dissipation in this case is P_2. Then $P_2 : P_1$ is **[NCERT : P L-93 | 2002]**

(a) 1 (b) 4 (c) 2 (d) 3

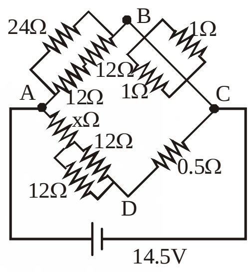
220. If in the circuit, power dissipation is 150 W, then R is **[NCERT : P L-93 | 2002]**



(a) 2Ω (b) 6Ω (c) 5Ω (d) 4Ω

Topic 5 Wheatstone Bridge and Different Measuring Instruments

221. The value of unknown resistance (x) for which the potential difference between B and D will be zero in the arrangement shown, is : **[NCERT : P L-101 | April 6, 2024 (I)]**

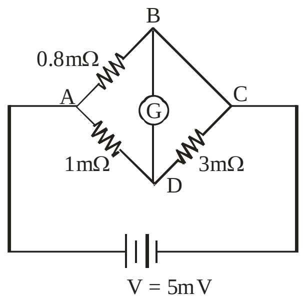


(a) 3 Ω (b) 9 Ω (c) 6 Ω (d) 42 Ω

222. In a metre - bridge when a resistance in the left gap is 2Ω and unknown resistance in the right gap, the balance length is found to be 40 cm. On shunting the unknown resistance with 2Ω, the balance length changes by: **[Feb. 1, 2024 (II)]**

(a) 62.5 cm (b) 22.5 cm (c) 20 cm (d) 65 cm

223. To measure the temperature coefficient of resistivity α of a semiconductor, an electrical arrangement shown in the figure is prepared. The arm BC is made up of the semiconductor. The experiment is being conducted at 25°C and resistance of the semiconductor arm is 3mΩ. Arm BC is cooled at a constant rate of 2°C/s. If the galvanometer G shows no deflection after 10 s, then α is: **[NCERT : P L-101 | Feb. 1, 2024 (II)]**



(a) $-1 \times 10^{-2}\,°C^{-1}$

(b) $-2 \times 10^{-2}\,°C^{-1}$

(c) $-2.5 \times 10^{-2}\,°C^{-1}$

(d) $-1.5 \times 10^{-2}\,°C^{-1}$

224. The resistance per centimeter of a meter bridge wire is r, with XΩ resistance in left gap. Balancing length from left end is at 40 cm with 25 Ω resistance in right gap. Now the wire is replaced by another wire of 2r resistance per centimeter. The new balancing length for same settings will be at **[Jan. 31, 2024 (II)]**

(a) 20 cm (b) 10 cm
(c) 80 cm (d) 40 cm

225. Two resistance of 100 Ω and 200 Ω are connected in series with a battery of 4*V* and negligible internal resistance. A voltmeter is used to measure voltage across 100Ω resistance, which gives reading as 1 *V*. The resistance of voltmeter must be _________ Ω.
[NCERT : P L-97 | Jan. 30, 2024 (II)]

226. A wire of length 10 cm and radius $\sqrt{7} \times 10^{-4}$m connected across the right gap of a meter bridge. When a resistance of 4.5 Ω is connected on the left gap by using a resistance box, the balance length is found to be at 60 cm from the left end. If the resistivity of the wire is R × 10^{-7}Ωm, then value of R is : **[NCERT : P L-101 | Jan. 27, 2024 (I)]**

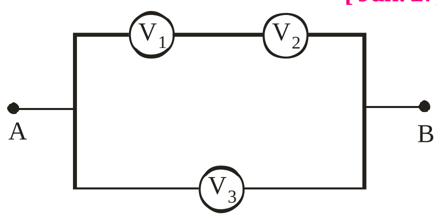
(a) 63 (b) 70 (c) 66 (d) 35

227. Wheatstone bridge principle is used to measure the specific resistance (S_1) of given wire, having length L, radius r. If X is the resistance of wire, then specific resistance is :

$S_1 = X\left(\frac{\pi r^2}{L}\right)$. If the length of the wire gets doubled then the value of specific resistance will be :
[NCERT : P L-84 | Jan. 27, 2024 (II)]

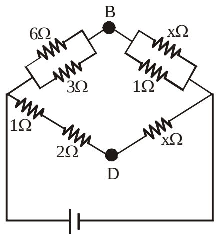
(a) $\frac{S_1}{4}$ (b) $2S_1$
(c) $\frac{S_1}{2}$ (d) S_1

228. Three voltmeters, all having different internal resistances are joined as shown in figure. When some potential difference is applied across A and B, their readings are V_1, V_2 and V_3. Choose the correct option.
[Jan. 27, 2024 (II)]



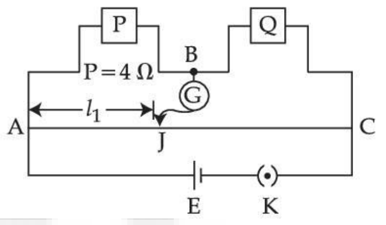
(a) $V_1 = V_2$ (b) $V_1 \neq V_3 - V_2$
(c) $V_1 + V_2 > V_3$ (d) $V_1 + V_2 = V_3$

229. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}$Ω. The value of n is ....
[NCERT : P L-101 | Jan. 30, 2023 (II)]

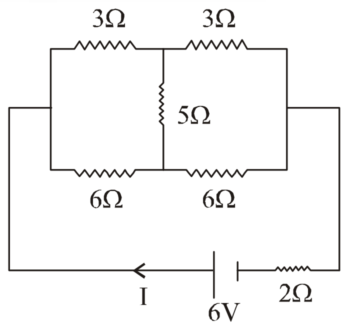


230. When two resistance R_1 and R_2 connected in series and introduced into the left gap of a meter bridge and a resistance of 10 Ω is introduced into the right gap, a null point is found at 60 cm from left side. When R_1 and R_2 are connected in parallel and introduced into the left gap, a resistance of 3 Ω is introduced into the right-gap to get null point at 40 cm from left end. The product of R_1 R_2 is _____Ω^2
[Jan. 29, 2023 (II)]

231. Resistances are connected in a meter bridge circuit as shown in the figure. The balancing length l_1 is 40 cm. Now an unknown resistance x is connected in series with P and new balancing length is found to be 80 cm measured from the same end. Then the value of x will be ______ Ω.
[July 26, 2022 (I)]

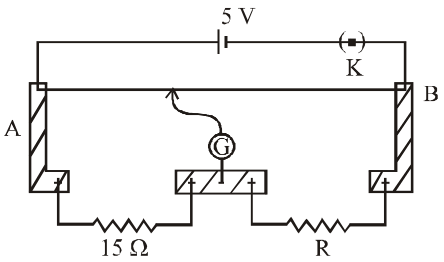


232. A battery of 6 V is connected to the circuit as shown below. The current I drawn from the battery is :
[NCERT : P L-101 | July 26, 2022 (II)]



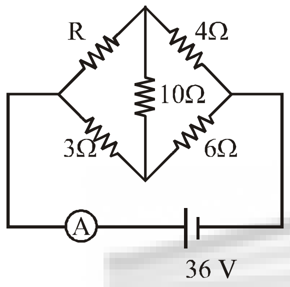
(a) 1A (b) 2A
(c) $\frac{6}{11}$A (d) $\frac{4}{3}$A

233. A meter bridge setup is shown in the figure. It is used to determine an unknown resistance R using a given resistor of 15 Ω. The galvanometer (G) shows null deflection when tapping key is at 43 cm mark from end A. If the end correction for end A is 2 cm then the determined value of R will be _______ Ω.
[NCERT : P L-101 | June 28, 2022 (I)]

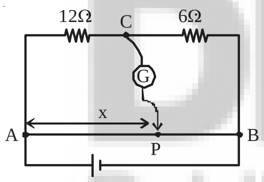


234. Current measured by the ammeter (A) in the reported circuit when no current flows through 10 Ω resistance will be __________ A.

[NCERT : P L-101 | June 28, 2022 (I)]



235. Consider a 72 cm long wire AB as shown in the figure. The galvanometer jockey is placed at P on AB at a distance x cm from A. The galvanometer shows zero deflection.



The value of x, to the nearest integer, is ________.

[NCERT : P L-101 | March 18, 2021 (II)]

236. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10 V is maintained across AC.

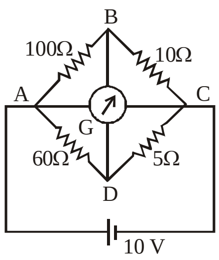
[NCERT : P L-101 | March 17, 2021 (II)]

(a) 2.44 μA

(b) 4.87 μA

(c) 2.44 mA

(d) 4.87 mA



237. Two resistors 400Ω and 800Ω are connected in series across a 6 V battery. The potential difference measured by a voltmeter of 10 kΩ across 400Ω resistor is close to:

[NCERT : P L-83 | Sep. 03, 2020 (II)]

(a) 2V (b) 1.8V

(c) 2.05V (d) 1.95V

238. Four resistances of 15 Ω, 12 Ω, 4 Ω and 10 Ω respectively in cyclic order to form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10 Ω to balance the network is _____ Ω.

[NCERT : P L-101 | NA. 8 Jan. 2020 I]

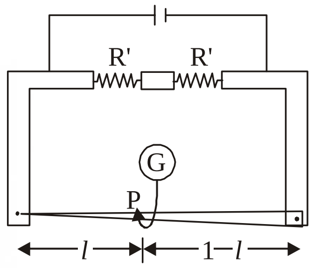
239. In a meter bridge, the wire of length 1 m has a non-uniform cross-section such that, the variation $\frac{dR}{dl}$ of its resistance R with length l is $\frac{dR}{dl} \propto \frac{1}{\sqrt{l}}$. Two equal resistances are connected as shown in the figure. The galvanometer has zero deflection when the jockey is at point P. What is the length AP? **[12 Jan. 2019 I]**

(a) 0.2 m

(b) 0.3 m

(c) 0.25 m

(d) 0.35 m



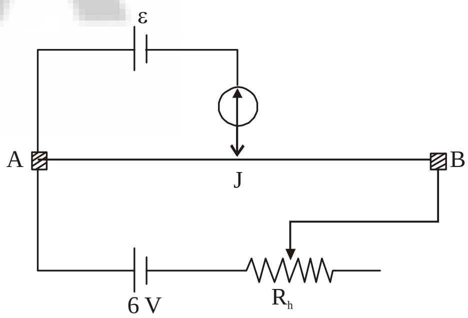
240. The resistance of the meter bridge AB in given figure is 4Ω. With a cell of emf ε = 0.5 V and rheostat resistance $R_h = 2Ω$ the null point is obtained at some point J. When the cell is replaced by another one of emf $ε = ε_2$ the same null point J is found for $R_h = 6Ω$. The emf $ε_2$ is: **[11 Jan. 2019 I]**

(a) 0.4 V

(b) 0.3 V

(c) 0.6 V

(d) 0.5 V



241. In a Wheatstone bridge (see fig.), Resistances P and Q are approximately equal. When R = 400 Ω, the bridge is balanced. On interchanging P and Q, the value of R, for balance, is 405Ω. The value of X is close to :

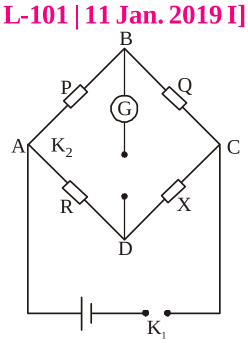
[NCERT : P L-101 | 11 Jan. 2019 I]

(a) 401.5 ohm

(b) 404.5 ohm

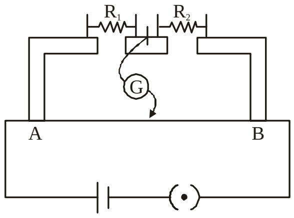
(c) 403.5 ohm

(d) 402.5 ohm



242. In the experimental set up of metre bridge shown in the figure, the null point is obtaine data distance of 40 cm from A. If a 10 Ω resistor is connected in series with R_1, the null point shifts by 10 cm. The resistance that should be connected in parallel with $(R_1 + 10)$ Ω such that the null point shifts back to its initial position is : **[11 Jan. 2019 II]**

(a) 20 Ω
(b) 40 Ω
(c) 60 Ω
(d) 30 Ω



243. On interchanging the resistances, the balance point of a meter bridge shifts to the left by 10 cm. The resistance of their series combination is 1kΩ. How much was the resistance on the left slot before interchanging the resistances? **[2018]**

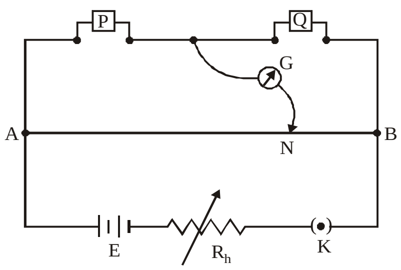
(a) 990 Ω (b) 505 Ω
(c) 550 Ω (d) 910 Ω

244. Which of the following statements is false ? **[NCERT : P L-101 | 2017]**

(a) A rheostat can be used as a potential divider
(b) Kirchhoff's second law represents energy conservation
(c) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude
(d) In a balanced wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.

245. In a meter bridge experiment resistances are connected as shown in the figure. Initially resistance P = 4 Ω and the neutral point N is at 60 cm from A. Now an unknown resistance R is connected in series to P and the new position of the neutral point is at 80 cm from A. The value of unknown resistance R is : **[Online April 9, 2017]**

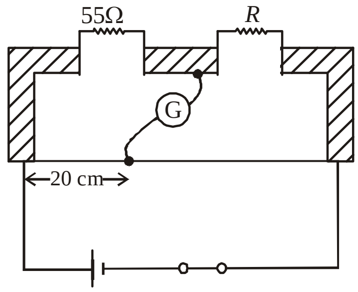
(a) $\frac{33}{5}$ Ω
(b) 6 Ω
(c) 7 Ω
(d) $\frac{20}{3}$ Ω



246. Shown in the figure below is a meter-bridge set up with null deflection in the galvanometer. **[2008]**

The value of the unknown resistor R is

(a) 13.75 Ω
(b) 220 Ω
(c) 110 Ω
(d) 55 Ω



247. In a Wheatstone's bridge, three resistances P, Q and R connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for the bridge to be balanced will be **[NCERT : P L-101 | 2006]**

(a) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$ (b) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1 S_2}$

(c) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1 S_2}$ (d) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$

248. In a meter bridge experiment null point is obtained at 20 cm. from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4 X against Y **[2004]**

(a) 40 cm (b) 80 cm
(c) 50 cm (d) 70 cm

249. An ammeter reads upto 1 ampere. Its internal resistance is 0.81ohm. To increase the range to 10 A the value of the required shunt is **[2003]**

(a) 0.03 Ω (b) 0.3 Ω
(c) 0.9 Ω (d) 0.09 Ω

ANSWER KEYS

1	(1027)	**26**	(b)	**51**	(a)	**76**	(b)	**101**	(9)	**126**	(25)	**151**	(15)	**176**	(a)	**201**	(b)	**226**	(c)
2	(748)	**27**	(144)	**52**	(b)	**77**	(100)	**102**	(b)	**127**	(a)	**152**	(c)	**177**	(c)	**202**	(b)	**227**	(d)
3	(16)	**28**	(a)	**53**	(c)	**78**	(a)	**103**	(d)	**128**	(4)	**153**	(d)	**178**	(3)	**203**	(a)	**228**	(d)
4	(b)	**29**	(48)	**54**	(c)	**79**	(20)	**104**	(10)	**129**	(c)	**154**	(c)	**179**	(d)	**204**	(b)	**229**	(2)
5	(32)	**30**	(12)	**55**	(a)	**80**	(c)	**105**	(70)	**130**	(d)	**155**	(2)	**180**	(d)	**205**	(a)	**230**	(30)
6	(22)	**31**	(c)	**56**	(a)	**81**	(c)	**106**	(4)	**131**	(60)	**156**	(8)	**181**	(16)	**206**	(a)	**231**	(20)
7	(c)	**32**	(300)	**57**	(c)	**82**	(a)	**107**	(3)	**132**	(6)	**157**	(b)	**182**	(a)	**207**	(c)	**232**	(a)
8	(d)	**33**	(a)	**58**	(d)	**83**	(10)	**108**	(c)	**133**	(400)	**158**	(d)	**183**	(b)	**208**	(c)	**233**	(19)
9	(b)	**34**	(1)	**59**	(d)	**84**	(d)	**109**	(b)	**134**	(3)	**159**	(d)	**184**	(a)	**209**	(c)	**234**	(10)
10	(a)	**35**	(d)	**60**	(b)	**85**	(a)	**110**	(30)	**135**	(75)	**160**	(b)	**185**	(a)	**210**	(d)	**235**	(48)
11	(15)	**36**	(4)	**61**	(d)	**86**	(2)	**111**	(c)	**136**	(1)	**161**	(b)	**186**	(14)	**211**	(c)	**236**	(d)
12	(b)	**37**	(c)	**62**	(b)	**87**	(b)	**112**	(b)	**137**	(5)	**162**	(c)	**187**	(c)	**212**	(c)	**237**	(d)
13	(3)	**38**	(d)	**63**	(160)	**88**	(a)	**113**	(c)	**138**	(b)	**163**	(b)	**188**	(15)	**213**	(b)	**238**	(10)
14	(25)	**39**	(b)	**64**	(d)	**89**	(4)	**114**	(c)	**139**	(a)	**164**	(b)	**189**	(b)	**214**	(c)	**239**	(c)
15	(125).	**40**	(5)	**65**	(5)	**90**	(d)	**115**	(a)	**140**	(2)	**165**	(a)	**190**	(975)	**215**	(b)	**240**	(b)
16	(25)	**41**	(300)	**66**	(1)	**91**	(b)	**116**	(b)	**141**	(5)	**166**	(c)	**191**	(4)	**216**	(b)	**241**	(d)
17	(b)	**42**	(b)	**67**	(b)	**92**	(10)	**117**	(a)	**142**	(1)	**167**	(c)	**192**	(b)	**217**	(a)	**242**	(c)
18	(a)	**43**	(b)	**68**	(c)	**93**	(8)	**118**	(a)	**143**	(1.5)	**168**	(c)	**193**	(3840)	**218**	(a)	**243**	(c)
19	(d)	**44**	(d)	**69**	(81)	**94**	(8)	**119**	(a)	**144**	(1)	**169**	(a)	**194**	(c)	**219**	(b)	**244**	(d)
20	(b)	**45**	(b)	**70**	(b)	**95**	(3)	**120**	(b)	**145**	(a)	**170**	(d)	**195**	(a)	**220**	(b)	**245**	(d)
21	(c)	**46**	(a)	**71**	(36)	**96**	(c)	**121**	(b)	**146**	(4)	**171**	(a)	**196**	(a)	**221**	(c)	**246**	(b)
22	(2)	**47**	(c)	**72**	(30)	**97**	(b)	**122**	(d)	**147**	(a)	**172**	(c)	**197**	(2500	**222**	(a)	**247**	(b)
23	(44)	**48**	(a)	**73**	(a)	**98**	(3)	**123**	(b)	**148**	(a)	**173**	(5)	**198**	(d)	**223**	(a)	**248**	(c)
24	(b)	**49**	(a)	**74**	(a)	**99**	(d)	**124**	(a)	**149**	(c)	**174**	(a)	**199**	(b)	**224**	(d)	**249**	(d)
25	(a)	**50**	(c)	**75**	(d)	**100**	(20)	**125**	(b)	**150**	(a)	**175**	(b)	**200**	(d)	**225**	(200)		

Chapter 3

Current Electricity

1. **(1027)** Given, Resistance of room temperature, $R_0 = 50\Omega$
Temperature coefficient of material, $\propto\ = 2.4\times10^{-4}\ °C^{-1}$
$R = R_0(1 + \alpha\Delta T)$
$\Rightarrow 62 = 50\,[1 + 2.4\times10^{-4}\,\Delta T]$
$\Rightarrow 0.24 = 2.4\times10^{-4}\,\Delta T \Rightarrow \Delta T = 1000°C$
$\Rightarrow T - 27° = 1000°C$
$\Rightarrow T = 1027°C$

2. **(748)** We know that
Resistance $R = R_0(1 + \alpha\Delta T)$

$$\Rightarrow \frac{\Delta R}{R_0} = \alpha\Delta T$$

Taking temperatures 0°C and 100°C at a time

$$\frac{R - R_0}{R_0} = \alpha\Delta T$$

$$\frac{10.2 - 10}{10} = \alpha(100 - 0) \qquad ...(i)$$

$$\alpha = \frac{0.2}{1000}$$

Taking temperatures 0°C and t°C we get

$$\Rightarrow \frac{10.95 - 10}{10} = \alpha(t - 0)$$

$$\frac{0.95}{10} = \frac{0.2}{1000}\times t \qquad [\text{using (i)}]$$

$$\therefore \frac{t}{100} = \frac{0.95}{0.2} = 475°C$$

$\Rightarrow t = 475 + 273 = 748\ K$

3. **(16)** Resistance $R = \dfrac{\rho l}{A} \Rightarrow R = \dfrac{\rho l}{\pi r^2} \Rightarrow R \propto \dfrac{l}{r^2}$

Volume of wire remains constant,
$V_i = V_f$

$$\pi r^2 l = \pi\frac{r^2}{4}l'$$

$l' = 4l$

$$\frac{R'}{R} = \left(\frac{4l}{\frac{r^2}{4}}\right)\frac{r^2}{l} = 16 \Rightarrow R' = 16R$$

Hence, x = 16

4. **(b)** Using $R_t = R_0\,(1 + \alpha\Delta t)$
Given $R_0 = 8\Omega$, $R_{100} = 10\Omega$
$\therefore R_{100} = R_0\,(1 + \alpha\Delta T)$
Also, $R_{400} = R_0\,(1 + \alpha\Delta T^1)$

$$\therefore 10 = 8\,(1 + \alpha\times100) \Rightarrow 100\alpha = \frac{1}{4}$$

$$\therefore R_{400} = 8\,(1 + 400\alpha) = 8\,(1+1) = 16\Omega$$

5. **(32)** Resistance

$$R = \frac{\rho\ell}{A} = \frac{\rho V}{A^2}\text{ or, } R \propto \frac{1}{(r^2)^2}$$

$$\therefore \frac{R_A}{R_B} = \frac{r_B^4}{r_A^4} \Rightarrow \frac{R_A}{2} = \left[\frac{4\times10^{-3}}{2\times10^{-3}}\right]^4$$

$$\therefore R_A = 32\ \Omega$$

6. **(22)** Current, $i = \dfrac{dq}{dt}$

$$\therefore\ q = \int_1^2 i\,dt = \int_1^2 \left(3t^2 + 4t^3\right)\cdot dt = \left|t^3 + t^4\right|_1^2$$

$= 2^3 - 1 + 2^4 - 1 = 22\ C$

7. **(c)** Resistance, $R_0 = 60\Omega$, $R_T = \dfrac{220}{2.75} = 80\Omega$

$R_T = R_0(1 + \alpha\Delta T)$
$80 = 60[1 + 2\times10^{-4}(T - 27)]$
$T \approx 1694°C$

8. **(d)** Charge, $q = \displaystyle\int_{t_1}^{t_2} I.dt = \int_0^{20}(20 + 3t)\,dt$

$$= 20t + \left.\frac{3t^2}{2}\right|_0^{20} = 1000\,C$$

9. **(b)** Equivalent resistance
$R_{eq} = R_1 + R_2 + R_3$
Resistivity depends on temperature.
The resistivity of the material is given by
$\rho_{T} = \rho_0\,(1 + \lambda\,\Delta T)$

10. **(a)** Let
Initial length = l_1
Final length = l_2
Initial area = A_1
Final area = A_2
$\therefore$ Volume remains same

$$\therefore A_1 l_1 = A_2 l_2 \Rightarrow A_1 l_1 = A_2\frac{l_1}{4}$$

$\Rightarrow 4A_1 = A_2$

Initial resistance, $R_1 = \dfrac{\rho l_1}{A_1} = 160\Omega$ (given)

Final resistance, $R_2 = \dfrac{\rho l_2}{A_2}$

$$\therefore \frac{R_2}{R_1} = \frac{l_2 A_1}{A_2 l_1} = \frac{l_1}{4}\frac{A_1}{4A_1 l_1}$$

$$\Rightarrow R_2 = \frac{1}{16}R_1 = \frac{1}{16}\times160 = 10\Omega$$

11. **(15)** For same supply voltage

$i_0 R_0 = i_{100} R_{100}$

$\Rightarrow 2 R_0 = 1.2 R_0 [1 + 100\alpha]$ ... (i)

$$\Rightarrow 1 + 100\alpha = \frac{5}{3} \Rightarrow 100\alpha = \frac{2}{3} \Rightarrow \alpha = \frac{1}{150}$$

At 50°C temperature

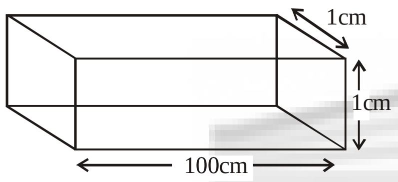
$i_{50} R_{50} = i_0 R_0$

$$\Rightarrow i_{50} = \frac{i_0 R_0}{R_{50}} = \frac{2 \times R_0}{R_0(1 + 50\alpha)}$$

$$= \frac{2}{1 + 50 \times \frac{1}{150}} = \frac{6}{4} = 1.5\text{A} = 15 \times 10^2 \text{ mA}$$

12. **(b)** Under the effect of applied electric field, the free electrons get accelerated due to electric field and they move from lower to higher potential. However, electron collides with lattice ion during passage and follow curved path.

13. **(3)**



Given,

Specific resistance, $\rho = 3 \times 10^{-7}\ \Omega$ m

$$\text{Resistance, } R = \rho \frac{\ell}{A} = \frac{3 \times 10^{-7} \times (1 \times 10^{-2})}{100 \times 1 \times 10^{-4}}$$

$= 3 \times 10^{-7}\ \Omega$

14. **(25)** Current, I = 2A; Cross sectional Area, $A = 25\text{ mm}^2 = 25 \times 10^{-6}\text{ m}^2$

Number of free electron, $n = 2 \times 10^{28}$

Charge on electron, $e = 1.6 \times 10^{-19}$ C

$$\text{Drift velocity } V_d = \frac{I}{neA}$$

$$= \frac{2}{2 \times 10^{28} \times 1.6 \times 10^{-19} \times 25 \times 10^{-6}}$$

$= 25 \times 10^{-6}\text{ ms}^{-1}$

15. **(125)** Number density of free electrons

$n = 8 \times 10^{28}\text{ m}^{-3}$

Area $= 2 \times 10^{-6}\text{ m}^2$ Current, I = 3.2 A

$$\text{Drift speed } V_d = \frac{I}{neA} = \frac{3.2}{8 \times 10^{28} \times 1.6 \times 10^{-19} \times 2 \times 10^{-6}}$$

$= 125 \times 10^{-6}$ m/s

16. **(25)** Let ℓ = initial length of the wire

A = cross section area of the wire

ρ = resistivity of material of the wire

$$\text{Initial resistance, } R = \rho \frac{\ell}{A}$$

New resistance,

$$R' = \rho \frac{1.2\ell}{0.96A} = 1.25\rho \frac{\ell}{A} = 1.25R$$

$$\% \text{ change} = \frac{R' - R}{R} = \frac{1.25R - R}{R} \times 100 = 25\%$$

17. **(b)** Resistivity (ρ) is given by

$$\rho = \frac{m}{ne^2\tau}$$

With increase in temperature, number density n increases and relaxation time τ decreases. But n is dominant over τ. Hence, resistivity (ρ) decreases.

18. **(a)** We have

$$V_d = \frac{eV\tau}{mL} \Rightarrow V_d \text{ is independent of cross sectional area.}$$

19. **(d)** Given that

$Q = (\alpha t - \beta t^2 + \gamma t^3)$

$$i = \frac{dQ}{dt} = (\alpha - 2\beta t + 3\gamma t^2) \quad \text{...(i)}$$

For minimum value of current

$$\frac{di}{dt} = (6\gamma t - 2\beta) = 0 \quad \Rightarrow t = \frac{\beta}{3\gamma}$$

Put this value in equation (i)

$$i = (\alpha - 2\beta t + 3\gamma t^2) = \alpha - 2\beta \times \frac{\beta}{3\gamma} + 3\gamma \times \left(\frac{\beta}{3\gamma}\right)^2$$

$$= \left(\alpha - \frac{\beta^2}{3\gamma}\right)$$

20. **(b)** Given that

Current, I = 2A

Voltage, V = 3.4 V

Using Ohm's Law, V = IR

Here resistivity, $\rho = 1.7 \times 10^{-8}\ \Omega$-m

$$R = \frac{3.4}{2} = 1.7\,\Omega$$

$$1.7 = \frac{\rho L}{A} \quad \left(\because R = \frac{\rho L}{A}\right)$$

$$L = \frac{1.7(A)}{\rho}; L^2 = \frac{1.7 A.L}{\rho} = \frac{1.7 V}{\rho}$$

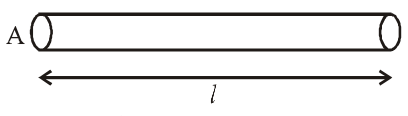
M = density × volume

$$\text{Volume, } V = \frac{8.92 \times 10^{-3}}{8.92 \times 10^3} = 10^{-6}$$

$$L^2 = \frac{1.7}{\rho}(10^{-6}) = \frac{1.7 \times 10^{-6}}{1.7 \times 10^{-8}} = 100$$

$\therefore$ L = 10 m

21. **(c)**



Let resistance of a wire R and length l.

$$R = \frac{\rho\ell}{A} = 5\Omega$$

$\therefore$ Volume of wire is constant in stretching

$$V_i = V_f \quad \Rightarrow \quad A_i\ell_i = A_f\ell_f$$

$$A\ell = A'(5\ell) \Rightarrow A' = \frac{A}{5}$$

$$R_f = \frac{\rho\ell_f}{A_f} = \frac{\rho(5\ell)}{\left(\frac{A}{5}\right)} = 25\left(\frac{\rho\ell}{A}\right) = 25 \times 5 = 125\,\Omega$$

22. **(2)** $R = \frac{\rho\ell}{A} = \frac{\rho\ell}{\pi\left(b^2 - a^2\right)}$ [$\because$ the C.S.A is $\pi(b^2 - a^2)$]

$$= \frac{2.4\times10^{-8}\times\pi}{\pi\left(4^2-2^2\right)\times10^{-6}} = \frac{2.4}{12}\times10^{-2} = 0.2\times10^{-2} = 2\times10^{-3}\,\Omega$$

So, n = 2

23. **(44)** Let $L_i = l_i$. Then, $L_f = 1.2\, l_i$

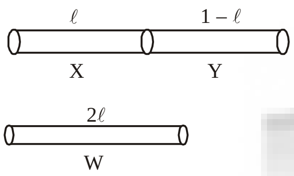
As volume is constant,

So resistance $\propto$ (length)^2

$$\frac{R_f}{R_i} = \left(\frac{1.2 l_i}{l_i}\right)^2 = 1.44 \Rightarrow R_f = 1.44 R_i$$

So, $\frac{\Delta R}{R_i}\times100 = \frac{1.44R_i - R_i}{R_i}\times100 = 44\%$

24. **(b)** Consider of the length of X part is ℓ then the length of Y part will be $1-\ell$.



$$\frac{R_X}{R_Y} = \frac{\ell_X}{\ell_Y} \qquad \left(\because\ R = \frac{\rho\ell}{A}\right)$$

When wire is stretched to double of its length, then resistance becomes 4 times.

$R_W = 4R_X = 2R_Y$

$\frac{R_X}{R_Y} = \frac{1}{2}$ So $\frac{\ell_X}{\ell_Y} = \frac{1}{2}$.

25. **(a)** Resistance, $R_1 = \rho\frac{L_1}{A_1}$

$$R_2 = \rho\left(\frac{3L_1}{A_1/3}\right) = 9\rho\frac{L_1}{A_1}$$

$$\therefore \frac{R_2}{R_1} = \frac{9\rho\frac{L_1}{A_1}}{\rho\frac{L_1}{A_1}} = 9$$

26. **(b)** Drift velocity, $v_d = \left(\frac{e\tau}{m}\right)E$

Here, τ = relaxation time

E = electric field

$$\Rightarrow\ v_d = \left(\frac{e\tau}{m}\right)\left(\frac{V}{\ell}\right) \qquad \left(\because\ E = \frac{V}{\ell}\right)$$

$$\therefore\ v_d \propto \frac{I}{\ell}$$

Here, ℓ = length of conductor

V = Potential difference applied across the wire.

As temperature increases, relaxation time decreases, hence v_d decreases.

Also, $v_d \propto v$, so drift velocity depends on the applied potential difference.

Drift velocity is also given by

$$v_d = \frac{I}{neA},$$

it is not mentioned that current is at steady state neither it is mentioned that n is constant for given conductor. So it can't be said that v_d is inversely proportional to A.

First and fourth statements are correct.

27. **(144)** We have

R = slope of I–V curve = tan 45° = 1

As, $R = \frac{\rho l}{A} \Rightarrow \rho = \frac{RA}{l} = \frac{1\times\pi\times(1.2\times10^{-2})^2}{31.4\times10^{-2}}$

$$= 144\times10^{-3}\ \Omega\,\text{cm}$$

28. **(a)** We know that

$R = R_0(1+\alpha\Delta T)$

So, $2 = R_0(1+\alpha\times10)$ ...(i)

$3 = R_0(1+\alpha\times30)$ ...(ii)

Dividing (i) by (ii), we get

$$\frac{3}{2} = \frac{1+30\alpha}{1+10\alpha} \Rightarrow 3 + 30\alpha = 2 + 60\alpha \Rightarrow 1 = 30\alpha$$

$$\Rightarrow \alpha = \frac{1}{30} = 0.033\ °C^{-1}$$

29. **(48)** I = J A

$$= 4\times10^6\left[\pi R^2 - \pi\left(\frac{R}{2}\right)^2\right] = 4\pi\times10^6\left[\frac{3R^2}{4}\right]$$

$= \pi\times10^6\times3\times16\times10^{-6} = 48\,\pi$ A

30. **(12)** We have

I = JA

$= 10^6\times\pi\,[4^2-2^2]\times10^{-6} = \pi\times12\,A$

So, x = 12

31. **(c)** $R = \frac{\rho l}{A}$

$$\frac{\Delta R}{R} = \frac{\Delta l}{l} - \frac{\Delta A}{A}$$

[**Note:** This is not relative error case, so –ve sign comes with $\frac{\Delta A}{A}$]

Now, V = constant

Al = constant

$$\Rightarrow \frac{\Delta A}{A} + \frac{\Delta l}{l} = 0 \Rightarrow -\frac{\Delta A}{A} = \frac{\Delta l}{l}$$

So, $\frac{\Delta R}{R} = \frac{\Delta l}{l} + \frac{\Delta l}{l}$ $\left[\because \frac{\Delta l}{l} = -\frac{\Delta A}{A}\right]$

$$= \frac{2\Delta l}{l} = 2\times0.4 = 0.8\%$$

32. **(300)** If length is increased by n times then, resistance increased by n^2 times

So, $R_f = 4R_i$

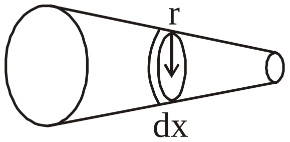
$\Delta R = R_f - R_i = 3R_i$

$$\%\ \Delta R = \frac{3R_i}{R_2}\times100 = 300\%$$

33. **(a)** Current is constant in the conductor. I = constant

Resistance of element of conductor, $dR = \frac{\rho dx}{\pi r^2}$

$dV = idR = \frac{i\rho dx}{\pi r^2}$



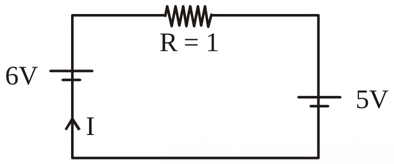
$E = \frac{dV}{dx} = \frac{i\,\rho}{\pi r^2}$

Drift velocity,

$V_d = \frac{eE\tau}{m}$ As $V_d \propto E$ and $E \propto \frac{1}{r^2}$

So, if r decreases, E will increase and hence V_d.

34. **(1)** From graph (figure 1) voltage at t = 3.2s = 6V



Current, $I = \frac{V}{R} = \frac{6-5}{1} = 1A$

35. **(d)** In parallel combination, equivalent resistance,

$$R = \frac{R_1 R_2}{R_1 + R_2} = \frac{\ell}{A}.\frac{\rho_1 \rho_2}{\rho_1 + \rho_2}\left[\because R = \rho\frac{\ell}{A}\right]$$

$$\text{or, } R = \frac{25\times10^{-2}}{3\times10^{-6}} \times \frac{1.7\times2.6\times10^{-16}}{4.3\times10^{-8}} \quad \therefore \quad R = 0.858 m\Omega$$

36. **(4)** $l_1 = l_2 = l_{eq}$

$A_1 = A_2 = A$ and $A_{eq} = 2A$

$$R_{eq} = \frac{R_1R_2}{R_1+R_2} \Rightarrow \frac{\rho(l)}{2A} = \frac{\left(\frac{\rho_1 l}{A}\right)\left(\frac{\rho_2 l}{A}\right)}{\frac{\rho_1 l}{A} + \frac{\rho_2 l}{A}}$$

$$\Rightarrow \frac{\rho}{2} = \frac{\rho_1\rho_2}{\rho_1+\rho_2} \Rightarrow \frac{\rho}{2} = \frac{\rho_1\rho_2}{(\rho_1+\rho_2)} = \frac{6\times3}{(6+3)} = 2$$

$\therefore \quad \rho = 4$

37. **(c)** From formula, drift velocity, $V_d = neV_dA$

$$\Rightarrow \quad n = \frac{1}{AeV_d} = \frac{10}{5\times10^{-6}\times1.6\times10^{-19}\times2\times10^{-3}}$$

$= 625 \times 10^{25}$

38. **(d)** Resistance of the conducting wire, $R_1 = \frac{\rho l}{A}$

When length of the wire is doubled, it length becomes $l' = 2l$.

New area of cross-section, $A' = \frac{A}{2}$

$$R_2 = \frac{\rho\times(2l)}{\left(\frac{A}{2}\right)} = 4\frac{\rho l}{A}$$

From the Ohm's law, $V = IR$

$$\therefore \text{Current, } I = \frac{V}{R_2} = \frac{V}{\left(\frac{4\rho l}{A}\right)} \Rightarrow I = \frac{1}{4}\frac{VA}{\rho l}$$

39. **(b)** Given, $i = \alpha_0 t + \beta t^2$

Put $\alpha_0 = 20$ and $\beta = 8$, we get $i = 20t + 8t^2$

$$\text{Current, } i = \frac{dq}{dt} \Rightarrow \int dq = \int idt \Rightarrow q = \int_0^{15}(20t+8t^2)dt$$

$$\Rightarrow q = \left(\frac{20t^2}{2} + \frac{8t^3}{3}\right)_0^{15} = 20\times\left(\frac{15^2-0^2}{2}\right) + \frac{8}{3}(15^3-0^3)$$

$$\Rightarrow q = 10\times(15)^2 + \frac{8(15)^3}{3} \Rightarrow q = 2250 + 9000 = 11250\,C$$

40. **(5)** Given : Conductivity of wire, $\sigma = 5\times10^7$ S/m

Radius of wire, $r = 0.5$ mm $= 5\times10^{-4}$ m

Electric field, $E = 10\times10^{-3}$ V/m

$J = \sigma E = 10\times10^{-3}\times5\times10^7 \Rightarrow J = 5\times10^5$

Since, $J = \frac{i}{A} \Rightarrow \frac{i}{A} = 5\times10^5$

$\Rightarrow i = 5\times10^5\times\pi r^2$

$= 5\times10^5\times\pi\times(5\times10^{-4})^2 = 125\pi\times10^{-3}$ A

$\therefore i = 125\pi$ mA $\qquad \therefore i = 5^3\pi$ mA $\qquad \therefore x = 5$

41. **(300)** Given,

Charge, $q = 20$ C, potential difference, $\Delta V = 15$ V

Work done, $W = q\Delta V = 20 \times 15 = 300$ J

42. **(b)** Resistance, $R = \frac{\rho\ell}{A} = \frac{\rho\ell^2}{(\text{Vol.})}$ or $R \propto \ell^2$

or, $\frac{R_1}{R_2} = \frac{\ell_1^2}{\ell_2^2}$

As length increases 25%, if $\ell_1 = \ell$ then

$\ell_2 = \ell + \ell\times\frac{25}{100} = 1.25\ell$

$\therefore \quad \frac{R}{R_2} = \frac{\ell^2}{(1.25\ell)^2}$ or, $R_2 = 1.5625R$

$\therefore$ % increase in resistance $R \simeq 56\%$

43. **(b)** $\rho_M = 98\times10^{-8}$; $\rho_A = 2.65\times10^{-8}$

$\rho_C = 1.724\times10^{-8}$; $\rho_T = 5.65\times10^{-8}$

$\therefore \rho_M > \rho_T > \rho_A > \rho_C$

44. **(d)** Charge mobility

$(\mu) = \frac{V_d}{E}$ [Where V_d = drift velocity]

and resistivity $(\rho) = \frac{E}{j} = \frac{EA}{I} \Rightarrow E = \frac{I(\rho)}{A}$

$$\Rightarrow \mu = \frac{V_d}{E} = \frac{V_dA}{I\rho}$$

$$= \frac{1.1\times10^{-3}\times\pi\times\left(5\times10^{-3}\right)^2}{5\times1.7\times10^{-8}} \Rightarrow \mu = 1.0\frac{m^2}{Vs}$$

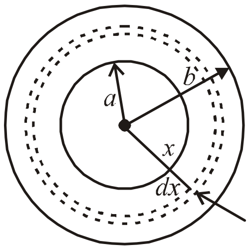
45. (b) Equation of straight line from graph

$$y = -mx + c \Rightarrow l\,nR = -m\left(\frac{1}{T^2}\right) + c$$

here, m & c are constants

$$R = e^{\left[-m\left(\frac{1}{T^2}\right)+c\right]} = e^{-m\left(\frac{1}{T^2}\right)} \times e^c \Rightarrow R(T) = R_0 e^{\frac{-T_0^2}{T^2}}$$

46. (a) $dR = \frac{(\rho)(dx)}{4\pi x^2}$



$$R = \int dR$$

$$\int dR = \rho \int_a^b \frac{dx}{4\pi x^2}$$

$$\Rightarrow R = \frac{\rho}{4\pi}\left[\frac{-1}{x}\right]_a^b$$

$$R = \left(\frac{\rho}{4\pi}\right).\left(\frac{1}{a} - \frac{1}{b}\right)$$

47. (c) $\rho = \frac{m}{ne^2\tau} = \frac{9.1\times10^{-31}}{8.5\times10^{28}\times(1.6\times10^{-19})^2\times25\times10^{-15}}$

$= 10^{-8}\,\Omega$-m

48. (a) Clearly, from graph

Current, $I = \frac{dq}{dt} = 0$ at $t = 4s$ [Since q is constant]

49. (a) Using, $I = neAv_d$

$\therefore$ Drift speed $v_d = \frac{1}{neA}$

$$= \frac{1.5}{9\times10^{28}\times1.6\times10^{-19}\times5\times10^{-6}} = 0.02\ \text{mms}^{-1}$$

50. (c) Resistance, $R = \frac{\rho\ell}{A}$

$R = \rho\frac{\ell}{A}\times\frac{\ell}{\ell} = \frac{\rho\ell^2}{V}$ [≫Volume (V) = A≫.]

Since resistivity and volume remains constant therefore % change in resistance

$$\frac{\Delta R}{R} = \frac{2\Delta\ell}{\ell} = 2\times(0.5) = 1\%$$

51. (a) Given, $R_1 = 100\,\Omega$, r' = r/2, R_2 = ?

Resistivity of wire, $R = \frac{\rho l}{A}$ $\because$ Area × length = volume

Hence, $R = \frac{\rho V}{A^2}$

Since, $\rho \to$ constant, $V \to$ constant

$R \propto \frac{1}{A^2}$ or $R \propto \frac{1}{r^4}$ $\because$ $A = \pi r^2$

$$\frac{R_2}{R_1} = 16 \Rightarrow R_2 = 16\times100 = 1600\,\Omega.$$

52. (b) $V = IR = (neAv_d)\rho\frac{\ell}{A}$ $\therefore$ $\rho = \frac{VA}{n_eAV_dl} = \frac{V}{n_eV_dl}$

Here V = potential difference
l = length of wire
n = no. of electrons per unit volume of conductor.
e = no. of electrons
Placing the value of above parameters we get resistivity

$$\rho = \frac{5}{8\times10^{28}\times1.6\times10^{-19}\times2.5\times10^{-4}\times0.1} = 1.6\times10^{-5}\Omega\text{m}$$

53. (c) $i = neAV_d$ and $V_d \propto \sqrt{E}$ (Given)

or, $i \propto \sqrt{E}$ or, $i^2 \propto E$ or, $i^2 \propto V$
Hence graph (c) correctly dipicts the *V-I* graph for a wire made of such type of material.

54. (c) Resistance of wire $(R) = \rho\frac{l}{A}$

If wire is bent in the middle then $l' = \frac{l}{2}, A' = 2A$

$\therefore$ New resistance, $R' = \rho\frac{l'}{A'} = \frac{\rho\frac{l}{2}}{2A} = \frac{\rho l}{4A} = \frac{R}{4}$.

55. (a) Resistance of wire

$R = \frac{\rho l}{A} = \frac{\rho l^2}{V}$ $(\because V = A\ell)$

Hence, $R = \rho\frac{\ell^2}{V}$ = constant × ℓ^2

$\therefore$ Fractional change in resistance

$\frac{\Delta R}{R} = 2\frac{\Delta l}{l} \Rightarrow 100\times\frac{\Delta R}{R} = 200\times\left(\frac{d\ell}{\ell}\right)$

$\because d\ell/\ell = 0.1\%$

$\therefore$ % change in $R = \left[200\times\left\{\frac{0.1}{100}\right\}\right] = 0.2\%$

$\therefore$ Resistance will increase by 0.2%.

56. (a) Let j be the current density.

Then $j\times2\pi r^2 = I \Rightarrow j = \frac{I}{2\pi r^2}$

$\therefore$ $E = \rho j = \frac{\rho I}{2\pi r^2}$

Now, $V_B - V_C = -\int_{a+b}^{a}\vec{E}\cdot\vec{dr} = -\int_{a+b}^{a}\frac{\rho I}{2\pi r^2}dr$

$= -\frac{\rho I}{2\pi}\left[-\frac{1}{r}\right]_{a+b}^{a} = \frac{\rho I}{2\pi a} - \frac{\rho I}{2\pi\,(a+b)}$

On applying superposition as mentioned we get

$\Delta V_{BC} = 2\times\Delta V'_{BC} = \frac{\rho I}{\pi a} - \frac{\rho I}{\pi(a+b)}$

57. (c) As shown in Answer (a) $E = \frac{\rho I}{2\pi r^2}$

58. (d) Resistance of a metal conductor at temperature t°C is given by $R_t = R_0(1 + \alpha t)$,

R_0 is the resistance of the wire at 0ºC
and α is the temperature coefficient of resistance.
Resistance at 50°C, $R_{50} = R_0(1 + 50\alpha)$ .. (i)
Resistance at 100°C, $R_{100} = R_0(1 + 100\alpha)$ ... (ii)
From (i), $R_{50} - R_0 = 50\alpha R_0$ ... (iii)
From (ii), $R_{100} - R_0 = 100\alpha R_0$ ... (iv)
Dividing (iii) by (iv), we get

$$\frac{R_{50} - R_0}{R_{100} - R_0} = \frac{1}{2}$$

Here, $R_{50} = 5\Omega$ and $R_{100} = 6\Omega$

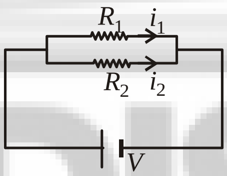
$$\therefore \frac{5 - R_0}{6 - R_0} = \frac{1}{2} \text{ or, } 6 - R_0 = 10 - 2R_0 \text{ or, } R_0 = 4\Omega.$$

59. **(d)** Let d_A and d_B are the diameter of wire A and B respectively.
Let ρ_B and ρ_A be the resistivity of wire A and B. We have given
$\rho_B = 2\rho_A$, $d_B = 2d_A$
If both resistances are equal
$R_B = R_A$

$$\Rightarrow \frac{\rho_B \ell_B}{A_B} = \frac{\rho_A \ell_A}{A_A} \quad \therefore \frac{\ell_B}{\ell_A} = \frac{\rho_A}{\rho_B} \times \frac{d_B^2}{d_A^2} = \frac{\rho_A}{2\rho_A} \times \frac{4d_A^2}{d_A^2} = 2$$

60. **(b)** Given,

$$\frac{\ell_1}{\ell_2} = \frac{4}{3} \text{ and } \frac{r_1}{r_2} = \frac{2}{3}$$

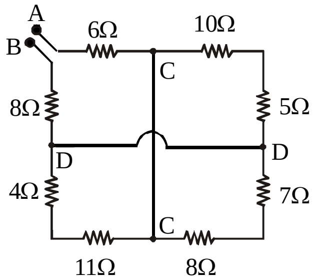


$$R_1 = \frac{\rho \ell_1}{\pi r_1^2}; \; R_2 = \frac{\rho \ell_2}{\pi r_2^2}$$

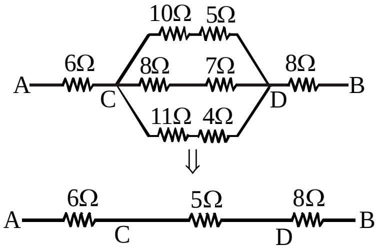
When wires are in parallel to the circuit potential difference across each wire is same
$i_1 R_1 = i_2 R_2$

$$\therefore \frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{\rho \ell_2}{\pi r_2^2} \times \frac{\pi r_1^2}{\rho r_1} = \frac{\ell_2}{\ell_1} \times \frac{r_1^2}{r_2^2} = \frac{3}{4} \times \frac{4}{9} = \frac{1}{3}$$

61. **(d)**

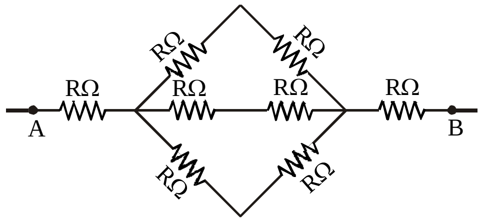


The given circuit can be redrawn as



$$\Rightarrow R_{eq} = 6\Omega + 5\Omega + 8\Omega = 19\Omega$$

62. **(b)** Due to symmetry, the two middle resistance can be removed.
Hence, the new circuit will be :



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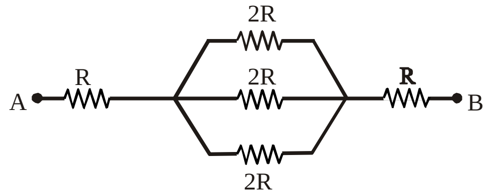
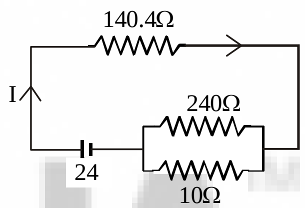


$$\text{New resistance} = 2R + \frac{2R}{3} = \frac{8R}{3}$$

63. **(160)** Equivalent resistance is,



$$R = 140.4 + \frac{240 \times 10}{240 + 10} = 140.4 + \frac{2400}{250} = 150\Omega$$

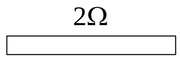
Hence, reading of ammeter is $= \frac{V}{R} \frac{24}{150} = 160 \text{ mA}$

64. **(d)** $R_{eq} = R_1 + (R_2 \| R_3 \| R_4)$

$$= R_1 + \frac{R_2 R_3 R_4}{R_2 R_3 + R_3 R_4 + R_4 R_2}$$

$$= 10 + \frac{8 \times 4 \times 8}{8 \times 4 + 4 \times 8 + 8 \times 8} = 12\Omega$$

$$\text{and current, } I = \frac{E}{R_{eq}} = \frac{12}{12} = 1\text{A}$$

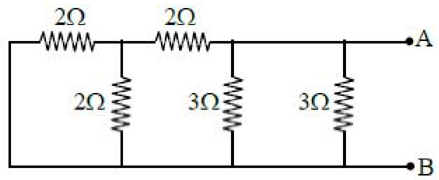
65. **(5)**  $\Rightarrow$ 10 equal part

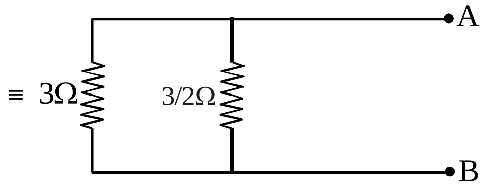
Each part has resistance, r = 2Ω

$$\therefore R_{eq} = (r \| r) \times 5$$

$$= \frac{r \cdot r}{r + r} \times 5 = \frac{r}{2} \times 5 = \frac{2}{2} \times 5 = 5\Omega$$

66. **(1)** Resistance 6Ω is short circuited





$$\therefore \quad R_{eq} = \frac{\frac{3}{2} \times 3}{\frac{3}{2} + 3} = 1\Omega$$

67. **(b)** In series combination

$R_{eq} = R_1 + R_2$

$2R_0 (1 + \alpha_s \Delta\theta) = R_0(1 + \alpha_1 \Delta\theta) + R_0(1 + \alpha_2 \Delta\theta)$

$\Rightarrow \; 2R_0 (1 + \alpha_s \Delta\theta) = 2R_0 + (\alpha_1 + \alpha_2) R_0 \Delta\theta$

$$\Rightarrow \quad \alpha_s = \frac{\alpha_1 + \alpha_2}{2}$$

For parallel combination $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\Rightarrow \frac{1}{\frac{R}{2}\left(1 + \alpha_p \Delta\theta\right)} = \frac{1}{R\left(1 + \alpha_1 \Delta\theta\right)} + \frac{1}{R\left(1 + \alpha_2 \Delta\theta\right)}$$

$$\Rightarrow \frac{2}{1 + \alpha_p \Delta\theta} = \frac{1}{1 + \alpha_1 \Delta\theta} + \frac{1}{1 + \alpha_2 \Delta\theta}$$

$$\Rightarrow \frac{2}{1 + \alpha_p \Delta\theta} = \frac{1 + \alpha_2 \Delta\theta + 1 + \alpha_1 \Delta\theta}{(1 + \alpha_1 \Delta\theta)(1 + \alpha_2 \Delta\theta)}$$

$$\Rightarrow \; 2\left[(1 + \alpha_1 \Delta\theta)(1 + \alpha_2 \Delta\theta)\right]$$

$$= \left[2 + (\alpha_1 + \alpha_2)\Delta\theta\right] \left[1 + \alpha_p \Delta\theta\right]$$

$$\Rightarrow \; 2\left[1 + \alpha_1 \Delta\theta + \alpha_2 \Delta\theta + \alpha_1 \alpha_2 \Delta\theta\right]$$

$$= 2 + 2\alpha_p \Delta\theta + (\alpha_1 + \alpha_2)\Delta\theta + \alpha_p (\alpha_1 + \alpha_2)\Delta\theta^2$$

Neglecting small terms

$\Rightarrow 2 + 2(\alpha_1 + \alpha_2)\Delta\theta = 2 + 2\alpha_p \Delta\theta + (\alpha_1 + \alpha_2)\Delta\theta$

$$\Rightarrow (\alpha_1 + \alpha_2)\Delta\theta = 2\alpha_p \Delta\theta \; \Rightarrow \; \alpha_p = \frac{\alpha_1 + \alpha_2}{2}$$

68. **(c)** Equivalent resistance in series grouping,

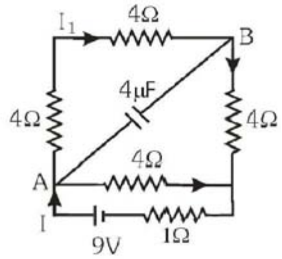
$R_{eq} = R_1 + R_2 + \ldots + R_n$

$R_{eq} = 3300 + 100 + 100 + 100 + 100 + 100 + 100 + 100$

$$i = \frac{4}{4000} = \frac{1}{1000} A$$

$$V_0 = i.R = \frac{1}{1000} \times 500 = 0.5V$$

69. **(81)** At steady state, capacitor behaves as open circuit.



$$\therefore I = \frac{V}{R_{eq}} = \frac{9}{1 + \frac{12 \times 4}{12 + 4}} = \frac{9}{4} A; \; I_1 = \left(\frac{4}{4 + 12}\right) \cdot \frac{9}{4} = \frac{9}{16} A$$

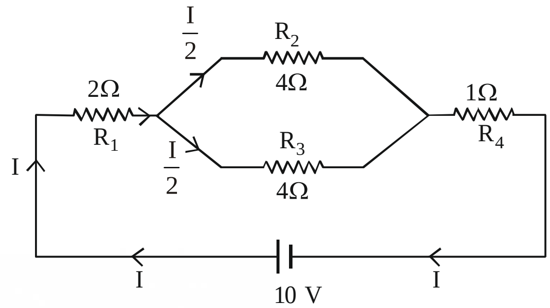
$\therefore$ Potential difference across capacitor,

$$V = I_1 \times 8 = \frac{9}{16} \times 8 = \frac{9}{2} V$$

$$\therefore \; U = \frac{1}{2} CV^2 = \frac{1}{2} \times 4 \times \frac{81}{4} \mu J = \frac{81}{2} \mu J = \frac{x}{2} \mu J \quad \text{(given)}$$

$\therefore \; x = 81$

70. **(b)**

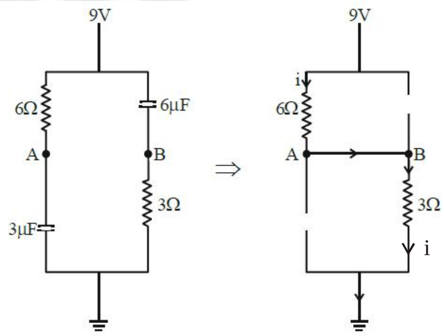


$R_{eq} = 2\,\Omega + 2\,\Omega + 1\,\Omega = 5\,\Omega$

$$\text{Current, } I = \frac{V}{R_{eq}} = \frac{10}{5} = 2A$$

$$\text{Current in resistance } R_3 = \frac{I}{2} = 1A$$

71. **(36)** At steady state, capacitor bahaves as an open circuit and current flows in circuit as shown in the figure below.



$R_{eq} = 9\Omega$

$$\text{Current, } i = \frac{9V}{9\Omega} = 1A$$

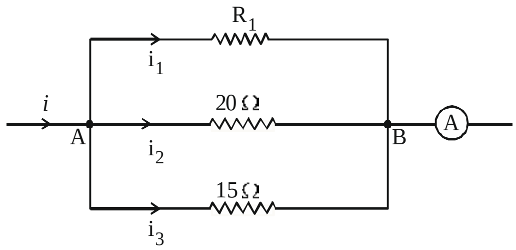
Potential difference across 6μF capacitor is

$\Delta V = 6i = 1 \times 6 = 6V$

$\therefore$ Charge stored in 6μF capacitor,

$Q = C\Delta V = 6 \times 6 \times 10^{-6} C = 36\,\mu C$

72. **(30)**



Given, $i_2 = 0.3$ A, $i = 0.9$A
So, $V_{AB} = i_2 \times R_2 = 20 \times 0.3 = 6V$

$$i_3 = \frac{V_{AB}}{R_3} = \frac{6}{15} = \frac{2}{5}A$$

$$\therefore i_1 = i - (i_2 + i_3) = \frac{9}{10} - \left(\frac{3}{10} + \frac{2}{5}\right) = \frac{1}{5}A$$

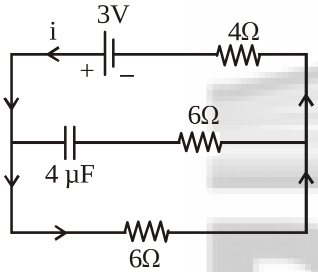
$$\therefore R_1 = \frac{V_{AB}}{i_1} = \frac{6}{\frac{1}{5}} = 30\Omega$$

73. **(a)** As wire is cut into 5 equal parts so resistance of each part $= \frac{R}{5}$

In parallel grouping, $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots\ldots\ldots + \frac{1}{R_n}$

$\therefore$ Total resistance $= \frac{1}{5} \times \frac{R}{5} = \frac{R}{25}$

74. **(a)**



Current flowing in the circuit in steady state

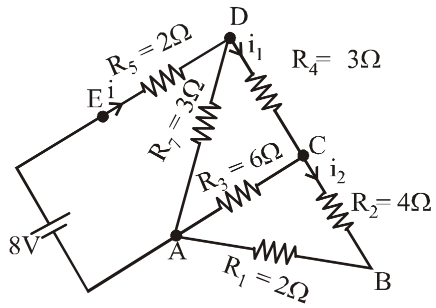
$$I = \frac{V}{r_{eq}} = \frac{3}{6+4} = \frac{3}{10}$$

[$\because$ In steady state current through capacitor is zero]
Potential difference on 6Ω resistance

$$V = R \times I = 6 \times \frac{3}{10} = 1.8 \text{ volt}$$

Capacitor will have same potential so charge,
$q = CV = (4\,\mu F) . (1.8 \text{ volt}) = 7.2\,\mu C$.

75. **(d)**



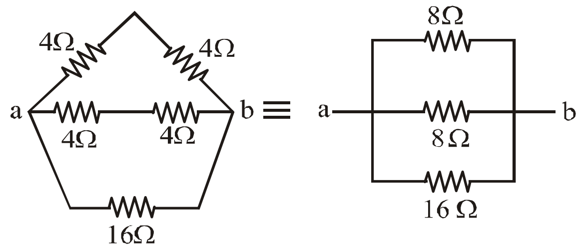
Equivalent resistance,
$R_{eq} = 4\Omega$

Current, $i = \frac{8}{4} = 2A$

Current through R_4, $i_1 = \frac{2 \times 3}{3+6} = \frac{2}{3}A$

Current through R_2, $i_2 = \frac{2/3}{2} = \frac{1}{3}A$

76. **(b)** The circuit can be reduced to



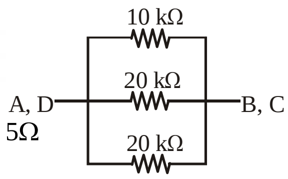
$$\Rightarrow R_{eq} = \frac{16 \times 4}{16+4} = \frac{16}{5}\Omega = 3.2\Omega$$

77. **(100)** For maximum resistance , when all the resisters are connected in series combination.
$\therefore R_{max} = 10R$
Here R = 10 ohm
For minimum resistance, when all the resistance are connected in parallel combination.

$$R_{min} = \frac{R}{10}$$

$$\therefore \frac{R_{max}}{R_{min}} = \frac{10R \times 10}{R} = 100$$

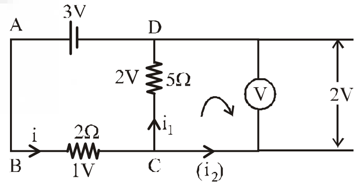
78. **(a)** Since, $V_A = V_D$; $V_C = V_B$



All resistors are in parallel.

$$\frac{1}{R_{eq}} = \frac{1}{10} + \frac{1}{20} + \frac{1}{20} \Rightarrow R_{eq} = 5\Omega$$

79. **(20)** Apply KVL in loop ABCD
we have, $-5i_1 + 2 = 0$



$$\Rightarrow i_1 = \frac{2V}{5\Omega} = \frac{2}{5}A$$

Current through 2Ω resistance

$$i = \frac{1V}{2\Omega} = \frac{1}{2}A$$

$\therefore$ Current flowing through voltmeter

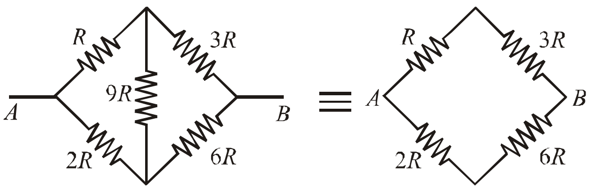
$$i_2 = i - i_1 = \frac{1}{2} - \frac{2}{5} = \frac{1}{10}A$$

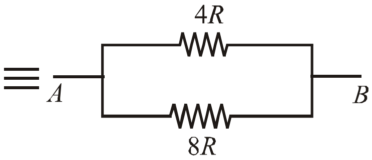
For voltmeter, $V = i_2 R$

$$\Rightarrow \quad 2 = \left(\frac{1}{10}\right) R \Rightarrow R = 20\Omega$$

80. **(c)** Wheat stone bridge is in balanced condition.

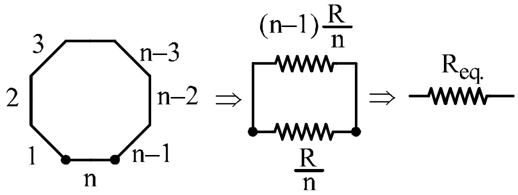
$$\frac{R}{2R} = \frac{3R}{6R} \Rightarrow \frac{1}{2} = \frac{1}{2}$$





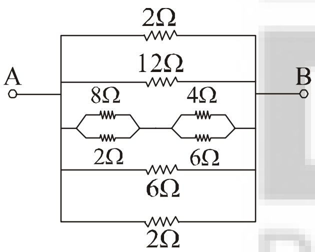
$$\frac{1}{R_{eq}}=\frac{1}{4R}+\frac{1}{8R}=\frac{2+1}{8R}=\frac{3}{8R}\Rightarrow R_{eq}=\frac{8R}{3}$$

81. **(c)**



$$R_{eq}=\frac{\frac{R}{n}.(n-1)\frac{R}{n}}{\frac{R}{n}+(n-1)\frac{R}{n}}=\frac{\frac{R^2}{n^2}(n-1)}{R}=\frac{R(n-1)}{n^2}$$

82. **(a)** The given circuit can be redrawn as

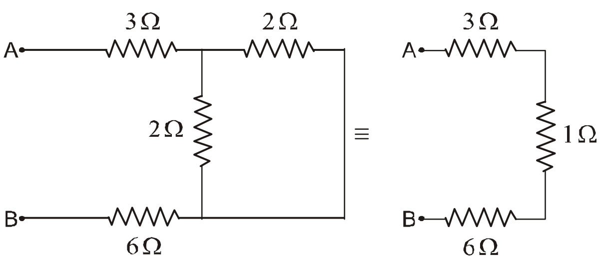


The net resistance between A and B

$$\frac{1}{R_{net}}=\frac{1}{2}+\frac{1}{12}+\frac{1}{4}+\frac{1}{6}+\frac{1}{2}=\frac{6+1+3+2+6}{12}=\frac{18}{12}=\frac{3}{2}$$

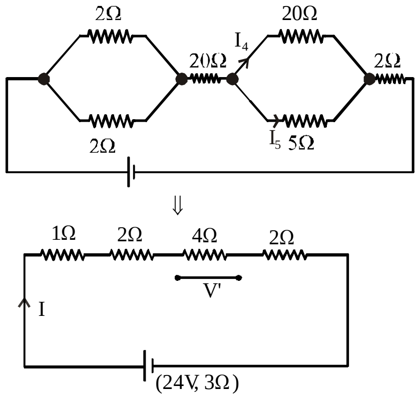
$$\Rightarrow R_{net}=\frac{2}{3}\Omega$$

83. **(10)** Both 4Ω resistance gets short.
Remove the resistors that have no current.



$R_{eq}=3+1+6$
$R_{eq}=10\,\Omega$

84. **(d)**



So, $R_{eq.}=12\ \Omega$

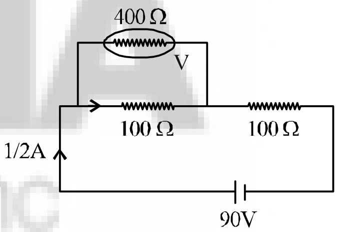
As $I=\frac{V}{R_{eq}}\ \Rightarrow\ I=\frac{24}{12}A$

So, $V'=\frac{24}{12}\times 4=8$ volt

$I_4=\frac{V'}{20}=\frac{8}{20}=\frac{2}{5}A$

$I_5=\frac{V'}{5}=\frac{8}{5}A$

85. **(a)**

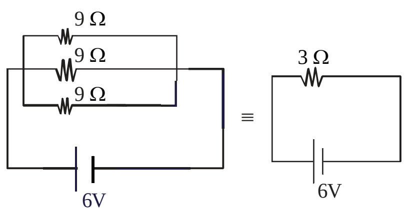


$$R_{eq}=\frac{400\times 100}{500}+100=180\Omega$$

$$i=\frac{V}{R_{eq}}\Rightarrow i=\frac{90}{180}=\frac{1}{2}A$$

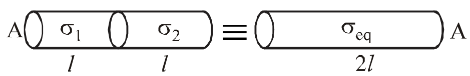
$$\text{Reading}=\frac{1}{2}\times\left(\frac{400}{500}\times 100\right)=40\text{ volt}$$

86. **(2)** Equivalent circuit of the above circuit is as shown below



$$I=\frac{6}{3}=2A$$

87. **(b)**



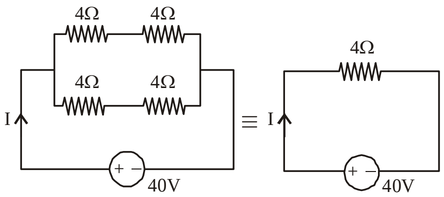
Let length of wire be 'ℓ' and area of wire as 'A'

For equivalent wire length = 2ℓ; area will be A
Equivalent thermal resistance in series will be given as
$R_{eq} = R_1 + R_2$

$$\Rightarrow \frac{2\ell}{\sigma_{eq}A} = \frac{\ell}{\sigma_1 A} + \frac{\ell}{\sigma_1 A} \qquad \left[\because R = \frac{\ell}{\sigma A}\right]$$

$$\Rightarrow \frac{2\ell}{\sigma_{eq}} = \frac{\ell}{\sigma_1} + \frac{\ell}{\sigma_2} \qquad \Rightarrow \sigma_{eq} = \frac{2\sigma_1\sigma_2}{\sigma_1 + \sigma_2}$$

88. (a) It follow Wheatstone bridge so, the equivalent circuit will be



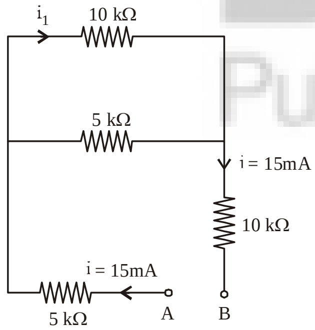
Apply KVL law
$-40 + 4I = 0 \Rightarrow I = 10$ A

89. (4) R_{eq} of 8 wires $= \dfrac{\rho\ell}{\pi\left(\dfrac{d}{2}\right)^2 \times 8} = \dfrac{\rho\ell}{2\pi d^2}$

R_{eq} of single wire $= \dfrac{\rho \times 2\ell}{\pi\dfrac{D^2}{4}} = \dfrac{8\rho\ell}{\pi D^2}$

So, $\dfrac{\rho\ell}{2\pi d^2} = \dfrac{8\rho\ell}{\pi D^2}$
$\Rightarrow D^2 = 16\, d^2$
$\Rightarrow D = 4d$

90. (d)



$i_1 = \dfrac{5}{10+5} \times 15 \text{ mA} = 5 \text{ mA}$
Kirchhoff's by voltage law
$V_A - 5i - 10i_1 - 10\, i = V_B$
$V_A - V_B = 75 + 50 + 150 = 275$ V

91. (b) As $R = \dfrac{\rho l}{A} \Rightarrow R_i = 14\Omega = \dfrac{\rho l_0}{\pi r_0^2}$

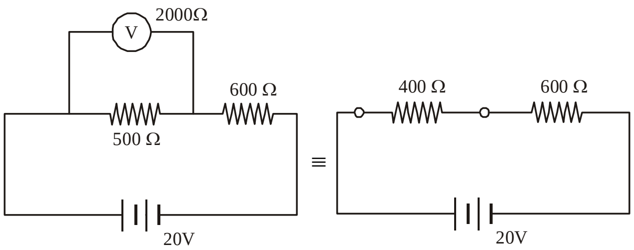
$$R_f = \frac{\rho l_0}{\pi\left(\dfrac{r_0}{3}\right)^2} = 9\frac{\rho l_0}{\pi r_0^2} = 9R_i = 9 \times 14 = 126\Omega$$

$$R_{eq} = \frac{R_f}{7} = \frac{126}{7} = 18\Omega$$

92. (10) We have $i = \dfrac{15}{1+2} = 5\text{A}$

And, $V_A = V_B = -15 + iR = -15 + 5 \times 1 = -10$ V
So, $V_B - V_A = 10$V.

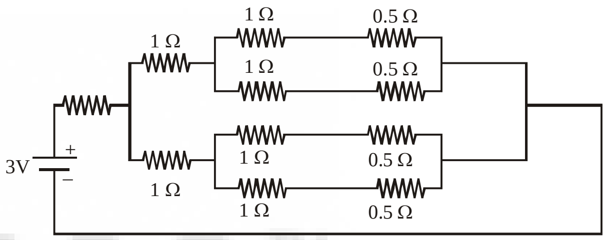
93. (8)



Voltage measured by voltmeter

= voltage across 400Ω $= \dfrac{400}{400+600} \times 20 = 8$V

94. (8)



From above figure, $R_{eq} = \dfrac{15}{8}\Omega$

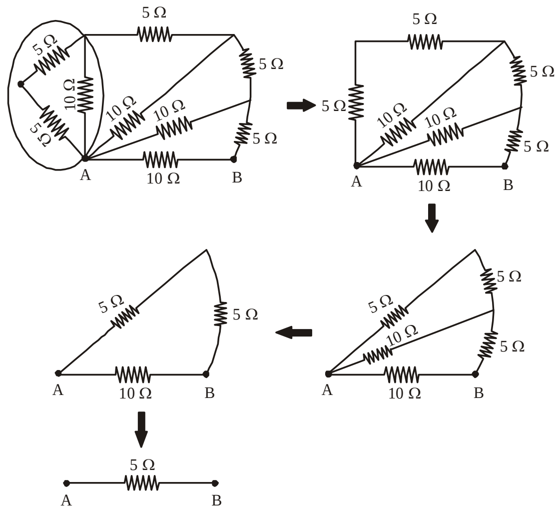
So, $I = \dfrac{V}{R} = \dfrac{3}{15/8} = \dfrac{24}{15} A = \dfrac{8}{5} A$ So, $a = 8$.

95. (3) We have $R_{eq} = \dfrac{ma}{3} + \dfrac{a}{2m}$

For R_{min}, $\dfrac{d\,R_{eq}}{dm} = 0 \Rightarrow \dfrac{a}{3} - \dfrac{a}{2m^2} = 0$

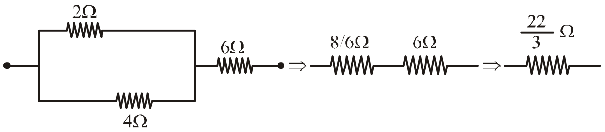
$$\Rightarrow \frac{a}{3} = \frac{a}{2m^2} \Rightarrow m^2 = \frac{3}{2} \Rightarrow m = \sqrt{\frac{3}{2}}$$

96. (c)



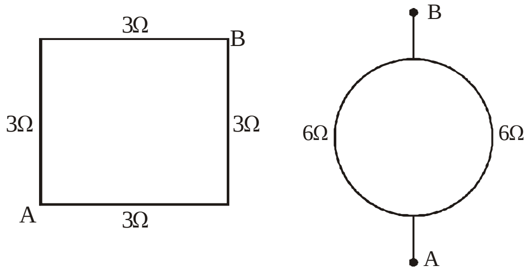
97. (b) As $R_{eq} = \dfrac{22}{3}\Omega = 7.33\Omega$

So, the best arrangement will be



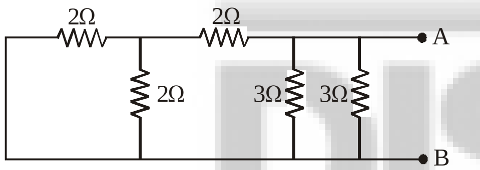
i.e., Parallel combination of 2Ω and 4Ω in series with 6Ω

98. (3)



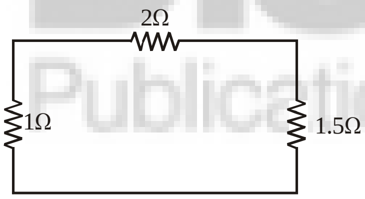
$$\frac{1}{R_{eq}} = \frac{1}{6} + \frac{1}{6} \Rightarrow R_{eq} = 3\Omega$$

99. (d) Current does not pass through 5Ω as potential difference across it is zero. Then circuit becomes



$2\Omega \parallel 2\Omega$ $\quad$ $3\Omega \parallel 3\Omega$

$$R_{eq} = \frac{3 \times 1.5}{3 + 1.5} = 1\Omega$$



100. (20) in series current i_1 will be $i_1 = \dfrac{20}{10 + 10n} = \dfrac{2}{1+n}$

Current in parallel will be $i_2 = \dfrac{20}{\dfrac{10}{n} + 10} = \dfrac{2}{1+n}$

$$\frac{i_2}{i_1} = 20 \Rightarrow \frac{\left(\dfrac{2n}{1+n}\right)}{\left(\dfrac{2}{1+n}\right)} = 20 \Rightarrow n = 20$$

101. (9) When switch is closed, $R_{eq} = \dfrac{3R}{2}$

When switch is closed, $R_{eq} = 2 \times \dfrac{R \times 2R}{3R} = \dfrac{4R}{3}$

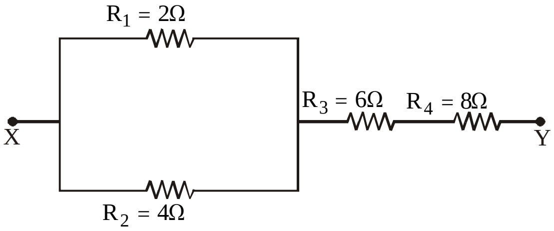
$$\frac{R_{open}}{R_{closed}} = \frac{3R}{2} \times \frac{3}{4R} = \frac{9}{8} \qquad \therefore x = 9$$

102. (b) $R_{net} = \dfrac{R_1 R_2}{R_1 + R_2}$

$$R_{net} = \left(\frac{\rho_1 \rho_2}{\rho_1 + \rho_2}\right)\frac{l}{A} \Rightarrow l = \frac{(\rho_{i} + \rho_A) A R_{net}}{\rho_i \rho_a}$$

Putting the required value we get $l = 97$ m

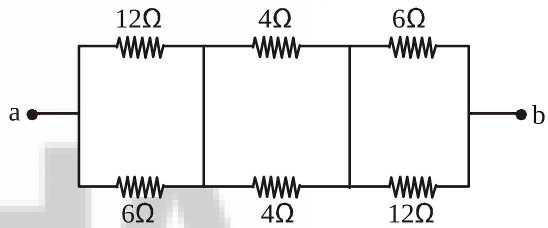
103. (d)



$$\text{Net Resistance} = \frac{1}{R_1} + \frac{1}{R_2} + R_3 + R_4$$

$$= \frac{1}{2} + \frac{1}{4} + 6 + 8 = \frac{2 \times 4}{2 + 4} + 14 = \frac{46}{3}\Omega$$

104. (10) When switch S_1 and S_2 are closed



$$\frac{1}{R_1} = \frac{1}{12} + \frac{1}{6} = \frac{1+2}{12} = \frac{1}{4} \qquad \therefore R_1 = 4\Omega$$

$$\frac{1}{R_2} = \frac{1}{4} + \frac{1}{4} = \frac{1+1}{4} \therefore R_2 = \frac{4}{2} = 2\Omega$$

$$\frac{1}{R_3} = \frac{1}{6} + \frac{1}{12} = \frac{2+1}{12} \therefore R_3 = \frac{13}{3} = 4\Omega$$

$\therefore R_{ab} = R_1 + R_2 + R_3 = 4 + 4 + 2 = 10\Omega.$

105. (70) Resistance 50 Ω and 20 Ω are in parallel.

$$\therefore \quad \frac{1}{R} = \frac{1}{50} + \frac{1}{20} = \frac{20 + 50}{1000} \Rightarrow R = \frac{1000}{70}$$

So, equivalent resistance of circuit

$$R_{eq} = 10 + \frac{1000}{70}$$

By voltage division rule

$$V_{10} = \frac{V \times R_{10}}{R_{eq}} = \frac{170 \times 10}{10 + \dfrac{1000}{70}} = 70 \quad \therefore \quad x = 70\text{ V}$$

106. (4) Equivalent resistance in series, $s = R_1 + R_2$

Equivalent resistance in parallel $P = \dfrac{R_1 R_2}{R_1 + R_2}$

Given $(R_1 + R_2) = n\left(\dfrac{R_1 R_2}{R_1 + R_2}\right)$

$\Rightarrow \quad R_1{}^2 + R_2{}^2 + 2R_1R_2 = nR_1R_2$

$$\Rightarrow \quad \frac{R_1^2}{R_1R_2} + \frac{R_2^2}{R_1R_2} + 2 = n \Rightarrow \frac{R_1}{R_2} + \frac{R_2}{R_1} + 2 = n$$

Let $\frac{R_1}{R_2} = \alpha$

Then, $\alpha + \frac{1}{\alpha} + 2 = n \Rightarrow \alpha^2 + \alpha(2-n) + 1 = 0$

for real value of 'α'

$(2-n)^2 - 4 \geq 0$

for minimum value $(2-n)^2 - 4 = 0$

$\Rightarrow n = 0$ or $n = 4$

$\Rightarrow n = 4 \quad [\because n \neq 0]$

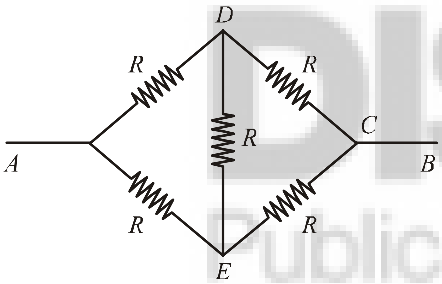
107. (3) In the given circuit, three $3k\,\Omega$ resistors are connected in parallel, this combination is in series with two resistors of $5k\,\Omega$ and $1\,k\Omega$.

Thus, equivalent resistance of the circuit

$$R_{eq} = 5k\Omega + 1k\Omega + 1k\Omega = 7k\Omega$$

$$i = \frac{E}{R_{eq}} = \frac{21}{7}\text{mA} = 3\text{ mA}$$

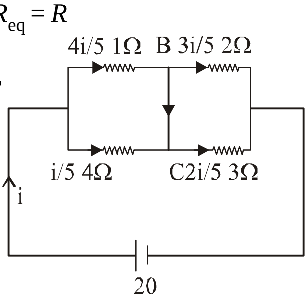
108. (c) The diagram can be drawn as



This is a wheatstone bridge. So, resistance along arm DE is ignored.

So, $\frac{1}{R_{eq}} = \frac{1}{2R} + \frac{1}{2R} \Rightarrow R_{eq} = R$

109. (b) From circuit diagram,



$$\frac{1}{R_1} = \frac{1}{1} + \frac{1}{4} \Rightarrow R_1 = \frac{4}{5}$$

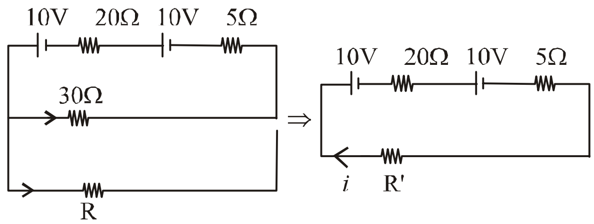
$$\frac{1}{R_2} = \frac{1}{2} + \frac{1}{3} \Rightarrow R_2 = \frac{6}{5}$$

$$R_{eff} = R_1 + R_2 = \frac{4}{5} + \frac{6}{5} = 2\Omega$$

$$i = \frac{v}{R_{eff}} = \frac{20}{2} = 10A$$

$$\therefore \quad I_{BC} = \frac{4i}{5} - \frac{3i}{5} = \frac{i}{5} = 2A$$

110. (30.00)



The resistance of 30Ω is in parallel with R. Their effective resistance

$$\frac{1}{R'} = \frac{1}{30} + \frac{1}{R} \Rightarrow R' = \frac{30R}{30+R}$$

Now, $10 - i \times 20 = 0$

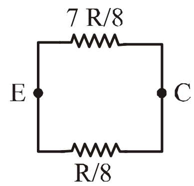
$i = 0.5\,\text{A}$

as, $i = \frac{E}{R_{eq}} \Rightarrow 0.5 = \frac{10+10}{R'+25}$

$$\Rightarrow 0.5 - \frac{20}{\frac{30R}{R+30} + 25} \Rightarrow R = 30\Omega$$

111. (c) $V_{1\Omega} = \frac{0.5}{2+0.5} \times 1 = 0.2\text{V}$

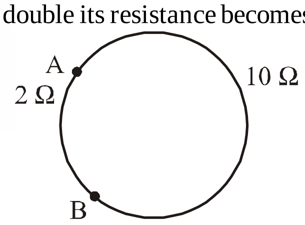
112. (b) $R_{eq} = \frac{\left(\frac{7R}{8}\right)\left(\frac{R}{8}\right)}{R} = \frac{7R}{64}$



113. (c) When length becomes double its resistance becomes $(R \propto l^2)$

$R = 4 \times 3 = 12\,\Omega$

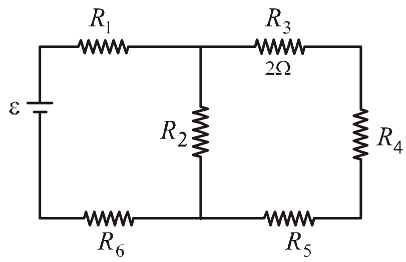
$$R_{eq} = \frac{2 \times 10}{12} = \frac{5}{3}\Omega$$



114. (c) R_3, R_4 and R_5 are in series so their equivalent

$R = 20 + 5 + 25 = 50\,\Omega$

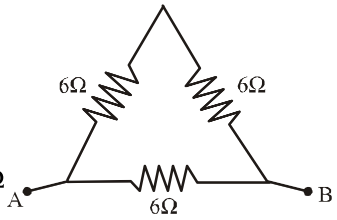
This is parallel with R_2, and so net resistance of the circuit



$$R_{eq} = \left(\frac{10 \times 50}{10+50}\right) + 15 + 30 = \frac{160}{3}\Omega$$

So, $i = \frac{\varepsilon}{R_{eq}} = \frac{15}{(100/3)} = \frac{9}{32}A$

115. (a) Resistance, $R \propto l$ so resistance of each side of the equilateral triangle = 6 Ω



Resistance R_{eq} between any two vertices

$$\frac{1}{R_{eq}} = \frac{1}{12} + \frac{1}{6} \Rightarrow R_{eq.} = 4\Omega$$

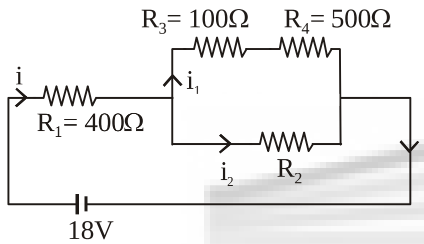
116. (b) Using, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$0.95\ R = \frac{RRv}{R + Rv}$ (measured value 5% less then internal resistance of voltmeter)

or, $0.95 \times 30 = 0.05\ Rv$

$\therefore Rv = 19 \times 30 = 570\ \Omega$

117. (a)



Across R_4 reading of voltmeter, $V_4 = 5V$

Current, $i_4 = \frac{V_4}{R_4} = 0.01A$

$V_3 = i_1 R_3 = 1V$

$V_3 + V_4 = 6V = V_2$

$V_1 + V_3 + V_4 = 18V$

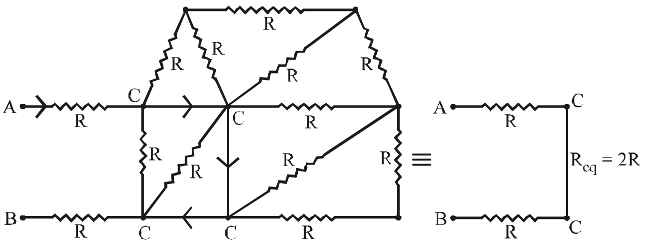
$\Rightarrow V_1 = 12\ V$

$$i = \frac{V_1}{R_1} = 0.03A$$

$i = i_1 + i_2 \Rightarrow i_2 = i - i_1 = 0.03 - 0.01A = 0.02\ A$

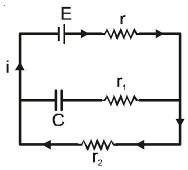
$$\therefore R_2 = \frac{V_2}{i_2} = \frac{6}{0.02} = 300\Omega$$

118. (a) Current will follow the path ACCCCB so we will get our final circuit as shown below



119. (a) In steady state, flow fo current through capacitor will be zero.

Current through the circuit,



$$i = \frac{E}{r + r_2}$$

Potential difference through capacitor

$$V_c = \frac{Q}{C} = E - ir = E - \left(\frac{E}{r + r_2}\right) r$$

$$\therefore \quad Q = CE\frac{r_2}{r + r_2}$$

120. (b) The potential difference in each loop is zero.

$\therefore$ No current will flow or current in each resistance is zero.

121. (b) Resistance between P and Q

$$r_{PQ} = r \,||\left(\frac{r}{3} + \frac{r}{2}\right) = \frac{r \times \frac{5}{6}r}{r + \frac{5}{6}r} = \frac{5}{11}r$$

Resistance between Q and R

$$r_{QR} = \frac{r}{2} \,||\, (r + \frac{r}{3}) = \frac{\frac{r}{2} \times \frac{4}{3}r}{\frac{r}{2} + \frac{4}{3}r} = \frac{4}{11}r$$

Resistance between P and R

$$r_{PR} = \frac{r}{3} \,||\left(\frac{r}{2} + r\right) = \frac{\frac{r}{3} \times \frac{3}{2}r}{\frac{r}{3} + \frac{3}{2}r} = \frac{3}{11}r$$

Hence, it is clear that r_{PQ} is maximum.

122. (d) Let R_1 and R_2 be the resistances of two conductors, then

$$R_1 = R_0\left[1 + \alpha_1 \Delta t\right]$$

$$R_2 = R_0\left[1 + \alpha_2 \Delta t\right]$$

Here, R_0 is the resistance of conductor at 0°C

In Series, $R = R_1 + R_2$

$$= R_0\left[2 + (\alpha_1 + \alpha_2)\Delta t\right] = 2R_0\left[1 + \left(\frac{\alpha_1 + \alpha_2}{2}\right)\Delta t\right]$$

$$\therefore \alpha_{eq} = \frac{\alpha_1 + \alpha_2}{2}$$

In Parallel, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_0\left[1 + \alpha_1 \Delta t\right]} + \frac{1}{R_0\left[1 + \alpha_2 \Delta t\right]}$

$$= \frac{1}{\frac{R_0}{2}(1 + \alpha_{eq}\Delta t)} = \frac{1}{R_0(1 + \alpha_1 \Delta t)} + \frac{1}{R_0(1 + \alpha_2 \Delta t)}$$

$$2(1 - \alpha_{eq}\Delta t) = (1 - \alpha_1 \Delta t)(1 - \alpha_2 \Delta t) \qquad \therefore \alpha_{eq} = \frac{\alpha_1 + \alpha_2}{2}$$

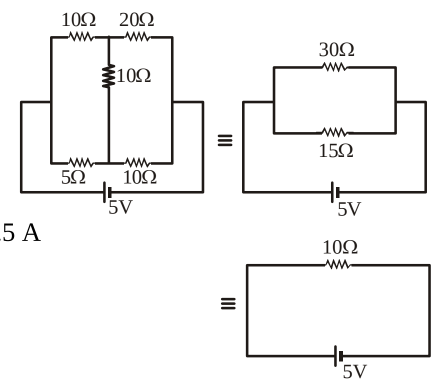
123. (b) The network of resistors is a balanced wheatstone bridge. Hence, no current will flow through centre resistor. The equivalent circuit is

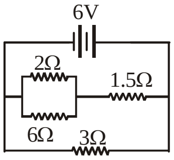
$$R_{eq} = \frac{15 \times 30}{15 + 30}$$

$$= 10\ \Omega$$

$$\Rightarrow \quad I = \frac{V}{R}$$

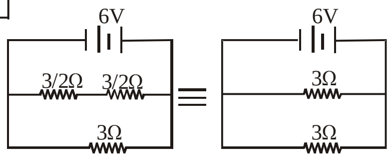
$$= \frac{5}{10} = 0.5\ A$$



124. (a) 

hence $R_{eq} = 3/2$;

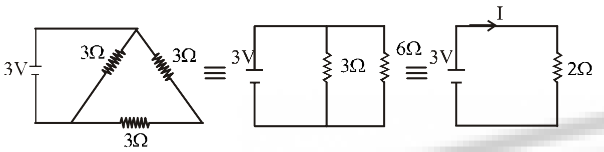
$\therefore I = \dfrac{6}{3/2} = 4A$

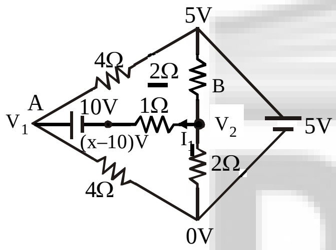


125. (b) In the given circuit, resistance of 3Ω is in parallel with series combination of two 3Ω resistance.

$$R_p = \frac{3\times 6}{3+6} = \frac{18}{9} = 2\Omega$$

Using ohm's law $V = IR \Rightarrow I = \dfrac{V}{R} = \dfrac{3}{2} = 1.5A$



126. (25) 

At B

$$\frac{v_2 - 5}{2} + \frac{v_2 - 0}{2} + \frac{v_2 - v_1 + 10}{1} = 0$$

$\Rightarrow$ $v_2 - 5 + v_2 + 2v_2 - 2v_1 + 20 = 0$

$\Rightarrow$ $4v_2 - 2v_1 + 15 = 0$ ...(i)

At A

$\Rightarrow$ $\dfrac{v_1 - 5}{4} + \dfrac{v_1 - 0}{4} + \dfrac{v_1 - 10 - y}{1} = 0$

$\Rightarrow$ $v_1 - 5 + v_1 + 4v_1 - 40 - 4v_2 = 0$

$\Rightarrow$ $6v_1 - 4v_2 + 45 = 0$ ...(i)

$\Rightarrow$ $-2v_1 + 4v_2 + 15 = 0$ ...(ii)

$4v_1 - 30 = 0$

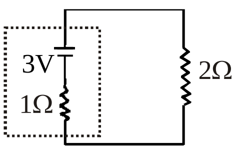
$\Rightarrow$ $v_1 = \dfrac{15}{2}$ & $4v_2 - 15 + 15 = 0 \Rightarrow v_2 = 0$

$\Rightarrow$ $i = \dfrac{v_2 - v_1 + 10}{1}$

$\Rightarrow$ $i = \dfrac{0 - 7.5 + 10}{1} \Rightarrow i = 2.5A = \dfrac{n}{10}A$

$n = 25$

127. (a) The circuit can be redrawn as



Current, $i = \dfrac{E}{R_{eq}} = \dfrac{3}{1+2} = 1A$

Terminal potential difference, $V = E - Ir$

$= 3 - 1 \times 1 = 2V$

128. (4) Electric field, $E = \dfrac{Q}{A\varepsilon_0}$

$\Rightarrow E \propto Q \Rightarrow \dfrac{E_2}{E_1} = \dfrac{Q_2}{Q_1}$

$\Rightarrow \dfrac{E_0/3}{E_0} = \dfrac{Q_2}{Q_0} \Rightarrow Q_2 = \dfrac{Q_0}{3}$

Now, $Q = Q_0 e^{-\frac{t}{RC}}$

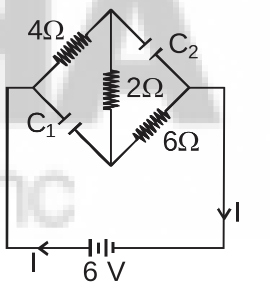
Also $\dfrac{Q_0}{3} = Q_0 e^{-\frac{t}{RC}} \Rightarrow ln\left(\dfrac{1}{3}\right) = \dfrac{-t}{RC}$

$\Rightarrow R = \dfrac{t}{C In 3} = 4\Omega$

129. (c) All the cells are connected in series,

$I = \dfrac{E_{eq}}{r_{eq}} = \dfrac{8\times 5}{8\times 0.2} = 25A$

Potential, $V = E - ir = 5 - 0.2 \times 25 = 0\,V$

130. (d) 

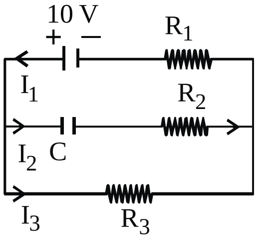
Equivalent Resistance in steady state $R_{eq} = 4 + 2 + 6 = 12\Omega$

Current, $I = \dfrac{V}{R_{eq}} = \dfrac{6}{12} = 0.5A$

Potential across C_1 is $V_1 = (4+2)I = 6 \times 0.5 = 3V$

Potential across C_2 is $V_2 = (6+2)I = 8 \times 0.5 = 4V$

$\dfrac{q_1}{q_2} = \dfrac{C_1V_1}{C_2V_2} = \dfrac{1}{2}$

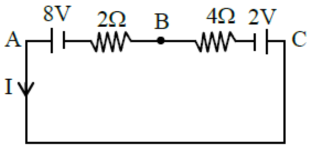
131. (60) 

In steady state current in capacitor is zero i.e., $I_2 = 0$

$I_1 = I_3 = \dfrac{V}{R_1 + R_3} = \dfrac{10}{4+6} = 1A$

$V_3 = V_2 + V_c$
$V_c = I_3R_3 = 1 \times 6 = 6\,V$
Charge $Q = CV_c = 10 \times 6 = 60\,\mu C$

132. (6)



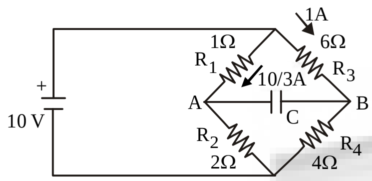
$$I = \frac{8-2}{2+4} = \frac{6}{6} = 1A$$

Applying Kirchhoff voltage law, KVL C to B

$V_C - 2 - 4 \times 1 = V_B$

$V_C - V_B = 6\,V$

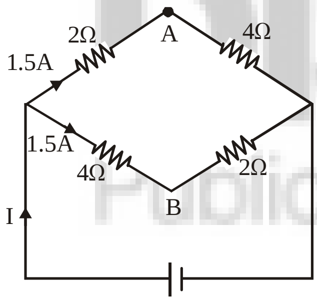
133. (400) Considering circuit diagram



$$V_A + \frac{10}{3}(1) - 6(1) = V_B \Rightarrow V_A - V_B = 6 - \frac{10}{3} = \frac{8}{3}V$$

$$Q = C(V_A - V_B) = 150 \times \frac{8}{3} = 400\mu C$$

134. (3)



$$R_{eq} = \frac{6 \times 6}{6+6} = 3\Omega$$

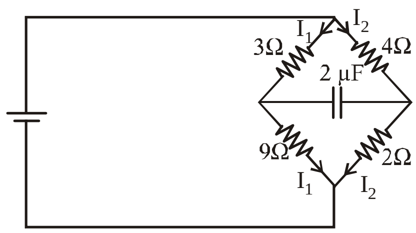
In the circuit $I = \frac{9}{3} = 3A$ $(\because V = IR_{eq})$

$V_C - V_A = 2 \times 1.5 = 3$ .....(i)
$V_C - V_B = 4 \times 1.5 = 6$ .....(ii)
from equation (i) and (ii)
The magnitude of voltage difference between the point A and B,
$V_A - V_B = 6 - 3 = 3$ Volt

135. (75) For the given circuit, current

$$I_1 = \frac{V}{R_{eq}} = \frac{12}{3+9} = 1A$$

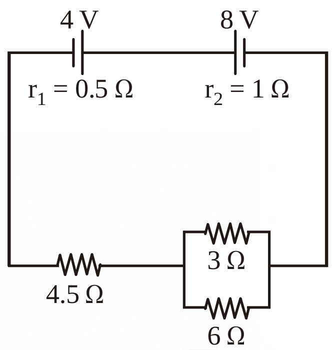
$$I_2 = \frac{V}{R'_{eq}} = \frac{12}{4+2} = 2A$$



Now using Kirchhoff rule,
$V_A - V_C = 3I_1 = 3V$ ...(i)
$V_A - V_D = 2 \times 4 = 8V$ ... (ii)
Subtracting eq. (i) from eq. (ii)
$V_C - V_D = 5V \Rightarrow V = 5V$

$\therefore$ Energy stored $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 6 \times 5^2 = 75\mu J$

136. (1)

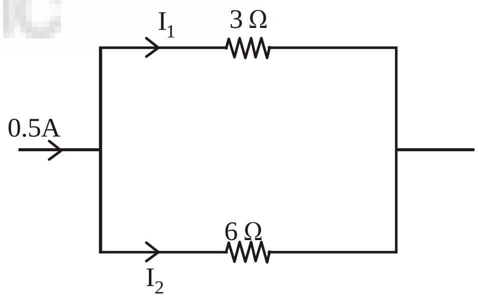


Effective emf,

$E_2 - E_1 = 8 - 4 = 4V$

$$R_{eq} = 0.5\,\Omega + 1\,\Omega + 4.5\,\Omega + \frac{6 \times 3}{3+6}\,\Omega = 8\,\Omega$$

Current, $I = \frac{4}{8} = 0.5A$



Current through 3Ω resistance,

$$\therefore I_1 = \left(\frac{6}{3+6}\right) \times 0.5 = \frac{2}{3} \times 0.5 = \frac{1}{3}A$$

$$\Rightarrow I_1 = \frac{x}{3} = \frac{1}{3} \therefore x = 1$$

137. (5) Reading of voltmeter, $V = 1.5\,V$
Net emf, $E = 1.5\,V + 1.5\,V = 3\,V$
External resistance, $R = 10\Omega$
Let r be the internal resistance of each cell.
Using, $V = IR$
$V = I \times 10$

$$\Rightarrow 1.5 = \left(\frac{3}{10+2r}\right) \times 10 \Rightarrow r = 5\Omega$$

138. (b) Resistance of the coil of galvanometer, $R_G = 2\Omega$. Capacitor behave as open circuit.
At steady state, current in the circuit is

$$i = \frac{4V}{6+2+8} = \frac{1}{4}A$$

Voltage across C_1 is

$$V_1 = V_{AC} = i\,(R_{AB} + R_G) = i\,(6\Omega + 2\Omega) = \frac{1}{4} \times 8 = 2V$$

Voltage across C_2 is

$$V_2 = V_{BD} = i\,(R_G + R_{CD}) = i\,(2\Omega + 8\Omega) = \frac{1}{4} \times 10 = 2.5V$$

$$\Rightarrow \frac{V_1}{V_2} = \frac{2}{2.5} = \frac{4}{5}$$

139. (a) Sum of current at junction point will be zero:

$$\frac{x-30}{10} + \frac{x-12}{20} + \frac{x-2}{30} = 0$$

$$\Rightarrow x\left(\frac{1}{10} + \frac{1}{20} + \frac{1}{30}\right) = \frac{30}{10} + \frac{12}{20} + \frac{2}{30}$$

$$\Rightarrow x\left(\frac{6+3+2}{60}\right) = \frac{180+36+4}{60}$$

$$\Rightarrow x = \frac{220}{11} = 20V$$

Hence, current through the 20Ω resistor will be

$$\frac{x-12}{20} = \frac{20-12}{20} = \frac{2}{5} = 0.4A$$

140. (2) We have $10I_1 = 10I_2 = 10V$

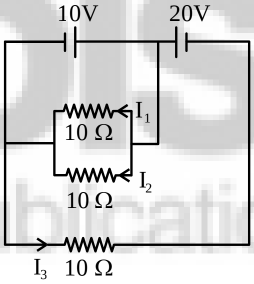
$\Rightarrow I_1 = I_2 = 1A$

and, $-10V + 20V - 10I_3 = 0$

[By KVL in largest loop]

$\Rightarrow 10V = 10I_3 \Rightarrow I_3 = 1\,A$

So, $\left|\dfrac{I_1 + I_3}{I_2}\right| = \dfrac{1+1}{1} = 2$



141. (5) When cell is connected in parallel

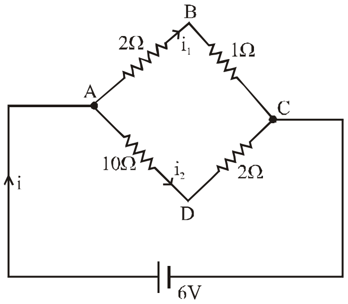
$$i = \frac{2\in}{2r + R}$$

When cell is connected in series

$$i = \frac{\in}{\frac{r}{2} + R} = \frac{2\in}{r + 2R} \text{ So, } \frac{2\in}{2r + R} = \frac{2\in}{r + 2R}$$

$\Rightarrow 2r + R = r + 2R \Rightarrow r = R \Rightarrow r = 5\Omega$

142. (1) As capacitor behaves like open switch to DC. So, circuit will look like as shown below



Here, $R_{eq} = \dfrac{3 \times 12}{3+12} = \dfrac{36}{15} = \dfrac{12}{5}\Omega$

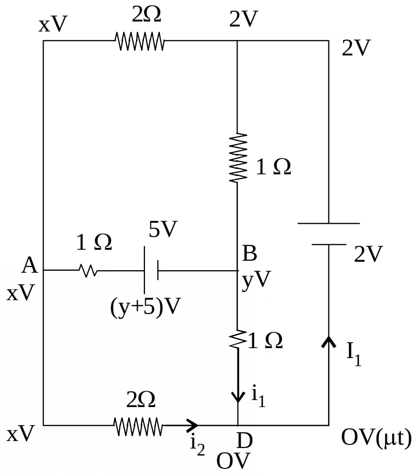
So, $i = \dfrac{6}{\frac{12}{5}} = \dfrac{5}{2} = 2.5A$

and, $i_1 = 2.5 \times \dfrac{12}{15} = 2A$; $i_2 = 2.5 \times \dfrac{3}{15} = 0.5A$

Applying KVL between B and D, we get

$V_B - V_D = -2i_1 + 10i_2 = -2 \times 2 + 10 \times 0.5 = 1A$

143. (1.5)



Junction law at A,

$$\frac{x-(y+5)}{1} + \frac{x-2}{2} + \frac{x-0}{2} = 0 \quad \text{...(1)}$$

Junction law at B,

$$\frac{y+5-x}{1} + \frac{y-0}{1} + \frac{y-2}{1} = 0 \quad \text{...(2)}$$

On solving equation (1) and Equation (2)

$x = 3$ & $y = 0$

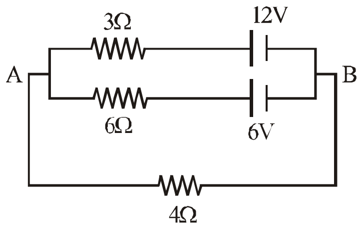
At D junction

$I_1 = i_1 + i_2$

$$I_1 = \frac{y-0}{1} + \frac{x-0}{2} = \frac{0-0}{1} + \frac{3-0}{2}$$

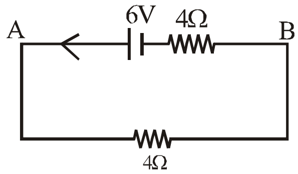
$I_1 = 1.5\,A$

144. (1)

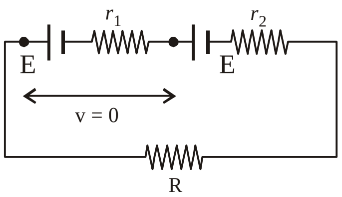


$$E_{eq} = \frac{\left(\frac{E_1}{r_1} + \frac{E_2}{r_2}\right)}{1/R_{eq}}$$

$$= \frac{\left(\frac{12}{3} - \frac{6}{6}\right)}{\frac{1}{3} + \frac{1}{6}} = 6\,V$$



145. (a)



We have, $E - ir_1 = 0$ $[\because V_{r_1} = 0]$

$\Rightarrow E - ir_1$

Now, $i = \dfrac{2E}{r_1 + r_2 + R}$

$\Rightarrow \dfrac{E}{r_1} = \dfrac{2E}{r_1 + r_2 + R}$ $\left[\because i = \dfrac{E}{r_1}\right]$

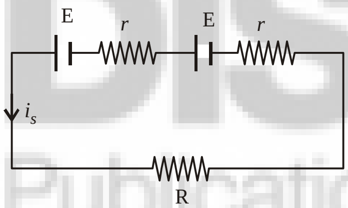
$\Rightarrow r_1 + r_2 + R = 2r_1 \Rightarrow R = r_1 - r_2$

146. (4) $E_{eq} = \dfrac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \dfrac{\frac{2}{1} + \frac{4}{1} + \frac{4}{1}}{\frac{1}{1} + \frac{1}{1} + \frac{1}{1}} = \dfrac{12}{3}$ V

$r_{eq} = \dfrac{1}{3}$ kΩ

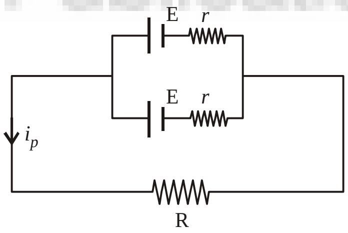
So, $V_o = E_{eq} - i r_{eq} = \dfrac{12}{3} - 0 \times \dfrac{1}{3} = 4$ V

147. (a) In series



$i_s = \dfrac{2E}{2r + 2}$

In parallel



$i_p = \dfrac{E}{\frac{r}{2} + 2} = \dfrac{2E}{r + 4}$

as, $i_s = i_p$

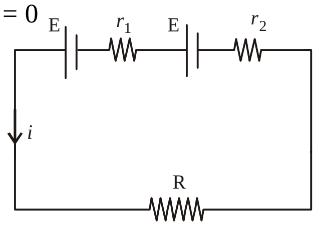
$\Rightarrow \dfrac{2E}{2r + 2} = \dfrac{2E}{r + 4}$

$\Rightarrow r = 2\Omega$

148. (a) We have,

$i = \dfrac{E_{net}}{R_{net}} = \dfrac{2E}{R + x_1 + x_3}$

As. P.d across second cell = 0



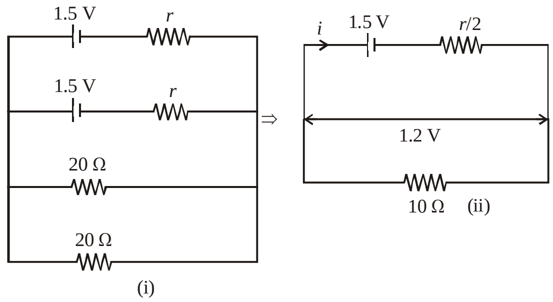
$\Rightarrow$ E-$ir_2 = 0$ [$\because V = E - iR$]

$\Rightarrow E - \dfrac{2Er_2}{R + r_1 + r_2} = 0$

$\Rightarrow R + r_1 + r_2 - 2r_3 = 0$

$\Rightarrow R = r_2 - r_1$

149. (c)



Here, $i = \dfrac{10}{1.2}$ A

From figure (ii), $1.2 = 1.5 - i\dfrac{r}{2}$

$1.2 = 1.5 - \left(\dfrac{1.2}{10}\right)\dfrac{r}{2} \Rightarrow 0.06\,r = 0.3$

$\Rightarrow r = \dfrac{0.30}{0.06} = 5\Omega$

150. (a) $i_r = \dfrac{25}{5 + R}$

in parallel, $E_{eq} = E = 5V$

$r_{eq} = \dfrac{r}{5} = \dfrac{1}{5}\Omega$

$i_2 = \dfrac{5}{R + \frac{1}{5}}$

putting $i_1 = i_2$,

we get, $4R = 4 \Rightarrow R = 1\Omega$.

151. (15) Here, $I = \dfrac{E}{R + r}$ $\therefore$ Terminal voltage $v = IR = \dfrac{ER}{R + r}$

When potential difference, V = 1.25V and $R_L = 5\Omega$, then

$1.25 = \dfrac{E(5)}{5 + r}$ ...(i)

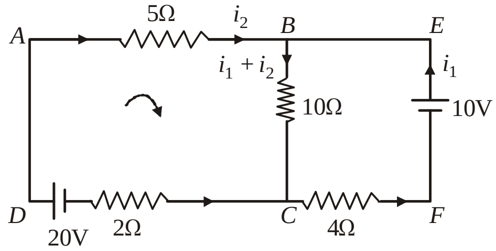
when potential difference V = 1 V and $R_L = 2\Omega$ then

$1 = \dfrac{E(2)}{2 + r}$ ...(ii)

From eq. (i) and (ii)

we get $E = \dfrac{3}{2} = \dfrac{15}{10}$ $\therefore$ value of x = 15

152. (c)



Using Kirchoff's loop law in loop *ABCD*

$-5i_2 - 10(i_1 + i_2) - 2i_2 + 20 = 0$

$\Rightarrow -10i_1 - 17i_2 + 20 = 0$ ...(i)

Using Kirchoff's loop law in loop *BEFC*

$\Rightarrow -10 + 4i_1 + 10(i_1 + i_2) = 0$

$\Rightarrow 14i_1 + 10i_2 + 10 = 0$ ...(ii)

Multiplying equation (i) by 10, we have

$(10i_1 + 17i_2 = 20) \times 10$

$\Rightarrow 100i_1 - 170i_2 = 200$ ...(iii)

Multiplying equation (ii) by 17, we have

$(14i_1 + 10i_2 = 10) \times 17$

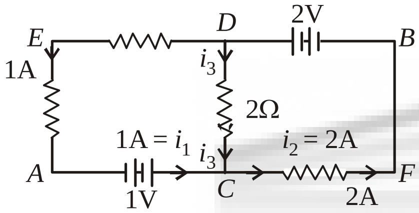
$\Rightarrow 238i_1 - 170i_2 = 170$ ...(iv)

On solving equations (iii) and (iv), we get

$-138i_1 = 30 \Rightarrow i_1 = -\dfrac{30}{138} = -0.217$

i_1 is negative it means current flows from positive to negative terminal.

153. (d)



Let us assume the potential at $A = V_A = 0$

Using Kirchoff's junction rule at *C*, we get

$i_1 + i_3 = i_2$

$1\text{A} + i_3 = 2\text{ A} \Rightarrow i_3 = 2A$

Now using Kirchoff's loop law along *ACDB*

$V_A + 1 + i_3(2) - 2 = V_B$

$\Rightarrow V_A + 1 + i_3(1) - 2 = V_B \Rightarrow V_B - V_A = 3 - 2 = 1$ volt

154. (c) The equivalent circuit can be drawn as

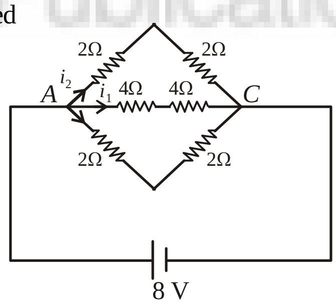
As $V_B = V_D$.

So arm BD will be removed

Voltage across $AC = 8$ V

Resistance $R_{AC} = 4 + 4$

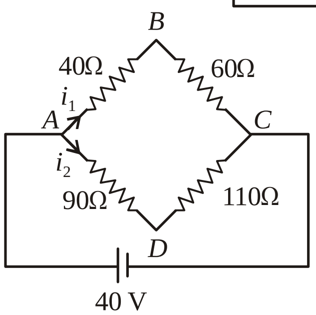
$= 8\ \Omega$



$i_1 = \dfrac{V}{R_{AC}} = \dfrac{8}{4+4}$

$= 1$ Amp

155. (2)



Current through *AB*, $i_1 = \dfrac{40}{40+60} = 0.4$

Current through *AD*, $i_2 = \dfrac{40}{90+110} = \dfrac{1}{5}$

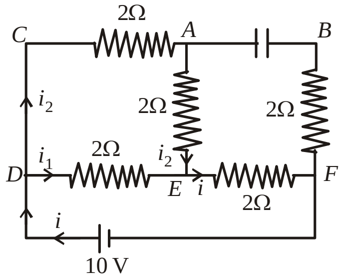
Using KVL in BAD loop

$V_B + i_1(40) - i_2(90) = V_D$

$\Rightarrow V_B - V_D = \dfrac{1}{5}(90) - \dfrac{4}{10}(40)$

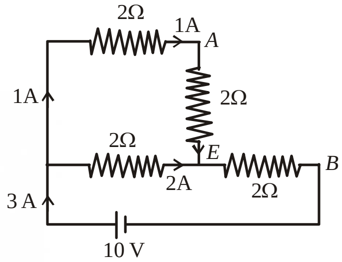
$\Rightarrow V_B - V_D = 18 - 16 = 2$ V

156. (08.00)



As capacitor is fully charged no current will flow through it.

We have the current distribution as shown in the figure.



Equivalent resistance,

$R_{eq} = \left(\dfrac{4\times 2}{4+2}\right) + 2$

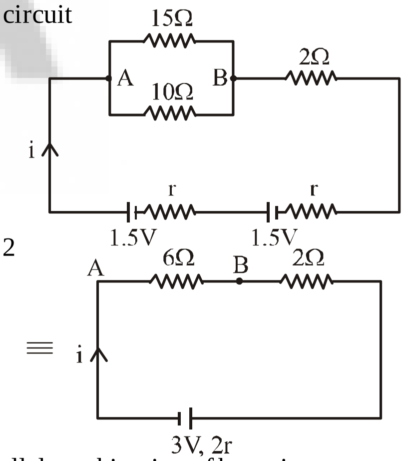
Net current,

$i = \dfrac{10}{\dfrac{4}{3}+2} = \dfrac{10\times 3}{10} = 3$ Amp

$i_1 = 2$ A and $i_2 = 1$ A

$V_{AEB} = 1\times 2 + 3\times 2 = 8$ V

157. (b) For the given circuit



$\text{i} = \dfrac{3}{8+2\text{r}}$

Now voltage across AB

$\text{i}\times 6 = \dfrac{3}{8+2\text{r}}\times 6 = 2$

$\Rightarrow 9 = 8 + 2\text{r}$

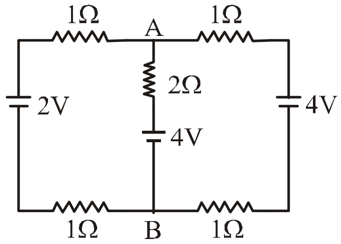
$\Rightarrow \text{r} = \dfrac{1}{2}\Omega$

158. (d) Applying parallel combination of batteries

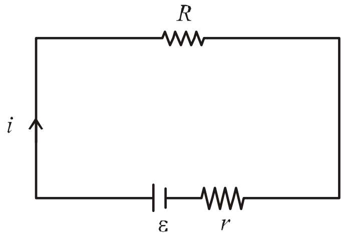
$$\dfrac{\dfrac{E_1}{1+1}+\dfrac{E_2}{2}+\dfrac{E_3}{1+1}}{\dfrac{1}{1+1}+\dfrac{1}{2}+\dfrac{1}{1+1}}$$

$$\Rightarrow \dfrac{\dfrac{2}{2}+\dfrac{4}{2}+\dfrac{4}{2}}{\dfrac{1}{2}+\dfrac{1}{2}+\dfrac{1}{2}} = \dfrac{5\times 2}{3}$$

$= \dfrac{10}{3} = 3.3$ Volt



159. (d) $i = \left(\dfrac{\varepsilon}{R+r}\right)$



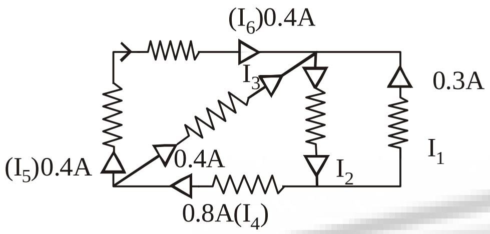
Power delivered to R.

$$P = i^2 R = \left(\frac{\varepsilon}{R+r}\right)^2 R$$

P to be maximum, $\dfrac{dP}{dR} = 0$

or $\dfrac{d}{dR}\left[\left(\dfrac{\varepsilon}{R+r}\right)^2 R\right] = 0$ or $R = r$

160. (b)



From KCL, $I_3 = 0.8 - 0.4 = 0.4$ A
$I_2 = 0.4 + 0.4 + 0.3 = 1.1$ A
and $I_6 = 0.4$ A

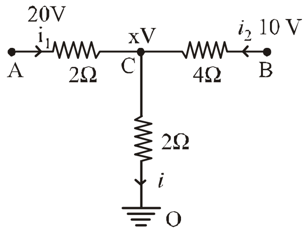
161. (b) Given, $E_1 = 1V, E_2 = 2V, E_3 = 3V, r_1 = 1\Omega$, $r_2 = 1\Omega$ and $r_3 = 1\Omega$. Here, $V_{AB} = V_{CD}$ because $i = 0$

$$V_{AB} = V_{CD} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \frac{\frac{1}{1} + \frac{2}{1} + \frac{3}{1}}{\frac{1}{1} + \frac{1}{1} + \frac{1}{1}} = \frac{6}{3} = 2V$$

162. (c) $i_2 = 0$ [Since current always choose least resistance path]

$$i_1 = \frac{V}{R_1} = \frac{10}{20} = 0.5A$$

163. (b) Let voltage at C = xV
From kirchhoff's current law,
KCL : $i_1 + i_2 = i$

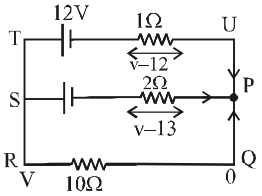


$$\frac{20 - x}{2} + \frac{10 - x}{4} = \frac{x - 0}{2}$$

$\Rightarrow x = 10$

$$\therefore i = \frac{V}{R} = \frac{X}{R} = \frac{10}{2} = 5A$$

164. (b) Using Kirchhoff's law at P we get



$$\frac{V-12}{1} + \frac{V-13}{2} + \frac{V-0}{10} = 0$$

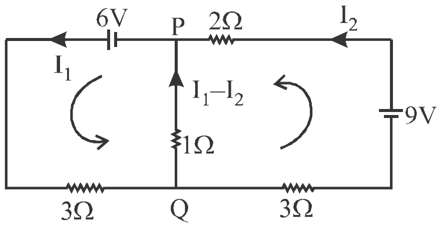
[Let potential at P, Q, U = 0
and at R = V]

$$\Rightarrow \frac{V}{1} + \frac{V}{2} + \frac{V}{10} = \frac{12}{1} + \frac{13}{2} + \frac{0}{10}$$

$$\Rightarrow \frac{10+5+1}{10} V = \frac{24+13}{2} \Rightarrow V\left(\frac{16}{10}\right) = \frac{37}{2}$$

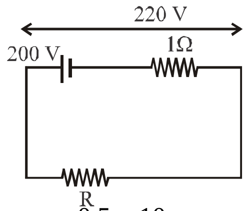
$$\Rightarrow V = \frac{37 \times 10}{16 \times 2} = \frac{370}{32} = 11.56 \text{ volt}$$

165. (a) From KVL, $-6 + 3I_1 + 1(I_1 - I_2) = 0$



$6 = 3I_1 + I_1 - I_2$; $4I_1 - I_2 = 6$ ...(i)
$-9 + 2I_2 - (I_1 - I_2) + 3I_2 = 0$
$-I_1 + 6I_2 = 9$ ...(ii)
On solving (i) and (ii)
$I_1 = 0.13$A
Direction Q to P, since $I_1 > I_2$.

166. (c) As 200 V battery is charging

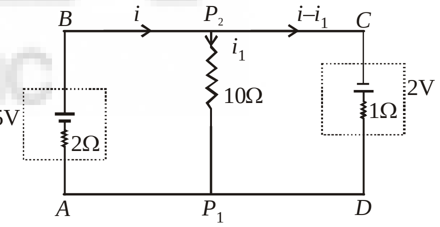


So, $220 = 200 + i.1$
$i = 20$ A
So, $20 \times R = 220$ V
$\Rightarrow R = 11\,\Omega$

167. (c) $\dfrac{100}{R+r} = \dfrac{90}{R} \Rightarrow \dfrac{R+r}{R} = \dfrac{10}{9} \Rightarrow 1 + \dfrac{0.5}{R} = \dfrac{10}{9}$

$\Rightarrow \dfrac{0.5}{R} = \dfrac{1}{9} \;\therefore\; R = 4.5\,\Omega$

168. (c) Applying Kirchoff's second law in $AB\,P_2P_1A$, we get
$-2i + 5 - 10\,i_1 = 0$
$2i + 10i_1 = 5$ .....(i)



Again applying Kirchoff's second law in $P_2\,CDP_1P_2$ we get,
$10\,i_1 + 2 - i + i_1 = 0$
$2_i - 22i_1 = 4$ ....(ii)
From (i) and (ii)

$32i_1 = 1 \Rightarrow i_1 = \dfrac{1}{32}$ A from P_2 to P_1

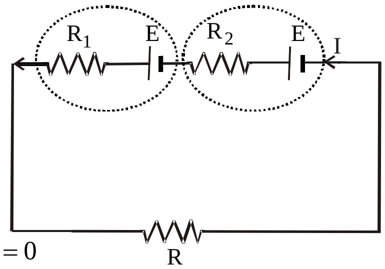
169. (a) Energy in capacitor = $\dfrac{1}{2}CV^2$
Work done by battery = $QV = CV^2$
where C = Capacitance of capacitor
V = Potential difference,
e = emf of battery

$$\text{Required ratio} = \frac{\frac{1}{2}CV^2}{CV^2} = \frac{1}{2} \quad (\because V = e)$$

170. (d) **Note :** Kirchhoff's first law is based on conservation of charge and Kirchhoff's second law is based on conservation of energy.

171. (a) Let E be the emf of each source of current

Current in the circuit



$$I = \frac{2E}{R + R_1 + R_2}$$

Potential difference across cell having internal resistance R_2

$V = E - iR_2 = 0$

$$E - \frac{2E}{R + R_1 + R_2} \cdot R_2 = 0$$

$$\Rightarrow R + R_1 + R_2 - 2R_2 = 0$$

$$\Rightarrow R + R_1 - R_2 = 0 \Rightarrow R = R_2 - R_1$$

172. (c) Power is, $P = \frac{v^2}{R} \Rightarrow P = \frac{v^2}{I\ell}A \Rightarrow P \propto \frac{1}{\ell}$

Also, power $P = I^2Rt$ $\quad \therefore P \propto t$

$$P \propto \frac{1}{\ell}$$

$$\frac{P_1}{P_2} = \frac{t_2}{t_1} = \frac{15}{20} = \frac{\ell_2}{\ell_1} \qquad \therefore \ell_2 = \frac{3}{4}\ell_1$$

Thus length should be decreased by $\frac{3}{4}$ times.

173. (5) Resistance of Heater is,

$$R_h = \frac{V^2}{P} = \frac{(100)^2}{1000} = 10\Omega$$

Voltage drop across heater is,

Also, $V = \sqrt{PR}$

$V = \sqrt{62.5 \times 10} = 25\,V$

Current through 10Ω resistance

$$i_1 = \frac{75}{10} = 7.5A,$$

Current through heater is

$$i_h = \frac{25}{10} = 2.5\,A.$$

Using Kirchoff's law

$i_R = i_1 - i_h = 5$

$$R = \frac{V}{CR}\frac{25}{5} = 5\Omega$$

174. (a) Power (P) is = V.I.

$\Rightarrow 110 = (220)\,(I) \Rightarrow I = \ 0.5\,A$

Now, current flowing is, $I = \frac{n.e}{t}$

$$\Rightarrow 0.5 = \left(\frac{n}{t}\right)(1.6 \times 10^{-19})$$

$$\Rightarrow \frac{n}{t} = \frac{0.5}{1.6 \times 10^{-19}} = 31.25 \times 10^{17}$$

175. (b) Power, $P = \frac{V^2}{R}$

As, $V_{5\Omega} = V_{10\Omega} = \text{constant}$

$$\Rightarrow P \propto \frac{1}{R}$$

$$\therefore \frac{P_{5\Omega}}{P_{10\Omega}} = \frac{10}{5} = \frac{2}{1}$$

176. (a) Resistance of filament of electric bulb

$$R = \frac{V^2}{P} = \frac{(200)^2}{50} = \frac{40000}{50} = 800\Omega$$

Therefore power dissipation of the bulb,

$$P = \frac{(V_{applied})^2}{R} = \frac{(100)^2}{800} = 12.5 \text{ watt}$$

177. (c) Power,

$P = I^2R$

Here, I = current

R= Resistance

$P_i = I_i^2 R$

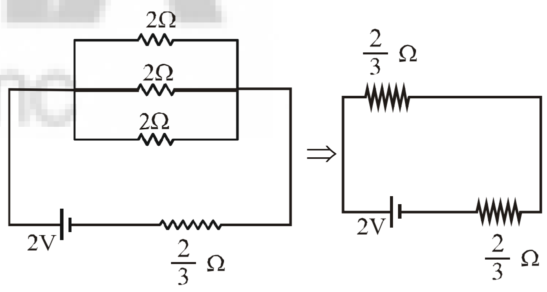
$P_f = (0.8I_i)^2R = 0.64I_i^2R$

$$\% \text{ decrease in power} = \frac{P_i - P_f}{P_i} \times 100 = (1 - 0.64) \times 100$$

$$= 0.36 \times 100 = 36\%$$

178. (3) Given,

Emf of the battery, V = 2V



$$\therefore \quad R_{eq} = 2 \times \frac{2}{3} = \frac{4}{3}\Omega$$

$$\text{Power, } P = \frac{V^2}{R_{eq}} = \frac{4}{4/3} = 3\text{ W}$$

179. (d) $\frac{v^2}{R} = W$ ...(i)

$$\frac{v^2}{\frac{1}{2}\left(\frac{R}{2}\right)} = W' \qquad \text{...(ii)}$$

From (i) & (ii), we get

$W' = 4W$

180. (d) Power $P = I^2R$ or, $P \propto R$ [$\because$ I = Constant]
For different combinations of resistances equivalent resistance

$$R_A = \frac{3R}{2}, R_B = \frac{2R}{3}, R_C = \frac{R}{3}, R_D = 3R$$

Therefore increasing order of power dissipation is $P_C < P_B < P_A < P_D$

181. (16) Power $P = VI = I^2 R = \frac{V^2}{R}$ and $R = \frac{\rho l}{A}$

If wire is cut in two equal half then $R = \frac{R}{2}$

Initial Power $P_1 = \frac{V_0^2}{R}$

After Power $P_2 = \frac{V_0^2}{R'} \times 2 \Rightarrow \frac{V_0^2}{R} \times 4$

$\therefore \frac{P_2}{P_1} = 4 = \frac{\sqrt{x}}{1} \quad \therefore x = 16$

182. (a) In parallel combination

Heat produced, $H_1 = \frac{V^2}{\left(\frac{R}{2}\right)} t = \frac{2V^2 t}{R}$

In series combination

Heat produced, $H_2 = \left(\frac{V^2}{2R}\right) t$

$\therefore \frac{H_2}{H_1} = 4$

183. (b) We have $H = i^2 Rt \Rightarrow H \propto i^2$

$$\Rightarrow \frac{H_1}{H_2} = \left(\frac{4}{16}\right)^2 = \frac{1}{16} \Rightarrow H_2 = 16H_1 = 16H$$

184. (a) Thermal energy is given by

$$H = P \times t = \frac{V^2}{R} \times t$$

Here, voltage V is same.

$$\therefore \quad \frac{H_1}{H_2} = \frac{\frac{V^2 t}{R}}{\frac{V^2 t}{3R}} = 3:1$$

185. (a) They have high resistivity, low-temperature coefficient of resistance ability to attain good resistance values in small size.

186. (14) For Bulb 1

$$R_1 = \frac{V^2}{P} = \frac{220^2}{100} = 484$$

For Bulb 2

$$R_2 = \frac{V^2}{P} = \frac{220^2}{60} = 484\left(\frac{10}{6}\right)$$

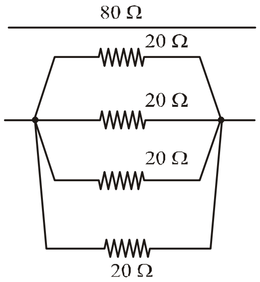
$$I = \frac{220}{484 + 484 \times \frac{10}{6}} \qquad \left[\because I = \frac{E}{R_1 + R_2}\right]$$

$P_1 = I^2 R_1 = 14.06$ W

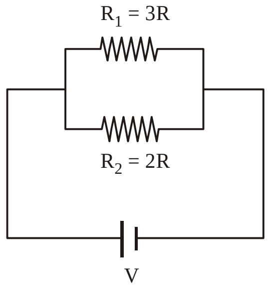
187. (c) **Statement 1 -** R = 80 Ω

$R_1 = R_2 = R_3 = R_4 = 20\,\Omega$

In parallel $R_{eq} = \frac{20}{4} = 5\,\Omega$



Statement 2 –



$$P_{th} = \frac{v^2}{R} \Rightarrow P \propto \frac{1}{R}$$

So, $\frac{P_1}{P_2} = \left(\frac{R_2}{R_1}\right) = \frac{2}{3}$ (where P is power)

188. (15) Thermal energy, $H = \frac{V^2}{R} t$

So, $H = \frac{V^2}{R_1} \times 20$ ...(i)

$H = \frac{V^2}{R_2} \times 60$ ...(ii)

Dividing (ii) by (i), we get

$$1 = \frac{R_2}{R_1} \times \frac{1}{3} \Rightarrow R_2 = 3R_1$$

Now, as $H = \frac{V^2}{R_{eq}} \times t \Rightarrow \frac{V^2}{R_1} \times 20 = \frac{V^2 \times t}{R_{eq}}$ [from (i)]

$$\Rightarrow \frac{20}{R_1} = \frac{t}{\frac{3R_1}{4}} \qquad \left[\because R_{eq} = \frac{R_1.3R_1}{R_1 + 3R_1}\right]$$

$\Rightarrow t = 15$ minutes

189. (b) Given

$\frac{1}{2}.\frac{\Delta U}{\Delta t} = P_{Bulb} \times N$, where $N =$ no. of bulb

$$\Rightarrow \frac{9 \times 10^4 \times 10 \times 40}{2 \times 3600} = 100 \times N \left[\because \frac{\Delta U}{\Delta t} = \frac{mgh}{3600} \frac{J}{S}\right]$$

$$\Rightarrow N = \frac{36 \times 10^6}{72 \times 10^4} \Rightarrow N = \frac{1}{2} \times 100 \Rightarrow N = 50$$

190. (975) As, $P = Vi$

$\Rightarrow 5 = 25i \Rightarrow i = 0.2A$

Now, $i = \frac{V_R}{R} \Rightarrow 0.2 = \frac{220 - 25}{R}$

$$R = \frac{195}{0.2} = 975\,\Omega$$

191. **(4)** First case $P_1 = \frac{V^2}{R} = \frac{(240)^2}{36}$

Second case $P_2 = \frac{V^2}{R/2} \times 2 = \frac{4v^2}{R} = \frac{4 \times (240)^2}{36}$

$\therefore \frac{P_1}{P_2} = \frac{1}{4} \Rightarrow x = 4.00$

192. **(b)** Given,

Mass of ice $m = \rho A \ell = 10^3 \times 10^{-4} \times 1 = 10^{-1}$ kg

Energy required to melt the ice

$\Delta Q_1 = ms\Delta t + mL = m(S\Delta t + L)$

$= 10^{-1}(2 \times 10^3 \times 10 + 3.33 \times 10^5) = 3.53 \times 10^4$ J

Heat produced in resistance

$\Delta Q_2 = i^2 Rt = \left(\frac{1}{2}\right)^2 (4 \times 10^3)(t)$

According to Question, $\Delta Q_1 = \Delta Q_2$

$\Rightarrow 3.53 \times 10^4 = \left(\frac{1}{2}\right)^2 \times 4 \times 10^3 \times t \Rightarrow t = 35.3$ sec

193. **(3840)** Rate of energy dissipated

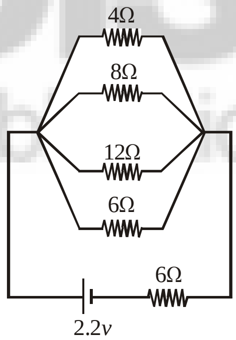
$= \frac{192J}{15} = i^2 R \Rightarrow 192 = 42 \times R, R = 12\Omega$

Energy $= i^2 Rt = (8)^2 \times 12 \times 5 = 3840\ J$

194. **(c)** Resistances 4Ω, 8Ω, $4 + 8\Omega$, $2 + 4\Omega$ are in parallel

$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{6} = \frac{6+3+2+4}{24} = \frac{15}{24}$

$\Rightarrow R_{eq} = \frac{24}{15}$



Total resistance

$R_{eq} = 1.6, R = 1.6 + 0.6 = 2.2\Omega$

$P = \frac{V^2}{R} = \frac{(2.2)^2}{2.2} = 2.2W$

195. **(a)** $\Delta Q = \Delta U + \Delta W$

$100 = \Delta U + 90 \Rightarrow \Delta U = 10$ watt

So, $t = \frac{25 \times 100}{10} = 250$ sec (a)

196. **(a)** Given, Power of electric bulb , P = 500W

$R = V_I \Rightarrow 500 = V_I$

$\Rightarrow I = 5$ Amp

As current remains same in series, using ohm's law

$V = I \times R_{eq}$

$\Rightarrow 200 = 5 \times R \Rightarrow R_{eq} = 40$

$\therefore R + 20 = 40 \Rightarrow R = 20\,\Omega$

197. **(2500)** From, $H = i^2 R\Delta T$

$10 \times 10^{-3} = (2 \times 10^{-3})^2 \times R \times 1 \quad \therefore R = 2500\ \Omega$

198. **(d)** Given : Power, $P = 1$ kW $= 1000$ W $= P_{output}$

$R = 2\Omega, V = 220$ V

Current, $I = \frac{P}{V} = \frac{1000}{220}$

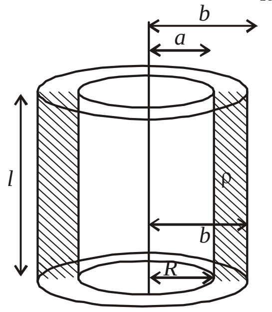
$P_{loss} = I^2 R = \left(\frac{1000}{220}\right)^2 \times 2$

$P_{in} = P_{output} + P_{loss}$

$\therefore$ Efficiency $= \frac{1000}{1000 + P_{loss}} \times 100 = 96\%.$

199. **(b)** Maximum power in external resistance is generated when it is equal to internal resistance of battery i.e., P_R maximum when $r = R$

The maximum Joule heating in R will take place for, the resistance of small element



$dR = \frac{\rho dr}{2\pi rl} \Rightarrow R = \frac{\rho}{2\pi l}\int_a^b \frac{dr}{r}$

$\Rightarrow R = \frac{\rho}{2\pi l} \ln \frac{b}{a}$

200. **(d)** Net Power, P

$= 15 \times 45 + 15 \times 100 + 15 \times 10 + 2 \times 1000$

$= 15 \times 155 + 2000$ W

Power, $P = VI \Rightarrow I = \frac{P}{V}$

$\therefore \quad I_{main} = \frac{15 \times 155 + 2000}{220} = 19.66\ A \approx 20A$

201. **(b)** Equivalent resistance,

$R_{eq} = \frac{4R \times 4R}{4R + 4R} + R + \frac{6R \times 12R}{6R + 12R} + R$

$= 2R + R + 4R + R = 8R.$

Using, $P = \frac{V^2}{R_{eq}} \Rightarrow 4 = \frac{16^2}{8R} \quad \therefore R = \frac{16^2}{4 \times 8} = 8\,\Omega$

202. **(b)** $\Delta Q = mS\Delta T + mL$

$\frac{V^2}{R} \times t = mS\Delta T + mL$

$\Rightarrow \frac{200^2}{20} \times t = 1 \times 4200 \times 80 + 1 \times 2260 \times 10^3$

$\Rightarrow t = 1298$ sec $\Rightarrow t \simeq 22$ sec

203. **(a)** As $R = \frac{V^2}{P}$, so $R_1 = \frac{220^2}{25}$ and $R_2 = \frac{220^2}{100}$

Current flown $i = \frac{220}{R_1 + R_2}$

$P_1 = i^2 R_1 = \frac{220^2}{\left(\frac{220^2}{25} + \frac{220^2}{100}\right)} \times \frac{220^2}{25} = 16$ W

Similarly, $P_2 = i^2 R_2 = 4$ W

204. **(b)** When two resistances are connected in series, $R_{eq} = 2R$

Power consumed, $P = \frac{\varepsilon^2}{R_{eq}} = \frac{\varepsilon^2}{2R}$

In parallel condition, $R_{eq} = R/2$.

New power, $P' = \dfrac{\varepsilon^2}{(R/2)}$

or $P' = 4P = 240\text{ W} (\because\ P = 60\text{ W})$

205. (a) Power, $P = I^2R$

$4.4 = 4 \times 10^{-6} \times R \Rightarrow R = 1.1 \times 10^6 \Omega$

When supply of 11 v is connected

Power, $P' = \dfrac{v^2}{R} = \dfrac{11^2}{1.1} \times \dfrac{11^2}{1.1} \times 10^{-6} = 11 \times 10^{-5}\text{ W}$

206. (a) Rate of heat i.e., Power developed in the wire $= P = \dfrac{V^2}{R}$

Resistance of the wire of length, L $R_1 = \dfrac{\rho L}{A} = \dfrac{\rho L}{\pi r^2}$

$\therefore$ Power, $P_1 = \dfrac{V^2}{R_1}$

Resistance of the wire when length is halved i.e., $L/2$

$$R_2 = \frac{\rho \frac{L}{2}}{\pi (2r)^2} = \frac{\rho L}{\pi 8 r^2} = \frac{R_1}{8}$$

$\therefore$ Power, $P_2 = \dfrac{V}{\frac{R_1}{8}} = \dfrac{8V}{R_1}$ or, $P_2 = 8P_1$

i.e., power increased 8 times of previous or original wire.

207. (c) $i = \dfrac{V}{R + \dfrac{Rr}{R+r}} \times \left(\dfrac{R}{R+r}\right) = \dfrac{V}{R+2r}$

So, $P = i^2R = \dfrac{V^2R}{(R+2r)^2}$

for H_{max}, P is maximum

$$\frac{dp}{dr} = 0 \Rightarrow \frac{(R+2r)^2 - 2(R+2r).2r}{(R+2r)^4} = 0$$

$\Rightarrow (R + 2r)(R + 2r - 4r) = 0$

$\Rightarrow r = -\dfrac{R}{2}$ or $r = \dfrac{R}{2}$ $\Rightarrow r = \dfrac{R}{2}$ so, $f = \dfrac{1}{2}$

208. (c) Total power consumed by electrical appliances in the building, $P_{total} = 2500\text{W}$

Watt = Volt × ampere

$\Rightarrow$ $2500 = V \times I \Rightarrow 2500 = 220\, I$

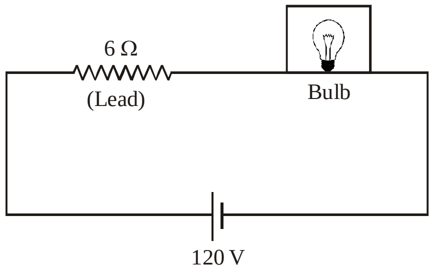
$\Rightarrow$ $I = \dfrac{2500}{220} = 11.36 \approx 12\text{A}$

(Minimum capacity of main fuse)

209. (c) Current in each bulb $= \dfrac{\text{Power}}{\text{Voltage}} = \dfrac{100}{220} = 0.45\text{A}$

Current through ammeter = 0.45 × 3 = 1.35 A

210. (d)



Power of bulb = 60 W (given)

Resistance of bulb $= \dfrac{120 \times 120}{60} = 240\Omega$ $\left[\because\ P = \dfrac{V^2}{R}\right]$

Power of heater = 240W (given)

Resistance of heater $= \dfrac{120 \times 120}{240} = 60\Omega$

Voltage across bulb before heater is switched on,

$V_1 = \dfrac{240}{246} \times 120 = 117.73$ volt

Voltage across bulb after heater is switched on,

$V_2 = \dfrac{48}{54} \times 120 = 106.66$ volt

Hence decrease in voltage

$V_1 - V_2 = 117.073 - 106.66 = 10.04$ Volt (approximately)

211. (c) $R_{25w} = \dfrac{220^2}{25} = 1936\Omega$

$R_{100w} = \dfrac{220^2}{100} = 484\Omega$

$V_{25w} = \dfrac{1936}{2420} \times 440 = 252\text{ V} > 220\text{ V}$

So, 25 watt bulb will fuse.

212. (c) Resistors 4 Ω, 6 Ω and 12 Ω are connected in parallel, its equivalent resistance (R) is given by

$\dfrac{1}{R} = \dfrac{1}{4} + \dfrac{1}{6} + \dfrac{1}{12} \Rightarrow R = \dfrac{12}{6} = 2\Omega$

Again R is connected to 1.5 V battery whose internal resistance $r = 1\ \Omega$.

Equivalent resistance now,

$R' = 2\Omega + 1\Omega = 3\Omega$

Current, $I_{total} = \dfrac{V}{R'} = \dfrac{1.5}{3} = \dfrac{1}{2}\text{A}$

$I_{total} = \dfrac{1}{2} = 3x + 2x + x = 6x \Rightarrow x = \dfrac{1}{12}$

$\therefore$ Current through 4Ω resistor = $3x$

$= 3 \times \dfrac{1}{12} = \dfrac{1}{4} A$

Therefore, rate of Joule heating in the 4Ω resistor

$= I^2R = \left(\dfrac{1}{4}\right)^2 \times 4 = \dfrac{1}{4} = 0.25\text{W}$

213. (b) Let resistance of bulb filament be R_0 at 0°C using $R = R_0(1 + \alpha\, \Delta t)$ we have

$R_1 = R_0 [1 + \alpha \times 100] = 100$ ....(1)

$R_2 = R_0[1 + \alpha \times T] = 200$ ....(2)

On dividing we get

$\frac{200}{100} = \frac{1+\alpha T}{1+100\alpha} \Rightarrow 2 = \frac{1+0.005T}{1+100\times 0.005}$

$\Rightarrow T = 400°C$

Note : We may use this expression as an approximation because the difference in the answers is appreciable. For accurate results one should use $R = R_0 e^{\alpha \Delta T}$

214. (c) The resistance of the electric bulb is

$R = \frac{V^2}{P} = \frac{(220)^2}{100}$

The power consumed when operated at 110 V is

$P' = \frac{V^2}{R} \Rightarrow P = \frac{(110)^2}{(220)^2/100} = \frac{100}{4} = 25 \text{ W}$

215. (b) Heat generated,

$H = \frac{V^2 t}{R}$

After cutting equal length of heater coil will become half. As $R \propto \ell$

Resistance of half the coil $= \frac{R}{2}$

$H' = \frac{V^2 t}{\frac{R}{2}} = 2H$

$\therefore$ As R reduces to half, 'H' will be doubled.

216. (b) Power, $P = Vi = \frac{V^2}{R}$

$\therefore$ Resistance of tungsten filament when in use

$R_{\text{hot}} = \frac{V^2}{P} = \frac{200\times 200}{100} = 400\Omega$

Resistance when not in use *i.e.*, cold resistance

$R_{\text{cold}} = \frac{400}{10} = 40\Omega$

217. (a) Thermistors are usually made of metaloxides with high temperature coefficient of resistivity.

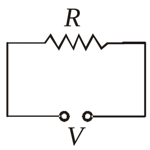
218. (a) Heat supplied in time t for heating 1L water from 10°C to 40°C

$\Delta Q = mC_p \times \Delta T = 1 \times 4180 \times (40 - 10) = 4180 \times 30$

But $\Delta Q = P \times t = 836 \times t \Rightarrow t = \frac{4180\times 30}{836} = 150\text{s}$

219. (b) **Case 1 :** Initial power dissipation,

$P_1 = \frac{V^2}{R}$

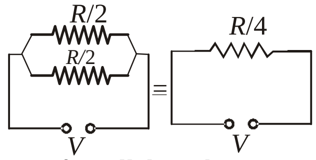


Case 2 : When wire is cut into two equal pieces, the resistance of each piece is $\frac{R}{2}$. When they are connected in parallel

Equivalent resistance, $R_{eq} = \frac{R/2}{2} = \frac{R}{4}$

Power dissipated,

$P_2 = \frac{V^2}{R/4} = 4\left(\frac{V^2}{R}\right) = 4P_1$



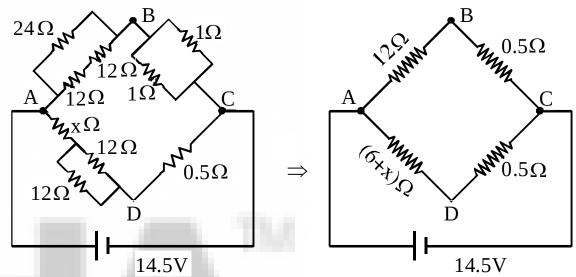
220. (b) The equivalent resistance of parallel combination of 2Ω and R is $R_{eq} = \frac{2\times R}{2+R}$

$\therefore$ Power dissipation $P = \frac{V^2}{R_{eq}}$ $\therefore$ $150 = \frac{(15)^2}{R_{eq}}$

$\Rightarrow 150 = \frac{225\times(R+2)}{2R} \Rightarrow \frac{2R}{2+R} = \frac{3}{2}$

$\Rightarrow 4R = 6 + 3R \Rightarrow R = 6\Omega$

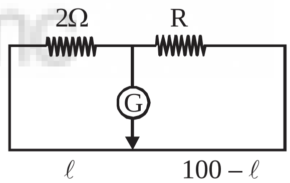
221. (c) Solving resistance in series and parallel,



Using balanced condition of Wheatstone Bridge

$\frac{12}{6+x} = \frac{0.5}{0.5} \Rightarrow x = 6\Omega$

222. (a)



Condition for Wheatstone Bridge is, $\frac{R_1}{R_2} = \frac{\ell}{100-\ell}$

In Ist case $\frac{2}{R} = \frac{40}{60} \Rightarrow R = 3\Omega$

on shunting with 2Ω resistance $R' = \frac{2\times 3}{2+3} = 1.2\Omega$

Applying condition of Wheatstone Bridge

$\frac{2}{1.2} = \frac{\ell}{100-\ell} \Rightarrow \ell = \frac{200}{3.2} = 62.5\text{cm}$

Balance length changes by $62.5 - 40 = 22.5$ cm

223. (a) If deflection through galvanometer is zero.

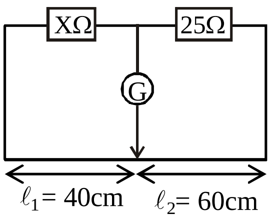
$\frac{0.8}{1} = \frac{R}{3} \Rightarrow R = 2.4\text{ m}\Omega$

Temperature fall is 20°C

Resistance, $\Delta R = R\ \alpha\ \Delta t = -10^{-2}C^{-1}$

$\Rightarrow \alpha = \frac{\Delta R}{R\Delta t} = \frac{-0.6}{3\times 20} = -1\times 10^{-2}°C^{-1}$

224. (d)



From the balancing condition of meter bridge

$$\frac{X}{\ell_1} = \frac{25}{100-\ell_1}$$

In first case

$$\frac{X}{r\ell_1} = \frac{25}{r\ell_2} \qquad ...(i)$$

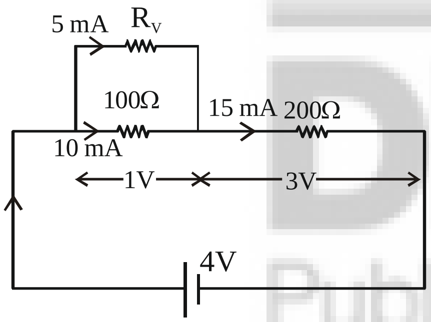
In second case

$$\frac{X}{2r\ell'_1} = \frac{25}{2r\ell'_2} \qquad ...(ii)$$

From (i) and (ii)

$\ell'_1 = \ell_1 = 40$ cm

225. (200)



$3 = 200 \times i \Rightarrow i = 15\,mA$

$1 = 100 \times i_1 \Rightarrow i_1 = 10\,mA$

Then, $i - i_1 = 15 - 10 = 5\,mA$

$$\therefore\ R_v = \frac{1}{5mA} = \frac{1}{5\times10^{-3}} = 200\,\Omega$$

226. (c) For null point in balanced condition, $\frac{P}{Q} = \frac{\ell_1}{100-\ell_1}$

$$\therefore\quad \frac{4.5}{60} = \frac{R}{40}$$

Also, $R = \frac{\rho\ell}{A} = \frac{\rho\ell}{\pi r^2} \Rightarrow 4.5 \times 40 = \rho \times \frac{0.1}{\pi\times7\times10^{-8}} \times 60$

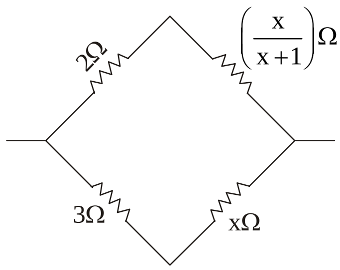
$\therefore\ \rho = 66\times10^{-7}\,\Omega m$

227. (d) Specific resistance is independent of dimension of wire so, it will remain unchanged i.e., S_1

228. (d) From Kirchhoff's voltage law, KVL,

$V_1 + V_2 - V_3 = 0 \Rightarrow V_1 + V_2 = V_3$

229. (2) The given circuit can be redrawn as



As potential difference between B and D is zero, the given circuit is wheatstone bridge,

$$\frac{2}{3} = \frac{\frac{x}{x+1}}{x} \Rightarrow \frac{2}{3} = \frac{1}{x+1} \Rightarrow x = 0.5 = \frac{1}{2}$$

$\therefore$ n = 2

230. (30) Case I: $\frac{R_1+R_2}{10} = \frac{60}{40} = \frac{3}{2} \Rightarrow R_1 + R_2 = 15$

Case II: $\frac{R_1R_2}{(R_1+R_2)\times3} = \frac{40}{60} \Rightarrow \frac{R_1R_2}{45} = \frac{2}{3}$

$\Rightarrow R_1R_2 = 30$

231. (20) Given,

Resistance in the left gap, P = 4Ω

From the balancing condition of meter bridge

$$\frac{P}{Q} = \frac{l_1}{100-l_1} = \frac{40\text{ cm}}{100\text{ cm} - 40\text{ cm}}$$

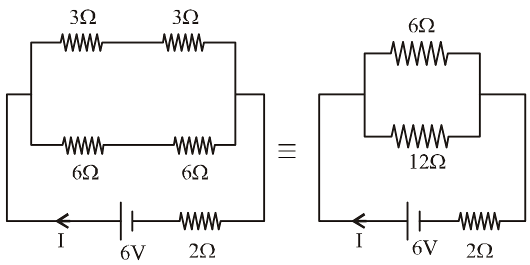
$$\frac{4}{Q} = \frac{40}{60} \Rightarrow \frac{4}{Q} = \frac{2}{3} \Rightarrow Q = 6\,\Omega$$

When unknown resistance x is connected in series with P, then

$$\frac{4+x}{6} = \frac{80}{100-80} = \frac{80}{20} \Rightarrow \frac{4+x}{6} = 4$$

$\Rightarrow 4 + x = 24 \Rightarrow x = 20\,\Omega$

232. (a) Balanced wheat stone bridge in circuit so there is no current in 5Ω resistor so it can be removed from the circuit.



The equivalent resistance will be

$$R_{eq} = \frac{6\times12}{6+12} + 2 = 6\,\Omega$$

Now, apply K.V.L, we have

$$I = \frac{V}{R_{eq}} = \frac{6}{6} = 1A$$

233. **(19)** After applying the condition of wheatstone bridge and adding the end correction

$$\frac{15}{43+2}=\frac{R}{102-45} \Rightarrow \frac{15}{45}=\frac{R}{57}$$

$\therefore R = 19\Omega$

234. **(10)** The given combination of resistance is wheatstone bridge

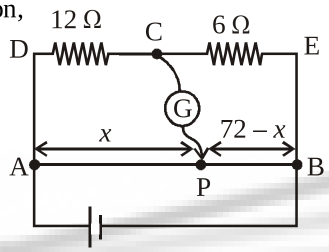
So, $6 \times R = 4 \times 3 \Rightarrow R = 2\Omega$

Therfore, the effective resistance of circuit is

$$R_{eq}=\frac{6\times 9}{6+9}=\frac{54}{15}=\frac{18}{5}\Omega$$

$$\text{So, } i=\frac{36}{R_{eq}}=\frac{36}{\frac{18}{5}}=10A$$

235. **(48)** In balanced condition,



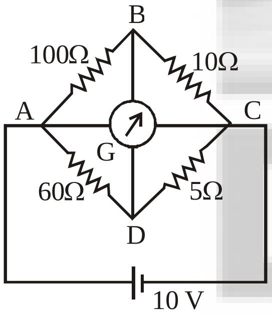
$$\frac{x}{12}=\frac{72-x}{6}$$

$\Rightarrow x = 2(72 - x)$

or, $3x = 144$

$\therefore \quad x=\frac{144}{3}=48$ cm

236. **(d)**



Current through the galvanometer,

$$I_G=\frac{V_B-V_D}{R_{BD}}$$

$$\frac{V_B-V_A}{100}+\frac{V_B-V_D}{15}+\frac{V_B-V_C}{10}=0$$

$$\Rightarrow \frac{V_B-10}{100}+\frac{V_B-V_D}{15}+\frac{V_B-0}{10}=0$$

$$\Rightarrow \frac{V_B-10}{20}+\frac{V_B-V_D}{3}+\frac{V_B}{2}=0$$

$$\Rightarrow 3V_B-30+20V_B-20V_D+30V_B=0$$

$$\Rightarrow 53V_B-20V_D=30 \qquad \text{...(i)}$$

Similarly,

$$\frac{V_D-10}{60}+\frac{V_D-V_B}{15}+\frac{V_D-0}{5}=0$$

$$\Rightarrow V_D-10+4V_D-4V_B+12V_D=0$$

$$\Rightarrow -4V_B+17V_D=10 \qquad \text{...(ii)}$$

Solving equations (i) and (ii), we get

$V_B = 0.86$ V and $V_D = 0.79$ V

$$\therefore I_G=\frac{V_B-V_D}{R_{BD}}=\frac{0.86-0.79}{15}=\frac{0.07}{15}$$

$\therefore I_G = 4.87$ mA

237. **(d)** The voltmeter of resistance 10kΩ is parallel to the resistance of 400Ω. So, their equivalent resistance is

$$\frac{1}{R'}=\frac{1}{10\ k\Omega}+\frac{1}{400\Omega}=\frac{1}{10000}+\frac{1}{400}$$

$$\Rightarrow \frac{1}{R'}=\frac{1+25}{10000}=\frac{26}{10000} \Rightarrow R'=\frac{10000}{26}\Omega$$

Using Ohm's law, current in the circuit

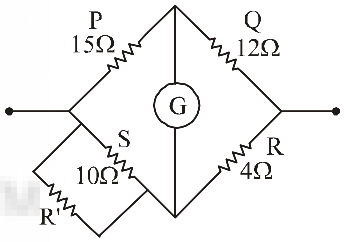
$$I=\frac{\text{Voltage}}{\text{Net Resistance}}=\frac{6}{\frac{10000}{26}+800}$$

Potential difference measured by voltmeter

$$V=IR'=\frac{6}{\frac{10000}{26}+800}\times\frac{10000}{26} \Rightarrow V=\frac{150}{77}=1.95\text{ volt}$$

238. **(10)** As per Wheatstone bridge balance condition $\frac{P}{Q}=\frac{S}{R}$

Let resistance R' is connected in parallel with resistance S of 10Ω



$$\therefore \frac{15}{12}=\frac{\frac{10R'}{10+R'}}{4}$$

$$\Rightarrow 5=\frac{10R'}{10+R'}$$

$\Rightarrow 50 + 5R' = 10R'$

$$\therefore R'=\frac{50}{5}=10\Omega$$

239. **(c)** We have given

$$\frac{dR}{d\ell}\propto\frac{1}{\sqrt{\ell}} \Rightarrow \frac{dR}{d\ell}=k\times\frac{1}{\sqrt{\ell}} \quad \text{(where k is constant)}$$

$$dR=k\frac{d\ell}{\sqrt{\ell}}$$

Let R_1 and R_2 be the resistance of AP and PB respectively. Using wheatstone bridge principle

$$\therefore \frac{R'}{R'}=\frac{R_1}{R_2} \text{ or } R_1=R_2$$

$$\text{Now, } \int dR=k\int\frac{d\ell}{\sqrt{\ell}} \quad \therefore R_1=k\int_0^{\ell}\ell^{-1/2}d\ell=k.2.\sqrt{\ell}$$

$$R_2=k\int_{\ell}^{1}\ell^{-1/2}d\ell=k.(2-2\sqrt{\ell})$$

Putting $R_1 = R_2$

$$k2\sqrt{\ell}=k(2-2\sqrt{\ell}) \quad \therefore 2\sqrt{\ell}=1 \Rightarrow \sqrt{\ell}=\frac{1}{2}$$

$$\text{i.e., } \ell=\frac{1}{4}\text{m} \Rightarrow 0.25\text{ m}$$

240. **(b)** Given, Emf of cell, $\varepsilon = 0.5$ v

Rheostat resistance, $R_h = 2\Omega$

Potential gradient is

$$\frac{dv}{dL}=\left(\frac{6}{2+4}\right)\times\frac{4}{L}$$

Let null point be at ℓ cm when cell of emf$\varepsilon = 0.5$ v is used.

thus $\varepsilon_1 = 0.5\text{V} = \left(\frac{6}{2+4}\right) \times \frac{4}{\text{L}} \times \ell$ ... (i)

For resistance $\text{R}_h = 6\Omega$ new potential gradient is $\left(\frac{6}{4+6}\right) \times \frac{4}{\text{L}}$ and at null point

$\left(\frac{6}{4+6}\right)\left(\frac{4}{\text{L}}\right) \times \ell = \varepsilon_2$ ... (ii)

Dividing equation (i) by (ii) we get

$\frac{0.5}{\varepsilon_2} = \frac{10}{6}$ thus $\varepsilon_2 = 0.3\text{V}$

241. **(d)** Initially, $\frac{\text{P}}{\text{Q}} = \frac{\text{R}_1}{\text{X}}$ ... (i)

After interchanging P and Q

$\frac{\text{Q}}{\text{P}} = \frac{\text{R}_2}{\text{X}}$ ... (ii)

From (i) and (ii), we get

$1 = \frac{\text{R}_1\text{R}_2}{\text{X}^2} \Rightarrow \text{X} = \sqrt{\text{R}_1\text{R}_2} = \sqrt{400 \times 405} = 402.5\,\Omega$

242. **(c)** Initially at null deflection $\frac{\text{R}_1}{\text{R}_2} = \frac{2}{3}$ ...(i)

Finally at null deflection, when null point is shifted

$\frac{\text{R}_1+10}{\text{R}_2} = 1 \Rightarrow \text{R}_1 + 10 = \text{R}_2$ ...(ii)

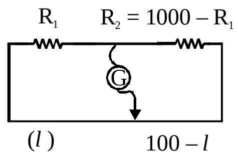
Solving equations (i) and (ii) we get

$\frac{2\text{R}_2}{3} + 10 = \text{R}_2$

$10 = \frac{\text{R}_2}{3} \Rightarrow \text{R}_2 = 30\Omega \;\&\; \text{R}_1 = 20\Omega$

Now if required resistance is R then $\frac{\frac{30\times\text{R}}{30+\text{R}}}{30} = \frac{2}{3} \Rightarrow \text{R} = 60\Omega$

243. **(c)** $\text{R}_1 + \text{R}_2 = 1000$



$\Rightarrow \text{R}_2 = 1000 - \text{R}_1$

On balancing condition

$\text{R}_1(100 - l) = (1000 - \text{R}_1)l$ ...(i)

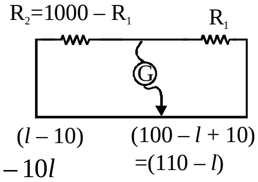
On Interchanging resistance balance point shifts left by 10 cm.

On balancing condition

$(1000 - \text{R}_1)(110 - l) = \text{R}_1(l - 10)$

or, $\text{R}_1(l - 10) = (1000 - \text{R}_1)(110 - l)$ ...(ii)

Dividing eqn (i) by (ii)



$\frac{100-l}{l-10} = \frac{l}{110-l}$

$\Rightarrow (100 - l)(110 - l) = l(l - 10)$

$\Rightarrow 11000 - 100l - 110l + l^2 = l^2 - 10l$

$\Rightarrow 11000 = 200l$ or, $l = 55$

Putting the value of 'l' in eqn (i)

$\text{R}_1(100 - 55) = (1000 - \text{R}_1)55$

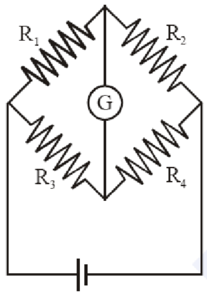
$\Rightarrow \text{R}_1(45) = (1000 - \text{R}_1)55$

$\Rightarrow \text{R}_1(9) = (1000 - \text{R}_1)11$

$\Rightarrow 20\,\text{R}_1 = 11000$

$\therefore \text{R}_1 = 550\text{K}\Omega$

244. **(d)** There is no change in null point, if the cell and the galvanometer are exchanged in a balanced wheatstone bridge.

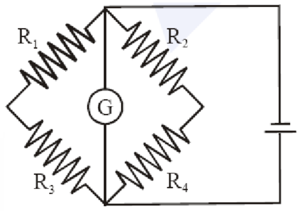


On balancing condition $\frac{R_1}{R_3} = \frac{R_2}{R_4}$

After exchange

On balancing condition

$\frac{R_1}{R_2} = \frac{R_3}{R_4}$



245. **(d)** In balance position of bridge, $\frac{\text{P}}{\text{Q}} = \frac{l}{(100-l)}$

Initially neutral position is 60 cm. from A, so

$\frac{4}{60} = \frac{\text{Q}}{40} \Rightarrow \text{Q} = \frac{16}{6} = \frac{8}{3}\Omega$

Now, when unknown resistance R is connected in series to P, neutral point is 80 cm from A then,

$\frac{4+\text{R}}{80} = \frac{\text{Q}}{20} \Rightarrow \frac{4+\text{R}}{80} = \frac{8}{60}$

$\text{R} = \frac{64}{6} - 4 = \frac{64-24}{6} = \frac{40}{6}\,\Omega$

Hence, the value of unknown resistance R is $= \frac{20}{3}\Omega$

246. **(b)** Given, balance point from one end, $\ell_1 = 20$ cm

From the condition for balance of metre bridge, we have

$\frac{55}{R} = \frac{\ell_1}{100-\ell_1} \Rightarrow \frac{55}{R} = \frac{20}{80} \Rightarrow R = 220\Omega$

247. **(b)** From balanced wheat stone bridge $\frac{P}{Q} = \frac{R}{S}$ where

$S = \frac{S_1S_2}{S_1+S_2}$

248. **(c)** From the balanced wheat stone bridge

$\frac{R_1}{R_2} = \frac{\ell_1}{\ell_2}$ where $\ell_2 = 100 - \ell_1$

In the first case $\frac{X}{Y} = \frac{20}{80}$; $Y = 4X$

In the second case

$\frac{4X}{Y} = \frac{\ell}{100-\ell} \Rightarrow \frac{4X}{4X} = \frac{\ell}{100-\ell} \Rightarrow \ell = 50$

249. **(d)** $i_g \times G = (i - i_g)\,S \therefore S = \frac{i_g \times G}{i - i_g} = \frac{1\times0.81}{10-1} = 0.09\Omega$

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Chapter 10

Hydrocarbons

Topic 1 Alkanes

1. In the given compound, the number of 2° carbon atom/s is _____. **[NCERT : P L-296 | April 8, 2024 (I)]**

$$CH_3-\underset{\overset{|}{H}}{C}\ CH_3\ -\underset{\overset{|}{H}}{C}H-\underset{\overset{|}{H}}{C}\ CH_3\ -CH_3$$

(a) Three (b) One (c) Two (d) Four

2. The number of different chain isomers for C_7H_{16} is _____. **[NV, April 4, 2024 (I)]**

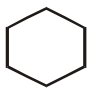
3. Number of alkanes obtained on electrolysis of a mixture of CH_3COONa and C_2H_5COONa is _____. **[NCERT : PL-301 | NV, Jan. 31, 2024 (I)]**

4. Number of isomeric products formed by monochlorination of 2-methylbutane in presence of sunlight is _______. **[NCERT : P L-303 | NV, Jan. 31, 2024 (II)]**

5. The incorrect statement regarding conformations of ethane is: **[NCERT : P L-305 | Jan. 27, 2024 (II)]**
   (a) Ethane has infinite number of conformations
   (b) The dihedral angle in staggered conformation is 60°
   (c) Eclipsed conformation is the most stable conformation.
   (d) The conformations of ethane are inter-convertible to one-another

6. In the following reaction 'X' is **[NCERT : P L-304 | April 13, 2023 (I)]**

$$CH_3(CH_2)_4CH_3 \xrightarrow[HCl.\Delta]{Anhy.AlCl_3} \underset{\text{Major product}}{'X'}$$

(a) $CH_3(CH_2)_4CH_2Cl$
(b) $Cl-CH_2-(CH_2)_4-CH_2-Cl$
(c) $CH_3\underset{\underset{CH_3}{|}}{C}H-(CH_2)_2CH_3$
(d) 

7. Number of bromo derivatives obtained on treating ethane with excess of Br_2, in diffused sunlight is _____. **[NV, April 06, 2023 (I)]**

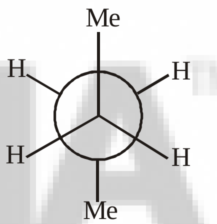
8. When a hydrocarbon A undergoes complete combustion it requires 11 equivalents of oxygen and produces 4 equivalents of water. What is the molecular formula of A ? **[NCERT : P L-303 | Jan. 31, 2023 (II)]**

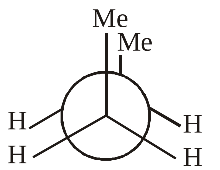
(a) C_9H_8 (b) $C_{11}H_4$ (c) C_5H_8 (d) $C_{11}H_8$

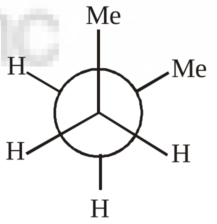
9. When a hydrocarbon A undergoes combustion in the presence of air, it requires 9.5 equivalents of oxygen and produces 3 equivalents of water. What is the molecular formula of A? **[NCERT : P L-303 | Jan. 29, 2023 (II)]**

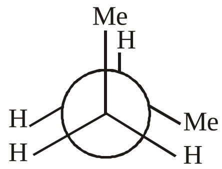
(a) C_8H_6 (b) C_9H_9 (c) C_6H_6 (d) C_9H_6

10. Which of the following conformations will be the most stable ? **[Jan. 25, 2023 (I)]**

(a) 

(b) 

(c) 

(d) 

11. Maximum number of isomeric monochloro derivatives which can be obtained from 2,2,5,5- tetramethylhexane by chlorination is _________ **[NV, Jan. 24, 2023 (II)]**

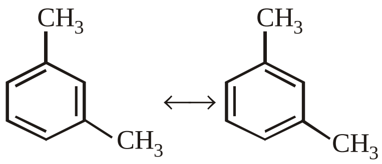
12. $(C_7H_5O_2)_2 \xrightarrow{hv} [X]\ \ 2\dot{C}_6H_5\ \ 2CO_2$

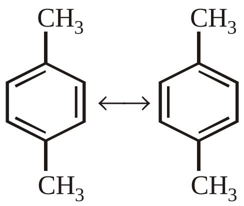
Consider the above reaction and identify the intermediate 'X' **[June 26, 2022 (I)]**

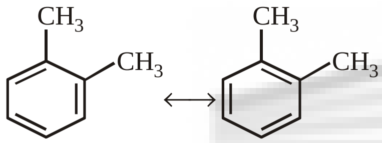
(a) $C_6H_5-\overset{\overset{O}{\|}}{C}{}^{\oplus}$ (b) $C_6H_5-\overset{\overset{O}{\|}}{C}-O^{\ominus}$

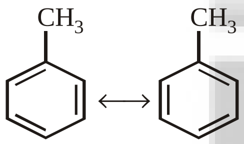
(c) $C_6H_5-\overset{\overset{O}{\|}}{C}-\ddot{\underset{\cdot\cdot}{O}}$ (d) $C_6H_5-\overset{\overset{O}{\|}}{C}-\ddot{\underset{\cdot\cdot}{O}}\cdot$

13. Which among the following pairs of the structures will give different products on ozonolysis?
(Consider the double bonds in the structures are rigid and not delocalized.) **[July 29, 2022 (I)]**

(a) 

(b) 

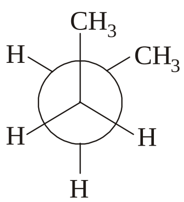
(c) 

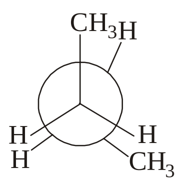
(d) 

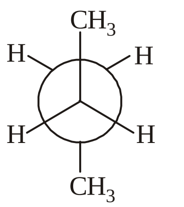
14. Total number of isomers (including stereoisomers) obtained on monochlorination of methylcyclohexane is ________. **[NV, July 26, 2022 (II)]**

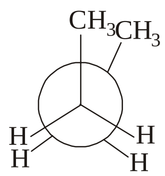
15. The total number of monobromo derivatives formed by the alkanes with molecular formula C_5H_{12} is (excluding stereoisomers) ______. **[NV, July 25, 2022 (II)]**

16. In the following structures, which one is having staggered conformation with maximum dihedral angle? **[June 25, 2022 (I)]**

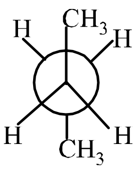
(a) 

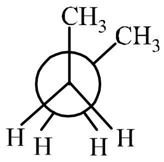
(b) 

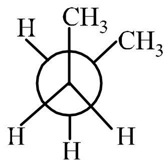
(c) 

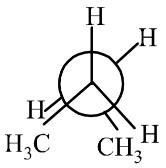
(d) 

17. Arrange the following conformational isomers of *n*-butane in order of their increasing potential energy: **[NCERT : P L-206 | Aug. 31, 2021 (II)]**


I


II

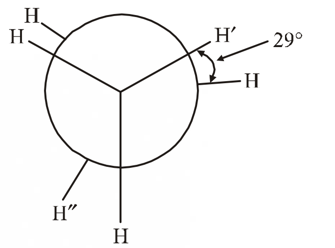

III


IV

(a) II < III < IV < I (b) I < IV < III < II
(c) II < IV < III < I (d) I < III < IV < II

18. The dihedral angle in staggered form of Newman projection of 1,1,1-Trichloroethane is .... degree. (Round off to the nearest integer) **[NV, July 27, 2021 (II)]**

19. In the following skew conformation of ethane, H′ – C – C – H″ dihedral angle is : **[NCERT : P L-305 | April 12, 2019 (II)]**



(a) 58° (b) 149° (c) 151° (d) 120°

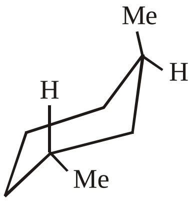
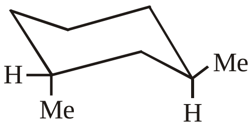
20. 25 g of an unknown hydrocarbon upon burning produces 88 g of CO_2 and 9 g of H_2O. This unknown hydrocarbon contains: **[April 12, 2019 (II)]**
(a) 20 g of carbon and 5 g of hydrogen
(b) 22 g of carbon and 3 g of hydrogen
(c) 24 g of carbon and 1 g of hydrogen
(d) 18 g of carbon and 7 g of hydrogen

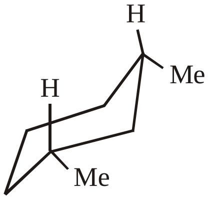
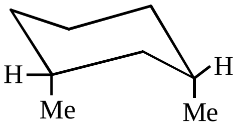
21. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion, and 40 mL of CO_2 is formed. The formula of the hydrocarbon is : **[NCERT : P L-303 | April 10, 2019 (I)]**
(a) C_4H_{10} (b) C_4H_6 (c) C_4H_7Cl (d) C_4H_8

22. Which of these factors does not govern the stability of a conformation in acyclic compounds ? **[April 10, 2019 (II)]**
(a) Steric interactions
(b) Torsional strain
(c) Electrostatic forces of interaction
(d) Angle strain

23. The major product obtained in the photo catalysed bromination of 2-methylbutane is: **[NCERT : P L-303 | 2005, Online May 19, 2012; Online April 12, 2014]**
(a) 1-bromo-2-methylbutane
(b) 1-bromo-3-methylbutane
(c) 2-bromo-3-methylbutane
(d) 2-bromo-2-methylbutane

24. Arrange in the correct order of stability (decreasing order) for the following molecules : **[Online April 22, 2013]**

(I)  (II) 

(III)  (IV) 

(a) (I) > (II) > (III) > (IV)
(b) (IV) > (III) > (II) ≈ (I)
(c) (I) > (II) ≈ (III) > (IV)
(d) (III) > (I) ≈ (II) > (IV)

25. Which branched chain isomer of the hydrocarbon with molecular mass 72u gives only one isomer of mono substituted alkyl halide ? **[2012; Similar 2003]**
(a) Tertiary butyl chloride
(b) Neopentane
(c) Isohexane
(d) Neohexane

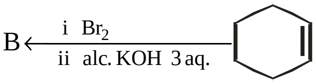
26. Which one of the following conformations of cyclohexane is chiral? **[2007]**
(a) Boat (b) Twist boat
(c) Rigid (d) Chair

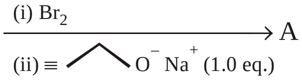
27. Increasing order of stability among the three main conformations (i.e., Eclipse, Anti, Gauche) of 2-fluoroethanol is **[2006]**
(a) Eclipse, Anti, Gauche
(b) Anti, Gauche, Eclipse
(c) Eclipse, Gauche, Anti
(d) Gauche, Eclipse, Anti

28. Of the five isomeric hexanes, the isomer which can give two monochlorinated compounds is **[2005]**
(a) 2-methylpentane (b) 2, 2-dimethylbutane
(c) 2, 3-dimethylbutane (d) n-hexane

Topic 2 Alkenes

29. The major products from the following reaction sequence are product A and product B.
[NCERT : P L-311 | NV, April 6, 2024 (I)]



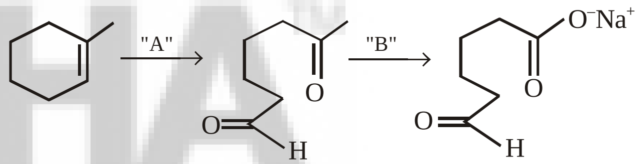


The total sum of π electrons in product A and product B are ______ (nearest integer)

30. Number of σ and π bonds present in ethylene molecule is respectively : **[NCERT : P L-306 | April 5, 2024 (I)]**
(a) 3 and 1 (b) 5 and 2 (c) 4 and 1 (d) 5 and 1

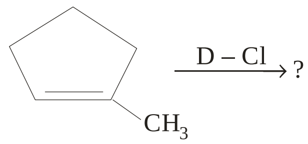
31. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.
[NCERT : P L-308 | April 5, 2024 (I)]
Assertion (A): Cis form of alkene is found to be more polar than the trans form
Reason (R): Dipole moment of trans isomer of 2-butene is zero.
In the light of the above statements, choose the **correct** answer from the options given below :
(a) Both **(A)** and **(R)** are true but **(R)** is **NOT** the correct explanation of **(A)**
(b) **(A)** is true but **(R)** is false
(c) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**
(d) **(A)** is false but **(R)** is true

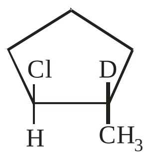
32.

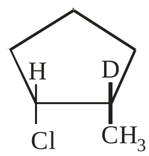


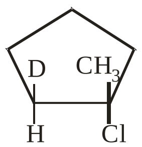
In the above chemical reaction sequence "A" and "B" respectively are : **[NCERT : P L-313 | April 4, 2024 (II)]**
(a) O_3, Zn/H_2O and NaOH(alc.) / I_2
(b) H_2O, H^+ and NaOH(alc.) / I_2
(c) H_2O, H^+ and $KMnO_4$
(d) O_3, Zn/H_2O and $KMnO_4$

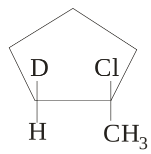
33. Major product of the following reaction is –
[NCERT : P L-312 | Jan. 31, 2024 (II)]



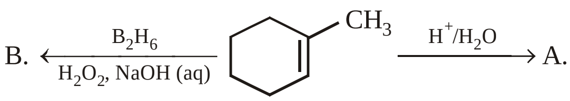
(a) 

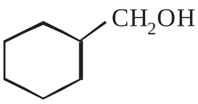
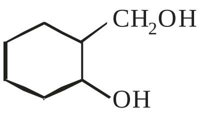
(b) 

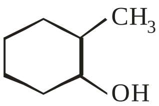
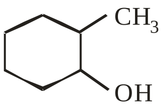
(c) 

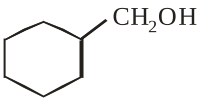
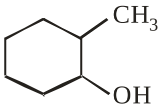
(d) 

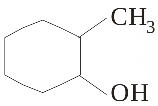
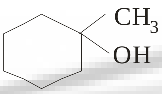
34. Products A and B formed in the following set of reactions are **[Jan. 30, 2024 (II)]**



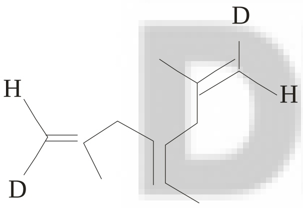
(a) A =  B = 

(b) A =  B = 

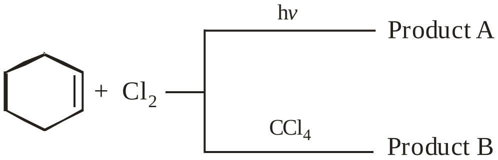
(c) A =  B = 

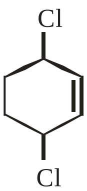
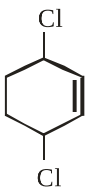
(d) A =  B = 

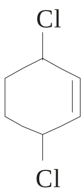
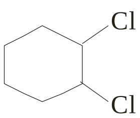
35. Number of geometrical isomers possible for the given structure is / are ____________. **[NV, Jan. 30, 2024 (II)]**

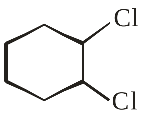
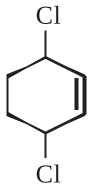


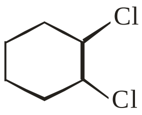
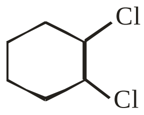
36. Identify product A and product B : **[NCERT : P L-312 | Jan. 29, 2024 (I)]**

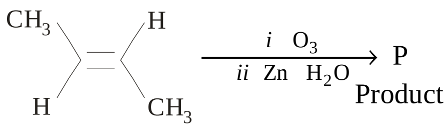


(a) A :  B : 

(b) A :  B : 

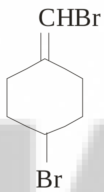
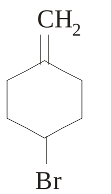
(c) A :  B : 

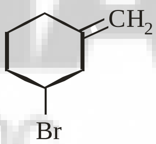
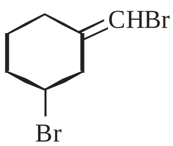
(d) A :  B : 

37. 

Consider the given reaction. The total number of oxygen atom/s present per molecule of the product (P) is _____. **[NCERT : P L-313 | NV, Jan. 29, 2024 (I)]**

38. Which one of the following will show geometrical isomerism ? **[NCERT : P L-308 | Jan. 29, 2024 (II)]**

(a)  (b) 

(c)  (d) 

39. The product formed in the following multistep reaction is:

$$CH_3-CH=CH_2 \xrightarrow[\text{(iii) PCC} \quad \text{(iv) } CH_3MgBr]{\text{(i) } B_2H_6 \quad \text{(ii) } H_2O_2,\ NaOH}$$ **[April 15, 2023 (I)]**

(a) $CH_3-CH_2-\underset{}{\overset{OH}{\overset{|}{C}H}}-CH_3$

(b) $CH_3-CH_2-CH_2-CH_2-OH$

(c) $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OCH_3$

(d) $CH_3-\overset{OH}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-CH_3$

40. 2 – hexene $\xrightarrow[\text{(ii) } H_2O]{\text{(i) } O_3}$ Products **[April 12, 2023 (I)]**

The two products formed in above reaction are -
(a) Butanoic acid and acetic acid
(b) Butanal and acetic acid
(c) Butanal and acetaldehyde
(d) Butanoic acid and acetaldehyde

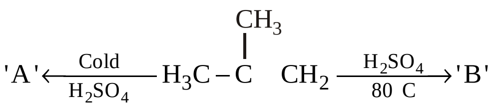
41. The number of possible isomeric products formed when 3-chloro-1-butene reacts with HCl through carbocation formation is ______ **[NV, April 11, 2023 (II)]**

42. Molar mass of the hydrocarbon (X) which on ozonolysis consumes one mole of O_3 per mole of (X) and gives one mole each of ethanal and propanone is _______ g mol^{-1}
(Molar mass of C : 12 g mol^{-1}, H : 1 g mol^{-1})
[NCERT : P L-313 | NV, April 08, 2023 (I)]

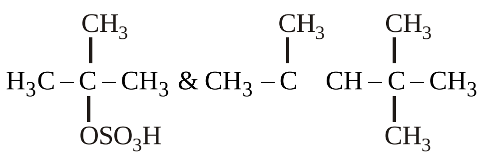
43. Choose the correct set of reagents for the following conversion
trans (Ph - CH = CH – CH_3) → cis (Ph - CH = CH – CH_3)
[Jan. 31, 2023 (I)]
(a) Br_2, alc KOH, $NaNH_2$, Na(Liq NH_3)
(b) Br_2, alc KOH, $NaNH_2$, H_2 Lindlar Catalyst
(c) Br_2, aq KOH, $NaNH_2$, H_2 Lindlar Catalyst
(d) Br_2, aq KOH, $NaNH_2$, Na(Liq NH_3)

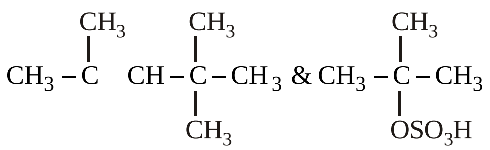
44. A hydrocarbon 'X' with formula C_6H_8 uses two moles of H_2 on catalytic hydrogenation of its one mole. On ozonolysis, 'X' yields two moles of methane dicarbaldehyde. The hydrocarbon 'X' is :
(a) hexa-1, 3, 5-triene **[Jan. 31, 2023 (II)]**
(b) 1-methylcyclopenta-1, 4-diene
(c) cyclohexa-1, 3-diene
(d) cyclohexa-1, 4-diene

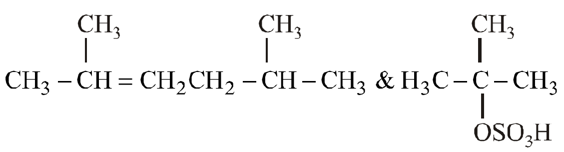
45. The major products 'A' and 'B', respectively, are

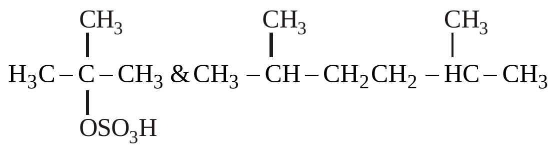


[Jan. 30, 2023 (I)]

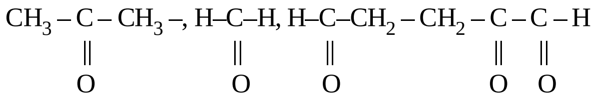
(a) 

(b) 

(c) 

(d) 

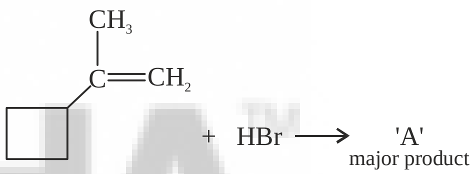
46. 17 mg of a hydrocarbon (M.F. $C_{10}H_{16}$) takes up 8.40 mL of the H_2 gas measured at 0ºC and 760 mm of Hg. Ozonolysis of the same hydrocarbon yields **[NV, Jan. 29, 2023 (I)]**

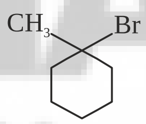


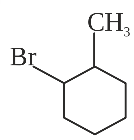
The number of double bond/s present in the hydrocarbon is ________ .

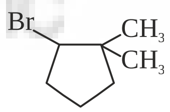
47. The one giving maximum number of isomeric alkenes on dehydrohalogenation reaction is (excluding rearrangement)
[Jan. 29, 2023 (II)]
(a) 1-Bromo-2-methylbutane
(b) 2-Bromopropane
(c) 2-Bromopentane
(d) 2-Bromo-3,3-dimethylpentane]

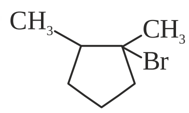
48. In the following given reaction 'A' is **[Jan. 24, 2023 (I)]**



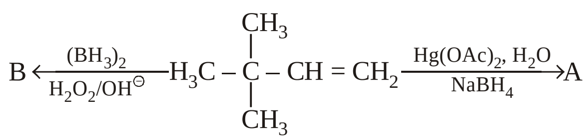
(a) 

(b) 

(c) 

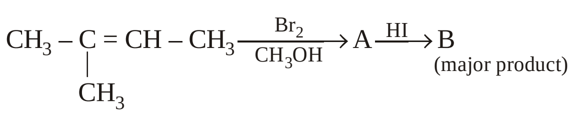
(d) 

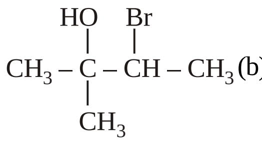
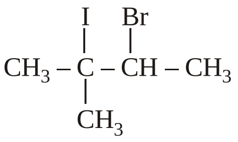
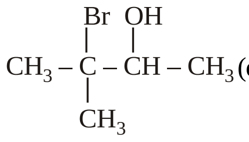
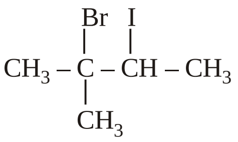
49. Choose the correct option for the following reactions.
[NCERT : P L-311, 312 | July 28, 2022 (I)]



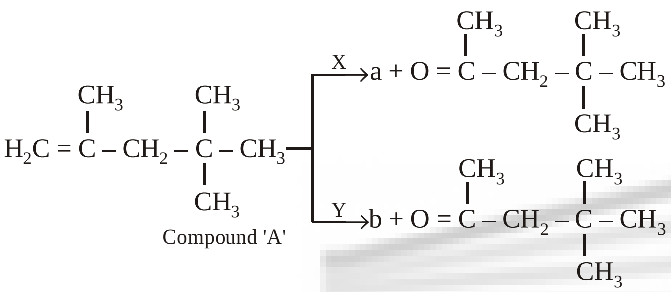
(A) 'A' and 'B' are both Markovnikov addition products.
(b) 'A' is Markovnikov product and 'B' is anti-Markovnikov product.
(c) 'A' and 'B' are both anti-Markovnikov products.
(d) 'B' is Markovnikov and 'A' is anti-Markovnikov product.

50. Major product 'B' of the following reaction sequence is:
[July 27, 2022 (II)]



(a) 
(b) 
(c) 
(d) 

51. A compound 'A' on reaction with 'X' and 'Y' produces the same major product but different byproduct 'a' and 'b'. Oxidation of 'a' gives a substance produced by ants. **[July 25, 2022 (I)]**



'X' and 'Y' respectively are
(a) $KMnO_4/H^+$ and dil. $KMnO_4$, 273 K
(b) $KMnO_4$(dilute), 273 K and $KMnO_4/H^+$
(c) $KMnO_4/H^+$ and O_3, H_2O/Zn
(d) O_3, H_2O/Zn and $KMnO_4/H^+$

52. A hydrocarbon 'X' is found to have molar mass of 80. A 10.0 mg of compound 'X' on hydrogenation consumed 8.40 mL of H_2 gas (measured at STP). Ozonolysis compound 'X' yields only formaldehyde and dialdehyde. The total number of fragments/molecules produced from the ozonolysis of compound 'X' is ________ . **[NV, June 30, 2022 (I)]**

53. Two isomers '*A*' and '*B*' with molecular formula C_4H_8 give different products on oxidation with $KMnO_4$ in acidic medium. Isomer '*A*' on reaction with $KMnO_4/H^+$ results in effervescence of a gas and gives ketone. The compound '*A*' is **[June 29, 2022 (I)]**
(a) But-1-ene (b) *cis*-But-2-ene
(c) *trans*-But-2ene (d) 2-methyl propene

54. '**A**' and '**B**' respectively are:

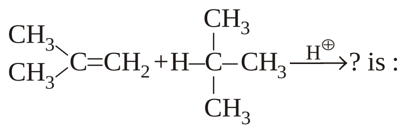
$$\mathbf{A} \xrightarrow[(2)\,Zn-H_2O]{(1)\,O_3} \text{Ethane}-1,2-\text{dicarbaldehyde}$$

Glyoxal/Oxaldehyde

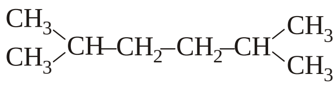
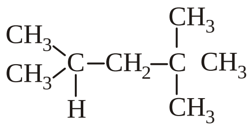
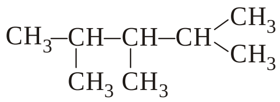
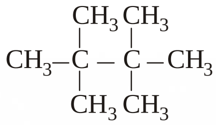
$$\mathbf{B} \xrightarrow[(2)\,Zn-H_2O]{(1)\,O_3} 5-\text{Oxohexanal}$$ **[June 27, 2022 (I)]**

(a) 1-methylcyclohex-1, 3-diene & cyclopentene
(b) Cyclohex-1, 3-diene & cyclopentene
(c) 1-methylcyclohex-1,4-diene & 1-methylcyclopent-1-ene
(d) Cyclohex-1,3-diene & 1-methylcyclopent-1-ene

55. The products formed in the following reaction.



[June 25, 2022 (I)]

(a) 
(b) 
(c) 
(d) 

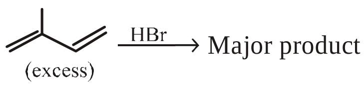
56. The major product 'A' of the following given reaction has _____ sp^2 hybridized carbon atoms.

$$2,7-\text{Dimethyl}-2,6-\text{octadiene} \xrightarrow{H} \underset{\text{Major Product}}{A}$$

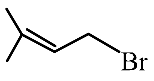
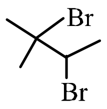
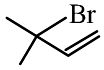
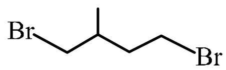
[NV, June 24, 2022 (I)]

57. Given below are two statements. **[NCERT : P L-306 | June 24, 2022 (II)]**
Statement I : The presence of weaker π - bonds make alkenes less stable than alkanes.
Statement II : The strength of the double bond is greater than that of carbon-carbon single bond.
In the light of the above statements, choose the *correct* answer from the options given below.
(a) Both Statement I and Statement II are correct.
(b) Both Statement I and Statement II are incorrect.
(c) Statement I is correct but Statement II is incorrect.
(d) Statement I is incorrect but Statement II is correct.

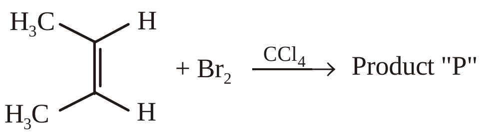
58. The major product formed in the following reaction is :



[Aug. 26, 2021 (I)]

(a) 
(b) 
(c) 
(d) 

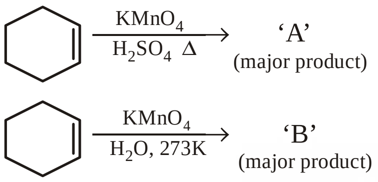
59. An organic compound 'A' C_4H_8 on treatment with $KMnO_4/H^+$ yields compound 'B' C_3H_6O.
Compound 'A' also yield compound 'B' an ozonolysis. Compound 'A' is : **[NCERT : PL-313 | July 25, 2021 (I)]**
(a) 2-Methylpropene (b) 1-Methylcyclopropane
(c) But-2-ene (d) Cyclobutane

60. 

Consider the above chemical reaction. The total number of stereoisomers possible for product 'P' is **[NV, July 25, 2021 (II)]**

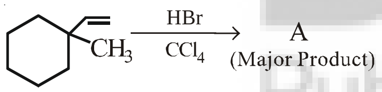
61. Which of the following molecules does not show stereo-isomerism ? **[July 22, 2021 (II)]**

(a) 3,4-Dimethylhex-3-ene
(b) 3-Methylhex-1-ene
(c) 3-Ethylhex-3-ene
(d) 4-Methylhex-1-ene

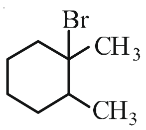
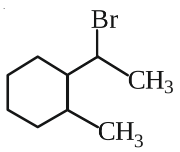
62. 

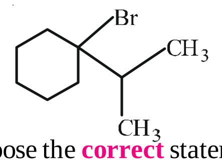
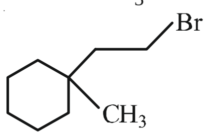
For above chemical reactions, identify the correct statement from the following: **[July 20, 2021 (I)]**

(a) Both compound 'A' and compound 'B' are dicarboxylic acids
(b) Both compound 'A' and compound 'B' are diols
(c) Compound 'A' is diol and compound 'B' is dicarboxylic acid
(d) Compound 'A' is dicarboxylic acid and compound 'B' is diol

63. 

Product "A" in the above chemical reaction is **[March 17, 2021 (I)]**

(a)  (b) 

(c)  (d) 

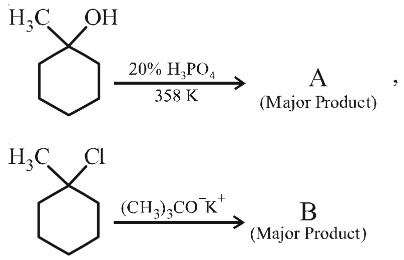
64. Choose the **correct** statement regarding the formation of carbocation A and B given **[NCERT : P L-311 | March 17, 2021 (II)]**

$CH_3-CH_2-CH=CH_2+HBr$

$\rightarrow CH_3-CH_2-CH_2-\overset{+}{C}H_2+Br^-$ "A"

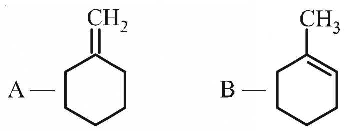
$\rightarrow CH_3-CH_2-\overset{+}{C}H-CH_3+Br^-$ "B"

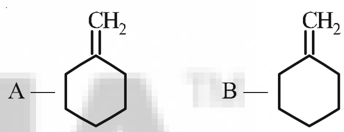
(a) Carbocation A is more stable and formed relatively at slow rate
(b) Carbocation A is more stable and formed relatively at faster rate
(c) Carbocation B is more stable and formed relatively at slow rate
(d) Carbocation B is more stable and formed relatively at faster rate

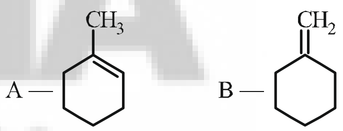
65. 

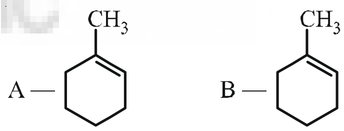
[March 16, 2021 (I)]

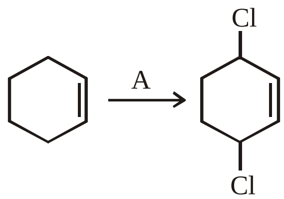
The products "A" and "B" formed in above reactions are

(a) 

(b) 

(c) 

(d) 

66. 

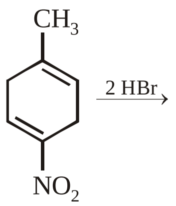
Identify the reagent(s) 'A' and condition(s) for the reaction **[March 16, 2021 (II)]**

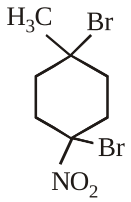
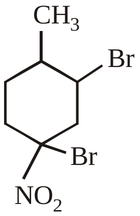
(a) A = HCl ; Anhydrous $AlCl_3$
(b) A = Cl_2 ; UV light
(c) A = Cl_2 ; dark, Anhydrous $AlCl_3$
(d) A = HCl, $ZnCl_2$

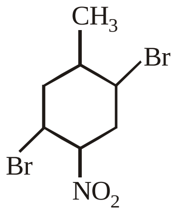
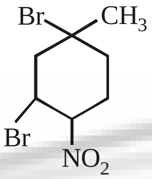
67. In $\overset{1}{C}H_2\ \overset{2}{C}\ \overset{3}{C}H-\overset{4}{C}H_3$ molecule, the hybridization of carbon 1, 2, 3 and 4 respectively, are : **[Feb. 26, 2021 (II)]**

(a) sp^2, sp^2, sp^2, sp^3 (b) sp^2, sp, sp^2, sp^3
(c) sp^3, sp, sp^3, sp^3 (d) sp^2, sp^3, sp^2, sp^3

68. The major product of the following reaction is : **[Sep. 06, 2020 (I)]**



(a)  (b) 

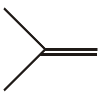
(c)  (d) 

69. Which of the following compounds shows geometrical isomerism? **[Sep. 06, 2020 (I)]**

(a) 2-methylpent-2-ene (b) 4-methylpent-2-ene
(c) 4-methylpent-1-ene (d) 2-methylpent-1-ene

70. The increasing order of the boiling point of the major products A, B and C of the following reactions will be: **[Sep. 06, 2020 (II)]**

(A) 

(B)  + HBr ⟶ B

(C)  + HBr ⟶ C

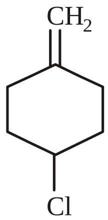
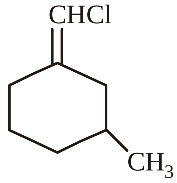
(a) B < C < A (b) C < A < B
(c) A < B < C (d) A < C < B

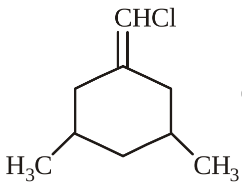
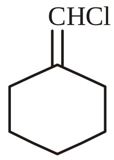
71. The major product formed in the following reaction is :

$CH_3CH = CHCH(CH_3)_2 \xrightarrow{HBr}$ **[Sep. 05, 2020 (II)]**

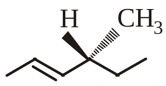
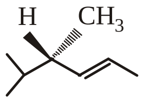
(a) $CH_3CH(Br)CH_2CH(CH_3)_2$
(b) $CH_3CH_2CH(Br)CH(CH_3)_2$
(c) $Br(CH_2)_3CH(CH_3)_2$
(d) $CH_3CH_2CH_2C(Br)(CH_3)_2$

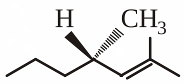
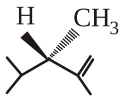
72. Among the following compounds, geometrical isomerism is exhibited by : **[Sep. 05, 2020 (II)]**

(a)  (b) 

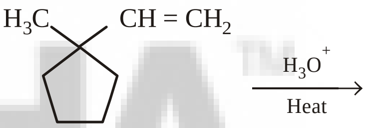
(c)  (d) 

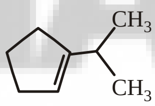
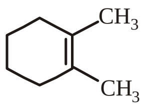
73. Which of the following compounds produces an optically inactive compound on hydrogenation? **[Sep. 03, 2020 (I)]**

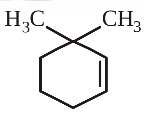
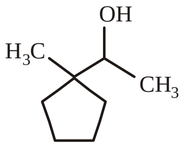
(a)  (b) 

(c)  (d) 

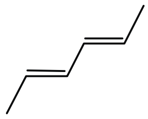
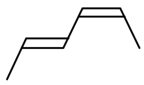
74. The major product in the following reaction is : **[Sep. 02, 2020 (I)]**

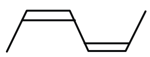


(a)  (b) 

(c)  (d) 

75. The correct order of heat of combustion for following alkadienes is: **[Jan. 09, 2020 (I)]**

(A)  (B) 

(C) 

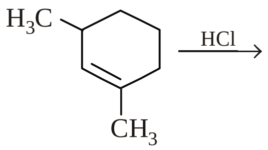
(a) (A) < (B) < (C) (b) (A) < (C) < (B)
(c) (C) < (B) < (A) (d) (B) < (C) < (A)

76. Which of the following has the shortest C–Cl bond? **[Jan. 09, 2020 (II)]**

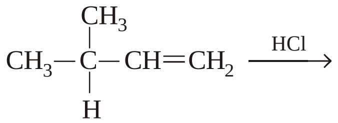
(a) $Cl–CH=CH_2$(b) $Cl–CH=CH–NO_2$
(c) $Cl–CH=CH–CH_3$ (d) $Cl–CH=CH–OCH_3$

77. Which of the following reactions will not produce a racemic product? **[Jan. 09, 2020 (II)]**

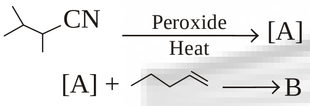
(a) $CH_3-\overset{\overset{O}{\|}}{C}\,CH_2\,CH_3 \xrightarrow{HCN}$

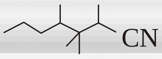
(b) 

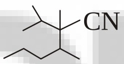
(c) $CH_3CH_2CH{=}CH_2 \xrightarrow{HBr}$

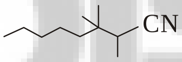
(d) 

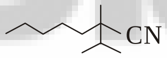
78. The major products A and B in the following reactions are: **[Jan. 08, 2020 (I)]**



(a) A =  and B = 

(b) A =  and B = 

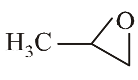
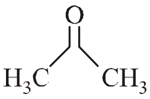
(c) A =  and B = 

(d) A =  and B = 

79. The major product of the following addition reaction is

$H_3C-CH=CH_2 \xrightarrow{Cl_2/H_2O}$ **[April 12, 2019 (I), 2016 (S)]**

(a) $H_3C-\underset{\underset{Cl}{|}}{CH}-\underset{\underset{OH}{|}}{CH_2}$ (b) $H_3C-\underset{\underset{OH}{|}}{CH}-\underset{\underset{Cl}{|}}{CH_2}$

(c)  (d) 

80. But-2-ene on reaction with alkaline $KMnO_4$ at elevated temperature followed by acidification will give : **[NCERT : P L-313 | April 12, 2019 (I)]**

(a) $CH_3-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH}-CH_3$

(b) one molecule of CH_3CHO and one molecule of CH_3COOH

(c) 2 molecules of CH_3COOH

(d) 2 molecules of CH_3CHO

81. Which one of the following alkenes when treated with HCl yields majorly an anti Markovnikov product ? **[April 8, 2019 (II)]**

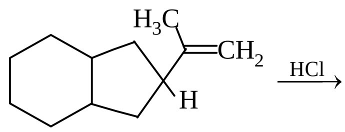
(a) $CH_3O-CH=CH_2$

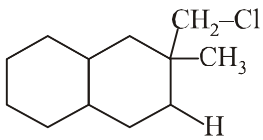
(b) $Cl-CH=CH_2$

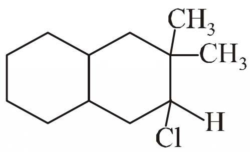
(c) $H_2N-CH=CH_2$

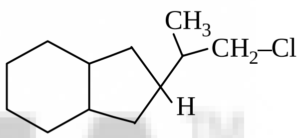
(d) $F_3C-CH=CH_2$

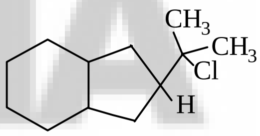
82. The major product of the following reaction is : **[Jan. 12, 2019 (II)]**



(a) 

(b) 

(c) 

(d) 

83. The *trans*-alkenes are formed by the reduction of alkynes with: **[2018; Similar Online April 11, 2014; 2012(S); 2008(S)]**

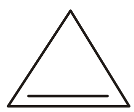
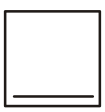
(a) H_2-Pd/C, $BaSO_4$ (b) $NaBH_4$

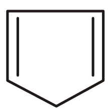
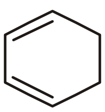
(c) Na/liq. NH_3 (d) Sn - HCl

84. 3-Methyl pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is : **[2017]**

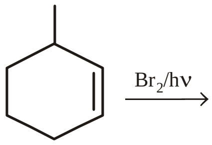
(a) Six (b) Zero (c) Two (d) Four

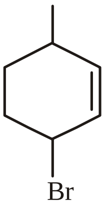
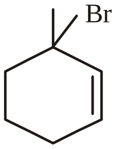
85. Which of the following compounds is most reactive to an aqueous solution of sodium carbonate ? **[Online April 10, 2016 (S), Online April 9, 2017]**

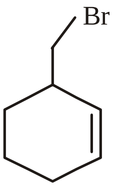
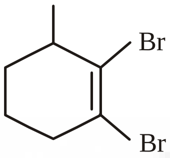
(a)  (b) 

(c)  (d) 

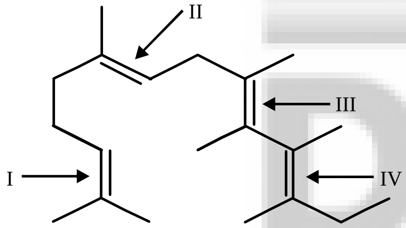
86. The major product of the following reaction is : **[Online April 9, 2017]**



(a)  (b) 

(c)  (d) 

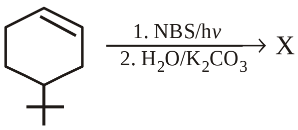
87. In the following structure, the double bonds are marked as I, II, III and IV **[Online April 9, 2017]**

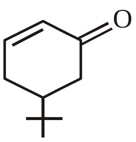
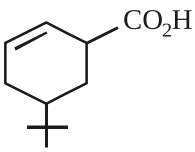


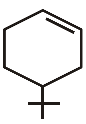
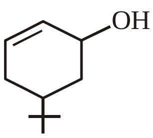
Geometrical isomerism is **not** possible at site (s) :

(a) III (b) I (c) I and III (d) III and IV

88. The product of the reaction given below is: **[2016]**



(a)  (b) 

(c)  (d) 

89. Which of the following compounds will exhibit geometrical isomerism ? **[2015; Similar 2002]**

(a) 2 - Phenyl -1 - butene
(b) 1, 1 - Diphenyl - 1 - propene
(c) 1 - Phenyl - 2 - butene
(d) 3 - Phenyl -1 - butene

90. The gas liberated by the electrolysis of dipotassium succinate solution is: **[Online April 11, 2014]**

(a) Ethane (b) Ethyne
(c) Ethene (d) Propene

91. In the presence of peroxide, HCl and HI do not give anti-Markownikoff's addition of alkenes because: **[NCERT : P L-312 | Online April 12, 2014]**

(a) One of the steps is endothermic in HCl and HI
(b) Both HCl and HI are strong acids
(c) HCl is oxidizing and the HI is reducing
(d) All the steps are exothermic in HCl and HI

92. The addition of HI in the presence of peroxide catalyst does not follow anti-Markovnikov's rule because : **[Online April 9, 2013]**

(a) HI is a strong reducing agent.
(b) H-I bond is too strong to be broken homolytically.
(c) I atom combines with H atom to give back HI.
(d) Iodine atom is not reactive enough to add across a double bond.

93. Consider the following sequence of reactions

$$CH_3CH = CH_2 \xrightarrow[700K]{Cl_2} A \xrightarrow[420K,12atm]{Na_2CO_3} B \xrightarrow[(ii)\ NaOH]{i\ HOCl} C$$

Compound 'C' is **[Online May 26, 2012]**

(a) $CH_2OH-CHOH-CH_2OH$ (b) $CH_3CH(OH)COONa$

(c) $HOCH_2 - CH = CH_2$ (d) $CH_3CH(OH)COCl$

94. Ozonolysis of an organic compound 'A' produces acetone and propionaldehyde in equimolar mixture. Identify 'A' from the following compounds: **[2008 (S), 2010 (S), 2011RS]**

(a) 1 – Pentene
(b) 2 – Pentene
(c) 2 – Methyl – 2 – pentene
(d) 2 – Methyl – 1 – pentene

95. Reaction of one molecule of HBr with one molecule of 1, 3-butadiene at 40 °C gives predominantly **[2005]**

(a) 1-bromo-2-butene under kinetically controlled conditions
(b) 3-bromobutene under thermodynamically controlled conditions
(c) 1-bromo-2-butene under thermodynamically controlled conditions
(d) 3-bromobutene under kinetically controlled conditions

96. Butene-1 may be converted to butane by reaction with **[2003]**

(a) Sn – HCl (b) Zn – Hg
(c) Pd/H_2 (d) Zn – HCl

Topic 3 Alkynes

97. The **incorrect** statement regarding ethyne is **[NCERT : PL-315 | April 9, 2024 (II)]**

(a) The C–C bonds in ethyne is shorter than that in ethene

(b) Both carbons are sp hybridised

(c) Ethyne is linear

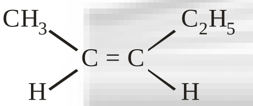
(d) The carbon-carbon bonds in ethyne is weaker than that in ethene

98. The major product of the following reaction is P.

$$CH_3C\equiv C-CH_3 \xrightarrow[\text{ii dil.KmnO}_4\ 273\text{K}]{\text{i Na / liq. NH}_3} \text{'P'}$$

Number of oxygen atoms present in product 'P' is _______ (nearest integer). **[NV, April 6, 2024 (I)]**

99. In the given reactions identify A and B **[NCERT : PL-317 | Feb. 1, 2024 (II)]**

$H_2 + A \xrightarrow{Pd/C}$ 

$$CH_3-C\equiv C-CH_3 + H_2 \xrightarrow{\text{Na / Liquid NH}_3} \text{"B"}$$

(a) A : n – Pentane B : Cis – 2 – butene

(b) A : 2 – Pentyne B : Cis – 2 – butene

(c) A : n – Pentane B : trans – 2 – butene

(d) A : 2 – Pentyne B : trans – 2 – butene

100. Compound A formed in the following reaction reacts with B gives the product C. Find out A and B

$$CH_3-C\equiv CH + Na \longrightarrow A \xrightarrow{B}$$

$$\underset{(C)}{CH_3-C\equiv C-CH_2-\underset{\underset{CH_3}{|}}{CH_2}}\quad NaBr$$

[NCERT : PL-316 | Jan. 30, 2024 (I)]

(a) $A = CH_3-C\equiv \overset{-}{C}Na,\ B = CH_3-CH_2-CH_2-Br$

(b) $A = CH_3-CH=CH_2,\ B = CH_3-CH_2-CH_2-Br$

(c) $A = CH_3-CH_2-CH_3,\ B = CH_3-C\equiv CH$

(d) $A = CH_3-C\equiv \overset{-}{C}Na,\ B = CH_3-CH_2-CH_3$

101. But-2-yne is reacted separately with one mole of Hydrogen as shown below: **[Feb. 01, 2023 (I)]**

$$\underline{B} \xleftarrow[\text{liq NH}_3]{\text{Na}} \underset{H_2}{CH_3-C\equiv C-CH_3} \xrightarrow[\Delta]{Pd/C} \underline{A}$$

(A) A is more soluble than B.

(B) The boiling point & melting point of A are higher and lower than B respectively.

(C) A is more polar than B because dipole moment of A is zero.

(D) Br_2 adds easily to B than A.

Identify the incorrect statements from the options given below:

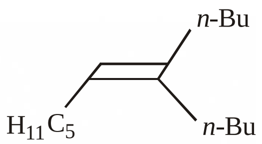
(a) A and B only (b) B, C & D only

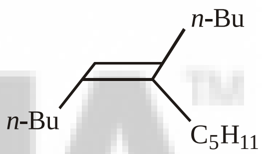
(c) A, C & D only (d) B and C only

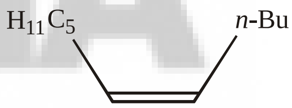
102. In bromination of propyne, with bromine 1, 1, 2, 2-tetrabromopropane is obtained in 27% yield. The amount of 1, 1, 2, 2-tetrabromopropane obtained from 1 g of bromine in this reaction is _______ $\times 10^{-1}$ g. (Nearest integer)
(Molar mass : Bromine = 80 g/mol) **[NV, July 29, 2022 (I)]**

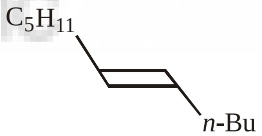
103. What will be the major product of following sequence of reactions? **[June 27, 2022 (II)]**

$$n\text{-Bu}-\equiv \xrightarrow[\text{(ii) Lindlar cat, } H_2]{\text{(i) } n\text{-BuLi, } n\text{-}C_5H_{11}Cl}$$

(a) 

(b) 

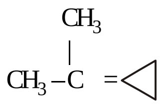
(c) 

(d) 

104. The number of sigma bonds in **[NV, July 25, 2021 (I)]**

$$H_3C-\underset{\underset{H}{|}}{C}=CH-C\equiv C-H \text{ is \_\_\_\_\_\_\_.}$$

105. An unsaturated hydrocarbon X on ozonolysis gives A. Compound A when warmed with ammonical silver nitrate forms a bright silver mirror along the sides of the test tube. The unsaturated hydrocarbon X is: **[March 16, 2021 (II)]**

(a) 

(b) $CH_3-\underset{\underset{CH_3}{|}}{C}=\underset{\underset{CH_3}{|}}{C}-CH_3$

(c) $HC\equiv C-CH_2-CH_3$ (d) $CH_3-C\equiv C-CH_3$

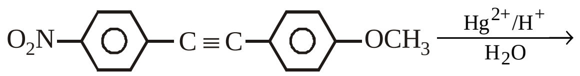
106. Consider the following chemical reaction.

$$CH \equiv CH \xrightarrow[\text{(2) CO, HCl, AlCl}_3]{\text{(1) Red hot Fe tube, 873K}} \text{Product}$$

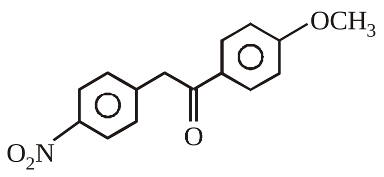
The number of sp^2 hybridized carbon atom(s) present in the product is ______ .

[NCERT : PL-318 | NV, Feb. 25, 2021 (I)]

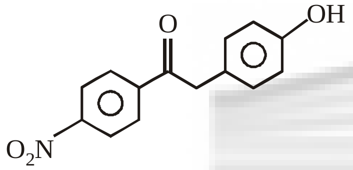
107. The major product obtained from the following reaction is: **[Sep. 06, 2020 (I)]**



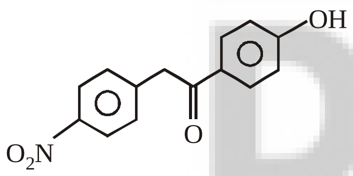
(a)



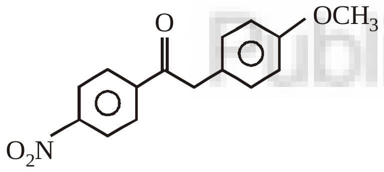
(b)



(c)



(d)



108. The major product (Y) in the following reactions is: **[Jan. 09, 2020 (I)]**

$$CH_3-\overset{CH_3}{\overset{|}{C}H}-C\equiv CH \xrightarrow[H_2O]{HgSO_4,\ H_2SO_4} X$$

$$\xrightarrow[\text{(ii) Conc. } H_2SO_4/\Delta]{\text{(i) } C_2H_5MgBr,\ H_2O} Y$$

(a) $CH_3-\overset{CH_3}{\overset{|}{C}H}-\underset{CH_3}{\underset{|}{C}}=CH-CH_3$

(b) $H_3C-\overset{CH_2}{\overset{\|}{C}}-\underset{C_2H_5}{\underset{|}{C}H}-CH_3$

(c) $CH_3-\overset{CH_3}{\overset{|}{C}H}-\underset{CH_2CH_3}{\underset{|}{C}}=CH_2$

(d) $CH_3-\overset{CH_3}{\overset{|}{C}}=\underset{CH_2CH_3}{\underset{|}{C}}-CH_3$

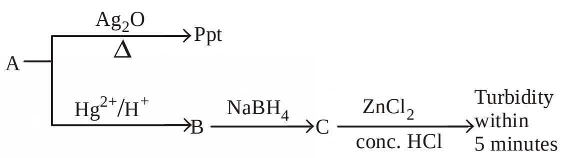
109. In the following sequence of reactions the maximum number of atoms present in molecule 'C' in one plane is ________.

$$A \xrightarrow[\text{Cu tube}]{\text{Red hot}} B \xrightarrow[\text{Anhydrous AlCl}_3]{CH_3Cl\text{ (1 eq.)}} C$$

(A is a lowest molecular weight alkyne)

[NV. Jan. 08, 2020 (II)]

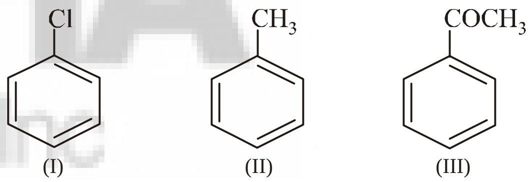
110. Consider the following reaction :



'A' is: **[April 12, 2019 (II)]**

(a) $CH\equiv CH$ (b) $CH_3-C\equiv C-CH_3$
(c) $CH_3-C\equiv CH$ (d) $CH_2=CH_2$

111. The increasing order of the reactivity of the following compounds towards electrophilic aromatic substitution reactions is: **[April 10, 2019 (I), April 9, 2019 (I) (S)]**



(a) II < I < III (b) III < II < I
(c) III < I < II (d) I < III < II

112. The major product of the following reaction is:

$$CH_3C\equiv CH \xrightarrow[\text{(ii) DI}]{\text{(i) DCl (1 equiv.)}}$$

[April 9, 2019 (I); Similar 2007]

(a) $CH_3CD(I)CHD(Cl)$ (b) $CH_3CD(Cl)CHD(I)$
(c) $CH_3CD_2CH(Cl)(I)$ (d) $CH_3C(I)(Cl)CHD_2$

113. The correct order for acid strength of compounds $CH\equiv CH$, $CH_3-C\equiv CH$ and $CH_2=CH_2$ is as follows: **[Jan. 12, 2019 (I)]**

(a) $CH\equiv CH > CH_2=CH_2 > CH_3-C\equiv CH$
(b) $CH_3-C\equiv CH > CH\equiv CH > CH_2=CH_2$
(c) $CH_3-C\equiv CH > CH_2=CH_2 > HC\equiv CH$
(d) $HC\equiv CH > CH_3-C\equiv CH > CH_2=CH_2$

114. When 2-butyne is treated with H_2/Lindlar's catalyst, compound X is produced as the major product and when treated with Na/liq. NH_3 it produces Y as the major product. Which of the following statements is correct?

[Online April 15, 2018 (II)]

(a) Y will have higher dipole moment and higher boiling point than X
(b) Y will have higher dipole moment and lower boiling point than X
(c) X will have lower dipole moment and lower boiling point than Y
(d) X will have higher dipole moment and higher boiling point than Y

115. Which one of the following class of compounds is obtained by polymerization of acetylene? **[NCERT : P L-318 | Online April 9, 2014]**
(a) Poly-yne (b) Poly-ene
(c) Poly-ester (d) Poly-amine

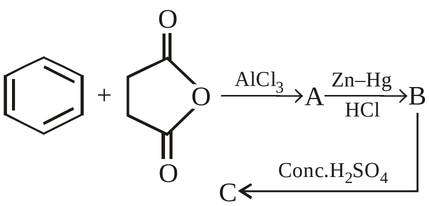
116. The hydration of propyne results in formation of **[Online May 26, 2012]**
(a) Acetone (b) Propanol-1
(c) Propene (d) Propanal

117. The treatment of CH_3MgX with $CH_3C \equiv C-H$ produces **[2008]**
(a) $CH_3-CH \quad CH_2$ (b) $CH_3C \equiv C-CH_3$
(c) $CH_3-\overset{H}{\overset{|}{C}}=\overset{H}{\overset{|}{C}}-CH_3$ (d) CH_4

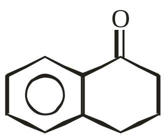
118. Which one of the following has minimum boiling point? **[2004]**
(a) 1 - Butene (b) 1 - Butyne
(c) *n*- Butane (d) Isobutane

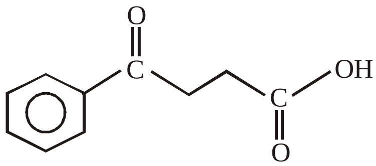
119. What is the product when acetylene reacts with hypochlorous acid? **[2002]**
(a) CH_3COCl (b) $ClCH_2CHO$
(c) Cl_2CHCHO (d) $ClCH_2COOH$.

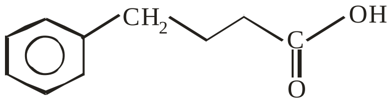
Topic 4 Aromatic Hydrocarbons

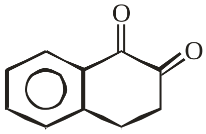
120. 

What is the structure of C ? **[April 9, 2024 (I)]**

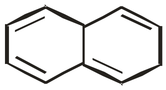
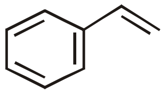
(a) 

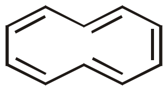
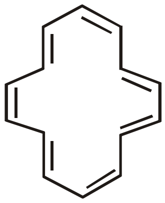
(b) 

(c) 

(d) 

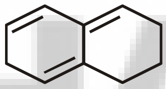
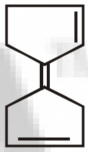
121. Which of the following are aromatic? **[NCERT : PL-321 | April 8, 2024 (I)]**

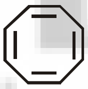
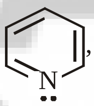
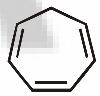
A.  B. 

C.  D. 

(a) B and D only (b) A and C only
(c) A and B only (d) C and D only

122. Total number of aromatic compounds among the following compounds is _______. **[NV, April 8, 2024 (II)]**

, , ,

, , 

123. Given below are two statements : **[NCERT : P L-322 | April 5, 2024 (I)]**

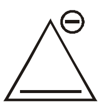
Statement I: Nitration of benzene involves the following step –

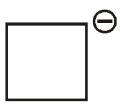
$$H-\overset{H}{\overset{|}{\underset{..}{O}}}{}^{\ominus}-NO_2 \rightleftharpoons H_2O + \overset{\oplus}{N}O_2$$

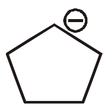
Statement II: Use of Lewis base promotes the electrophilic substitution of benzene.

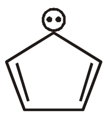
In the light of the above statements, choose the **most appropriate** answer from the options given below :
(a) Both **Statement I** and **Statement II** are incorrect
(b) **Statement I** is correct but **Statement II** is incorrect
(c) Both **Statement I** and **Statement II** are correct
(d) **Statement I** is incorrect but **Statement II** is correct

124. Correct order of stability of carbanion is **[NCERT : P L-321 | April 4, 2024 (II)]**


a


b


c

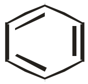
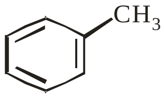
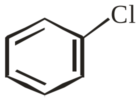
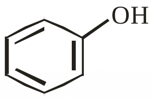

d

(a) C > B > D > A (b) A > B > C > D
(c) D > A > C > B (d) D > C > B > A

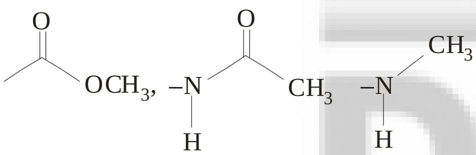
125. The set of meta directing functional groups from the following sets is: **[NCERT : P L-324 | Feb. 1, 2024 (II)]**

(a) $-CN, -NH_2, -NHR, -OCH_3$
(b) $-CN, -CHO, -NHCOCH_3, -COOR$
(c) $-NO_2, -NH_2, -COOH, -COOR$
(d) $-NO_2, -CHO, -SO_3H, -COR$

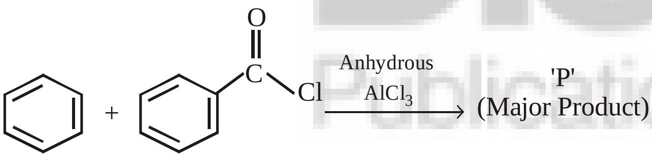
126. Which of the following compound will most easily be attacked by an electrophile? **[NCERT : P L-325 | Feb. 1, 2024 (I)]**

(a) 
(b) 
(c) 
(d) 

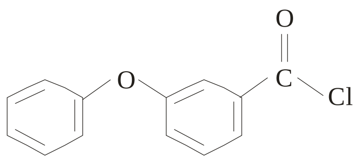
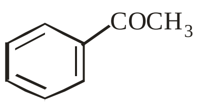
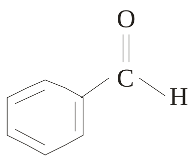
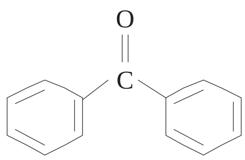
127. Total number of deactivating groups in aromatic eletrophilic susbstitution reaction among the following is ________. **[NCERT : P L-325 | NV, Feb. 1, 2024 (I)]**


$-C \equiv N$, $-OCH_3$

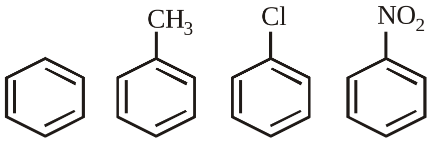
128. Identify major product 'P' formed in the following reaction.



[NCERT : P L-322 | Jan. 31, 2024 (II)]

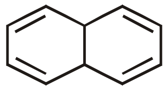
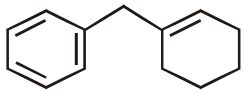
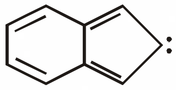
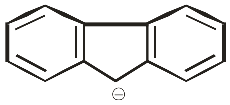
(a) 
(b) 
(c) 
(d) 

129. The correct order of reactivity in electrophilic substitution reaction of the following compounds is : **[Jan. 31, 2024 (II)]**


A B C D

(a) B > C > A > D (b) D > C > B > A
(c) A > B > C > D (d) B > A > C > D

130. Among the given organic compounds, the total number of aromatic compounds is ______. **[NV, Jan. 27, 2024 (I)]**

(A) 
(B) 
(C) 
(D) 

131. Given below are two statements: **[April 13, 2023 (II)]**

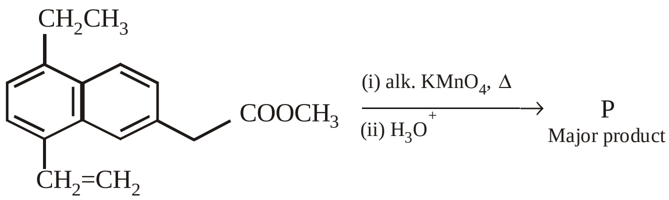
Statement-I : Tropolone is an aromatic compound and has 8π electrons.

Statement-II : π electrons of > C = O group in tropolone is involved in aromaticity.

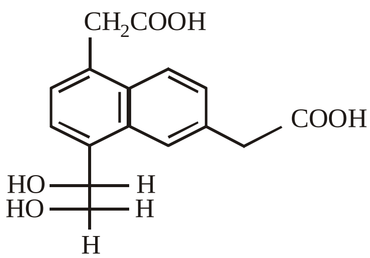
In the light of the above statements, choose the correct answer from the options given below:

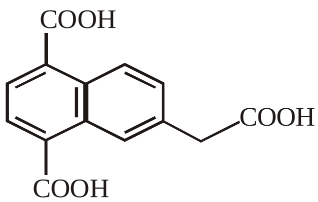
(a) Both Statement I and Statement II are true
(b) Statement I is true but Statement II is false
(c) Statement I is false but Statement II is true
(d) Both Statement I and Statement II are false

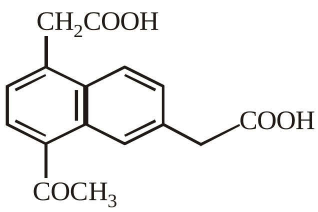
132. The major product 'P' formed in the given reaction is

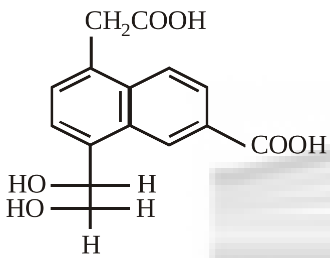


[April 10, 2023 (I)]

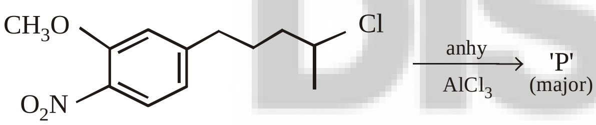
(a) 

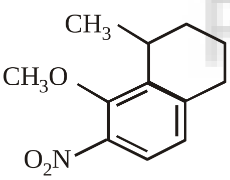
(b) 

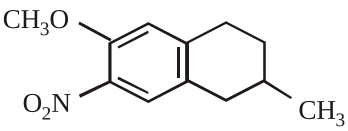
(c) 

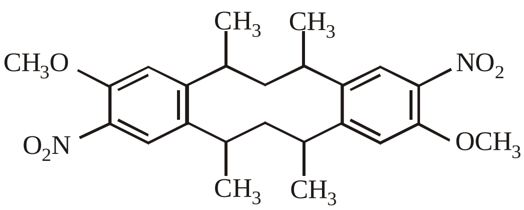
(d) 

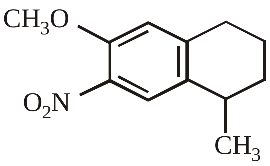
133. The major product ‘P’ formed in the given reaction is: **[April 10, 2023 (II)]**

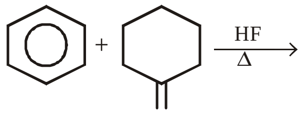


(a) 

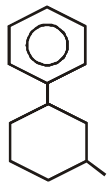
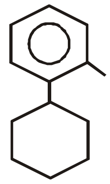
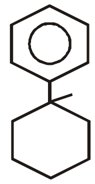
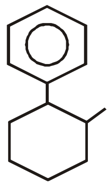
(b) 

(c) 

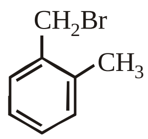
(d) 

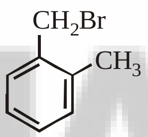
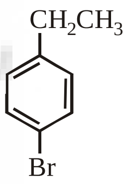
134. 'X' is :  X Major product

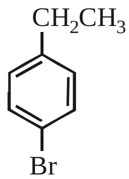
[Feb. 01, 2023 (II)]

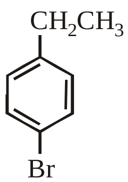
(a)  (b)  (c)  (d) 

135. Two isomers (A) and (B) with molar mass 184 g/mol and elemental composition C, 52.2%; H, 4.9% and Br 42.9% gave benzoic acid and *p*-bromobenzoic acid, respectively on oxidation with $KMnO_4$. Isomer 'A' is optically active and gives a pale yellow precipitate when warmed with alcoholic $AgNO_3$. Isomer 'A' and 'B' are, respectively : **[June 29, 2022 (II)]**

(a) $H_3C-CHBr-C_6H_5$ and 

(b)  and 

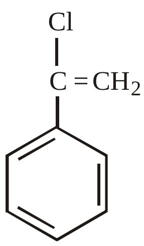
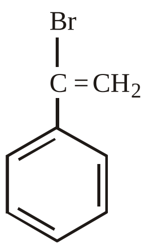
(c) $H_3C-CHBr-C_6H_5$ and 

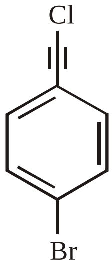
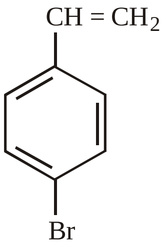
(d)  and $H_3C-CHBr-C_6H_5$

136. Product ‘A’ of following sequence of reactions is

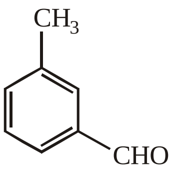
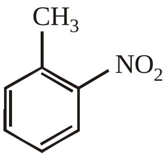
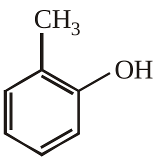
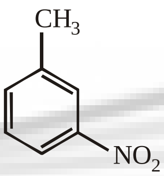
Ethylbenzene $\xrightarrow[\text{(b)}Cl_2,\Delta \\ \text{(c)alc.KOH}]{\text{(a)}Br_2.Fe}$ ‘A’ (Major product)

[June 27, 2022 (II)]

(a)  (b) 

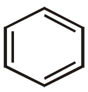
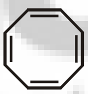
(c) 
(d) 

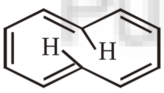
137. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product? **[June 26, 2022 (II)]**

(a) 
(b) 
(c) 
(d) 

138. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.
[NCERT : P L-321 | July 27, 2022 (I)]

Assertion A : [6] Annulene. [8] Annulene and cis –[10] Annulene, are respectively aromatic, not-aromatic and aromatic.

[6] Annulene  [8] Annulene 

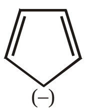
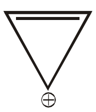
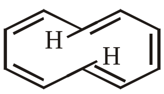
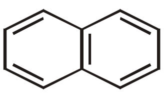
Cis-[10] Annulene 

Reason R : Planarity is one of the requirements of aromatic systems.

In the light of the above statements, choose the **most appropriate** answer from the options given below.

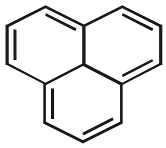
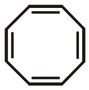
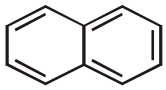
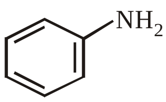
(a) Both A and R are correct and R is the correct explanation of A.
(b) Both A and R are correct but R is NOT the correct explanation of A.
(c) A is correct but R is not correct.
(d) A is not correct but R is correct.

139. Which of the following compounds is **not** aromatic? **[July 26, 2022 (I)]**

(a) 
(b) 
(c) 
(d) 

140. In the presence of sunlight, benzene reacts with Cl_2 to give product, X. The number of hydrogens in X is ________. **[NCERT : P L-323 | NV, July 26, 2022 (I)]**

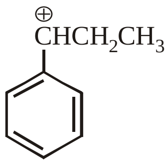
141. Which of the following is not an example of benzenoid compound ? **[NCERT : P L-318 | July 26, 2022 (II)]**

(a) 
(b) 
(c) 
(d) 

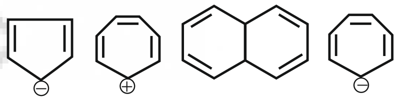
142.  + $CH_3CH_2CH_2Cl \xrightarrow{\text{Anhydrous, } AlCl_3}$ 'A'
Major Product

The stable carbocation formed in the above reaction is :
[NCERT : P L-323 | June 29, 2022 (II)]

(a) $CH_3CH_2\overset{\oplus}{C}H_2$ (b) $CH_3\overset{\oplus}{C}H_2$

(c) $CH_3-\overset{\oplus}{C}H-CH_3$ (d) 

143. Which of the following structures are aromatic in nature? **[June 28, 2022 (I)]**



A B C D

(a) A,B,C and D (b) Only A and B
(c) Only A and C (d) Only B, C and D

144. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R.**

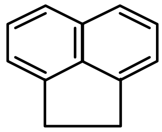
Assertion A: A mixture contains benzoic acid and naphthalene. The pure benzoic acid can be separated out by the use of benzene.

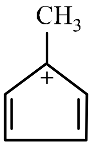
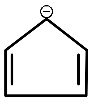
Reason R: Benzoic acid is soluble in hot water.

In the light of the above statements, choose the **most appropriate** answer from the options given below.
[June 25, 2022 (II)]

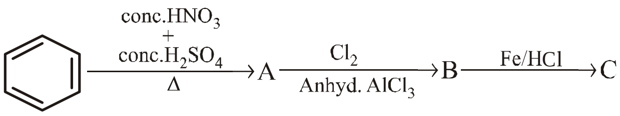
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

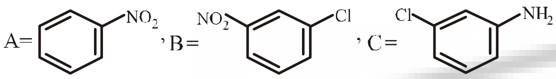
145. Which one of the following compounds is aromatic in nature ? **[Sep. 1, 2021 (II)]**

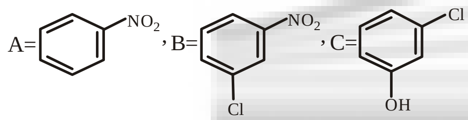
(a)  (b) 

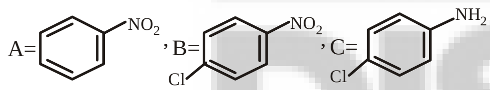
(c)  (d) 

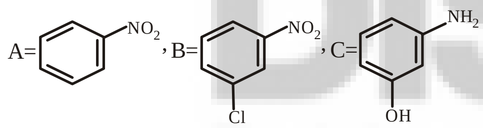
146. Identify correct A, B and C in the reaction sequence given below : **[Aug. 31, 2021 (II)]**



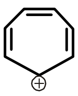
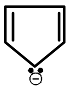
(a) 

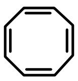
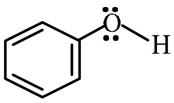
(b) 

(c) 

(d) 

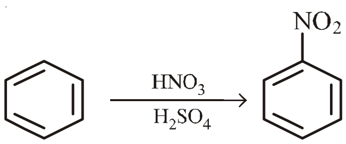
147. Which one of the following compounds is not aromatic? **[Aug. 26, 2021 (II); Similar March 16, 2021 (I)]**

(a)  (b) 

(c)  (d) 

148. Benzene on nitration gives nitrobenzene in presence of HNO_3 and H_2SO_4 mixture, where : **[NCERT : P L-322 | July 20, 2021 (II)]**

(a) both H_2SO_4 and HNO_3 act as a bases
(b) HNO_3 acts as an acid and H_2SO_4 acts as a base
(c) both H_2SO_4 and HNO_3 act as an acids
(d) HNO_3 acts as a base and H_2SO_4 acts as an acid

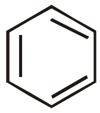
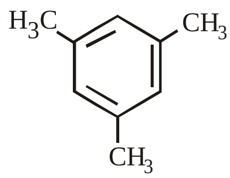
149. 

In the above reaction, 3.9 g of benzene on nitration gives 4.92 g of nitrobenzene. The percentage yield of nitrobenzene in the above reaction is ________%. (Round off to the Nearest Integer)
(Given atomic mass : C : 12.0 u, H : 1.0 u, O : 16.0 u, N : 14.0 u) **[NV, March 17, 2021 (I)]**

150. For the given reaction :

$$\underset{\underset{CH_3}{|}}{CH}\;\;CHBr \xrightarrow[\text{2. Red hot iron tube, 873K}]{\text{1. } NaNH_2} \underset{\text{(major product)}}{(A)}$$

What is 'A'? **[Feb. 26, 2021 (I)]**

(a)  (b) 

(c) $CH_3CH_2CH_2NH_2$ (d) $\underset{\underset{CH_3}{|}}{CH} = CH - NH_2$

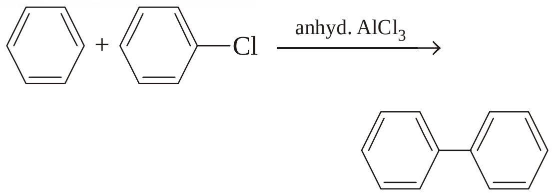
151. The correct sequence of reagents used in the preparation of 4-bromo-2-nitroethyl benzene from benzene is: **[Feb. 25, 2021 (II)]**

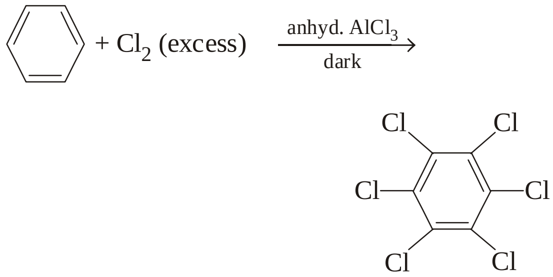
(a) $CH_3COCl/AlCl_3$, Zn-Hg/HCl, $Br_2/AlBr_3$, HNO_3/H_2SO_4
(b) HNO_3/H_2SO_4, $Br_2/AlCl_3$, $CH_3COCl/AlCl_3$, Zn-Hg/HCl
(c) $CH_3COCl/AlCl_3$, $Br_2/AlBr_3$, HNO_3/H_2SO_4, Zn/HCl
(d) $Br_2/AlBr_3$, $CH_3COCl/AlCl_3$, HNO_3/H_2SO_4, Zn/HCl

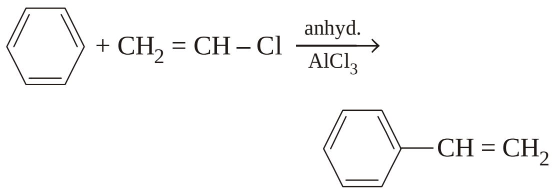
152. The number of sp^2 hybrid orbitals in a molecule of benzene is: **[Jan. 09, 2020 (II)]**

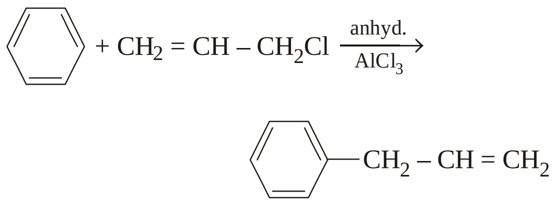
(a) 24 (b) 6 (c) 18 (d) 12

153. Consider the following reactions:

(A) 

(B) 

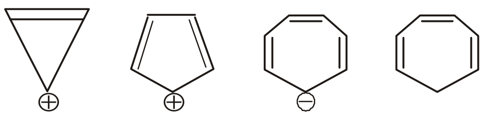
(C) 

(D) 

Which of these reactions are possible ? **[Jan. 07, 2020 (II)]**

(a) (A) and (B) (b) (A) and (D)
(c) (B), (C) and (D) (d) (B) and (D)

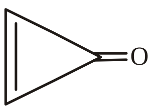
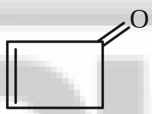
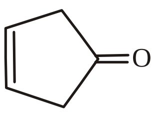
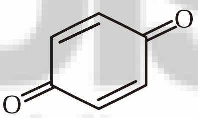
154. Which compound (s) out of the following is/are not aromatic? **[Jan. 11, 2019 (I), Jan. 9, 2019 (II)]**



(A) (B) (C) (D)

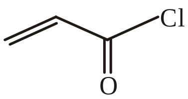
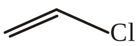
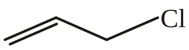
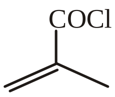
(a) (B), (C) and (D) (b) (C) and (D)
(c) (B) (d) (A) and (C)

155. Which of the following compounds will show highest dipole moment ? **[Online April 9, 2017]**

(I) 
(II) 
(III) 
(IV) 

(a) (I) (b) (II) (c) (III) (d) (IV)

156. Which of the following compounds will not undergo Friedel Craft's reaction with benzene ? **[Online April 8, 2017]**

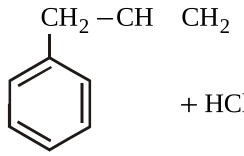
(a) 
(b) 
(c) 
(d) 

157. In the following sequence of reactions :

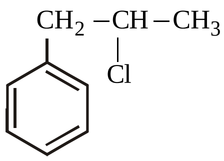
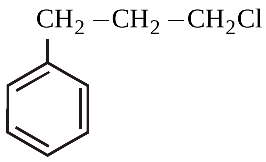
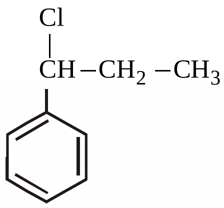
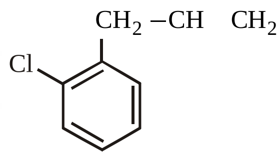
$$\text{Toluene} \xrightarrow{KMnO_4} A \xrightarrow{SOCl_2} B \xrightarrow[BaSO_4]{H_2/Pd} C$$

the product C is : **[2015]**

(a) $C_6H_5CH_2OH$ (b) C_6H_5CHO
(c) C_6H_5COOH (d) $C_6H_5CH_3$

158.  $+ HCl \longrightarrow X,$

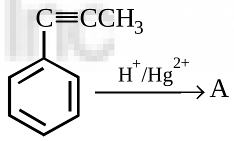
X is :
[Online April 9, 2013; Similar Online April 16, 2018]

(a) 
(b) 
(c) 
(d) 

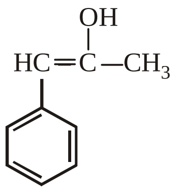
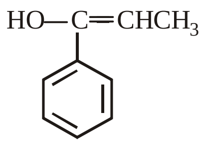
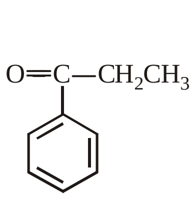
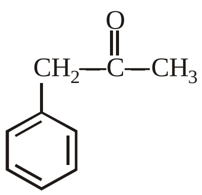
159. Which of the following would not give 2-phenylbutane as the major product in a Friedel-Crafts alkylation reaction ? **[Online April 22, 2013]**

(a) 1-butene + HF
(b) 2-butanol + H_2SO_4
(c) Butanoyl chloride + $AlCl_3$, then Zn, HCl
(d) Butyl chloride + $AlCl_3$

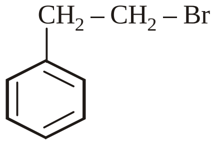
160. In the given reaction, **[Online May 12, 2012]**

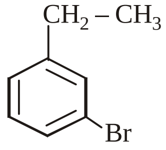


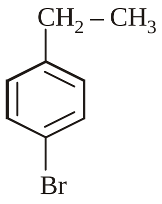
the product 'A' is

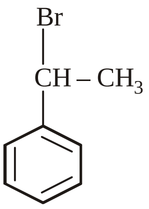
(a) 
(b) 
(c) 
(d) 

161. The product of the reaction between ethyl benzene and *N*-bromosuccinamide is **[Online May 19, 2012]**

(a) 

(b) 

(c) 

(d) 

162. Toluene is nitrated and the resulting product is reduced with tin and hydrochloric acid. The product so obtained is diazotised and then heated wth cuprous bromide. The reaction mixture so formed contains **[2008]**

(a) mixture of *o*- and *p*-bromotoluenes
(b) mixture of *o*- and *p*-dibromobenzenes
(c) mixture of *o*- and *p*-bromoanilines
(d) mixture of *o*- and *m*-bromotoluenes

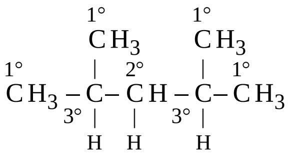
ANSWER KEYS

1	(b)	18	(60)	35	(4)	52	(4)	69	(b)	86	(b)	103	(c)	120	(a)	137	(c)	154	(a)
2	(9)	19	(b)	36	(b)	53	(d)	70	(a)	87	(b)	104	(10)	121	(a)	138	(d)	155	(a)
3	(3)	20	(c)	37	(1)	54	(d)	71	(d)	88	(d)	105	(c)	122	(1)	139	(c)	156	(b)
4	(9)	21	(b)	38	(d)	55	(b)	72	(b)	89	(c)	106	(7)	123	(b)	140	(9)	157	(b)
5	(c)	22	(d)	39	(a)	56	(2)	73	(d)	90	(c)	107	(a)	124	(d)	141	(a, b)	158	(c)
6	(c)	23	(d)	40	(a)	57	(a)	74	(b)	91	(d)	108	(d)	125	(d)	142	(c)	159	(c)
7	(9)	24	(d)	41	(4)	58	(a)	75	(a)	92	(d)	109	(13)	126	(d)	143	(b)	160	(c)
8	(a)	25	(b)	42	(70)	59	(a)	76	(b)	93	(a)	110	(c)	127	(1)	144	(d)	161	(d)
9	(a)	26	(b)	43	(b)	60	(2)	77	(d)	94	(c)	111	(c)	128	(d)	145	(a, d)	162	(a)
10	(a)	27	(a)	44	(d)	61	(c)	78	(d)	95	(c)	112	(d)	129	(d)	146	(a)		
11	(3)	28	(c)	45	(a)	62	(d)	79	(b)	96	(c)	113	(d)	130	(3)	147	(c)		
12	(d)	29	(8)	46	(3)	63	(c)	80	(c)	97	(d)	114	(d)	131	(b)	148	(d)		
13	(c)	30	(d)	47	(c)	64	(d)	81	(d)	98	(2)	115	(b)	132	(d)	149	(80)		
14	(12)	31	(c)	48	(d)	65	(c)	82	(d)	99	(d)	116	(a)	133	(d)	150	(b)		
15	(8)	32	(a)	49	(b)	66	(b)	83	(c)	100	(a)	117	(d)	134	(a)	151	(a)		
16	(c)	33	(c) or (d)	50	(b)	67	(b)	84	(d)	101	(b)	118	(d)	135	(c)	152	(c)		
17	(d)	34	(b)	51	(d)	68	(d)	85	(c)	102	(3)	119	(c)	136	(d)	153	(d)		

Chapter 10

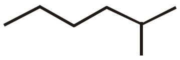
Hydrocarbons

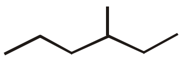
1. **(b)** Structure of given compound is

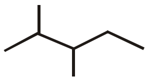
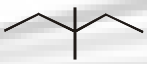


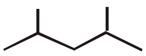
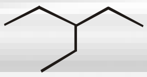
Only one 2° carbon is present in this compound.

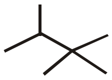
2. **(9)** Different chain iosmers of C_7H_{16} are :

(i)  (ii) 

(iii)  (iv) 

(v)  (vi) 

(vii)  (viii) 

(ix) 

3. **(3)** $CH_3COONa \xrightarrow{\text{Electrolysis}} \dot{C}H_3$

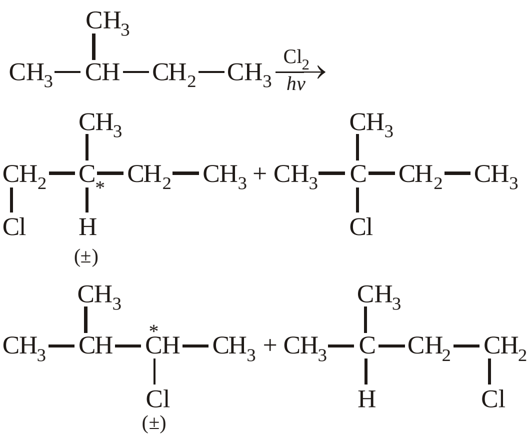
$C_2H_5COONa \xrightarrow{\text{Electrolysis}} \dot{C}_2H_5$

$2\dot{C}_2H_5 \longrightarrow \underset{(1)}{CH_3-CH_2-CH_2-CH_3}$

$2\dot{C}H_3 \longrightarrow \underset{(2)}{CH_3-CH_3}$

$\dot{C}H_3 + \dot{C}_2H_5 \longrightarrow \underset{(3)}{CH_3-CH_2-CH_3}$

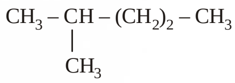
4. **(6)**



5. **(c)** Eclipsed conformation is the least stable conformation of ethane.
The electron clouds of the C–H bond come closer to each other resulting in increase in electron cloud repulsion, more energy and less stability.

6. **(c)** n-alkanes on heating in this presence of anhydrous $AlCl_3$ and hydrogen chloride gas isomerise to branched chain alkanes. The major product has one methyl side chain.

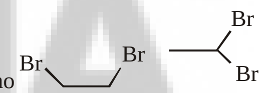
$CH_3-(CH_2)_4-CH_3 \xrightarrow[\text{HCl, }\Delta]{\text{Anhy. AlCl}_3}$

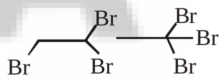


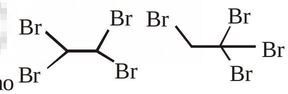
2 – methylpentane
(major)

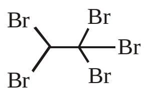
7. **(9)** $CH_3-CH_3+Br_2\text{ (Excess)} \xrightarrow{hv}$

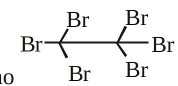
Monobromo 

Dibromo 

Tribromo 

Tretrabromo 

Pentabromo 

Hexabromo 

8. **(a)** $C_xH_y + \left(x+\frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

$\frac{y}{2} = 4 \Rightarrow y = 8;\ x + \frac{8}{4} = 11 \Rightarrow x = 9$

$\therefore$ Hydrocarbon will be = C_9H_8

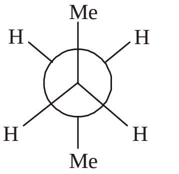
9. **(a)** $C_xH_y + \left(x+\frac{y}{4}\right)O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

$x + \frac{y}{4} = 9.5$ ...(i) & $\frac{y}{2} = 3$ ...(ii)

By solving equation (i) and (ii) we get.
$x = 8, y = 6$

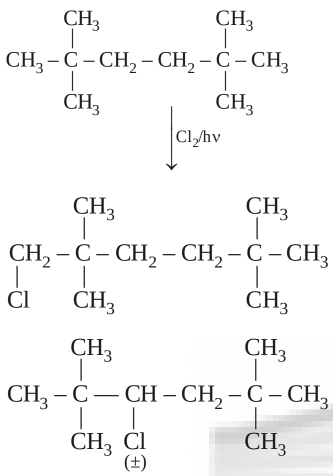
$\therefore$ The molecular formula of A is C_8H_6.

10. **(a)** The staggered conformation



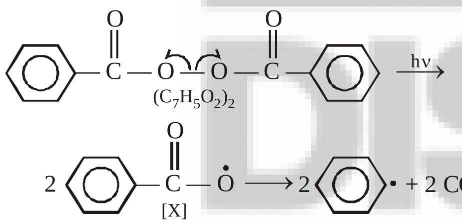
has lowest van der waal and torsional strain. Hence it must be most stable.

11. **(3)**

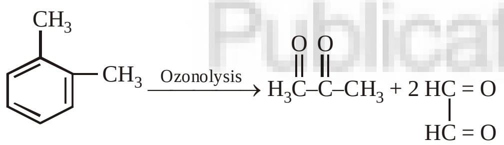


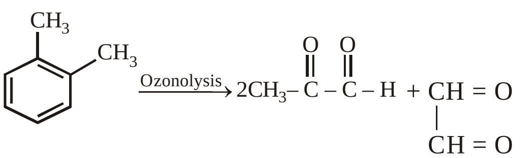
Total numbers of isomer = 3

12. **(d)**

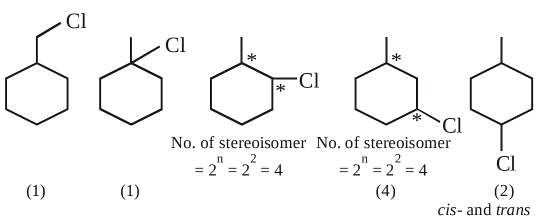


13. **(c)**





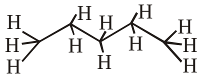
14. **(12)**



$\Rightarrow$ Total number of isomers = 1 + 1 + 4 + 4 + 2 = 12

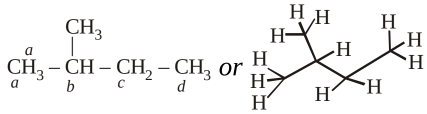
15. **(8)** Number of monohalogen derivatives are equal to the number of chemically different hydrogen atoms present in the compound. Possible number of structures for C_5H_{12} are-

(i) $\overset{a}{C}H_3 - \overset{b}{C}H_2 - \overset{c}{C}H_2 - \overset{b}{C}H_2 - \overset{a}{C}H_3$ *or*



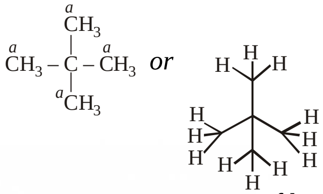
3-types of hydrogen
↓
3-*Products*

(ii)



4-types of hydrogen
↓
4-*Products*

(iii)



1-type of hydrogen
↓
1-*Product*

$\therefore$ Total number of monobromo derivatives in the hydrocarbon having molecular formula $C_5H_{12} = 3 + 4 + 1 = 8$

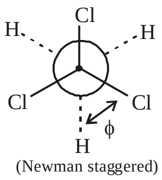
16. **(c)** Conformations (*a*) and (*c*) are staggered, while (*b*) and (*d*) are eclipsed. In the anti-conformation (*c*), the dihedral angle between two methyl groups is largest (180º).

17. **(d)** In II and IV, both $-CH_3$ groups are at 60°. In IV, there is more repulsion between $-CH_3$ and –H than that in II between –H and –H. Potential energy $\propto \frac{1}{\text{Stability}}$

Stability order : I > III > IV > II

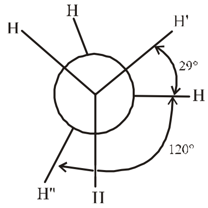
So, Potential energy : II > IV > III > I

18. **(60)** Staggered form is produced when the rearrangement of atoms or group takes place by an angle of 60°. 1, 1, 1 trichloroethane ($CCl_3 - CH_3$) in eclipsed form on rotation by 60° gives staggered form.



Dihedral angle(ϕ) = 60°

19. **(b)** A dihedral angle is the angle between two C – H bonds projected on a plane orthogonal to the C – C bond. In the given conformation, the dihedral angle H′ – C – C –H″ is the sum of $H' - C - C - H_a + H_a - C - C - H''$ i.e. $29 + 120 = 149°$



20. **(c)** Let the hydrocarbon be C_xH_y.

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

25g (excess) 88g 9g

2 mol $\frac{1}{2}$ mol

$x = 2y = 1$

$\because$ $x = 2$ and $y = 1$, the hydrocarbon will be C_2H.
Hence, 2 mol carbon contains 24 g and 1 mol hydrogen contains 1g.

21. **(b)** Let the hydrocarbon be C_xH_y.

$$C_xH_y + \left(x+\frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

Before combustion: 10 mL 55 mL 0

After combustion: 0 $55-10\left(x+\frac{y}{4}\right)$ 10 x

Volume of CO_2, $10x = 40$; $x = 4$

$55-10\left(x+\frac{y}{4}\right)=0$; $y = 6$

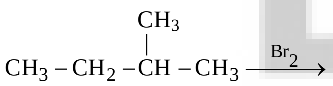
$\therefore$ Hydrocarbon is C_4H_6

22. **(d)** In acyclic or open chain compounds, angle strain is absent.

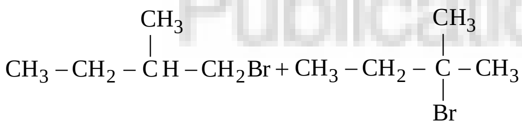
23. **(d)** The order of substitution in different alkanes is :

$$3° > 2° > 1°$$

Thus, the bromination of 2-methylbutane mainly gives 2-bromo - 2 - methylbutane.

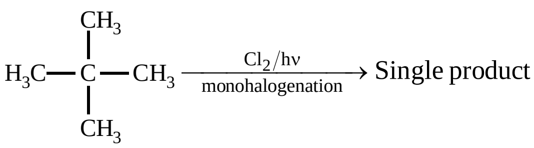


2-Methylbutane



1-Bromo-2 methylbutane (minor) 2-Bromo-2-methylbutane (major)

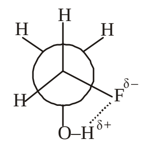
24. **(d)** (III) Diequatorial *cis*-1,3-dimethylcyclohexane (I) *trans*-1,3-dimethylcyclohexane (one Me is equatorial and the other is axial) ≈ (II) > (IV) Diaxial *cis* -1,3-dimethyl cyclohexane.

25. **(b)** 

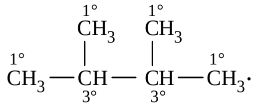
Neopentane

In neopentane, all hydrogen atoms are equivalent.

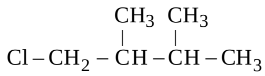
26. **(b)** Chiral conformation will not have plane of symmetry. Since twist boat does not have plane of symmetry, it is chiral.

27. **(a)** 

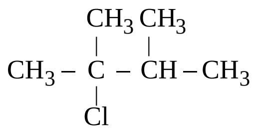
Due to hydrogen bonding between H and F, gauche conformation is most stable, hence the correct order is Eclipse, Anti, Gauche.

28. **(c)** 

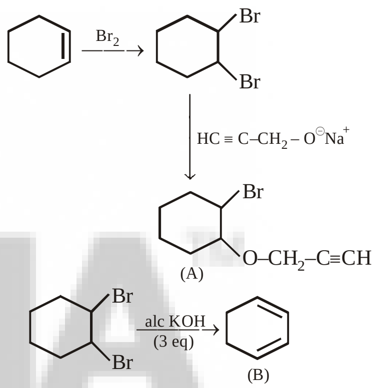
Since it contains only two types of H-atoms, hence it will give only two monochlorinated compounds, viz.



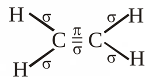
1-Chloro-2, 3-dimethylbutane

and 

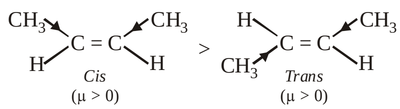
2-Chloro-2,3-dimethylbutane

29. **(8)** 

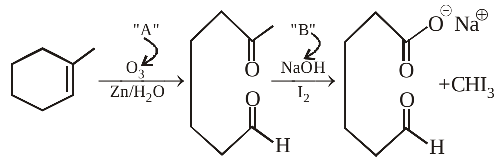
The total sum of π electrons in product A and B is 8.

30. **(d)** Ethylene is  it has 5σ bonds and 1π bond.

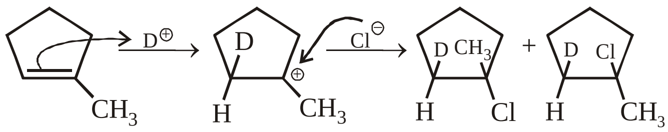
31. **(c)** Dipole moment is a vector quantity and for a molecule net dipole moment is the vector sum of all bond dipoles hence dipole moment of *Cis* form is greater than *Trans* form.



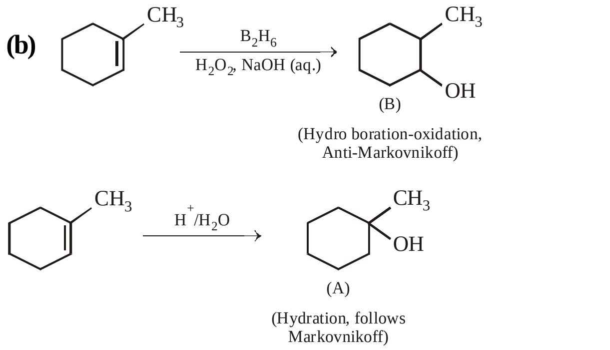
32. **(a)** First reaction is reductive ozonolysis and second is iodoform reaction.



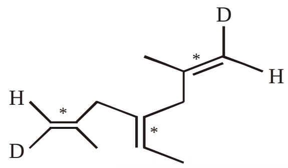
33. **(c) or (d)**



34. (b)

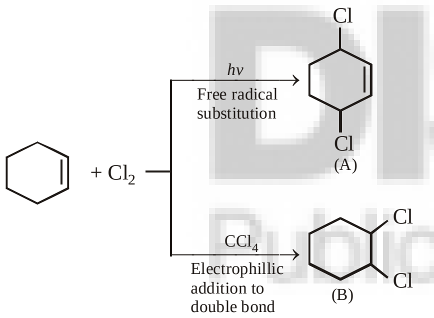


35. (4) We can use the EZ nomenclature for determining the geometrical isomers of this compound.



First stereocentre = E or Z – isomer.
Second stereocentre = E or Z – isomer.
Third stereocentre = We don't count it as the compound has the same two substituents and we have done it already once for one substituent.
Thus, total geometrical isomers = 4

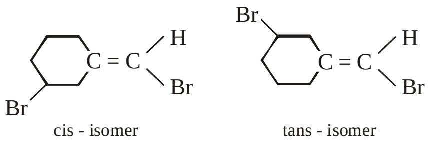
36. (b)



37. (1) $CH_3-CH=CH-CH_3 \xrightarrow[\text{(ii) Zn + } H_2O]{\text{(i) } O_3} 2CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-H$

The total number of oxygen atom present per molecule of the product is 1.

38. (d)



cis - isomer tans - isomer

Compound in option (a) will result in the same compound when rotation along the C = C double bond is performed (formation of two such isomers, not an actual rotation along the double bond).
Same will be for compound in (d).
For (c), we cannot decide the cis- and trans- isomers as these are two H-atoms on one doubly-bonded carbon atom.

39. (a) $CH_3-CH=CH_2 \xrightarrow[\text{ii) } H_2O_2\text{, NaOH}]{\text{i) } B_2H_6} CH_3-CH_2-\overset{\overset{\displaystyle OH}{|}}{CH_2}$

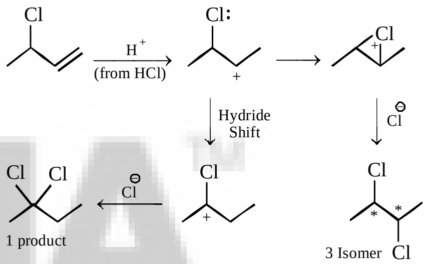
$\xrightarrow{\text{P.C.C.}} CH_3-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-H \xrightarrow{CH_3MgBr} CH_3-CH_2-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_3$

40. (a)

$\xrightarrow[\text{(ii) } H_2O]{\text{(i) } O_3} \underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Butanoic acid}}{CH_3CH_2CH_2COOH}$

it is oxidative ozonolysis.

41. (4)



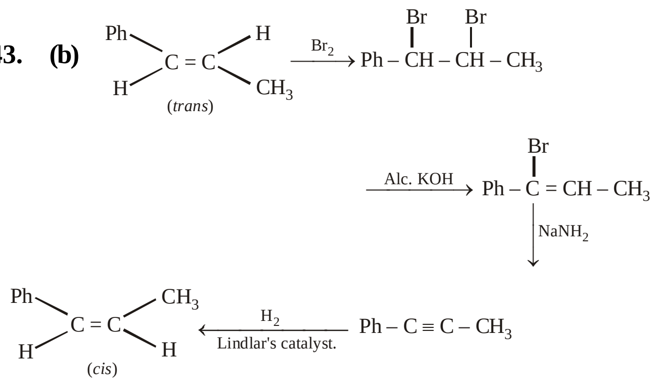
Total Possible Isomeric product = 1 + 3 = 4

42. (70)

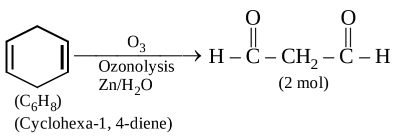
$\underset{\text{Hydrocarbon (X)}}{CH_3-CH=C(CH_3)_2} \xrightarrow{\text{Ozonolysis}} CH_3-CHO + O=C(CH_3)_2$

Hence molar mass of hydrocarbon (X) is 70 g/mol.

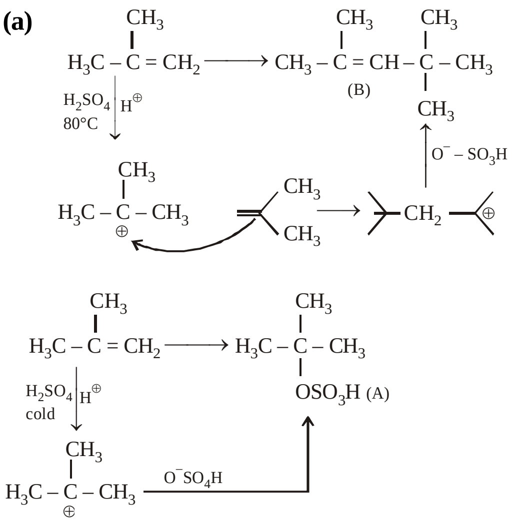
43. (b)



44. (d)



45. (a)



46. (3) Moles of hydrocarbon $= \dfrac{17\times10^{-3}}{136} = 1.25\times10^{-4}$

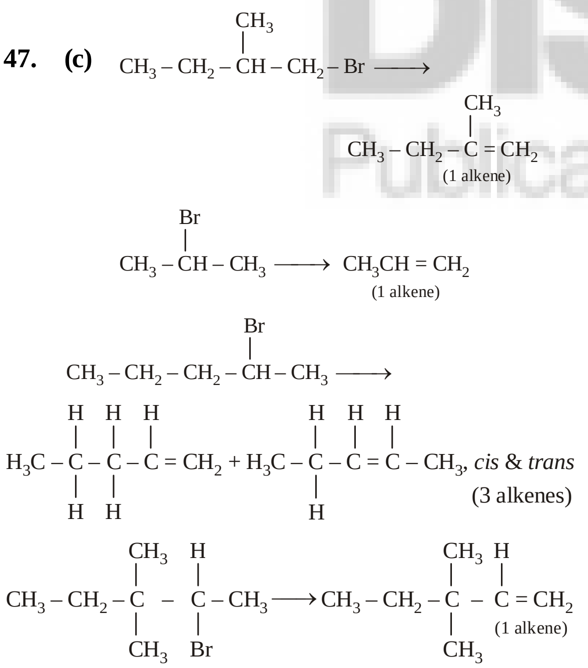
Moles of H_2 gas $= \dfrac{8.4\times10^{-3}}{22.4} = 0.375\times10^{-3}$

$= 3.75\times10^{-4}$

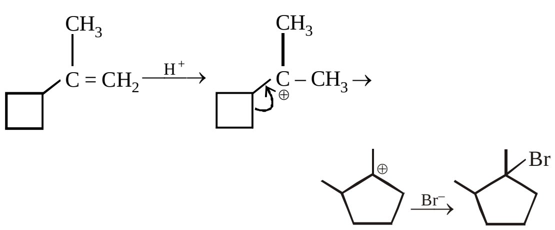
Hydrogen molecule used for 1 molecule of hydrocarbon is 3.

$= \dfrac{3.75\times10^{-4}}{1.25\times10^{-4}} = 3$

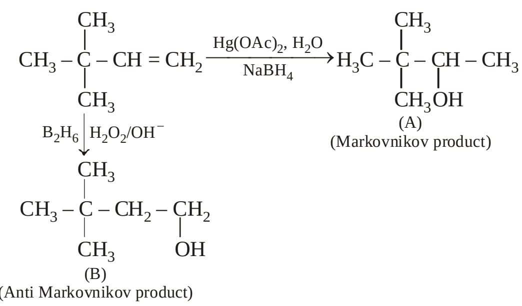
47. (c)



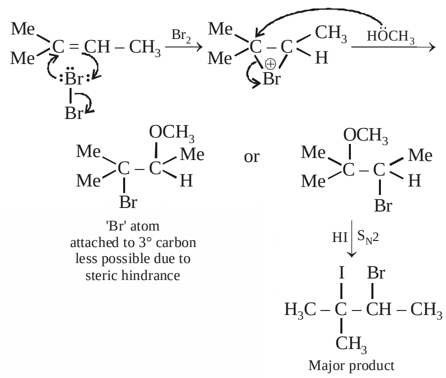
48. (d)



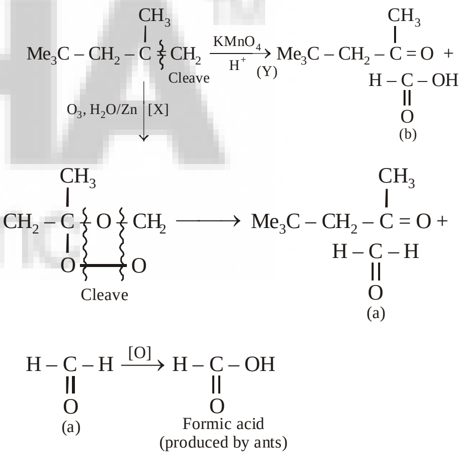
49. (b)



50. (b)



51. (d)



52. (4) Moles of X $= \dfrac{10\text{ mg}}{80} = 0.125$ m mol.

Moles consumed of $H_2 = \dfrac{8.4}{22.4} = 0.375$ m mol.

$\dfrac{n_{H_2}}{n_X} = \dfrac{0.375}{0.125} = 3$

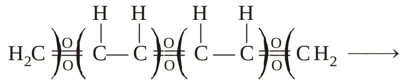
So, the compound X have 3 double bonds.

Ozonolysis of the compound yields only formaldehyde and dialdehyde, so the compound should be

$H_2C{=}CH-CH{=}CH-\overset{H}{C}{=}CH_2$

Molecular mass $= (12\times6) + 1\times8 = 72 + 8 = 80$ amu

Ozonolysis form:



$$\underbrace{2\,HCHO + 2\,C_2O_2H_2}_{\text{4 molecules}}$$

53. **(d)** Three isomers are possible for an oxidisable molecule having molecular formula C_4H_8.

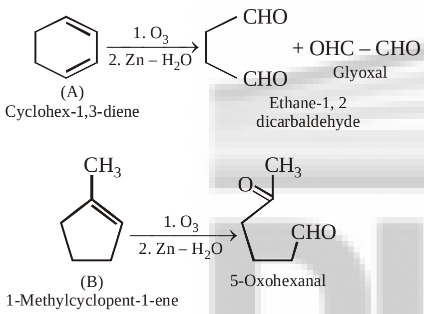
$CH_3CH = CHCH_3$ (But-2-ene) $CH_3CH_2CH = CH_2$ (But-1-ene) $CH_3 - \overset{CH_3}{\overset{|}{C}} = CH_2$ (2-Methylpropene)

Oxidation with $KMnO_4$ to give a ketone along with evolution of effervescences is possibly only with 2-methylpropene

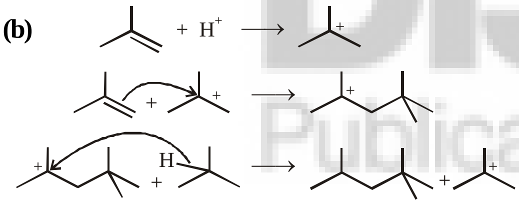
$$\underset{(A)}{CH_3 - \overset{CH_3}{\overset{|}{C}} = CH_2} \xrightarrow{KMnO_4/H^+} CH_3 - \overset{CH_3}{\overset{|}{C}} = O + CO_2\uparrow$$

Thus isomer A should be 2 – methylpropene.

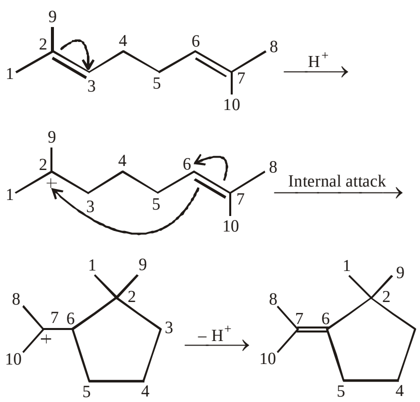
54. **(d)**



55. **(b)**



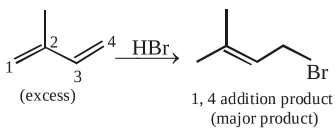
56. **(2)**



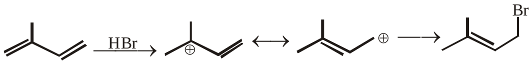
Number of sp^2 hybridised carbon atoms = (6 and 7) 2

57. **(a)** Both the statements are correct.

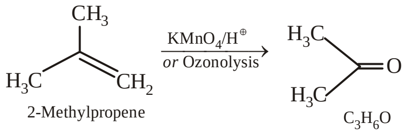
58. **(a)**



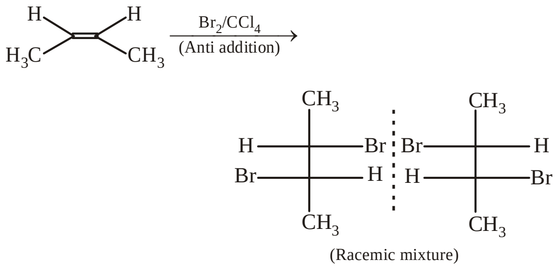
Mechanism :



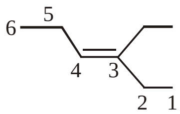
59. **(a)**



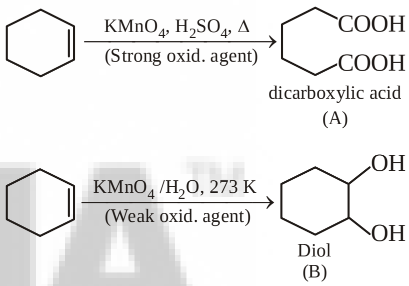
60. **(2)**



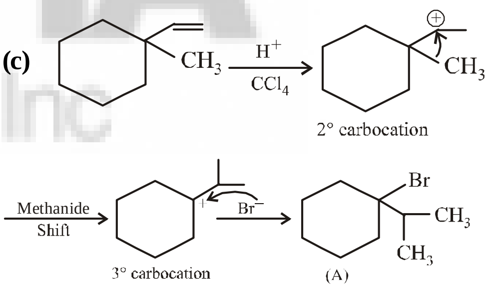
61. **(c)**



62. **(d)**



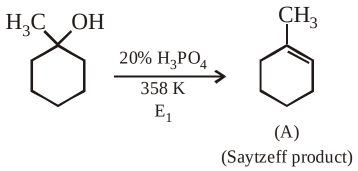
63. **(c)**

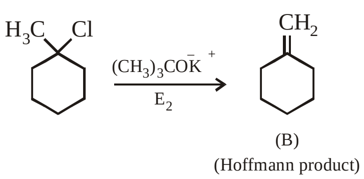


64. **(d)** Carbocation B is more stable as it is secondary carbocation having more number of α-hydrogens and having greater +I effect.

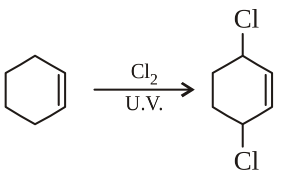
∴ Carbocation B formed at a faster rate than carbocation A.

65. **(c)**



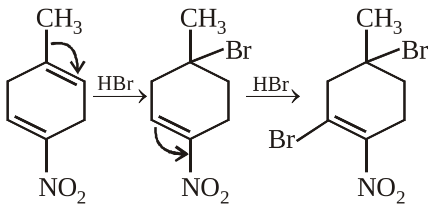


66. **(b)** The reagent, Cl_2; UV light is used for free radical allylic substitution.

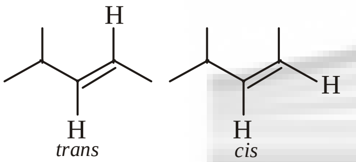


67. **(b)** $\underset{sp^2}{CH_2} = \underset{sp}{C} = \underset{sp^2}{CH} - \underset{sp^3}{CH_3}$

68. **(d)**

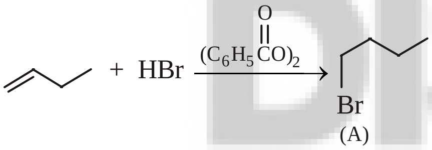


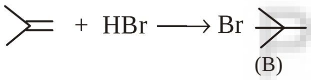
69. **(b)**

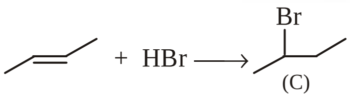


4-Methylpent-2-ene
Geometrical isomers

70. **(a)**







The boiling points of isomeric haloalkanes decrease with increase in branching.
So order of B.P. is : A > C > B.

71. **(d)** $CH_3CH = CHCH(CH_3)_2 \xrightarrow{H^+}$

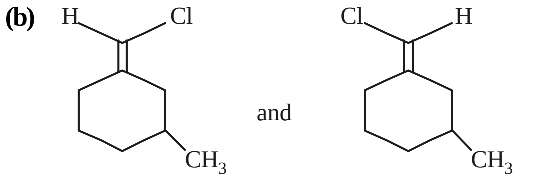
$CH_3CH_2 - \overset{+}{C}H - \underset{\displaystyle CH_3}{\underset{|}{C}HCH_3} \xrightarrow{1,2\text{-}\overline{H}\text{ shift}}$

2° carbocation

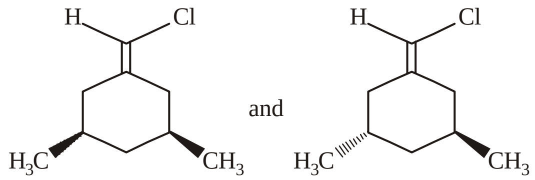
$CH_3CH_2 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{\overset{+}{C}CH_3}} \xrightarrow{Br^-} CH_3CH_2 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle Br}{\overset{|}{C}CH_3}}}$

3° carbocation

72. **(b)**

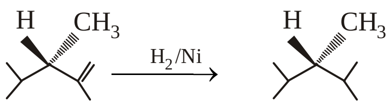


Geometrical isomers



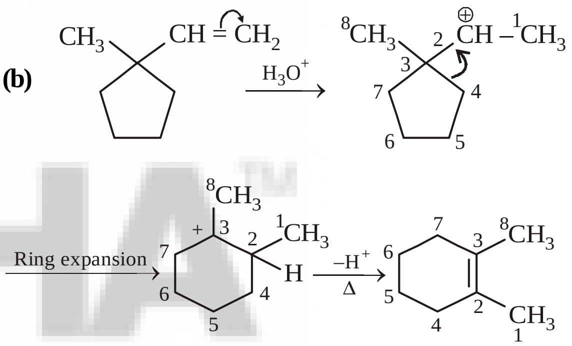
Geometrical isomers

73. **(d)**

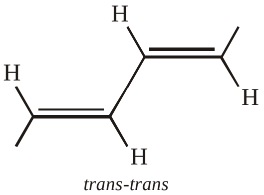


Optically inactive
(No chiral centre)

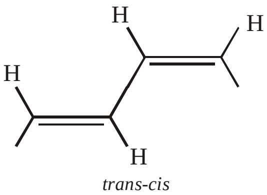
74. **(b)**



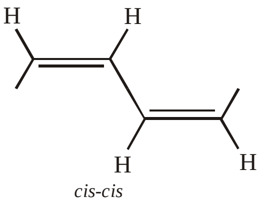
75. **(a)** In isomers of hydrocarbon heat of combustion is inversely proportional to the stability. Between two geometrical isomers *trans* isomer is more stable than *cis*.

(A) 

Most stable due to *trans-trans* arrangement

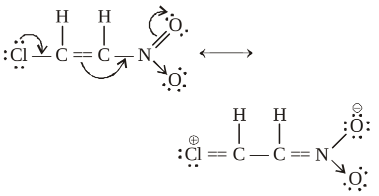
(B) 

Next stable due to *trans-cis* arrangement

(C) 

Least stable due to *cis-cis* arrangement

76. **(b)** In Cl–CH=CH–NO_2 double bond character in carbon-chlorine bond is maximum due to resonance and so the bond length is shortest.

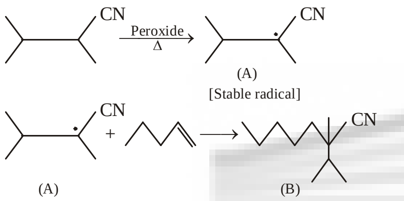


$(CH_3)_2CH–CH=CH_2 \xrightarrow{HCl} (CH_3)_2CH–\overset{+}{C}H–CH_3$

77. **(d)** $\xrightarrow{\text{Hydride shift}} CH_3–\overset{+}{\underset{CH_3}{C}}–CH_2–CH_3 \longrightarrow CH_3–\overset{Cl}{\underset{CH_3}{C}}–CH_2–CH_3$

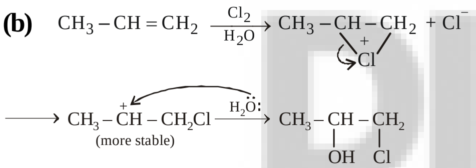
There is no chiral carbon in the product of this reaction.

78. **(d)**

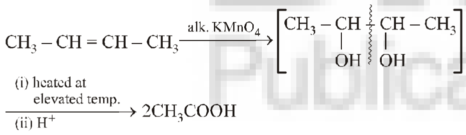


(A) is more stable radical and undergoes Markovnikov addition to form (B).

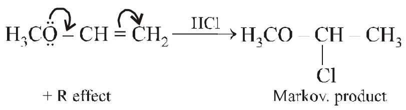
79. **(b)**

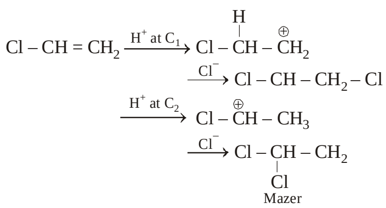


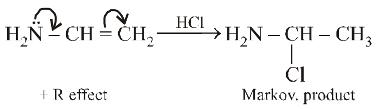
80. **(c)**

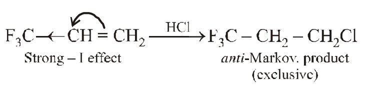


81. **(d)**

(a) 

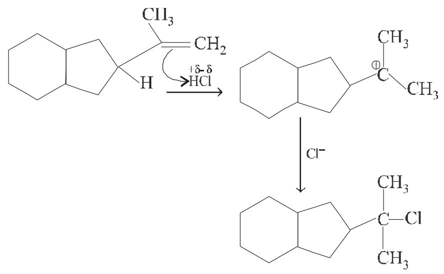
(b) 

(c) 

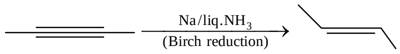
(d) 

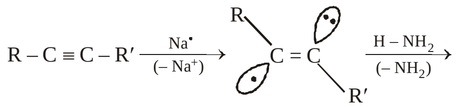
Due to lighter e^- withdrawing nature of CF_3 group it show antimarkornikoff product.

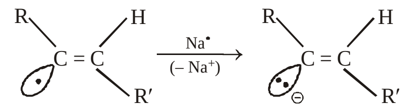
82. **(d)**



83. **(c)**

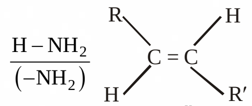






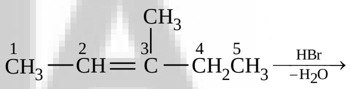
trans - Vinylic radical (more stable than *cis*)

Vinylic anion (more stable)

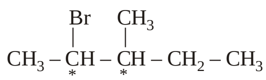


trans - Alkene

84. **(d)** Addition of HBr on 3-methylpent-2-ene in presence of peroxide takes place according to *anti*-Markownikov's rule.



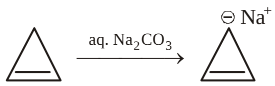
3-Methylpent-2-ene



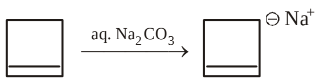
2-Bromo-3-methylpentane (2 chiral centres)

Since two chiral centres are present in the product, four stereoisomers (2^n) are possible.

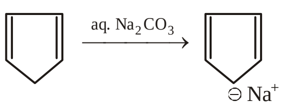
85. **(c)**

(a) 

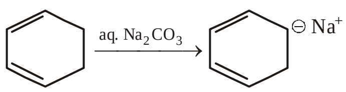
Antiaromatic ($4\pi e^-$) **Unstable**.

(b) 

Antiaromatic ($4\pi e^-$) **Unstable**.

(c) 

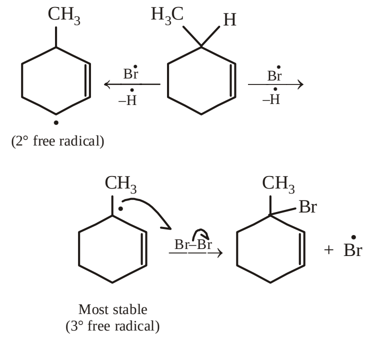
Aromatic ($6\pi e^-$) **Stable**.

(d) 

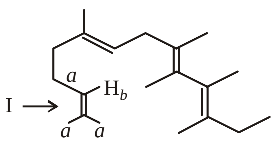
Homoaromatic ($6\pi e^-$)

No delocalization of electrons in whole ring, so less stable than (*c*).

86. **(b)** $Br_2 \xrightarrow{h\nu} 2\dot{B}r$

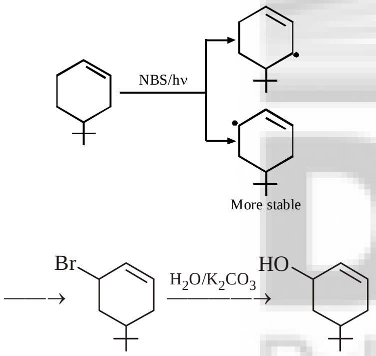


87. **(b)**



Both substituents are same
(G.I. not possible)

88. **(d)** N – bromosuccinimide results into bromination at allylic and benzylic positions.



89. **(c)** $H_3C—\underset{}{\overset{H}{\overset{|}{C}}}=CH—CH_2Ph$

90. **(c)** Ethene is obtained by electrolysis of dipotassium succinate as follows:

$$\begin{array}{l} CH_2COOK \\ | \\ CH_2COOK \end{array} \xrightarrow{\text{ionization}} \begin{array}{l} CH_2COO^- \\ | \\ CH_2COO^- \end{array} + 2K^+$$

Pot. succinate

$$2H_2O \xrightleftharpoons{\text{ionization}} 2OH^- + 2H^+$$

At anode :

$$\begin{array}{l} CH_2COO^- \\ | \\ CH_2COO^- \end{array} - 2e^- \longrightarrow \left[\begin{array}{l} CH_2COO \\ | \\ CH_2COO \end{array}\right] \longrightarrow \begin{array}{l} CH_2 \\ \| \\ CH_2 \end{array} + 2CO_2$$

Unstable

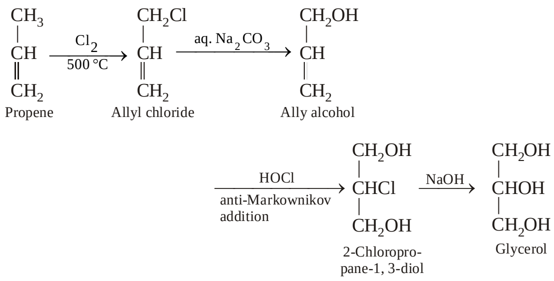
At cathode :

$$2H^+ + 2e^- \longrightarrow [2H] \longrightarrow H_2$$

91. **(d)** Anti-Markownikov addition is possible only in case of HBr and not in HCl and HI. In HBr, both the chain initiation and propagation steps are exothermic, while in HCl, first step is exothermic, and second step is endothermic and in HI, no step is exothermic. Hence HCl and HI do not undergo anti-Markownikov's addition.

92. **(d)** HI does not exhibit peroxide effect. HI bond although dissociates easily into iodine radicals, they being bigger in size are not much reactive but recombine together to form iodine molecule.

93. **(a)**



94. **(c)** From the products formed it is clear that the compound has 5 carbon atoms with a double bond and methyl group on 2nd carbon atom.

$$CH_3-\overset{\overset{CH_3}{|}}{C}=CH-CH_2-CH_3$$

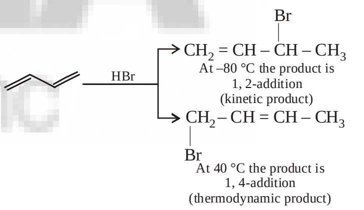
2–Methyl–pent–2–ene
(A)

$$\Big\downarrow O_3/Zn,\ H_2O$$

$$CH_3-\overset{\overset{CH_3}{|}}{C}=O+CH_3-CH_2-CHO$$

Acetone Propionaldehyde

95. **(c)**

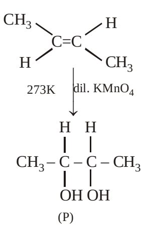


96. **(c)** Alkenes combine with hydrogen under pressure and in presence of a catalyst (Ni, Pt or Pd) and form alkanes.

Butene - 1 $\xrightarrow{H_2/Pd}$ Butane.

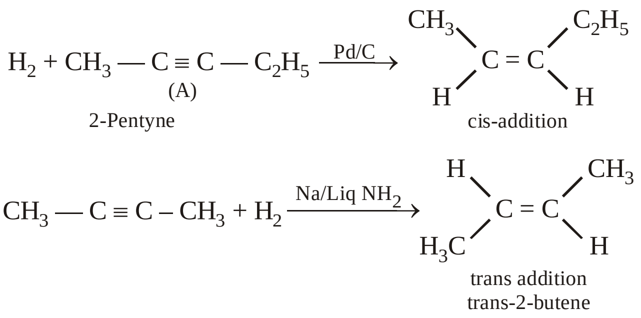
97. **(d)** The carbon-carbon bonds in ethyne is stronger than that in ethene.
(H–C≡C–H) Ethyne is linear and carbon atoms are sp-hybridised.

98. **(2)** $CH_3-C\equiv C-CH_3 \xrightarrow{Na/liq.NH_3}$



Number of oxygen atoms present in product 'P' is 2.

99. **(d)** A : 2 – Pentyne B : trans-2-butene



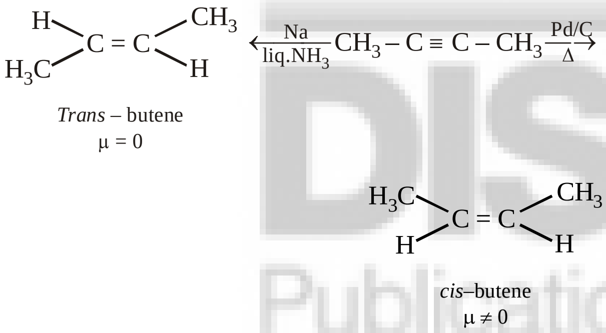
100. **(a)** Reaction takes place as:

$$CH_3-C\equiv CH+Na\longrightarrow \underset{(A)}{CH_3-C\equiv C^-\ Na^+}+H_2\uparrow$$

$$CH_3-C\equiv C^-Na^+ + \underset{(B)}{CH_3CH_2CH_2-Br}\longrightarrow$$

$$\underset{(C)}{CH_3-C\equiv C-CH_2-CH_2-CH_3}+NaBr$$

101. **(b)** Since *cis*-butene (A) is more polar than *trans*-butene (B) it has higher boiling point. However, *trans*-butene has better packing than *cis*-butene. So, *trans*-butene (B) has higher melting point than the *cis*-isomer (A).



102. **(3)** $CH_3-C\equiv CH+2Br_2\rightarrow CH_3-CBr_2-CHBr_2$

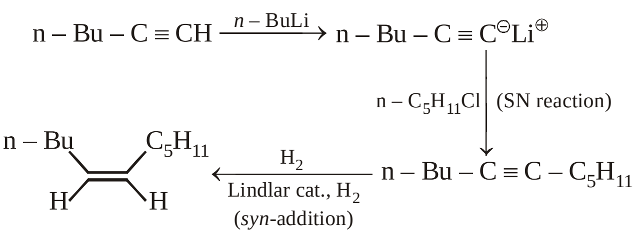
(molar mass = 360)

2×160 g Br_2 produces $= 360\times 0.27$ g Compound

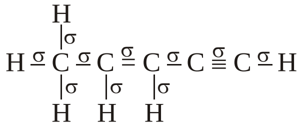
$$1\text{ g } Br_2 \text{ produces} = \frac{360\times 0.27}{2\times 160}\text{ g}$$

$= 0.30375 = 3.0375\times 10^{-1}$

103. **(c)** Alkyl lithium act as a base.

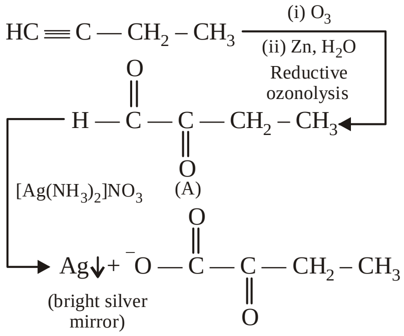


104. **(10)**

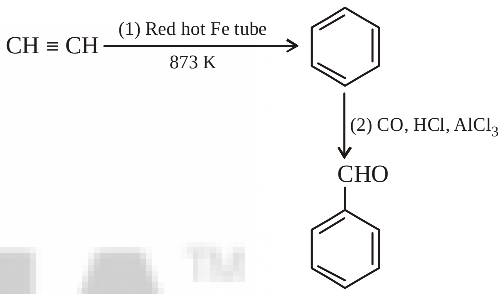


Numbers of σ bonds = 10

105. **(c)**

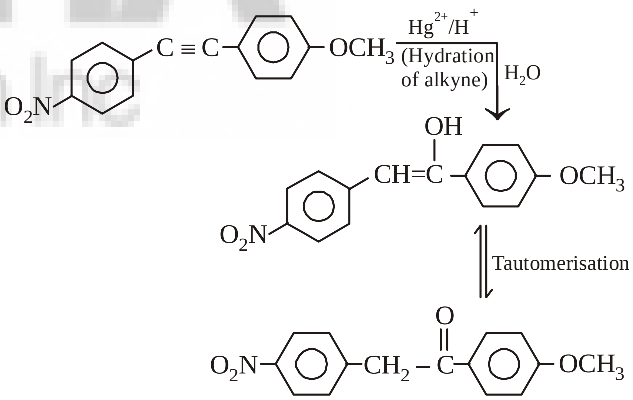


106. **(7)**

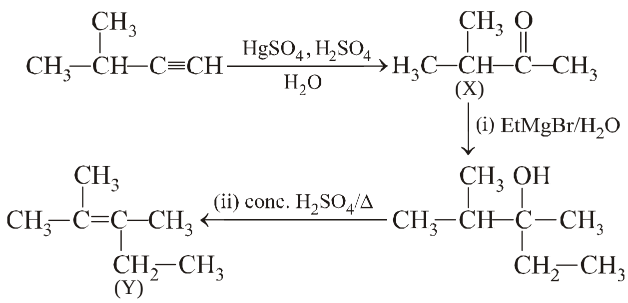


In benzaldehyde, total number of sp^2 carbons are 7.

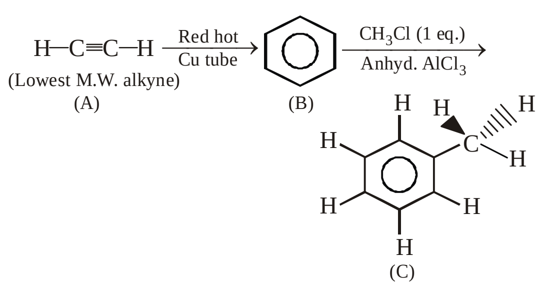
107. **(a)**



108. **(d)**



109. **(13)**

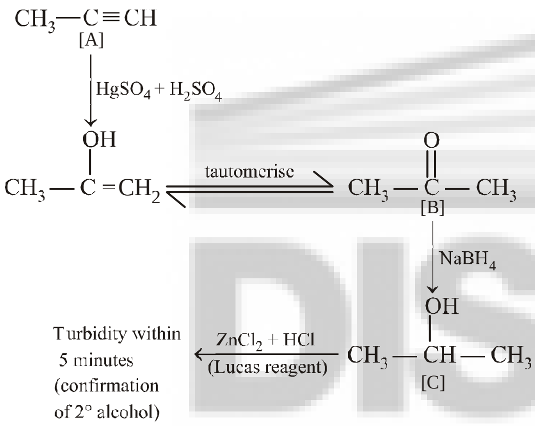


Number of atoms present in molecule (C) in one plane = 13

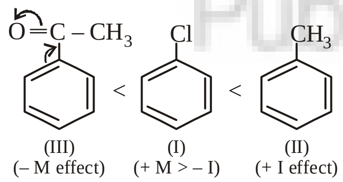
110. **(c)**

(i) Reaction of 'A' with Ag_2O to give ppt indicates $-C \equiv CH$ type of linkage.

(ii) Going backward in the second set, compound 'C' when heated with $ZnCl_2$ and conc. HCl gives turbidity within 5 minutes, it indicates that 'C' is a 2° alcohol, (C). Hence 'B' is a ketone and 'A' is prop-1-yne.



111. **(c)**



112. **(d)** $CH_3-C\equiv C-H \xrightarrow[1\ eq]{DCl} CH_3-\underset{Cl}{\underset{|}{C}}=\underset{D}{\underset{|}{C}}H \longrightarrow$

$$CH_3-\underset{Cl}{\underset{|}{\overset{+}{C}}}-\underset{D}{\underset{|}{\overset{-}{C}}}H \xrightarrow{\overset{+}{D}\overset{-}{I}} CH_3-\underset{Cl}{\underset{|}{\overset{I}{\overset{|}{C}}}}-\underset{D}{\underset{|}{\overset{D}{\overset{|}{C}}}}H$$

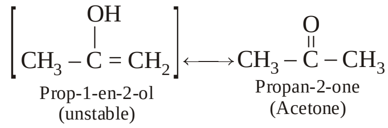
Due to combined +I effect of $-CH_3$ and +M effect of –Cl, positive charge is more stable at the second carbon.

113. **(d)** $\underset{sp}{HC \equiv CH} > H_3C \rightarrow C \equiv CH > \underset{sp^2}{CH_2 = CH_2}$

114. **(d)** When but-2-yne is treated with H_2/Lindlar's catalyst, compound X (*cis*-but-2-ene) is produced as the major product; and when treated with Na/liq NH_3 it produces Y (*trans* -but-2-ene) as the major product. *Cis*-isomer(X) will have higher dipole moment and higher boiling point than *trans* (Y).

115. **(b)** $\underset{\text{Acetylene}}{3\,CH \equiv CH} \longrightarrow \underset{\text{Benzene}}{C_6H_6}$ (poly-ene)

116. **(a)** $\underset{\text{Propyne}}{CH_3-C\equiv CH} + H_2O \xrightarrow[HgSO_4]{H_2SO_4}$



117. **(d)** $CH_3MgX + CH_3-C\equiv C-H \longrightarrow$

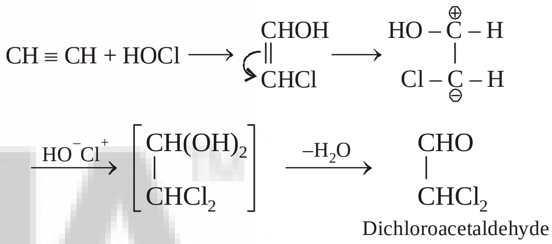
$$CH_3-C\equiv CMgX + CH_4(g)$$

118. **(d)** Among isomeric alkanes, the straight chain isomer has higher boiling point due to large surface area than the branched chain isomer. The greater the branching of the chain, the lower is the boiling point. Due to the presence of π electrons in alkynes, these moleculs are polar and hence, have higher boiling points than the corresponding alkanes.

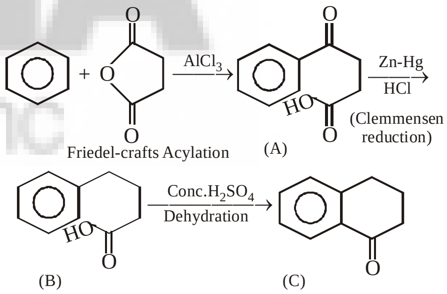
Thus b.pt. follows the order :

alkynes > alkanes (straight chain) > alkenes > branched chain alkanes.

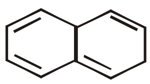
119. **(c)**

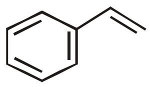


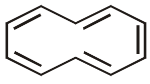
120. **(a)**

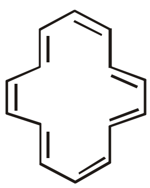


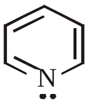
121. **(a)** For a compound to be aromatic it should be planar and follow Huckel's rule of $(4n+2)\pi$ electrons.

A.  $\rightarrow$ Non aromatic

B.  $\rightarrow$ Aromatic

C.  $\rightarrow$ Non aromatic

D.  $\rightarrow$ Aromatic

122. (1) 

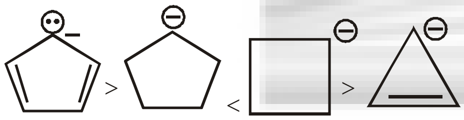
123. (b) In nitration of benzene concentrated H_2SO_4 and HNO_3 is used as reagent which generates electrophile $\overset{\oplus}{N}O_2$ in following steps:

$$H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H-\overset{\displaystyle H}{\underset{\oplus}{O}}-NO_2$$

$$\rightleftharpoons HSO_4^- + H_2O + NO_2^{\oplus}$$

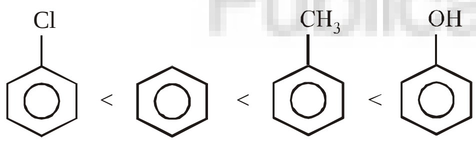
Lewis acids can promote the formation of electrophiles not Lewis base

124. (d) As we know compound (4) is aromatic and the compound (1) is anti-aromatic. Hence compound (4) is most stable and compound (1) is least stable among these in compound (2) and (3) carbon atom having charge is sp^3 hybridised. On the basis of angle strain theory compound (3) is more stable than compound (2).

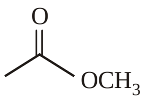


125. (d) $-NO_2, -CHO, -SO_3H, -COR$.
Ortho and para directing groups are:
$-NH_2$, $-NHR$, $-NHCOCH_3$, $-OCH_3$, $-CH_3$, $-C_2H_5$ etc.
meta directing groups are:
$-NO_2$, $-CN$, $-CHO$, $-COR$, $-COOH$, $-COOR$, $-SO_3H$ etc.

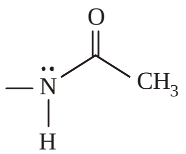
126. (d) Order of increasing reactivity towards electrophilic substitution reaction is:



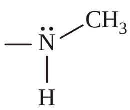
127. (1)



Deactivating withdraw electron by –M effect



Weakly activating due to delocalisation of electron pair of nitrogen with carbonyl group by + M



Activating due to donation of lone pair of nitrogen to ring system by +M

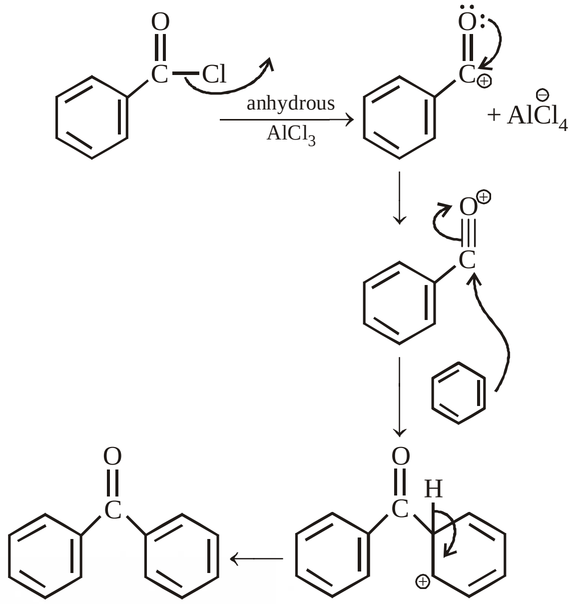
$-C \equiv N$

Deactivating due to –M and –I effect of CN^- group

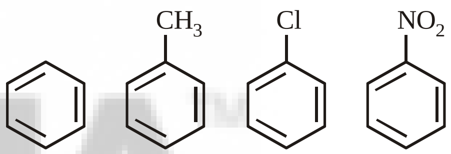
$-OCH_3$

Activating due to donation of electron pair present on the oxygen to ring system by +M

128. (d)



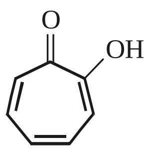
129. (d) $B > A > C > D$



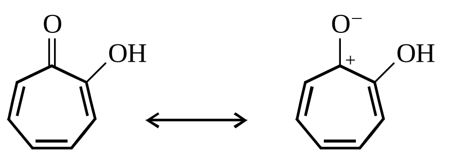
A B C D

– CH_3 will show +I and +M effect.
– Cl will show –I and +M effect but inductive effect will be more influential.
– NO_2 will show –I and –M effect.

130. (3) B, C and D are Aromatic.
B has one aromatic benzene ring, C has two rings fused and conjugated with all atoms sp^2-hybridised, D has three rings in conjugation.
All three have $(4n + 2)\pi$ electrons.

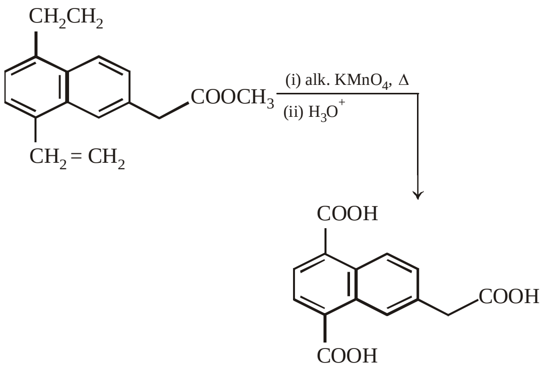
131. (b) 

Tropolone is an aromatic compound and has 8π electrons ($6\pi e^-$ are endocyclic and $2\pi e^-$ are exocyclic) and π electrons of $>C = O$ group in tropolone is not involved in aromaticity.

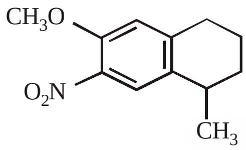


aromatic compound ($6\ \pi e^-$)

132. (d) $KMnO_4$ oxidises benzylic carbon containing atleast one α–hydrogen atom to –COOH.

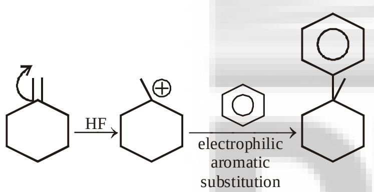


133. (d)

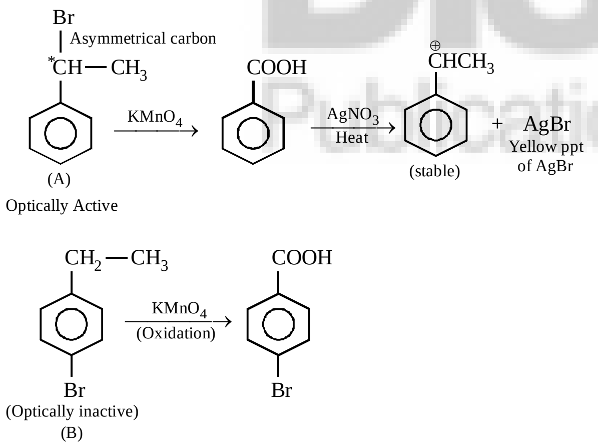


$AlCl_3$ gives rise to a carbcation here. Carbocations in the side chains of a ring undergo cyclization or ring formation.

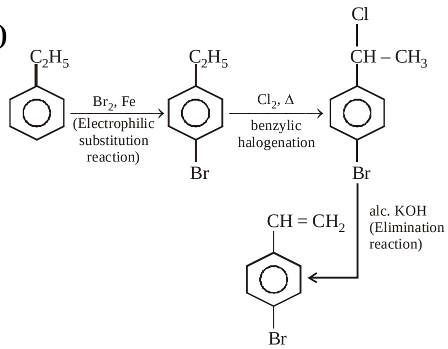
134. (a)



135. (c)



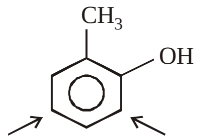
136. (d)



137. (c) Electrophile will attack at ortho and para position with respect to better electron releasing group (ERG)

–OH donates through +M and $–CH_3$ donates through +H

ERG : – OH > – CH_3



Para position with respect to – OH group and it will be meta position with respect to $–CH_3$ group.

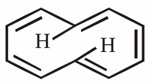
138. (d) Assertion:

Annulene	Huckle's rule	Planarity	Aromaticity
[6]	$4n + 2 = 6, n = 1$	Planar	Aromatic
[8]	$4n + 2 \neq 8$	Non-planar	Non-aromatic
cis – [10]	$4n + 2 = 10, n = 2$	Non-Planar	Non-aromatic

[8] annulene is non-aromatic because it does not obey Huckel's rule and it is non-planar.

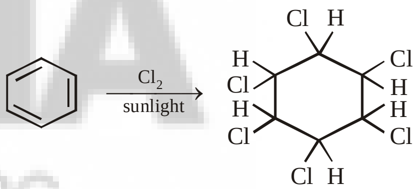
Reason: It is correct. Although it has $(4n + 2)\pi$ electrons, i.e. 10, but it is not planar.

139. (c)



Due to the steric repulsion between the two hydrogen atom this molecule can not achieve planarity, hence compound is not aromatic.

140. (6)



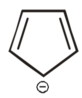
141. (a, b) Neither (*a*) nor (*b*) obey Huckel's $(4n+2)\pi$ electrons, (*a*) has 12π instead of 14π electrons while (*b*) has 8π instead of 10π elctrons.

142. (c) $CH_3 - CH_2CH_2Cl \xrightarrow{AlCl_3} CH_3 - CH_2 - \overset{+}{C}H_2$

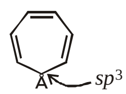
$\downarrow$ Hydride shift

$CH_3 - \overset{+}{C}H - CH_3$ (more stable)

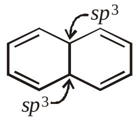
143. (b)

(a) 

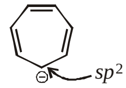
$(4n + 2)\pi e^- = 6$
Planar
∴ Aromatic

(b) 

$(4n + 2)\pi e^- = 6$
Planar
∴ Aromatic

(c) 

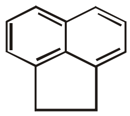
$(4n + 2)\pi e^- = 8$
Non-planar
∴ Non-aromatic

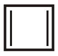
(d) 

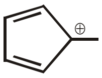
$(4n + 2)\pi e^- = 8$
Planar
$4n\pi e^-$ ∴ Anti-aromatic

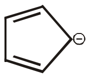
144. (d) Benzoic acid and naphthalene, both being organic compounds, are soluble in benzene, hence can't be reparated by benzene. These can be effectively separated by crystallization. Benzoic acid is soluble in hot water whereas naphthalene is insoluble. Hence assertion is false but reason is true.

145. (a, d)

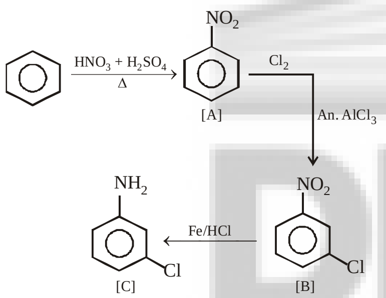
(a)  $\Rightarrow$ 10 πe^- in cyclic conjugation with all contributing atoms in a plane
$\Rightarrow$ Aromatic

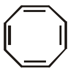
(b)  $\Rightarrow$ 4πe^- in ring conjugation
$\Rightarrow$ Anti-aromatic

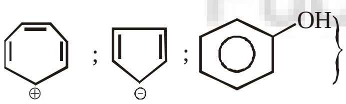
(c)  $CH_3 \Rightarrow$ 4πe^- in ring conjugation
$\Rightarrow$ Anti-aromatic

(d)  $\Rightarrow$ 6πe^- in ring conjugation
$\Rightarrow$ Aromatic

146. (a)



147. (c)  : Non-aromatic

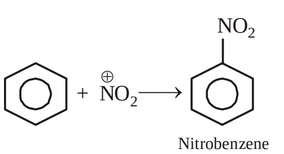


All are aromatic, having 6π electrons

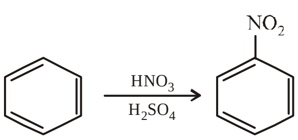
148. (d) Reagent for nitration of benzene

$$\underset{\text{(Acid)}}{H_2SO_4} + \underset{\text{(Base)}}{HNO_3} \rightleftharpoons HSO_4^{\ominus} + H_2\overset{\oplus}{N}O_3$$

$$H_2\overset{\oplus}{N}O_3 \rightleftharpoons H_2O + \overset{\oplus}{N}O_2$$



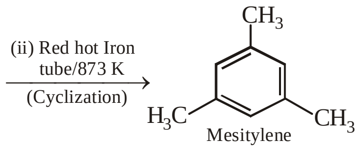
Electrophilic substitution reaction

149. (80) 

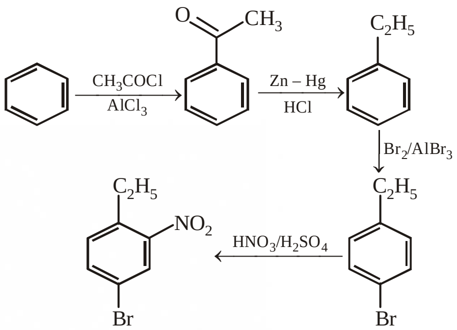
$$\text{Moles} = \frac{3.9}{78} = 0.05\,; \quad \text{Moles} = \frac{4.92}{123} = 0.04$$

$$\text{Percentage yield of nitrobenzene} = \frac{0.04}{0.05} \times 100 = 80\%$$

150. (b) $CH_3-CH=CH-Br \xrightarrow[(-\,HBr)]{(i)\ NaNH_2} \underset{\displaystyle CH_3}{\underset{|}{C}} \equiv CH$

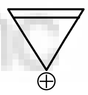


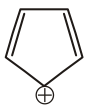
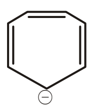
151. (a)



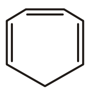
152. (c) In benzene, each carbon atom is sp^2 hybridised. Therefore, total 18 sp^2 hybrid orbitals are present in benzene.

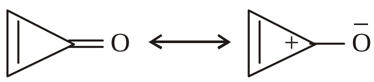
153. (d) Vinyl halides and aryl halides are unreactive towards Friedel Craft's reaction.
Therefore, reactions (A) and (C) are not possible.

154. (a)  is aromatic; $(4 \times 0 + 2) = 2\,\pi e^-$ in conjugation

 and  are anti-aromatic due to 4 $n\pi e^-$.

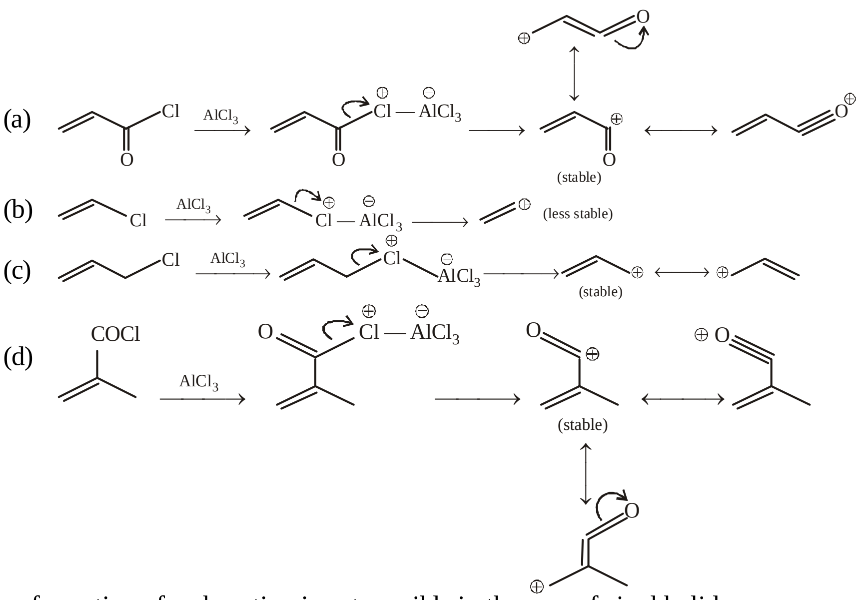
4πe^- 8πe^-

 is non-aromatic due to the presence of sp^3 carbon.

155. (a) 

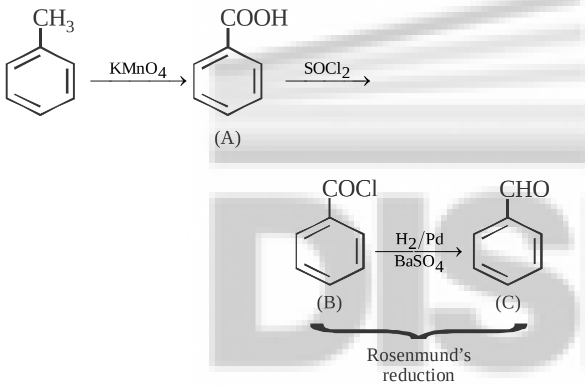
A dipolar resonance structure has aromatic character in the ring and would be expected to make a major contribution to the overall structure.
Conjugation is possible only in opion –(I).

156. (b)

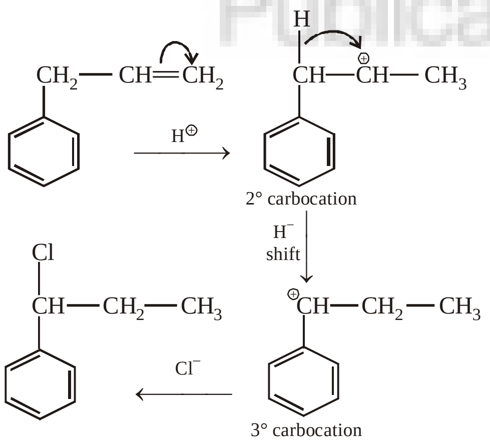


Hence, formation of carbocation is not possible in the case of vinyl halide.

157. (b)



158. (c)

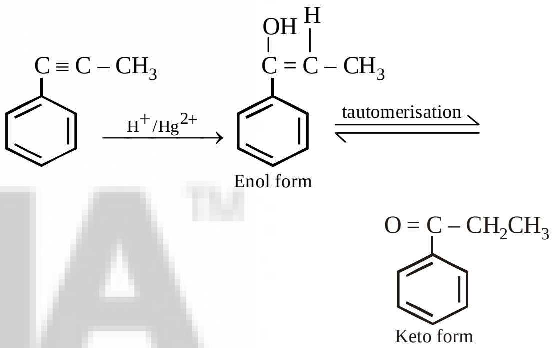


159. (c) In (*c*) Friedal-Craft's alkylation reaction will give propyl phenyl ketone which further on Clemmenson's reduction will give butylbenzene.

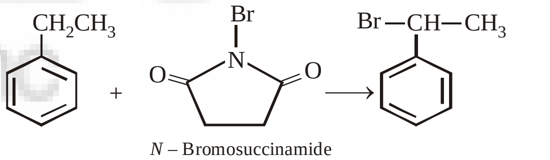
$$\underset{\text{Butanoyl chloride}}{C_6H_6 + CH_3CH_2CH_2COCl} \xrightarrow{AlCl_3} C_6H_5COCH_2CH_2CH_3$$

$$\xrightarrow{\text{Zn-Hg/HCl}} \underset{\text{Butylbenzene}}{C_6H_5CH_2CH_2CH_2CH_3}$$

160. (c)

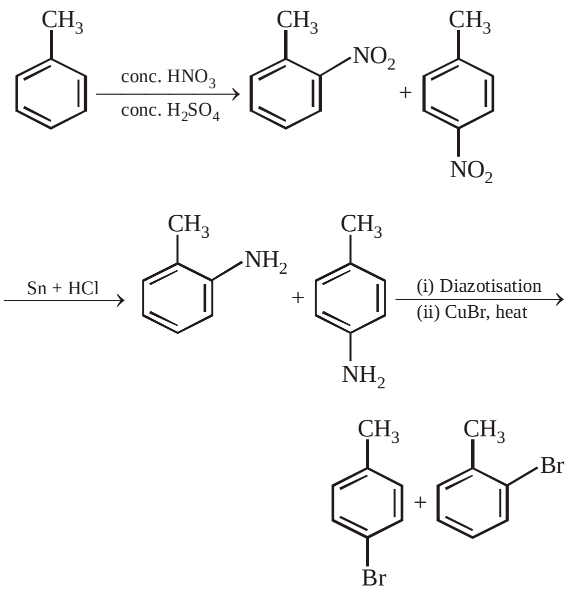


161. (d)



The given reagent will substitute –Br at benzylic position.

162. (a)



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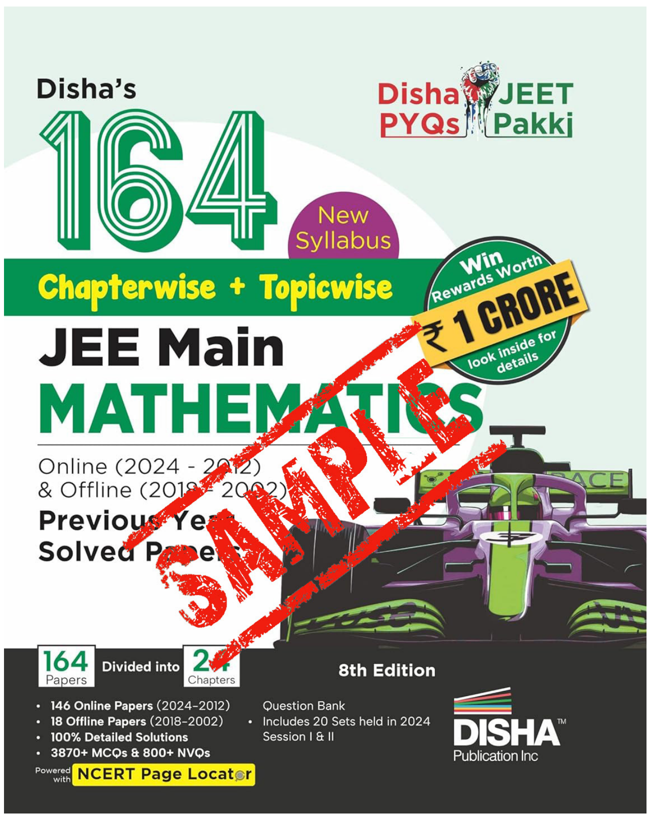

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Chapter 11

Three Dimensional Geometry

Topic 1 — Direction Ratios & Direction cosines of a Line, Angle between two lines in terms of dc's and dr's, Projection of a Point on a Line, Projection of a Line Segment Joining two Points

1. Let P(x, y, z) be a point in the first octant, whose projection in the xy-plane is the point Q. Let OP = γ ; the angle between OQ and the positive x-axis be θ; and the angle between OP and the positive z-axis be ϕ, where O is the origin. Then the distance of P from the x-axis is :

[NCERT : P L-464 | April 8, 2024 (I)]

(a) $\gamma\sqrt{1-\sin^2\phi\cos^2\theta}$ (b) $\gamma\sqrt{1+\cos^2\theta\sin^2\phi}$

(c) $\gamma\sqrt{1-\sin^2\theta\cos^2\phi}$ (d) $\gamma\sqrt{1+\cos^2\phi\sin^2\theta}$

2. Consider a line L passing through the points P(1,2,1) and Q(2,1, –1). If the mirror image of the point A(2,2,2) in the line L is (α, β, γ), then $\alpha + \beta + 6\gamma$ is equal to ......

[NCERT : P L-465 | NA, April. 4, 2024(II)]

3. Let P(3, 2, 3), Q(4, 6, 2) and R(7, 3, 2) be the vertices of ΔPQR. Then, the angle $\angle QPR$ is

[NCERT : P L-464 | Jan. 29, 2024(II)]

(a) $\cos^{-1}\left(\frac{7}{18}\right)$ (b) $\frac{\pi}{3}$

(c) $\cos^{-1}\left(\frac{1}{18}\right)$ (d) $\frac{\pi}{6}$

4. Let $P(-2, -1, 1)$ and $Q\left(\frac{56}{17}, \frac{43}{17}, \frac{111}{17}\right)$ be the vertices of the rhombus $PRQS$. If the direction ratios of the diagonal RS are $\alpha, -1, \beta$, where both α and β are integers of minimum absolute values, then $\alpha^2 + \beta^2$ is equal to __________.

[NCERT : P L-465 | NA, July 28, 2022(I)]

5. If two straight lines whose direction cosines are given by the relations $l + m - n = 0$, $3l^2 + m^2 + cnl = 0$ are parallel, then the positive value of c is:

[NCERT : P L-465 | NA, June 27, 2022 (I)]

(a) 6 (b) 4 (c) 3 (d) 2

6. Let α be the angle between the lines whose direction cosines satisfy the equations $l + m - n = 0$ and $l^2 + m^2 - n^2 = 0$. Then the value of $\sin^4\alpha + \cos^4\alpha$ is:

[NCERT : P L-465 | 2013 (S), 2014 (S), 2018 (S) Feb. 25, 2021 (I)]

(a) $\frac{3}{4}$ (b) $\frac{5}{8}$ (c) $\frac{1}{2}$ (d) $\frac{3}{8}$

7. If a point R(4, y, z) lies on the line segment joining the points P(2, –3, 4) and Q(8, 0, 10), then distance of R from the origin is : **[NCERT : P L-469 | April 08, 2019 (II)]**

(a) $2\sqrt{14}$ (b) $2\sqrt{21}$ (c) 6 (d) $\sqrt{53}$

8. ABC is triangle in a plane with vertices A (2, 3, 5), B (–1, 3, 2) and C (λ, 5, μ). If the median through A is equally inclined to the coordinate axes, then the value of $(\lambda^3 + \mu^3 + 5)$ is:

[NCERT : P L-465 | 2013 (S), 2014 (S), Online April 10, 2016]

(a) 1130 (b) 1348 (c) 1077 (d) 676

9. A line in the 3-dimensional space makes an angle θ $\left(0 < \theta \le \frac{\pi}{2}\right)$ with both the x and y axes. Then the set of all values of θ is the interval:

[NCERT : P L-465 | Online April 9, 2014]

(a) $\left(0, \frac{\pi}{4}\right]$ (b) $\left[\frac{\pi}{6}, \frac{\pi}{3}\right]$

(c) $\left[\frac{\pi}{4}, \frac{\pi}{2}\right]$ (d) $\left(\frac{\pi}{3}, \frac{\pi}{2}\right]$

10. A line AB in three-dimensional space makes angles 45° and 120° with the positive x-axis and the positive y-axis respectively. If AB makes an acute angle θ with the positive z-axis, then θ equals

[NCERT : P L-465 | 2007 (S), 2010]

(a) 45° (b) 60° (c) 75° (d) 30°

11. The projections of a vector on the three coordinate axis are 6, –3, 2 respectively. The direction cosines of the vector are :

[NCERT : P L-465 | 2009, 2013 (S)]

(a) $\frac{6}{5}, \frac{-3}{5}, \frac{2}{5}$ (b) $\frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$

(c) $\frac{-6}{7}, \frac{-3}{7}, \frac{2}{7}$ (d) 6, –3, 2

12. A line makes the same angle θ, with each of the x and z axis. If the angle β, which it makes with y-axis, is such that $\sin^2\beta = 3\sin^2\theta$, then $\cos^2\theta$ equals

[NCERT : P L-465 | 2004]

(a) $\frac{2}{5}$ (b) $\frac{1}{5}$ (c) $\frac{3}{5}$ (d) $\frac{2}{3}$

Topic 2

Equation of a Straight Line in Cartesian and Vector Form, Angle Between two Lines, Condition of parallelism & perpendicularity of two lines, Perpendicular Distance of a Point from a Line, Shortest Distance between two Skew Lines, Distance Between two Parallel Lines.

13. Let the line L intersect the lines $x-2=-y=z-1$, $2(x+1)=2(y-1)=z+1$ and be parallel to the line $\frac{x-2}{3}=\frac{y-1}{1}=\frac{z-2}{2}$. Then which of the following points lies on L ?

[NCERT : P L-475 | April 9, 2024 (I)]

(a) $\left(-\frac{1}{3},1,1\right)$ (b) $\left(-\frac{1}{3},1,-1\right)$

(c) $\left(-\frac{1}{3},-1,-1\right)$ (d) $\left(-\frac{1}{3},-1,1\right)$

14. The shortest distance between the line

$\frac{x-3}{4}=\frac{y+7}{-11}=\frac{z-1}{5}$ and $\frac{x-5}{3}=\frac{y-9}{-6}=\frac{z+2}{1}$ is :

[NCERT : P L-475 | April 9, 2024 (I)]

(a) $\frac{187}{\sqrt{563}}$ (b) $\frac{178}{\sqrt{563}}$

(c) $\frac{185}{\sqrt{563}}$ (d) $\frac{179}{\sqrt{563}}$

15. Consider the line L passing through the points (1, 2, 3) and (2, 3, 5). The distance of the point $\left(\frac{11}{3},\frac{11}{3},\frac{19}{3}\right)$ from the line L along the line $\frac{3x-11}{2}=\frac{3y-11}{1}=\frac{3z-19}{2}$ is equal to:

[NCERT : P L-477 | April 9, 2024 (II)]

(a) 3 (b) 5

(c) 4 (d) 6

16. The square of the distance of the image of the point (6, 1, 5) in the line $\frac{x-1}{3}=\frac{y}{2}=\frac{z-2}{4}$, from the origin is ______.

[NCERT : P L-477 | NA, April 9, 2024 (II)]

17. If the shortest distance between the lines

$L_1 : \vec{r} = (2+\lambda)\hat{i}+(1-3\lambda)\hat{j}+(3+4\lambda)\hat{k}, \lambda \in \mathbb{R}$

$L_2 : \vec{r} = 2(1+\mu)\hat{i}+3(1+\mu)\hat{j}+(5+\mu)\hat{k}, \mu \in \mathbb{R}$

is $\frac{m}{\sqrt{n}}$, where gcd (m, n) = 1, then the value of m + n equals.

[NCERT : P L-478 | April 8, 2024 (I)]

(a) 384 (b) 387

(c) 377 (d) 390

18. Let $P(\alpha, \beta, \gamma)$ be the image of the point Q(l, 6, 4) in the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$. Then $2\alpha+\beta+\gamma$ is equal to ________.

[NCERT : P L-465 | NA, April 8, 2024 (II)]

19. If the shortest distance between the lines $\frac{x-\lambda}{2}=\frac{y-4}{3}=\frac{z-3}{4}$ and $\frac{x-2}{4}=\frac{y-4}{6}=\frac{z-7}{8}$ is $\frac{13}{\sqrt{29}}$, then a value of λ is:

[NCERT : P L-478 | April 8, 2024 (II)]

(a) $-\frac{13}{25}$ (b) $\frac{13}{25}$

(c) 1 (d) -1

20. The shortest distance between the lines $\frac{x-3}{2}=\frac{y+15}{-7}=\frac{z-9}{5}$ and $\frac{x+1}{2}=\frac{y-1}{1}=\frac{z-9}{-3}$ is

[NCERT : P L-475 | April. 6, 2024(I)]

(a) $6\sqrt{3}$ (b) $4\sqrt{3}$

(c) $5\sqrt{3}$ (d) $8\sqrt{3}$

21. Let P be the point (10, –2, –1) and Q be the foot of the perpendicular drawn from the point R(1, 7, 6) on the line passing through the points (2, –5, 11) and (–6, 7, –5). Then the length of the line segment PQ is equal to ________. **[NCERT : P L-478 | NA, April. 6, 2024(I)]**

22. Let P (α, β, γ) be the image of the point Q(3, –3, 1) in the line $\frac{x-0}{1}=\frac{y-3}{1}=\frac{z-1}{-1}$ and R be the point (2, 5, –1). If the area of the triangle PQR is λ and $\lambda^2 = 14K$, then K is equal to:

[NCERT : P L-471 | April 6, 2024(II)]

(a) 36 (b) 72
(c) 18 (d) 81

23. If the shortest distance between the lines

$\frac{x-\lambda}{3}=\frac{y-2}{-1}=\frac{z-1}{1}$ and $\frac{x+2}{-3}=\frac{y+5}{2}=\frac{z-4}{4}$ is $\frac{44}{\sqrt{30}}$,

then the largest possible value of $|\lambda|$ is equal to ________.

[NCERT : P L-475 | NA, April 6, 2024(II)]

24. Let d be the distance of the point of intersection of the lines $\frac{x+6}{3}=\frac{y}{2}=\frac{z+1}{1}$ and $\frac{x-7}{4}=\frac{y-9}{3}=\frac{z-4}{2}$ from the point (7, 8, 9). Then $d^2 + 6$ is equal to :

[NCERT : P L-469 | April. 5, 2024(I)]

(a) 72 (b) 69
(c) 75 (d) 78

25. If the line $\frac{2-x}{3}=\frac{3y-2}{4\lambda+1}=4-z$ makes a right angle with the line $\frac{x+3}{3\mu}=\frac{1-2y}{6}=\frac{5-z}{7}$, then $4\lambda + 9\mu$ is equal to:

[NCERT : P L-471 | April. 5, 2024(I)]

(a) 13 (b) 4 (c) 5 (d) 6

26. Let (α, β, γ) be the point (8, 5, 7) in the line $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-2}{5}$. Then $\alpha+\beta+\gamma$ is equal to

[NCERT : P L-477 | April 5, 2024 (II)]

(a) 16 (b) 18
(c) 14 (d) 20

27. Let the point $(-1, \alpha, \beta)$ lie on the line of the shortest distance between the lines $\frac{x+2}{-3}=\frac{y-2}{4}=\frac{z-5}{2}$ and $\frac{x+2}{-1}=\frac{y+6}{2}=\frac{z-1}{0}$. Then $(\alpha-\beta)^2$ is equal to ______.

[NCERT : P L-469 | NA, April 5, 2024 (II)]

28. Let the point, on the line passing through the points P(1, –2, 3) and Q(5, –4, 7), farther from the origin and at a distance of 9 units from the point P, be (α, β, γ). Then $\alpha^2+\beta^2+\gamma^2$ is equal to :

[NCERT : P L-469 | April. 4, 2024(I)]

(a) 155 (b) 150 (c) 160 (d) 165

29. If the shortest distance between the lines

$\frac{x+2}{2}=\frac{y+3}{3}=\frac{z-5}{4}$ and $\frac{x-3}{1}=\frac{y+2}{-3}=\frac{z+4}{2}$ is $\frac{38}{3\sqrt{5}}K$ and $\int_0^k [x^2]dx = \alpha - \sqrt{\alpha}$, where [x] denotes the greatest integer function, then $6\alpha^3$ is equal to _____

[NCERT : P L-475 | NA, April. 4, 2024(I)]

30. Let P be the point of intersection of the lines $\frac{x-2}{1}=\frac{y-4}{5}=\frac{z-2}{1}$ and $\frac{x-3}{2}=\frac{y-3}{3}=\frac{z-3}{2}$. Then, the shortest distance of P from the line $4x = 2y = z$ is

[NCERT : P L-477 | April. 4, 2024(II)]

(a) $\frac{5\sqrt{14}}{7}$ (b) $\frac{\sqrt{14}}{7}$
(c) $\frac{3\sqrt{14}}{7}$ (d) $\frac{6\sqrt{14}}{7}$

31. If the shortest distance between the lines $\frac{x-\lambda}{-2}=\frac{y-2}{1}=\frac{z-1}{1}$ and $\frac{x-\sqrt{3}}{1}=\frac{y-1}{-2}=\frac{z-2}{1}$ is 1, then the sum of all possible values of λ is:

(a) 0 (b) $2\sqrt{3}$ (c) $3\sqrt{3}$ (d) $-2\sqrt{3}$

[NCERT : P L-477 | Feb. 1, 2024(I)]

32. Let the line of the shortest distance between the lines

$L_1 : \vec{r} = (\hat{i}+2\hat{j}+3\hat{k}) + \lambda(\hat{i}-\hat{j}+\hat{k})$ and

$L_2 : \vec{r} = (4\hat{i}+5\hat{j}+6\hat{k}) + \mu(\hat{i}+\hat{j}+\hat{k})$

intersects L_1 and L_2 at P and Q respectively. If (α, β, γ) is the mid point of line segment PQ, then $2(\alpha+\beta+\gamma)$ is equal to ______ . **[NCERT : P L-478 | NA, Feb. 1, 2024(I)]**

33. Let P and Q be the points on the line $\frac{x+3}{8}=\frac{y-4}{2}=\frac{z+1}{2}$ which are at a distance of 6 units from the point R (1, 2, 3). If the centroid of the triangle PQR is (α, β, γ) then $\alpha^2+\beta^2+\gamma^2$ is:

[NCERT : P L-469 | Feb. 1, 2024(II)]

(a) 18 (b) 24 (c) 26 (d) 36

34. If the mirror image of the point P(3, 4, 9) in the line $\frac{x-1}{3}=\frac{y+1}{2}=\frac{z-2}{1}$ is (α, β, γ), then $14(\alpha+\beta+\gamma)$ is:

[NCERT : P L-469 | Feb. 1, 2024(II)]

(a) 102 (b) 138 (c) 132 (d) 108

35. The distance of the point Q(0, 2, – 2) form the line passing through the point P(5, – 4, 3) and perpendicular to the lines $\vec{r} = (-3\hat{i}+2\hat{k}) + \lambda(2\hat{i}+3\hat{j}+5\hat{k})$, $\lambda \in \mathbb{R}$ and $\vec{r} = (\hat{i}-2\hat{j}+\hat{k}) + \mu(-\hat{i}+3\hat{j}+2\hat{k})$, $\mu \in \mathbb{R}$ is :

[NCERT : P L-470 | Jan. 31, 2024(I)]

(a) $\sqrt{54}$ (b) $\sqrt{86}$ (c) $\sqrt{74}$ (d) $\sqrt{20}$

36. Let Q and R be the feet of perpendiculars from the point P(a, a, a) on the lines x = y, z = 1 and x = – y, z = – 1 respectively. If $\angle QPR$ is a right angle, then 12 a^2 is equal to ______

[NCERT : P L-469 | NA, Jan. 31, 2024(I)]

37. Let (α, β, γ) be mirror image of the point (2, 3, 5) in the line $\frac{x-1}{2} - \frac{y-2}{3} - \frac{z-3}{4}$. Then $2\alpha + 3\beta + 4\gamma$ is equal to

[NCERT : P L-469 | Jan. 31, 2024(II)]

(a) 32 (b) 33 (c) 31 (d) 34

38. The shortest distance between lines L_1 and L_2, where $L_1 : \frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+4}{2}$ and L_2 is the line passing through the points A (–4, 4, 3). B (–1, 6, 3) and perpendicular to the line $\frac{x-3}{-2} = \frac{y}{3} = \frac{z-1}{1}$, is

[NCERT : P L-475 | Jan. 31, 2024(II)]

(a) $\frac{121}{\sqrt{221}}$ (b) $\frac{24}{\sqrt{117}}$

(c) $\frac{141}{\sqrt{221}}$ (d) $\frac{42}{\sqrt{117}}$

39. A line passes through A(4, –6, –2) and B(16, –2, 4). The point P(a, b, c) where a, b, c are non-negative integers, on the line AB lies at a distance of 21 units, from the point A. The distance between the points P(a, b, c) and Q(4, –12, 3) is equal to __________.

[NCERT : P L-469 | NA, Jan. 31, 2024(II)]

40. Let (α, β, γ) be the foot of perpendicular from the point (1, 2, 3) on the line $\frac{x+3}{5} = \frac{y-1}{2} = \frac{z+4}{3}$. Then $19(\alpha + \beta + \gamma)$ is equal to:

[NCERT : P L-469 | Jan. 30, 2024(I)]

(a) 102 (b) 101 (c) 99 (d) 100

41. If d_1 is the shortest distance between the lines $x + 1 = 2y = -12z$, $x = y + 2 = 6z - 6$ and d_2 is the shortest distance between the lines $\frac{x-1}{2} = \frac{y+8}{-7} = \frac{z-4}{5}$, $\frac{x-1}{2} = \frac{y-2}{1} = \frac{z-6}{-3}$, then the value of $\frac{32\sqrt{3}d_1}{d_2}$ is:

[NCERT : P L-475 | Jan. 30, 2024(I)]

42. Let $L_1 : \vec{r} = (\hat{i} - \hat{j} + 2\hat{k}) + \lambda(\hat{i} - \hat{j} + 2\hat{k}), \lambda \in R$

$L_2 : \vec{r} = (\hat{j} - \hat{k}) + \mu(3\hat{i} + \hat{j} + p\hat{k}), \mu \in IR$, and

$L_3 : \vec{r} = \delta(l\hat{i} + m\hat{j} + n\hat{k}), \delta \in IR$

be three lines such that L_1 is perpendicular to L_2 and L_3 is perpendicular to both L_1 and L_2. Then, the point which lies on L_3 is **[NCERT : P L-470 | Jan. 30, 2024(II)]**

(a) (–1, 7, 4) (b) (–, 1–7, 4)

(c) (1, 7, –4) (d) (1, – 7, 4)

43. Let a line passing through the point (–1, 2, 3) intersect the lines $L_1 : \frac{x-1}{3} = \frac{y-2}{2} = \frac{z+1}{-2}$ at $M(\alpha, \beta, \gamma)$ and $L_2 : \frac{x+2}{-3} = \frac{y-2}{-2} = \frac{z-1}{4}$ at $N(a, b, c)$. Then, the value of $\frac{(\alpha+\beta+\gamma)^2}{(a+b+c)^2}$ equals ________ .

[NCERT : P L-469 | NA, Jan. 30, 2024(II)]

44. Let PQR be a triangle with R(–1, 4, 2). Suppose M (2, 1, 2) is the mid point of PQ. The distance of the centroid of ΔPQR from the point of intersection of the lines $\frac{x-2}{0} = \frac{y}{2} = \frac{z+3}{-1}$ and $\frac{x-1}{1} = \frac{y+3}{-3} = \frac{z+1}{1}$ is

[NCERT : P L-469 | Jan. 29, 2024(I)]

(a) $\sqrt{99}$ (b) 9 (c) $\sqrt{69}$ (d) 69

45. A line with direction ratios 2, 1, 2 meets the lines $x = y + 2 = z$ and $x + 2 = 2y = 2z$ respectively at the points P and Q. If the length of the perpendicular from the point (1, 2, 12) to the line PQ is l, then l^2 is ______.

[NCERT : P L-469 | NA, Jan. 29, 2024(I)]

46. Let O be the origin, and M and N be the point on the lines $\frac{x-5}{4} = \frac{y-4}{1} = \frac{z-5}{3}$ and $\frac{x+8}{12} = \frac{y+2}{5} = \frac{z+11}{9}$ respectively such that MN is the shortest distance between the given lines. Then $\overrightarrow{OM}.\overrightarrow{ON}$ is equal to ______.

[NCERT : P L-469 | NA, Jan. 29, 2024(II)]

47. The distance, of the point (7, –2, 11) from the line $\frac{x-6}{1} = \frac{y-4}{0} = \frac{z-8}{3}$ along the line $\frac{x-5}{2} = \frac{y-1}{-3} = \frac{z-5}{6}$, is : **[NCERT : P L-477 | Jan. 27, 2024(I)]**

(a) 12 (b) 14 (c) 18 (d) 21

48. If the shortest distance between the lines $\frac{x-4}{1} = \frac{y+1}{2} = \frac{z}{-3}$ and $\frac{x-\lambda}{2} = \frac{y+1}{4} = \frac{z-2}{-5}$ is $\frac{6}{\sqrt{5}}$, then the sum of all possible values of λ is :

[NCERT : P L-475 | Jan. 27, 2024(I)]

(a) 5 (b) 8

(c) 7 (d) 10

49. Let the image of the point (1, 0, 7) in the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$ be the point (α, β, γ). Then which one of the following point lies on the line passing through (α, β, γ) and making angles $\frac{2\pi}{3}$ and $\frac{3\pi}{4}$ with y - axis and z - axis respectively and an acute angle with x - axis?

[NCERT : P L-469 | Jan. 27, 2024(II)]

(a) $(1,-2,1+\sqrt{2})$ (b) $(1,2,1-\sqrt{2})$

(c) $(3,4,3-2\sqrt{2})$ (d) $(3,-4,3+2\sqrt{2})$

50. The lines $\frac{x-2}{2}=\frac{y}{-2}=\frac{z-7}{16}$ and $\frac{x+3}{4}=\frac{y+2}{3}=\frac{z+2}{1}$ intersect at the point P. If the distance of P from the line $\frac{x+1}{2}=\frac{y-1}{3}=\frac{z-1}{1}$ is l, then $14l^2$ is equal to______.

[NCERT : P L-469 | NA, Jan. 27, 2024(II)]

51. Let S be the set of all values of λ, for which the shortest distance between the lines $\frac{x-\lambda}{0}=\frac{y-3}{4}=\frac{z+6}{1}$ and $\frac{x+\lambda}{3}=\frac{y}{-4}=\frac{z-6}{0}$ is 13. Then $8\left|\sum_{\lambda\in S}\lambda\right|$ is equal to

[NCERT : P L-475 | April 15, 2023 (I)]

(a) 304 (b) 308 (c) 306 (d) 302

52. Let a line ℓ pass through the origin and be perpendicular to the lines

$\ell_1 : \vec{r}=(\hat{i}-11\hat{j}-7\hat{k})+\lambda(\hat{i}+2\hat{j}+3\hat{k}),\ \lambda\in\mathbb{R}$

and $\ell_2 : \vec{r}=(-\hat{i}+\hat{k})+\mu(2\hat{i}+2\hat{j}+\hat{k}),\ \mu\in\mathbb{R}$.

If P is the point of intersection of ℓ and ℓ_1, and $Q(\alpha, \beta, \lambda)$ is the foot of perpendicular from P on ℓ_2, then $9(\alpha+\beta+\gamma)$ is equal to _______.

[NCERT : P L-470 | NA, April 11, 2023 (I)]

53. The shortest distance between the lines $\frac{x+2}{1}=\frac{y}{-2}=\frac{z-5}{2}$ and $\frac{x-4}{1}=\frac{y-1}{2}=\frac{z+3}{0}$ is

[NCERT : P L-475 | April 10, 2023 (I)]

(a) 6 (b) 9 (c) 7 (d) 8

54. The shortest distance between the lines $\frac{x-4}{4}=\frac{y+2}{5}=\frac{z+3}{3}$ and $\frac{x-1}{3}=\frac{y-3}{4}=\frac{z-4}{2}$ is

[NCERT : P L-475 | April 8, 2023 (I)]

(a) $3\sqrt{6}$ (b) $6\sqrt{3}$

(c) $6\sqrt{2}$ (d) $2\sqrt{6}$

55. One vertex of a rectangular parallelopiped is at the origin O and the lengths of its edges along x, y and z axes are 3, 4 and 5 units respectively. Let P be the vertex (3, 4, 5). Then the shortest distance between the diagonal OP and an edge parallel to z axis, not passing through O or P is:

[NCERT : P L-475 | April 6, 2023 (I)]

(a) $\frac{12}{\sqrt{5}}$ (b) $\frac{12}{5\sqrt{5}}$ (c) $12\sqrt{5}$ (d) $\frac{12}{5}$

56. If the lines $\frac{x-1}{2}=\frac{2-y}{-3}=\frac{z-3}{\alpha}$ and $\frac{x-4}{5}=\frac{y-1}{2}=\frac{z}{\beta}$ intersect, then the magnitude of the minimum value of $8\alpha\beta$ is __________.

[NCERT : P L-469 | NA, April 6, 2023 (II)]

57. The shortest distance between the lines $\frac{x-5}{1}=\frac{y-2}{2}=\frac{z-4}{-3}$ and $\frac{x+3}{1}=\frac{y+5}{4}=\frac{z-1}{-5}$ is

[NCERT : P L-475 | Feb. 1, 2023 (I)]

(a) $4\sqrt{3}$ (b) $7\sqrt{3}$ (c) $5\sqrt{3}$ (d) $6\sqrt{3}$

58. The line l_1 passes through the point (2, 6, 2) and is perpendicular to the plane $2x + y - 2z = 10$. Then the shortest distance between the line l_1 and the line $\frac{x+1}{2}=\frac{y+4}{-3}=\frac{z}{2}$ is:

[NCERT : P L-477 | Jan. 30, 2023 (I)]

(a) 7 (b) $\frac{19}{3}$ (c) $\frac{19}{3}$ (d) 9

59. Let a line L pass through the point P(2, 3, 1) and be parallel to the line $x + 3y - 2z - 2 = 0 = x - y + 2z$. If the distance of L from the point (5, 3, 8) is α, then $3\alpha^2$ is equal to ______.

[NCERT : P L-469 | NA, Jan. 30, 2023 (II)]

60. Let the co-ordinates of one vertex of ΔABC be $A(0, 2, \alpha)$ and the other two vertices lie on the line $\frac{x+\alpha}{5}=\frac{y-1}{2}=\frac{z+4}{3}$. For $\alpha\in\mathbb{Z}$ if the area of ΔABC is 21 sq. units and the line segment BC has length $2\sqrt{21}$ units, then α^2 is equal to ______.

[NCERT : P L-469 | NA, Jan. 29, 2023 (I)]

61. Shortest distance between the lines $\frac{x-1}{2}=\frac{y+8}{-7}=\frac{z-4}{5}$ and $\frac{x-1}{2}=\frac{y-2}{1}=\frac{z-6}{-3}$ is

[NCERT : P L-475 | Jan. 29, 2023 (II)]

(a) $2\sqrt{3}$ (b) $4\sqrt{3}$ (c) $3\sqrt{3}$ (d) $5\sqrt{3}$

62. The distance of the point P(4, 6, –2) from the line passing through the point (–3, 2, 3) and parallel to a line with direction ratios 3, 3, –1 is equal to :

[NCERT : P L-469 | Jan. 25, 2023 (I)]

(a) 3 (b) $\sqrt{6}$ (c) $2\sqrt{3}$ (d) $\sqrt{14}$

63. Consider the lines L_1 and L_2 given by

$L_1 : \frac{x-1}{2} = \frac{y-3}{1} = \frac{z-2}{2}$ $\quad L_2 : \frac{x-2}{1} = \frac{y-2}{2} = \frac{z-3}{3}$

A line L_3 having direction ratios 1, –1, –2, intersects L_1 and L_2 at the points P and Q respectively. Then the length of line segment PQ is

[NCERT : P L-469 | Jan. 25, 2023 (I)]

(a) $2\sqrt{6}$ (b) $3\sqrt{2}$

(c) $4\sqrt{3}$ (d) 4

64. The shortest distance between the lines $x + 1 = 2y = -12z$ and $x = y + 2 = 6z - 6$ is

[NCERT : P L-475 | Jan. 25, 2023 (II)]

(a) 2 (b) 3

(c) $\frac{5}{2}$ (d) $\frac{3}{2}$

65. The foot of perpendicular of the point (2, 0, 5) on the line $\frac{x+1}{2} = \frac{y-1}{5} = \frac{z+1}{-1}$ is (α, β, γ). Then. Which of the following is NOT correct?

[NCERT : P L-469 | Jan. 25, 2023 (II)]

(a) $\frac{\alpha\beta}{\gamma} = \frac{4}{15}$ (b) $\frac{\alpha}{\beta} = -8$

(c) $\frac{\beta}{\gamma} = -5$ (d) $\frac{\gamma}{\alpha} = \frac{5}{8}$

66. If the shortest distance between the line joining the points(1, 2, 3) and (2, 3, 4), and the line $\frac{x-1}{2} = \frac{y+1}{-1} = \frac{z-2}{0}$ is α, then $28\alpha^2$ is equal to _____.

[NCERT : P L-477 | NA, Jan. 25, 2023 (II)]

67. The shortest distance between the lines $\frac{x-2}{3} = \frac{y+1}{2} = \frac{z-6}{2}$ and $\frac{x-6}{3} = \frac{1-y}{2} = \frac{z+8}{0}$ is equal to _________.

[NCERT : P L-475 | NA, Jan. 24, 2023 (I)]

68. If the shortest between the lines

$\frac{x+\sqrt{6}}{2} = \frac{y-\sqrt{6}}{3} = \frac{z-\sqrt{6}}{4}$ and

$\frac{x-\lambda}{3} = \frac{y-2\sqrt{6}}{4} = \frac{z+2\sqrt{6}}{5}$

is 6, then the square of sum of all possible values of λ is

[NCERT : P L-475 | NA, Jan. 24, 2023 (II)]

69. If the length of the perpendicular drawn from the point $P(a, 4, 2), a > 0$ on the line $\frac{x+1}{2} = \frac{y-3}{3} = \frac{z-1}{-1}$ is $2\sqrt{6}$ units and $Q(\alpha_1, \alpha_2, \alpha_3)$ is the image of the point P in this line, then $a + \sum_{i=1}^{3}\alpha_i$ is equal to:

[NCERT : P L-469 | July 27, 2022 (II)]

(a) 7 (b) 8 (c) 12 (d) 14

70. Let Q and R be two points on the line $\frac{x+1}{2} = \frac{y+2}{3} = \frac{z-1}{2}$ at a distance $\sqrt{26}$ from the point P(4, 2, 7). Then the square of the area of the triangle PQR is _______.

[NCERT : P L-469 | NA July 26, 2022 (I)]

71. The shortest distance between the lines $\frac{x+7}{-6} = \frac{y-6}{7} = z$ and $\frac{7-x}{2} = y-2 = z-6$ is

[NCERT : P L-475 | July 25, 2022 (II)]

(a) $2\sqrt{29}$ (b) 1

(c) $\sqrt{\frac{37}{29}}$ (d) $\frac{\sqrt{29}}{2}$

72. Consider a triangle ABC whose vertices are $A(0, \alpha, \alpha)$, $B(\alpha, 0, \alpha)$ and $C(\alpha, \alpha, 0)$, $\alpha > 0$. Let D be a point moving on the line $x = z - 3 = 0 = y$ and G be the centroid of ΔABC. If the minimum length of GD is $\sqrt{\frac{57}{2}}$, then α is equal to ________.

[NCERT : P L-469 | NA, June 30, 2022 (I)]

73. Let the image of the point P(1, 2, 3) in the line $L: \frac{x-6}{3} = \frac{y-1}{2} = \frac{z-2}{3}$ be Q. Let R (α, β, γ) be a point that divides internally the line segment PQ in the ratio 1 : 3. Then the value of $22(\alpha + \beta + \gamma)$ is equal to ______.

[NCERT : P L-469 | NA, June 28, 2022 (II)]

74. The shortest distance between the lines $\frac{x-3}{2} = \frac{y-2}{3} = \frac{z-1}{-1}$ and $\frac{x+3}{2} = \frac{y-6}{1} = \frac{z-5}{3}$ is :

[NCERT : P L-475 | June 27, 2022 (II)]

(a) $\frac{18}{\sqrt{5}}$ (b) $\frac{22}{3\sqrt{5}}$

(c) $\frac{46}{3\sqrt{5}}$ (d) $6\sqrt{3}$

75. If the two lines $l_1 : \frac{x-2}{3}=\frac{y+1}{-2}$, $z = 2$ and $l_2 : \frac{x-1}{1}=\frac{2y+3}{\alpha}=\frac{z+5}{2}$ perpendicular, then an angle between the lines l_2 and $l_3 : \frac{1-x}{3}=\frac{2y-1}{-4}=\frac{z}{4}$ is :

[NCERT : P L-472 | June 26, 2022 (I)]

(a) $\cos^{-1}\left(\frac{29}{4}\right)$ (b) $\sec^{-1}\left(\frac{29}{4}\right)$

(c) $\cos^{-1}\left(\frac{2}{29}\right)$ (d) $\cos^{-1}\left(\frac{2}{\sqrt{29}}\right)$

76. If the shortest distance between the line $\vec{r}=(-\hat{i}+3\hat{k})+\lambda(\hat{i}-a\hat{j})$ and $\vec{r}=(-\hat{j}+2\hat{k})+\mu(\hat{i}-\hat{j}+\hat{k})$ is $\sqrt{\frac{2}{3}}$, then the integral value of a is equal to

[NCERT : P L-475 | NA, June 24, 2022 (I)]

77. Let a line having direction ratios 1, – 4, 2 intersect the lines $\frac{x-7}{3}=\frac{y-1}{-1}=\frac{z+2}{1}$ and $\frac{x}{2}=\frac{y-7}{3}=\frac{z}{1}$ at the point A and B. Then $(AB)^2$ is equal to _____ .

[NCERT : P L-469 | NA, June 24, 2022 (I)]

78. If the shortest distance between the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{\lambda}$ and $\frac{x-2}{1}=\frac{y-4}{4}=\frac{z-5}{5}$ is $\frac{1}{\sqrt{3}}$, then the sum of all possible values of λ is :

[NCERT : P L-475 | June 24, 2022 (II)]

(a) 16 (b) 6 (c) 12 (d) 15

79. If the shortest distance between the lines $\vec{r_1}=\alpha\hat{i}+2\hat{j}+2\hat{k}+\lambda\left(\hat{i}-2\hat{j}+2\hat{k}\right)$, $\lambda \in R$, $\alpha > 0$ and $\vec{r_2}=-4\hat{i}-\hat{k}+\mu\left(3\hat{i}-2\hat{j}-2\hat{k}\right)$, $\mu \in R$ is 9, then α is equal to _______ .

[NCERT : P L-475 | 2016 (S), 2020 (S), NA, Jul, 20, 2021 (I)]

80. If (a, b, c) is the image of the point (1, 2, –3) in the line, $\frac{x+1}{2}=\frac{y-3}{-2}=\frac{z}{-1}$, then $a + b + c$ is equals to:

[NCERT : P L-469 | Sep. 05, 2020 (I)]

(a) 2 (b) – 1

(c) 3 (d) 1

81. The lines $\vec{r}=(\hat{i}-\hat{j})+l(2\hat{i}+\hat{k})$ and $\vec{r}=(2\hat{i}-\hat{j})+m(\hat{i}+\hat{j}-\hat{k})$

[NCERT : P L-470 | Sep. 03, 2020 (I)]

(a) do not intersect for any values of l and m

(b) intersect for all values of l and m

(c) intersect when $l = 2$ and $m = \frac{1}{2}$

(d) intersect when $l = 1$ and $m = 2$

82. If the foot of the perpendicular drawn from the point (1, 0, 3) on a line passing through (α, 7, 1) is (5/3, 7/3, 17/3), then α is equal to __________.

[NCERT : P L-469 | NA, Jan. 07, 2020 (II)]

83. If the length of the perpendicular from the point (β, 0, β) ($\beta \neq 0$) to the line, $\frac{x}{1}=\frac{y-1}{0}=\frac{z+1}{-1}$ is $\sqrt{\frac{3}{2}}$, then β is equal to:

[NCERT : P L-469 | April 10, 2019 (I)]

(a) 1 (b) 2 (c) –1 (d) –2

84. The vertices B and C of a ΔABC lie on the line, $\frac{x+2}{3}=\frac{y-1}{0}=\frac{z}{4}$ such that BC = 5 units. Then the area (in sq. units) of this triangle, given that the point A (1, –1, 2), is:

[NCERT : P L-469 | April 09, 2019 (II)]

(a) $5\sqrt{17}$ (b) $2\sqrt{34}$ (c) 6 (d) $\sqrt{34}$

85. The length of the perpendicular from the point (2, –1, 4) on the straight line, $\frac{x+3}{10}=\frac{y-2}{-7}=\frac{z}{1}$ is :

[NCERT : P L-469 | 2011 (S), 2012 (S), April 08, 2019 (I)]

(a) greater than 3 but less than 4

(b) less than 2

(c) greater than 2 but less than 3

(d) greater than 4

86. If the lines $x = ay + b$, $z = cy + d$ and $x = a'z + b'$, $y = c'z + d'$ are perpendicular, then:

[NCERT : P L-471 | 2003 (S), Jan. 09, 2019 (II)]

(a) ab' + bc' + 1 = 0 (b) cc' + a + a' = 0

(c) bb' + cc' + 1 = 0 (d) aa' + c + c' = 0

87. If the angle between the lines, $\frac{x}{2}=\frac{y}{2}=\frac{z}{1}$ and $\frac{5-x}{-2}=\frac{7y-14}{P}=\frac{z-3}{4}$ is $\cos^{-1}\left(\frac{2}{3}\right)$, then P is equal to

[NCERT : P L-471 | 2005 (S), Online April 16, 2018]

(a) $-\frac{7}{4}$ (b) $\frac{2}{7}$ (c) $-\frac{4}{7}$ (d) $\frac{7}{2}$

88. Equation of the line of the shortest distance between the lines $\frac{x}{1}=\frac{y}{-1}=\frac{z}{1}$ and $\frac{x-1}{0}=\frac{y+1}{-2}=\frac{z}{1}$ is:

[NCERT : P L-466 | Online April 19, 2014]

(a) $\frac{x}{1}=\frac{y}{-1}=\frac{z}{-2}$ (b) $\frac{x-1}{1}=\frac{y+1}{-1}=\frac{z}{-2}$

(c) $\frac{x-1}{1}=\frac{y+1}{-1}=\frac{z}{1}$ (d) $\frac{x}{-2}=\frac{y}{1}=\frac{z}{2}$

89. If two lines L_1 and L_2 in space, are defined by

$L_1=\left\{x=\sqrt{\lambda}y+\left(\sqrt{\lambda}-1\right),\ z=\left(\sqrt{\lambda}-1\right)y+\sqrt{\lambda}\right\}$ and

$L_2=\left\{x=\sqrt{\mu}y+\left(1-\sqrt{\mu}\right),\ z=\left(1-\sqrt{\mu}\right)y+\sqrt{\mu}\right\}$

then L_1 is perpendicular to L_2, for all non-negative reals λ and μ, such that :

[NCERT : P L-471 | Online April 23, 2013]

(a) $\sqrt{\lambda}+\sqrt{\mu}=1$ (b) $\lambda\neq\mu$

(c) $\lambda+\mu=0$ (d) $\lambda=\mu$

ANSWER KEYS

1	(a)	**10**	(b)	**19**	(c)	**28**	(a)	**37**	(b)	**46**	(9)	**55**	(d)	**64**	(a)	**73**	(125)	**82**	(4)
2	(6)	**11**	(b)	**20**	(b)	**29**	(48)	**38**	(c)	**47**	(b)	**56**	(18)	**65**	(c)	**74**	(a)	**83**	(c)
3	(b)	**12**	(c)	**21**	(13)	**30**	(c)	**39**	(22)	**48**	(b) ;	**57**	(d)	**66**	(18)	**75**	(b)	**84**	(d)
4	(450)	**13**	(b)	**22**	(d)	**31**	(b)	**40**	(b)	**49**	(c)	**58**	(d)	**67**	(14)	**76**	(2)	**85**	(a)
5	(a)	**14**	(a)	**23**	(43)	**32**	(21)	**41**	(16)	**50**	(108)	**59**	(158)	**68**	(384)	**77**	(84)	**86**	(d)
6	(b)	**15**	(a)	**24**	(c)	**33**	(a)	**42**	(a)	**51**	(c)	**60**	(9)	**69**	(b)	**78**	(a)	**87**	(d)
7	(a)	**16**	(62)	**25**	(d)	**34**	(d)	**43**	(196)	**52**	(5)	**61**	(b)	**70**	(153)	**79**	(6)	**88**	(b)
8	(b)	**17**	(b)	**26**	(c)	**35**	(c)	**44**	(c)	**53**	(b)	**62**	(d)	**71**	(a)	**80**	(a)	**89**	(d)
9	(c)	**18**	(11)	**27**	(25)	**36**	(12)	**45**	(65)	**54**	(a)	**63**	(a)	**72**	(6)	**81**	(a)		

Chapter 11

Three Dimensional Geometry

1. **(a)** Projection of P(x, y, z) on xy-plane = Q(x,y,0)

$x^2 + y^2 + z^2 = \gamma^2$

Now, $\overrightarrow{OQ} = x\hat{i} + y\hat{j}$

So, $\cos\theta = \dfrac{x}{\sqrt{x^2+y^2}}$ and $\cos\phi = \dfrac{z}{\sqrt{x^2+y^2+z^2}}$

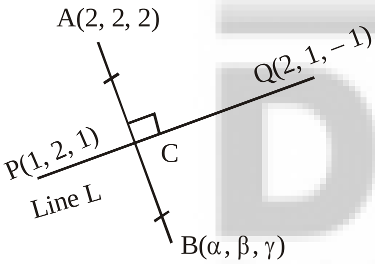
$\Rightarrow \sin^2\phi = \dfrac{x^2+y^2}{x^2+y^2+z^2}$

Distance of P from x-axis is $\sqrt{y^2+z^2}$

$\Rightarrow d = \sqrt{\gamma^2 - x^2} = \gamma\sqrt{1-\dfrac{x^2}{\gamma^2}}$ $\{\because x^2+y^2+z^2=\gamma^2\}$

$\Rightarrow \gamma\sqrt{1-\cos^2\theta\sin^2\phi}$

2. **(6)**



DR's of Line L = – 1 : 1 : 2

DR's of AB = $\alpha - 2 : \beta - 2 : \gamma - 2$

$AB \perp L \Rightarrow 2 - \alpha + \beta - 2 + 2\gamma - 4 = 0$

$2\gamma + \beta - \alpha = 4$ ...(i)

Let C is mid-point of AB

$C\left(\dfrac{\alpha+2}{2} + \dfrac{\beta+2}{2}, \dfrac{\gamma+2}{2}\right)$

DR's of PC = $\dfrac{\alpha}{2} : \dfrac{\beta-2}{2} : \dfrac{\gamma}{2}$

Line PC & PQ are same.

$\Rightarrow \dfrac{-\alpha}{2} = \dfrac{\beta-2}{2} = \dfrac{\gamma}{2} = K$ (let)

$\alpha = -2K$

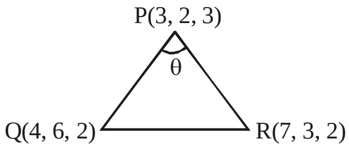
$\beta = 2K + 2$

$\gamma = 4K$

Use in (i)$\Rightarrow K = \dfrac{1}{6}$

$\therefore$ Value of $\alpha + \beta + 6\gamma = 24K + 2 = 6$

3. **(b)** Given ΔPQR



Direction ratio of PR = (4, 1, –1)

Direction ratio of PQ = (1, 4, –1)

Now, $\cos\theta = \left|\dfrac{4+4+1}{\sqrt{18}.\sqrt{18}}\right| = \dfrac{1}{2}$

$\theta = \dfrac{\pi}{3}$

4. **(450)** $RS \equiv (\alpha, -1, \beta)$

Now direction ratio's of $PQ \equiv \left(\dfrac{56}{17}+2, \dfrac{43}{17}+1, \dfrac{111}{17}-1\right)$

$\equiv \left(\dfrac{90}{17}, \dfrac{60}{17}, \dfrac{94}{17}\right)$

$\Rightarrow \dfrac{90}{17}\alpha + \dfrac{60}{17}(-1) + \dfrac{94}{17}\beta = 0 \Rightarrow 90\alpha + 94\beta = 60$

$\Rightarrow \beta = \dfrac{60-90\alpha}{94} \Rightarrow \beta = \dfrac{30(2-3\alpha)}{94}$

$\Rightarrow \beta = -30\dfrac{(3\alpha-2)}{94} \Rightarrow \beta = \dfrac{-15}{47}(3\alpha-2)$

$\Rightarrow \dfrac{\beta}{-15} = \dfrac{3\alpha-2}{47} \Rightarrow \beta = -15, \alpha = -15$

Now $\alpha^2 + \beta^2 = 225 + 225 = 450$

5. **(a)** Given equations are

$l + m - n = 0 \Rightarrow n = l + m$

Now, put the value of n in another equation then,

$3l^2 + m^2 + cl\,(l + m) = 0$

$3l^2 + m^2 + cl^2 + clm = 0$

$(3 + c)l^2 + clm + m^2 = 0$

$(3+c)\left(\dfrac{l}{m}\right)^2 + c\left(\dfrac{l}{m}\right) + 1 = 0$ ...(i)

Given that lines are parallel.

Then, roots of (i) must be equal $\Rightarrow D = 0$

$c^2 - 4(3 + c) = 0 \Rightarrow c^2 - 4c - 12 = 0$

$(c - 6)\,(c + 2) = 0 \Rightarrow c = 6$ or $c = -2$.

Therefore, +ve value of $c = 6$.

6. **(b)** Given that,

$l + m - n = 0 \Rightarrow l = n - m$ ...(i)

and $l^2 + m^2 - n^2 = 0$ ...(ii)

Substitute l from (i) into (ii)

$\Rightarrow (n-m)^2 + m^2 - n^2 = 0$

$\Rightarrow 2m(m-n) = 0 \Rightarrow m = 0$ or $m = n$

Case-I : If $m = 0$,

$l = n$ [from (i)]

We know that,

$$l^2 + m^2 + n^2 = 1 \Rightarrow l^2 = \frac{1}{2} \Rightarrow l_1, l_2 = \frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}$$

$$\because l = n \Rightarrow n_1, n_2 = \frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}$$

$\therefore \left(\frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}\right)$ or $\left(\frac{-1}{\sqrt{2}}, 0, \frac{-1}{\sqrt{2}}\right)$ are direction cosines of line L_1.

Case-II : If $m = n$

$\Rightarrow l = 0$ [from (i)]

$$l^2 + m^2 + n^2 = 1 \Rightarrow m^2 = \frac{1}{2} \Rightarrow m_1, m_2 = \frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}$$

$$\because m = n \Rightarrow n_1, n_2 = \frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}$$

$\therefore \left(0, \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ or $\left(0, \frac{-1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right)$ are direction cosines of line L_2.

$$\cos\alpha = l_1 l_2 + m_1 m_2 + n_1 n_2 = 0 + 0 \pm \frac{1}{2} = \pm\frac{1}{2}$$

$$\cos^2\alpha = \frac{1}{4} \Rightarrow \sin^2\alpha = \frac{3}{4}$$

So, $\sin^4\alpha + \cos^4\alpha = \frac{5}{8}$

7. **(a)** Here, P, Q, R are collinear

$\therefore \overrightarrow{PR} = \lambda \overrightarrow{PQ}$

$$2\hat{i} + (y+3)\hat{j} + (z-4)\hat{k} = \lambda[6\hat{i} + 3\hat{j} + 6\hat{k}]$$

$$\Rightarrow 6\lambda = 2, y + 3 = 3\lambda, z - 4 = 6\lambda \Rightarrow \lambda = \frac{1}{3}, y = -2, z = 6$$

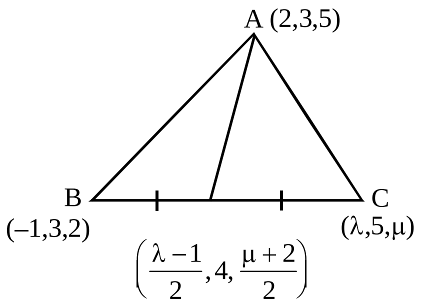
$\therefore$ Point $R\,(4, -2, 6)$

Now, OR $= \sqrt{(4)^2 + (-2)^2 + (6)^2} = \sqrt{56} = 2\sqrt{14}$

8. **(b)** DR's of AD are $\frac{\lambda-1}{2} - 2, 4-3, \frac{\mu+2}{2} - 5$

i.e. $\frac{\lambda-5}{2}, 1, \frac{\mu-8}{2}$

$\because$ This median is making equal angles with coordinate axes, therefore,



$$\frac{\lambda-5}{2} = 1 = \frac{\mu-8}{2}$$

$\Rightarrow \lambda = 7$ & $\mu = 10$

$\therefore \lambda^3 + \mu^3 + 5 = 1348$

9. **(c)** It makes θ with x and y-axis.

Let line makes α with z-axis. $\alpha \in \left[0.\frac{\pi}{2}\right]$

$l = \cos\theta$, $m = \cos\theta$, $n = \cos\alpha$

we have $l^2 + m^2 + n^2 = 1$

$\Rightarrow \cos^2\theta + \cos^2\theta + \cos^2\alpha = 1$

$\Rightarrow 2\cos^2\theta = 1 - \cos^2\alpha$

$\Rightarrow \cos^2\theta = \frac{\sin^2\alpha}{2} \Rightarrow \cos\theta = \frac{\sin\alpha}{\sqrt{2}}$

As $\alpha \in \left[0, \frac{\pi}{2}\right]$ then $\theta \in \left[\frac{\pi}{4}, \frac{\pi}{2}\right]$

10. **(b)** As per question, direction cosines of the line :

$l = \cos 45° = \frac{1}{\sqrt{2}}$, $m = \cos 120° = \frac{-1}{2}$, $n = \cos\theta$

where θ is the angle, which line makes with positive z-axis.

We know that, $l^2 + m^2 + n^2 = 1$

$\Rightarrow \frac{1}{2} + \frac{1}{4} + \cos^2\theta = 1$

$\Rightarrow \cos^2\theta = \frac{1}{4}$

$\Rightarrow \cos\theta = \frac{1}{2} = \cos\frac{\pi}{3}$ (θ being acute)

$\Rightarrow \theta = \frac{\pi}{3}$

11. **(b)** Let $P\,(x_1, y_1, z_1)$ and $Q\,(x_2, y_2, z_2)$ be the initial and final points of the vector whose projections on the three coordinate axes are 6, – 3, 2 then

$x_2 - x_1 = 6$; $y_2 - y_1 = -3$; $z_2 - z_1 = 2$

So that direction ratios of $\overrightarrow{PQ}$ are 6, – 3, 2

$\therefore$ Direction cosines of $\overrightarrow{PQ}$ are

$$\Rightarrow \frac{6}{\sqrt{6^2+(-3)^2+2^2}}, \frac{-3}{\sqrt{6^2+(-3)^2+2^2}},$$

$$\frac{2}{\sqrt{6^2+(-3)^2+2^2}} = \frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$$

12. **(c)** As per question the direction cosines of the line are $\cos\theta, \cos\beta, \cos\theta$

$\therefore \quad \cos^2\theta + \cos^2\beta + \cos^2\theta = 1$

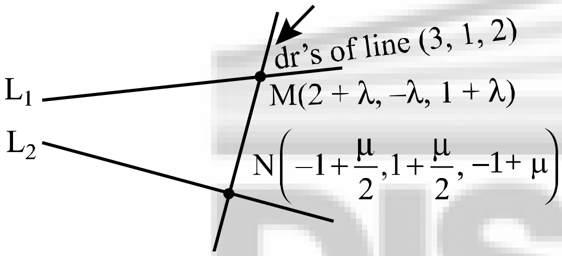
$\because \quad 2\cos^2\theta = 1 - \cos^2\theta$

$\Rightarrow \quad 2\cos^2\theta = \sin^2\beta = 3\sin^2\theta$ (given)

$\Rightarrow \quad 2\cos^2\theta = 3 - 3\cos^2\theta$

$\therefore \quad \cos^2\theta = \frac{3}{5}$

13. **(b)**



$$L_1 : \frac{x-2}{1} = \frac{y}{-1} = \frac{z-1}{1} = \lambda$$

$$L_2 : \frac{x+1}{\frac{1}{2}} = \frac{y-1}{\frac{1}{2}} = \frac{z+1}{1} = \mu$$

dr's of line MN will be

$< 3+\lambda-\frac{\mu}{2}, -1-\lambda-\frac{\mu}{2}, 2+\lambda-\mu >$ & it will be proportional to <3, 1, 2>

$$\therefore \quad \frac{3+\lambda-\frac{\mu}{2}}{3} = \frac{-1-\lambda-\frac{\mu}{2}}{1} = \frac{2+\lambda-\mu}{2}$$

On solving we get

$4\lambda + \mu = -6$ ...(i)

$4 + 3\lambda = 0$ ...(ii)

On solving (i) and (ii)

$\Rightarrow \quad \lambda = -\frac{4}{3}$ & $\mu = -\frac{2}{3}$

$\therefore$ Coordinate of M will be $\left(\frac{2}{3}, \frac{4}{3}, -\frac{1}{3}\right)$

and equation of required line will be.

$$\frac{x-\frac{2}{3}}{3} = \frac{y-\frac{4}{3}}{1} = \frac{z+\frac{1}{3}}{2} = k$$

So any point on this line will be

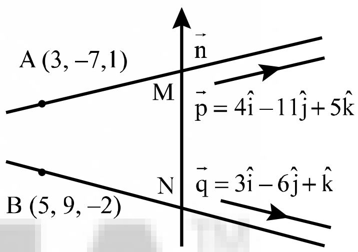
$$\left(\frac{2}{3}+3k, \frac{4}{3}+k, -\frac{1}{3}+2k\right)$$

$$\because \frac{2}{3}+3k = -\frac{1}{3} \Rightarrow k = -\frac{1}{3}$$

$\therefore$ Point lie on the line for

$k = -\frac{1}{3}$ is $\left(-\frac{1}{3}, 1, -1\right)$

14. **(a)**



$\vec{n} = \vec{p} \times \vec{q}$

$$\vec{n} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & -11 & 5 \\ 3 & -6 & 1 \end{vmatrix} = 19\hat{i} + 11\hat{j} + 9\hat{k}$$

S.d. = projection of $\overrightarrow{AB}$ on $\vec{n}$

$$= \left|\frac{\overrightarrow{AB}\cdot\vec{n}}{|\vec{n}|}\right| = \left|\frac{(2\hat{i}+16\hat{j}-3k)\cdot(19\hat{i}+11\hat{j}+9\hat{k})}{\sqrt{361+121+81}}\right|$$

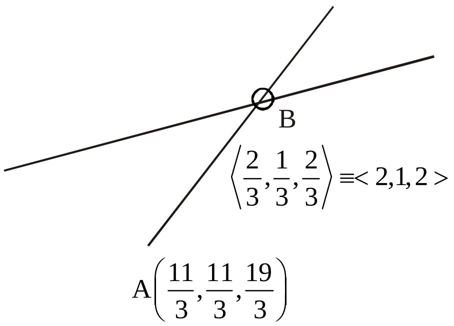
$$= \frac{38+176-27}{\sqrt{563}}$$

$$\text{S.d.} = \frac{187}{\sqrt{563}}$$

15. **(a)** $\frac{x-1}{2-1} = \frac{y-2}{3-2} = \frac{z-3}{5-3}$

$$\Rightarrow \quad \frac{x-1}{1} = \frac{y-2}{1} = \frac{z-3}{2} = \lambda$$

$A \equiv \left(\frac{11}{3}, \frac{11}{3}, \frac{19}{3}\right)$



$B(1+\lambda, 2+\lambda, 3+2\lambda)$

D.R. of AB $= \left\langle \frac{3\lambda-8}{3}, \frac{3\lambda-5}{3}, \frac{6\lambda-10}{3} \right\rangle$

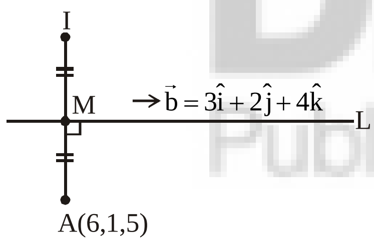
$\frac{3\lambda-8}{3\lambda-5} = \frac{2}{1} \Rightarrow 3\lambda - 8 = 6\lambda - 10$

$3\lambda = 2$

$\lambda = \frac{2}{3} \Rightarrow B\left(\frac{5}{3}, \frac{8}{3}, \frac{13}{3}\right)$

$AB = \frac{\sqrt{36+9+36}}{3} = \frac{9}{3} = 3$

16. **(62)**



Let $M(3\lambda+1, 2\lambda, 4\lambda+2)$ be the four of perpendicular from A on L.

$\overrightarrow{AM} \cdot \vec{b} = 0$

$\Rightarrow \quad 9\lambda - 15 + 4\lambda - 2 + 16\lambda - 12 = 0$

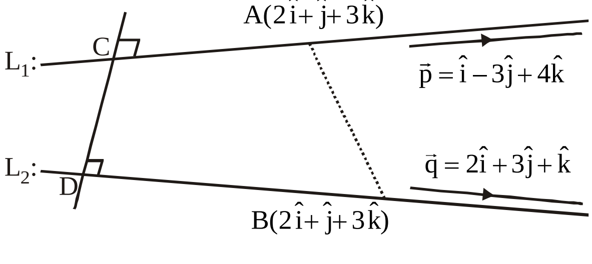
$\Rightarrow \quad 29\lambda = 29$

$\Rightarrow \quad \lambda = 1$

M (4, 2, 6), I = (2, 3, 7) I is the image of A in Line L.

Required Distance $= \sqrt{4+9+49} = \sqrt{62}$

17. **(b)** Let d be the shortest distance between L_1 and L_2.

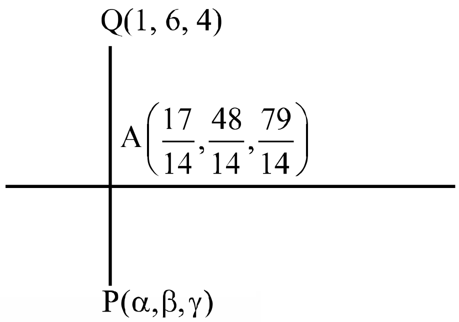


$$\vec{p} \times \vec{q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -3 & 4 \\ 2 & 3 & 1 \end{vmatrix} = -15\hat{i} + 7\hat{k}$$

$$d = \left| \frac{\overrightarrow{AB}.\vec{p} \times \vec{q}}{|\vec{p} \times \vec{q}|} \right| = \left| \frac{(0\hat{i} + 2\hat{j} + 2\hat{k}).(-15\hat{i} + 7\hat{j} + 9\hat{k})}{\sqrt{355}} \right| = \frac{32}{\sqrt{355}}$$

$\therefore m + n = 32 + 355 = 387$

18. **(11)**



Given, $\frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3} = t$

So, Direction ratio is $\vec{b} = \hat{i} + 2\hat{j} + 3\hat{k}$

and A(t, 2t + 1, 3t + 2) will be a general point on given line.

$\therefore \quad \overrightarrow{QA} = (t-1)\hat{i} + (2t-5)\hat{j} + (3t-2)\hat{k}$

Now $\overrightarrow{QA}.\vec{b} = 0 \quad \{\because \overrightarrow{QA} \perp \vec{b}\}$

$\Rightarrow \quad (t-1) + 2(2t-5) + 3(3t-2) = 0$

$\Rightarrow \quad 14t = 17 \Rightarrow t = 17/14$

Hence point A is $A\left(\frac{17}{14}, \frac{48}{14}, \frac{79}{14}\right)$

Since A is mid point of P and Q

$\alpha = \frac{20}{14} \quad \beta = \frac{12}{14} \quad \gamma = \frac{102}{14}$

$2\alpha + \beta + \gamma = \frac{154}{14} = 11$

19. **(c)** From the given information

$$\left.\begin{array}{l} \vec{r}_1 = (\lambda\hat{i} + 4\hat{j} + 3\hat{k}) + \alpha(2\hat{i} + 3\hat{j} + 4\hat{k}) \\ \vec{r}_2 = (2\hat{i} + 4\hat{j} + 7\hat{k}) + \beta(2\hat{i} + 3\hat{j} + 4\hat{k}) \end{array}\right\} \begin{array}{l} \vec{b} = 2\hat{i} + 3\hat{j} + 4\hat{k} \\ \vec{a}_1 = \lambda\hat{i} + 4\hat{j} + 3\hat{k} \\ \vec{a}_2 = 2\hat{i} + 4\hat{j} + 7\hat{k} \end{array}$$

Shortest dist. $= \frac{|\vec{b} \times (\vec{a}_2 - \vec{a}_1)|}{|\vec{b}|} = \frac{13}{\sqrt{29}}$

$$\frac{\left|(2\hat{i} + 3\hat{j} + 4\hat{k}) \times ((2-\lambda)\hat{i} + 4\hat{k})\right|}{\sqrt{29}} = \frac{13}{\sqrt{29}}$$

$$\left|-8\hat{j}-3(2-\lambda)\hat{k}+12\hat{i}+4(2-\lambda)\hat{j}\right|=13$$

$$\left|12\hat{i}-4\lambda\hat{j}+(3\lambda-6)\hat{k}\right|=13$$

$$144+16\lambda^2+(3\lambda-6)^2=169$$

$$16\lambda^2+(3\lambda-6)^2=25$$

$$25\lambda^2-36\lambda+11=0 \Rightarrow \lambda=1,\frac{11}{25}$$

20. **(b)** Given lines are

$$\frac{x-3}{2}=\frac{y+15}{-7}=\frac{z-9}{5} \quad \& \quad \frac{x+1}{2}=\frac{y-1}{1}=\frac{z-9}{-3}$$

Shortest distance $=\dfrac{|(\vec{a}_2-\vec{a}_1).(\vec{b}_1\times\vec{b}_2)|}{|\vec{b}_1\times\vec{b}_2|}$

$a_1 = 3, -15, 9$ $\quad b_1 = 2, -7, 5$
$a_2 = -1, 1, 9$ $\quad b_2 = 2, 1, -3$
$a_2 - a_1 = -4, 16, 0$

$$\vec{b}_1\times\vec{b}_2=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & -7 & 5\\ 2 & 1 & -3\end{vmatrix}=\hat{i}(16)-\hat{j}(-16)+\hat{k}(16)$$

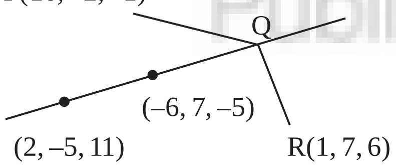
$$=16(\hat{i}+\hat{j}+\hat{k})$$

$$|\vec{b}_1\times\vec{b}_2|=16\sqrt{3}$$

$$\therefore\ (\vec{a}_2-\vec{a}_1).(\vec{b}_1\times\vec{b}_2)=16[-4+16]=(16)(12)$$

$$S.D.=\frac{(16)(12)}{16\sqrt{3}}=4\sqrt{3}$$

21. **(13)** P(10, –2, –1)



The given line : $\dfrac{x+6}{-8}=\dfrac{y-7}{12}=\dfrac{z+5}{-16}=\lambda$

Then co-ordinate of Q is,

Q = $(2\lambda-6,\ 7-3\lambda,\ 4\lambda-5)$

Now, $\overrightarrow{QR}=(2\lambda-7,\ -3\lambda,\ 4\lambda-11)$

Since, QR is perpendicular to the line

$\therefore\ \overrightarrow{QR}\cdot(dr's \text{ of line})=0$

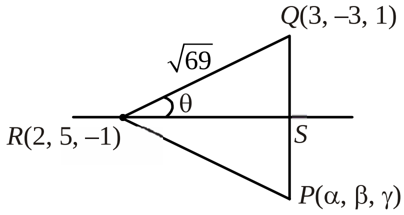
$\Rightarrow 4\lambda-14+9\lambda+16\lambda-44=0$

$\Rightarrow 29\lambda=58 \Rightarrow \lambda=2$

$\therefore\ Q=(-2, 1, 3)$

$$PQ=\sqrt{144+9+16}=\sqrt{169}=13$$

22. **(d)**



$RQ=\sqrt{1+64+4}=\sqrt{69}$

$\overrightarrow{RQ}=\hat{i}-8\hat{j}+2\hat{k}$

Vector along $\overrightarrow{RS}=\hat{i}+\hat{j}-\hat{k}$

$$\cos\theta=\frac{\overrightarrow{RQ}\cdot\overrightarrow{RS}}{|\overrightarrow{RQ}||\overrightarrow{RS}|}=\left|\frac{1-8-2}{\sqrt{69}\sqrt{3}}\right|=\frac{9}{3\sqrt{23}}$$

$$\cos\theta=\frac{3}{\sqrt{23}}$$

$$RS=\sqrt{69}\times\frac{3}{23}=3\sqrt{3}$$

$$\sin\theta=\frac{\sqrt{14}}{\sqrt{23}}=\frac{QS}{\sqrt{69}}$$

$$QS=\sqrt{42}$$

area $=\dfrac{1}{2}$. 2QS. RS $=\sqrt{42}.3\sqrt{3}$

$\lambda = 9\sqrt{14}$

$\lambda^2 = 81.14 = 14k$

$k = 81$

23. **(43)** $\bar{a}_1=\lambda\hat{i}+2\hat{j}+\hat{k}$

$\bar{a}_2=-2\hat{\ }-5\hat{\ }+4\hat{k} \quad j \quad i$

$\vec{p}=3\hat{i}-\hat{j}+\hat{k}$

$\vec{q}=-3\hat{i}+2\hat{j}+4\hat{k}$

$(\lambda+2)\hat{i}+7\hat{j}-3\hat{k}=\bar{a}_1-\bar{a}_2$

$\vec{p}\times\vec{q}=-6\hat{i}-15\hat{j}+3\hat{k}$

Shortest distance $=\left|\dfrac{(\bar{a}_2-\bar{a}_1).(\vec{p}\times\vec{q})}{|\vec{p}\times\vec{q}|}\right|$

$$\frac{44}{\sqrt{30}}=\frac{|-6\lambda-12-105-9|}{\sqrt{(-6)^2+(-15)^2+3^2}}$$

$$\frac{44}{\sqrt{30}}=\frac{|6\lambda+126|}{3\sqrt{30}}$$

$132 = |6\lambda + 126|$
$\lambda = 1, \lambda = -43$
largest possible $|\lambda|$ is $|\lambda| = 43$

24. (c) Let $\frac{x+6}{3} = \frac{y}{2} = \frac{z+1}{1} = \lambda$ ... (i)

$x = 3\lambda - 6, y = 2\lambda, z = \lambda - 1$

and $\frac{x-7}{4} = \frac{y-9}{3} = \frac{z-4}{2} = \mu$ ... (ii)

$x = 4\mu + 7, y = 3\mu + 9, z = 2\mu + 4$

$3\lambda - 6 = 4\mu + 7 \Rightarrow 3\lambda - 4\mu = 13$ ... (iii) × 2

$2\lambda = 3\mu + 9 \Rightarrow 2\lambda - 3\mu = 9$ ... (iv) × 3

$6\lambda - 8\mu = 26$

$6\lambda - 9\mu = 27$

$-\quad+\quad-$

$\mu = -1$

$\Rightarrow 3\lambda - 4(-1) = 13 \Rightarrow 3\lambda = 9 \Rightarrow \lambda = 3$

$\because \lambda - 1 = 2\mu + 4$

$\Rightarrow 3 - 1 = 2(-1) + 4$

$\Rightarrow 2 = 2$ satisty

$\therefore$ point of intersection is (3, 6, 2)

$d^2 = 16 + 4 + 49 = 69$

Now, $d^2 + 6 = 69 + 6 = 75$

25. (d) $\frac{2-x}{3} = \frac{3y-2}{4\lambda+1} = 4 - z$

$\Rightarrow \frac{x-2}{(-3)} = \frac{y - \frac{2}{3}}{\left(\frac{4\lambda+1}{3}\right)} = \frac{z-4}{(-1)}$

$\frac{x+3}{3\mu} = \frac{1-2y}{6} = \frac{5-z}{7}$ ... (i)

$\frac{x+3}{3\mu} = \frac{y - \frac{1}{2}}{(-3)} = \frac{z-5}{(-7)}$ ... (ii)

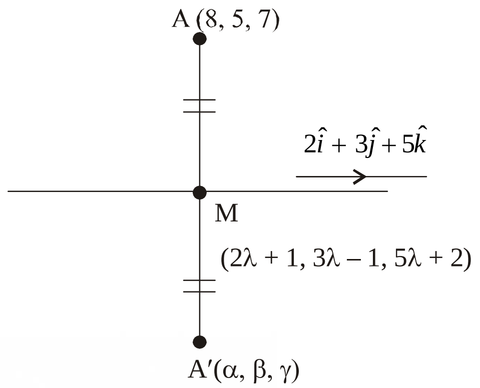
For right angle $a_1 a_2 + b_1 b_2 + c_1 c_2 = 0$

$\Rightarrow (-3)(3\mu) + \left(\frac{4\lambda+1}{3}\right)(-3) + (-1)(-7) = 0$

$-9\mu - 4\lambda - 1 + 7 = 0$

$4\lambda + 9\mu = 6$

26. (c) Let M be arbitrary point on the given line.

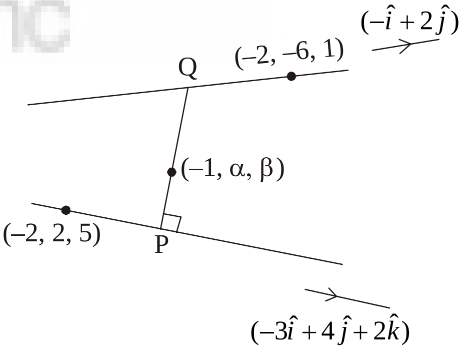


$\overrightarrow{AM} \cdot (2\hat{i} + 3\hat{j} + 5\hat{k}) = 0$
$(2\lambda - 7)(2) + (3\lambda - 6)(3) + (5\lambda - 5)(5) = 0$
$38\lambda = 57$

$\lambda = \frac{3}{2}$

$M\left(4, \frac{7}{2}, \frac{19}{2}\right)$
$A'(0, 2, 12)$
$\therefore \quad \alpha + \beta + \gamma = 14$

27. (25)



Coordinate of point P and Q, are
$P(-3\lambda - 2, 4\lambda + 2, 2\lambda + 5)$
$Q(-\mu - 2, 2\mu - 6, 1)$
dr′s of $PQ = (3\lambda - \mu, 2\mu - 4\lambda - 8, -2\lambda - 4)$

dr′s of PQ = $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & 2 & 0 \\ -3 & 4 & 0 \end{vmatrix}$

$= (4\hat{i} + 2\hat{j} + 2\hat{k})$ OR (2, 1, 1)

$$\frac{3\lambda-\mu}{2}=\frac{2\mu-4\lambda-8}{1}=\frac{-2\lambda-4}{1}$$

$\Rightarrow \mu=\lambda+2 \,\&\, 7\lambda=\mu-8$

$\lambda=-1 \quad \mu=1$

$Q:(-3,-4,1)$

Equation of line PQ: $\dfrac{x+3}{2}=\dfrac{y+4}{1}=\dfrac{z-1}{1}$

$(-1,\alpha,\beta)\Rightarrow 1=\dfrac{\alpha+4}{1}=\dfrac{\beta-1}{1}$

$\Rightarrow \quad \alpha=-3, \beta=2$

$\therefore \quad (\alpha-\beta)^2=25$

28. (a) Line PQ, $\dfrac{x-1}{4}=\dfrac{y+2}{-2}=\dfrac{z-3}{4}$

Any point on PQ be $R(4\lambda+1, -2\lambda-2, 4\lambda+3)$

$PR=9$ unit

$(PR)^2=81$

$(4\lambda+1-1)^2+(-2\lambda-2+2)^2+(4\lambda+3-3)^2=81$

$\Rightarrow 16\lambda^2+4\lambda^2+16\lambda^2=81 \Rightarrow 36\lambda^2=81 \Rightarrow \lambda=\pm\dfrac{3}{2}$

$\therefore$ R can be $(7,-5,9)$ or $(-5,1,-3)$.

Distance from origin for both points be

$\sqrt{49+25+81}=\sqrt{155}$ and $\sqrt{25+1+9}=\sqrt{35}$

$\therefore$ Distance of $(7,-5,9)$ is farthest from origin.

$\therefore$ $(\alpha,\beta,\gamma)=(7,-5,9)$

Now $7^2+(-5)^2+9^2=155$.

29. (48) $\dfrac{38}{3\sqrt{5}}k=\dfrac{(5\hat{i}+5\hat{j}-9\hat{k})}{\sqrt{5}}\cdot\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 3 & 4\\ 1 & -3 & 2\end{vmatrix}$

$\Rightarrow \dfrac{38}{3\sqrt{5}}k=\dfrac{19}{\sqrt{5}}$

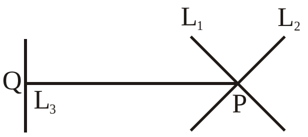
$\Rightarrow k=\dfrac{19}{\sqrt{5}}\times\dfrac{3\sqrt{5}}{38} \Rightarrow k=\dfrac{3}{2}$

$\int_0^{3/2}[x^2]dx=\int_0^1 0dx+\int_1^{\sqrt{2}}1dx+\int_{\sqrt{2}}^{3/2}2dx$

$=2-\sqrt{2}$

$\alpha=2\Rightarrow 6\alpha^3=48.$

30. (c)



$L_1=\dfrac{x-2}{1}=\dfrac{y-4}{5}=\dfrac{z-2}{1}=\lambda$

$P(\lambda+2, 5\lambda+4, \lambda+2)$

$L_2=\dfrac{x-3}{2}=\dfrac{y-2}{3}=\dfrac{z-3}{2}=\mu$

$P(2\mu+3, 3\mu+2, 2\mu+3)$

$\lambda+2=2\mu+3 \qquad 3\mu+2=5\lambda+4$

$\lambda=2\mu+1 \qquad 3\mu=5\lambda+2$

$3\mu=5(2\mu+1)+2$

$3\mu=10\mu+7$

$\mu=-1 \quad \lambda=-1$

$P(1,-1,1)$

$L_3=\dfrac{x}{\frac{1}{4}}=\dfrac{y}{\frac{1}{2}}=\dfrac{z}{1}$

$L_3=\dfrac{x}{1}=\dfrac{y}{2}=\dfrac{z}{4}=k$

Coordinates of $Q(k, 2k, 4k)$

DR's of PQ $=\langle k-1, 2k+1, 4k-1\rangle$

$PQ\perp$ to L_3

$(k-1)+2(2k+1)+4(4k-1)=0$

$k-1+4k+2+16k-4=0$

$k=\dfrac{1}{7}$, then the coordinate $Q\left(\dfrac{1}{7},\dfrac{2}{7},\dfrac{4}{7}\right)$

$PQ=\sqrt{\left(1-\dfrac{1}{7}\right)^2+\left(-1-\dfrac{2}{7}\right)^2+\left(1-\dfrac{4}{7}\right)^2}$

$=\sqrt{\dfrac{36}{49}+\dfrac{81}{49}+\dfrac{9}{49}}=\dfrac{\sqrt{126}}{7}$

$PQ=\dfrac{3\sqrt{14}}{7}$

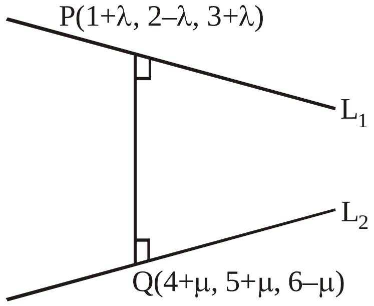
31. (b) Lines L_1 and L_2 are passing through $(\lambda, 2, 1)$ & $(\sqrt{3},1,2)$ respectively. Given, shortest distance = 1

$$\Rightarrow \frac{\begin{vmatrix}\sqrt{3}-\lambda & -1 & 1\\ -2 & 1 & 1\\ 1 & -2 & 1\end{vmatrix}}{\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ -2 & 1 & 1\\ 1 & -2 & 1\end{vmatrix}}=1$$

$\Rightarrow \left|\dfrac{\sqrt{3}-\lambda}{\sqrt{3}}\right|=1\Rightarrow \lambda=0, 2\sqrt{3}$

$\therefore$ Required sum $=2\sqrt{3}$

32. **(21)**



$\vec{b}=\hat{i}-\hat{j}+\hat{k}$ (Direction vector of L_1),

$\vec{d}=\hat{i}+\hat{j}-\hat{k}$ (Direction vector of L_2)

$\vec{b}\times\vec{d}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 1 & -1 & 1\\ 1 & 1 & -1\end{vmatrix}=0\hat{i}+2\hat{j}+2\hat{k}$ (Direction vector of Line perpendicular to L_1 and L_2)

DR's of PQ line

$=(0,2,2)=(3+\mu-\lambda, 3+\mu+\lambda, 3-\mu-\lambda)$

$$\frac{3+\mu-\lambda}{0}=\frac{3+\mu+\lambda}{2}=\frac{3-\mu-\lambda}{2}$$

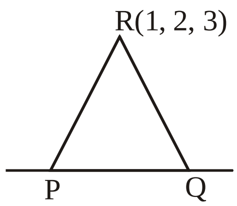
Solving above equations we get $\mu=-\frac{3}{2}$ and $\lambda=\frac{3}{2}$

point $P\equiv\left(\frac{5}{2},\frac{1}{2},\frac{9}{2}\right)$, $Q\equiv\left(\frac{5}{2},\frac{7}{2},\frac{15}{2}\right)$

Mid point of PQ = $\left(\frac{5}{2},2,6\right)=(\alpha,\beta,\gamma)$

$2(\alpha+\beta+\gamma)=5+4+12=21$

33. **(a)**



Let $A(8\lambda-3, 2\lambda+4, 2\lambda-1)$ be general point on given line

Let if AR = 6 then,

$\Rightarrow (8\lambda-4)^2+(2\lambda+2)^2+(2\lambda-4)^2=36$

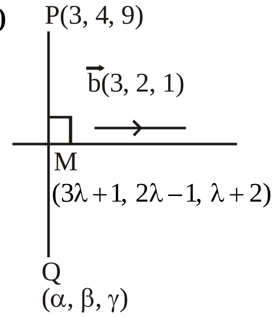
$\Rightarrow \lambda=0, 1$. Hence the co-ordinate of P.

and Q will be P(–3, 4, –1) & Q(5, 6, 1).

Centroid of $\Delta PQR=(1,4,1)\equiv(\alpha,\beta,\gamma)$

$\alpha^2+\beta^2+\gamma^2=18$

34. **(d)**



Clearly, $\overrightarrow{PM}.\vec{b}=0$

$\Rightarrow(3\lambda-2)+2(2\lambda-5)+(\lambda-7)=0$

$\Rightarrow 14\lambda=23\Rightarrow\lambda=\frac{23}{14}$

Hence co-ordinates of point M is $\left(\frac{83}{14},\frac{32}{14},\frac{51}{14}\right)$

$\therefore\ \frac{\alpha+3}{2}=\frac{83}{14}\Rightarrow\alpha=\frac{62}{7}$

$\frac{\beta+4}{2}=\frac{32}{14}\Rightarrow\beta=\frac{4}{7}\Rightarrow\frac{\gamma+9}{2}=\frac{51}{14}\Rightarrow\gamma=\frac{-12}{7}$

Hence, $14(\alpha+\beta+\gamma)=108$

35. **(c)** A vector in the direction of the required line can be obtained by cross product of

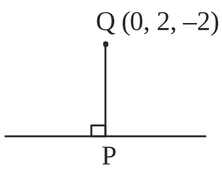
$$\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 3 & 5\\ -1 & 3 & 2\end{vmatrix}=-9\hat{i}-9\hat{j}+9\hat{k}$$

Required line

$\vec{r}=\left(5\hat{i}-4\hat{j}+3\hat{k}\right)+\lambda\left(-9\hat{i}-9\hat{j}+9\hat{k}\right)$

$\vec{r}=\left(5\hat{i}-4\hat{j}+3\hat{k}\right)+\lambda\left(\hat{i}+\hat{j}-\hat{k}\right)$

Now distance of (0, 2, –2)



P.V. of $P\equiv(5+\lambda)\hat{i}+(\lambda-4)\hat{j}+(3-\lambda)\hat{k}$

$\overrightarrow{QP}=(5+\lambda)\hat{i}+(\lambda-6)\hat{j}+(5-\lambda)\hat{k}$

$\overrightarrow{QP}.\left(\hat{i}+\hat{j}-\hat{k}\right)=0$

$5+\lambda+\lambda-6-5+\lambda=0\ \Rightarrow\ \lambda=2$

$\left|\overrightarrow{QP}\right|=\sqrt{49+16+9}=\sqrt{74}$

36. **(12)** $L_1 : \frac{x}{1} = \frac{y}{1} = \frac{z-1}{0} = r \quad \to Q(r, r, 1)$

$L_2 : \frac{x}{1} = \frac{y}{-1} = \frac{z+1}{0} = k \quad \to R(k, -k, -1)$

Given P(a, a, a)

Dr's of $PQ = (a-r), (a-r), (a-1)$

Dr's of $L_1 = 1, 1, 0$

$\therefore \quad 1(a-r) + (a-r) = 0 \Rightarrow \quad a - r = 0$

$\Rightarrow \quad a = r$

Dr's of $PR = (a-k), (a+k), (a+1)$

Dr's of $L_2 = (1, -1, 0)$

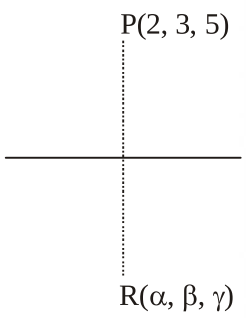
$a - k - a - k = 0 \Rightarrow k = 0$

As $PQ \perp PR$

$(a-r)(a-k) + (a-r)(a+k) + (a-1)(a+1) = 0$

$a = 1$ or $-1 \Rightarrow 12a^2 = 12$

37. **(b)** $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ ...(i)



$\because \quad \overrightarrow{PR}$ is perpendicular to Eq. (i)

$\Rightarrow \quad \overrightarrow{PR}.(2, 3, 4) = 0$

$(\alpha - 2, \beta - 3, \gamma - 5) . (2, 3, 4) = 0$

$\Rightarrow \quad 2\alpha + 3\beta + 4\gamma = 4 + 9 + 20 = 33$

38. **(c)** $L_2 = \frac{x+4}{3} = \frac{y-4}{2} = \frac{z-3}{0}$

$\vec{b}_1 = 2\hat{i} - 3\hat{j} + 2\hat{k}, \vec{b}_2 = 3\hat{i} + 2\hat{j}$

$\vec{b}_1 \times \vec{b}_2 = -4\hat{i} + 6\hat{j} + 13\hat{k}$

$$\therefore \quad S.D = \frac{\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ 2 & -3 & 2 \\ 3 & 2 & 0 \end{vmatrix}}{|\vec{b}_1 \times \vec{b}_2|}$$

$$= \frac{\begin{vmatrix} 5 & -5 & -7 \\ 2 & -3 & 2 \\ 3 & 2 & 0 \end{vmatrix}}{|\vec{b}_1 \times \vec{b}_2|}$$

$$= \frac{141}{|-4\hat{i} + 6\hat{j} + 13\hat{k}|} = \frac{141}{\sqrt{16 + 36 + 169}} = \frac{141}{\sqrt{221}}$$

39. **(22)** Equation of line AB is

$\frac{x-4}{12} = \frac{x+6}{4} = \frac{z+2}{6} = \lambda$

$\therefore \quad P(12\lambda + 4, 4\lambda - 6, 6\lambda - 2)$

$PA = \sqrt{(12\lambda)^2 + (4\lambda)^2 + (6\lambda)^2} \Rightarrow 196\lambda^2 = 441$

$\Rightarrow \lambda = \pm\frac{3}{2}$

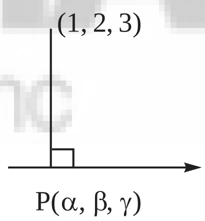
$\frac{x-4}{\frac{6}{7}} = \frac{y+6}{\frac{2}{7}} = \frac{z+2}{\frac{3}{7}} = 21$

$P\left(21 \times \frac{6}{7} + 4, \frac{2}{7} \times 21 - 6, \frac{3}{7} \times 21 - 2\right)$

$= P(22, 0, 7) = P(a, b, c)$

$\therefore \quad PQ = \sqrt{324 + 144 + 16} = 22$

40. **(b)**



Given: $\frac{x+3}{5} = \frac{y-1}{2} = \frac{z+4}{3} = k$ (say)

$\Rightarrow x = 5k - 3$

$y = 2k + 1, \; z = 3k - 4$

Let foot $P(5k - 3, \; 2k + 1, \; 3k - 4)$

DR's of $AP : 5k - 4, \; 2k - 1, \; 3k - 7$

DR's of Line : 5, 2, 3

Condition of perpendicular lines

$(25k - 20) + (4k - 2) + (9k - 21) = 0$

Then $k = \frac{43}{38}$

$\therefore (\alpha, \beta, \gamma) = \left(\frac{101}{38}, \frac{124}{38}, \frac{-23}{38}\right)$

Then $19(\alpha+\beta+\gamma) = 101$

41. **(16)** Let $L_1 = \frac{x+1}{1} - \frac{y}{1/2} = \frac{z}{-1/12}$,

$L_2 = \frac{x}{1} = \frac{y+2}{1} = \frac{z-1}{\frac{1}{6}}$,

d_1 = shortest distance between lines L_1 & L_2

$$d_1 = \left|\frac{(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2)}{|(\vec{b}_1 \times \vec{b}_2)|}\right|$$

$d_1 = 2$

$L_3 : \frac{x-1}{2} = \frac{y+8}{-7} = \frac{z-4}{5}$, $L_4 : \frac{x-1}{2} = \frac{y-2}{1} = \frac{z-6}{-3}$

d_2= shortest distance between L_3 and L_4,

$d_2 = \frac{12}{\sqrt{3}}$

Now, $\frac{32\sqrt{3}d_1}{d_2} = \frac{32\sqrt{3}\times 2}{\frac{12}{\sqrt{3}}} = \frac{32\times 3}{6} = 16$

42. **(a)** According to the question:

$L_1 \perp L_2$, $L_3 \perp L_1$ and $L_3 \perp L_2$

$\therefore$ $3 - 1 + 2p = 0$

$p = -1$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 2 \\ 3 & 1 & -1 \end{vmatrix} = -\hat{i} + 7\hat{j} + 4\hat{k}$$

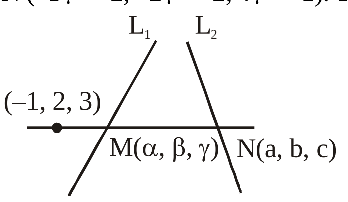
$\therefore$ $(-\delta, 7\delta, 4\delta)$ will lie on L_3

For $\delta = 1$ the point will be $(-1, 7, 4)$

43. **(196)**

$M(3\lambda + 1, 2\lambda + 2, -2\lambda - 1)$ Then, $\alpha + \beta + \gamma = 3\lambda + 2$

$N(-3\mu - 2, -2\mu + 2, 4\mu + 1)$. Then, $a + b + c = -\mu + 1$



Now, $\frac{3\lambda+2}{-3\mu-1} = \frac{2\lambda}{-2\mu} = \frac{-2\lambda-4}{4\mu-2}$

$\Rightarrow 3\lambda\mu + 2\mu = 3\lambda\mu + \lambda$

$\Rightarrow 2\mu = \lambda$ ...(i)

$2\lambda\mu - \lambda = \lambda\mu + 2\mu$

$\Rightarrow \lambda\mu = \lambda + 2\mu$ ...(ii)

$\Rightarrow \lambda\mu = 2\lambda$ ($\because$ from (i) and (ii))

$\Rightarrow \mu = 2 \ (\lambda \neq 0)$

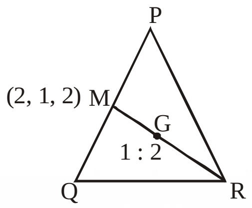
$\therefore \lambda = 4$

Now, $\alpha + \beta + \gamma = 14$

& $a + b + c = -1$

Then, $\frac{(\alpha+\beta+\gamma)^2}{(a+b+c)^2} = 196$

44. **(c)**



Centroid G divides MR in 1 : 2

G(1, 2, 2)

Point of intersection A of given lines is (2, –6, 0)

$AG = \sqrt{69}$

45. **(65)** Let $P(t, t-2, t)$ and $Q(2s-2, s, s)$

D.R's of PQ are 2, 1, 2

$\frac{2s-2-t}{2} = \frac{s-t-2}{2} = \frac{s-t}{2}$

$\Rightarrow t = 6$ and $s = 2$

$\Rightarrow P(6, 4, 6)$ and $Q(2, 2, 2)$

PQ: $\frac{x-2}{2} = \frac{y-2}{1} = \frac{z-2}{2} = \lambda$

Let $F(2\lambda+2, \lambda+2, \lambda+2)$

$A(1, 2, 12)$

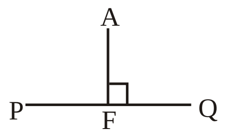
$\overrightarrow{AF}.\overrightarrow{PQ} = 0$ $[AF \perp PQ]$

$\therefore \lambda = 2$

So, $F(6, 4, 6)$ and $AF = \sqrt{65}$

$\Rightarrow l = \sqrt{65}$

$\Rightarrow l^2 = 65$



46. **(9)** $L_1 : \frac{x-5}{4} = \frac{y-4}{1} = \frac{z-5}{3} = \lambda$ (let)

dr's of $\vec{b}_1 = (4, 1, 3)$

$M(4\lambda+5, \lambda+4, 3\lambda+5)$

$L_2: \frac{x+8}{12} = \frac{y+2}{5} = \frac{z+11}{9} = \mu$ (let)

dr's of $\vec{b}_2 = (12, 5, 9)$

$N(12\mu - 8, 5\mu - 2, 9\mu - 11)$

$MN = (4\lambda - 12\mu + 13, \lambda - 5\mu + 6, 3\lambda - 9\mu + 16)$ ... (i)

Now, $\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & 1 & 3 \\ 12 & 5 & 9 \end{vmatrix} = -6\hat{i} + 8\hat{k}$ ...(ii)

From equation (i) and (ii)

$$\therefore \underset{\textbf{I}}{\frac{4\lambda - 12\mu + 13}{-6}} = \underset{\textbf{II}}{\frac{\lambda - 5\mu + 6}{0}} = \underset{\textbf{III}}{\frac{3\lambda - 9\mu + 16}{8}}$$

Solving I and II, we get

$\lambda - 5\mu + 6 = 0$ ...(iii)

Solving I and III, we get

$\lambda - 3\mu + 4 = 0$ ...(iv)

Solve (iii) and (iv), we get

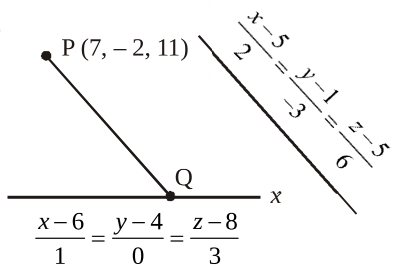
$\lambda = -1,\ \mu = 1$

$\therefore M(1, 3, 2)$

$N(4, 3, -2)$

$\therefore\ \overrightarrow{OM}.\overrightarrow{ON} = 4 + 9 - 4 = 9$

47. (b)



$\frac{x-6}{1} = \frac{y-4}{0} = \frac{z-8}{3} = \lambda$

$Q(\lambda + 6, 4, 3\lambda + 8)$

D.r. of $PQ = \lambda - 1, 6, 3\lambda - 3$

D.r of line $= 2, -3, 6$ $\therefore \frac{\lambda - 1}{2} = \frac{6}{-3} = \frac{3\lambda - 3}{6} \Rightarrow \lambda = -3$

$\therefore Q(3, 4, -1)$

PQ is $= \sqrt{(7-3)^2 + (4+2)^2 + (11+1)^2} = 14.$

48. (b) $\frac{x-4}{1} = \frac{y+1}{2} = \frac{z}{-3}$; $\frac{x-\lambda}{2} = \frac{y+1}{4} = \frac{z-2}{-5}$

the shortest distance between the lines

$$= \left| \frac{(\vec{a}_1 - \vec{a}_2)\cdot(\vec{b}_1 \times \vec{b}_2)}{(\vec{b}_1 \times \vec{b}_2)} \right| = \left| \frac{\begin{vmatrix} \lambda - 4 & 0 & 2 \\ 1 & 2 & -3 \\ 2 & 4 & -5 \end{vmatrix}}{\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & -3 \\ 2 & 4 & -5 \end{vmatrix}} \right|$$

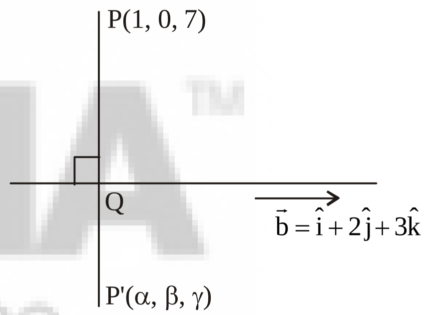
$$= \left| \frac{(\lambda - 4)(-10 + 12) - 0 + 2(4 - 4)}{|2\hat{i} - 1\hat{j} + 0\hat{k}|} \right|$$

$\frac{6}{\sqrt{5}} = \left| \frac{2(\lambda - 4)}{\sqrt{5}} \right| \Rightarrow 3 = |\lambda - 4|$

$\lambda - 4 = \pm 3 \Rightarrow \lambda = 7, 1$

Sum of all possible values of λ is = 8

49. (c) $L_1 = \frac{x}{1} = \frac{y-1}{2} = \frac{z-2}{3} = \lambda$



$Q(\lambda, 16 + 2\lambda, 2 + 3\lambda)$

D. r of PQ = $(\lambda - 1), (1 + 2\lambda), (3\lambda - 5)$

D.r. of $L_1 = 1, 2, 3$

PQ is perpendicular to line L_1

$1(\lambda - 1) + 2(1 + 2\lambda) + 3(3\lambda - 5) = 0$

$\Rightarrow \lambda - 1 + 4\lambda + 2 + 9\lambda - 15 = 0$

$14\lambda = 14 \Rightarrow \lambda = 1$. So, Q(1, 3, 5)

Q is midpoint of P & P′

$\frac{\alpha + 1}{2} = 1, \frac{\beta + 0}{2} = 3, \frac{\gamma + 7}{2} = 5$

$\therefore (\alpha, \beta, \gamma) = (1, 6, 3)$

Let required line having direction cosine (l, m, n)

$l^2 + m^2 + n^2 = 1 \Rightarrow l^2 + \cos^2\frac{2\pi}{3} + \cos^2\frac{3\pi}{4} = 1$

$\Rightarrow\ l^2 + \left(-\frac{1}{2}\right)^2 + \left(-\frac{1}{\sqrt{2}}\right)^2 = 1 \Rightarrow l^2 = \frac{1}{4}$

$\therefore \quad l = \dfrac{1}{2}$ [Line make acute angle with x-axis]

Equation of line passing through (1, 6, 3) will be

$$\vec{r} = (\hat{i} + 6\hat{j} + 3\hat{k}) + \mu\left(\frac{1}{2}\hat{i} - \frac{1}{2}\hat{j} - \frac{1}{\sqrt{2}}\hat{k}\right)$$

Option (c) satisfying for $\mu = 4$

50. **(108)** $\dfrac{x-2}{1} = \dfrac{y}{-1} = \dfrac{z-7}{8} = \lambda$

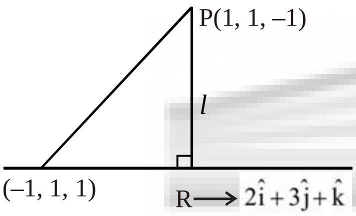
$\dfrac{x+3}{4} = \dfrac{y+2}{3} = \dfrac{z+2}{1} = k$

$\Rightarrow \quad \lambda + 2 = 4k - 3$ and $-\lambda = 3k - 2$

$\Rightarrow \quad k = 1, \lambda = -1$

Now, $8\lambda + 7 = k - 2 \Rightarrow -1 = -1$ satisfy

$\therefore \quad P = (1, 1, -1)$



Projection of $\overrightarrow{QP} = 2\hat{i} - 2\hat{k}$ on $2\hat{i} + 3\hat{j} + \hat{k}$ is

$|\overline{QR}| = \dfrac{4-2}{\sqrt{4+9+1}} = \dfrac{2}{\sqrt{14}}$ and $|\overline{QP}| = 2\sqrt{2}$

$\therefore \quad l^2 = |\overline{PQ}|^2 - |\overline{QR}|^2 = 8 - \dfrac{4}{14} = \dfrac{108}{14}$

$\Rightarrow \quad 14l^2 = 108$

51. **(c)** Given the shortest distance = 13

$$\Rightarrow \frac{\left\| \begin{vmatrix} 0 & 4 & 1 \\ 3 & -4 & 0 \\ 2\lambda & 3 & -12 \end{vmatrix} \right\|}{\left\| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 4 & 1 \\ 3 & -4 & 0 \end{vmatrix} \right\|} = 13$$

$$\Rightarrow \frac{|153 + 8\lambda|}{|4\hat{i} + 3\hat{j} - 12\hat{k}|} = 13$$

$$\Rightarrow \frac{|153 + 8\lambda|}{13} = 13 \Rightarrow |153 + 8\lambda| = 169$$

$$\Rightarrow 153 + 8\lambda = 169, -169 \Rightarrow \lambda = \frac{16}{8}, \frac{-322}{8}$$

So, $8\left|\sum_{\lambda \in S} \lambda\right| = 306$

52. **(5)** Let $\ell = (0\hat{i} + 0\hat{j} + 0\hat{k}) + \gamma(a\hat{i} + b\hat{j} + c\hat{k})$

$= \gamma(a\hat{i} + b\hat{j} + c\hat{k})$

$$= a\hat{i} + b\hat{j} + c\hat{k} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 3 \\ 2 & 2 & 1 \end{vmatrix} = -4\hat{i} - 5\hat{j} - 2\hat{k}$$

$= \ell = y(-4\hat{i} + 5\hat{j} + 2\hat{k})$

and, $\ell_1 \; (1+\lambda)\hat{i} + (-11 + 2\lambda)\hat{j} + (-7 + 3\lambda)\hat{k}$

P is intersection of ℓ and ℓ_1

$-4\gamma = 1 + \lambda, 5\lambda = -1\lambda + 2\lambda, -2\lambda = -7 + 3\lambda$

By solving there equation $\gamma = -1$, P (4, –5, 2)

Let $Q(-1 + 2\mu, 2\mu, 1 + \mu)$

then, $\overrightarrow{PQ} = (5 - 2\mu, -5 - 2\mu, 1 - \mu)$

$\overrightarrow{PQ} \cdot (2\hat{i} + 2\hat{j} + \hat{k}) = 0 \Rightarrow -2 + 4\mu + 4\mu + 1 + \mu = 0$

$\mu = \dfrac{1}{9} \Rightarrow Q\left(\dfrac{-7}{9}, \dfrac{2}{9}, \dfrac{10}{9}\right)$

$9(\alpha + \beta + \gamma) = 9\left(\dfrac{-7}{9} + \dfrac{2}{9} + \dfrac{10}{9}\right) \Rightarrow \alpha + \beta + y = \dfrac{5}{9}$

53. **(b)** Given the lines

$\dfrac{x+2}{1} = \dfrac{y}{-2} = \dfrac{z-5}{2}$ & $\dfrac{x-4}{1} = \dfrac{y-1}{2} = \dfrac{z+3}{0}$

$$\text{Shortest distance} = \frac{\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}}{\left\| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} \right\|}$$

$$= \frac{\begin{vmatrix} 6 & 1 & -8 \\ 1 & -2 & 2 \\ 1 & 2 & 0 \end{vmatrix}}{\left\| \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 2 \\ 1 & 2 & 0 \end{vmatrix} \right\|} = \frac{54}{6} = 9$$

54. **(a)** Shortest distance

$$= \left| \frac{[\vec{a}_2 - \vec{a}_1 \; \vec{b}_1 \; \vec{b}_2]}{|\vec{b}_1 \times \vec{b}_2|} \right|$$

$\vec{a}_1 = (4, -2, -3), \; \vec{b}_1 = (4, 5, 3)$

$\vec{a}_2 = (1, 3, 4), \; \vec{b}_2 = (3, 4, 2)$

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & 5 & 3 \\ 3 & 4 & 2 \end{vmatrix} = \hat{i}(-2) - \hat{j}(-1) + \hat{k}(1) = (-2, 1, 1)$$

$$[\vec{a}_2-\vec{a}_1\ \ \vec{b}_1\ \vec{b}_2]=\begin{vmatrix}-3 & 5 & 7\\ 4 & 5 & 3\\ 3 & 4 & 2\end{vmatrix}=18\ ;\ S_d=\frac{18}{\sqrt{6}}=3\sqrt{6}$$

55. **(d)** Equation of line OP passes through (0, 0, 0) and (3, 4, 5)

is $\frac{x}{3}=\frac{y}{4}=\frac{z}{5}$

Equation of edge parallel to z-axis and passes through (3, 0, 5) & (3, 0, 0) is

$$\frac{x-3}{0}=\frac{y-0}{0}=\frac{z-5}{1}$$

$$\text{S.D}=\frac{(\vec{a}_2-\vec{a}_1)\cdot(\vec{b}_1\times\vec{b}_2)}{|\vec{b}_1\times\vec{b}_2|}$$

$$=\frac{\begin{vmatrix}3 & 0 & 5\\ 3 & 4 & 5\\ 0 & 0 & 1\end{vmatrix}}{\left\|\begin{matrix}\hat{i} & \hat{j} & \hat{k}\\ 3 & 4 & 5\\ 0 & 0 & 1\end{matrix}\right\|}=\frac{3(4)}{|4\hat{i}-3\hat{j}|}=\frac{12}{5}$$

56. **(18)** Given the lines $\frac{x-1}{2}=\frac{2-y}{-3}=\frac{z-3}{\alpha}$

And $\frac{x-4}{5}=\frac{y-1}{2}=\frac{z}{\beta}$ intersect

So, point on first line (1,2,3) and point on second line (4,1,0).

Vector joining both points is $-3\hat{i}+\hat{j}+3\hat{k}$

Now vector along first line is $2\hat{i}+3\hat{j}+\alpha\hat{k}$

Also vector along second line is $5\hat{i}+2\hat{j}+\beta\hat{k}$

Now these three vectors must be coplanar

$$\Rightarrow\begin{vmatrix}2 & 3 & \alpha\\ 5 & 2 & \beta\\ -3 & 1 & 3\end{vmatrix}=0$$

$$\Rightarrow 2(6-\beta)-3(15+3\beta)+\alpha(11)=0$$

$$\Rightarrow \alpha-\beta=3 \Rightarrow \alpha=3+\beta$$

Now, $8(3+\beta)\cdot\beta=8\left(\beta^2+3\beta\right)$

$$=8\left(\beta^2+3\beta+\frac{9}{4}-\frac{9}{4}\right)=8\left(\beta+\frac{3}{2}\right)^2-18$$

So magnitude of minimum value = 18

57. **(d)** We have shortest distance between two lines

$\frac{x-x_1}{a_1}=\frac{y-y_1}{a_2}=\frac{z-z_1}{a_3}$ ab &

$\frac{x-x_2}{b_1}=\frac{y-y_2}{b_2}=\frac{z-z_2}{b_3}$

$$\frac{\begin{vmatrix}x_1-x_2 & y_1-y_2 & z_1-z_2\\ a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\end{vmatrix}}{\sqrt{(a_1b_3-a_3b_2)^2+(a_1b_3-a_3b_1)^2+(a_1b_2-a_2b_1)^2}}$$

$$=\frac{\begin{vmatrix}5-(3) & 2-(-5) & 4-1\\ 1 & 2 & -3\\ 1 & 4 & -5\end{vmatrix}}{\sqrt{(-10+12)^2+(-5+3)^2+(4-2)^2}}$$

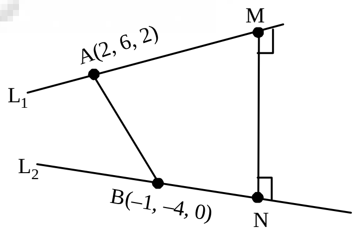
$$=\frac{\begin{vmatrix}8 & 7 & 3\\ 1 & 2 & -3\\ 1 & 4 & -5\end{vmatrix}}{\sqrt{(2)^2+(2)^2+(2)^2}}=\frac{16+14+6}{\sqrt{12}}=\frac{36}{\sqrt{12}}=\frac{36}{2\sqrt{3}}$$

$$=\frac{18}{\sqrt{3}}=6\sqrt{3}$$

58. **(d)** Since the line ℓ, is given by

$$L_1:\frac{x-2}{2}=\frac{y-6}{1}=\frac{z-2}{-2}$$

and $L_2:\frac{x+1}{2}=\frac{y+4}{-3}=\frac{z}{2}$



Now shortest distance $=\left|\frac{\overrightarrow{AB}\cdot\overrightarrow{MN}}{MN}\right|$

$$\overrightarrow{AB}=3\hat{i}+10\hat{j}+2\hat{k}$$

$$\overrightarrow{MN}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 1 & -2\\ 2 & -3 & 2\end{vmatrix}=-4\hat{i}-8\hat{j}-8\hat{k}$$

$$MN=\sqrt{16+64+64}=12$$

So, required distance $=\left|\frac{-12-80-16}{12}\right|=9$

59. **(158)** Since, $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 3 & -2 \\ 1 & -1 & 2 \end{vmatrix} = 4\hat{i} - 4\hat{j} - 4\hat{k}$

Now, equation of line is $\frac{x-2}{1} = \frac{y-3}{-1} = \frac{z-1}{-1}$

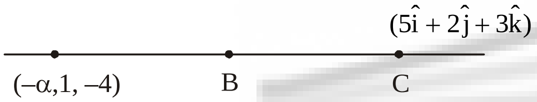
Let Q be (5, 3, 8) and foot of $\perp$ from Q on this line be R.
Now, R $\equiv$ (k + 2, –k + 3, –k + 1) and
DR of QR are (k – 3, –k, –k –7)
So, (1)(k – 3) + (–1)(–k) + (–1)(–k –7) = 0

$\Rightarrow k = -\frac{4}{3}$

$\therefore \alpha^2 = \left(\frac{13}{3}\right)^2 + \left(\frac{4}{3}\right)^2 + \left(\frac{17}{3}\right)^2 = \frac{474}{9}$

$\therefore 3\alpha^2 = 158$

60. **(9)** Since A $\cdot$ (0, 2, α)



Now, $\left| \frac{1}{2} . 2\sqrt{21} . \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \alpha & 1 & \alpha+4 \\ 5 & 2 & 3 \end{vmatrix} \frac{1}{\sqrt{25+4+9}} \right| = 21\sqrt{21}$

$\Rightarrow \sqrt{(2\alpha+5)^2 + (2\alpha+20)^2 + (2\alpha-5)^2} = \sqrt{21}\sqrt{38}$

$\Rightarrow\ 12\alpha^2 + 80\alpha + 450 = 798$
$\Rightarrow\ 12\alpha^2 + 80\alpha - 348 = 0$
$\Rightarrow\ \alpha = 3 \Rightarrow \alpha^2 = 9$

61. **(b)** $\frac{x-1}{2} = \frac{y+8}{-7} = \frac{z-4}{5}$;

$\vec{a}_1 = \hat{i} - 8\hat{j} + 4\hat{k}, \vec{b}_1 = 2\hat{i} - 7\hat{i} + 5\hat{k}$

$\frac{x-1}{2} = \frac{y-2}{1} = \frac{z-6}{-3}$;

$\vec{a}_2 = \hat{i} + 2\hat{j} + 6\hat{k}, \vec{b}_2 = 2\hat{i} + \hat{j} - 3\hat{k}$

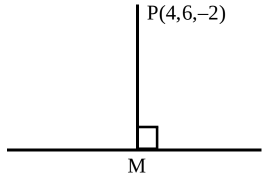
$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -7 & 5 \\ 2 & 1 & -3 \end{vmatrix}$

$= \hat{i}(16) - \hat{j}(-16) + \hat{k}(16) = 16\left(\hat{i} + \hat{j} + \hat{k}\right)$

$d = \frac{(\vec{a}_1 - \vec{a}_2) \cdot (\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}$

$= \left| \frac{(-10\hat{j} - 2\hat{k}) \cdot 16(\hat{i} + \hat{j} + \hat{k})}{16\sqrt{3}} \right| = \left| \frac{-12}{\sqrt{3}} \right| = 4\sqrt{3}$

62. **(d)**



Equation of line is $\frac{x+3}{3} = \frac{y-2}{3} = \frac{z-3}{-1} = \lambda$

M(3λ – 3, 3λ + 2, 3 – λ)
D.R of PM (3λ – 7, 3λ – 4, 5 – λ)
Since PM is perpendicular to line
$\Rightarrow 3(3\lambda - 7) + 3(3\lambda - 4) - 1(5 - \lambda) = 0$
$\Rightarrow \lambda_2 = 2$
Put λ = 2 in cordinate M.
$\Rightarrow$ M(3, 8, 1) $\Rightarrow$ PM = $\sqrt{14}$

63. **(a)** Let P (2λ + 1, λ + 3, 2λ + 2) and Q = (μ + 2, 2μ + 2, 3μ + 3)
Take direction ratio's of PQ to get equation of line

$\Rightarrow \frac{2\lambda - \mu - 1}{1} = \frac{\lambda - 2\mu + 1}{-1} = \frac{2\lambda - 3\mu - 1}{-2}$

By comparing the above equations we get
$\Rightarrow \lambda = \mu = 3 \Rightarrow$ P (7, 6, 8) and Q (5, 8, 12)
PQ = $2\sqrt{6}$

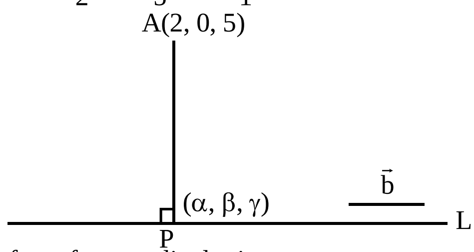
64. **(a)** $\frac{x+1}{1} = \frac{y}{\frac{1}{2}} = \frac{z}{\frac{-1}{12}}$ and $\frac{x}{1} = \frac{y+2}{1} = \frac{z-1}{\frac{1}{6}}$

$\Rightarrow$ shortest distance $= \frac{\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}}{|\vec{p} \times \vec{q}|}$

$\left\{ \vec{p} \times \vec{q} \equiv \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & \frac{1}{2} & \frac{-1}{12} \\ 1 & 1 & \frac{1}{6} \end{vmatrix} = \frac{1}{6}\hat{i} - \frac{1}{4}\hat{j} + \frac{1}{2}\hat{k} \text{ or } 2\hat{i} - 3\hat{j} + 6\hat{k} \right\}$

S.D. $= \frac{(-\hat{i} + 2\hat{j} - \hat{k}) \cdot (2\hat{i} - 3\hat{j} + 6\hat{k})}{\sqrt{2^2 + 3^2 + 6^2}} = \left| \frac{-14}{7} \right| = 2$

65. **(c)** $L: \frac{x+1}{2} = \frac{y-1}{5} = \frac{z+1}{-1} = \lambda(\text{let})$



Let foot of perpendicular is
P(2λ – 1, 5λ + 1, –λ – 1) = (α, β, γ)

$\overrightarrow{PA} = \left(2 - (2\lambda - 1)\hat{i} + \left(0 - (5\lambda + 1)\right)\hat{j} + \left(5 - (-\lambda - 1)\right)\hat{k}\right)$

$\overrightarrow{PA} = (3 - 2\lambda)\hat{i} - (5\lambda + 1)\hat{j} + (6 + \lambda)\hat{k}$

Direction ratio of line $\Rightarrow \vec{b} = 2\hat{i} + 5\hat{j} - \hat{k}$

Now, $\overrightarrow{PA}.\vec{b} = |\overrightarrow{PA}||\vec{b}|\cos 90° = 0$

$\Rightarrow 2(3-2\lambda) - 5(5\lambda+1) - (6+\lambda) = 0$

$\Rightarrow \lambda = \frac{-1}{6}$

$P(2\lambda-1, 5\lambda+1, -\lambda-1) \equiv P(\alpha, \beta, \gamma)$

$\Rightarrow \alpha = 2\left(-\frac{1}{6}\right) - 1 = -\frac{4}{3} \Rightarrow \alpha = -\frac{4}{3}$

$\Rightarrow \beta = 5\left(-\frac{1}{6}\right) + 1 = \frac{1}{6} \Rightarrow \beta = \frac{1}{6}$

$\Rightarrow \gamma = -\lambda - 1 = \frac{1}{6} - 1 \Rightarrow \gamma = -\frac{5}{6}$

$\therefore$ Check options

66. **(18)** $\vec{P} = (2,3,4) - (1,2,3) = (1,1,1)$

$\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(\hat{i} + \hat{j} + \hat{k}) \qquad \vec{r} = \vec{a} + \lambda\vec{p}$

$\vec{r} = (\hat{i} - \hat{j} + 2\hat{k}) + \mu(2\hat{i} - \hat{j}) \qquad \vec{r} = \vec{b} + \mu\vec{q}$

$$\vec{p} \times \vec{q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ 2 & -1 & 0 \end{vmatrix} = \hat{i} + 2\hat{j} - 3\hat{k}$$

$$d = \left|\frac{(\vec{b} - \vec{a}) \cdot (\vec{p} \times \vec{q})}{|\vec{p} \times \vec{q}|}\right| \Rightarrow d = \left|\frac{(-3\hat{j} - \hat{k}) \cdot (\hat{i} + 2\hat{j} - 3\hat{k})}{\sqrt{14}}\right|$$

$$d = \left|\frac{0 - 6 + 3}{\sqrt{14}}\right| = \frac{3}{\sqrt{14}}; \quad \alpha = \frac{3}{\sqrt{14}}$$

Now, $28\alpha^2 = 28 \times \frac{9}{14} = 18$

67. **(14)** Shortest distance between the lines

Since $\vec{a}_1 = (2, -1, 6)$, $\vec{a}_2 = (6, 1, -8)$ and

$\vec{b}_1 = (3, 2, 2)$, $\vec{b}_2 = (3, -2, 0)$

Now $(\vec{a}_2 - \vec{a}_1) = (4, 2, -14)$

$\vec{b}_1 \times \vec{b}_2 = (4, 6, -12)$

So, shortest distance $= \left|\frac{(\vec{a}_2 - \vec{a}_1)(\vec{b}_1 \times \vec{b}_2)}{|\vec{b}_1 \times \vec{b}_2|}\right|$

$$= \left|\frac{16 + 12 + 168}{\sqrt{16 + 36 + 144}}\right| = \left|\frac{196}{14}\right| = 14$$

68. **(384)** Given the lines

$$\frac{x + \sqrt{6}}{2} = \frac{y - \sqrt{6}}{3} = \frac{z - \sqrt{6}}{4}$$

$$\frac{x - \lambda}{3} = \frac{y - 2\sqrt{6}}{4} = \frac{z + 2\sqrt{6}}{5}$$

Now, Vector along line of shortest distance

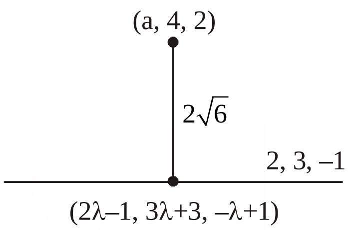
$$= \begin{vmatrix} i & j & k \\ 2 & 3 & 4 \\ 3 & 4 & 5 \end{vmatrix} \Rightarrow -\hat{i} + 2\hat{j} - k \text{(its magnitude is } \sqrt{6})$$

$$\text{Now, } \frac{1}{\sqrt{6}} \begin{vmatrix} \sqrt{6} + \lambda & \sqrt{6} & -3\sqrt{6} \\ 2 & 3 & 4 \\ 3 & 4 & 5 \end{vmatrix} \Rightarrow \pm 6$$

$\Rightarrow \lambda = -2\sqrt{6}, 10\sqrt{6}$

Then, square of sum of these values is 384

69. **(b)**



Given line is $\frac{x+1}{2} = \frac{y-3}{3} = \frac{z-1}{-1} = \lambda$

$x = 2\lambda - 1,\ y = 3\lambda + 3,\ z = -\lambda + 1.$

$(2\lambda - 1 - a)2 + (3\lambda - 1)3 + (-\lambda - 1)(-1) = 0$

$\Rightarrow 4\lambda - 2 - 2a + 9\lambda - 3 + \lambda + 1 = 0$

$\Rightarrow 14\lambda - 4 - 2a = 0 \Rightarrow 7\lambda - 2 - a = 0$ and,

$(2\lambda - 1 - a)^2 + (3\lambda - 1)^2 + (\lambda + 1)^2 = 24$

$\Rightarrow (5\lambda - 1)^2 + (3\lambda - 1)^2 + (\lambda + 1)^2 = 24$

$\Rightarrow 35\lambda^2 - 14\lambda - 21 = 0 \Rightarrow (\lambda - 1)(35\lambda + 21) = 0$

For, $\lambda = 1 \Rightarrow a = 5$

Let $(\alpha_1, \alpha_2, \alpha_3)$ be reflection of point P

$\alpha_1 + 5 = 2 \qquad \alpha_2 + 4 = 12 \qquad \alpha_3 + 2 = 0$

$\alpha_1 = -3 \qquad \alpha_2 = 8 \qquad \alpha_3 = -2$

$a + \alpha_1 + \alpha_2 + \alpha_3 = 8$

70. **(153)** Given line is $\frac{x+1}{2} = \frac{y+2}{3} = \frac{z-1}{2}$

let $\frac{x+1}{2} = \frac{y+2}{3} = \frac{z-1}{2} = \lambda$

$x = 2\lambda - 1,\ y = 3\lambda - 2,\ z = 2\lambda + 1$

let point $Q(2\lambda - 1, 3\lambda - 2, 2\lambda + 1)$

Then, distance of PQ $= \sqrt{26}$.

$(2\lambda - 5)^2 + (3\lambda - 4)^2 + (2\lambda - 6)^2 = 26$

$4\lambda^2 + 25 - 20\lambda + 9\lambda^2 + 16 - 24\lambda + 4\lambda^2 + 36 - 24\lambda = 26$

$17\lambda^2 - 68\lambda + 51 = 0 \quad \Rightarrow 17(\lambda^2 - 4\lambda + 3) = 0$

$\Rightarrow \quad \lambda^2 - 4\lambda + 3 = 0 \Rightarrow (\lambda - 1)(\lambda - 3) = 0$

$\Rightarrow \quad \lambda = 1, 3$

Put λ in point Q.

$Q \rightarrow (2(1) - 1, 3(1) - 2, 2(1) + (1) \rightarrow (1, 1, 3)$

$R \rightarrow (2(3) - 1, 3(3) - 2, 2(3) + 1) \rightarrow (5, 7, 7)$

Area of triangle PQR $= \frac{1}{2}\left|\overrightarrow{PQ} \times \overrightarrow{PR}\right|$

$= \frac{1}{2}\left|(3\hat{i} + \hat{j} + 4\hat{k}) \times (\hat{i} \times 5\hat{j})\right|$

$= \sqrt{153}$

71. **(a)** Here, $\vec{a}_1 = -7\hat{i} + 6\hat{j},\ \vec{b}_1 = -6\hat{i} + 7\hat{j} + \hat{k}$

$\vec{a}_2 = 7\hat{i} + 2\hat{j} + 6\hat{k}$, $\vec{b}_2 = -2\hat{i} + \hat{j} + \hat{k}$

$\vec{a}_2 - \vec{a}_1 = 14\hat{i} - 4\hat{j} + 6\hat{k}$

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -6 & 7 & 1 \\ -2 & 1 & 1 \end{vmatrix} = 6\hat{i} + 4\hat{j} + 8\hat{k}$$

$$\text{Distance} = \frac{(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2)}{\left|\vec{b}_1 \times \vec{b}_2\right|} = \frac{116}{\sqrt{116}} = \sqrt{116} = 2\sqrt{29}$$

72. **(6)** Centroid of $\Delta ABC = G\left(\frac{2\alpha}{3}, \frac{2\alpha}{3}, \frac{2\alpha}{3}\right)$

Given equation of line is $\frac{x}{1} = \frac{z-3}{-1} = \frac{y}{0} = \lambda$

$x = \lambda, y = 0, z = -\lambda + 3$

$\therefore$ $D(\lambda, 0, -\lambda + 3)$ be any point on given line

$$\therefore\ GD = \sqrt{\left(\lambda - \frac{2\alpha}{3}\right)^2 + \left(\frac{2\alpha}{3}\right)^2 + \left(-\lambda + 3 - \frac{2\alpha}{3}\right)^2}$$

$$GD_1 = \left(\lambda - \frac{2\alpha}{3}\right)^2 + \left(\frac{2\alpha}{3}\right)^2 + \left(-\lambda + 3 - \frac{2\alpha}{3}\right)^2$$

$$\frac{d\,GD_1}{d\lambda} = 2\left(\lambda - \frac{2\alpha}{3}\right) - 2\left(-\lambda + 3 - \frac{2\alpha}{3}\right)$$

$= 4\lambda - 6 = 0 \quad \Rightarrow \quad \lambda = \frac{3}{2}$

$\therefore$ Minimum GD

$$= \sqrt{\left(\frac{3}{2} - \frac{2\alpha}{3}\right)^2 + \left(\frac{2\alpha}{3}\right)^2 + \left(-\frac{3}{2} + 3 - \frac{2\alpha}{3}\right)^2}$$

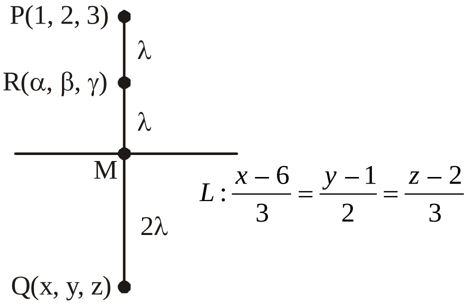
$$\sqrt{\frac{57}{2}} = \sqrt{\left(\frac{9-4\alpha}{6}\right)^2 + \frac{4\alpha^2}{9} + \left(\frac{9-4\alpha}{6}\right)^2}$$

$\Rightarrow \frac{57}{2} = \frac{24\alpha^2 - 72\alpha + 81}{18}$

$\Rightarrow \alpha^2 - 3\alpha - 18 = 0 \quad \Rightarrow \quad \alpha = -3, 6$

$\therefore\ \alpha = 6 \quad (\because \alpha > 0).$

73. **(125)**



Let $\frac{x-6}{3} = \frac{y-1}{2} = \frac{z-2}{3} = \lambda$ ...(i)

from eqn (i)

Let M be the mid-point of PQ

$\therefore\ M = (3\lambda + 6, 2\lambda + 1, 3\lambda + 2)$

Now $\overrightarrow{PM} = \overrightarrow{OM} - \overrightarrow{OP}$

$\therefore\ PM = (3\lambda + 5)\hat{i} + (2\lambda - 1)\hat{j} + (3\lambda - 1)\hat{k}$

Here DR's of normal to the line L is: (3, 2, 3)

$\therefore$ normal vector to the line L is: $(3\hat{i} + 2\hat{j} + 3\hat{k})$

$\because\ \overrightarrow{PM} \perp (3\hat{i} + 2\hat{j} + 3\hat{k})$

$\therefore\ 3(3\lambda + 5) + 2(2\lambda - 1) + 3(3\lambda - 1) = 0$

$\therefore\ \lambda = \frac{-5}{11}$

$\therefore\ M\left(\frac{51}{11}, \frac{1}{11}, \frac{7}{11}\right)$

Since R is mid-point of PM

$\therefore\ 22(\alpha + \beta + \gamma) = 125$

74. **(a)** Give lines are $\frac{x-3}{2} = \frac{y-2}{3} = \frac{z-1}{-1}$ and

$\frac{x+3}{2} = \frac{y-6}{1} = \frac{z-5}{3}$

Lines passes through the points $\vec{a}_1 = (3, 2, 1)$ and

$\vec{a}_2 = (-3, 6, 5)$, $\vec{b}_1 = 2\hat{i} + 3\hat{j} - \hat{k}$

$\vec{b}_1 = 2\hat{i} + \hat{j} - 3k$, $\vec{a}_2 - \vec{a}_1 = 6\hat{i} - 4j - 4\hat{k}$

$$\text{SHORTEST DISTANCE} = \frac{|(\vec{a}_2 - \vec{a}_1)(\vec{b}_1 \times \vec{b}_2)|}{|(\vec{b}_1 \times \vec{b}_2)|}$$

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & -1 \\ 2 & 1 & 3 \end{vmatrix} = 10\hat{i} - 8\hat{j} - 4\hat{k}$$

$(\vec{a}_2 - \vec{a}_1)\cdot(\vec{b}_1 \times \vec{b}_2) = 60 + 32 + 16 = 108$

$|\vec{b}_1 \times \vec{b}_2| = \sqrt{100 + 64 + 16} = \sqrt{180}$

$$S.D=\frac{108}{\sqrt{180}}=\frac{108}{6\sqrt{5}}=\frac{18}{\sqrt{5}}$$

75. **(b)** Given lines l_1, l_2 and l_3 are

$$l_1:\frac{x-2}{3}=\frac{y+1}{-2}=\frac{z-2}{0}$$

$$l_2:\frac{x-1}{1}=\frac{y+\frac{3}{2}}{\frac{\alpha}{2}}=\frac{z+5}{2}$$

$$l_3:\frac{x-1}{-3}=\frac{y-\frac{1}{2}}{-2}=\frac{z-0}{4}$$

$$l_1\perp l_2\Rightarrow\frac{|3-\alpha+0|}{\sqrt{13}\sqrt{1+\frac{\alpha^2}{4}+4}}=0\Rightarrow\alpha=3$$

angle between l_2 & l_3

$$\cos\theta=\frac{\left|1\times(-3)+(-2)\left(\frac{\alpha}{2}\right)+2\times4\right|}{\sqrt{1+4+\frac{\alpha^2}{4}}\sqrt{9+16+4}}=\frac{|-3-\alpha+8|}{\sqrt{5+\frac{\alpha^2}{4}}\sqrt{29}}$$

put $\alpha=3$, $\cos\theta=\dfrac{2}{\sqrt{\frac{29}{4}}\sqrt{29}}=\dfrac{4}{29}$

$$\theta=\cos^{-1}\left(\frac{4}{29}\right)\Rightarrow\theta=\sec^{-1}\left(\frac{29}{4}\right)$$

76. **(2)** Given points are
$a_1=(-1,0,3)$ and $a_2=(0,-1,2)$ with direction ratio's $b_1=(1,-a,0)$ and $b_2=(1,-1,1)$ respectively

$$\vec{a}_2-\vec{a}=\left(\hat{i}-\hat{j}+\hat{k}\right).$$

$$\vec{b}_1\times\vec{b}_2=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\1&-a&0\\1&-1&1\end{vmatrix}$$

$$\vec{b}_1\times\vec{b}_2=\hat{i}(-a)-\hat{j}+\hat{k}(a-1)$$

Now, take modulus of $\vec{b}_1\times\vec{b}_2$.

$$\left|\vec{b}_1\times\vec{b}_2\right|=\sqrt{a^2+1+(a-1)^2}$$

$$(a_2-a_1)\left|\vec{b}_1\times\vec{b}_2\right|=2-2a$$

According to question,

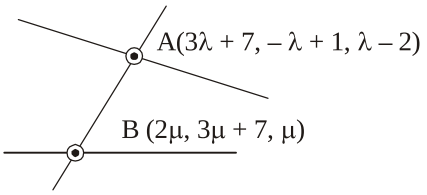
$$\frac{2(1-a)}{\sqrt{a^2+1+(a-1)^2}}=\sqrt{\frac{2}{3}}$$

Take square both sides, $\dfrac{4(1-a)^2}{a^2+1+a^2+1-2a}=\dfrac{2}{3}$

$$\Rightarrow 2a^2+5a+2=0\ \Rightarrow(a-2)(2a-1)=0$$

Therefore, $a=2$ and $\frac{1}{2}$.

77. **(84)** Given a lines with direction ratios 'A' with $(3\lambda+7,-\lambda+1,\lambda-2)$ & 'B' with $(2\mu,3\mu+7,\mu)$.



So, direction ratios of AB represented as,
$(3\lambda-2\mu+7,-\lambda-3\mu-6,\lambda-\mu-2)$
Equation of line AB is,

$$\frac{3\lambda-2\mu+7}{1}=\frac{\lambda+3\mu+6}{-4}=\frac{\lambda-\mu-2}{2}$$

Compare first two, first and third then, the required equations are

$5\lambda-3\mu=-16$ ...(i)

$\lambda-\mu=-2$ ...(ii)

Multiply (ii) by 3 and subtract from equation (i), then, we get $\lambda=-5$, $\mu=-3$.
Direction ratio's of A & B points are, A = (–8, 6, 7) & B = (–6, –2, –3) respectively.
Square of distance, $(AB)^2=4+64+16=84$.

78. **(a)** Given points and direction ratios are shown below.

$a_1=(1,2,3)$, $a_2=(2,4,5)$, $\vec{b}_1=2\hat{i}+3\hat{j}+\lambda\hat{k}$

$\vec{b}_2=\hat{i}+4\hat{j}+5\hat{k}$

Apply shortest distance formula,

$$\text{Shortest distance}=\frac{|(a_2-a_1).(b_1\times b_2)|}{|b_1\times b_2|}$$

$$\text{S.D.}=\frac{\left|\left((2-1)\hat{i}+(4-2)\hat{j}+(5-3)\hat{k}\right).(\vec{b}_1\times\vec{b}_2)\right|}{|b_1\times b_2|}\quad\text{... (i)}$$

Take, $\vec{b}_1\times\vec{b}_2=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\2&3&\lambda\\1&4&5\end{vmatrix}$

$$=\hat{i}(15-4\lambda)+\hat{j}(\lambda-10)+\hat{k}(5)$$

$$=(15-4\lambda)\hat{i}+(\lambda-10)\hat{j}+5\hat{k}$$

$$|\vec{b}_1\times\vec{b}_2|=\sqrt{(15-4\lambda)^2+(\lambda-10)^2+25}$$

From equation (i),

$$\text{S.D.}=\frac{\left|\left(\hat{i}+2\hat{j}+2\hat{k}\right).\left[(15-4\lambda)\hat{i}+(\lambda-10)\hat{j}+5k\right]\right|}{\sqrt{(15-4\lambda)^2+(\lambda-10)^2+25}}$$

$$\Rightarrow \frac{|15-4\lambda+2\lambda-20+10|}{\sqrt{(15-4\lambda)^2+(\lambda-10)^2+25}}=\frac{1}{\sqrt{3}}$$

Take square both sides,

$\Rightarrow 3(5-2\lambda)^2 = 225+16\lambda^2-120\lambda+\lambda^2+100-20\lambda+25$

$12\lambda^2+75-60\lambda = 17\lambda^2-140\lambda+350$

$5\lambda^2-80\lambda+275=0 \Rightarrow \lambda^2-16\lambda+55=0$

$(\lambda-5)(\lambda-11)=0 \Rightarrow \lambda=5, 11$

Sum of values of $\lambda = 5+11=16$

79. **(6)** If $\vec{r}=\vec{a}+\lambda\vec{b}$ and $\vec{r}=\vec{c}+\lambda\vec{d}$

$\therefore\ \vec{a}-\vec{c}=(\alpha+4)\hat{i}+2\hat{j}+3\hat{k}$

$$\frac{\vec{b}\times\vec{d}}{|\vec{b}\times\vec{d}|}=\frac{(2\hat{i}+2\hat{j}+\hat{k})}{3}$$

Then shortest distance between two lines is,

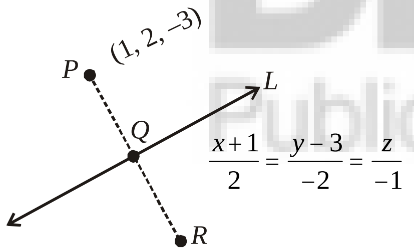
$$\frac{(\vec{a}-\vec{c}).(\vec{b}\times\vec{d})}{|\vec{b}\times\vec{d}|}=9$$

$$\Rightarrow\ \left((\alpha+4)\hat{i}+2\hat{j}+3\hat{k}\right).\frac{(2\hat{i}+2\hat{j}+\hat{k})}{3}=9$$

$\Rightarrow\ 2\alpha+15=27 \Rightarrow \alpha=6$

80. **(a)** $\dfrac{x+1}{2}=\dfrac{y-3}{-2}=\dfrac{z}{-1}=\lambda$

Any point on line $= Q(2\lambda-1, -2\lambda+3, -\lambda)$



$\therefore$ D.r. of $PQ = [2\lambda-2, -2\lambda+1, -\lambda+3]$

D.r. of given line = [2, –2, –1]

$\because$ PQ is perpendicular to line L

$\therefore 2(2\lambda-2)-2(-2\lambda+1)-1(-\lambda+3)=0$

$\Rightarrow 4\lambda-4+4\lambda-2+\lambda-3=0$

$\Rightarrow 9\lambda-9=0 \Rightarrow \lambda=1$

$\because$ Q is mid point of $PR = Q = (1, 1, -1)$

$\therefore$ Coordinate of image $R = (1, 0, 1) = (a, b, c)$

$\therefore\ a+b+c=2$

81. **(a)** $L_1 \equiv \vec{r}=(\hat{i}-\hat{j})+\ell(2\hat{i}+\hat{k})$

$L_2 \equiv \vec{r}=(2\hat{i}-\hat{j})+m(\hat{i}+\hat{j}-\hat{k})$

Equating coeff. of $\hat{i}$, $\hat{j}$ and $\hat{k}$ of L_1 and L_2

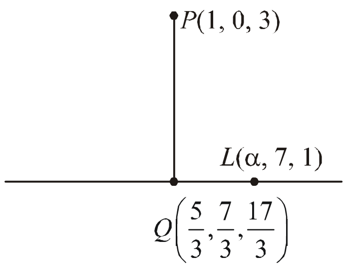
$2l+1=m+2$ ...(i)

$-1=-1+m \Rightarrow m=0$ ...(ii)

$l=-m$ ...(iii)

$\Rightarrow m=l=0$, which is not satisfy eqn. (i) hence lines do not intersect for any value of l and m.

82. **(4)** Since, PQ is perpendicular to L



$$\therefore \left(1-\frac{5}{3}\right)\left(\alpha-\frac{5}{3}\right)+\left(\frac{-7}{3}\right)\left(7-\frac{7}{3}\right)+\left(3-\frac{17}{3}\right)\left(1-\frac{17}{3}\right)=0$$

$$\Rightarrow\ \frac{-2\alpha}{3}+\frac{10}{9}-\frac{98}{9}+\frac{112}{9}=0$$

$$\Rightarrow\ \frac{2\alpha}{3}=\frac{24}{9}\ \Rightarrow\ \alpha=4$$

83. **(c)** Given, $\dfrac{x}{1}=\dfrac{y-1}{0}=\dfrac{z+1}{-1}=p$ (let) and point P $(\beta, 0, \beta)$

Any point on line A = $(p, 1, -p-1)$

Now, DR of AP are $< p-\beta, 1-0, -p-1-\beta >$

Which is perpendicular to line.

$\therefore (p-\beta)\,1+0.1-1\,(-p-1-\beta)=0$

$\Rightarrow p-\beta+p+1+\beta=0 \Rightarrow p=\dfrac{-1}{2}$

$\therefore$ Point $A\left(\dfrac{-1}{2},1,-\dfrac{1}{2}\right)$

Given that distance AP $=\sqrt{\dfrac{3}{2}} \Rightarrow AP^2=\dfrac{3}{2}$

$$\Rightarrow\left(\beta+\frac{1}{2}\right)^2+1+\left(\beta+\frac{1}{2}\right)^2=\frac{3}{2}\ \text{or}\ 2\left(\beta+\frac{1}{2}\right)^2=\frac{1}{2}$$

$$\Rightarrow\left(\beta+\frac{1}{2}\right)^2=\frac{1}{4}\Rightarrow\beta=0,-1,(\beta\neq0)$$

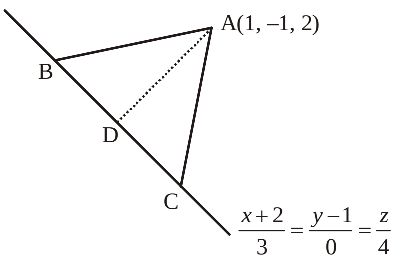
$\therefore\ \beta=-1$

84. **(d)** Let a point D on BC = $(3\lambda-2, 1, 4\lambda)$

$\overrightarrow{AD}=(3\lambda-3)\hat{i}+2\hat{j}+(4\lambda-2)\hat{k}$

$\because\ \overrightarrow{AD}\perp\overrightarrow{BC}$, $\therefore\ \overrightarrow{AD}.\overrightarrow{BC}=0$

$$\Rightarrow\ (3\lambda-3)3+2(0)+(4\lambda-2)4=0\Rightarrow\lambda=\frac{17}{25}$$



Hence, $D=\left(\frac{1}{25},1,\frac{68}{25}\right)$

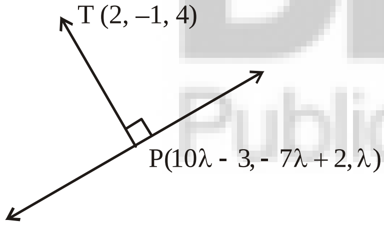
$$|\overrightarrow{AD}|=\sqrt{\left(\frac{1}{25}-1\right)^2+(2)^2+\left(\frac{68}{25}-2\right)^2}$$

$$=\sqrt{\frac{(24)^2+4(25)^2+(18)^2}{25}}=\sqrt{\frac{3400}{25}}=\frac{2\sqrt{34}}{5}$$

Area of triangle $=\frac{1}{2}\times|\overrightarrow{BC}|\times|\overrightarrow{AD}|$

$$=\frac{1}{2}\times 5\times\frac{2\sqrt{34}}{5}=\sqrt{34} \qquad [\because BC=5]$$

85. **(a)** Let P be the foot of perpendicular from point T (2, – 1, 4) on the given line. So P can be assumed as P $(10\lambda-3,-7\lambda+2,\lambda)$



DR's of TP proportional to $10\lambda-5,-7\lambda+3,\lambda-4$

$\because$ TP and given line are perpendicular, so

$$10(10\lambda-5)-7(-7\lambda+3)+1(\lambda-4)=0 \Rightarrow \lambda=\frac{1}{2}$$

$$\Rightarrow TP=\sqrt{(10\lambda-5)^2+(-7\lambda+3)^2+(\lambda-4)^2}$$

$$=\sqrt{0+\frac{1}{4}+\frac{49}{4}}=\sqrt{12.5}=3.54$$

Hence, the length of perpendicular is greater than 3 but less than 4.

86. **(d)** First line is: $x=ay+b, z=cy+d$

$$\frac{x-b}{a}=\frac{y}{1}=\frac{z-d}{c}$$

and another line is: $x=a'z+b', y=c'z+d'$

$$\Rightarrow \frac{x-b'}{a'}=\frac{y-d'}{c'}=\frac{z}{1}$$

$\because$ Both lines are perpendicular to each other

$\therefore$ $aa'+c'+c=0$

87. **(d)** Let θ be the angle between the two lines

Here direction cosines of $\frac{x}{2}=\frac{y}{2}=\frac{z}{1}$ are 2, 2, 1

Also second line can be written as:

$$\frac{x-5}{2}=\frac{y-2}{\frac{P}{7}}=\frac{z-3}{4}$$

$\therefore$ its direction cosines are $2,\frac{P}{7},4$

$$\because \quad \cos\theta=\left|\frac{a_1a_2+b_1b_2+c_1c_2}{\sqrt{a_1^2+b_1^2+c_1^2}\sqrt{a_2^2+b_2^2+c_2^2}}\right|$$

$$\Rightarrow \frac{2}{3}=\left|\frac{(2\times 2)+\left(2\times\frac{P}{7}\right)+(1\times 4)}{\sqrt{2^2+2^2+1^2}\sqrt{2^2+\frac{P^2}{49}+4^2}}\right|$$

$$=\frac{4+\frac{2P}{7}+4}{3\times\sqrt{2^2+\frac{P^2}{49}+4^2}}$$

$$\Rightarrow \left(4+\frac{P}{7}\right)^2=20+\frac{P^2}{49} \Rightarrow 16+\frac{8P}{7}+\frac{P^2}{49}=20+\frac{P^2}{49}$$

$$\Rightarrow \frac{8P}{7}=4 \Rightarrow P=\frac{7}{2}$$

88. **(b)** Let equation of the required line be

$$\frac{x-x_1}{a}=\frac{y-y_1}{b}=\frac{z-z_1}{c} \qquad \text{...(i)}$$

Given two lines

$$\frac{x}{1}=\frac{y}{-1}=\frac{z}{1} \qquad \text{...(ii)}$$

and $\frac{x-1}{0}=\frac{y+1}{-2}=\frac{z}{1}$ ...(iii)

Since the line (i) is perpendicular to both the lines (ii) and (iii), therefore

$a-b+c=0$ ...(iv)

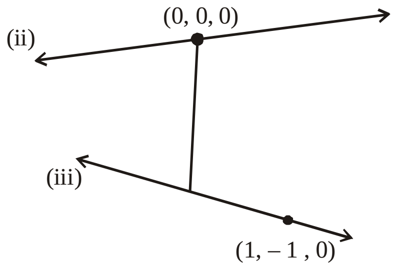
$-2b+c=0$ ...(v)

From (iv) and (v) c = $2b$ and $a+b=0$, which are not satisfy by options (c) and (d). Hence options (c) and (d) are rejected.

Thus point (x_1, y_1, z_1) on the required line will be either (0, 0, 0) or (1, –1, 0).

Now foot of the perpendicular from point (0, 0, 0) to the line (iii)

$= (1, -2r - 1, r)$



The direction ratios of the line joining the points (0, 0, 0) and $(1, -2r - 1, r)$ are $1, -2r - 1, r$

Since, $a + b = 0$.

$\therefore\ 1 - 2r - 1 = 0 \Rightarrow r = 0$

Hence direction ratio are 1, – 1, 0

But $c = 2b$ i.e. $0 = 2(-1)$, which is not true.

Hence the shortest line does not pass through the point (0, 0, 0). Therefore option (a) is also rejected.

89. **(d)** For L_1,

$$x = \sqrt{\lambda}y + (\sqrt{\lambda} - 1) \Rightarrow y = \frac{x - (\sqrt{\lambda} - 1)}{\sqrt{\lambda}} \quad \text{...(i)}$$

$$z = (\sqrt{\lambda} - 1)y + \sqrt{\lambda} \Rightarrow y = \frac{z - \sqrt{\lambda}}{\sqrt{\lambda} - 1} \quad \text{...(ii)}$$

From (i) and (ii)

$$\frac{x - (\sqrt{\lambda} - 1)}{\sqrt{\lambda}} = \frac{y - 0}{1} = \frac{z - \sqrt{\lambda}}{\sqrt{\lambda} - 1} \quad \text{...(iii)}$$

The equation (A) is the equation of line L_1.

Similarly equation of line L_2 is

$$\frac{x - (1 - \sqrt{\mu})}{\sqrt{\mu}} = \frac{y - 0}{1} = \frac{z - \sqrt{\mu}}{1 - \sqrt{\mu}}$$

Since $L_1 \perp L_2$, therefore

$$\sqrt{\lambda}\sqrt{\mu} + 1 \times 1 + (\sqrt{\lambda} - 1)(1 - \sqrt{\mu}) = 0$$

$$\Rightarrow \sqrt{\lambda} + \sqrt{\mu} = 0 \Rightarrow \sqrt{\lambda} = -\sqrt{\mu}$$

$$\Rightarrow \lambda = \mu$$