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CONTENTS

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BITSAT SOLVED PAPER 2024 SESSION-I

(memory based)

INSTRUCTIONS

- *This question paper contains total 130 questions divided into four parts:*

  Part I : Physics Q. No. 1 to 30

  Part II : Chemistry Q. No. 31 to 60

  Part III : (A) English Proficiency Q. No. 61 to 70

  (B) Logical Reasoning Q. No. 71 to 90

  Part IV : Mathematics Q. No. 91 to 130
- *All questions are multiple choice questions with four options, only one of them is correct.*
- *Each correct answer awarded 3 marks and –1 for each incorrect answer.*
- *Duration of paper-3 Hours*

PART - I : PHYSICS

1. The dimensions of coefficient of self inductance are

(a) $[ML^2T^{-2}A^{-2}]$ (b) $[ML^2T^{-2}A^{-1}]$

(c) $[MLT^{-2}A^{-2}]$ (d) $[MLT^{-2}A^{-1}]$

2. When light is incident on a metal surface the maximum kinetic energy of emitted electrons

(a) vary with intensity of light

(b) vary with frequency of light

(c) vary with speed of light

(d) vary irregularly

3. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3}ms^{-2}$, in the third second is:

(a) 6 m (b) 4 m

(c) $\frac{10}{3}$ m (d) $\frac{19}{3}$ m

4. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

(a) 20 m/s (b) 40 m/s

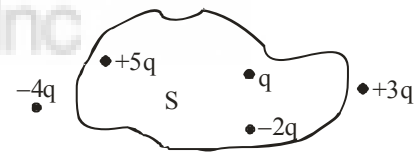
(c) $10\sqrt{30}$ m/s (d) 10 m/s

5. For a particle inside a uniform spherical shell, the gravitational force on the particle is

(a) infinite (b) zero

(c) $\frac{-Gm_1m_2}{r^2}$ (d) $\frac{Gm_1m_2}{r^2}$

6. Five charges +q, +5q, –2q, +3q and –4q are situated as shown in the figure. The electric flux due to this configuration through the surface S is :



(a) $\frac{5q}{\epsilon_0}$ (b) $\frac{4q}{\epsilon_0}$ (c) $\frac{3q}{\epsilon_0}$ (d) $\frac{q}{\epsilon_0}$

7. A body is thrown with a velocity of 9.8 ms^{-1} making an angle of 30º with the horizontal. It will hit the ground after a time

(a) 3.0 s (b) 2.0 s (c) 1.5 s (d) 1 s

8. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration 1.0 m/s^2. If g = 10 ms^{-2}, the tension in the supporting cable is

(a) 8600 N (b) 9680 N

(c) 11000 N (d) 1200 N

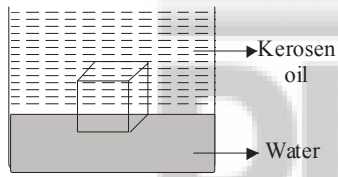
9. Five cells each of emf E and internal resistance r send the same amount of current through an external resistance R whether the cells are connected in parallel or in series. Then the ratio $\left(\frac{R}{r}\right)$ is

(a) 2 (b) $\frac{1}{2}$ (c) $\frac{1}{5}$ (d) 1

10. A particle of mass 2 kg is on a smooth horizontal table and moves in a circular path of radius 0.6 m. The height of the table from the ground is 0.8 m. If the angular speed of the particle is 12 rad s^{-1}, the magnitude of its angular momentum about a point on the ground right under the centre of the circle is

(a) 14.4 kg m^2s^{-1} (b) 8.64 kg m^2s^{-1}
(c) 20.16 kg m^2s^{-1} (d) 11.52 kg m^2s^{-1}

11. A cube of ice floats partly in water and partly in kerosene oil. The radio of volume of ice immersed in water to that in kerosene oil (specific gravity of Kerosene oil = 0.8, specific gravity of ice = 0.9)



(a) 8 : 9 (b) 5 : 4 (c) 9 : 10 (d) 1 : 1

12. A source supplies heat to a system at the rate of 1000 W. If the system performs work at a rate of 200 W. The rate at which internal energy of the system increases

(a) 1200 W (b) 600 W
(c) 500 W (d) 800 W

13. The electrostatic force $\left(\vec{F}_1\right)$ and magnetic force $\left(\vec{F}_2\right)$ acting on a charge q moving with velocity v can be written:

(a) $\vec{F}_1 = q\vec{V}.\vec{E}, \vec{F}_2 = q\left(\vec{B}.\vec{V}\right)$

(b) $\vec{F}_1 = q\vec{B}, \vec{F}_2 = q\left(\vec{B}\times\vec{V}\right)$

(c) $\vec{F}_1 = q\vec{E}, \vec{F}_2 = q\left(\vec{V}\times\vec{B}\right)$

(d) $\vec{F}_1 = q\vec{E}, \vec{F}_2 = q\left(\vec{B}\times\vec{V}\right)$

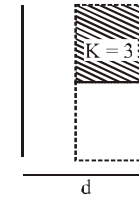
14. A rectangular loop of length 2.5 m and width 2 m is placed at 60° to a magnetic field of 4 T. The loop is removed from the field in 10 sec. The average emf induced in the loop during this time is

(a) −2V (b) +2V (c) +1V (d) −1V

15. If the kinetic energy of a free electron doubles, it's de-Broglie wavelength changes by the factor

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

16. A parallel plate capacitor with plate area A and plate separation d = 2 m has a capacitance of 4 μF.
The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant K= 3 (as shown in figure) will be:



(a) 2μF (b) 32μF
(c) 6μF (d) 8μF

17. The kinetic energy of a satellite in its orbit around the earth is E. What should be the kinetic energy of the satellite so as to enable it to escape from the gravitational pull of the earth?

(a) 4 E (b) 2 E (c) $\sqrt{2}$ E (d) E

18. If the distance between object and its two times magnified virtual image produced by a curved mirror is 15 cm, the focal length of the mirror must be:

(a) $\frac{10}{3}$ cm (b) − 12 cm
(c) − 10 cm (d) 15 cm

19. A plane progressive wave is given by y = 2 cos $2\pi(330\,t - x)$ m. The frequency of the wave is :

(a) 165 Hz (b) 330 Hz
(c) 660 Hz (d) 340 Hz

20. The property of light which cannot be explained by Huygen's construction of wavefront is

(a) Refraction (b) Reflection
(c) Diffraction (d) Origin of spectra

21. The minimum excitation energy of an electron revolving in the first orbit of hydrogen is

(a) 3.4 eV (b) 8.5 eV
(c) 10.2 eV (d) 13.6 eV

22. Young's modules of materials of a wire of Length 'L' and cross-sectional area A is Y. If the length of the wire is doubled and cross-sectional area is halved then Young's modules will be:

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

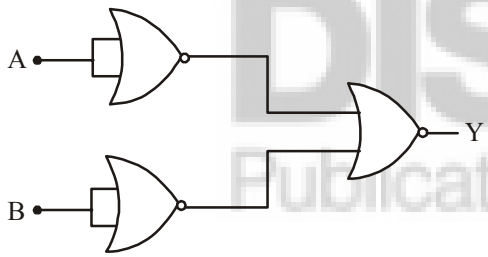
23. When a light ray incidents on the surface of a medium, the reflected ray is completely polarized. Then the angle between reflected and refracted rays is
(a) 45° (b) 90° (c) 120° (d) 180°

24. The nucleus having highest binding energy per nucleon is
(a) $^{16}_{8}O$ (b) $^{56}_{26}Fe$
(c) $^{208}_{84}Pb$ (d) $\frac{4}{2}He$

25. A reverse biased zener diode when operated in the breakdown region works as
(a) an amplifier
(b) an oscillator
(c) a voltage regulator
(d) a rectifier

26. On celcius scale the temperature of body increases by 40°C. The increase in temperature on Fahrenheit scale is:
(a) 70°F (b) 68°F (c) 72°F (d) 75°F

27. Identify the logic operation performed by the following circuit.



(a) OR (b) AND
(c) NOT (d) NAND

28. Two vessels A and B are of the same size and are at same temperature. A contains 1g of hydrogen and B contains 1g of oxygen. P_A and P_B are the pressures of the gases in A and B respectively, then $\frac{P_A}{P_B}$ is:
(a) 8 (b) 16 (c) 32 (d) 4

29. An alternating voltage $V(t) = 220 \sin 100 \pi t$ volt is applied to a purely resistive load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is:
(a) 5 *ms* (b) 3.3 *ms*
(c) 7.2 *ms* (d) 2.2 *ms*

30. A simple pendulum doing small oscillations at a place R height above earth surface has time period of $T_1 = 4$ s. T_2 would be it's time period if it is brought to a point which is at a height 2R from earth surface. Choose the correct relation [R = radius of Earth]:
(a) $T_1 = T_2$ (b) $2T_1 = 3T_2$
(c) $3T_1 = 2T_2$ (d) $2T_1 = T_2$

PART - II : CHEMISTRY

31. A photon of wavelength 3000 Å strikes a metal surface. The work function of the metal is 2.13 eV. What is the kinetic energy of the emitted photoelectron?
($h = 6.626 \times 10^{-34}$ Js)
(a) 4.0 eV (b) 3.0 eV
(c) 2.0 eV (d) 1.0 eV

32. Ferrocene is:
(a) $Fe(n^5 - C_5H_5)_2$ (b) $Fe(n^2 - C_5H_5)_3$
(c) $Cr(n^5 - C_5H_5)_5$ (d) $Os(n^5 - C_5H_5)_2$

33. The chemical name of calgon is
(a) Sodium hexametaphosphite
(b) Potassium hexametaphosphate
(c) Calcium hexametaphosphate
(d) Sodium hexametaphosphate

34. Identify the species having one π-bond and maximum number of canonical forms from the following :
(a) SO_3 (b) O_2
(c) SO_2 (d) CO_3^{2-}

35. sp^3d^2 hybridisation is not displayed by :
(a) BrF_5 (b) SF_6
(c) $[CrF_6]^{3-}$ (d) PF_5

36. A stream of electrons from a heated filament was passed between two charged plates kept at a potential difference *V* volt. If 'e' and *m* are charge and mass of an electron, respectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by:
(a) $\sqrt{meV}$ (b) $\sqrt{2meV}$
(c) meV (d) $2meV$

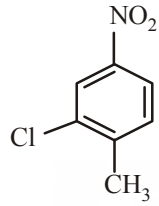
37. Glycosidic linkage between C_1 of α-glucose and C_2 of β-fructose is found in
(a) maltose (b) sucrose
(c) lactose (d) amylose

38. Thermal decomposition of lithium nitrate gives
(a) LiO_2, O_2, NO_2 (b) Li_2O, O_2, N_2O
(c) Li_2O, O_2, N_2 (d) Li_2O, O_2, NO_2

39. In the reaction, A $\rightarrow$ products, If the concentration of the reactant is doubled rate of the reaction remains unchanged. The order of the reaction with respect to A is
(a) 1 (b) 2 (c) 0.5 (d) 0

40. In which of the following molecules, all bond lengths are not equal?
(a) SF_6 (b) PCl_5 (c) BCl_3 (d) CCl_4

41. The IUPAC name of the following molecule is



(a) 2-Methyl-5 nitro-1-chlorobenzene
(b) 3-Chloro-4 methyl-1-nitrobenzene
(c) 2-Chloro-1 methyl-4-nitorbenzene
(d) 2-Chloro-4 nitro-1-methylbenzene

42. The complex with highest magnitude of crystal field splitting energy (Δ_0) is
(a) $[Cr(OH_2)_6]^{3+}$ (b) $[Ti(OH_2)_6]^{3+}$
(c) $[Fe(OH_2)_6]^{3+}$ (d) $[Mn(OH_2)_6]^{3+}$

43. The combustion of benzene (l) gives CO_2 (g) and H_2O (l). Given that heat of combustion of benzene at constant volume is –3263.9 kJ mol^{-1} at 25 °C; heat of combustion (in kJ mol^{-1}) of benzene at constant pressure will be :
(R= 8.314 JK^{-1} mol^{-1})
(a) 4152.6 (b) –452.46
(c) 3260 (d) –3267.6

44. In a first order reaction, the concentration of the reactant, decreases from 0.8 M to 0.4 M in 15 minutes. The time taken for the concentration to change from 0.1 M to 0.025 M is
(a) 7.5 minutes (b) 15 minutes
(c) 30 minutes (d) 60 minutes

45. Arrange the following free radicals in the correct order of their stability

(i) $CH_2 = \dot{C}H$ (ii) $\dot{C}H_3$

(iii) $CH_3 - \dot{C}H - CH_3$ (iv) $(CH_3)_3\dot{C}$

(a) i > ii > iii > iv (b) iv > iii > ii > i
(c) i < ii < iii < iv (d) iv > iii > i > ii

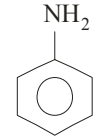
46. In which mode of expression, the concentration of a solution remains independent of temperature?
(a) Molarity (b) Normality
(c) Formality (d) Molality

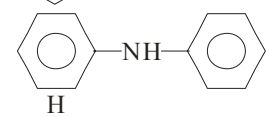
47. Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following:
(a) $q = 0, \Delta T \neq 0, w = 0$
(b) $q = 0, \Delta T < 0, w \neq 0$
(c) $q = \neq 0, \Delta T = 0, w = 0$
(d) $q = 0, \Delta T = 0, w = 0$

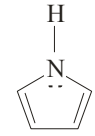
48. An unknown alochol is treated with the "Lucas reagent" to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism :
(a) secondary alcohol by S_N1
(b) tertiary alcohol by S_N1
(c) secondary alcohol by S_N2
(d) tertiary alcohol by S_N2

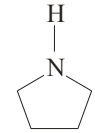
49. IUPAC name of $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is
(a) (Amino methane) chloro (diammine) platinum (II) chloride.
(b) Chlorodiammine (methanamine) platinum (II) chloride.
(c) Diamminechloro (methanamine) platinum (II) chloride.
(d) Diamminechloro (methylamine) platinum (IV) chloride.

50. Which of the following is strongest Bronsted base?

(a) 

(b) 

(c) 

(d) 

51. Calamine, malachite, magnetite and cryolite, respectively, are
(a) $ZnCO_3, CuCO_3.Cu(OH)_2, Fe_3O_4, Na_3A1F_6$
(b) $ZnSO_4, Cu(OH)_2, Fe_3O_4, Na_3AlF_6$
(c) $ZnSO_4, CuCO_3, Fe_2O_3, AlF_3$
(d) $ZnCO_3, CuCO_3, Fe_2O_3, Na_3AlF_6$

52. The naturally occurring amino acid that contains only one basic functional group in its chemical structure is
(a) arginine (b) lysine
(c) asparagine (d) histidine

53. Which of the following substances show the highest colligative properties?
(a) 0.1 M $BaCl_2$ (b) 0.1 M $AgNO_3$
(c) 0.1 M urea (d) 0.1 M $(NH_4)_3PO_4$

54. The ratio $\frac{K_P}{K_C}$ for the reaction
$CO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_{2(g)}$ is:
(a) $(RT)^{1/2}$ (b) RT
(c) 1 (d) $\frac{1}{\sqrt{RT}}$

55. The metal that shows highest and maximum number of oxidation state is:
(a) Fe (b) Mn (c) Ti (d) Co

56. ..... is a potent vasodilator.
(a) Histamine (b) Serotonin
(c) Codeine (d) Cimetidine

57. Which of the following complexes will exhibit maximum attraction to an applied magnetic field?
(a) $[Zn(H_2O)_6]^{2+}$ (b) $[Co(H_2O)_6]^{2+}$
(c) $[Co(en)_3]^{3+}$ (d) $[Ni(H_2O)_6]^{2+}$

58. Zinc acetate - antimony trioxide catalyst used in the preparation of which polymer?
(a) High density polythene
(b) Teflon
(c) Terylene
(d) PVC

59. The sol formed in the following unbalanced equation is
$As_2O_3 + H_2S \rightarrow$
(a) As_2S_2 (b) As_2S_3 (c) As (d) S

60. Dinitrogen is a robust compound, but reacts at high altitude to form oxides. The oxide of nitrogen that can damage plant leaves and retard photosynthesis is :
(a) NO (b) NO_3^- (c) NO_2 (d) NO_2^-

PART - III (A): ENGLISH PROFICIENCY

DIRECTION (Q. 61): *Rearrange the given five sentences (A, B, C, D) and (E) in a proper sequence so as to form a meaningful paragraph and then answer the given questions.*

A. With so many products and opportunities available in the market, it is very easy to get this planning wrong.
B. Planning, therefore, is imperative and should begin as early as possible.
C. What amount will we need and when will we need it?
D. Most of us would put our children's education above any other priority in life including our own retirement.
E. So, let's try to find the best solution by asking two important question.

61. Which of the following should be the **FIRST** sentence after rearrangement?
(a) A (b) B (c) C (d) D

DIRECTION (Q. 62) : *For each of the following questions, select the pair that expresses a relationship most similar to that expressed in the capitalized pair.*

62. ISLAND : OCEAN ::
(a) Hill : Stream (b) Forest : Valley
(c) Tree : Field (d) Oasis : Desert

DIRECTION (Q. 63) : *In the following questions, sentences are given with blanks to be filled with appropriate phrasal verbs. Choose the correct alternative from the given options.*

63. I am afraid my computer will _____ if I try to run it at too high a speed.
(a) break down (b) break out
(c) break even (d) break away

DIRECTION (Q. 64) : *Read the following passage and answer the question that follows*

Samantha was known in her community for her exceptional culinary skills. Every year, she hosted a charity dinner that drew attendees from all over town. This year's event was particularly special because Samantha had announced that all proceeds would go towards the local animal shelter, which had been

struggling financially. The dinner was a huge success, with a wide variety of gourmet dishes that left everyone impressed. As guests enjoyed their meals, many praised Samantha not only for her cooking but also for her generosity and commitment to a cause so close to their hearts.

However, after the event, several guests remarked on how the meal seemed to be even more elaborate than usual. Some suspected that Samantha had spared no expense to ensure the evening was perfect. While discussing the event, a few individuals noted that Samantha had mentioned earlier in the week that she was considering making some personal sacrifices to fund the charity event, but they hadn't taken her seriously at the time.

64. Based on the passage, what can be inferred about Samantha's attitude towards the charity event?

(a) Samantha was indifferent about the outcome of the charity dinner.
(b) Samantha was willing to make personal sacrifices to ensure the charity event's success.
(c) Samantha was dissatisfied with the financial outcome of the event.
(d) Samantha preferred to host simple events rather than elaborate ones.

DIRECTION (Q. 65): *Choose the correct spelling of the given words.*

65. (a) Sovereignty (b) Soveriegnty
(c) Sovereignity (d) Soveriegnity

DIRECTIONS (Qs. 66-67) : *In the following questions, the sentences have been given in Active / Passive Voice. From the given alternatives, choose the one which best expresses the given sentence in Passive / Active Voice as your answer.*

66. He likes people to call him Sir.

(a) He likes to be called Sir by people.
(b) He likes to be call Sir by people.
(c) He likes people who call him Sir.
(d) To call him Sir is liked by people.

67. The telegraph wires have been cut.

(a) Someone has been cut the telegraph wires
(b) No one has cut he telegraph wires.
(c) The telegraph wires have cut someone.
(d) Someone has cut the telegraph wires.

DIRECTION (Q. 68): *In the following questions, sentences are given with blanks to be filled in with an appropriate word(s). Four/five alternatives are suggested for each question. Choose the correct alternative as your answer.*

68. He was so filled with contempt for the prisoner that he gave him a _____look.

(a) humiliated (b) derisive
(c) pitying (d) hurtful

DIRECTION (Q. 69) : *In the following questions, some of the sentences have errors and some have none. Find out which part of a sentence has an error. The number of that part is your answer. If there is no error, your answer is (d) i.e., No error.*

69. Having lived / (a) in Kerala for ten years, / (b) my friend is used to speak Malayalam with his friends./ (c) No Error (d)

DIRECTION (Q. 70) : *Read the paragraph and choose a suitable summary from the given options*

In recent years, urban gardening has become a popular trend as more city dwellers seek to reconnect with nature and improve their living environments. Urban gardening involves cultivating plants in small spaces, such as balconies, rooftops, or community plots. This practice not only enhances the aesthetic appeal of urban areas but also contributes to environmental sustainability by reducing the carbon footprint associated with transporting produce from rural farms to cities.

Many urban gardeners have discovered that growing their own fruits and vegetables can be both rewarding and cost-effective. It provides them with fresh, organic produce and a sense of accomplishment. Furthermore, urban gardens often foster a sense of community, as individuals and families collaborate on gardening projects and share their harvests. Despite some challenges, such as limited space and potential soil contamination, urban gardening continues to gain traction as a meaningful and practical activity for city residents.

70. Which of the following best summarizes the passage?

(a) Urban gardening is mainly about growing plants for decorative purposes in cities.

(b) Urban gardening helps city dwellers enjoy fresh produce and build community connections, while also contributing to environmental sustainability.
(c) Urban gardening is an expensive hobby that requires significant investment and space.
(d) Urban gardening is primarily practiced by people in rural areas who want to experience city life.

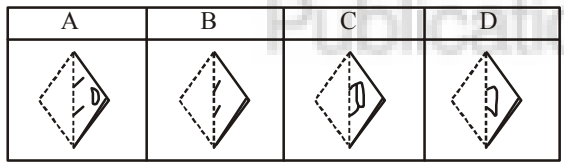
PART - III (B) : LOGICAL REASONING

71. Select the option figure that will complete the series of question figures.
Question figures

Option Figures

(a) B (b) D (c) C (d) A

72. Which pattern will the given transparent sheet resemble when it is folded at the dotted line ?



(a) C (b) B (c) A (d) D

73. Which of the following doesn't fit into the series?
5-1-96, 27-1-96, 18-2-96, 12-3-96, 2-4-96.
(a) 18-2-96 (b) 27-1-96
(c) 12-3-96 (d) 5-1-96

74. If 'Q' means '+', 'J" means '×', 'T' means '–' and 'K' means '÷', then what is the value of 18K3Q7J2T8?
(a) 15 (b) 10 (c) 18 (d) 12

75. In a code language, if LUCK is wtitten as L2U1C3K1, then what is the last digit for the code for XEROX in that same language ?
(a) 4 (b) 3 (c) 2 (d) 1

76. Raju walks 4 km towards East. Then, he turns left and walks another 3 km .In which direction and at what distance is he from his initial position?
(a) South-West, 5 km
(b) North-East, 5 km
(c) South-East, 5 km
(d) North-West, 5 km

77. Read the given statements and the following conclusions carefully and select which of the conclusions logically follow(s) from the statements.
Statements :
All blue are colours.
All colours are shades.
Conclusion :
1. All blue are shades.
2. Some shades are colors.
(a) All the conclusions follow
(b) Only conclusion 1 follows
(c) Only conclusion 2 follows
(d) No conclusions follow.

78. Read the given statement(s) and conclusioins carefully and select which of the conclusions logically follow(s) from the statement(s)
Statement :
All razors are blades
All blades are metal
Conclusions :
1. All metals are razors
2. Some metals are blades.
(a) All the conclusions follow
(b) Neither conclusion follows
(c) Only conclusion 2 follows
(d) Only conclusions I follows.

DIRECTIONS (Qs. 79-81): Study the following information carefully to answer these questions :

Eight friends J, K, L, M, N, O, P and Q are sitting around a circle facing the centre. J is not the neighour of N. L is third to the right of K. Q is second to the left of N who is next to the right of L. O is not the neighbour of N or K and is to the immediate left of P.

79. Which of the following is the correct position of L?
(a) To the immediate right of N
(b) To the immediate right of Q
(c) To the immediate left of N
(d) To the immediate left of Q

80. Which of the following pair of persons represent O's neighbours?

(a) L&N (b) P&K
(c) M&P (d) N&P

81. Which of the following groups has the first person sitting between the other two persons?

(a) PKJ (b) JQL
(c) QNL (d) None of these

82. In a joint family, there are father, mother, 3 married sons and one unmarried daughter. Of the sons, two have 2 daughters each and one has a son. How many females members are there in the family?

(a) 2 (b) 3
(c) 6 (d) 9

83. Pointing towards a woman in a photograph Vijay said, "She is the daughter of the father of sister of my brother". How is the lady in the photograph related to Vijay?

(a) Wife (b) Mother
(c) Sister (d) Daughter

84. If 'yellow' means 'green', 'green' means 'white', white means 'red', 'red' means 'black', 'black' means 'blue' and 'blue' means 'violet', which of the following represents the colour of human blood?

(a) black (b) violet
(c) red (d) None of these

85. Which one of the letters when sequentially placed at the gaps in the given letter series shall complete it?

m _ _ l m _ l _ m m _ l

(a) mllml (b) mlmll
(c) llmlm (d) mmlml

DIRECTIONS (Qs. 86-87): *Read the following information carefully and answer the questions which follow:*

Among A, B, C, D and E each scored different marks in an examination. Only one person scored more than C. E scored more than A but less than D. D did not Score the highest marks. The one who scored the second lowest, scored 71 % marks. C scored 92% marks.

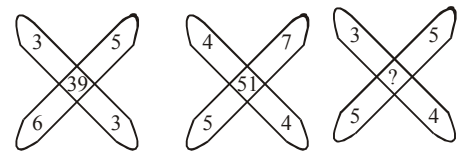
86. Who amongst the following is most likely to have scored 87% marks?

(a) A (b) B
(c) D (d) E

87. Which of the following percentages is most likely to be B's percentage in the exam?

(a) 68% (b) 71%
(c) 84% (d) 97%

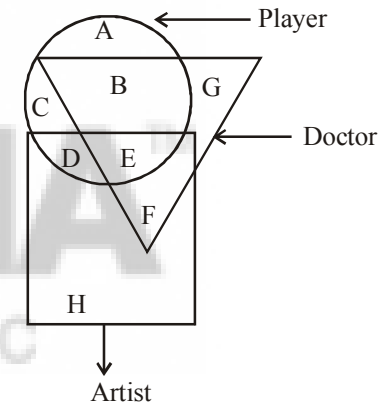
88.



A B C

(a) 47 (b) 45
(c) 37 (d) 35

89. In the following venn diagram identify the better which denotes players who are also doctors but not artist.



(a) B+E (b) E
(c) B (d) A

90. In the following questions, there are two words/ set of letters/numbers to the left of the sign :: which are connected in some way. The same relationship obtains between the third words/ set of letters/numbers and one of the four alternatives under it. Find the correct alternative.

TOMATO : MTOOTA :: 123412 : ?

(a) 312214 (b) 123456
(c) 321124 (d) 213314

PART - IV : MATHEMATICS

91. Number of subsets of set of letter of word 'MONOTONE'.

(a) 8 (b) 256

(c) 64 (d) 32

92. If $|z_1| = 2, |z_2| = 3, |z_3| = 4$ and $|2z_1 + 3z_2 + 4z_3| = 4$, then absolute value of $8z_2z_3 + 27\, z_3z_1 + 64z_1z_2$ equals

(a) 24 (b) 48

(c) 72 (d) 96

93. If tan 15° and tan 30° are the roots of the equation

$x^2 + px + q = 0$, then $pq =$

(a) $\frac{6\sqrt{3}+10}{\sqrt{3}}$ (b) $\frac{10-6\sqrt{3}}{3}$

(c) $\frac{10+6\sqrt{3}}{3}$ (d) $\frac{10-6\sqrt{3}}{\sqrt{3}}$

94. In an examination, 62% of the candidates failed in English, 42% in Mathematics and 20% in both. The number of those who passed in both the subjects is

(a) 11 (b) 16

(c) 18 (d) None of these

95. The domain of the real valued function

$$f(x) = \sqrt{\frac{2x^2 - 7x + 5}{3x^2 - 5x - 2}} \text{ is}$$

(a) $\left(-\infty, -\frac{1}{3}\right) \cup [1, 2) \cup \left[\frac{5}{2}, \infty\right)$

(b) $(-\infty, 1) \cup (2, \infty)$

(c) $\left(-\frac{1}{3}, \frac{5}{2}\right]$

(d) $\left(-\infty, \frac{-1}{3}\right] \cup \left[\frac{5}{2}, \infty\right)$

96. The number of arrangements of all digits of 12345 such that at least 3 digits will not come in its position is

(a) 89 (b) 109

(c) 78 (d) 57

97. If the 17^{th} and the 18^{th} terms in the expansion of $(2 + a)^{50}$ are equal, then the coefficient of x^{35} in the expansion of $(a + x)^{-2}$ is

(a) -35 (b) 35

(c) 36 (d) -36

98. If arithmetic mean of two distinct positive real number a and b ($a > b$) be twice their geometric mean, then $a : b =$

(a) $(2+\sqrt{3}) : (2-\sqrt{3})$

(b) $(2+\sqrt{5}) : (2-\sqrt{5})$

(c) $(2+\sqrt{2}) : (2-\sqrt{2})$

(d) None of these

99. The distance from the origin to the image of (1, 1) with respect to the line $x + y + 5 = 0$ is

(a) $7\sqrt{2}$ (b) $3\sqrt{2}$

(c) $6\sqrt{2}$ (d) $4\sqrt{2}$

100. From a point A (0, 3) on the circle $(x + 2)^2 + (y-3)^2 = 4$, a chord AB is drawn and it is extended to a point Q such that AQ = 2AB. Then the locus of Q is

(a) $(x+4)^2 + (y-3)^2 = 16$

(b) $(x+1)^2 + (y-3)^2 = 32$

(c) $(x+1)^2 + (y-3)^2 = 4$

(d) $(x+1)^2 + (y-3)^2 = 1$

101. The range of $(8 \sin \theta + 6 \cos \theta)^2 + 2$ is

(a) (0, 2) (b) [2, 102]

(c) $(-\infty, \infty)$ (d) (2, 1)

102. Let L_1 be the length of the common chord of the curves $x^2 + y^2 = 9$ and $y^2 = 8x$, and L_2 be the length of the latus rectum of $y^2 = 8x$, then:

(a) $L_1 > L_2$ (b) $L_1 = L_2$

(c) $L_1 < L_2$ (d) $\frac{L_1}{L_2} = \sqrt{2}$

103. A (3, 2, 0), B (5, 3, 2), C (–9, 6, –3) are three points forming a triangle. AD, the bisector of angle BAC meets BC in D. Find the co-ordinates of D.

(a) $\frac{19}{8}, \frac{57}{15}, \frac{57}{15}$ (b) $\frac{19}{8}, \frac{57}{16}, \frac{17}{16}$

(c) (2, 3, 0) (d) (4, 5, 6)

104. $\lim_{n\to\infty} \prod_{r=3}^{\infty} \frac{r^3 - 8}{r^3 + 8}$ equals to

(a) $\frac{2}{7}$ (b) $\frac{3}{7}$

(c) $\frac{4}{7}$ (d) $\frac{6}{7}$

105. The mean of n items is $\overline{X}$. If the first item is increased by 1, second by 2 and so on, the new mean is :

(a) $\overline{X} + \frac{x}{2}$ (b) $\overline{X} + x$

(c) $\overline{X} + \frac{n+1}{2}$ (d) None of these

106. A book contains 1000 pages. A page is chosen at random. The probability that the sum of the digits of the marked number on the page is equal to 9, is

(a) $\frac{23}{500}$ (b) $\frac{11}{200}$

(c) $\frac{7}{100}$ (d) None of these

107. If a function f : $\mathbf{R} - \{l\} \to \mathbf{R} - \{m\}$ defined by $f(x) = \frac{x+3}{x-2}$ is a bijection, then $3l + 2m =$

(a) 10 (b) 12

(c) 8 (d) 14

108. If $A = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}, P = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ and $X = APA^T$, then $A^T X^{50} A =$

(a) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 1 \\ 0 & -1 \end{bmatrix}$

(c) $\begin{bmatrix} 25 & 1 \\ 1 & -25 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix}$

109. The variance of 20 observations is 5. If each observation is multiplied by 2, then the new variance of the resulting observation is

(a) $2^3 \times 5$ (b) $2^2 \times 5$

(c) 2×5 (d) $2^4 \times 5$

110. Let $f(x) = \sin x$, $g(x) = \cos x$, $h(x) = x^2$ then

$$\lim_{x\to 1} \frac{f\left(g\left(h(x)\right)\right) - f\left(g\left(h(1)\right)\right)}{x-1} =$$

(a) 0 (b) –2 sin 1 cos (cos1)

(c) ∞ (d) –2 sin1 cos 1

111. If $\cos\cot^{-1}\left(\frac{1}{2}\right) = \cot(\cos^{-1} x)$, then the value of x is

(a) $\frac{1}{\sqrt{6}}$ (b) $\frac{-1}{\sqrt{12}}$

(c) $\frac{2}{\sqrt{6}}$ (d) $\frac{-2}{\sqrt{6}}$

112. If A is a square matrix of order 3, then |Adj(Adj A^2)|=

(a) $|A|^2$ (b) $|A|^4$

(c) $|A|^8$ (d) $|A|^{16}$

113. If the system of linear equations $2x + y - z = 7$;

$x - 3y + 2z = 1$; $x + 4y + \delta z = k$,

where $\delta, k \in R$ has infinitely many solutions, then $\delta + k$ is equal to:

(a) -3 (b) 3
(c) 6 (d) 9

114. $f(x)=\sin x+\cos x, g(x)=x^2-1$, then $g(f(x))$ is invertible if

(a) $\frac{-\pi}{4}\le x\le\frac{\pi}{4}$ (b) $\frac{-\pi}{2}\le x\le 0$

(c) $\frac{-\pi}{2}\le x\le\pi$ (d) $0\le x\le\frac{\pi}{2}$

115. If the function $f(x)$, defined below, is continuous on the interval [0, 8], then

$$f(x)=\begin{cases}x^2+ax+b & , \ 0\le x<2\\ 3x+2 & , \ 2\le x\le 4\\ 2ax+5b & , \ 4<x\le 8\end{cases}$$

(a) $a=3, b=-2$ (b) $a=-3, b=2$
(c) $a=-3, b=-2$ (d) $a=3, b=2$

116. If $y=\tan^{-1}\frac{1}{x^2+x+1}+\tan^{-1}\frac{1}{x^2+3x+3}+\tan^{-1}\frac{1}{x^2+5x+7}+....\text{to } n \text{ terms, then } \frac{dy}{dx}=$

(a) $\frac{1}{x^2+n^2}-\frac{1}{x^2+1}$

(b) $\frac{1}{(x+n)^2+1}-\frac{1}{x^2+1}$

(c) $\frac{1}{x^2+(n+1)^2}-\frac{1}{x^2+1}$

(d) None of these

117. Let the function $g:(-\infty,\infty)\to\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ be given by $g(u)=2\tan^{-1}(e^u)-\frac{\pi}{2}$. Then, g is

(a) even and is strictly increasing in $(0, \infty)$
(b) odd and is strictly decreasing in $(-\infty, \infty)$
(c) odd and is strictly increasing in $(-\infty, \infty)$
(d) neither even nor odd, but is strictly increasing in $(-\infty, \infty)$

118. The altitude of a cone is 20 cm and its semi-vertical angle is 30°. If the semi-vertical angle is increasing at the rate of 2° per second, then the radius of the base is increasing at the rate of

(a) 30 cm/sec (b) $\frac{160}{3}$ cm/sec
(c) 10 cm/sec (d) 160 cm/sec

119. If p : It raining today, q : I go to school, r : I shall meet any friends and s : I shall go for a movie, then which of the following is the proposition : 'If it does not rain or if I do not go to school, then I shall meet my friend and go for a movie'?

(a) $\sim(p\wedge q)\Rightarrow(r\wedge s)$
(b) $\sim(p\wedge\sim q)\Rightarrow(r\wedge s)$
(c) $\sim(p\wedge q)\Rightarrow(r\vee s)$
(d) None of these

120. $\int\sqrt{x+\sqrt{x^2+2}}\,dx=$

(a) $\frac{3}{2}\left(x+\sqrt{x+2}\right)^{3/2}-2\left(x+\sqrt{x^2+2}\right)^{1/4}+C$

(b) $\frac{1}{3}\left(x+\sqrt{x^2+2}\right)^{3/2}-2\left(x+\sqrt{x^2+2}\right)^{1/4}+C$

(c) $\left(x+\sqrt{x^2+2}\right)^{-3/2}-2\left(x+\sqrt{x^2+2}\right)^{-1/2}+C$

(d) $\frac{\left(x+\sqrt{x^2+2}\right)^2-6}{3\sqrt{x+\sqrt{x^2+2}}}+C$

121. $f(x)=\begin{cases}4 & -\infty<x<-\sqrt{5}\\ x^2-1 & -\sqrt{5}\le x\le\sqrt{5}\\ 4 & \sqrt{5}\le x<\infty\end{cases}$

If k is the number of points where $f(x)$ is not differentiable then $k-2=$

(a) 2 (b) 1
(c) 0 (d) 3

122. The point of inflexion for the curve $y=(x-a)^n$, where n is odd integer and $n\ge 3$ is

(a) $(a, 0)$ (b) $(0, a)$

(c) $(0, 0)$ (d) None of these

123. $\int_0^{\frac{\pi}{2}} \frac{\sin\left(\frac{\pi}{4}+x\right)+\sin\left(\frac{3\pi}{4}+x\right)}{\cos x+\sin x}\,dx =$

(a) $\frac{\pi}{\sqrt{2}}$ (b) $\frac{\pi}{2\sqrt{2}}$

(c) $\frac{\pi}{3\sqrt{2}}$ (d) $\frac{\pi}{4\sqrt{2}}$

124. If the area bounded by the curves $y = ax^2$ and $x = ay^2$, $(a > 0)$ is 3 sq units, then the value of a is

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

(c) 1 (d) 4

125. Let p, q, r be three logical statements. Consider the compound statements

$S_1 : ((\sim p) \vee q) \vee ((\sim p) \vee r)$ and

$S_2 : p \rightarrow (q \vee r)$

Then, which of the following is **NOT** true?

(a) If S_2 is true, then S_1 is true

(b) If S_2 is false, then S_1 is false

(c) If S_2 is false, then S_1 is true

(d) If S_1 is false, then S_2 is false

126. The value of $\int e^{\tan\theta}(\sec\theta - \sin\theta)d\theta$ is

(a) $e^{\tan\theta}\sec\theta + c$

(b) $e^{\tan\theta}\sin\theta + c$

(c) $e^{\tan\theta}(\sec\theta + \sin\theta) + c$

(d) $e^{\tan\theta}\cos\theta + c$

127. The population $p(t)$ at time t of a certain mouse species satisfies the differential equation $\frac{dp(t)}{dt} = 0.5\,p(t) - 450$. If $p(0) = 850$, then the time at which the population becomes zero is :

(a) $2ln\,18$ (b) $ln\,9$

(c) $\frac{1}{2}ln\,18$ (d) $ln\,18$

128. Let the foot of perpendicular from a point P(1, 2, –1) to the straight line $L : \frac{x}{1} = \frac{y}{0} = \frac{z}{-1}$ be N. Let a line be drawn from P parallel to the plane $x + y + 2z = 0$ which meets L at point Q. If α is the acute angle between the lines PN and PQ, then $\cos\alpha$ is equal to _____.

(a) $\frac{1}{\sqrt{5}}$ (b) $\frac{\sqrt{3}}{2}$

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

129. For two events A and B, if $P(A) = P\left(\frac{A}{B}\right) = \frac{1}{4}$ and $P\left(\frac{B}{A}\right) = \frac{1}{2}$, then which of the following is not true?

(a) A and B are independent

(b) $P\left(\frac{A'}{B}\right) = \frac{3}{4}$

(c) $P\left(\frac{B'}{A'}\right) = \frac{1}{2}$

(d) None of these

130. Consider the following two propositions:

$P_1 : \sim(p \rightarrow \sim q)$

$P_2 : (p \wedge \sim q) \wedge ((\sim p) \vee q)$

If the proposition $p \rightarrow ((\sim p) \vee q)$ is evaluated as FALSE, then :

(a) P_1 is TRUE and P_2 is FALSE

(b) P_1 is FALSE and P_2 is TRUE

(c) Both P_1 and P_2 are FALSE

(d) Both P_1 and P_2 are TRUE

SOLUTIONS

PART - I : PHYSICS

1. (a) Energy stored in an inductor, $U = \frac{1}{2}LI^2$

$\Rightarrow \quad L = \frac{2U}{I^2}$ $\quad \therefore$

$[L] = \frac{[ML^2T^{-2}]}{[A]^2} = [ML^2T^{-2}A^{-2}]$

2. (b) Max. K.E. = $h\nu - W_0$; so Max. K.E. $\propto \nu$

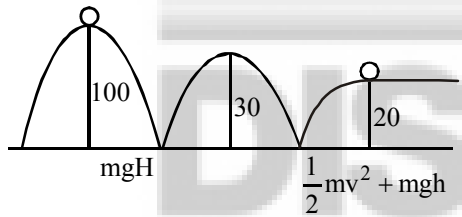
3. (c) Distance travelled in the nth second is given by

$t_n = u + \frac{a}{2}(2n-1)$

put $u = 0,\ a = \frac{4}{3}ms^{-2}$, $n = 3$

$\therefore \quad d = 0 + \frac{4}{3\times 2}(2\times 3 - 1) = \frac{4}{6}\times 5 = \frac{10}{3}m$

4. (b)



Using conservation of energy,

$m(10\times 100) = m\left(\frac{1}{2}v^2 + 10\times 20\right)$

or $\quad \frac{1}{2}v^2 = 800$ or $v = \sqrt{1600} = 40$ m/s

5. (b) Various regions of spherical shell attract the point mass inside it in various directions. These forces cancel each other completely. Therefore the gravitational force on the particle is zero.

6. (b) Using Gauss's law, $\phi = \frac{q}{\epsilon_0}$

Here, q = charge inside the closed surface

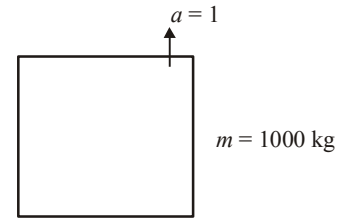
$\therefore \phi = \frac{q + (-2q) + 5q}{\epsilon_0}$

$\Rightarrow \phi = \frac{4q}{\epsilon_0}$

7. (d) Time of flight = $\frac{2u\sin\theta}{g}$

$= \frac{2\times 9.8\times \sin 30^\circ}{9.8} = 2\times\frac{1}{2} = 1\text{sec}.$

8. (c)



Total mass = (60 + 940) kg = 1000 kg

Let T be the tension in the supporting cable, then

$T - 1000g = 1000 \times 1$

$\Rightarrow \quad T = 1000 \times 11 = 11000$ N

9. (d) Given : Number of cells, $n = 5$, emf of each cell = E

Internal resistance of each cell = r

In series, current through resistance R

$I = \frac{nE}{nr + R} = \frac{5E}{5r + R}$

In parallel, current through resistance R

$I' = \frac{E}{\frac{r}{n} + R} = \frac{nE}{r + nR} = \frac{5E}{r + 5R}$

According to question, $I = I'$

$\therefore \frac{5E}{5r + 5R} = \frac{5E}{r + 5R} \Rightarrow 5r + R = r + 5R$

or $R = r \quad \therefore \frac{R}{r} = 1$

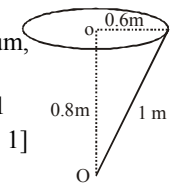
10. (a) Angular momentum,

$L_0 = mvr \sin 90^\circ$

$= 2 \times 0.6 \times 12 \times 1 \times 1$

[As $V = r\omega$, Sin 90° = 1]

So, $L_0 = 14.4$ kgm^2/s



11. (d) Let V_1 be, the volume immersed in water.

V_2 be the volume immersed in oil.

In equilibrium condition,

$v_1\rho_w g + v_2\rho_0 g = (v_1 + v_2)\rho_e g$

$v_1 + \frac{v_2\rho_0}{\rho_w} = (v_1 + v_2)\frac{\rho_c}{\rho_w}$

$\Rightarrow v_1 + 0.8v_2 = 0.9v_1 + 0.9v_2 \Rightarrow 0.1v_1 = 0.1v_2$

$\Rightarrow v_1 : v_2 = 1 : 1$

12. **(d)** Given,

Rate of heat supplied, $\frac{dQ}{dt} = 1000W$

Rate of work performed, $\frac{dw}{dt} = 200W$

Using first law of thermodynamics

$dQ = dU + dw$

$$\Rightarrow \underset{W}{\frac{dU}{dt}} = \frac{dQ}{dt} - \frac{dw}{dt} \Rightarrow \frac{dU}{dt} = 1000 - 200 = 800$$

13. **(c)** Electrostatic force, $\vec{F}_1 = q\vec{E}$

Magnetic force, $\vec{F}_2 = q\left(\vec{V} \times \vec{B}\right)$

14. **(c)** Average emf, $e = \frac{\text{Change in flux}}{\text{Time}} = -\frac{\Delta\phi}{\Delta t}$

$$= -\frac{0 - \left(4 \times (2.5 \times 2)\cos 60°\right)}{10} = +1V$$

15. **(d)** de-Broglie wavelength,

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2.m.(K.E)}} \quad \therefore \quad \lambda \propto \frac{1}{\sqrt{K.E}}$$

If K.E is doubled, λ becomes $\frac{\lambda}{\sqrt{2}}$

16. **(c)** We have, $C_i = \frac{A\epsilon_0}{d} = 4\mu F$

$$C_f = \frac{A\epsilon_0}{d - t + \frac{t}{k}} = \frac{A\epsilon_0}{d - \frac{d}{2} + \frac{d}{2\times 3}}$$

$$= \frac{A\epsilon_0}{d\left(1 - \frac{1}{2} + \frac{1}{6}\right)}$$

$$= \frac{4\mu F}{\frac{2}{3}} = 6\mu F$$

17. **(b)** We know that $v_e = \sqrt{2}\, v_0$, where v_0 is orbital velocity.

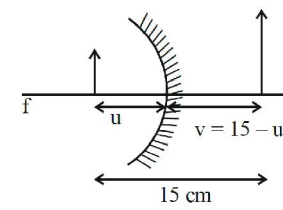
K.E. in the orbit, $E = \frac{1}{2} M v_0^2$

K.E. to escape $E = \frac{1}{2} M v_e^2 = \frac{1}{2} M (2 v_0^2)$

$$= \frac{1}{2} M v_0^2 \times 2 = 2E$$

18. **(c)** Since, image is magnified. So, it is a concave mirror.

$$\therefore \quad m = 2 = \frac{-v}{u}$$



$$2 = \frac{-(15 - u)}{-u}$$

$2u = 15 - u$

$3u = 15 \Rightarrow u = 5$ cm

$v = 15 - u = 15 - 5 = 10$ cm

By mirror formula,

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$= \frac{1}{10} + \frac{1}{(-5)} = \frac{1-2}{10} = \frac{-1}{10}$$

$f = -10$ cm

19. **(b)** Equation of wave is, $y = 2\cos 2\pi(330t - x)$ m

$y = A\cos(\omega t - kx)$

On comparing $\omega = 2\pi \times 330$ $[\because \omega = 2\pi F]$

$2\pi f = 2\pi \times 330 \Rightarrow f = 330$ Hz

20. **(d)** The property of light which cannot be explained by Huygen's construction of wave front is origin of spectra.

21. **(c)** Energy of electron in n^{th} orbit

$$E_n = \frac{-13.6eV}{n^2}$$

Excitation energy of electron from n = 1 to n = 2

$$E = -13.6\left[\frac{1}{2^2} - \frac{1}{1}\right] = -13.6\left[\frac{1}{4} - \frac{1}{1}\right] = 10^{-2}\,eV$$

So, Minimum excitation energy = 10.2 eV

22. **(c)** Young's modulus depends on the material not depends on length and cross sectional area. So Young's modulus remains constant.

23. **(b)** According to Brewester's law if the reflected ray is completely polarized, then the reflected and refracted ray is perpendicular to each other.

Thus, $\theta = 90°$

24. **(b)** The binding energy per nucleon is practically independent of the atomic number for nuclei of mass number in range $30 < A < 17°$.

So, $_{26}Fe^{56}$ has maximum binding energy per nucleon.

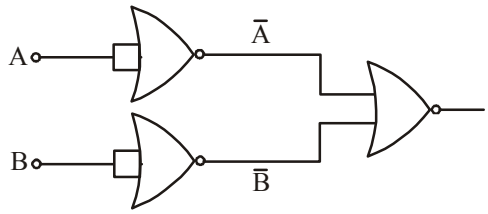
25. **(c)** In the breakdown region, a reverse biased zener diode works as a voltage regulator.

26. **(c)** Since $\frac{F-32}{9}=\frac{C}{5}$

$\Rightarrow \Delta C=\frac{5}{9}\Delta F$

$\Rightarrow 40=\frac{5}{9}\Delta F \Rightarrow \Delta F=72°F$

27. **(b)**



$Y=\overline{\overline{A}+\overline{B}}$

$=\overline{\overline{A}}.\overline{\overline{B}}$

$=A.B$

So, $Y=A.B$

Therefore gate is AND gate.

28. **(b)** $n_A=\frac{1}{2}$ mol, $n_B=\frac{1}{32}$ mol

By ideal gas equation,

$PV=nRT \Rightarrow P \propto n$

$\therefore \frac{P_A}{P_B}=\frac{n_A}{n_B}=\frac{32}{2}=16$

29. **(b)** Rising half to peak

$t=T/6$

$t=\frac{2\pi}{6\omega}=\frac{\pi}{3\omega}=\frac{\pi}{300\pi}=\frac{1}{300}=3.3$ ms

Here $\omega=100\,\pi$ rad / s

30. **(c)** Time period of simple pendulum,

$T=2\pi\sqrt{\frac{l}{g}}$ & $g=\frac{GM}{(R+h)^2}$

$\therefore T \propto (R+h)$

$\Rightarrow \frac{T_1}{T_2}=\frac{(R+h_1)}{(R+h_2)}=\frac{(R+R)}{(R+2R)}=\frac{2}{3} \Rightarrow 3T_1=2T_2$

PART - II : CHEMISTRY

31. **(c)** $\lambda=3000Å=3\times10^{-7}$m, $\phi=2.13$ eV

$K.E.=h\nu-h\nu_0=h\nu-\phi=\frac{hc}{\lambda}-\phi$

$=\frac{(6.626\times10^{-34}\times3\times10^8)}{3\times10^{-7}}-(2.13\times1.6\times10^{-19})$

$=\frac{1.98\times10^{-25}}{3\times10^{-7}}-\left(3.408\times10^{-19}\right)$

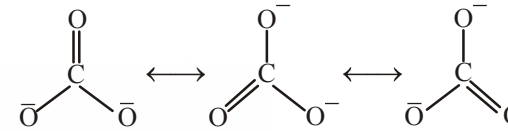
$=(6.60\times10^{-19})-(3.408\times10^{-19})$

$=3.192\times10^{-19}$ J $=2.0$ eV

32. **(a)** Ferrocene has two cyclopentadienyl rings coordinated to an Fe^{2+} ion. The hapticity of each ring is 5.

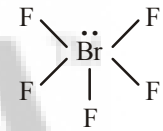
33. **(d)** Calgon is sodium hexametaphosphate with the formula $Na_6P_6O_{18}$.

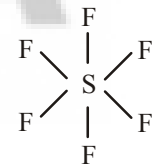
34. **(d)**

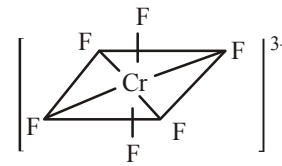


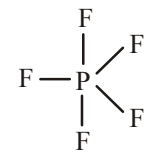
3 Canonical structures

35. **(d)**

(a) BrF_5  sp^3d^2

(b) SF_6  sp^3d^2

(c) $[CrF_6]^{3-}$  sp^3d^2

(d) PF_5  sp^3d

36. **(b)** As electron of charge 'e' is passed through '*V*' volt, kinetic energy of electron will be eV.

Wavelength of electron wave $(\lambda) = \frac{h}{\sqrt{2m \cdot KE}}$

$\lambda = \frac{h}{\sqrt{2meV}} \quad \therefore \quad \frac{h}{\lambda} = \sqrt{2meV}$

37. (b)
- Maltose is composed of two glucose units.
- Sucrose has glycosidic linkage between C_1 of α-glucose and C_2 of β-fructose.
- Lactose is composed of galactose and glucose
- Amylose has glycosidic linkage between C_1 of α-glucose C_4 of α-glucose.

38. (d) $LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$.
lithium nitrate

39. (d) $r_1 = k[A]^n$ and $r_2 = k[2A]^n$
$\because \quad r_1 = r_2 \quad \therefore \quad k[A]^n = k(2[A])^n$
or, $2^n = 1$
or, $2^n = 2^\circ \Rightarrow n = 0$
It is a zero order reaction.

40. (b) In PCl_5 bond length of axial bond is greater than the length of equatorial bond.

41. (c) $-NO_2$ and $-Cl$ are written as prefixes with $-CH_3$ being given the highest preference for numbering (C – 1).
Thus, the name of the compound will be 2-chloro-1-methyl-4-nitrobenzene.

42. (a) Smaller cations prefer coordinate bonding due to greater polarizing power.
$Ti^{+3} = 67$ pm radius, $Cr^{3+} = 62$ pm radius
$Mn^{+3} = 65$ pm radius, $Fe^{+3} = 65$ pm radius
So, Cr^{3+} has highest tendency to attract ligand.

43. (d)

$$C_6H_6(l) + \frac{15}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$$

$$\Delta n_g = 6 - \frac{15}{2} = -\frac{3}{2}$$

$$\Delta H = \Delta U + \Delta n_g RT$$

$$= -3263.9 + \left(-\frac{3}{2}\right) \times 8.314 \times 10^{-3} \times 298$$

$$= -3263.9 + (-3.71) = -3267.6 \text{ kJ mol}^{-1}$$

44. (c) As the concentration of reactant decreases from 0.8 to 0.4 in 15 minutes, hence the $t_{1/2}$ is 15 minutes. To fall the concentration from 0.1 to 0.025, we need two half lives, i.e., 30 minutes.

45. (b) The stability of free radicals follows the order:-

$\dot{C}H_3 < 1^\circ < 2^\circ < 3^\circ$

Thus, stability order will be :- iv > iii > ii > i

46. (d) Molality – Moles of solute/mass of solvent in kg
$\because$ Molality does not involve volume term.
$\therefore$ It is independent of temperature.

47. (d) $\Delta U = q + w$

For a adiabatic process, $\boxed{q = 0}$

$\Delta U = w = -p_{ex} \Delta v$
For free expansion of ideal gas $p_{ex} = 0$

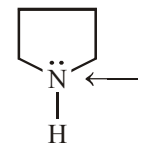
$\boxed{\Delta U = w = 0}$

As $\Delta U = C \Delta T = 0$, $\boxed{\Delta T = 0}$

48. (b) Reaction of alcohols with Lucas reagent proceeds through carbocation formation. (S_N1 reaction).
Further, 3° carbocations (from tertiary alcohols) are highly stable, thus reaction proceeds through S_N1 mechanism.

49. (c) The complex is a cationic complex with two ammine (NH_3), one chloro (Cl) and one methanamine ligand.
Thus, the name will be :-
Diamminechloro (methanamine) platinum (II) chloride.

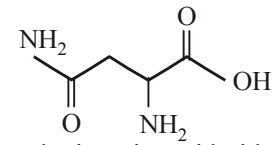
50. (d)



localised lone pair & sp^2 makes it easier to lose electron pair or getting protonated.

51. (a) Calamine $\rightarrow ZnCO_3$
Malachite $\rightarrow CuCO_3.Cu(OH)_2$
Magnetite $\rightarrow Fe_3O_4$
Cryolite $\rightarrow Na_3AlF_6$

52. (c) Asparagine has only one basic functional group in its chemical structure.



Others are basic amino acid with more than one basic functional group.

53. **(d)** Colligative property depends on the number of particles or ions. Option (d) consists 4 of ions due to which it shows highest colligative property.

54. **(d)** $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$

K_P and K_C are related as

$$K_P = K_C (RT)^{\Delta n_g}$$

$$\Rightarrow \quad \Delta n_g = n_P - n_R = 1 - 1\frac{1}{2} = -\frac{1}{2}$$

Δn_g for the given reaction $= -\frac{1}{2}$

$$\therefore \frac{K_P}{K_C} = \frac{1}{\sqrt{RT}}$$

55. **(b)** Mn shows highest oxidation state of + 7 in 3d series metals. Ti; Co and Fe shows highest. Oxidation state of +4, +4 and +6 respectively. Oxidation state of +4, +4 and +6 respectively.

56. **(a)**

57. **(b)** Complex with maximum number of unpaired electron will exhibit maximum attraction to an applied magnetic field.

$[Zn(H_2O)_6]^{2+} \rightarrow d^{10}$ system $\rightarrow t_{2g}^6 e_g^4$,

0 unpaired e^-

$[Co(H_2O)_6]^{2+} \rightarrow d^7$ system $\rightarrow t_{2g}^5 e_g^2$,

3 unpaired e^-

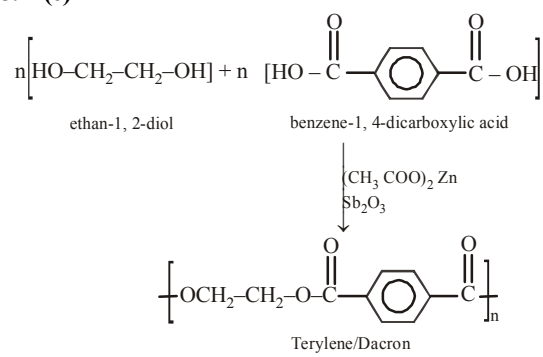
$[Co(en)_3]^{3+} \rightarrow d^6$ system $\rightarrow t_{2g}^6 e_g^0$,

0 unpaired e^-

$[Ni(H_2O)_6]^{2+} \rightarrow d^8$ system $\rightarrow t_{2g}^6 e_g^2$,

2 unpaired e^-

58. **(c)**



59. **(b)** $As_2O_3 + 3H_2S \rightarrow As_2S_3 + 3H_2O$

60. **(c)** $N_2(g) + O_2(g) \rightarrow 2NO(g)$

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

Higher concentration of NO_2 damage the leaves and retard the rate of photosynthesis.

PART - III (A): ENGLISH PROFICIENCY

61. **(d)** All the sentences except D are following some other sentences as they appear to be linked with something that has been said earlier. So, D will be the introductory sentence. B will follow D as it correctly makes a link with the 'priority' mentioned in D. A will come next as it explains why 'this planning (mentioned in B)' may go wrong. E will fall next as it tries to find the solution by asking two important questions. Finally, C with the two questions will conclude the paragraph.

62. **(d)** Relation - surrounded object - surroundings; an island is a piece of land surrounded by water on all sides as an oasis is surrounded by desert on all sides.

63. **(a)** 'Break down' means 'fail or to cease to function'; 'break out' means 'escape, especially forcefully or defiantly'; 'break even' means 'neither gain nor lose money' and 'break away' means 'become separated, literally or figuratively'. Hence, option (a) is the correct answer.

64. **(b)** The passage reveals that Samantha had mentioned she was considering making personal sacrifices to fund the charity event, and guests remarked that the event was more elaborate than usual. This indicates that Samantha was committed to the success of the event and willing to go to great lengths, including making personal sacrifices, to ensure it met her high standards and benefited the animal shelter.

65. **(a)** Sovereignty

66. **(a)** He likes to be called Sir by people.

67. **(d)** Someone has cut the telegraph wires.

68. **(a)** He was so filled with contempt for the prisoner that he gave him a **humiliated** look.

69. **(c)** Speak in Malayalam.

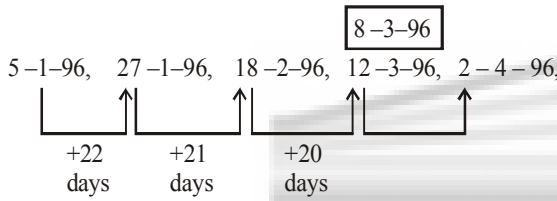
70. (b) The passage discusses how urban gardening allows city residents to grow

their own produce, thereby providing fresh and organic food, fostering community relationships, and enhancing environmental sustainability. It highlights the benefits of urban gardening and acknowledges the challenges faced but does not emphasize it as merely decorative, expensive, or a practice for rural individuals seeking city experiences. Therefore, option B best encapsulates the main points of the passage.

PART - III (B) : LOGICAL REASONING

71. (b) **72. (a)**

73. (c)



74. (d) 18 K 3 Q 7 J 2 T 8

$18 \div 3 + 7 \times 2 - 8$

$6 + 14 - 8$

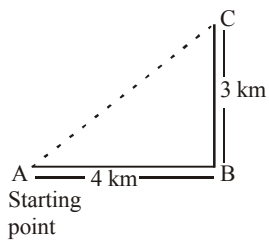
$20 - 8 = 12$

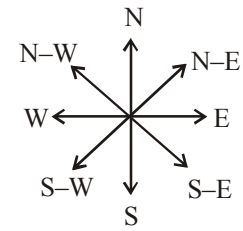
75. (a) As

where the place value of L is 12, U is 21, C is 3 and K is 11, So the last number is written with the present letter.

Same as,

76. (b)





according to the question.

by Pythagoras theorem,

$AC^2 = BC^2 + AB^2$

$AC^2 = 3^2 + 4^2$

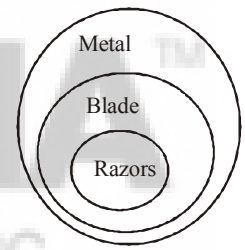
$AC^2 = 9 + 16$

$AC = \sqrt{25} = 5$ Km

So, Raju is 5 Km far from his initial point and Raju is North-East direction from initial point.

77. (a)

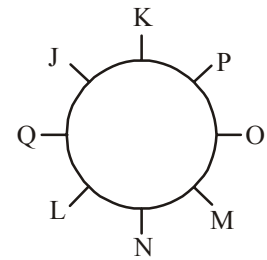
78. (c)



only conclusion 2 follows.

(Sol. 79-81):

Seating arrangement is as follows:



79. (b) **80.** (c) **81.** (d)

82. (d) The female members are:-

(i) mother

(ii) Wives of 3 married sons

(iii) unmarried daughter

(iv) 2 daughter of each of two sons
∴ Total No of females
$= 1 + 3 + 1 + 2 \times 2 = 9$

83. (c) Sister of my brother = My sister
Father of my sister = My father
Daughter of my father = My sister

84. (d) The colour of human blood is red. Here *white* means *red*. Therefore *white* is our answer.
Do not opt for *black* because *red* means *black* implies that black is called red.

85. (b) m m l l
m m l l
m m l l

(Sol. 86-87) :

B > C > D > E > A
92% 71%

86. (c) D is most likely to have scored 87% marks.

87. (d) B scored more than D. There-fore, B must have scored more than 97% marks.

88. (c) In fig (A), $(3 \times 3) + (6 \times 5) = 39$
In fig (B), $(4 \times 4) + (5 \times 7) = 51$
∴ In fig (C), missing number
$= (3 \times 4) + (5 \times 5) = 37$

89. (c) Area common to ◯ and △.

90. (a) Substitute numbers for letters :

PART - IV : MATHEMATICS

91. (d) Set created out of alphabet of word 'MONOTONE' is {M, N, O, T, E}
∴ Total number of subsets $= 2^5 = 32$

92. (d) $|8z_2z_3 + 27z_3z_1 + 64z_1z_2| = |z_1||z_2||z_3|$

$$\left|\frac{8}{z_1} + \frac{27}{z_2} + \frac{64}{z_3}\right|$$

$$= (2)(3)(4)\left|\frac{8\bar{z}_1}{|z_1|^2} + \frac{27\bar{z}_2}{|z_2|^2} + \frac{64\bar{z}_3}{|z_3|^2}\right|$$

$$= 24\left|2\bar{z}_1 + 3\bar{z}_2 + 4\bar{z}_3\right|$$

$$= 24\left|\overline{2z_1 + 3z_2 + 4z_3}\right|$$

$$= 24\left|2z_1 + 3z_2 + 4z_3\right| = (24)(4) = 96$$

93. (b) ∵ $\tan 15° = \tan(45 - 30)° = \dfrac{\sqrt{3}-1}{\sqrt{3}+1}$

∴ $\tan 15° + \tan 30° = -p$

$$\Rightarrow \quad p = \frac{-4}{\sqrt{3}\left(\sqrt{3}+1\right)}$$

$q = \tan 15° \times \tan 30°$

$$= \frac{\sqrt{3}-1}{\sqrt{3}\left(\sqrt{3}+1\right)} \Rightarrow q = \frac{\sqrt{3}-1}{\sqrt{3}\left(\sqrt{3}+1\right)}$$

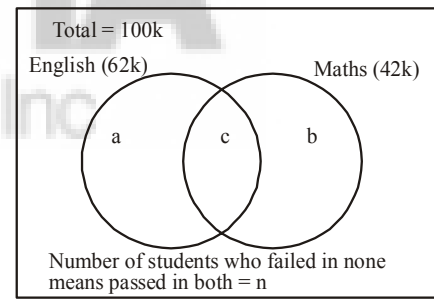
$$\therefore \quad p \cdot q = \frac{-4}{\sqrt{3}\left(\sqrt{3}+1\right)} \times \frac{\left(\sqrt{3}-1\right)}{\sqrt{3}\left(\sqrt{3}+1\right)}$$

$$\Rightarrow \quad p \cdot q = \frac{-4(\sqrt{3}-1)}{3(\sqrt{3}+1)^2} = \frac{10 - 6\sqrt{3}}{3}$$

$$\Rightarrow \quad p \cdot q = \frac{10 - 6\sqrt{3}}{3}$$

⇒ Option (b) is correct.

94 (b)



From the given condition,
a + c = 62k; b + c = 42k and c = 20k
Hence a = 42k and b = 22k
Number of students who failed in none means passed in both = n = 100k – (a + b + c)
= 100k – (42k + 22k + 20k) = 16k. or 16%

95. (a) Given function $f(x) = \sqrt{\dfrac{2x^2 - 7x + 5}{3x^2 - 5x - 2}}$

Here, f(x) should be greater than or equal to 0.

So, $2x^2-7x+5=0$

$\Rightarrow \quad 2x^2-5x-2x+5=0$

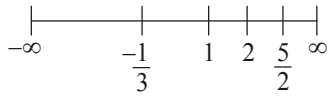
$\Rightarrow \quad (x-1)(2x-5)=0$

$\Rightarrow \quad x=1, \frac{5}{2}$

$3x^2-5x-2=0 \Rightarrow 3x^2-6x+x-2=0$

$3x(x-2)+1(x-2)=0 \Rightarrow (x-2)(3x+1)=0$

$\Rightarrow \quad x=2, \frac{-1}{3}$

Now, 

When we include $x=\frac{-1}{3}, 2$ then f(x) would give not define value so, we will exclude these values from the domain.

When we take values between $\left(-\frac{1}{3}, 1\right)$ and $\left(2, \frac{5}{2}\right)$ then it would give negative values so, these interval will not include in domain.

So, domain is $\left(-\infty, \frac{-1}{3}\right) \cup [1, 2) \cup \left[\frac{5}{2}, \infty\right)$

96. **(b)** Total number of ways such that at least 3 digits will not come in its position

$= {}^5C_3\{3! - {}^3C_1 2! + {}^3C_2 1! - {}^3C_3 0!\}$
$+ {}^5C_4\{4! - {}^4C_1(3!) + {}^4C_2(2!) - {}^4C_3(1!) + {}^4C_4(0!)\}$
$+ {}^5C_4\{5! - {}^5C_1 4! + {}^5C_2 3! - {}^5C_3 2! + {}^5C_4 1! - {}^5C_5(0!)\}$
$= 10(2) + 5(9) + (44) = 20 + 45 + 44 = 109$

97. **(d)** Given, 17^{th} and 18^{th} terms in the expansion $(2+a)^{50}$ are equal

$\therefore T_{17} = T_{18}$

$\Rightarrow {}^{50}C_{16}(2)^{34}(a)^{16} = {}^{50}C_{17}(2)^{33}(a)^{17}$

$\Rightarrow a = \frac{{}^{50}C_{16}}{{}^{50}C_{17}} \times 2 = 1$

$\therefore$ Now, coefficient of x^{35} in the expansion $(1+x)^{-2} = -36$

$\because$ Coefficient of x^r is $(r+1)$ in $(1-x)^{-2}$.

98. **(a)** By the given condition,

$\frac{a+b}{2} = 2\sqrt{ab} \Rightarrow a+b = 4\sqrt{ab}$

Now, $(a-b)^2 = (a+b)^2 - 4ab = 16ab - 4ab = 12ab$

$\therefore \quad a-b = \sqrt{12ab} = 2\sqrt{3}\sqrt{ab}.$

(Taking +ve sign only as $a > b$)

$\therefore \quad \frac{a+b}{a-b} = \frac{4\sqrt{ab}}{2\sqrt{3}\sqrt{ab}} = \frac{2}{\sqrt{3}}$

By componendo and dividendo,

$\frac{2a}{2b} = \frac{2+\sqrt{3}}{2-\sqrt{3}}$ or $\frac{a}{b} = \frac{2+\sqrt{3}}{2-\sqrt{3}}$

99. **(c)** As we know that the image of (1, 1) with respect to line $x+y+5=0$ is

$\frac{x-1}{1} = \frac{y-1}{1} = \frac{2(1+1+5)}{1+1}$

$\Rightarrow x-1=-7, y-1=-7$

$\Rightarrow x=-6, y=-6$

$\therefore$ Image of point (1, 1) is (–6, –6)

Now, distance from origin

This is the required transformed equation.

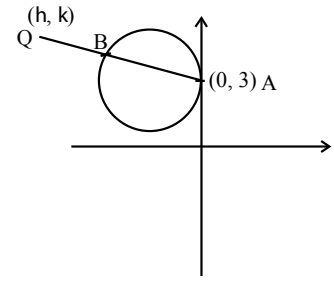
$D = \sqrt{(0+6)^2 + (0+6)^2}$

$D = \sqrt{72} = 6\sqrt{2}$

100. **(a)** Given equation of circle

$(x+2)^2 + (y-3)^2 = 4$

Let the coordinates of Q is (h, k).



Coordinate of B which is midpoint of AQ because AQ = 2AB.

Then, $B = \left(\frac{0+h}{2}, \frac{k+3}{2}\right) \to \left(\frac{h}{2}, \frac{k+3}{2}\right)$

Point B also satisfy the equation of circle.

$(x+2)^2 + (y-3)^2 = 4$

$\left(\frac{h}{2}+2\right)^2 + \left(\frac{k+3}{2}-3\right)^2 = 4$

$\frac{(h+4)^2}{4} + \frac{(k-3)^2}{4} = 4$

$(h+4)^2 + (k-3)^2 = 16$

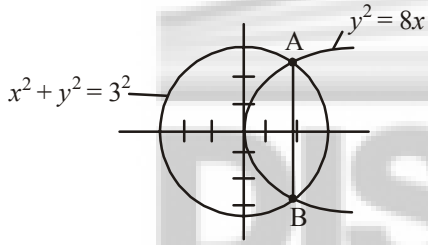
Replace (h, k) by (x, y), then, the required equation is $(x+4)^2 + (y-3)^2 = 16$.

101. (b) $-10 \le 8\sin\theta + 6\cos\theta \le 10$

$\Rightarrow 0 \le (8\sin\theta + 6\cos\theta)^2 \le 100$

$\Rightarrow 2 \le (8\sin\theta + 6\cos\theta)^2 + 2 \le 102$

102. (c)



We have : $x^2 + (8x) = 9$

$\Rightarrow x^2 + 9x - x - 9 = 0$

$\Rightarrow x(x+9) - 1(x+9) = 0$

$\Rightarrow (x+9)(x-1) = 0 \quad \Rightarrow x = -9, 1$

for $x = 1$, $y = \pm 2\sqrt{2x} = \pm 2\sqrt{2}$

L_1 = Length of AB =

$\sqrt{(2\sqrt{2}+2\sqrt{2})^2 + (1-1)^2} = 4\sqrt{2}$

L_2 = Length of latus rectum = $4a = 4 \times 2 = 8$

$L_1 < L_2$

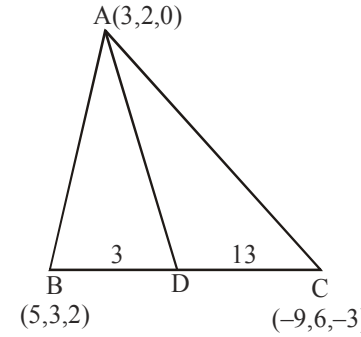
103. (b) Since AD is the bisector of $\angle$ BAC.

$\Rightarrow \frac{BD}{DC} = \frac{AB}{AC}$ ..... (i)

Now,

$AB = \sqrt{(5-3)^2 + (3-2)^2 + (2-0)^2}$

$= \sqrt{4+1+4} = \sqrt{9} = 3$



$AC = \sqrt{(-9-3)^2 + (6-2)^2 + (-3-0)^2}$

$= \sqrt{144+16+9} = 13$

$\therefore \frac{BD}{DC} = \frac{3}{13}$

Hence, D divides BC in the ratio 3 : 13

The co-ordinates of D are

$\left(\frac{3(-9)+13(5)}{3+13}, \frac{3(6)+13(3)}{3+13}, \frac{3(-3)+13(2)}{3+13}\right)$

$= \left(\frac{19}{8}, \frac{57}{16}, \frac{17}{16}\right)$

104. (a) $\lim_{n\to\infty} \prod_{r=3}^{\infty} \frac{r^3-8}{r^3+8} = \left(\frac{3^3-8}{3^3+8}\right)\left(\frac{4^3-8}{4^3+8}\right)$

$\ldots\ldots\left(\frac{n^3-8}{n^3+8}\right)$

$= \lim_{n\to\infty}\left[\frac{(3-2)(3^2+2^2+3.2)}{(3+2)(3^2+2^2-3.2)}\right]\left[\frac{(4-2)(4^2+2+4.2)}{(4+2)(4^2+2^2-4.2)}\right]$

$\ldots\ldots\left[\frac{(n-2)(n^2+2^n+n.2)}{(n+2)(n^2+2^2-n.2)}\right]$

$= \lim_{n\to\infty}\left[\frac{(3-2)(4-2).....(n-2)}{(3+2)(4+2).....(n+2)}\right]$

$\left[\frac{(3^2+2^2+3.2)(4^2+2^2+4.2).....(n^2+2^2+n.2)}{(3^2+2^2-3.2)(4^2+2^2-4.2).....(n^2+2^2-n.2)}\right]$

$$= \left[\frac{1.2.3.4.5.6.....}{5.6.7.8.....}\right]\left[\frac{19.28.39.52.63.....}{7.12.19.28.39.52.....}\right]$$

$$= \frac{2}{7}$$

105. (c) Let the items be $a_1, a_2, ..., a_n$.

then $\overline{X} = \frac{a_1 + a_2 + ... + a_n}{n}$.

Now, according to the given condition:

$$\overline{X} = \frac{(a_1 + 1) + (a_2 + 2) + ... + (a_n + n)}{n}$$

$$= \overline{X} + \frac{1 + 2 + 3 + ... + n}{n} = \overline{X} + \frac{n(n+1)}{2n}$$

(using sum of n natural nos.)

$$= \overline{X} + \frac{n+1}{2}.$$

106. (b) $n(S)$ = Total number of ways = 1000

The favourable cases that the sum of the digits of the marked number on the page is equal to 9 are one digit number or two digits numbers or three digits numbers, if three digit number is *abc*. Then,

$a + b + c = 9;\ 0 \le a, b, c \le 9.$

$\therefore$ $n(E)$ = Number of favourable ways

= Number of solutions of the equation

$= {}^{9+3-1}C_{3-1} = {}^{11}C_2 = 55$

$\therefore$ Required probability

$$= \frac{n(E)}{n(S)} = \frac{55}{1000} = \frac{11}{200}.$$

107. (c) $f(x) = \frac{x+3}{x-2}$

$\because$ $f(x)$ is not defined for $x = 2$

i.e. domain of $f(x)$ is R – {2}

$\therefore$ $l = 2$

Now, $y = \frac{x+3}{x-2}$

$xy - 2y = x + 3$

$x(y-1) = 2y + 3$

$$x = \frac{2y+3}{y-1}$$

y can take any value except $y = 1$

Co-domain = R – {1}

$m = 1$

$3l + 2m = 3(2) + 2(1) = 8$

108. (d) Since $AA^T = I$ therefore matrix A is orthogonal matrix.

Now, $A^T X^{50} A = A^T X^{49} (APA^T) A$

$= A^T X^{49} AP(A^T A) = A^T X^{49} AP$

$= A^T X^{48} (APA^T) AP = A^T X^{48} AP^2 .....$

$= A^T AP^{50} = IP^{50} = P^{50}$

$\because \quad P = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \Rightarrow P^2 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$

$\Rightarrow \quad P^3 = \begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix} .....$

$\Rightarrow \quad P^{50} = \begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix}$

So, $A^T X^{50} A = P^{50} = \begin{bmatrix} 1 & 50 \\ 0 & 1 \end{bmatrix}$

109. (b) Let the observations be $x_1, x_2, ..., x_{20}$ and $\overline{x}$ be their mean. Given that, variance = 5 and n = 20. We know that,

$$\text{Variance } (\sigma^2) = \frac{1}{n}\sum_{i=1}^{20} (x_i - \overline{x})^2$$

$$\text{i.e. } 5 = \frac{1}{20}\sum_{i=1}^{20} (x_i - \overline{x})^2$$

$$\text{or } \sum_{i=1}^{20} (x_i - \overline{x})^2 = 100 \qquad ...(i)$$

If each observation is multiplied by 2 and the new resulting observations are y_i, then

$y_i = 2x_i$ i.e., $x_i = \frac{1}{2} y_i$.

Therefore,

$$\bar{y} = \frac{1}{n}\sum_{i=1}^{20} y_i = \frac{1}{20}\sum_{i=1}^{20} 2x_i = 2.\frac{1}{20}\sum_{i=1}^{20} x_i$$

i.e., $\bar{y} = 2\bar{x}$ or $\bar{x} = \frac{1}{2}\bar{y}$.

On substituting the values of x_i and $\bar{x}$ in eq. (i), we get

$$\sum_{i=1}^{20}\left(\frac{1}{2}y_i - \frac{1}{2}\bar{y}\right)^2 = 100$$

i.e., $\sum_{i=1}^{20}(y_i - \bar{y})^2 = 400$.

Thus, the variance of new observations

$$= \frac{1}{20}\times 400 = 20 = 2^2 \times 5.$$

110. (b) Given $f(x) = \sin x$, $g(x) = \cos x$, $h(x) = x^2$

$$\lim_{x\to 1}\frac{f\left(g\left(h(x)\right)\right) - f\left(g\left(h(1)\right)\right)}{x-1}$$

$$\lim_{x\to 1}\frac{\sin\left(\cos x^2\right) - \sin\left(\cos 1\right)}{x-1}$$

If Apply limit it gives $\frac{0}{0}$ form, then apply L'Hospital rule.

$$\Rightarrow \lim_{x\to 1}\frac{\cos\left(\cos x^2\right)\left(-\sin x^2\right)(2x) - 0}{1-0}$$

Apply the limit,

$\Rightarrow -2(1)\sin(1)\cos(\cos 1)$

$= -2\sin(1)\cos(\cos 1)$

111. (a) We have

$$\cos\left(\cot^{-1}\left(\frac{1}{2}\right)\right) = \cot(\cos^{-1} x)$$

Let $\cot^{-1}\left(\frac{1}{2}\right) = \alpha \Rightarrow \cot\alpha = \frac{1}{2} \Rightarrow \cos^{-1}\frac{1}{\sqrt{5}}$

$$\Rightarrow \cos\left(\cos^{-1}\frac{1}{\sqrt{5}}\right) = \cot\left(\cot^{-1}\frac{x}{\sqrt{1-x^2}}\right)$$

$$\Rightarrow \frac{1}{\sqrt{5}} = \frac{x}{\sqrt{1-x^2}} \quad \Rightarrow \sqrt{1-x^2} = \sqrt{5}x$$

On squaring both sides, we get,

$$1 - x^2 = 5x^2 \Rightarrow 1 = 6x^2$$

$$\Rightarrow x = \pm\frac{1}{\sqrt{6}}$$

$$\therefore x = \frac{1}{\sqrt{6}} \qquad \text{[neglecting –ve sign]}$$

112. (c) $|\text{adj}(\text{adj } A^2)| =$

$|\text{adj } A| = |A|^{n-1} = |A|^2$

$|\text{adj } A^2| = |\text{adj } A|^2 = (|A|^2)^2 = |A|^4$

$|\text{adj}(\text{adj } A^2)| = (|A|^4)^{3-1}$

$= (|A|^4)^2 = |A|^8$

113. (b) For getting infinite solutions $D = 0$, $D_1 = D_2 = D = 0$ then check all the three equations

Let $\Delta = \begin{vmatrix} 2 & 1 & -1 \\ 1 & -3 & 2 \\ 1 & 4 & \delta \end{vmatrix} = 0 \quad \Rightarrow \delta = -3$

And $\Delta_1 = \begin{vmatrix} 7 & 1 & -1 \\ 1 & -3 & 2 \\ k & 4 & -3 \end{vmatrix} = 0 \Rightarrow k = 6$

$\Rightarrow \delta + k = 3$

114. (a) Given that, $f(x) = \sin x + \cos x$

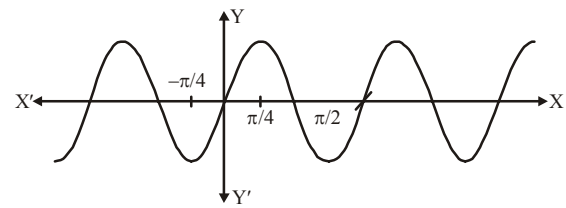
$g(x) = x^2 - 1$

$g[f(x)] = (\sin x + \cos x)^2 - 1$

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

$= 1 + \sin 2x - 1 = \sin 2x$

($\because \sin^2 x + \cos^2 x = 1$, $\sin x = 2\sin x\cos x$)



Among the given options, $\sin 2x$ is monotonous (here strictly increasing) in $-\frac{\pi}{4} \le x \le \frac{\pi}{4}$.

So, $g(f(x))$ is invertible in $-\frac{\pi}{4} \le x \le \frac{\pi}{4}$.

115. (a) Here, $f(x)$ is continuous on the interval $[0, 8]$.
So it will also be continuous on 2 and 4.
At $x = 2$,

$$\lim_{x \to 2^-} f(x) = \lim_{x \to 2^+} f(x)$$

$$\lim_{x \to 2^-} (x^2 + ax + b) = \lim_{x \to 2^+} (3x + 2)$$

$$4 + 2a + b = 3(2) + 2$$

$$\therefore 2a + b = 4 \quad \ldots(i)$$

At $x = 4$,

$$\lim_{x \to 4^-} f(x) = \lim_{x \to 4^+} f(x)$$

$$\lim_{x \to 4^-} (3x + 2) = \lim_{x \to 4^+} 2ax + 5b$$

$$3(4) + 2 = 2a(4) + 5b$$

$$\therefore 8a + 5b = 14 \quad \ldots(ii)$$

On solving Eqs. (i) and (ii), we get
$a = 3$ and $b = -2$.

116. (b) Given, $y = \tan^{-1}\frac{1}{x^2 + x + 1}$

$$+ \tan^{-1}\frac{1}{x^2 + 3x + 3} + \tan^{-1}\frac{1}{x^2 + 5x + 7} + \cdots\cdots$$

to n terms

$$= \tan^{-1}\left\{\frac{1}{1 + x(x+1)}\right\} + \tan^{-1}\left\{\frac{1}{1 + (x+1)(x+2)}\right\}$$

$$+ \tan^{-1}\left\{\frac{1}{1 + (x+2)(x+3)}\right\}$$

$$+ \ldots\ldots\ldots + \tan^{-1}\left\{\frac{1}{1 + (x + (n-1))(x+n)}\right\}$$

$$= \tan^{-1}\left\{\frac{(x+1) - x}{1 + (x+1)x}\right\}$$

$$+ \tan^{-1}\left\{\frac{(x+2) - (x+1)}{1 + (x+2)(x+1)}\right\}$$

$$+ \tan^{-1}\left\{\frac{(x+3) - (x+2)}{1 + (x+3)(x+2)}\right\}$$

$$+ \ldots\ldots + \tan^{-1}\left\{\frac{(x+n) - (x+n-1)}{1 + (x+n)(x+n-1)}\right\}$$

$$\therefore y = \{\tan^{-1}(x+1) - \tan^{-1}(x)\}$$

$$+ \{\tan^{-1}(x+2) - \tan^{-1}(x+1)\}$$

$$+ \{\tan^{-1}(x+3) - \tan^{-1}(x+2)\}$$

$$+ \ldots\ldots\ldots + \{\tan^{-1}(x+n) - \tan^{-1}[x + (n-1)]\}$$

So, $y = \tan^{-1}(x+n) - \tan^{-1}(x)$

On differentiating both sides w.r.t. x, we get

$$\frac{dy}{dx} = \frac{1}{1 + (x+n)^2} - \frac{1}{1 + x^2}$$

117. (c) Given that $g(u) = 2\tan^{-1}(e^u) - \frac{\pi}{2}$

$$\therefore \quad g(-u) = 2\tan^{-1}\left(e^{-u}\right) - \frac{\pi}{2} =$$

$$2\tan^{-1}\left(\frac{1}{e^u}\right) - \frac{\pi}{2}$$

$$= 2\cot^{-1}\left(e^u\right) - \frac{\pi}{2} = 2\left[\frac{\pi}{2} - \tan^{-1}\left(e^u\right)\right] - \frac{\pi}{2}$$

$$= \pi - 2\tan^{-1}(e^u) - \frac{\pi}{2}$$

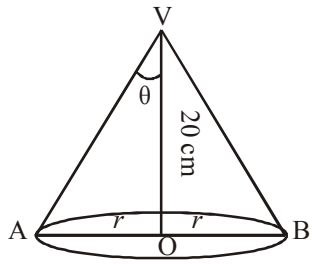
$$= \frac{\pi}{2} - 2\tan^{-1}(e^u) = -g(u)$$

$\therefore$ g is an odd function.

Also $g'(u) = \frac{2e^u}{1 + e^{2u}} > 0$, $\forall u \in (-\infty, \infty)$

$\therefore$ g is strictly increasing on $(-\infty, \infty)$.

118. (b) Let θ be the semi-vertical angle and r be the radius of the cone at time t.
Then, $r = 20 \tan \theta$



$$\Rightarrow \quad \frac{dr}{dt} = 20 \sec^2 \theta \frac{d\theta}{dt}$$

$$\Rightarrow \quad \frac{dr}{dt} = 20 \sec^2 30^\circ \times 2$$

$$\left[\because \theta = 30^\circ \text{ and } \frac{d\theta}{dt} = 2\right]$$

$$\Rightarrow \quad \frac{dr}{dt} = 20 \times \frac{4}{3} \times 2 \text{ cm/s} = \frac{160}{3} \text{ cm/s}$$

119. (a) Correct result is $(\sim p \vee \sim q) \Rightarrow (r \wedge s)$

So, $\sim (p \wedge q) \Rightarrow (r \wedge s)$

120. (d) $\int \sqrt{x + \sqrt{x^2 + 2}}\, dx$

$$\sqrt{x + \sqrt{x^2 + 2}} = t \Rightarrow x + \sqrt{x^2 + 2} = t^2$$

$$\sqrt{x^2 + 2} = t^2 - x$$

$$\Rightarrow x^2 + 2 = t^4 + x^2 - 2t^2 x$$

$$\Rightarrow x = \frac{t^4 - 2}{2t^2} \Rightarrow dx = \frac{t^4 + 2}{t^3} dt$$

$$\int t . \frac{t^4 + 2}{t^3} dt = \int \left(t^2 + \frac{2}{t^2}\right) dt = \frac{t^3}{3} - \frac{2}{t} + C$$

$$= \frac{t^3}{3} - \frac{2}{t} + C = \frac{t^4 - 6}{3t} + C$$

$$= \frac{(x + \sqrt{x^2 + 2})^2 - 6}{3\sqrt{x + \sqrt{x^2 + 2}}} + C$$

121. (c) Here f(x) is continous $\forall x \in \mathbf{R}$

Now At $x = -\sqrt{5}$

L.H.D = 0

R.H.D = $2x = -2\sqrt{5}$

$\Rightarrow$ f(x) is not differentiable at $x = -\sqrt{5}$

At $x = \sqrt{5}$

L.H.D. = $2x = 2\sqrt{5}$

R.H.D. = 0

$\Rightarrow$ f(x) is not differentiable at $x = \sqrt{5}$

$\Rightarrow k = 2$

$k - 2 = 2 - 2 = 0$

122. (a) Here $\frac{d^2y}{dx^2} = n(n-1)(x-a)^{n-2}$

Now, $\frac{d^2y}{dx^2} = 0 \Rightarrow x = a$

Differentiating equation of the curve n times, we get, $\frac{d^n y}{dx^n} = n!$

$\therefore$ at $x = a$, $\frac{d^n y}{dx^n} \neq 0$ and $\frac{d^{n-1} y}{dx^{n-1}} = 0$,

where n is odd.
Therefore $(a, 0)$ is the point of inflexion

123. (b) Let $I = \int_0^{\frac{\pi}{2}} \frac{\sin\left(\frac{\pi}{4} + x\right) + \sin\left(\frac{3\pi}{4} + x\right)}{\cos x + \sin x} dx$

$$\Rightarrow I = \int_0^{\pi/2} \frac{\sin\left(\frac{3\pi}{4} - x\right) + \sin\left(\frac{5\pi}{4} - x\right)}{\sin x + \cos x} dx$$

$$\Rightarrow I = \int_0^{\pi/2} \frac{\sin\left(\frac{\pi}{4} + x\right) - \sin\left(\frac{3\pi}{4} + x\right)}{\cos x + \sin x} dx$$

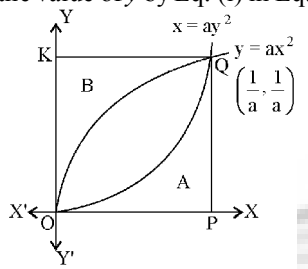
Now $I + I = \int_0^{\pi/2} \frac{2\sin\left(\frac{\pi}{4}+x\right)}{\cos x + \sin x} dx$

$\Rightarrow I = \int_0^{\pi/2} \frac{\frac{1}{\sqrt{2}}\cos x + \frac{1}{\sqrt{2}}\sin x}{\cos x - \sin x} dx = \frac{\pi}{2\sqrt{2}}$

124. (b) We have given, $y = ax^2$ ...(i)

and $x = ay^2$ ...(ii)

Put the value of y by Eq. (i) in Eq. (ii), we get



$x = a \times a^2 x^4 \Rightarrow x^4 a^3 - x = 0$

$x(x^3 a^3 - 1) = 0 \Rightarrow x = 0, \frac{1}{2}$

When, $x = 0 \Rightarrow y = 0$ and $x = \frac{1}{a} \Rightarrow y = \frac{1}{a}$

Here, points of intersection of curves $y = ax^2$ and $x = ay^2$ are (0, 0) and $\left(\frac{1}{a}, \frac{1}{a}\right)$.

∴ Required area

$A = \int_{x=a}^{x=b} [f_2(x) - f_1(x)]\, dx$

$3 = \int_0^{1/a} \left(\frac{\sqrt{x}}{\sqrt{a}} - ax^2\right) dx$

$3 = \left[\frac{1}{\sqrt{a}} \times \frac{2}{3} x^{3/2} - \frac{ax^3}{3}\right]_0^{1/a}$

$3 = \frac{2}{3\sqrt{a}}\left[\left(\frac{1}{a}\right)^{3/2}\right] - \frac{a}{3}\left[\left(\frac{1}{a}\right)^3\right]$

$3 = \frac{2}{3\sqrt{a}} \times \frac{1}{a\sqrt{a}} - \frac{a}{3} \times \frac{1}{a^3}$

$3 = \frac{2}{3a^2} - \frac{1}{3a^2} \Rightarrow 3 = \frac{2-1}{3a^2} \Rightarrow 9a^2 = 1$

$a^2 = \frac{1}{9} \Rightarrow a = \frac{1}{3}$

125. (c) Given statement $S_1 : (\sim p \vee q) \vee (\sim p \vee r)$

$\equiv \sim p \vee (q \vee r)$

$S_2 : p \to (q \vee r)$

$\equiv \sim p \vee (q \vee r) \to$ By conditional law

$S_1 \equiv S_2$

126. (d) Let $I = \int e^{\tan\theta}(\sec\theta - \sin\theta) d\theta$

Put $\tan\theta = t \Rightarrow \sec^2\theta\, d\theta = dt \Rightarrow d\theta = \frac{dt}{1+t^2}$

$\Rightarrow I = \int e^t \left(\sqrt{1+t^2} - \frac{t}{\sqrt{1+t^2}}\right) \frac{dt}{1+t^2}$

$= \int e^t \left(\frac{1}{\sqrt{1+t^2}} - \frac{t}{(1+t^2)^{3/2}}\right) dt$

Integrating first part by parts we have,

$= \frac{1}{\sqrt{1+t^2}} e^t + \int \frac{t}{(1+t^2)^{3/2}} . e^t dt$

$- \int \frac{t}{(1+t^2)^{3/2}} e^t dt + c$

$= \frac{e^t}{\sqrt{1+t^2}} + c = e^{\tan\theta}\cos\theta + c$

127. (a) Given differential equation is

$$\frac{dp(t)}{dt} = 0.5p(t) - 450$$

$$\Rightarrow \frac{dp(t)}{dt} = \frac{1}{2}p(t) - 450$$

$$\Rightarrow \frac{dp(t)}{dt} = \frac{p(t) - 900}{2}$$

$$\Rightarrow 2\frac{dp(t)}{dt} = -\left[900 - p(t)\right]$$

$$\Rightarrow 2\frac{dp(t)}{900 - p(t)} = -dt$$

Integrate both the side, we get :

$$-2\int \frac{dp(t)}{900 - p(t)} = \int dt$$

Let $900 - p(t) = u \Rightarrow -dp(t) = du$

$\therefore$ We have; $2\int \frac{du}{u} = \int dt \Rightarrow 2\, ln\, u = t + c$

$\Rightarrow 2ln[900 - p(t)] = t + c$ when $t = 0, p(0) = 850$

$$2\, ln(50) = c \Rightarrow 2\left[\ln\left(\frac{900 - p(t)}{50}\right)\right] = t$$

$$\Rightarrow 900 - p(t) = 50e^{\frac{t}{2}}$$

$$\Rightarrow p(t) = 900 - 50e^{\frac{t}{2}}$$

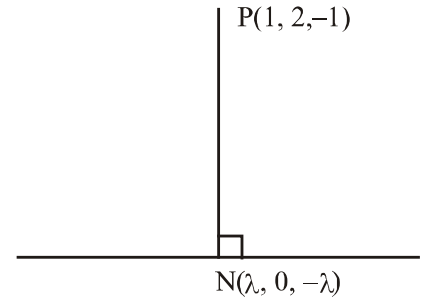
let $p(t_1) = 0$

$$0 = 900 - 50e^{\frac{t_1}{2}} \quad \therefore \quad t_1 = 2ln\,18$$

128. (c) Let $\frac{x}{1} = \frac{y}{0} = \frac{z}{-1} = \lambda$

$\Rightarrow N(\lambda, 0, -\lambda)$

$\vec{b} = \hat{i} - \hat{k}$



$\because \overrightarrow{PN} \cdot \vec{b} = 0$

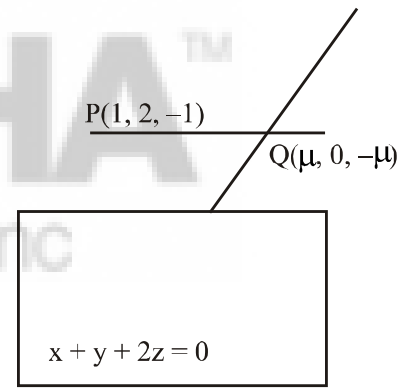
$\Rightarrow 1(1 - \lambda) - (\lambda - 1) = 0 \Rightarrow \lambda = 1$

$\Rightarrow N(1, 0, -1)$

Let $Q(\mu, 0, -\mu)$

$\because \vec{n} = \hat{i} + \hat{j} + 2\hat{k}$

Now,



$\because \overrightarrow{PQ} \cdot \vec{n} = 0$

$\Rightarrow \mu = -1$

$\Rightarrow Q(-1, 0, 1)$

$\overrightarrow{PN} = 2\hat{j}$ and $\overrightarrow{PQ} = 2\hat{i} + 2\hat{j} - 2\hat{k}$

$$\Rightarrow \cos\alpha = \frac{1}{\sqrt{3}}$$

129. (d)

$$P\left(\frac{B}{A}\right)=\frac{1}{2}\Rightarrow\frac{P(B\cap A)}{P(A)}=\frac{1}{2}\Rightarrow P(B\cap A)=\frac{1}{8}$$

$$P\left(\frac{A}{B}\right)=\frac{1}{4}\Rightarrow\frac{P(A\cap B)}{P(B)}=\frac{1}{4}\Rightarrow P(B)=\frac{1}{2}$$

$$P(A\cap B)=\frac{1}{8}=P(A).P(B)$$

$\therefore$ Events A and B are independent.

Now, $P\left(\frac{A'}{B}\right)=\frac{P(A'\cap B)}{P(B)}=\frac{P(A')P(B)}{P(B)}=\frac{3}{4}$

and $P\left(\frac{B'}{A'}\right)=\frac{P(B'\cap A')}{P(A')}=\frac{P(B')P(A')}{P(A')}=\frac{1}{2}$

130. (c) Given propositions $P_1:\sim(p\rightarrow\sim q)$

$P_2:\ (p\wedge\sim q)\wedge((\sim p)\vee q)$

Required table is shown below.

p	q	$\sim p$	$\sim q$	$\sim p\vee q$	$p\rightarrow(\sim p\vee q)$	$p\rightarrow\sim q$	$\sim(p\rightarrow\sim q)$	$p\wedge\sim q$	$(p\wedge\sim q)\wedge((\sim p)\vee q)$
T	T	F	F	T	T	F	T	F	F
T	F	F	T	F	F	T	F	T	F
F	T	T	F	T	T	T	F	F	F
F	F	T	T	T	T	T	F	F	F