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DISHA Publication Inc.
A23, FIEE Complex, Okhla Industrial Area, Phase 2,
New Delhi – 110020
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This sample book is prepared from the book "TARGET NTA JEE Main 2024 - 11 Previous Year Solved Papers with 10 Mock Tests 25th Edition "

ISBN - 9789355647030

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Content

SOLVED PAPERS

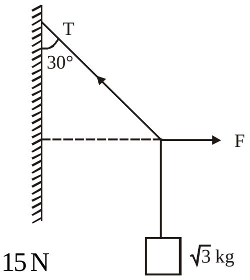
MOCK PAPERS

SOLUTIONS

PART-A: PHYSICS

SECTION-I

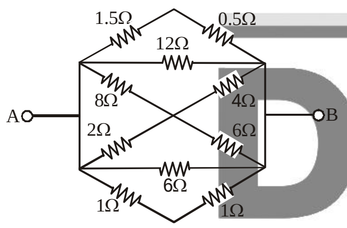
1. A block of $\sqrt{3}$kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is : (Given g = 10 ms^{-2})



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

2. A flask contains hydrogen and oxygen in the ratio of 2 : 1 by mass at temperature 27°C. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is :
(a) 2 : 1 (b) 1 : 1 (c) 1 : 4 (d) 4 : 1

3. The equivalent resistance between A and B is ......

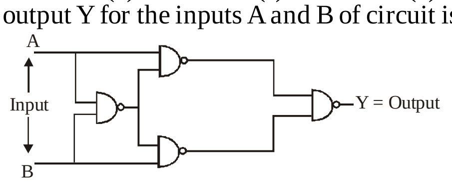


(a) $\frac{2}{3}\Omega$ (b) $\frac{1}{2}\Omega$ (c) $\frac{3}{2}\Omega$ (d) $\frac{1}{3}\Omega$

4. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : The nuclear density of nuclides $^{10}_{5}B$, $^{6}_{3}Li$, $^{56}_{26}Fe$, $^{20}_{10}Ne$ and $^{209}_{83}Bi$ can be arranged as $\rho^N_{Bi} > \rho^N_{Fe} > \rho^N_{Ne} > \rho^N_{B} > \rho^N_{Li}$.
Reason R : The radius R of nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.
In the light of the above statement, choose the correct answer from the options given below :
(a) Both A and R are true and R is the correct explanation of A
(b) A is false but R is true
(c) A is true but R is false
(d) Both A and R are true but R is NOT the correct explanation of A

5. A thin prism P_1 with an angle 6° and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is :
(a) 6° (b) 1.3° (c) 7.8° (d) 4.5°

6. The output Y for the inputs A and B of circuit is given by



Truth table of the shown circuit is :

(a)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(b)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(c)

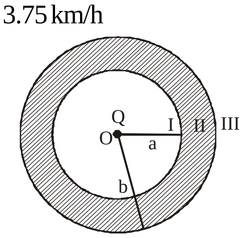
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(d)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

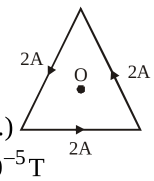
7. A vehicle travels 4 km with speed of 3 km/h and another 4 km with speed of 5 km/h, then its average speed is :
(a) 4.25 km/h (b) 3.50 km/h
(c) 4.00 km/h (d) 3.75 km/h

8. As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II and III is given by :
(I : r < a, II : a < r < b, III : r > b)



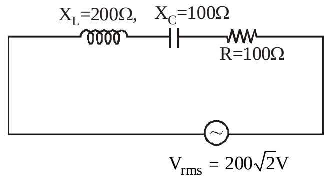
(a) $E_I = 0, E_{II} = 0, E_{III} \neq 0$ (b) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$
(c) $E_I \neq 0, E_{II} = 0, E_{III} = 0$ (d) $E_I = 0, E_{II} = 0, E_{III} = 0$

9. As shown in the figure, a current of 2A flowing in an equilateral triangle of side $4\sqrt{3}$cm. The magnetic field at the centroid O of the triangle is:
(Neglect the effect of earth's magnetic field.)



(a) $4\sqrt{3} \times 10^{-4}$T (b) $4\sqrt{3} \times 10^{-5}$T
(c) $\sqrt{3} \times 10^{-4}$T (d) $3\sqrt{3} \times 10^{-5}$T

10. In the given circuit, rms value of current (Irms) through the resistor R is :



(a) 2A (b) $\frac{1}{2}$A (c) 20 A (d) $2\sqrt{2}$A

11. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m s^{-1} each. The recoil velocity of the gun is :
(a) 0.02 m/s (b) 2.5 m/s (c) 1.5 m/s (d) 0.6 m/s

12. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : Efficiency of a reversible heat engine will be highest at –273°C temperature of cold reservoir.
Reason R : The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1 - \frac{T_2}{T_1}\right)$.

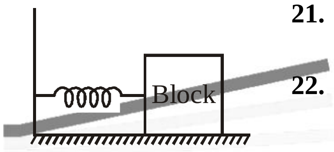
In the light of the above statements, choose the correct answer from the options given below :
(a) A is true but R is false
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is false but R is true
(d) Both A and R are true and R is the correct explanation of A

13. Match List I with List II.

	List I		List II
A.	Torque	I	$kg\,m^{-1}\,s^{-2}$
B.	Energy density	II	$kg\,ms^{-1}$
C.	Pressure gradient	III	$kg\,m^{-2}\,s^{-2}$
D.	Impulse	IV	$kg\,m^{2}\,s^{-2}$

Choose the correct answer from the options given below:
(a) A-IV, B-III, C-I, D-II (b) A-I, B-IV, C-III, D-II
(c) A-IV, B-I, C-II, D-III (d) A-IV, B-I, C-III, D-II

14. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio ω_2/ω_1 is :



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

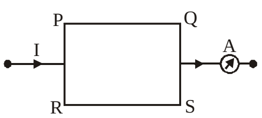
15. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to:
(a) 3 (b) $\frac{9}{4}$ (c) $\frac{3}{2}$ (d) 4

16. Match List I with List II :

	List I		List II
A.	Attenuation	I	Combination of a receiver and transmitter.
B.	Transducer	II	Process of retrieval of information from thecarrier wave at received
C.	Demodulation	III	Converts one form of energy into another
D.	Repeater	IV	Loss of strength of a signal while propagating through a medium

Choose the correct answer from the options given below:
(a) A-I, B-II, C-III, D-IV (b) A-II, B-III, C-IV, D-I
(c) A-IV, B-III, C-I, D-II (d) A-IV, B-III, C-II, D-I

17. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $f_{PQ}^{I} : f_{PQ}^{21}$ is:



(a) 1 : 2 (b) 1 : 4 (c) 1 : 5 (d) 1 : 3

18. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire 'B' will be (wires having uniform circular cross sections)
(a) 6.06×10^{-2} mm (b) 2.77×10^{-2} mm
(c) 3.0×10^{-2} mm (d) 6.9×10^{-2} mm

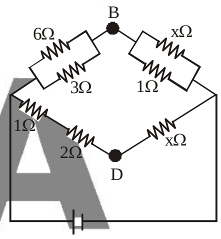
19. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be:
(a) $2\sqrt{gR}$ (b) $\sqrt{gR}$ (c) $\sqrt{\frac{gR}{2}}$ (d) $\sqrt{2gR}$

20. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is :
(a) $\frac{1}{2\pi}\frac{W}{m^2}$ (b) $\frac{1}{40\pi}\frac{W}{m^2}$ (c) $\frac{1}{10\pi}\frac{W}{m^2}$ (d) $\frac{1}{20\pi}\frac{W}{m^2}$

SECTION-II

21. A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temperature on absolute scale will be.......... K when the faulty thermometer reads 41°C.

22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is ....



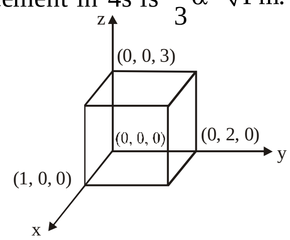
23. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{x}{7}$ s. The value of x is .... $\left(\text{Take } \pi = \frac{22}{7}\right)$

24. In a Young's double slit experiment, the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits, then $\frac{I_1 + I_2}{I_0} = ...$

25. A radioactive nucleus decays by two different process. The half life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$s. The value of α is _____.

26. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4s is $\frac{1}{3}\alpha^2\sqrt{P}$m. The value of α will be ....

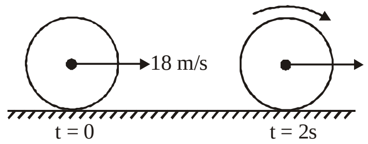
27. As shown in figure, a cuboid lies in a region with electric field $E = 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$. The magnitude of charge within the cuboid is $n\epsilon_0$ C N/C. The value of n is ——— (if dimension of cuboid is $1 \times 2 \times 3\,m^3$)



28. In an ac generator, a rectangular coil of 100 turns each having area $14 \times 10^{-2}\,m^2$ is rotated at 360 rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be ________ V. $\left(\text{Take } \pi = \frac{22}{7}\right)$

29. A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x} ms^{-2}$. The value of x _______. $\left(\text{Take } \pi = \frac{22}{7}\right)$

30. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m/s at t = 0 s on a rough horizontal surface. It starts off with a purely sliding motion at t = 0 s. After 2s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2s will be ________ J (given, coefficient of friction is 0.3 and g = 10 m/s^2).



PART-B: CHEMISTRY

SECTION-I

31. Which of the following reaction is correct ?

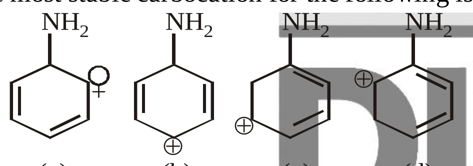
(a) $2LiNO_3 \xrightarrow{\Delta} 2LiNO_2 + O_2$

(b) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 2N_2O_4 + O_2$

(c) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

(d) $2LiNO_3 \xrightarrow{\Delta} 2Li + 2NO_2 + O_2$

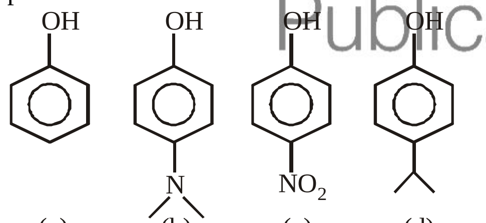
32. The most stable carbocation for the following is:



(a) (b) (c) (d)

(a) c (b) d (c) b (d) a

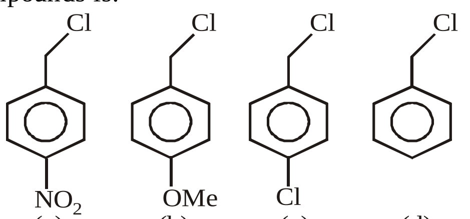
33. The correct order of pK_a values for the following compounds is:



(a) (b) (c) (d)

(a) c > a > d > b (b) b > d > a > c
(c) b > a > d > c (d) a > b > c > d

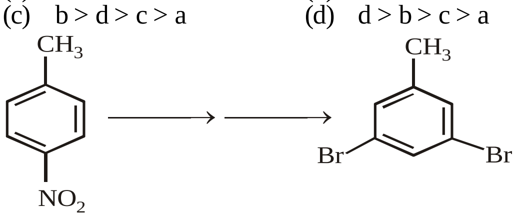
34. Decreasing order towards S_N1 reaction for the following compounds is:



(a) (b) (c) (d)

(a) a > c > d > b (b) a > b > c > d
(c) b > d > c > a (d) d > b > c > a

35.



(X) (Y)

In the above conversion of compound (X) to product (Y), the sequence of reagents to be used will be:
(a) (i) Br_2, Fe (ii) Fe, H^+ (iii) $LiAlH_4$
(b) (i) Br_2(aq) (ii) $LiAlH_4$ (iii) H_3O^+
(c) (i) Fe, H^+ (ii) Br_2(aq) (iii) HNO_2 (iv) CuBr
(d) (i) Fe, H^+ (ii) Br_2(aq) (iii) HNO_2 (iv) H_3PO_2.

36. Maximum number of electrons that can be accommodated in shell with n = 4 are:
(a) 16 (b) 32 (c) 50 (d) 72

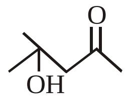
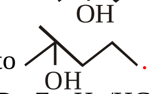
37. Match List I with List II:

	List I (Complexes)		List II (Hybridisation)
(A)	$[Ni(CO)_4]$	I	sp^3
(B)	$[Cu(NH_3)_4]^{2+}$	II	dsp^2
(C)	$[Fe(NH_3)_6]^{2+}$	III	sp^3d^2
(D)	$[Fe(H_2O)_6]^{2+}$	IV	d^2sp^3

(a) A – II, B – I, C – III, D – IV (b) A – I, B – II, C – III, D – IV
(c) A – II, B – I, C – IV, D – III (d) A – I, B – II, C – IV, D – III

38. The Cl – Co – Cl bond angle values in a fac-$[Co(NH_3)_3Cl_3]$ complex is/are:
(a) 90° & 180° (b) 90°
(c) 180° (d) 90° & 120°

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

Assertion A :  can be easily reduced using Zn-Hg/HCl to .

Reason R : Zn-Hg/HCl is used to reduce carbonyl group to $-CH_2-$ group.

In the light of the above statements, choose the correct answer from the options given below:
(a) A is false but R is true
(b) A is true but R is false
(c) Both A and R are true but R is not the correct explanation of A
(d) Both A and R are true and R is the correct explanation of A

40. Chlorides of which metal are soluble in organic solvents:
(a) Ca (b) Mg (c) K (d) Be

41. Given below are two statements : One is labelled as **Assertion A** and the other labelled as **Reason R**.
Assertion A: Antihistamines do not affect the secretion of acid in stomach.
Reason R : Antiallergic and antacid drugs work on different receptors.
In the light of the above statements, choose the correct answer from the options given below:
(a) A is false but R is true
(b) Both A and R are true and R is the correct explanation of A

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

42. The wave function (Ψ) of 2s is given by

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{1/2}\left(2-\frac{r}{a_0}\right)e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0

(a) $r_0 = a_0$ (b) $r_0 = 4a_0$ (c) $r_0 = \frac{a_0}{2}$ (d) $r_0 = 2a_0$.

43. $KMnO_4$ oxidises I^- in acidic and neutral/faintly alkaline solution, respectively to

(a) I_2 & IO_3^- (b) IO_3^- & I_2
(c) IO_3^- & IO_3^- (d) I_2 & I_2

44. Bond dissociation energy of E–H bond of the "H_2E" hydrides of group 16 elements (given below), follows order.

(A) O (B) S (C) Se (D) Te
(a) A > B > C > D (b) A > B > D > C
(c) B > A > C > D (d) D > C > B > A

45. The water quality of a pond was analysed and its BOD was found to be 4. The pond has

(a) Highly polluted water
(b) Water has high amount of fluoride compounds
(c) Very clean water
(d) Slightly polluted water

46. Match List I with List II:

	List I (Mixture)		List II (Separation Technique)
(A)	$CHCl_3 + C_6H_5NH_2$	I	Steam distillation
(B)	$C_6H_{14} + C_5H_{12}$	II	Differential extraction
(C)	$C_6H_5NH_2 + H_2O$	III	Distillation
(D)	Organic compound in H_2O	IV	Fractional distillation

(a) A-IV, B-I, C-III, D-II (b) A-III, B-IV, C-I, D-II
(c) A-II, B-I, C-III, D-IV (d) A-III, B-I, C-IV, D-II

47. Boric acid in solid, whereas BF_3 is gas at room temperature because of

(a) Strong ionic bond in Boric acid
(b) Strong van der Waal's interaction in Boric acid
(c) Strong hydrogen bond in Boric acid
(d) Strong covalent bond in BF_3

48. Given below are two statements:

Statement I: During Electrolytic refining, the pure metal is made to act as anode and its impure metallic form is used as cathode.

Statement II: During the Hall-Heroult electrolysis process, purified Al_2O_3 is mixed with Na_3AlF_6 to lower the melting point of the mixture.

In the light of the above statements, choose the most appropriate answer from the options given below:

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

49. Formulae for Nessler's reagent is:

(a) KHg_2I_2 (b) $KHgI_3$ (c) K_2HgI_4 (d) HgI_2

50. 1 L, 0.02 M solution of $[Co(NH_3)_5SO_4]Br$ is mixed with 1L, 0.02 M solution of $[Co(NH_3)_5Br]SO_4$. The resulting solution is divided into two equal parts (X) and treated with excess $AgNO_3$ solution and $BaCl_2$ solution respectively as shown below:

1 L Solution (X) + $AgNO_3$ solution (excess) $\rightarrow$ Y

1 L Solution (X) + $BaCl_2$ solution (excess) $\rightarrow$ Z

The number of moles of Y and Z respectively are

(a) 0.02, 0.02 (b) 0.01, 0.01
(c) 0.02, 0.01 (d) 0.01, 0.02

SECTION-II

51. 1 mole of ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27°C. The work done is 3 kJ mol^{-1}. The final temperature of the gas is _______K (Nearest integer). Given $C_v = 20$ J $mol^{-1}K^{-1}$.

52. Iron oxide FeO, crystallises in a cubic lattice with a unit cell edge length of 5.0Å. If density of the FeO in the crystal is 4.0 g cm^{-3}, then the number of FeO units present per unit cell is _____ (Nearest integer)

Given : Molar mass of Fe and O is 56 and 16g mol^{-1} respectively.

$N_A = 6.0 \times 10^{23}$ mol^{-1}.

53. An organic compound undergoes first order decomposition. If the time taken for the 60% decomposition is 540 s, then the time required for 90% decomposition will be is _______ s. (Nearest integer).

Given : ln 10 = 2.3; log 2 = 0.3

54. Lead storage battery contains 38% by weight solution of H_2SO_4. The van't Hoff factor is 2.67 at this concentration. The temperature in Kelvin at which the solution in the battery will freeze is ____ (Nearest integer).

Given $K_f = 1.8$ K kg mol^{-1}.

55. Consider the following equation :

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, $\Delta H = -190$ kJ

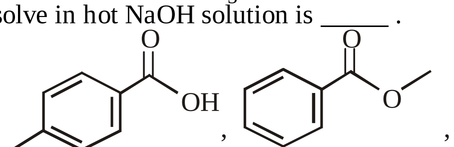
The number of factors which will increase the yield of SO_3 at equilibrium from the following is _______

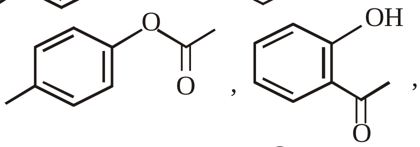
A. Increasing temperature
B. Increasing pressure
C. Adding more SO_2
D. Adding more O_2
E. Addition of catalyst

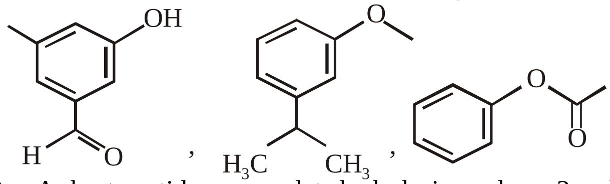
56. The graph of $\log\frac{x}{m}$ vs log p for an adsorption process is a straight line inclined at an angle of 45° with intercept equal to 0.6020. The mass of gas adsorbed per unit mass of adsorbent at the pressure of 0.4 atm is ______$\times 10^{-1}$ (Nearest integer)

Given : log 2 = 0.3010

57. Number of compounds from the following which will not dissolve in cold $NaHCO_3$ and NaOH solutions but will dissolve in hot NaOH solution is _____ .







58. A short peptide on complete hydrolysis produces 3 moles of glycine (G), two moles of leucine (L) and two moles of valine (V) per mole of peptide. The number of peptide linkages in it are _______

59. The strength of 50 volume solution of hydrogen peroxide is ______ g/L (Nearest integer).

Given:
Molar mass of H_2O_2 is 34 g mol^{-1}
Molar volume of gas at STP = 22.7 L.

60. The electrode potential of the following half cell at 298 K
$X | X^{2+} (0.001\ M) || Y^{2+} (0.01\ M) | Y$ is _____$\times 10^{-2}$ V
(Nearest integer).
Given : $E^0_{X^{2+}|X} = -2.36V$; $E^0_{Y^{2+}|Y} = +0.36V$
$\frac{2.303RT}{F} = 0.06V$

PART-C: MATHEMATICS

SECTION-I

61. Consider the following statements:
P : I have fever Q : I will not take medicine
R : I will take rest
The statement. "If I have fever, then I will take medicine and I will take rest" is equivalent to:
(a) $((\sim P) \vee \sim Q) \wedge ((\sim P) \vee R)$
(b) $((\sim P) \vee \sim Q) \wedge ((\sim P) \vee \sim R)$
(c) $(P \vee Q) \wedge ((\sim P) \vee R)$ (d) $(P \vee \sim Q) \wedge (P \vee \sim R)$

62. Let A be a point on the x-axis. Common tangents are drawn from A to the curves $x^2 + y^2 = 8$ and $y^2 = 16x$. If one of these tangents touches the two curves at Q and R, then $(QR)^2$ is equal to
(a) 64 (b) 76 (c) 81 (d) 72

63. Let q be the maximum integral value of p in [0, 10] for which the roots of the equation $x^2 - px + \frac{5}{4}p = 0$ are rational. Then the area of the region $\{(x, y) : 0 \le y \le (x - q)^2, 0 \le x \le q\}$ is
(a) 243 (b) 25 (c) $\frac{125}{3}$ (d) 164

64. If the functions $f(x) = \frac{x^3}{3} + 2bx + \frac{ax^2}{2}$ and $g(x) = \frac{x^3}{3} + ax + bx^2, a \ne 2b$ have a common extreme point, then a + 2b + 7 is equal to
(a) 4 (b) $\frac{3}{2}$ (c) 3 (d) 6

65. The range of the function $f(x) = \sqrt{3-x} + \sqrt{2+x}$ is
(a) $[\sqrt{5}, \sqrt{10}]$ (b) $[2\sqrt{2}, \sqrt{11}]$
(c) $[\sqrt{5}, \sqrt{13}]$ (d) $[\sqrt{2}, \sqrt{7}]$

66. The solution of the differential equation
$\frac{dy}{dx} = -\left(\frac{x^2 + 3y^2}{3x^2 + y^2}\right), y(1) = 0$ is
(a) $\log_e|x+y| - \frac{xy}{(x+y)^2} = 0$ (b) $\log_e|x+y| + \frac{xy}{(x+y)^2} = 0$
(c) $\log_e|x+y| + \frac{2xy}{(x+y)^2} = 0$ (d) $\log_e|x+y| - \frac{2xy}{(x+y)^2} = 0$

67. Let $x = (8\sqrt{3}+13)^{13}$ and $y = (7\sqrt{2}+9)^9$. If [t] denotes the greatest integer $\le$ t, then
(a) [x] + [y] is even (b) [x] is odd but [y] is even
(c) [x] is even but [y] is odd
(d) [x] and [y] are both odd

68. A vector $\vec{v}$ in the first octant is inclined to the x-axis at 60°, to the y-axis at 45° and to the z-axis at an acute angle. If a plane passing through the points $(\sqrt{2}, -1, 1)$ and (a, b, c), is normal to $\vec{v}$, then
(a) $\sqrt{2}a + b + c = 1$ (b) $a + b + \sqrt{2}c = 1$
(c) $a + \sqrt{2}b + c = 1$ (d) $\sqrt{2}b - b + c = 1$

69. Let f, g and h be the real valued functions defined on $\mathbb{R}$ as $f(x) = \begin{cases} \frac{x}{|x|}, & x \ne 0 \\ 1, & x = 0 \end{cases}$,
$g(x) = \begin{cases} \frac{\sin(x+1)}{(x+1)}, & x \ne -1 \\ 1, & x = -1 \end{cases}$ and h(x) = 2[x] – f(x), where [x] is the greatest integer $\le$ x. Then the value of $\lim_{x \to 1} g(h(x-1))$ is
(a) 1 (b) sin(1) (c) –1 (d) 0

70. The number of ways of selecting two numbers a and b, $a \in \{2,4,6,.....,100\}$ and $b \in \{1,3,5,.....,99\}$ such that 2 is the remainder when a + b is divided by 23 is
(a) 186 (b) 54 (c) 108 (d) 268

71. If P is a 3 × 3 real matrix such that $P^T = aP + (a-1)I$, where a > 1, then
(a) P is a singular matrix (b) |Adj P| > 1
(c) |Adj P| = $\frac{1}{2}$ (d) |Adj P| = 1

72. Let $\lambda \in \mathbb{R}, \vec{a} = \lambda\hat{i} + 2\hat{j} - 3\hat{k}, \vec{b} = \hat{i} - \lambda\hat{j} + 2\hat{k}$.
If $((\vec{a}+\vec{b}) \times (\vec{a} \times \vec{b})) \times (\vec{a} - \vec{b}) = 8\hat{i} - 40\hat{j} - 24\hat{k}$, then $|\lambda(\vec{a}+\vec{b}) \times (\vec{a}-\vec{b})|^2$ is equal to
(a) 140 (b) 132 (c) 144 (d) 136

73. Let $\vec{a}$ and $\vec{b}$ be two vectors. Let $|\vec{a}| = 1, |\vec{b}| = 4$ and $\vec{a} \cdot \vec{b} = 2$. If $\vec{c} = (2\vec{a} \times \vec{b}) - 3\vec{b}$, then the value of $\vec{b} \cdot \vec{c}$ is
(a) –24 (b) –48 (c) –84 (d) –60

74. Let $a_1 = 1, a_2, a_3, a_4$,.....be consecutive natural numbers.
Then $\tan^{-1}\left(\frac{1}{1+a_1a_2}\right) + \tan^{-1}\left(\frac{1}{1+a_2a_3}\right) + ... + \tan^{-1}\left(\frac{1}{1+a_{2021}a_{2022}}\right)$ is equal to
(a) $\frac{\pi}{4} - \cot^{-1}(2022)$ (b) $\cot^{-1}(2022) - \frac{\pi}{4}$
(c) $\tan^{-1}(2022) - \frac{\pi}{4}$ (d) $\frac{\pi}{4} - \tan^{-1}(2022)$

75. The parabolas : $ax^2 + 2bx + cy = 0$ and $dx^2 + 2ex + fy = 0$ intersect on the line y = 1. If a, b, c, d, e, f are positive real numbers and a, b, c are in G.P., then
(a) d, e, f are in A.P. (b) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in G.P.
(c) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in A.P. (d) d, e, f are in G.P.

76. If a plane passes through the points (–1, k, 0), (2, k, –1), (1, 1, 2) and is parallel to the line $\frac{x-1}{1} = \frac{2y+1}{2} = \frac{z+1}{-1}$, then the value of $\frac{k^2+1}{(k-1)(k-2)}$ is

(a) $\frac{17}{5}$ (b) $\frac{5}{17}$ (c) $\frac{6}{13}$ (d) $\frac{13}{6}$

77. Let a, b, c > 1, a^3, b^3 and c^3 be in A.P., and $\log_a b$, $\log_c a$ and $\log_b c$ be in G.P. If the sum of first 20 terms of an A.P., whose first term is $\frac{a+4b+c}{3}$ and the common difference is $\frac{a-8b+c}{10}$ is –444, then abc is equal to

(a) 343 (b) 216 (c) $\frac{343}{8}$ (d) $\frac{125}{8}$

78. Let S be the set of all values of a_1 for which the mean deviation about the mean of 100 consecutive positive integers $a_1, a_2, a_3, ..., a_{100}$ is 25. Then S is

(a) ϕ (b) {99} (c) $\mathbb{N}$ (d) {9}

79. $\lim\limits_{n\to\infty} \frac{3}{n}\left\{4+\left(2+\frac{1}{n}\right)^2+\left(2+\frac{2}{n}\right)^2+..+\left(3-\frac{1}{n}\right)^2\right\}$ is equal to

(a) 12 (b) $\frac{19}{3}$ (c) 0 (d) 19

80. For $\alpha, \beta \in \mathbb{R}$, suppose the system of linear equations
$x - y + z = 5$; $2x + 2y + \alpha z = 8$; $3x - y + 4z = \beta$
has infinitely many solutions. Then α and β are the roots of

(a) $x^2 - 10x + 16 = 0$ (b) $x^2 + 18x + 56 = 0$
(c) $x^2 - 18x + 56 = 0$ (d) $x^2 + 14x + 24 = 0$

SECTION-II

81. 50^{th} root of a number x is 12 and 50^{th} root of another number y is 18. Then the remainder obtained on dividing (x + y) by 25 is ______.

82. Let A = {1, 2, 3, 5, 8, 9}. Then the number of possible functions $f : A \to A$ such that $f(m \cdot n) = f(m) \cdot f(n)$ for every

83. Let $P(a_1, b_1)$ and $Q(a_2, b_2)$ be two distinct points on a circle with center $C\left(\sqrt{2}, \sqrt{3}\right)$. Let O be the origin and OC be perpendicular to both CP and CQ. If the area of the triangle OCP is $\frac{\sqrt{35}}{2}$. then $a_1^2 + a_2^2 + b_1^2 + b_2^2$ is equal to ______.

84. The 8^{th} common term of the series
$S_1 = 3 + 7 + 11 + 15 + 19 + ...$, $S_2 = 1 + 6 + 11 + 16 + 21 + ...$
is ______.

85. 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 ______.

86. If

$$\int \sqrt{\sec 2x - 1}\,dx = \alpha \log_e \left|\cos 2x + \beta + \sqrt{\cos 2x\left(1+\cos\frac{1}{\beta}x\right)}\right|$$

+ constant, then $\beta - \alpha$ is equal to ______.

87. If the value of real number a > 0 for which $x^2 - 5ax + 1 = 0$ and $x^2 - ax - 5 = 0$ have a common real roots is $\frac{3}{\sqrt{2\beta}}$ then β is equal to ______.

88. The number of seven digits odd numbers, that can be formed using all the seven digits 1, 2, 2, 2, 3, 3, 5 is ______.

89. A bag contains six balls of different colours. Two balls are drawn in succession with replacement. The probability that both the balls are of the same colour is p. Next four balls are drawn in succession with replacement and the probability that exactly three balls are of the same colours is q. If p : q = m : n, where m and n are coprime, then m + n is equal to ______.

90. Let A be the area of the region
$\{(x, y): y \geq x^2, y \geq (1-x)^2, y \leq 2x(1-x)\}$.
Then 540 A is equal to

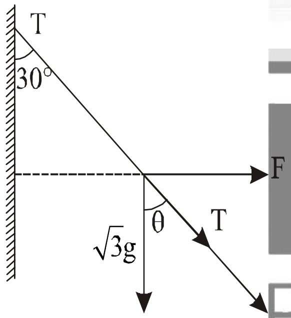
January 30 (Shift-II)

ANSWER KEYS																	
PHYSICS																	
1	(a)	**4**	(b)	**7**	(d)	**10**	(a)	**13**	(d)	**16**	(d)	**19**	(b)	**22**	(2)	**25**	(300)
2	(b)	**5**	(d)	**8**	(b)	**11**	(d)	**14**	(b)	**17**	(b)	**20**	(b)	**23**	(88)	**26**	(4)
3	(a)	**6**	(d)	**9**	(d)	**12**	(d)	**15**	(b)	**18**	(d)	**21**	(313)	**24**	(3)	**27**	(12)

PHYSICS																			
1	(a)	**4**	(b)	**7**	(d)	**10**	(a)	**13**	(d)	**16**	(d)	**19**	(b)	**22**	(2)	**25**	(300)	**28**	(1584)
2	(b)	**5**	(d)	**8**	(b)	**11**	(d)	**14**	(b)	**17**	(b)	**20**	(b)	**23**	(88)	**26**	(4)	**29**	(125)
3	(a)	**6**	(d)	**9**	(d)	**12**	(d)	**15**	(b)	**18**	(d)	**21**	(313)	**24**	(3)	**27**	(12)	**30**	(54)
CHEMISTRY																			
31	(c)	**34**	(c)	**37**	(d)	**40**	(d)	**43**	(a)	**46**	(b)	**49**	(c)	**52**	(4)	**55**	(3)	**58**	(6)
32	(a)	**35**	(d)	**38**	(b)	**41**	(b)	**44**	(a)	**47**	(c)	**50**	(b)	**53**	(1350)	**56**	(16)	**59**	(150)
33	(b)	**36**	(b)	**39**	(a)	**42**	(d)	**45**	(c)	**48**	(a)	**51**	(150)	**54**	(243)	**57**	(3)	**60**	(275)
MATHEMATICS																			
61	(a)	**64**	(d)	**67**	(a)	**70**	(c)	**73**	(b)	**76**	(d)	**79**	(d)	**82**	(432)	**85**	(158)	**88**	(240)
62	(d)	**65**	(a)	**68**	(c)	**71**	(d)	**74**	(a, c)	**77**	(b)	**80**	(c)	**83**	(24)	**86**	(1)	**89**	(14)
63	(a)	**66**	(c)	**69**	(a)	**72**	(a)	**75**	(c)	**78**	(c)	**81**	(23)	**84**	(151)	**87**	(13)	**90**	(25)

PHYSICS

1. (a)



From the free body diagram shown above,

$\cos\theta = \dfrac{\sqrt{3}g}{T} \quad \because \theta = 30° \quad \therefore \dfrac{\sqrt{3}}{2} = \dfrac{\sqrt{3}g}{T}$

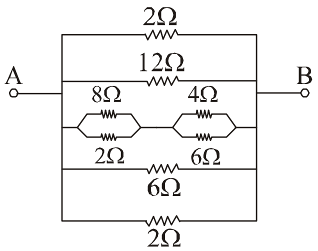
$\Rightarrow T = 20\ N$

2. (b) Average kinetic energy for diatomic gases

$K_{av} = \dfrac{5}{2}kT$

$\therefore \dfrac{(K_{av})_H}{(K_{av})_O} = \dfrac{(27+273)}{(27+273)} = 1$

3. (a) The given circuit can be redrawn as



The net resistance between A and B

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

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

4. (b) Nuclear density is independent of A. Hence Assertion is False.
The radius R of nucleus is related to its mass number by $R = R_0 A^{1/3}$ (Here, R_0 = constant)

5. (d) Angle of deviation for first prism

$\delta_1 = A_1(\mu_1 - 1)$

Angle of deviation for second prism

$\delta_2 = A_2(\mu_2 - 1)$

$= A_2(1.72 - 1)$

For dispersion without deviation

$\delta_1 = \delta_2$

$\Rightarrow 6°(1.54 - 1) = A_2(1.72 - 1)$

$\Rightarrow A_2 = \dfrac{6° \times 0.54}{0.72} = \dfrac{18°}{4} = 4.5°$

6. (d) $Y = \overline{A \cdot (\overline{A \cdot B}) \cdot B \cdot (\overline{A \cdot B})}$

$= A \cdot (\overline{AB}) + B \cdot (\overline{AB}) = A \cdot (\bar{A} + \bar{B}) + B \cdot (\bar{A} + \bar{B})$

$= A\bar{B} + B\bar{A}$ = XOR gate

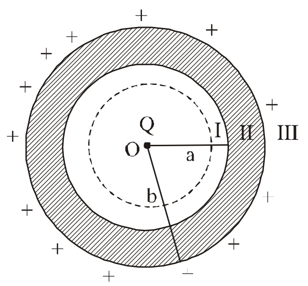
7. (d) Given, First distance travelled,
$S_1 = 4\ km$
Second distance travelled, $S_2 = 4\ km$

$V_{av} = \dfrac{\text{Distance}}{\text{time}} = \dfrac{S_1 + S_2}{\dfrac{S_1}{V_1} + \dfrac{S_1}{V_2}}$

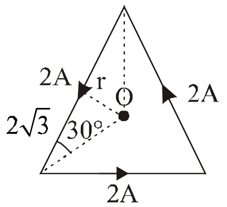
Here, V_1 and V_2 are the velocities during first and second distance travelled

$\Rightarrow V_{av} = \dfrac{4+4}{\dfrac{4}{3} + \dfrac{4}{5}} \Rightarrow V_{av} = \dfrac{15}{4} = 3.75\ km/h$

8. (b) In region I Electric field will be due to charge Q
$E_{II} = 0$. Since electric field inside conductor is zero.
$E_{III} \neq 0$, Electric field will be due to charge Q only or just due to free charge



9. **(d)**



From Figure

$$\Rightarrow \frac{r}{2\sqrt{3}} = \tan 30^\circ \Rightarrow r = 2\text{ cm}$$

Magnetic field at the centroid of triangle,

$$B = 3\times\frac{\mu_0 i}{4\pi r}(\sin 60^\circ + \sin 60^\circ) \Rightarrow B = 3\times\frac{\mu_0 i}{2\pi r}\sin 60^\circ$$

$$= 3\times\frac{2\times10^{-7}\times 2}{2\times10^{-2}}\times\frac{\sqrt{3}}{2} = 3\sqrt{3}\times10^{-5}$$

10. **(a)** Given,

Capacitive reactance, $X_C = 100\,\Omega$

Inductive reactance, $X_L = 200\,\Omega$

Resistance, $R = 100\,\Omega$

Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{100^2 + (200-100)^2} = 100\sqrt{2}\,\Omega$

RMS value of current,

$$i_{rms} = \frac{V_{rms}}{Z} = \frac{200\sqrt{2}}{100\sqrt{2}} = 2A$$

11. **(d)** Given, mass of machine gun, M = 10 kg

mass of bullet, $m = 20\text{ g} = 20\times10^{-3}$ kg

velocity of bullet, V= 100 ms^{-1}, let V be the recoil velocity of gun, using conservation of momentum

nmv = MV

$$\Rightarrow 20\times10^{-3}\times\frac{180}{60}\times100 = 10V$$

$\because$ n = 180 bullets per minute

$\Rightarrow$ v = 0.6 m/s

12. **(d)** Efficiency of Heat engine,

$$\eta = 1 - \frac{T_{sink}}{T_{source}}$$

When T_{sink} = 0 K, Efficiency, η = 1 Maximum

Both A and R are true and R is the correct explanation of A

13. **(d)** Torque = kg $ms^{-2}\times m$

Energy density = $\frac{\text{Energy}}{\text{Volume}}$ = kg $m^{-1}\,s^{-2}$

Pressure gradient = kg $m^{-2}s^{-2}$

Impulse = $kgms^{-1}$

14. **(b)** Angular frequency in spring mass system is given by

$$\omega = \sqrt{\frac{k}{m}}$$

When m = 1 kg

$$\omega_1 = \sqrt{\frac{k}{m}} = \sqrt{\frac{k}{1}}$$

When m = 2 kg, $\omega_2 = \sqrt{\frac{k}{2}}$

$$\frac{\omega_2}{\omega_1} = \sqrt{\frac{k/2}{k}} = \sqrt{\frac{1}{2}}$$

15. **(b)** When electron is accelerated through a potential difference V_1

Kinetic energy, $KE = \frac{P^2}{2m}, \left(\because \text{Momentum, } P = \frac{h}{\lambda}\right)$

$$KE = eV_1 = \frac{\left(\frac{h}{\lambda}\right)^2}{2m}$$

When potential is changed to V_2, then

$$KE = eV_2 = \frac{\left(\frac{h}{1.5\lambda}\right)^2}{2m} \quad \therefore \frac{V_1}{V_2} = (1.5)^2 = \frac{9}{4}$$

16. **(d)** Attenuation - Loss of strength of a signal while propagating through a medium.

Transducer - Converts one form of energy into another.

Demodulation - Process of retrieval of information from the carrier wave at received.

Repeator - Combination of a receiver and transmitter.

17. **(b)** Magnetic force per unit length on wire PQ due to wire RS is given by

$$\frac{F}{\ell} = \frac{\mu_o}{4\pi}\frac{2I_1I_2}{r}$$

$\therefore \quad F_1 \propto I_1 I_2 \propto (I)^2$

When ammeter current reading is changed to 2I.

$F_2 \propto (2I)^2$

$\therefore \quad F_1 : F_2 = 1 : 4$

18. **(d)** Young's modulus,

$$Y = \frac{F/A}{\frac{\Delta\ell}{\ell}}$$

$$\Rightarrow F = \frac{YA}{\ell}\Delta\ell$$

As F and Y is same for two wire.

$$\therefore \frac{F}{Y} = \frac{A_1\Delta\ell_1}{\ell_1} = \frac{A_2\Delta\ell_2}{\ell_2}$$

$$\therefore \frac{\Delta\ell_2}{\Delta\ell_1} = \frac{A_1}{A_2}\times\frac{\ell_2}{\ell_1}$$

Here, $\Delta\ell_1 = 0.2$ mm, $\ell_2 = 2\ell_1$, $A_2 = (2.4)^2 A_1$

$$\Rightarrow \frac{\Delta\ell_2}{0.2} = \frac{1}{2.4\times2.4}\times\frac{2}{1}$$

$\Rightarrow \Delta\ell_2 = 6.9\times10^{-2}$ mm

19. **(b)** From the energy conservation
Loss in gravitational PE = Gain in KE

$$\left(-\frac{GMm}{2R}\right)-\left(-\frac{GMm}{R}\right)=\frac{1}{2}mv^2$$

$$\Rightarrow v^2=\frac{GM}{R}=gR \Rightarrow v=\sqrt{gR}$$

20. **(b)** Energy emitted per unit time = $\frac{5}{100}\times 100 = 5$ W

At a distance 5 m from the source,

Intensity = $\frac{\text{Power}}{4\pi(5)^2}=\frac{5}{4\pi(5)^2}$

The intensity is due to both electric and magnetic field,

Intensity due to electric field = $\frac{1}{2}\times\frac{5}{4\pi\times 5^2}=\frac{1}{40\pi}$ W/m^2

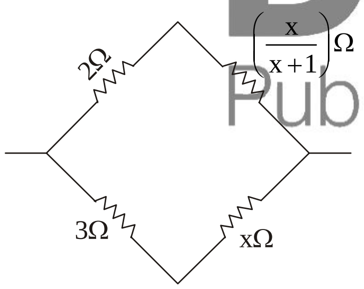
21. **(313)** We know that

$$\frac{\text{Reading – Lower fixed point}}{\text{Upper fixed point – Lower fixed point}}=\text{Constant}$$

$$\frac{41°-5°}{95°-5°}=\frac{C-0°}{100°-0°}$$

$$\Rightarrow C=\frac{36}{90}\times 100=40°C=313\text{ K}$$

22. **(2)** The given circuit can be redrawn as



As potential difference between B and D is zero, the given circuit is wheatstone bridge,

$$\therefore \frac{2}{3}=\frac{\frac{x}{x+1}}{x} \Rightarrow \frac{2}{3}=\frac{1}{x+1} \Rightarrow x=0.5=\frac{1}{2}$$

n = 2

23. **(88)** Given, $4v^2=50-x^2$

$$\Rightarrow v^2=\frac{1}{4}(50-x^2) \Rightarrow v=\frac{1}{2}\sqrt{50-x^2}$$

Comparing with velocity in SHM

$v=\omega\sqrt{A^2-x^2}$

Angular, frequency

$\omega=\frac{1}{2}$

Time period, $T=\frac{2\pi}{\omega}=4\pi=\frac{88}{7}$

x = 88

24. **(3)** Resultant intensity in Young's double slit experiment

$I=4I_0\cos^2\left(\frac{\Delta\phi}{2}\right)$

For path difference $\frac{\lambda}{4}$ phase difference,

$$\Delta\phi=\frac{2\pi}{\lambda}\times\frac{\lambda}{4}=\frac{\pi}{4} \qquad \therefore\ I_1=4I_0\cos^2\left(\frac{\pi}{4}\right)=2I_0$$

For path difference $\frac{\lambda}{3}$

$$I_2=4I_0\cos^2\left(\frac{2\pi}{\lambda}\times\frac{\lambda}{3}\right)=I_0 \Rightarrow \frac{I_1+I_2}{I_0}=3$$

25. **(300)** Half life of first process, $t_1=5$ minutes $=5\times 60=300$ s
Half life of second process t_2 = 30 s
Using the law of radioactive decay for first process

$\frac{dN_1}{dt}=-\lambda_1 N$

For second process $\frac{dN_2}{dt}=-\lambda_2 N$

$\frac{dN}{dt}=-(\lambda_1+\lambda_2)N \Rightarrow \lambda_{eq}=\lambda_1+\lambda_2$

$$\therefore \frac{0.693}{t_{1/2}}=\frac{0.693}{t_1}+\frac{0.693}{t_2}$$

$$\Rightarrow \frac{1}{t_{1/2}}=\frac{1}{300}+\frac{1}{30}=\frac{11}{300}$$

$$\Rightarrow t_{1/2}=\frac{300}{11}$$

26. **(4)** Power, $P=\frac{\text{Total work done}}{\text{time}}=\frac{\frac{1}{2}mv^2}{t}$

$$\Rightarrow \frac{1}{2}mV^2=Pt$$

$$\Rightarrow V=\sqrt{\frac{2Pt}{m}} \Rightarrow \frac{dx}{dt}=\sqrt{\frac{2Pt}{m}} \Rightarrow x=\sqrt{\frac{2P}{m}}\frac{2}{3}[t^{3/2}]_0^4$$

$$\Rightarrow x=\frac{16\sqrt{P}}{3}=\frac{1}{3}\times 16\sqrt{P}\ (\because \text{ mass m = 2 kg time t = 4s})$$

$\Rightarrow \alpha=4$

27. **(12)** Given, electric field

$\vec{E}=2x^2\hat{i}-4y\hat{j}+6\hat{k}$

Electric flux for face, x = 1, $\phi=2\times(1)^2\times 2\times 3=12$
Electric flux for face, y = 2, $\phi=-4\times 2\times 3\times 1=-24$
Electric flux for face, z = 3, $\phi=6\times 1\times 2=12$
Electric flux for faces x = 0, y = 0, is zero.
Electric flux for z = 0, $\phi=-12$
$\phi_{net}=-24+12=-12$
From the Gauss's theorem

$-12=\frac{q}{\epsilon_0}$

$|q|=12\ \epsilon_0$

28. **(1584)**
Given, area of rectangular coil, $A=14\times 10^{-2}$ m^2
Magnetic field, B = 3T

Number of turns, n = 100

$\xi_{max} = NAB\omega$

$= 100 \times 14 \times 10^{-2} \times 3 \times \frac{360 \times 2\pi}{60} = 1584\,V$

29. **(125)** Given, radius of horizontal circle, R = 180 cm = 1.8 m

Angular frequency, $\omega = \frac{28 \times 2\pi}{60}$ rad s^{-1}

Acceleration, $a = \omega^2 R = \left(\frac{28 \times 2\pi}{60}\right)^2 \times 1.8$

$= \left(\frac{56}{60} \times \frac{22}{7}\right)^2 \times 1.8 = \frac{(44)^2}{225} \times 1.8$

$= \frac{1936 \times 1.8}{225} \Rightarrow x = 125$

30. **(54)** Acceleration in rough horizontal surface, $a = -\mu_k g = -3$

Using v = u + at

$v = 18 - 3 \times 2$

$\Rightarrow v = 12$ m/s

$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

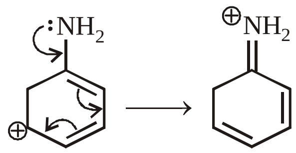
Here, I = moment of inertia of disc $= \frac{1}{2}mr^2$

$KE = \frac{1}{2}mv^2 + \frac{1}{2}\frac{mr^2}{2}\frac{v^2}{r^2} = \frac{3}{4}mv^2$

$\Rightarrow KE = 3 \times 18 = 54$ J

CHEMISTRY

31. **(c)** $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

32. **(a)** 

The +M effect of NH_2 is stabilizing the carbocation.

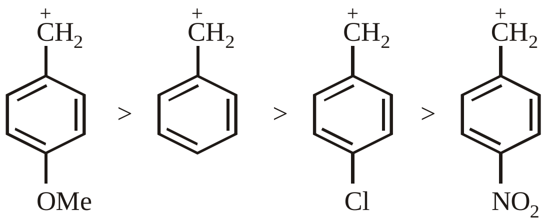
33. **(b)** Due to $-M$ effect of $-NO_2$ group, it increases acidity +M effect of $N(CH_3)_2$ decreases acidity.

Hyperconjugation of isopropyl decrease acidity

$\therefore$ order of acidic strength.

(C) > (A) > (D) > (B)

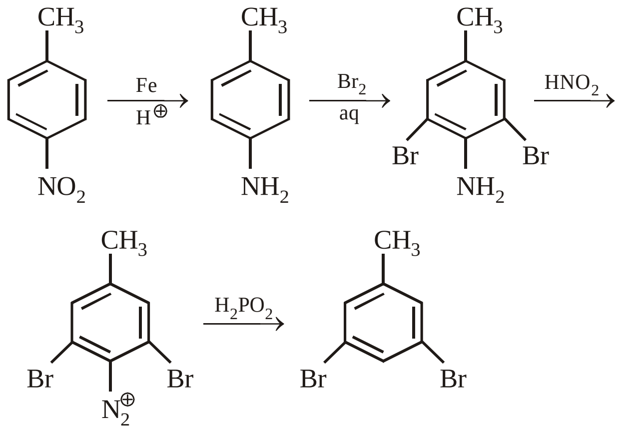
34. **(c)** The rate of S_N1 reaction depends upon stability of carbocation which follows the order.



$\therefore$ Reactivity order

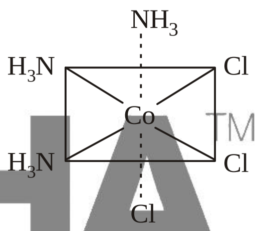
(B) > (D) > (C) > (A)

35. **(d)**

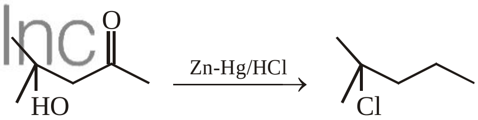


36. **(b)** The number of electrons in the orbitals of sub-shell of *n* = 4 are 4s (2), 4p (6), 4d (10), 4f (14), total 32 electrons.

37. **(d)** For $[Fe(NH_3)_6]^{+2}$, $\Delta_0 < P$, hence the pairing of electrons does not occur in t_{2g}. Therefore complex is outer orbital and its hybridisation is $sp^3 d^2$.

38. **(b)** 

The Cl – Co – Cl bond angle in above octahedral complex is 90°.

39. **(a)** 

The acid sensitive alcohol group reacts with HCl, hence Clemmenson reduction is not suitable for above conversion.

40. **(d)** $BeCl_2$ having covalent nature is soluble in organic solvent.

41. **(b)** Antiallergic and antacid drugs work on different receptors.

42. **(d)** At node $\Psi_{2s} = 0$

$\therefore\ 2 - \frac{r_0}{a_0} = 0 \Rightarrow r_0 = 2a_0$

43. **(a)** In acidic medium

$2MnO_4^- + 101^- + 16H^+ \rightarrow 2MnO^{2+} + 5I_2 + 8H_2O$

In neutral/faintly alkaline solution

$2MnO_4^- + I^- + H_2O \rightarrow 2MnO_2 + 2OH^- + IO_2^-$

44. **(a)** Bond dissociation energy of E–H bond in hydrides of group 16 follows the order:

$H_2O > H_2S > H_2Se > H_2Te$

45. **(c)** Clean water as BOD value of < 5 while polluted water has BOD of 15 or more.

46. **(b)** A-(III), B-(IV), C-I, D-II.

47. **(c)** Boric acid has strong hydrogen bonding while BF_3 does not. Therefore boric acid is solid.

48. **(a)** In Electrolytic refining, the pure metal is used as cathode and impure metal is used as anode.

49. **(c)** Nessler's reagent is K_2HgI_4.

50. **(b)** $\underset{0.01\ \text{mol}}{[Co(NH_3)_5SO_4]Br} + \underset{\text{excess}}{AgNO_3} \rightarrow \underset{0.01\ \text{Mol}}{AgBr\downarrow}$

$\underset{0.01\ \text{mol}}{[Co(NH_3)_5Br]SO_4} + \underset{\text{excess}}{BaCl_2} \rightarrow \underset{0.01\ \text{Mol}}{BaSO_4\downarrow}$

Note: Concentration term is 0.02 M in 2L of solution after mining. Hence number of moles should be 0.01 for each complex.

51. **(150)** $q = 0, \Delta U = w$

$1 \times 20 \times [T_2 - 300] = -3000$

$T_2 - 300 = -150 \Rightarrow T_2 = 150\text{ K}.$

52. **(4)** $d = \dfrac{Z \times M}{N_A \times a^3}$

$$4 = \frac{Z \times 72}{6 \times 10^{23} \times 125 \times 10^{-24}} \Rightarrow Z = 4.166 \simeq 4$$

53. **(1350)** $\dfrac{t_1}{t_2} = \dfrac{\frac{1}{K}\ln\frac{a_0}{0.4\,a_0}}{\frac{1}{K}\ln\frac{a_0}{0.1\,a_0}}$

$$\frac{540}{t_2} = \frac{\ln\frac{10}{4}}{\ln 10} \Rightarrow \frac{540}{t_2} = \frac{\log 10 - \log 4}{\log 10}$$

$$\frac{540}{t_2} = \frac{1-0.6}{1} \Rightarrow \frac{540}{t_2} = 0.4$$

$$\Rightarrow t_2 = \frac{540}{0.4} = 1350\text{ sec}$$

54. **(243)** $\Delta T_f = i.K_f.m$

$$\Rightarrow \Delta T_f = 2.67 \times 1.8 \times \frac{38}{98} \times \frac{1000}{62}$$

$\Rightarrow \Delta T_f = 30.05\text{ K}$

$\therefore$ Freezing temperature $= 273 - 30 = 243$ K.

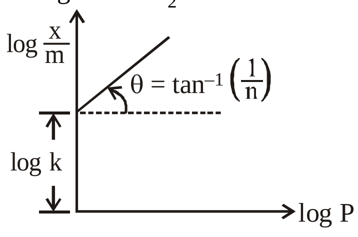
55. **(3)** The yield of SO_3 at equilibrium will be due to :

(B) Increasing pressure

(C) Adding more SO_2

(D) Adding more SO_2

56. **(16)**



$$\log\frac{x}{m} = \log k + \frac{1}{n}\log P$$

$\dfrac{1}{n} = \tan 45° = 1$

$\log k = 0.6020 = \log 4 \Rightarrow k = 4$

$$\therefore \frac{x}{m} = k.P^{1/n} \Rightarrow \frac{x}{m} = 4\,(0.4) = 1.6$$

$$\frac{x}{m} = 1.6 = 16 \times 10^{-1}$$

57. **(3)** Compound 2nd, 3rd, 7th.

58. **(6)** Number of peptide linkage = (amino acid – 1) = 7 – 1 = 6

59. **(150)** Molarity $= \dfrac{50}{11.35}$

$\therefore$ Strength in g/L $= \dfrac{50}{11.35} \times 34$

60. **(275)** $X + Y^{2+} \rightarrow Y + X^{2+}$

$E^0_{Cell} = 0.36 - (-2.36) = 2.72$ V

$$E_{Cell} = 2.72 - \frac{0.06}{2}\log\frac{0.001}{0.01}$$

$= 2.72 + 0.03 = 2.75$ V

$= 275 \times 10^{-2}$ V

MATHEMATICS

61. **(a)** From given statement

$P \rightarrow (\sim Q \wedge R)$

$\sim P \vee (\sim Q \wedge R)$

$(\sim P \vee \sim Q) \wedge (\sim P \vee R)$

62. **(d)** Common tangent on parabola

$y = mx + \dfrac{4}{m}$

$$\frac{\left|\frac{4}{m}\right|}{\sqrt{1+m^2}} = 2\sqrt{2} \therefore m = \pm 1$$

$y = \pm x \pm 4.$ Point of contact on parabola

Let $m = 1$, $\left(\dfrac{a}{m^2}, \dfrac{2a}{m}\right)$

$R(4, 8)$

Point of contact on circle $Q(-2, 2)$

$\therefore (QR)^2 = 36 + 36 = 72$

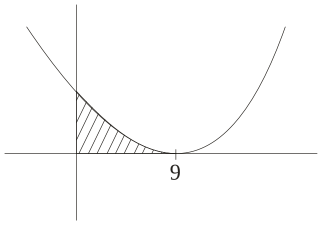
63. **(a)** Given $x^2 - px + \dfrac{5p}{4} = 0$

$D = p^2 - 5p = p(p - 5)$

At p = 9, D become a perfect square

$\therefore q = 9$

$0 \le y \le (x - 9)^2$



$$\text{Area} = \int_0^9 (x-9)^2\,dx = \left[\frac{(x-9)^3}{3}\right]_0^9 = 243$$

64. **(d)** $f'(x) = x^2 + 2b + ax = 0$ ...(i)

$g'(x) = x^2 + a + 2bx = 0$ ...(ii)

(i) – (ii)
$(2b-a)-x(2b-a)=0$
$\therefore x=1$ is the common root
Put $x=1$ in $f'(x)=0$ or $g'(x)=0$
$1+2b+a=0$
$7+2b+a=6$

65. **(a)** Given $y=\sqrt{3-x}+\sqrt{2+x}$

By squaring on both sides

$$y^2=3-x+2+x+2\sqrt{(3-x(2+x))}$$
$$=5+2\sqrt{6+x-x^2}$$
$$y^2=5+2\sqrt{\frac{25}{4}-\left(x-\frac{1}{2}\right)^2}$$

y maximum if $\left(x-\frac{1}{2}\right)^2=0$

$$y_{max}=\sqrt{5+5}=\sqrt{10}$$

y get minimum if $\left(x-\frac{1}{2}\right)^2=\frac{25}{4}$

$$y_{min}=\sqrt{5}$$

66. **(c)** Put $y=mx$

$$m+x\frac{dm}{dx}=-\left(\frac{1+3m^2}{3+m^2}\right)$$
$$x\frac{dm}{dx}=-\frac{(m+1)^3}{3+m^2}$$
$$\frac{(3+m^2)dm}{(m+1)^3}+\frac{dx}{x}=0$$
$$\int\frac{4dm}{(m+1)^3}+\int\frac{dm}{m+1}-\int\frac{2dm}{(m+1)^2}+\int\frac{dx}{x}=0$$
$$\frac{-2}{(m+1)^2}+\ln(m+1)+\frac{2}{m+1}+\ln x=c$$
$$\frac{-2x^2}{(x+y)^2}+\ln\left(\frac{x+y}{x}\right)+\frac{2x}{x+y}+\ln x=c$$
$$\frac{2xy}{(x+y)^2}+\ln(x+y)=c$$

$\therefore c=0$, as $x=1, y=0$

$$\therefore \frac{2xy}{(x+y)^2}+\ln(x+y)=0$$

67. **(a)** $x=(8\sqrt{3}+13)^{13}={}^{13}C_0(8\sqrt{3})^{13}+{}^{13}C_1(8\sqrt{3})^{12}(13)^1+\ldots$ ...(i)

$x'=(8\sqrt{3}-13)^{13}={}^{13}C_0(8\sqrt{3})^{13}-{}^{13}C_1(8\sqrt{3})^{12}(13)^1+$ ...(ii)

By (i) – (ii)

$$x-x'=2\left[{}^{13}C_1(8\sqrt{3})^{12}(13)^1+{}^{13}C_3(8\sqrt{3})^{10}\cdot(13)^3\ldots\right]$$

therefore, $x-x'$ is even integer, hence $[x]$ is even

Now, $y=(7\sqrt{2}+9)^9={}^9C_0(7\sqrt{2})^9+{}^9C_1(7\sqrt{2})^8(9)^1$
$+{}^9C_2(7\sqrt{2})^7(9)^2$ ...(iv)

By (iii) – (iv)

$$y-y'=2\left[{}^9C_1(7\sqrt{2})^8(9)^1+{}^9C_3(7\sqrt{2})^6(9)^3+\ldots\ldots\ldots\right]$$

$y-y'$ = Even ineger hence $[y]$ is even

68. **(c)** Unit vector $\hat{v}$ define as,

$$\hat{v}=\cos 60^o\hat{i}+\cos 45^o\hat{j}+\cos\gamma\hat{k}$$
$$\Rightarrow \frac{1}{4}+\frac{1}{2}+\cos^2\gamma=1(\gamma\to\text{Acute})$$
$$\cos^2\gamma=1-\frac{3}{4}\Rightarrow \cos^2\gamma=\frac{1}{4}$$
$$\cos\gamma=\frac{1}{2}\Rightarrow\gamma=60^o$$

Equation of plane is

$$\frac{1}{2}(x-\sqrt{2})+\frac{1}{\sqrt{2}}(y+1)+\frac{1}{2}(z-1)=0$$
$$\Rightarrow x+\sqrt{2}y+z=1$$

(a, b, c) lies on it.

$$\Rightarrow a+\sqrt{2}b+c=1$$

69. **(a)** Let $k=1-x$

At $x\to 1; k\to 0$

$$\text{LHL}=\lim_{k\to 0}g(h(-k)) \quad k>0$$
$$=\lim_{k\to 0}g(-2+1)=g(-1)=1 \quad [\because f(x)=-1, \forall x<0]$$
$$\text{RHL}=\lim_{k\to 0}g(h(k))=\lim_{k\to 0}g(-1)=1 \quad k>0$$
$$[\because f(x)=1, \forall x>0]$$

70. **(c)** Given $a\in\{2,4,6,8,10,\ldots\ldots\ldots\ldots,100\}$

$$b\in\{1,3,5,7,9,\ldots\ldots\ldots\ldots,99\}$$

Now, $a+b\in\{25,71,117,163\}$

(i) a + b = 25, no. of ordered pairs (a, b) is 12
(ii) a + b = 71, no. of ordered pairs (a, b) is 35
(iii) a + b = 117, no. of ordered pairs (a, b) is 42
(iv) a + b = 163, no. of ordered pairs (a, b) is 19
$\therefore$ total = 12 + 35 + 42 + 19 = 108 pairs

71. **(d)** Given $P^T=aP+(a-1)I$

$$(P^T)^T=(aP+(a-1)I)^T$$
$$\Rightarrow P=aP^T+(a-1)I$$
$$\Rightarrow P^T-P=a(P-P^T)$$
$$\Rightarrow P=P^T,\ \text{as } a\neq -1$$

Now, $P=aP+(a-1)I$

$$\Rightarrow P=-I\Rightarrow|P|=1$$
$$\Rightarrow|\text{adj }P|=|P|^{n-1}=(1)^{n-1}=1$$

72. **(a)** Given $\vec{a}=\lambda\hat{i}+2\hat{j}-3\hat{k},\ \vec{b}=\hat{i}-\lambda\hat{j}+2\hat{k}$

$$-\left(\left(\vec{a}-\vec{b}\right)\times\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}\times\vec{b}\right)\right)=8\hat{i}-40\hat{j}-24\hat{k}$$

$$\Rightarrow\left(\vec{b}-\vec{a}\right)\times\left(\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}\times\vec{b}\right)\right)=8\hat{i}-40\hat{j}-24\hat{k}$$

$$\Rightarrow\left(\left(\vec{a}-\vec{b}\right)\cdot\left(\vec{a}+\vec{b}\right)\right)\left(\vec{a}\times\vec{b}\right)=8\hat{i}-40\hat{j}-24\hat{k}$$

$$\Rightarrow 8\left(\vec{a}\times\vec{b}\right)=8\hat{i}-40\hat{j}-24\hat{k}$$

Now, $\vec{a}\times\vec{b}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ \lambda & 2 & -3\\ 1 & -\lambda & 2\end{vmatrix}$

$$=\left(4-3\lambda\right)\hat{i}-\left(2\lambda+3\right)\hat{j}+\left(-\lambda^2-2\right)\hat{k}\Rightarrow\lambda=1$$

$\therefore\ \vec{a}=\hat{i}+2\hat{j}-3\hat{k}\ ,\ \vec{b}=\hat{i}-\hat{j}+2\hat{k}$

$\Rightarrow\vec{a}+\vec{b}=2\hat{i}+\hat{j}-\hat{k},\ \vec{a}-\vec{b}=3\hat{j}-5\hat{k}$

$$\Rightarrow\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}-\vec{b}\right)=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 1 & -1\\ 0 & 3 & -5\end{vmatrix}=2\hat{i}+10\hat{j}+6\hat{k}$$

$\therefore$ required answer $=4+100+36=140$

73. **(b)** Given, $\vec{c}=\left(2\vec{a}\times\vec{b}\right)-3\vec{b}$

Multiply $\vec{b}$ both sides,

$\vec{b}\cdot\vec{c}=\vec{b}\cdot(2\vec{a}\times\vec{b})-3|\vec{b}|^2$

Since, $\vec{b}\cdot(2\vec{a}\times\vec{b})=0$

then, $\vec{b}\cdot\vec{c}=-3|\vec{b}|^2$

$\vec{b}\cdot\vec{c}=-3\times16=-48$

74. **(a, c)** By given condition

$a_2-a_1=a_3-a_2=\ldots=a_{2022}-a_{2021}=1$

$$\therefore\tan^{-1}\left(\frac{a_2-a_1}{1+a_1a_2}\right)+\tan^{-1}\left(\frac{a_3-a_2}{1+a_2a_3}\right)+\ldots..+\tan^{-1}\left(\frac{a_{2022}-a_{2021}}{1+a_{2021}a_{2022}}\right)$$

$$\left[\tan^{-1}a_2-\tan^{-1}a_1\right]+\left[\tan^{-1}a_3-\tan^{-1}a_2\right]+\ldots\ldots..+\left[\tan^{-1}a_{2022}-\tan^{-1}a_{2021}\right]$$

$=\tan^{-1}a_{2022}-\tan^{-1}a_1$

Since, $a_{2022}=2022\Rightarrow a_1=1$

$=\tan^{-1}(2022)-\tan^{-1}1=\tan^{-1}2022-\dfrac{\pi}{4}$ (option c)

$=\left(\dfrac{\pi}{2}-\cot^{-1}(2022)\right)-\dfrac{\pi}{4}$

$=\dfrac{\pi}{4}-\cot^{-1}(2022)$ (option a)

75. **(c)** Given $ax^2+2bx+c=0$

Since a, b, c in G.P

So, $b^2=ac$

$\Rightarrow ax^2+2\sqrt{ac}\,x+c=0$

$\Rightarrow\left(x\sqrt{a}+\sqrt{c}\right)^2=0$

$x^2-\dfrac{\sqrt{c}}{\sqrt{a}}$ ...(i)

Now, $dx^2+2ex+f=0$

$\Rightarrow d\left(\dfrac{c}{a}\right)+2e\left[-\dfrac{\sqrt{c}}{\sqrt{a}}\right]+f=0$

$\Rightarrow\dfrac{dc}{a}+f=2e\sqrt{\dfrac{c}{a}}$

$\Rightarrow\dfrac{d}{a}+\dfrac{f}{c}=2e\sqrt{\dfrac{1}{ac}}$

$\Rightarrow\dfrac{d}{a}+\dfrac{f}{c}=\dfrac{2e}{b}\left[\text{as } b=\sqrt{ae}\right]$

$\therefore\dfrac{d}{a},\dfrac{e}{b},\dfrac{f}{c}$ are in A.P.

76. **(d)** Given line equation can be define as,

$$\frac{x-1}{1}=\frac{y+\frac{1}{2}}{1}=\frac{z+1}{-1}$$

Points: A(–1, k, 0), B(2, k, –1), C(1, 1, 2)

$\overrightarrow{CA}=-2\hat{i}+(k-1)\hat{j}-2\hat{k}$

$\overrightarrow{CB}=\hat{i}+(k-1)\hat{j}-3\hat{k}$

Normal vector of plane ABC,

$$\overrightarrow{CA}\times\overrightarrow{CB}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ -2 & k-1 & -2\\ 1 & k-1 & -3\end{vmatrix}$$

$=\hat{i}(-3k+3+2k-2)-\hat{j}(6+2)+\hat{k}(-2k+2-k+1)$

$=(1-k)\hat{i}-8\hat{j}+(3-3k)\hat{k}$

The line $\dfrac{x-1}{1}=\dfrac{y+\frac{1}{2}}{1}=\dfrac{z+1}{-1}$ is perpendicular to normal vector.

$\therefore 1\cdot(1-k)+1(-8)+(-1)(3-3k)=0$

$\Rightarrow 1-k-8-3+3k=0$

$\Rightarrow 2k=10\Rightarrow k=5$

$\therefore\dfrac{k^2+1}{(k-1)(k-2)}=\dfrac{26}{4\cdot3}=\dfrac{13}{6}$

77. **(b)** Given a^3, b^3, c^3 be in A.P. $\rightarrow a^3+c^3=2b^3$ ...(i)

$\log_c a, \log_a b, \log_b c$ are in G.P.

$\therefore\dfrac{\log b}{\log a}\cdot\dfrac{\log c}{\log b}=\left(\dfrac{\log a}{\log c}\right)^2$

$\therefore(\log a)^3=(\log c)^3\Rightarrow a=c$ ...(ii)

From (i) & (ii)

$a=b=c$

$T_1=\dfrac{a+4b+c}{3}=2a;\ d=\dfrac{a-8b+c}{10}=\dfrac{-6a}{10}=\dfrac{-3}{5}a$

$\therefore S_{20} = \frac{20}{2}\left[4a + 19\left(-\frac{3}{5}a\right)\right]$

$= 10\left[\frac{20a - 57a}{5}\right]$

$\therefore -74a = -444 \Rightarrow \boxed{a = 6}$

$\therefore abc = 6^3 = 216$

78. **(c)** Let a_1 be any natural number

$a_1, a_1 + 1, a_1 + 2, \ldots\ldots\ldots, a_1 + 99$ are values of a_1 'S

Now,

$\bar{x} = \frac{a_1(a_1+1)+(a_1+2)+\ldots\ldots+a_1+99}{100}$

$= \frac{100a_1 + (1+2+\ldots\ldots+99)}{100}$

$= a_1 + \frac{99\times100}{2\times100} = a_1 + \frac{99}{2}$

So, mean deviation about mean $= \frac{\sum_{1=1}^{100}|x_i - \bar{x}|}{100}$

$= \frac{2\left(\frac{99}{2}+\frac{97}{2}+\frac{95}{2}+\ldots..+\frac{1}{2}\right)}{100}$

$= \frac{1+3+\ldots\ldots\ldots+99}{100} = \frac{\frac{50}{2}[1+99]}{100} = 25$

So, it is true for every natural number 'a_1'

79. **(d)** Given series can be define as $\lim_{n\to\infty}\frac{3}{n}\sum_{r=0}^{n-1}\left(2+\frac{r}{n}\right)^2$

$\frac{r}{n} \to x, \quad \frac{1}{n} \to dx$

$= 3\int_0^1 (2+x)^2\,dx = 27 - 8 = 19$

80. **(c)** Define coefficient in matrix,

$\begin{vmatrix} 1 & -1 & 1 \\ 2 & 2 & \alpha \\ 3 & -1 & 4 \end{vmatrix} = 0;\ 8 + \alpha - 2(-4+1) + 3(-\alpha - 2) = 0$

$8 + \alpha + 6 - 3\alpha - 6 = 0 \Rightarrow 2\alpha = 8 \Rightarrow \alpha = 4$

81. **(23)** $x + y = 12^{50} + 18^{50} = \left((12)^2\right)^{25} + \left((18)^2\right)^{25}$

$= (150-6)^{25} + (325-1)^{25}$

$= 25K - (6^{25} + 1) = 25K - ((5+1)^{25} + 1)$

$= 25K_1 - 2$

Remainder = 23

82. **(432)** Since, $f(1) = (f(1))^2 \Rightarrow f(1) = 1$

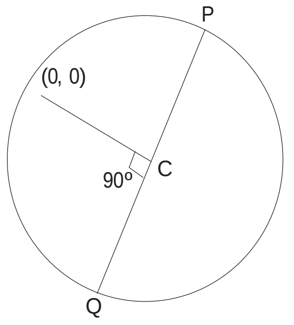
Now, $f(1) = 1$; $f(9) = f(3) \times f(3)$

i.e., $f(3) = 1$ or 3

Total function $= 1 \times 6 \times 2 \times 6 \times 6 \times 1 = 432$

83. **(24)** Since area of ΔOCP

$= \frac{1}{2}\times PC\times\sqrt{5} = \frac{\sqrt{35}}{2};\ PC = \sqrt{7}$



$a_1^2 + b_1^2 + a_2^2 + b_2^2 = OP^2 + OQ^2$

$= 2(5+7) = 24$

84. **(151)** Common series S with terms 11, 31 ...

$T_8 = 11 + (8-1)\times 20 = 11 + 140 = 151$

85. **(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, $(1)(k-3) + (-1)(-k) + (-1)(-k-7) = 0$

$\Rightarrow k = -\frac{4}{3}$

$\therefore \alpha^2 = \left(\frac{13}{3}\right)^2 + \left(\frac{4}{3}\right)^2 + \left(\frac{17}{3}\right)^2 = \frac{474}{9}$

$\therefore 3\alpha^2 = 158$

86. **(1)** $\int\sqrt{\sec 2x - 1}\,dx = \int\sqrt{\frac{1-\cos 2x}{\cos 2x}}dx$

We have $1 - \cos 2x = 2\sin^2 x$,

$\cos 2x = 2\cos^2 x - 1$

$= \sqrt{2}\int\frac{\sin x}{\sqrt{2\cos^2 x - 1}}dx$

Put $\cos x = t \Rightarrow -\sin x\,dx = dt$

$= -\sqrt{2}\int\frac{dt}{\sqrt{2t^2 - 1}} = -\sqrt{2}\int\frac{dt}{\sqrt{(\sqrt{2}t)^2 - 1}}$

$= -\ln\left|\sqrt{2}\cos x + \sqrt{\cos 2x}\right| + c$

$= -\frac{1}{2}\ln\left|2\cos^2 x + \cos 2x + 2\sqrt{\cos 2x}\cdot\sqrt{2}\cos x\right| + c$

$= -\frac{1}{2}\ln\left|\cos 2x + \frac{1}{2} + \sqrt{\cos 2x}\cdot\sqrt{1+\cos 2x}\right| + c$

$\therefore \beta = \frac{1}{2},\ \alpha = -\frac{1}{2} \Rightarrow \beta - \alpha = 1$

87. **(13)** Since condition for common root

$\therefore (4a)(26a) = (-6)^2 = 36$

$\Rightarrow a^2 = \dfrac{9}{26} \qquad \therefore a = \dfrac{3}{\sqrt{26}} \Rightarrow \beta = 13$

88. **(240)** Digits are 1, 2, 2, 2, 3, 3, 5
2, 3 are repeating 3 & 2 times,

If unit digit 5, then total numbers $= \dfrac{6!}{3!2!} = 60$

If unit digit 3, then total numbers $= \dfrac{6!}{3!} = 120$

If unit digit 1, then total numbers $= \dfrac{6!}{3!2!} = 60$

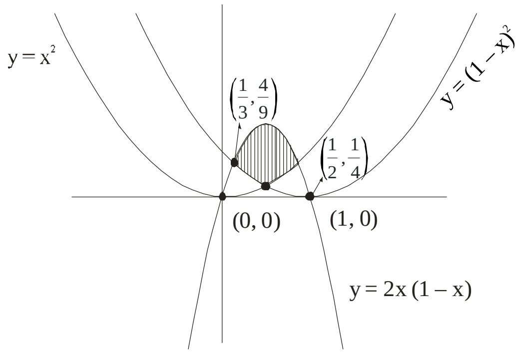
$\therefore$ total numbers $= 60 + 60 + 120 = 240$

89. **(14)** $p = \dfrac{^6C_1}{6\times 6} = \dfrac{6}{6\times 6} = \dfrac{1}{6}$

$q = \dfrac{^6C_1 \times {^5C_1} \times 4}{6\times 6\times 6\times 6} = \dfrac{5}{54}$

$[\therefore p : q = 9 : 5]$
$p + q = m + n = 14$

90. **(25)**



$$A = 2\int_{\frac{1}{3}}^{\frac{1}{2}} \left(2x - 2x^2 - (1-x)^2\right) dx$$

$$A = 2\left[x^2 - \frac{2x^3}{3} - \frac{(x-1)^3}{3}\right]_{\frac{1}{3}}^{\frac{1}{2}}$$

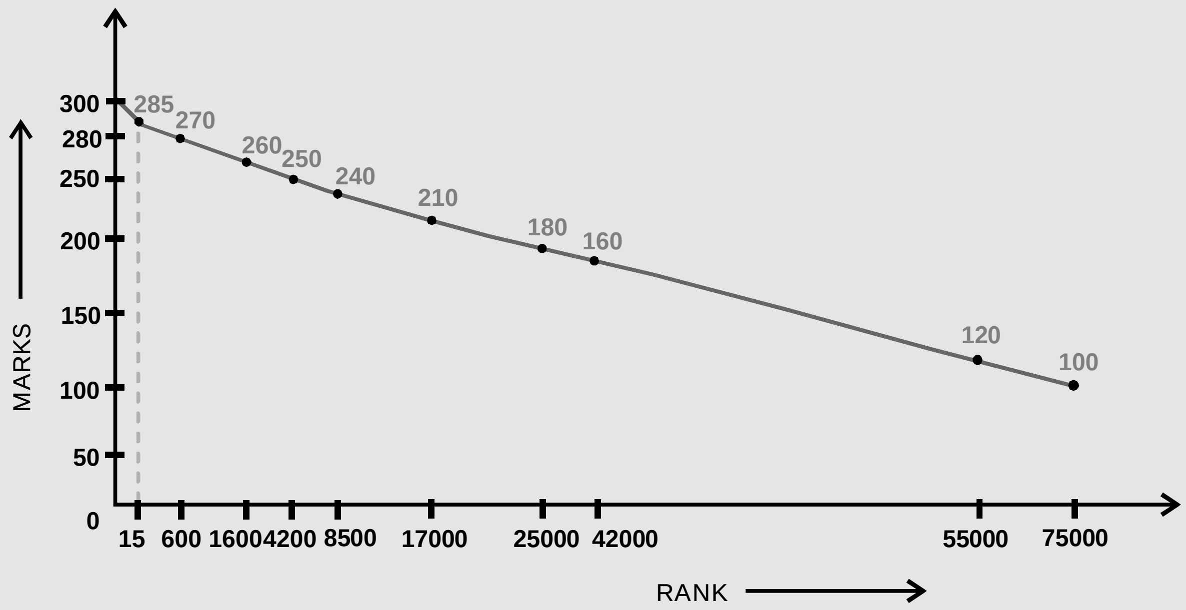
$$A = 2\left[\frac{1}{4} - \frac{2}{3}\times\frac{1}{8} - \frac{1}{24} - \frac{1}{9} - \frac{2}{3}\times\frac{1}{27} - \frac{8}{3\times 27}\right] \Rightarrow \frac{5}{108}$$

$$540A = \frac{5}{108}\times 540 = 25$$

YOUR RANK PREDICTOR

JEE Main

The Rank Predictor will predict the expected rank for JEE Main e.g., If your expected Marks lies between 300-280, your expected Rank will be between 1 to 15.



As per the difficulty of paper your Rank may vary ±5 to ±10%