Solved Paper 2013*

Instructions

- There are 150 questions in all. The number of questions in each part is as given below.

		No. of Questions
Part I	Physics	1–40
Part II	Chemistry	41–80
Part III	a. English Proficiency	81–95
	b. Logical Reasoning	96–105
Part IV	Mathematics	106–150

- All questions are Multiple Choice Questions having four options out of which **only one** is correct.
- Each correct answer fetches 3 marks while incorrect answer has a penalty of 1 mark.
- Time allotted to complete this paper is 3 hrs.

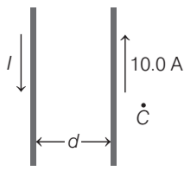
PART I

Physics

1. A square shape current loop of side length l and carrying current I lies in a uniform magnetic field B acting perpendicular to the plane of square loop and directed inward. The net magnetic force acting on current loop is

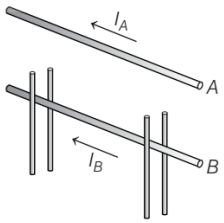
a. lBL ***b.*** $4IBL$ ***c.*** zero ***d.*** $2IBL$

2. Two parallel conductors carry current in opposite directions, as shown in figure. One conductor carries a current of 10.0 A. Point C is a distance $d/2$ to the right of the 10.0 A current. If $d = 18$ cm and l is adjusted so that the magnetic field at C is zero, the value of the current I is



a. 10.0 A ***b.*** 30.0 A
c. 8.0 A ***d.*** 18.0 A

3. Two long, parallel conductors carry currents in the same direction, as shown in figure. Conductor A carries a current of 100 A and is held firmly in position. Conductor B carries a current I_B and is allowed to slide freely up and down (parallel to A) between a set of non-conducting guides. The mass per unit length of conductor B is 0.1 g/cm and the distance between the two conductors is 5 cm. If system of conductors is in equilibrium, then the value of current I_B is



a. 250 A ***b.*** 240 A ***c.*** 220 A ***d.*** 230 A

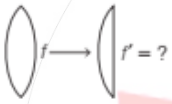
4. The number of photo electrons in a photoelectric effect experiment depends on the
a. frequency of light *b.* intensity of light
c. Both (a) and (b) *d.* Neither (a) nor (b)

5. In hydrogen atom, if $\lambda_1, \lambda_2, \lambda_3$ are shortest wavelengths in Lyman, Balmer and Paschen series respectively, then $\lambda_1 : \lambda_2 : \lambda_3$ equals
a. 1 : 4 : 9 *b.* 9 : 4 : 1
c. 1 : 2 : 3 *d.* 3 : 2 : 1

6. Half-lives of elements A and B are 1 h and 2 h, respectively. Which one of the following is correct?
a. Element A decays slower
b. Decay constant of A is smaller
c. If initial number of nuclei are same, then activity of A is more
d. Mean life of A is more

7. A glass piece is dipped in a liquid of refractive index 4/3, it gets dissappeared in the liquid. The refractive index of the glass piece is
a. $\frac{3}{4}$ *b.* $\frac{5}{3}$ *c.* $\frac{4}{5}$ *d.* $\frac{4}{3}$

8.

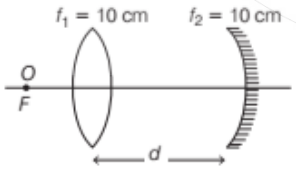


If the bio-convex lens is cut as shown in the figure, then the new focal length f' is
a. $2f$ *b.* f *c.* $f/2$ *d.* infinite

9. Refractive index of a medium depends
a. on the medium only
b. on the incident light only
c. Both (a) and (b)
d. None of the above

10. A point object is placed at the focus of a convex mirror. The image will be formed at
a. infinity *b.* centre of curvature
c. at focus itself *d.* None of these

11.

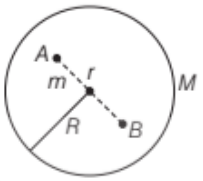


A point object is placed at the focus of the bi-convex lens. What should be the value of d, so the final image forms at infinity?
a. 10 cm *b.* 20 cm
c. 15 cm *d.* None of these

12. The image formed by a concave spherical mirror
a. is always virtual
b. is always real
c. is always inverted
d. may be erect

13. The total energy of a revolving satellite around the earth is $-k$ J. The minimum energy required to throw it out of earth's gravitational fields, is
a. k J *b.* $\frac{k}{2}$ J
c. $2k$ J *d.* None of these

14.



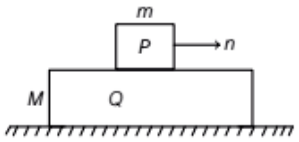
There is a shell of mass M and density of shell is uniform. The work done to take a point mass from point A to B is ($AB = r$)
a. $\frac{GmM}{r}$ *b.* $\frac{GmM}{R}$
c. $-\frac{GmM}{r}$ *d.* zero

15. A body of mass $m = 20$ g is attached to an elastic spring of length $L = 50$ cm and spring constant $k = 2\ \text{Nm}^{-1}$. The system is revolved in a horizontal plane with a frequency $v = 30$ rev/min. Find the radius of the circular motion and the tension in the spring.
a. 0.25 m, 0.1 N
b. 0.5 m, 0.52 N
c. 0.55 m, 0.1 N
d. 0.9 m, 0.2 N

16. A gramophone record of mass M and radius R is rotating at an angular velocity ω. A coin of mass m is gently placed on the record at a distance $r = R/2$ from its centre. The new angular velocity of the system is
a. $\frac{2\omega M}{(2M + m)}$ *b.* $\frac{2\omega M}{(M + 2m)}$
c. ω *d.* $\frac{\omega M}{m}$

17. A block of mass $m = 1$ kg is placed over a plank Q of mass $M = 6$ kg, placed over a smooth horizontal surface as shown in figure. Block P is given a velocity $v = 2\ \text{m/s}^2$ to the right.

If the coefficient of friction between P and Q is $\mu = 0.3$. Find the acceleration of Q relative to P.



a. $4\ m/s^2$ **b.** $3.5\ m/s^2$
c. $2\ m/s^2$ **d.** $10.0\ m/s^2$

18. A man runs at a speed of 4 m/s to overtake a standing bus. When he is 6 m behind the door at $t = 0$, the bus moves forward and continuous with a constant acceleration of $1.2\ m/s^2$. The man reaches the door in time t. Then

a. $4t = 6 + 0.6\,t^2$
b. $1.2\,t^2 = 4t$
c. $4t^2 = 1.2\,t$
d. $6 + 4t = 0.2\,t^2$

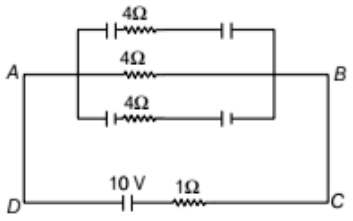
19. In completly inelastic collision

a. the complete KE of the medium must lost
b. the linear momentum of the system must remain conserved during collision
c. Both (a) and (b)
d. Neither (a) nor (b)

20. The number of particles per unit volume is given by $n = -\dfrac{D(n_2 - n_1)}{x_2 - x_1}$ are crossing a unit area perpendicular to X-axis in unit time, when n_1 and n_2 are the number of particles per unit volume for the values x_1 and x_2 of x, respectively. Then, the dimensional formula of diffusion constant D is

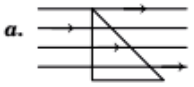
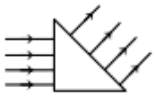
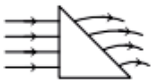
a. $[LT^0]$ **b.** $[L^2T^{-4}]$
c. $[LT^{-3}]$ **d.** $[L^2T^{-1}]$

21. In the given circuit (as shown in figure). Each capacitor has a capacity of $3\ \mu F$. What will be the net charge on each capacitor?



a. $48\ \mu C$ **b.** $24\ \mu C$
c. $12\ \mu C$ **d.** None of these

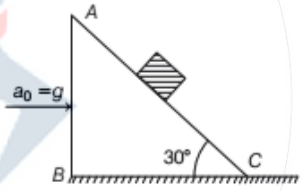
22. A solid conductor is placed in an uniform electric field as shown in figure. Which path will the lines of force follow?

a. 
b. 
c. 
d. 

23. A bomb at rest explodes into three parts of the same mass. The linear momentum of two parts are $-2P\,\hat{\mathbf{i}}$ and $P\,\hat{\mathbf{j}}$. The magnitude of momentum of third part is $P\sqrt{x}$. Find x.

a. 1 **b.** 5 **c.** 2 **d.** 10

24. Block is placed on an inclined plane. The block is moving towards right horizontally with an acceleration $a_0 = g$. The length of the inclined plane (AC) is equal to 1 m. Whole the situation are shown in the figure. Assume that, all the surfaces are frictionless. The time taken by the block to reach from C to A is (Take, $g = 10\ m/s^2$)

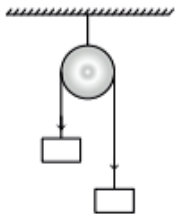


a. 0.74 s **b.** 0.9 s **c.** 0.52 s **d.** 1.24 s

25. Pseudo force is

a. electromagnetic in nature **b.** a nuclear force
c. a gravitational force **d.** None of these

26. A light in extensible string that goes over a smooth fixed pulley as shown in the figure connect two blocks of masses 0.36 kg and 0.72 kg. Taking, $g = 10\ m/s^2$. Find the work done by string on the block of mass 0.36 kg during the first second after the system is released from rest.



a. 4 J **b.** 2 J **c.** 8 J **d.** 10 J

27. In the equation $A = 3BC^2$, A and C have dimensions of capacitance and magnetic induction respectively. In MKS system, the dimensional formula of B is

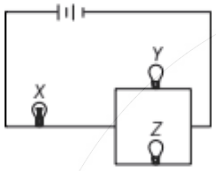
a. $[M^{-3}L^{-2}T^{-2}Q^{-4}]$ *b.* $[ML^{-2}]$

c. $[M^{-3}L^{-2}Q^{4}T^{8}]$ *d.* $[M^{-3}L^{-2}Q^{4}T^{4}]$

28. Infinite number of masses each 1 kg are placed along the x-axis at $x = \pm 1$ m, ± 2 m, ± 4m, ± 8m, ± 16m ..... The magnitude of the resultant gravitational potential in terms of gravitational constant G at the origin ($x = 0$) is

a. $G/2$ *b.* G *c.* $2G$ *d.* $4G$

29. Three bulbs X, Y and Z are connected as shown in figure. The bulbs Y and Z are identical. If bulb Z gets fused then,



a. Both X and Y will glow more brightly

b. Both X and Y will glow less brightly

c. X will glow less brightly and Y will glow more brightly

d. X will glow more brightly and Y will glow less brightly

30. Active state of n-p-n transistor, in circuit is achieved by

a. low input voltage *b.* high input voltage

c. Both (a) and (b) *d.* Neither (a) nor (b)

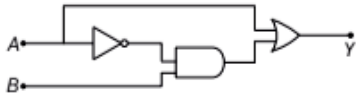
31. A turntable of radius $R = 10$ m is rotation making 98 rev in 10 s with a boy of mass $m = 60$ kg standing at its centre. He starts running along a radius. Find the frequency of the turntable when the boy is 4 m from the centre. The moment of inertia of the turntable about its axis 1000 kg-m^2.

a. 10 Hz *b.* 2.5 Hz *c.* 5 Hz *d.* 4 Hz

32. To transmit a signal, if height of transmitting signal above surface of the earth is H, this signal can be received on surface of the earth upto distance d from transmitter. Then

a. $d \propto H$ *b.* $d \propto H^2$ *c.* $d \propto H^{1/2}$ *d.* $d \propto H^{3/2}$

33. The circuit is equivalent to



a. AND gate *b.* OR gate

c. Not gate *d.* None of these

34. Length of 20 cm (exact) long pipe is measured by two instruments and reported as 19.65 cm and 20.1 cm

a. 19.65 cm is more accurate

b. both measurements are equally precise

c. both measurements are equally accurate

d. 20.1 cm is less precise

35. An electric pump on the ground floor of a building takes 10 min to fill a tank of volume 2000 L with water. If the tank is 40 m above the ground and the efficiency of the pump is 40%, how much electric power is consumed by the pump in filling the tank?
[Take, $g = 10$ m/s^2]

a. 2 kW *b.* 3.33 kW

c. 4 kW *d.* 6 kW

36. A vessel containing 1 mole of O_2 gas (molar mass 32) at temperature T. The pressure of the gas is p. An identical vessel containing one mole of He gas (molar mass 4) at temperature $2T$ has a pressure of

a. $p/8$ *b.* p

c. $2p$ *d.* $8p$

37. The temperature of an ideal gas is increased from 27°C to 127°C, then percentage increase in v_{rms} is

a. 37 % *b.* 11%

c. 33% *d.* 15.5%

38. A particle of mass $m = 5$ g is executing simple harmonic motion with an amplitude 0.3 m and time period $\pi/5$ s. The maximum value of force acting on the particle is

a. 5 N *b.* 4 N

c. 0.5 N *d.* 0.15 N

39. A partition wall has two layers of different materials A and B in contact with each other. They have the same thickness but the thermal conductivity of layer A is twice that of B. At steady state if the temperature difference across the layer B is 50 K, then the corresponding difference across the layer A is

a. 50 K *b.* 12.5 K

c. 25 K *d.* 60 K

40. Pulse rate of a normal person is 75 per min. The time period of heart is

a. 0.8 s *b.* 0.75 s *c.* 1.25 s *d.* 1.75 s

Chemistry

41. For the properties mentioned, the correct trend for the different species is in

a. strength of Lewis acid— $BCl_3 > AlCl_3 > GaCl_3$

b. inert pair effect— Al> Ga> In

c. oxidising property— $Al^{3+} > In^{3+} > Tl^{3+}$

d. first ionisation enthalpy— B> Al> Tl

42. Bohr's theory is applicable to

a. He *b.* Li^{2+}

c. He^{2+} *d.* None of these

43. Using MOT, which of the following pair denotes paramagnetic species

a. B_2 and C_2 *b.* B_2 and O_2

c. N_2 and C_2 *d.* O_2 and O_2^{2-}

44. 0.1 g of metal combines with 46.6 mL of oxygen at STP. The equivalent weight of metal is

a. 12 *b.* 24

c. 18 *d.* 36

45. Which of the following choice represent correct order of first ionisation enthalpy ?

a. B < C < N < O < F *b.* B > C > N > O > F

c. B < C < N > O < F *d.* B < C < N > O > F

46. Which of the following reactant produces most stable alkene on treatment with base?

a. 2-chlorobutane

b. 2, 3-dichlorobutane

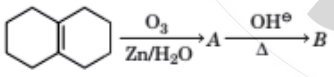
c. 2, 2-dichlorobutane

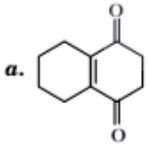
d. 2, 3-dichloro-2, 3-dimethylbutane

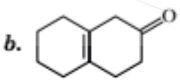
47. Which of the following is more acidic among the given halogen compounds?

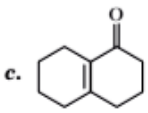
a. CHF_3 *b.* CHI_3 *c.* $CHCl_3$ *d.* $CHBr_3$

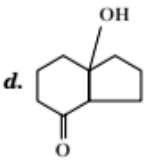
48. What will be the final product of the reaction ?



a. 

b. 

c. 

d. 

49. The vapour pressure of a solvent decreased by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of solute in solution is 0.2, what would be the mole fraction of solvent, if the decrease in vapour pressure is 20 mm of Hg ?

a. 0.8 *b.* 0.6 *c.* 0.4 *d.* 0.3

50. Choose the law that corresponds to data shown for the following reaction, $A + B \rightarrow$ products

Exp.	[A]	[B]	Initial rate
1	0.012	0.035	0.1
2	0.024	0.070	0.8
3	0.024	0.035	0.1
4	0.012	0.070	0.8

a. Rate = $k[B]^3$ *b.* Rate = $k[B]^4$

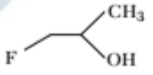
c. Rate = $k[A][B]^3$ *d.* Rate = $k[A]^3[B]$

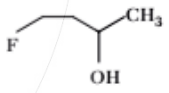
51. The magnitude of Δ_o will be highest in which of the following complex?

a. $[Cr(CN)_6]^{3-}$ *b.* $[Cr(H_2O)_6]^{3+}$

c. $[Cr(NH_3)_6]^{3+}$ *d.* $[Cr(C_2O_4)_3]^{3-}$

52. Arrange these in correct order of decreasing reactivity.





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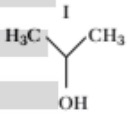
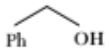


III



IV

a. I > II > III > IV *b.* I > III > II > IV

c. IV > III > II > I *d.* IV > III > I > II

53. When 2-methyl propan-1-ol is treated with a mixture of conc. HCl and $ZnCl_2$, turbidity appears immediately due to the formation of

a. 2-methyl propane

b. 2-methyl propene

c. 2-chloro-2-methyl propane

d. 2-chlorobutane

54. Gastric juice in human stomach has pH value about 1.8 and pH of small intestine is about 7.8. The pK_a value of aspirin is 3.5. Aspirin will be
- **a.** ionised in the small intestine and stomach
- **b.** ionised in the stomach and almost unionised in the small intestine
- **c.** unionised in small intestine and stomach
- **d.** completely ionised in small intestine and stomach

55. When a solution of potassium chromate is treated with an excess of dilute nitric acid
- **a.** Cr^{3+} and $Cr_2O_7^{2-}$ are formed
- **b.** $Cr_2O_7^{2-}$ and H_2O are formed
- **c.** CrO_4^{2-} reduced to Cr^{3+}
- **d.** CrO_4^{2-} oxidised to $Cr_2O_7^{2-}$ only

56. Calcium carbide reacts with heavy water to form
- **a.** C_2D_2
- **b.** CaD_2
- **c.** CaD_2O
- **d.** CD_2

57. Fluorine acts as strongest oxidising agent because of its high
- **a.** electron affinity
- **b.** ionisation enthalpy
- **c.** hydration enthalpy
- **d.** bond enthalpy

58. The reaction of P_4 with X leads selectively to P_4O_6. The X is
- **a.** dry O_2
- **b.** moist O_2
- **c.** mixture of O_2 and N_2
- **d.** O_2 in presence of aqueous NaOH

59. The acidic strength for the hydrides of group 15 follows the order
- **a.** $NH_3 > PH_3 > AsH_3 > SbH_3$
- **b.** $NH_3 < PH_3 < AsH_3 < SbH_3$
- **c.** $NH_3 > PH_3 > SbH_3 > AsH_3$
- **d.** $NH_3 < PH_3 < SbH_3 < AsH_3$

60. Which of the following statements are incorrect in context of borax ?
- **a.** It is made up of two triangular BO_3 units and two tetrahedral BO_4 units
- **b.** One mole of borax can be used as a buffer
- **c.** It is a useful primary standard for titrating against acids
- **d.** Aqueous solution of borax can be used as buffer

61. Salt $(A) + S \longrightarrow B \xrightarrow{BaCl_2}$ white precipitate

A is paramagnetic in nature and contains about 55% K. Thus, A is
- **a.** K_2O
- **b.** K_2O_2
- **c.** KO_2
- **d.** K_2SO_4

62. When equal volume each of two sols of AgI, one obtained by adding $AgNO_3$ to slight excess of KI and another obtained by adding KI to slight excess of $AgNO_3$ are mixed together. It is observed that
- **a.** the sol particles acquired more electric charge
- **b.** the sols coagulated each other mutually
- **c.** a true solution is obtained
- **d.** the two sols stabilised each other

63. In the extraction of Ag, Zn is removed from (Zn-Ag) alloy through
- **a.** cupellation
- **b.** fractional crystallisation
- **c.** distillation
- **d.** electrolytic refining

64. A reaction takes place in three steps. The rate constants are k_1, k_2 and k_3. The overall rate constant $k = \frac{k_1 k_3}{k_2}$. If E_1, E_2 and E_3 (energy of activation) are 60, 30 and 10 kJ, respectively, the overall energy of activation is
- **a.** 40
- **b.** 30
- **c.** 400
- **d.** 300

65. If $E^\circ_{Fe^{3+}/Fe}$ and $E^\circ_{Fe^{2+}/Fe}$ are -0.36 V and -0.439 V respectively, then the value of $E^\circ_{Fe^{3+}/Fe^{2+}}$ is
- **a.** $(-0.036 - 0.439)$ V
- **b.** $[3(-0.36) + 2(-0.439)]$ V
- **c.** $(-0.36 - 0.439)$ V
- **d.** $[3(-0.36) - 2(-0.439)]$ V

66. KCl crystallises in the same type of lattice as does NaCl. Given that, $r_{Na^+} / r_{Cl^-} = 0.55$ and $r_{K^+} / r_{Cl^-} = 0.74$. Determine the ratio of the side of the unit cell for KCl to that of NaCl.
- **a.** 0.124
- **b.** 1.123
- **c.** 0.891
- **d.** 1.414

67. The compound formed as a result of oxidation of propyl benzene by $KMnO_4$ is
- **a.** benzaldehye
- **b.** benzyl alcohol
- **c.** benzoic acid
- **d.** acetophenone

68. Which of the following is an outer *d*-orbital or high spin complex?
- **a.** $[Co(NH_3)_6]^{3+}$
- **b.** $[Ni(CN)_4]^{2-}$
- **c.** $[NiCl_4]^{2-}$
- **d.** $[CoF_6]^{3-}$

69. The monosaccharide having anomeric carbon atoms are
- **a.** geometrical isomers
- **b.** α and β-optical isomers
- **c.** having symmetrical carbon atoms
- **d.** None of the above

70. Amine is not formed in the reaction

I. Hydrolysis of RCN

II. Reduction of RCH=NOH

III. Hydrolysis of RNC

IV. Hydrolysis of RCONH$_2$

The correct answer is

a. I, II and IV ***b.*** I and IV

c. II and III ***d.*** I, II and III

71. In vulcanisation of rubber

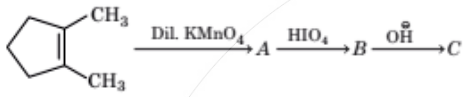
a. sulphur reacts to form a new compound

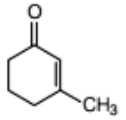
b. sulphur cross-links are introduced

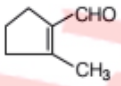
c. sulphur forms a very thin protective layer on rubber

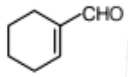
d. All of the above

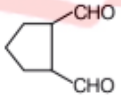
72. What will be the correct structural formula of product for the following reaction ?



a.


b.


c.


d.


73. What will be the correct relation between product when 2-methyl cyclohexene is treated with (i) B_2H_6 in presence of H_2O_2/OH and (ii) H_2O / H_2SO_4 (also consider stereochemistry of product)?

a. They are metamers

b. They are tautomers

c. They are functional isomers

d. They are positional isomers

74. The equilibrium constant K_p for the reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is $1.6 \times 10^{-4}(\text{atm})^{-2}$ at 400°C. What will be the equilibrium constant at 500°C, if heat of the reaction in this temperature range is -25.14 kcal ?

a. 1.231×10^{-4} $(\text{atm})^{-2}$

b. $1.876 \times 10^{-7}(\text{atm})^{-2}$

c. 1.462×10^{-5} $(\text{atm})^{-2}$

d. 3.462×10^{-5} $(\text{atm})^{-2}$

75. At 27°C, K_p value for reaction $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ is 0.1 atm

The K_C value for this reaction is

a. 4×10^{-3} ***b.*** 6×10^{-3}

c. 2×10^{-3} ***d.*** 9×10^{-3}

76. At constant temperature and pressure which one of the following statements is correct for the reaction ?

$$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$$

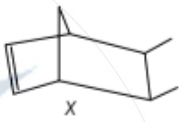
a. $\Delta H = \Delta E$

b. $\Delta H < \Delta E$

c. $\Delta H > \Delta E$

d. ΔH is independent of physical state of reactant

77. IUPAC name and degree of unsaturation of compound X is



a. 2, 3-dimethyl bicyclo [2,2,1] hept-5 ene, 2

b. 1, 2-dimethyl bicyclo [2, 2, 1] hept-4 ene, 3

c. 5, 6-dimethyl bicyclo [2, 2, 1] hept-2 ene, 3

d. 4, 5-dimethyl bicyclo [2, 2, 1] hept-1 ene, 2

78. The oxidation state of sulphur in $Na_2S_4O_6$ is

a. $+6$ ***b.*** $+\frac{3}{2}$

c. $+\frac{5}{2}$ ***d.*** -2

79. Which of the following antibiotic contains nitro group attached to aromatic nucleus in its structure

a. tetracyclin ***b.*** penicillin

c. streptomycin ***d.*** chloramphenicol

80. The behaviour of the gas becomes more ideal at

I. very low pressure

II. value of Z is unity

III. very high pressure

IV. value of Z is greater than one

Choose the correct option.

a. I and II are correct

b. I and IV are correct

c. I and III are correct

d. III and IV are correct

a. English Proficiency

Directions (Q.Nos. 81-83) *Out of the four alternatives, choose the one which expresses the right meaning of the word.*

81. Sagacious
- **a.** Shameless
- **b.** Wise
- **c.** Powerless
- **d.** Foolish

82. Remedial
- **a.** Corrective
- **b.** Proficient
- **c.** General
- **d.** Optional

83. Reticent
- **a.** Confident
- **b.** Sad
- **c.** Truthful
- **d.** Secretive

Directions (Q. Nos. 84-86) *Choose the word apposite in meaning to the given word.*

84. Fidelity
- **a.** Faith
- **b.** Devotedness
- **c.** Allegiance
- **d.** Treachery

85. Infrangible
- **a.** Complecated
- **b.** Breakable
- **c.** Weird
- **d.** Software

86. Progeny
- **a.** Kid
- **b.** Parent
- **c.** Friend
- **d.** Enemy

Directions (Q. Nos. 87-89) *A part of sentence is underlined. Balance are given alternatives to the underlined part a, b, c and d which may improve the sentence. Choose the correct alternative.*

87. It was not possible to <u>drag</u> any conclusion so he left the case.
- **a.** Fetch
- **b.** Find
- **c.** Draw
- **d.** No improvement

88. I am <u>looking after</u> my pen which is missing.
- **a.** Looking for
- **b.** Looking in
- **c.** Looking back
- **d.** No improvement

89. "<u>Mind</u> your language !" he shouted.
- **a.** change
- **b.** inspect
- **c.** hold
- **d.** No improvement

Directions (Q. Nos. 90-92) *Sentence Completion*

90. I ..... to go there when I was student.
- **a.** liked
- **b.** used
- **c.** prefer
- **d.** denied

91. She was angry ..... me.
- **a.** at
- **b.** about
- **c.** with
- **d.** in

92. You should not laugh ..... the poor.
- **a.** on
- **b.** at
- **c.** with
- **d.** over

Directions (Q. Nos. 93-95) *Sentence rearrangement*

93. 1. He is a famous doctor.
P. Once I had to consult with him.
Q. I never believed him.
R. He suggested me a proper remedy.
S. I become completely fine.
6. Now I also admit this fact.
- **a.** P Q R S
- **b.** Q P S R
- **c.** Q P R S
- **d.** R Q S P

94. 1. We don't know the plan of Ram.
P. He cares for his friends.
Q. He is a complete person.
R. We want some help and advice.
S. As we are in a trouble.
6. We hope he will do his best for us.
- **a.** P R S Q
- **b.** Q P R S
- **c.** P Q R S
- **d.** P S R Q

95. 1. It is not my problem.
P. All residents of this society are careless.
Q. I am unable to convince anyone.
R. They don't want to do some good.
S. Every one seems to be unwise here.
6. We all have to suffer one day.
- **a.** P R S Q
- **b.** P R Q S
- **c.** P Q R S
- **d.** P S R Q

b. Logical Reasoning

96. In a certain code language 'DOME' is written as '8943' and 'MEAL' is written as '4321'. What group of letters can be formed for the code '38249'?

a. EOADM ***b.*** MEDOA
c. EMDAO ***d.*** EDAMO

97. Find the missing number from the given response.

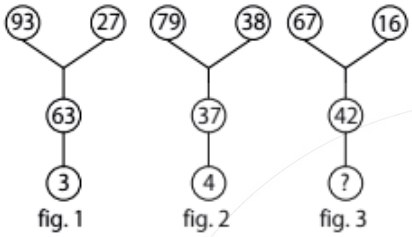
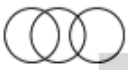


fig. 1 fig. 2 fig. 3

a. 5 ***b.*** 6
c. 8 ***d.*** 9

98. Which of the following correctly represents the relationship among illiterates, poor people and unemployed?

a. 
b. 
c. 
d. 

99. 'A' starts crossing the field diagonally from North-West. After walking half the distance, he turns right, walks some distance and turns left. Which direction is 'A' facing now?

a. North-East ***b.*** North-West
c. South-East ***d.*** South-West

100. In a classroom, there are 5 rows and 5 children A, B, C, D and E are seated one behind the other in 5 separate rows as follows

- A is sitting behind C but in front of B.
- C is sitting behind E and A is sitting in front of B.
- C is sitting behind E and D is sitting in front of E.
- The order in which they are sitting from the first row to the last is

a. D E C A B ***b.*** B A C E D
c. A C B D E ***d.*** A B E D C

101. Which of the following will fill the series?

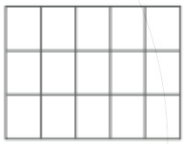
$$2, 9, 28, \frac{?}{}, 126$$

a. 64 ***b.*** 65
c. 72 ***d.*** 56

102. Which one of the following figures completes the original figure?

a.  ***b.***  ***c.***  ***d.*** 

103. How many squares are there in the following figure?



a. 24 ***b.*** 25
c. 26 ***d.*** 27

104. Two signs in the equations have been interchanged, find out the two signs to make equation correct.

$$3 + 5 \times 8 + 2 - 10 = 13$$

a. + and − ***b.*** × and ÷
c. ÷ and − ***d.*** ÷ and +

105. **Assertion** [A]=India is a democratic country.
Reason [R]=India has a constitution of its own.

Choose the correct alternative from the given options.

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

Mathematics

106. The value of $\sum_{k=1}^{6}\left(\frac{\sin 2\pi k}{7}-\frac{i\cos 2\pi k}{7}\right)$ is

a. -1 *b.* 0
c. $-i$ *d.* i

107. The mean life of a sample of 60 bulbs was 650 and the standard deviation was 8 h. A second sample of 80 bulbs has a mean life of 660 h and standard deviation 7 h. Find the over all standard deviation.

a. 8.97
b. 8.98
c. 8.94
d. None of the above

108. Let R be the relation on the set R of all real numbers, defined by aRb iff $|a-b|\le 1$. Then, R is

a. reflexive and symmetric only
b. reflexive and transitive only
c. equivalence
d. None of the above

109. The value of $\int_0^{10\pi}([\sec^{-1}x]+[\cot^{-1}x])\,dx$, where $[.]$ denotes the greatest integer function, is

a. $10\pi-\tan^{-1}x$ *b.* $8\pi-\sec 1$
c. $10\pi-\sec 1$ *d.* $10\pi+\sec 1$

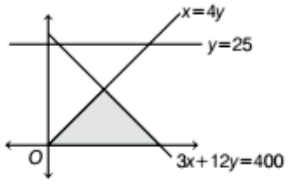
110. The value of the expression $\sin[\cot^{-1}(\cos(\tan^{-1}1))]$ is

a. 0 *b.* 1
c. $\frac{1}{\sqrt{3}}$ *d.* $\sqrt{\frac{2}{3}}$

111. The sum of the series $1+2\cdot 2+3\cdot 2^2+4\cdot 2^3+\ldots+100\cdot 2^{99}$ is

a. $100\cdot 2^{100}+1$ *b.* $99\cdot 2^{100}+1$
c. $99\cdot 2^{99}-1$ *d.* $100\cdot 2^{100}-1$

112. The shaded region given below represents the constraints (other than $x\ge 0, y\ge 0$)



a. $3x+4y\le 400,\ y\le 25,\ x\le 4y$
b. $3x+12y\ge 400,\ y\le 25,\ x\ge 4y$
c. $3x+12y\le 400,\ y\le 25,\ x\ge 4y$
d. None of the above

113. The coefficient of x^n in the expansion of $\log_e\left(\frac{1}{1+x+x^2+x^3}\right)$, when n is odd, is

a. $-\frac{2}{n}$ *b.* $-\frac{1}{n}$
c. $\frac{1}{n}$ *d.* None of these

114. The maximum value of $f(x)=\frac{\log x}{x}$ is

a. 1 *b.* $\frac{2}{e}$
c. e *d.* $\frac{1}{e}$

115. Let $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ be non-zero vectors such that no two are collinear and $(\mathbf{a}\times\mathbf{b})\times\mathbf{c}=\frac{1}{3}|\mathbf{b}||\mathbf{c}|\mathbf{a}$. If θ is the acute angle between the vectors $\mathbf{b}$ and $\mathbf{c}$, then $\sin\theta$ is equal to

a. $\frac{2\sqrt{2}}{3}$ *b.* $\frac{\sqrt{2}}{3}$
c. $\frac{2}{3}$ *d.* $\frac{1}{3}$

116. The value of $\lim_{x\to 0}\left(\frac{1+5x^2}{1+3x^2}\right)^{1/x^2}$ is

a. e^2 *b.* e
c. $1/e$ *d.* $1/e^2$

117. An object is observed from the points A, B and C lying in a horizontal straight line which passes directly underneeth the object. The angular elevation at B is twice that at A and at C three times that at A. If $AB=a$, $BC=b$, then the height of the object is

a. $\frac{3a}{2b}\sqrt{(a+b)(3b-a)}$
b. $\frac{3b}{2a}\sqrt{(a+b)(3a-b)}$
c. $\frac{a}{2b}\sqrt{(a+b)(3b-a)}$
d. None of the above

118. Function $f:(-\infty,-1]\to(0,e^5]$ defined by $f(x)=e^{x^3-3x+2}$ is

a. many-one and onto *b.* many-one and into
c. one-one and onto *d.* one-one and into

119. The foci of the conic section $25x^2+16y^2-150x=175$ are

a. $(0,\pm 3)$ *b.* $(0,\pm 2)$
c. $(3,\pm 3)$ *d.* $(0,\pm 1)$

120. The system of equations

$$x-y+3z=4$$
$$x+z=2$$
$$x+y-z=0 \text{ has}$$

a. a unique solution
b. finitely many solution
c. infinitely many solutions
d. None of the above

121. The sum of the sequence 5, 55, 555, ... upto n infinite terms is

a. $\frac{5}{9}\left[\frac{10(10^n-1)+n}{9}\right]$
b. $\frac{5}{9}\left[\frac{10(10^n-1)}{9}-n\right]$
c. $\frac{5}{9}\left[\frac{10(10^{n+1}-1)}{9}-n\right]$
d. $\frac{5}{9}\left[\frac{10(10^{n-1}-1)}{9}-n\right]$

122. A plane passes through the point $(1,-2,3)$ and is parallel to the plane $2x-2y+z=0$. The distance of the point $(-1,2,0)$ from the plane is

a. 2 *b.* 3 *c.* 4 *d.* 5

123. The distance between the pair of lines represented by the equation $x^2-6xy+9y^2+3y-9y-4=0$ is

a. $\frac{15}{\sqrt{10}}$ *b.* $\frac{1}{2}$
c. $\sqrt{\frac{5}{2}}$ *d.* $\frac{1}{\sqrt{10}}$

124. If $A=\{x\in\mathbb{C}:x^4-1=0\}$
$B=\{x\in\mathbb{C}:x^2-1=0\}$
$C=\{x\in\mathbb{C}:x^2+1=0\}$
where $\mathbb{C}$ is complex plane.

a. $A=B\cup C$ *b.* $C=A\cap B$
c. $B=A\cap C$ *d.* $A=B\cap C$

125. The general solution of the differential equation $\frac{dy}{dx}+\sin\left(\frac{x+y}{2}\right)=\sin\left(\frac{x-y}{2}\right)$ is

a. $\log\tan\left(\frac{y}{2}\right)=C-2\sin x$
b. $\log\tan\left(\frac{y}{4}\right)=C-2\sin\left(\frac{x}{2}\right)$
c. $\log\tan\left(\frac{y}{2}+\frac{\pi}{4}\right)=C-2\sin x$
d. None of the above

126. The set of all real x satisfying the inequality $\frac{3-|x|}{4-|x|}\geq 0$

a. $[-3,3]\cup(-\infty,-4)\cup(4,\infty)$
b. $(-\infty,-4)\cup(4,\infty)$
c. $(-\infty,-3)\cup(4,\infty)$
d. $(-\infty,-3)\cup(3,\infty)$

127. If N is the any four digit number say x_1,x_2,x_3,x_4, then the maximum value of $\frac{N}{x_1+x_2+x_3+x_4}$ is equal to

a. 1000 *b.* $\frac{1111}{4}$
c. 800 *d.* None of these

128. If A and B are two events such that $P(A)=0.6$, $P(B)=0.2$ and $P\left(\frac{A}{B}\right)=0.5$, then $P\left(\frac{A'}{B'}\right)$ equals to

a. $\frac{1}{10}$ *b.* $\frac{3}{10}$ *c.* $\frac{3}{8}$ *d.* $\frac{6}{7}$

129. The quartile deviation for the data

x:	2	3	4	5	6
y:	3	4	8	4	1

is

a. 0 *b.* $\frac{1}{4}$ *c.* $\frac{1}{2}$ *d.* 1

130. If $\int f(x)\cos x\,dx=\frac{1}{2}f^2(x)+C$, then $f(x)$ can be

a. x *b.* 1
c. $\cos x$ *d.* $\sin x$

131. There are 10 points in a plane, out of these 6 are collinear. If 'n' is the number of triangles formed by joining these points, then

a. $n\leq 100$ *b.* $100<n<140$
c. $140<n\leq 190$ *d.* $n>190$

132. $\frac{{}^8C_0}{6} - {}^8C_1 + {}^8C_2 \cdot 6 - {}^8C_3 \cdot 6^2 + {}^8C_4 \cdot 6^3 + \ldots + {}^8C_8 \cdot 6^7$ equals to

a. 0 *b.* 6^7

c. 6^8 *d.* $\frac{5^8}{6}$

133. A committee of 4 students is selected at random from a group consisting 8 boys and 4 girls. Given that there is atleast one girl on the committee, then the probability that there are exactly 2 girls on the committee is

a. $\frac{68}{125}$ *b.* $\frac{56}{165}$

c. $\frac{63}{625}$ *d.* $\frac{168}{425}$

134. What are the values of c for which Rolle's theorem for the function $f(x) = x^3 - 3x^2 + 2x$ in the interval $[0, 2]$ is verified ?

a. $c = \pm 1$ *b.* $c = 1 \pm \frac{1}{\sqrt{3}}$

c. $c = \pm 2$ *d.* None of these

135. If $\int \frac{4}{\sin^4 x + \cos^4 x}\,dx = a \tan^{-1}\left(\frac{\tan x - \frac{1}{\tan x}}{b}\right) + c$, then find the value of a and b, respectively.

a. $2\sqrt{2}, \sqrt{2}$ *b.* $\sqrt{2}, 2$

c. $\sqrt{3}, \sqrt{2}$ *d.* $\sqrt{2}, 4$

136. If $A = \begin{bmatrix} -5 & -8 & 0 \\ 3 & 5 & 0 \\ 1 & 2 & -1 \end{bmatrix}$, then A is

a. idempotent *b.* nilpotent

c. involutory *d.* periodic

137. The radius of the circle passing through the foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{19} = 1$ and having its centre $(0, 3)$ is

a. 4 *b.* $\frac{3}{7}$ *c.* $\sqrt{12}$ *d.* $\frac{7}{2}$

138. Let L be the line of intersection of the planes $2x + 3y + z = 1$ and $x + 3y + 2z = 2$. If L makes an angle α with the positive X-axis, then $\cos\alpha$ is equal to

a. 1/2 *b.* 1 *c.* $1/\sqrt{2}$ *d.* $1/\sqrt{3}$

139. If OAB is an equilateral triangle inscribed in the parabola $y^2 = 4ax$ with O as the vertex, then the length of the side of the ΔOAB is

a. $8a\sqrt{3}$ *b.* $4a\sqrt{3}$

c. $2a\sqrt{3}$ *d.* $a\sqrt{3}$

140. If $f(x + y) = f(x) \cdot f(y)$ for all real x, y and $f(0) \neq 0$, then function $g(x) = \frac{f(x)}{1 + \{f(x)\}^2}$ is

a. even function *b.* odd function

c. odd, if $f(x) > 0$ *d.* neither even nor odd

141. If $f(x) = (\tan^{-1} x)^2 + \frac{2}{\sqrt{x^2 + 1}}$, then $f(x)$ is increasing in

a. $(0, \infty)$ *b.* $(-\infty, 0)$

c. $(-\infty, -5)$ *d.* None of these

142. The number of solutions of $\cos x = |1 + \sin x|$, $0 \le x \le 3\pi$ is

a. 1 *b.* 2

c. 3 *d.* 4

143. If a, b, c are in GP and $a^{1/x} = b^{1/y} = c^{1/z}$, then x, y, z are in

a. AP *b.* GP

c. HP *d.* None of these

144. The acute angle between the lines, whose direction cosines are given by $2l - m + 2n = 0$, $lm + mn + nl = 0$, is

a. $\frac{\pi}{6}$ *b.* $\frac{\pi}{4}$

c. $\frac{\pi}{3}$ *d.* $\frac{\pi}{2}$

145. The equation of the lines through (1, 1) and making angles of 45° with the line $x + y = 0$ are

a. $x - 1 = 0, x - y = 0$

b. $x - y = 0, y - 1 = 0$

c. $x + y - 2 = 0, y - 1 = 0$

d. $x - 1 = 0, y - 1 = 0$

146. The area of the figure bounded by two branches of the curve $(y - x)^2 = x^3$ and straight line $x = 1$ is

a. $\frac{4}{5}$ sq unit *b.* $\frac{4}{7}$ sq unit

c. $\frac{4}{9}$ sq unit *d.* $\frac{4}{11}$ sq unit

147. If $(x + iy)^{1/3} = 2 + 3i$, then $3x + 2y$ is equal to

a. − 20 *b.* − 60 *c.* − 120 *d.* 60

148. In a town of 10000 families it was found that 40% family buy newspaper *A*, 20% buy newspaper *B* and 10% families buy newspaper *C*, 5% families buy *A* and *B*, 3% buy *B* and *C* and 4% buy *A* and *C*. If 2% families buy all the three newspaper, then the number of families which buy *A* only is

a. 3100
b. 3300
c. 2900
d. 1400

149. If $|\mathbf{a}|=2, |\mathbf{b}|=5$ and $|\mathbf{a}\times\mathbf{b}|=8$, then $|\mathbf{a}\cdot\mathbf{b}|$ is equal to

a. 3 ***b.*** 4 ***c.*** 5 ***d.*** 6

150. The equation of circle which passes through the origin and cuts off intercepts 5 and 6 from the positive parts of the *X*-axis and *Y*-axis respectively is $\left(x-\frac{5}{2}\right)^2+(y-3)^2=\lambda$, where λ is

a. 61/4 ***b.*** 4/6 ***c.*** 1/4 ***d.*** 0

Answers

Physics

1. (c)	**2.** (b)	**3.** (a)	**4.** (b)	**5.** (a)	**6.** (c)	**7.** (d)	**8.** (a)	**9.** (c)	**10.** (d)
11. (b)	**12.** (d)	**13.** (a)	**14.** (d)	**15.** (c)	**16.** (a)	**17.** (b)	**18.** (a)	**19.** (b)	**20.** (d)
21. (c)	**22.** (c)	**23.** (b)	**24.** (a)	**25.** (d)	**26.** (c)	**27.** (d)	**28.** (d)	**29.** (c)	**30.** (d)
31. (c)	**32.** (c)	**33.** (b)	**34.** (d)	**35.** (b)	**36.** (c)	**37.** (d)	**38.** (d)	**39.** (c)	**40.** (a)

Chemistry

41. (d)	**42.** (b)	**43.** (b)	**44.** (a)	**45.** (c)	**46.** (d)	**47.** (c)	**48.** (d)	**49.** (b)	**50.** (a)
51. (a)	**52.** (c)	**53.** (c)	**54.** (a)	**55.** (b)	**56.** (a)	**57.** (c)	**58.** (c)	**59.** (b)	**60.** (b)
61. (c)	**62.** (b)	**63.** (c)	**64.** (a)	**65.** (d)	**66.** (b)	**67.** (c)	**68.** (d)	**69.** (b)	**70.** (b)
71. (b)	**72.** (a)	**73.** (d)	**74.** (c)	**75.** (a)	**76.** (b)	**77.** (c)	**78.** (c)	**79.** (d)	**80.** (a)

English Proficieny

81. (b)	**82.** (a)	**83.** (d)	**84.** (d)	**85.** (b)	**86.** (b)	**87.** (c)	**88.** (a)	**89.** (d)	**90.** (b)
91. (c)	**92.** (b)	**93.** (c)	**94.** (b)	**95.** (a)					

Logical Reasoning

96. (d)	**87.** (d)	**98.** (b)	**99.** (c)	**100.** (a)	**101.** (b)	**102.** (b)	**103.** (c)	**104.** (d)	**105.** (b)

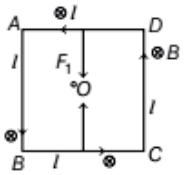
Mathematics

106. (d)	**107.** (c)	**108.** (a)	**109.** (c)	**110.** (d)	**111.** (b)	**112.** (c)	**113.** (b)	**114.** (d)	**115.** (a)
116. (a)	**117.** (c)	**118.** (d)	**119.** (c)	**120.** (c)	**121.** (b)	**122.** (d)	**123.** (c)	**124.** (a)	**125.** (b)
126. (a)	**127.** (a)	**128.** (c)	**129.** (d)	**130.** (d)	**131.** (a)	**132.** (d)	**133.** (d)	**134.** (b)	**135.** (a)
136. (c)	**137.** (a)	**138.** (d)	**139.** (a)	**140.** (a)	**141.** (a)	**142.** (c)	**143.** (a)	**144.** (d)	**145.** (d)
146. (a)	**147.** (c)	**148.** (b)	**149.** (d)	**150.** (a)					

Hints & Solutions

Physics

1. ***(c)*** Let the current is flowing in anti-clockwise direction as shown in figure.



Now, magnetic force on $AD = F_1 = ilB$ towards centre O (By Fleming's left hand rule)

Similarly, magnetic force on $BC = F_2 = ilB$ towards centre O.

Since, two forces are equal in magnitude and opposite in direction and lie in same line of action, therefore they cancel out each other.

Also, magnetic force on $CD = F_3 = ilB$ towards centre O (By Fleming's left hand rule)

Similarly, magnetic force on $AB = F_4 = ilB$ towards centre O.

Again, two forces are equal in magnitude and opposite in direction and lie in same line of action, therefore they cancel out each other.

So, the net force on the current loop is zero.

2. ***(b)*** The magnetic field at C due to first conductor is

$B_1 = \frac{\mu_0}{2\pi}\frac{i}{3d/2}$ (Since, point C is separated by $d + \frac{d}{2} = \frac{3d}{2}$ from 1st conductor)

The direction of field is perpendicular to the plane of paper and directed outward.

The magnetic field at C due to second conductor is $B_2 = \frac{\mu_0}{2\pi}\frac{10}{d/2}$ (Since, point C is separated by $\frac{d}{2}$ from 2nd conductor)

The direction of field is perpendicular to the plane of paper and directed inward.

Since, direction of B_1 and B_2 at point C is in opposite direction and the magnetic field at C is zero, therefore,

$$B_1 = B_2$$

$$\frac{\mu_0}{2\pi}\frac{i}{3d/2} = \frac{\mu_0}{2\pi}\frac{10}{d/2}$$

On solving, we get

$$i = 30.0\ \text{A}$$

3. ***(a)*** When system of conductors is in equilibrium,

The magnetic force of attraction per unit length between conductors = weight of conductor B per unit length.

$$\frac{\mu_0}{2\pi}\frac{I_A \times I_B}{d} = \frac{mg}{L} = \left(\frac{m}{L}\right)g$$

$$\frac{\mu_0}{2\pi}\frac{I_A \times I_B}{d} = \left(\frac{m}{L}\right)g$$

$$2 \times 10^{-7} \times \frac{100 \times I_B}{0.05} = (0.01\ \text{kg/m}) \times 10$$

On solving, we get

$$I_B = 250\ \text{A}$$

4. ***(b)*** Number of photo electrons depends on the intensity of incident light only.

5. ***(a)*** For hydrogen atom,

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right),\ n_2 > n_1$$

For the shortest wavelength of Lyman series,

$n_1 = 1,\ n_2 = \infty \Rightarrow \frac{1}{\lambda_1} = R$

For the shortest wavelength of Balmer series,

$n_1 = 2,\ n_2 = \infty \Rightarrow \frac{1}{\lambda_2} = \frac{R}{4}$

For the shortest wavelength of Paschen series,

$n_1 = 3,\ n_2 = \infty \Rightarrow \frac{1}{\lambda_3} = \frac{R}{9}$

So, $\lambda_1 = \frac{1}{R},\ \lambda_2 = \frac{4}{R},\ \lambda_3 = \frac{9}{R}$

$\Rightarrow \quad \lambda_1 : \lambda_2 : \lambda_3 = 1 : 4 : 9$

6. ***(c)*** Let, initial number of nuclei of each element = N_o

Decay constants,

$$\lambda_A = \frac{0.693}{1}\ \text{hr}^{-1},\ \lambda_B = \frac{0.693}{2}\ \text{hr}^{-1}$$

$$\lambda_A > \lambda_B$$

Activities, $R_A = \lambda_A N_0$

$R_B = \lambda_B N_0$

$\Rightarrow \quad R_A > R_B$ as $\lambda_A > \lambda_B$

Less half-life of element A implies faster decay

Mean life, $\tau = \frac{1}{\lambda}$

$$\tau_A = \frac{1}{\lambda_A},\ \tau_B = \frac{1}{\lambda_B}$$

$$\tau_A < \tau_B \text{ as } \lambda_A > \lambda_B$$

7. ***(d)*** The glass piece will dissappear only, if the refractive index of the glass and liquid is same.

So, refractive index of glass piece must be 4/3.

8. ***(a)*** Focal length of bi-convex lens,

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \quad \frac{1}{f} = (\mu - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

[Since, $R_1 = R$ and $R_2 = -R$]

$$f = \frac{R}{2(\mu - 1)} \qquad \ldots(i)$$

and new focal length of lens,

$$\frac{1}{f'} = (\mu - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$$

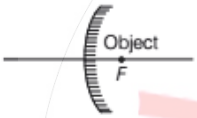
$$\Rightarrow \quad f' = \frac{R}{\mu - 1} \qquad \ldots(ii)$$

From Eqs. (i) and (ii), we get

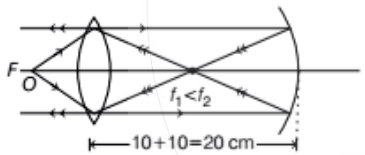
$$f' = 2f$$

9. ***(c)*** Refractive index of a medium depends on the medium as well as on the wavelength of the incident light.

10. ***(d)*** Image will not form, because object is placed on the side from where reflection is not possible.



11. ***(b)*** The ray diagram for the given situation is shown below.



The final image will be at infinity only, if the focii of lens and mirror coincides. The situation could be understood on the basis of given diagram. So, the value of $d = 10 + 10 = 20$ cm.

12. ***(d)*** The image formed by a concave spherical mirror could be real, virtual, erect and inverted.

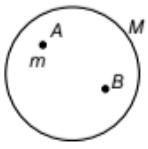
13. ***(a)*** Minimum energy required to through the satellite out of earth's gravitational field is equal to its binding energy.

$\therefore$ Binding energy, BE = −TE

$= -(-k)$ [Given, TE = $-k$]

$= k$J

14. ***(d)***



The gravitational field at A and B are zero because inside the spherical shell, gravitational field is zero. So, no work required to make change between the points A and B.

15. ***(c)*** Angular velocity, $\omega = 2\pi f = 2\pi \times \frac{30}{60} = \pi$ rad/s

For an elastic spring force, $F = k \times x$, where x is the extension.

Radius of circular motion, $r = L + x$

Centripetal force = $mr\omega^2 = F$

$\Rightarrow m(L + x)\omega^2 = kx$

$$\Rightarrow \quad x = \frac{mL\omega^2}{k - m\omega^2} = \frac{0.02 \times 0.5 \times (3.14)^2}{2 - 0.02 \times (3.14)^2}$$

$= 0.05$ m

Radius of the circular motion(r)

$= L + x = 0.5 + 0.05$

$= 0.55$ m

Tension in the spring,

$$T = kx = 2 \times 0.05 = 0.1 \text{ N}$$

16. ***(a)*** The initial angular momentum of the rotating record is

$$L = I\omega$$

where, $$I = \frac{1}{2}MR^2$$

Let ω' be the angular velocity of the record when the coin of mass m is placed on it at a distance r from its centre.

The new angular momentum of the system becomes

$$L' = (I + mr^2)\omega'$$

Since, no external torque acts on the system, the angular momentum is conserved *i.e.*,

$$L' = L \text{ or } (I + mr^2)\omega' = I\omega$$

or $$\omega' = \frac{I\omega}{I + mr^2} = \frac{\frac{1}{2}MR^2\omega}{\frac{1}{2}MR^2 + mr^2}$$

or $$\omega' = \frac{\omega}{1 + \frac{2mr^2}{MR^2}} \qquad \ldots(i)$$

Putting $r = \frac{R}{2}$ in Eq. (i), we get

$$\omega' = \left[\frac{\omega}{1 + \frac{2m \times \left(\frac{R}{2}\right)^2}{MR^2}}\right]$$

$$\Rightarrow \quad \omega' = \frac{2\omega M}{2M + m}$$

17. ***(b)*** Frictional force between P and Q is $f = \mu mg$ which will retard P and accelerate Q.

Retardation of P, $a_P = -\frac{f}{m} = \frac{-\mu mg}{m} = -\mu g$

Acceleration of Q, $a_Q = \frac{+f}{M} = \frac{\mu mg}{M}$

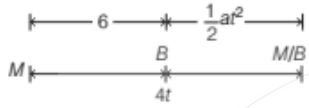
Acceleration of Q relative to P is

$$a_{QP} = a_Q - a_P = \frac{\mu mg}{M} - (-\mu g)$$

$$= \mu g\left[1 + \frac{m}{M}\right] = 0.3 \times 10\left[1 + \frac{1}{6}\right]$$

$$\Rightarrow \quad a_{QP} = 3.5 \text{ m/s}^2$$

18. ***(a)*** Let us draw the figure for given situation,



The man needs to cover the distance by bus is time t and 6 m to catch the bus.

$$\Rightarrow \quad 4t = 6 + \frac{1}{2} \times 1.2 \times t^2$$

$$\Rightarrow \quad 4t = 6 + 0.6\, t^2$$

19. ***(b)*** In any type of collision, the linear momentum of the system remain conserved even during collision.

20. ***(d)*** Given that, $n = -\frac{D(n_2 - n_1)}{x_2 - x_1}$

$$\Rightarrow \quad D = -\frac{n(x_2 - x_1)}{n_2 - n_1}$$

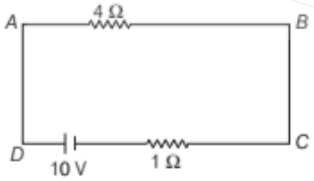
Here, $[n] = \left[\frac{1}{\text{area} \times \text{time}}\right] = \frac{1}{[L^2T]} = [L^{-2}T^{-1}]$

$x_2 - x_1 = [L]$ and $n_2 - n_1 = \left[\frac{1}{\text{volume}}\right] = \left[\frac{1}{L^3}\right]$

$= [L^{-3}]$

So, $[D] = \frac{[L^{-2}T^{-1}L]}{[L^{-3}]} = [L^2T^{-1}]$

21. ***(c)*** Since, capacitors work as open circuit for DC supply, hence it can be drawn as



$\therefore$ Equivalent resistance $= 4 + 1 = 5\,\Omega$

$\therefore$ Current, $I = \frac{V}{R} = \frac{10}{5} = 2\text{A}$

Potential difference between point A and B

$= I \times 4 = 2 \times 4 = 8\text{V}$

$\because$ Two capacitors of $3\,\mu\text{F}$ each are in series

$\therefore$ Potential difference across each capacitor

$$= \frac{8}{2} = 4 \text{ V}$$

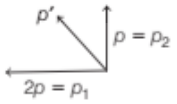
Charge on each capacitor, $q = CV = 3 \times 4$

$= 12\,\mu\text{C}$

22. ***(c)*** The electric field inside a conductor is zero and is always perpendicular to the surface of a conductor.

23. ***(b)*** Given, $\mathbf{p}_1 = -2p\hat{\mathbf{i}} = 2p$ along negative X-axis.

$\mathbf{p}_2 = p\hat{\mathbf{j}} = p$ along Y-axis.



The magnitude of resultant momentum of two parts

$$p' = \sqrt{p_1^2 + p_2^2} = \sqrt{(2p)^2 + p^2} = p\sqrt{5}$$

As the bomb was initially at rest, hence final momentum of all the three parts must be zero

$$\mathbf{p}_3 + \mathbf{p}' = 0$$

$$\mathbf{p}_3 = -\mathbf{p}' = -\mathbf{p}\sqrt{5}$$

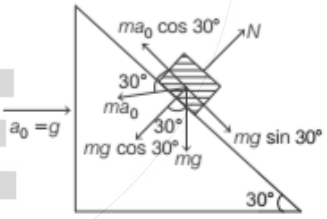
$\therefore$ Magnitude of $\mathbf{p}_3$,

$$= \sqrt{5}\mathbf{p}$$

$$= \sqrt{x} \cdot \mathbf{p} \qquad \text{(Given)}$$

$$\therefore \quad x = 5$$

24. ***(a)*** The forces on smaller block is given as



For the motion of the block along the incline plane in upward direction.

Net force on the block = mass × acceleration of the block

$$ma_0 \cos 30° - mg \sin 30° = ma$$

$$\Rightarrow \quad mg \cos 30° - mg \sin 30° = ma \qquad (\because a_0 = g)$$

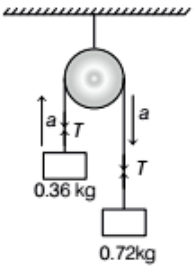
$$\Rightarrow \quad a = \left(\frac{\sqrt{3} - 1}{2}\right) g = 3.66 \text{ m/s}^2$$

Now, from equation of motion, $s = \frac{1}{2}at^2$

$$\Rightarrow \quad t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 1}{3.66}} = 0.74 \text{ s}$$

25. ***(d)*** Pseudo force is not a real force.

26. ***(c)*** The given situation is shown below. Here, a is common acceleration of the blocks and T is tension in string.



So, acceleration, $a = \dfrac{\text{Net pulling force}}{\text{Total mass}}$

$$= \frac{0.72\,g - 0.36\,g}{0.72 + 0.36} = \frac{g}{3}$$

Distance, travelled in 1 $s = ut + \dfrac{1}{2}at^2$

$$= 0 + \frac{1}{2} \times \frac{g}{3} \times (1)^2 = \frac{g}{6}$$

So, $T - mg = ma$

$T - 0.36\,g = 0.36\,a$

$T = 0.48\,g$

Now, work done by string on the block

$W_T = Ts\cos 0°$ (on 0.36 kg of mass)

$$= (0.48\,g)\left(\frac{g}{6}\right)(1) = 0.08\,g^2$$

$$= 0.08 \times (10)^2 = 8\ \text{J}$$

27. ***(d)*** We know that, capacitance, $C = \dfrac{Q}{V}$

$$= \frac{Q}{(W/Q)} \qquad \left[\because V = \frac{W}{Q}\right]$$

$$= \frac{Q_2}{W}$$

$\therefore \quad [C] = \dfrac{[Q^2]}{[W]}$

$\Rightarrow \quad [A] = \dfrac{[Q^2]}{[ML^2T^{-2}]}$ [Given, $C = A$]

$\Rightarrow \quad [A] = [M^{-1}L^{-2}T^2Q^2]$

Again we know that, $F = BQv$

$\Rightarrow \quad B = \dfrac{F}{Qv} \Rightarrow [B] = \dfrac{[F]}{[Q][v]}$

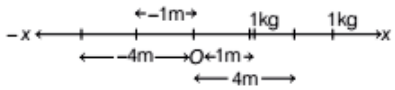
$\Rightarrow \quad [C] = \dfrac{[MLT^{-2}]}{[Q][LT^{-1}]}$ [Given, $B = C$]

$\Rightarrow \quad [C] = [MT^{-1}Q^{-1}]$

Given, $A = 3BC^2 \Rightarrow B = \dfrac{A}{3C^2} \Rightarrow [B] = \dfrac{[A]}{[C]^2}$

$$= \frac{[M^{-1}L^{-2}T^2Q^2]}{[MT^{-1}Q^{-1}]^2} = [M^{-3}L^{-2}T^4Q^4]$$

28. ***(d)*** The given situation is shown below.



Hence, resultant gravitational potential at origin O is given as

$$V = 2GM\left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \ldots\right)$$

$$= 2G \times 1\left(\frac{1}{1} + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}\right)$$

It forms a GP, so

Sum of GP $= \dfrac{a}{1-r}$

Hence, $V = 2G\left(\dfrac{1}{1 - \frac{1}{2}}\right) = 4G$

29. ***(c)*** If bulb Z is fused, the current stops flowing through Z. The effective resistance of the circuit due to bulbs X and Y in series becomes more as compared to before. Due to which, the current in the circuit decrease.

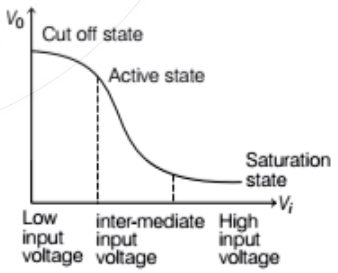
$\therefore$ Brightness $\propto$ (Current)^2

So, the brightness of bulb X decreases, because total current decreases.

Now, bulb Y gets more current than before fusing the bulb, Z. Hence, more current will flow through it in comparision to before.

$\therefore$ Brightness of bulb Y will increase.

30. ***(d)*** Transfer characteristic of transistor is



Active state is achieved at inter-mediate input voltage.

31. ***(c)*** Initial moment of inertia of the system is

M_1 = moment of inertia of turntable + Moment of inertia of boy at the centre

$= 1000 + 0 = 1000\ \text{kgm}^2$

Initial frequency, $\nu_1 = \frac{98}{10} = 9.8$ rev / s

Final moment of the system

M_2 = MI of turntable + MI of boy at a distance 4 m from the centre of turntable.

$= 1000 + 60 \times (4)^2 = 1960$ kgm^2

Since no external torque acts, the angular momentum of the system is conserved *i.e.*,

$$I_2\omega_2 = I_1\omega_1$$

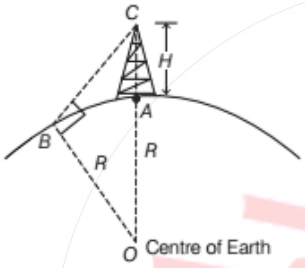
$$\Rightarrow \quad I_2 \cdot 2\pi\nu_2 = I_1 \cdot 2\pi\nu_1$$

$$\Rightarrow \quad I_2\nu_2 = I_1\nu_1$$

$$\Rightarrow \quad \nu_2 = \frac{I_1\nu_1}{I_2} = \frac{1000 \times 9.8}{1960}$$

$$\Rightarrow \quad \nu_2 = 5 \text{ rev/s} = 5 \text{ Hz}$$

32. ***(c)*** The given situation is shown below.



In ΔBOC,

$$OB^2 + BC^2 = OC^2$$

$$R^2 + BC^2 = (R + H)^2$$

$$\Rightarrow \quad BC = \sqrt{2RH + H^2} = \sqrt{RH\left(2 + \frac{H}{R}\right)}$$

Here, $\frac{H}{R} << 2$

So, $BC = \sqrt{2RH}$

$BC = AB = d$ = distance of reach

$$\Rightarrow \quad d = \sqrt{2RH} \propto H^{1/2}$$

where, R = constant = 6400 km

= radius of the earth

33.(***b***) Output of given logic circuit is

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

Since, $X + YZ = (X + Z)(X + Z)$ [By Boolean alzebra]

$= 1 \cdot (A + B) = A + B$ $[\because (A + \bar{A}) = 1]$

This is the output of OR gate.

34. ***(d)*** Accuracy is closeness to true/exact value.

Precision is based on instrument, more decimal places in measurement indicate more precision.

So, 20.1 cm is less precise as compared to 19.65 cm, because 20.1 cm has lesser number of decimal places.

35. ***(b)*** Volume of tank, V = 2000 L

$= 2000 \times 10^{-3}$ m$^3 = 2$m^3

Mass of water, $m = \rho_w \times V = 1000 \times 2 = 2 \times 10^3$ kg

Work done to lift this mass to a height *i.e.*, $h = 40$ m is

$W = mgh = 2 \times 10^3 \times 10 \times 40 = 8 \times 10^5$ J

$$\text{Power needed} = \frac{\text{Work done}}{\text{Time taken}} = \frac{8 \times 10^5}{10 \times 60}$$

$$P' = \frac{4}{3} \times 10^3 \text{ W}$$

If P is the total power consumed, the useful power available = 40% of P

i.e. $P' = 0.4\,P$

$$0.4\,P = \frac{4}{3} \times 10^3$$

$$\Rightarrow \quad P = 3.33 \times 10^3 \text{ W} = 3.33 \text{ kW}$$

36. ***(c)*** Applying gas equation, $pV = nRT$

We can write; $p_1V = n_1RT_1$

and $p_2V = n_2RT_2$

$$\Rightarrow \quad \frac{p_2}{p_1} = \frac{n_2}{n_1} \times \frac{T_2}{T_1} = \frac{1}{1} \times \frac{2T}{T} = 2$$

$$\Rightarrow \quad p_2 = 2p$$

37. ***(d)*** Given, $T_1 = 27 + 273 = 300$ K

$T_2 = 127 + 273 = 400$ K

We know, $v_{rms} = \sqrt{\frac{3RT}{M}}$

$$\Rightarrow \% \text{ increase in } v_{rms} = \frac{\sqrt{\frac{3RT_2}{M}} - \sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_1}{M}}} \times 100$$

$$= \frac{\sqrt{T_2} - \sqrt{T_1}}{\sqrt{T_1}} \times 100 = \frac{\sqrt{400} - \sqrt{300}}{\sqrt{300}} \times 100$$

$$= \frac{20 - 17.32}{17.32} \times 100$$

$\Rightarrow \%$ increase in $v_{rms} = 15.5\%$

38. ***(d)*** We know,

Maximum acceleration in SHM, $a_{max} = \omega^2 A = \frac{4\pi^2}{T^2} A$

$$= \frac{4\pi^2}{\left(\frac{\pi}{5}\right)^2} \times 0.3 = 30 \text{ m/s}^2$$

Maximum force, $F_{max} = ma_{max} = \frac{5}{1000} \times 30$

$= 0.15$ N

39. ***(c)*** Let T be the junction temperature

Here, $K_A = 2K_B$, $T - T_B = 50\text{K}$

At the steady state, $H_A = H_B$

$$\Rightarrow \quad \frac{K_A A(T_A - T)}{L} = \frac{K_B A(T - T_B)}{L}$$

$$\Rightarrow \quad 2K_B(T_A - T) = K_B(T - T_B)$$

$$\Rightarrow \quad T_A - T = \frac{T - T_B}{2} = \frac{50}{2} = 25\text{ K}$$

40. ***(a)*** The beat frequency of heart is

$$\nu = \frac{75}{(1\text{ min})} = \frac{75}{60\text{ s}}$$

$$= 1.25\text{ s}^{-1}$$

$$= 1.25\text{ Hz}$$

The time period of heart is

$$T = \frac{1}{\nu} = \frac{1}{1.25\text{ s}^{-1}} = 0.8\text{ s}$$

Chemistry

41. ***(d)*** As we know, on moving down the group first ionisation enthalpy decreases top to bottom, therefore order of first ionisation enthalpy for group 13 element is

$$\text{B} > \text{Al} > \text{Ga} > \text{In} > \text{Tl}$$

42. ***(b)*** Bohr's theory is applicable to H-like species containing one electron only, *e.g.*, Li^{2+}.

43. ***(b)*** Among given four pairs, B_2 and O_2 are paramagnetic due to presence of unpaired electron.

$$\text{MO(EC) of } B_2 = \sigma 1s^2 \sigma^* 1s^2\ \sigma 2s^2 \sigma^* 2s^2\ \pi 2p_x^1 = \pi 2p_y^1$$

$$\text{MO(EC) of } O_2 = \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2 \sigma^* 2s^2\ \sigma 2p_z^2$$

$$\pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^1 = \pi^* 2p_y^1$$

44. ***(a)*** 1 mole of O_2 = 4 eq. of oxygen

22400 mL of O_2 = 4 eq. of oxygen

$$46.6\text{mL of } O_2 = \frac{4}{22400} \times 46.6 = 0.00832\text{ eq.}$$

Equivalent of metal = Equivalent of oxygen

$$\frac{\text{Weight}}{\text{Equivalent}} = 0.00832$$

$$\frac{0.1}{\text{Equivalent}} = 0.00832$$

$$\therefore \quad \text{Equivalent} = \frac{0.1}{0.00832} = 12.0$$

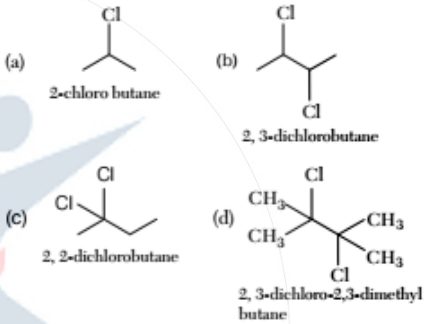
45. ***(c)*** Ionisation enthalpy is the minimum amount of enthalpy required to remove the outermost electron from an isolated gaseous atom. Quantitatively, it depends on the attraction between electron present on outermost shell and nucleus. Greater the interaction between outermost electron and nucleus, higher will be its ionisation enthalpy. So correct order of first ionisation enthalpy must be

$$\text{B} < \text{C} < \text{N} < \text{O} < \text{F}$$

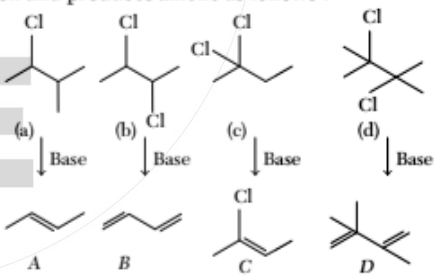
But due to extra stable half-filled electronic configuration of p-orbital of N has more value of first ionisation enthalpy than oxygen, hence correct order is

$$\text{B} < \text{C} < \text{N} > \text{O} > \text{F}$$

46. ***(d)*** Molecular structure of given names of organic compounds are written as



According to Saytzeff's rule, more substituted (alkylated) alkene are more stable. When the alkyl halide is treated with base, it undergo elimination reaction and produces alkene as follows :



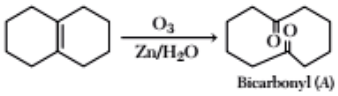
Conjugation Greater the conjugation greater will be the stability of product.

Hence, (d) has maximum stability, the correct choice is (d), which is stabilised by conjugation as well as Saytzeff's rule.

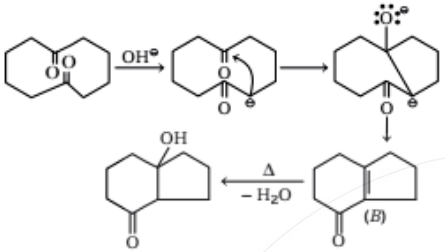
47. ***(c)*** Due to stronger $-I$ effect of F than Cl, CHF_3 should be more acidic than $CHCl_3$. But actually reverse is true. This is due to $:CCl_3^-$ left after the removal of a proton from $CHCl_3$ is stabilised by resonance due to presence of d-orbitals in Cl while $:CF_3^-$ left after the removal of a proton from CHF_3 is not stabilised by resonance due to the absence of d-orbitals on F.

$\therefore$ $CHCl_3$ is more acidic among the given halogen compound.

48. ***(d)*** **Ozonolysis** On ozonolysis the given alkene undergo ozonide formation followed by reduction to produce bicarbonyl compound as



Now, this bicarbonyl compound undergoes interamolecular aldol condensation as follows



49. ***(b)*** This question is based on Raoult's law. It represent that, the partial pressure of each component in the solution is directly proportional to its mole fraction for a solution *i.e.*, $p_A \propto \chi_A$ and $p_B \propto \chi_B$.

From Raoult's law,

$$p^\circ - p_s = p^\circ \times \text{mole fraction of solute}$$

$$10 = p^\circ \times 0.2 \quad \ldots(i)$$

$$20 = p^\circ \times \chi_2 \quad \ldots(ii)$$

$$\therefore \quad \chi_2 = 0.4 \quad \text{(on comparing)}$$

and $\chi_1 = 1 - 0.4 = 0.6$

where, χ_1, χ_2 = mole fractions of solvent and solute respectively.

50. ***(a)*** It is seen that, in experiments (3) and (2), $[A]$ is constant and $[B]$ is doubled and rates becomes 8 times, so order w.r.t, $[B] = 3$. In experiments (1) and (3), $[B]$ is constant and $[A]$ is doubled, but rate does not change, so order w.r.t. $[A] = 0$

Thus, rate $= k\,[B]^3$.

51. ***(a)*** The crystal field splitting, Δ_o depends upon the field produced by the ligand and charge on the metal ion. In all these complexes of chromium, charge acquired by metal ion is + 3. Therefore, Δ_o depends upon the field produced by the ligand.

In accordance with the spectrochemical series, the increasing order of field strength is

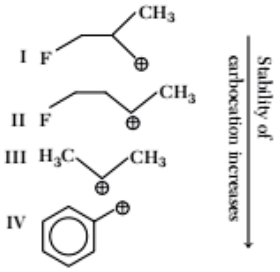
$$C_2O_4^{2-} < H_2O < NH_3 < CN^-$$

Thus, CN^- is the strong field ligand and will produce highest magnitude of Δ_o.

52. ***(c)*** This problem includes conceptual mixing of carbocation stability and reactivity of alcohol.

- Remove the —OH^- group by dehydration and then arrange the carbocation in increasing order of stability
- Order of carbocation stability is same as S_N1 reactivity of alkyl halides.

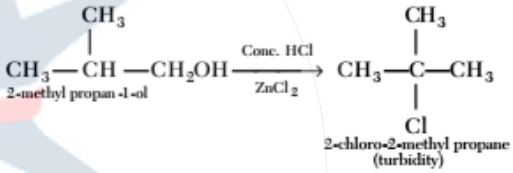
The carbocation is formed during reaction of alcohol by removal of —OH group. More stable the carbocation more will be its reactivity. During formation of carbocation, reactions are as follows :



Benzyl carbocation is more stable due to conjugation with phenyl ring.

Hence, the correct order of decreasing reactivity is IV> III> II> I.

53. ***(c)*** When 2-methyl propan-1-ol is treated with a mixture of conc. HCl and $ZnCl_2$ (Lucas reagent) then *tert*-alkyl halide is formed and produce turbidity due to its less solubility.



54. ***(a)*** Aspirin is a moderate acid ($pK_a = 3.5$). Therefore, it is almost unionised in stomach due to its strong acidic medium. It happens due to common ion effect. On the other hand, in small intestine, the medium is alkaline, hence, aspirin will be sufficiently ionised in it.

55. ***(b)*** The reaction of K_2CrO_4 with dilute nitric acid is represented as

$$2K_2CrO_4 + 2HNO_3 \longrightarrow K_2Cr_2O_7 + KNO_3 + H_2O$$

It's ionic equation is

$$2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$$

Hence, $Cr_2O_7^{2-}$ and H_2O are formed.

56. ***(a)*** When CaC_2 reacts with water molecule to form acetylene. Similarly, it reacts with D_2O to form C_2D_2.

$$CaC_2 + 2D_2O \longrightarrow C_2D_2 + Ca(OD)_2$$

57. ***(c)*** Fluorine acts as strongest oxidising agent due to

(a) low enthalpy of dissociation of F—F bond

(b) high hydration enthalpy of F^-.

58. ***(c)*** The reaction of P_4 with X leads selectively to P_4O_6. The reaction is as follows

$$P_4 + 3O_2 \xrightarrow{O_2 + N_2} P_4O_6$$

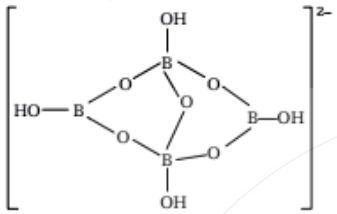
N_2 prevents the further reaction of P_4O_6 into P_4O_{10}.

59. ***(b)*** The acidic strength of hydrides is inversely proportional to their stability. Since, the stability of hydrides decreases from N to Sb. Therefore, the acidic strength increases from N to Sb. Hence, the correct order would be

$$NH_3 < PH_3 < AsH_3 < SbH_3$$

Caution point As the stability decreases from NH_3 to BiH_3, the reducing character of hydrides increases.

60. ***(b)*** Borax is $Na_2B_4O_7 \cdot 10H_2O$ in which 2 molecules of water among 10 molecules form a part of structure and exists as $Na_2[B_4O_5(OH)_4] \cdot 8H_2O$,



$$Na_2[B_4O_5(OH)_4] \cdot 8H_2O + 2HCl \longrightarrow 2NaCl + 4H_3BO_3 + 5H_2O$$

Methyl orange with pH value of 3.7 is used to detect end point. Aqueous solution of borax acts as buffer, because borax is salt of strong base NaOH and weak acid H_3BO_3.

61. ***(c)*** Among the given oxides, only KO_2 *i.e.*, potassium superoxide is paramagnetic in nature. This is because peroxide ion, O_2^- has three electron bond which makes it paramagnetic and coloured.

O^{2-}	$^-O-O^-$	$[O \equiv\equiv O]^{2-}$
Oxide ion	Peroxide ion	Superoxide ion

Hence, *A* is KO_2.

62. ***(b)*** The two sols prepared contains not only AgI but also KI and $AgNO_3$ as these are taken in excess amounts. When these sols are mixed, the sols being oppositely charged coagulates each other.

63. ***(c)*** The extraction of Ag using (Zn-Ag) alloy is called Parke's process.

As zinc is volatile at 920°C while Ag is not. Thus, on heating (Zn + Ag) alloy, zinc vapourises while Ag remains at the bottom of the vessel. Hence, Zn is removed from (Zn / Ag) alloy through distillation.

64. ***(a)*** $k_1 = Ae^{E_{a_1}/RT}$; $k_2 = Ae^{-E_{a_2}/RT}$

Given that, $k_3 = Ae^{-E_{a_3}/RT}$

Overall rate, $k = \dfrac{k_1 k_3}{k_2}$

Therefore, overall, $E_a = E_{a_1} + E_{a_3} - E_{a_2}$

$= 60 + 10 - 30 = 40$ kJ

65. *(d)* Given that, $E^\circ_{Fe^{3+}/Fe} = -0.36$ V;

$E^\circ_{Fe^{2+}/Fe} = -0.439$ V

$Fe^{3+} + 3e^- \longrightarrow Fe$; $\Delta G_1 = -3F(E^\circ_{Fe^{3+}/Fe})$

$Fe^{2+} + 2e^- \longrightarrow Fe$; $\Delta G_2 = -2F(E^\circ_{Fe^{2+}/Fe})$

$Fe^{3+} + e^- \longrightarrow Fe^{2+}$; $\Delta G_3 = -F(E^\circ_{Fe^{3+}/Fe^{2+}})$

$E^\circ_{Fe^{3+}/Fe^{2+}} = 3E^\circ_{Fe^{3+}/Fe} - 2E^\circ_{Fe^{2+}/Fe}$

$= [3(-0.36) - 2(-0.439)]$ V

66. ***(b)*** Given that, $r_{Na^+}/r_{Cl^-} = 0.55$

$r_{K^+}/r_{Cl^-} = 0.74$

$\dfrac{r_{KCl}}{r_{NaCl}} = ?$

$\because \quad \dfrac{r_{Na^+}}{r_{Cl^-}} = 0.55$

$\therefore \quad \dfrac{r_{Na^+}}{r_{Cl^-}} + 1 = 0.55 + 1$

$\dfrac{r_{Na^+} + r_{Cl^-}}{r_{Cl^-}} = 1.55 \quad \ldots(i)$

$\therefore \quad \dfrac{r_{K^+}}{r_{Cl^-}} = 0.74$

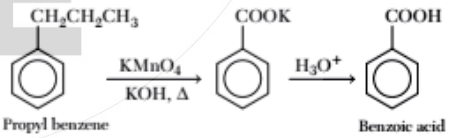
$\therefore \quad \dfrac{r_{K^+}}{r_{Cl^-}} + 1 = 0.74 + 1$

$\dfrac{r_{K^+} + r_{Cl^-}}{r_{Cl^-}} = 1.74 \quad \ldots(ii)$

Dividing Eq. (ii) by Eq. (i), we get

$$\frac{r_{K^+} + r_{Cl^-}}{r_{Na^+} + r_{Cl^-}} = \frac{1.74}{1.55} = 1.1226 = 1.23$$

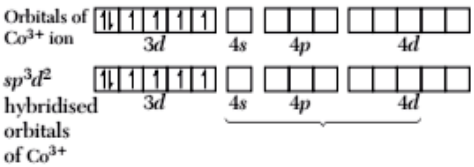
67. ***(c)*** When alkyl benzene is treated with acidic or alkaline $KMnO_4$, the entire side chain is oxidised to the carboxylic acid irrespective of length of the side chain.



68. *(d)* $[Co(NH_3)_6]^{3+}$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ are inner *d*-orbital or low spin complex while $[CoF_6]^{3-}$ is outer *d*-orbital or high spin complex.

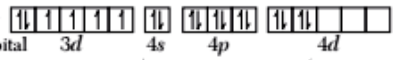
$[CoF_6]^{3-}$, Co = [Ar] $4s^2\ 3d^7,\ 4p^0$

Co^{3+} = [Ar] $3d^6,\ 4s^0,\ 4p^0$

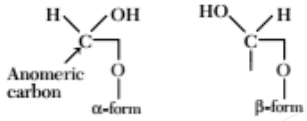


Here, F^- is a weak legand so, no pairing of electron takes place.

$[CoF_6]^{3-}$ (Outer orbital or high spin complex)



69. ***(b)*** C_1 carbon of monosaccharides is called anomeric carbon. When —OH group attached with C_1 carbon is towards right, it is called α-form and when —OH group is towards left, it is called β-form. Such pair or optical isomers which differ in the configuration only around anomeric carbon are called anomers.



70. ***(b)*** In I and IV, amine is not formed.

I. Hydrolysis of *R*CN;

$$RCN \longrightarrow RCOOH + NH_3$$

II. Reduction of *R*CH=NOH;

$$RCH{=}NOH \longrightarrow RCH_2NH_2 + H_2O$$

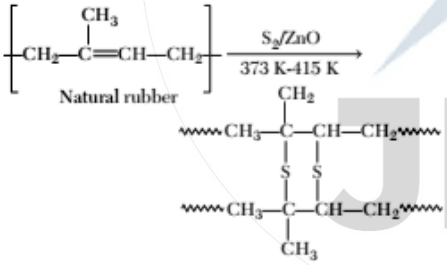
III. Hydrolysis of *R*NC ;

$$RNC + 2H_2O \xrightarrow{\Delta} RNH_2 + HCOOH$$

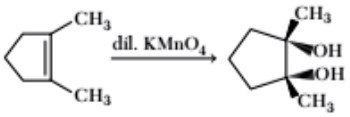
IV. Hydrolysis of $RCONH_2$;

$$RCONH_2 \longrightarrow RCOOH + NH_3$$

71. ***(b)*** In vulcanisation of rubber, sulphur cross-links are introduced at the reactive sites of double bonds.

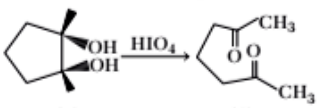


72. ***(a)*** **Hydroxylation reaction** The alkene on treatment with dil. $KMnO_4$ produces *vicinal cis* diol.

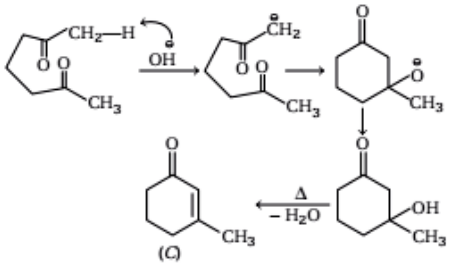


vicinal cis diol

Malaprade oxidation *cis* diol undergo malaprade oxidation in presence of HIO_4 and believe to proceed as

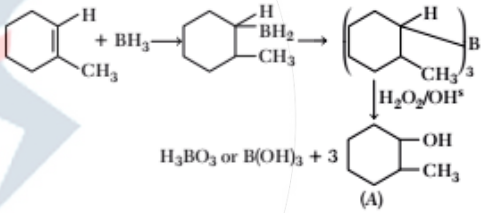


Intramolecular aldol reaction This diketone undergo intramolecular aldol condensation to produce the cyclic α, β-unsaturated ketone as follows

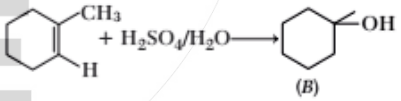


73. ***(d)*** This problem includes conceptual mixing of hydroboration. This problem can be solved by using the skill of electrophilic addition reaction in hydroboration oxidation reaction including isomerism. The steps to solve this problems are complete reaction with acid and then identify the isomerism in the out come products.

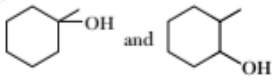
(i) **Hydroboration-oxidation** When alkene or substituted alkene is treated with B_2H_6, it gives alkyl borane which on treatment with H_2O_2 / OH^- causes oxidation of alkyl borane to give alcohol. The above reaction is believed to proceed as



(ii) When 2-methyl cyclohexene is treated with H_2O / H_2SO_4.



A and *B* have difference in position of OH only, so *A* and *B* are position isomers.



74. ***(c)*** Equilibrium constants at different temperature and heat of the reaction are related by the equation.

$$\ln \frac{K_{p_2}}{K_{p_1}} = \frac{\Delta H^\circ}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$2.303 \log \frac{K_{p_2}}{K_{p_1}} = \frac{\Delta H^\circ}{R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$\log K_{p_2} = \frac{-25140}{2.303 \times 2}\left[\frac{773 - 673}{773 \times 673}\right] + \log (1.6 \times 10^{-4})$$

$$\log K_{p_2} = -4.835$$

$$\therefore \quad K_{p_2} = 1.462 \times 10^{-5} \text{ (atm)}^{-2}$$

75. ***(a)*** $K_p = K_C\,(RT)^{\Delta n}$ $[\because \Delta n = 1]$

$$\Rightarrow \quad K_C = \frac{K_p}{RT} = \frac{0.1}{0.082 \times 300} = 4 \times 10^{-3}$$

76. ***(b)*** As we know, $\Delta H = \Delta E + \Delta n\, RT$

where, Δn = gaseous product moles − gaseous reactant moles

For the reaction,

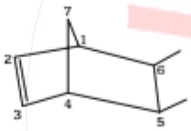
$$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$$

$$\Delta n = 1 - \left(1 + \frac{1}{2}\right) = -\frac{1}{2}$$

$$\therefore \quad \Delta H = \Delta E - \frac{1}{2}RT$$

Hence, $\Delta H < \Delta E$

77. ***(c)*** This problem contains conceptual mixing of nomenclature of cyclic hydrocarbon and degree of unsaturation. This problem can be solved by identifying the parent chain, functional group, position of functional group, substituent and their position one by one and then write the name of compound according to IUPAC names then calculate degree of unsaturation.



Total carbon atom forming the bicyclic ring = 7 (hept.)

functional group ⇒ double bond (ene)

Position of double bond ⇒ 2, 2-ene

Substituents ⇒ 2-methyl group ⇒ dimethyl

Position of substituents = 5, 6 ⟶ 5, 6-dimethyl

Number of cyclic chain = 2 ⟶ Bicyclo

3-bridges are of 2 carbons, 2 carbons and one carbon hence,

IUPAC name = 5, 6-dimethyl bicyclo [2, 2, 1] hept-2-ene

Molecular formula of compound is C_9H_{14}.

Degree of unsaturation can be calculated as

$$u = (C + 1) - \frac{H}{2} + \frac{N}{2}$$

where, u = degree of unsaturation

C = number of carbons

H = number of hydrogens

N = number of nitrogens

Hence, for a compound having molecular formula C_9H_{14}, the degree of unsaturation may be calculated as

$$u = (9 + 1) - \frac{14}{2} = 10 - 7 = 3$$

78. ***(c)*** Oxidation number of Na = + 1

Oxidation number of O = − 2

Let oxidation number of S = x

$\therefore$ 2 (O.N. of Na) + 4(O.N. of S) + 6(O.N. of O) = 0

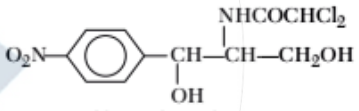
$2(+1) + 4x + 6(-2) = 0$

$$+2 + 4x - 12 = 0 \Rightarrow 4x = +12 - 2$$

$$\Rightarrow \quad x = +\frac{10}{4}$$

$$\Rightarrow \quad x = +\frac{5}{2}$$

79. ***(d)*** Among the given antibiotics, only chloramphenicol contains a nitro group attached to aromatic ring. Its structure is as follows



Chloramphenicol

80. ***(a)*** The deviation from ideal behaviour can be measured in terms of compressibility factor Z.

$$Z = \frac{pV}{nRT}$$

For ideal gas $Z = 1$,

i.e., $pV = nRT$

At very low pressures all gases shown have Z = 1 and behave as ideal gas. At high pressure all the gases have Z > 1 which show the deviation from ideality.

At intermediate pressures, most gases have Z < 1 which also show the deviation from ideality.

a. English Proficiency

81. ***(b)*** Sagacious having or showing keen mental discernment and good judgement; wise, shrewd, so 'wise' is correct answer.

82. ***(a)*** Remedial means done to correct or improve something, so 'corrective' is correct answer.

83. ***(d)*** Reticent means not revealing one's thoughts or feelings readily, so 'secretive' is correct answer.

84. ***(d)*** Fidelity means 'faithfulness in relations', so 'treachery' is its correct antonym.

85. ***(b)*** Infrangible means 'strong', so 'breakable' is its correct antonym.

86. ***(b)*** Progeny means 'child', so 'parent' is its correct antonym.

87. ***(c)*** Use of 'draw' is more suitable for using before word 'conclusion', so option (c) is correct.

88. ***(a)*** Use of 'looking for' is proper because 'look for' means 'to search for something' which suits here.

89. ***(d)*** 'Mind your language' is proper to use here because it gives proper sense of sentence.

90. ***(b)*** 'Use to' is used when any habit is to be shown, so use of option (b) is proper.

91. ***(c)*** 'Angry' agrees with preposition 'with', so use of option (c) is correct here.

92. ***(b)*** Laugh agrees with preposition 'at', so use of option (b) is correct here.

93. ***(c)*** According to sequence of events, so option (c) is best answer.

94. ***(b)*** According to sequence of events, option (b) best suits here.

95. ***(a)*** According to sequence of events, option (a) is proper here.

b. Logical Reasoning

96. ***(d)*** As

D ⟶ 8 and M ⟶ 4

O ⟶ 9 E ⟶ 3

M ⟶ 4 A ⟶ 2

E ⟶ 3 L ⟶ 1

In the same way 38249 will be coded as

3 ⟶ E

8 ⟶ D

2 ⟶ A

4 ⟶ M

9 ⟶ O

Hence, option (d) is correct.

97. ***(d)*** From fig. 1, $93 - (27 + 63) = 93 - 90 = 3$

From fig. 2, $79 - (38 + 37) = 79 - 75 = 4$

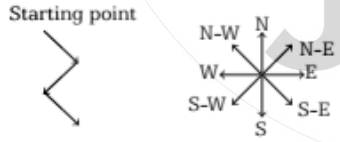
From fig. 3, $67 - (16 + 42) = 67 - 58 = 9$

Hence, option (d) is correct.

98. ***(b)*** Some poor people can be unemployed, some unemployed people can be illiterates and some illiterates can be poor. Hence, correct diagram is

Hence, option (b) is correct.

99. ***(c)*** Starting point



Hence, 'A' is moving in South-East direction.

Hence option (c) is correct.

100. ***(a)*** From the information given in the question the arrangement of students is

1st ⟶ D

2nd ⟶ E

3rd ⟶ C

4th ⟶ A

5th ⟶ B

Hence, option (a) is correct.

101. ***(b)*** The given series follows the pattern

$1^3 + 1 = 1 + 1 = 2$

$2^3 + 1 = 8 + 1 = 9$

$3^3 + 1 = 27 + 1 = 28$

$4^3 + 1 = 64 + 1 = \boxed{65}$

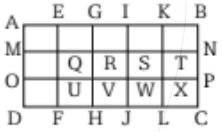
$5^3 + 1 = 125 + 1 = 126$

Hence, option (b) is correct.

102. ***(b)*** Clearly, option figure (b) completes the original figure which looks like the figure given below

Hence, option (b) is correct.

103. ***(c)*** On labelling the figure, we get



Each row contains five squares.

∴ Total number of single squares $= 5 \times 3 = 15$

Now, combination of 4 small squares will be

= 8 (*i.e.*, AOVG, EUWI, GVXK, IWPB, MDHR, QFJS, RHLT and SJCN)

Now, combination of 9 small squares will be

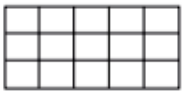
= 3 (*i.e.*, ADJI, EFLK and GHCB)

∴ Total number of squares

= 15 + 8 + 3 = 26 squares

Hence, option (c) is correct.

Alternate method : Given



m = number of rows = 3 and n = number of columns = 5

So, total number of squares
$= m \times n + (m-1) \times (n-1) + \ldots$
$= 3 \times 5 + 2 \times 4 + 1 \times 3 = 15 + 8 + 3 = 26$

104. ***(d)*** Interchanging symbols + and – as given in option (a) the above equation becomes
$3 \div 5 \times 8 - 2 + 10$
$= \frac{3}{5} \times 8 - 2 + 10 = \frac{24}{5} + 8 \neq 13$

Interchanging symbols × and ÷ as given in option (b), we get
$3 \times 5 \div 8 + 2 - 10$
$= 3 \times \frac{5}{8} + 2 - 10 = \frac{15}{8} - 8 \neq 13$

Interchanging symbols ÷ and – as given in option (c), we get
$3 - 5 \times 8 + 2 \div 10$
$= 3 - 5 \times 8 + \frac{2}{10}$
$= 3 - 40 + \frac{2}{10} \neq 13$

Interchanging symbols ÷ and + as given in option (d), we get
$3 + 5 \times 8 \div 2 - 10$
$= 3 + 5 \times \frac{8}{2} - 10$
$= 3 + 20 - 10 = 13$

Hence, option (d) is correct.

105. ***(b)*** Both Assertion and Reason are correct but India is a democratic country because the government is elected by its citizens and not because India has its own constitution.

Hence, option (b) is correct.

Mathematics

106. ***(d)*** Given, $\sum_{k=1}^{6}\left(\frac{\sin 2\pi k}{7} - \frac{i\cos 2\pi k}{7}\right)$

$= \sum_{k=1}^{6} -i\left(\frac{\cos 2\pi k}{7} + \frac{i\sin 2\pi k}{7}\right)$

$= -i\sum_{k=1}^{6} e^{i2\pi k/7} = -i[e^{i2\pi/7} + e^{i4\pi/7} + \ldots e^{i12\pi/7}]$

$= -i\left[e^{i2\pi/7}\frac{(1-e^{i12\pi/7})}{1-e^{i2\pi/7}}\right] = -i\left[\frac{e^{i2\pi/7} - e^{i14\pi/7}}{1-e^{i2\pi/7}}\right]$

$= -i\left[\frac{e^{i2\pi/7} - e^{2\pi i}}{1-e^{i2\pi/7}}\right] = -i\left[\frac{e^{i2\pi/7} - 1}{1-e^{i2\pi/7}}\right] = i$

107. ***(c)*** Given, $n_1 = 60$, $\bar{x}_1 = 650$, $\sigma_1 = 8$, $n_2 = 80$, $\bar{x}_2 = 660$, $\sigma_2 = 7$

$\therefore$ Combined SD

$= \sqrt{\frac{n_1\sigma_1^2 + n_2\sigma_2^2}{n_1+n_2} + \frac{n_1 n_2(\bar{x}_1 - \bar{x}_2)^2}{(n_1+n_2)^2}}$

$= \sqrt{\frac{60 \times 64 + 80 \times 49}{60+80} + \frac{60 \times 80(650-660)^2}{(60+80)^2}}$

$= \sqrt{\frac{3840 + 3920}{140} + \frac{(4800 \times 100)}{(140)^2}}$

$= \sqrt{\frac{7760}{140} + \frac{480000}{19600}} = \sqrt{\frac{776}{14} + \frac{4800}{196}}$

$= \sqrt{55.42 + 24.49} = \sqrt{79.91} = 8.94$

108. ***(a)*** Since, $|a-a| = 0 < 1$, so aRa, $\forall\ a \in R$

$\therefore R$ is reflexive.

Now, $aRb \Rightarrow |a-b| \leq 1 \Rightarrow |b-a| \leq 1 \Rightarrow bRa$

$\therefore R$ is symmetric.

But R is not transitive

As, $1R2$, $2R3$ but $1\ R3$ $\quad [\because |1-3| = 2 > 1]$

109. ***(c)*** Given that,

$I = \int_0^{10\pi}([\sec^{-1}x] + [\cot^{-1}x])dx$

$= \int_0^{\sec 1}([\sec^{-1}x] + [\cot^{-1}x])dx + \int_{\sec 1}^{10\pi}([\sec^{-1}x] + [\cot^{-1}x])dx$

$= \int_0^{\sec 1}(0+0)dx + \int_{\sec 1}^{10\pi}(1+0)dx$

$= 0 + [x]_{\sec 1}^{10\pi} = 10\pi - \sec 1$

110. ***(d)*** $\sin\left[\cot^{-1}\left(\cos\frac{\pi}{4}\right)\right]$

$= \sin\left[\cot^{-1}\frac{1}{\sqrt{2}}\right] = \sin\left[\sin^{-1}\sqrt{\frac{2}{3}}\right] = \sqrt{\frac{2}{3}}$

111. ***(b)*** Let

$S = 1 + 2\cdot 2 + 3\cdot 2^2 + 4\cdot 2^3 + \ldots + 100\cdot 2^{99}$ $\quad \ldots(i)$

It is an arithmetico-geometric series. On multiplying Eq. (i) by 2 and then subtracting, we get

$S = 1 + 2\cdot 2 + 3\cdot 2^2 + 4\cdot 2^3 + \ldots + 100\cdot 2^{99}$

$2S = 1\cdot 2 + 2\cdot 2^2 + 3\cdot 2^3 + \ldots + 99\cdot 2^{99} + 100\cdot 2^{100}$

$-S = 1 + 2 + 2^2 + 2^3 + \ldots + 2^{99} - 100\cdot 2^{100}$

$\Rightarrow -S = \frac{1(2^{100}-1)}{2-1} - 100\cdot 2^{100}$

$\Rightarrow -S = 2^{100} - 1 - 100\cdot 2^{100}$

$\Rightarrow -S = -1 - 99\cdot 2^{100}$

$\Rightarrow \quad S = 99\cdot 2^{100} + 1$

112. ***(c)*** Consider a point $(2, 0)$ on the X-axis.

Substituting $x = 2,\ y = 0$ in

$$3x + 12y = 6 < 400.$$

Hence, one constraints is $3x + 12y \le 400$

Again, substituting $x = 2,\ y = 0$ in

$$x - 4y = 2 - 0 > 0$$

$\therefore\ x - 4y \ge 0$ is other constraints or $x \ge 4y$

and also the third constraint from the figure is $y \le 25$.

Hence, the correct alternative is (c).

113. ***(b)*** $\log\left(\dfrac{1}{1+x+x^2+x^3}\right) = \log\left(\dfrac{1-x}{1-x^4}\right)$

$$= \log_e(1-x) - \log(1-x^4) = -\sum_{r=1}^{\infty}\frac{x^r}{r} + \sum_{r=1}^{\infty}\frac{x^{4r}}{r}$$

When n is odd, there is no term in the second series containing x^n, therefore the coefficient x^n is zero in the second series and in the first series the coefficient of x^n is $-\dfrac{1}{n}$. Hence, when n is odd, then the coefficient of x^n in the whole expansion is $-\dfrac{1}{n} + 0 = -\dfrac{1}{n}$.

114. ***(d)*** For maximum value, find $f'(x)$

$$f'(x) = \frac{1}{x^2}(1 - \log x)$$

$f'(x) > 0$ for $x < e$ and $f'(x) < 0$ for $x > e$

$\Rightarrow f(x)$ is increasing for $x < e$ and decreasing for $x > e$

$\Rightarrow x = e$ is the point of local maxima.

$\therefore$ Maximum value of $f(x) = 1/e$

Hence, the answer is (d).

115. ***(a)*** We have, $(\mathbf{a} \times \mathbf{b}) \times \mathbf{c} = \dfrac{1}{3}|\mathbf{b}||\mathbf{c}|\mathbf{a}$

$$\Rightarrow (\mathbf{a}\cdot\mathbf{c})\mathbf{b} - (\mathbf{b}\cdot\mathbf{c})\mathbf{a} = \frac{1}{3}|\mathbf{b}||\mathbf{c}|\mathbf{a}$$

$$\Rightarrow (\mathbf{a}\cdot\mathbf{c})\mathbf{b} - \{(\mathbf{b}\cdot\mathbf{c}) + \frac{1}{3}|\mathbf{b}||\mathbf{c}|\}\mathbf{a} = 0$$

$$\Rightarrow (\mathbf{a}\cdot\mathbf{c}) = 0 \text{ and } \mathbf{b}\cdot\mathbf{c} + \frac{1}{3}|\mathbf{b}||\mathbf{c}| = 0$$

($\because \theta$ is the angle between $\mathbf{b}$ and $\mathbf{c}$)

$$\Rightarrow |\mathbf{b}||\mathbf{c}|\cos\theta + \frac{1}{3}|\mathbf{b}||\mathbf{c}| = 0 \Rightarrow \cos\theta = -\frac{1}{3}$$

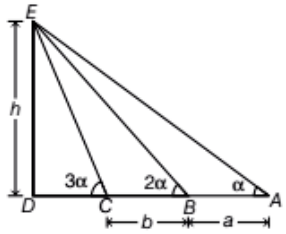
$$\therefore \sin\theta = \sqrt{\frac{8}{9}} = \frac{2\sqrt{2}}{3}$$

116. ***(a)*** $\lim\limits_{x\to 0}\left(\dfrac{1+5x^2}{1+3x^2}\right)^{1/x^2} = \lim\limits_{x\to 0}\left(1 + \dfrac{2x^2}{1+3x^2}\right)^{1/x^2}$

$$= e^{\lim\limits_{x\to 0}\left(\frac{2x^2}{1+3x^2}\right)} = e^2$$

117. ***(c)*** Let $ED = h,\ \angle EAB = \alpha$

$\therefore\ \angle EBD = 2\alpha,\ \angle ECD = 3\alpha$



Now, $\angle DBE = \angle EAB + \angle BEA$

$\Rightarrow 2\alpha = \alpha + \angle BEA$

$\Rightarrow \angle BEA = \alpha = \angle EAB$

$\Rightarrow AB = EB = a$

Similarly, $\angle BEC = \alpha$

From ΔEBC, $\dfrac{BC}{\sin\alpha} = \dfrac{EB}{\sin(180^\circ - 3\alpha)}$

$$\Rightarrow \frac{b}{\sin\alpha} = \frac{a}{\sin 3\alpha}$$

$$\Rightarrow \frac{a}{b} = \frac{\sin 3\alpha}{\sin\alpha}$$

$$\Rightarrow \frac{a}{b} = \frac{3\sin\alpha - 4\sin^3\alpha}{\sin\alpha} = 3 - 4\sin^2\alpha$$

$$\Rightarrow 4\sin^2\alpha = 3 - \frac{a}{b} = \frac{3b-a}{b}$$

$$\Rightarrow \sin\alpha = \sqrt{\frac{3b-a}{4b}}$$

From ΔEBD, $\sin 2\alpha = \dfrac{ED}{EB}$

$$\Rightarrow ED = a\cdot 2\sin\alpha\cdot\cos\alpha$$

$$\Rightarrow h = 2a\sqrt{\frac{3b-a}{4b}}\cdot\sqrt{1-\frac{3b-a}{4b}}$$

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

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

118. ***(d)*** We have, $f(x) = e^{x^3 - 3x + 2}$

Let $h(x) = x^3 - 3x + 2$

$\therefore\ h'(x) = 3x^2 - 3 = 3(x^2 - 1)$

$\Rightarrow h'(x) \ge 0$ for $x \in (-\infty, -1]$

$\therefore f(x)$ is increasing function.

$\therefore f(x)$ is one-one.

Now, range of $f(x) = (0, e^4]$

But codomain of $f(x) = (0, e^5]$

$\therefore f(x)$ is an into function.

119. ***(c)*** Given equation can be rewritten as

$$\frac{(x-3)^2}{16}+\frac{y^2}{25}=1$$

$\therefore \quad a^2=16$ and $b^2=25$

Now, $\quad e=\sqrt{1-\frac{16}{25}}=\sqrt{\frac{25-16}{25}}=\sqrt{\frac{9}{25}}=\frac{3}{5}$

Hence, the foci of conic section are $(3, \pm be)$ *i.e.*, $(3, \pm 3)$.

So, option (c) is correct.

120. ***(c)*** Let $D=\begin{vmatrix}1 & -1 & 3\\ 1 & 0 & 1\\ 1 & 1 & -1\end{vmatrix}$

$=1(0-1)-1(1+1)+3(1)=-1-2+3=0$

$D_1=\begin{vmatrix}4 & -1 & 3\\ 2 & 0 & 1\\ 0 & 1 & -1\end{vmatrix}=4(0-1)-1(0+2)+3(2)$

$=-4-2+6=0$

$D_2=\begin{vmatrix}1 & 4 & 3\\ 1 & 2 & 1\\ 1 & 0 & -1\end{vmatrix}$

$=1(-2)+4(1+1)+3(0-2)=-2+8-6=0$

$D_3=\begin{vmatrix}1 & -1 & 4\\ 1 & 0 & 2\\ 1 & 1 & 0\end{vmatrix}$

$=1(0-2)-1(2-0)+4(1-0)$

$=-2-2+4=0$

Hence, the given system of equations has infinitely many solutions.

121. ***(b)*** $S_n=5+55+555+\ldots$ upto n terms

$=5[1+11+111+\ldots \text{ upto } n \text{ terms}]$

$=\frac{5}{9}[9+99+999+\ldots \text{ upto } n \text{ terms}]$

$=\frac{5}{9}[(10-1)+(10^2-1)+(10^3-1)+\ldots \text{ upto } n \text{ terms}]$

$=\frac{5}{9}[(10+10^2+10^3+\ldots \text{ upto } n \text{ terms})$

$-(1+1+1+1+\ldots \text{ upto } n \text{ terms})]$

$=\frac{5}{9}\left[\frac{10(10^n-1)}{10-1}-n\right]=\frac{5}{9}\left[\frac{10(10^n-1)}{9}-n\right]$

122. ***(d)*** Let the parallel plane to $2x-2y+z=0$ is $2x-2y+z+\lambda=0$

It passes through $(1,-2,3)$.

$\therefore \quad 2+4+3+\lambda=0$

$\Rightarrow \quad \lambda=-9$

The distance of $(-1, 2, 0)$ from the plane

$2x-2y+z-9=0$ is $\left|\frac{-2-4-9}{\sqrt{4+4+1}}\right|=\left|\frac{-15}{3}\right|=5$

123. ***(c)*** Clearly, we have

$a=1, h=-3, b=9, g=\frac{3}{2}, f=\frac{-9}{2}$ and $c=-4$

Required distance $=\left|2\sqrt{\frac{f^2-bc}{b(a+b)}}\right|$

$=\left|2\sqrt{\frac{\left(\frac{-9}{2}\right)^2+9\times 4}{9(9+1)}}\right|$

$=\left|2\sqrt{\frac{225}{4\times 90}}\right|=\left|\frac{2\sqrt{5}}{2\sqrt{2}}\right|=\sqrt{\frac{5}{2}}$

124. ***(a)*** $A=\{1,-1,i,-i\}$

$B=\{1,-1\}, \; C=\{i,-i\}$

Now, $B\cup C=\{1,-1,i,-i\}=A$

125. ***(b)*** We have, $\frac{dy}{dx}+\sin\left(\frac{x+y}{2}\right)=\sin\left(\frac{x-y}{2}\right)$

$\Rightarrow \quad \frac{dy}{dx}=\sin\left(\frac{x-y}{2}\right)-\sin\left(\frac{x+y}{2}\right)$

$\Rightarrow \quad \frac{dy}{dx}=-2\cos\left(\frac{x}{2}\right)\sin\left(\frac{y}{2}\right)$

$\Rightarrow \quad \frac{dy}{\sin\left(\frac{y}{2}\right)}=-2\cos\left(\frac{x}{2}\right)dx$

On integrating both sides, we get

$\int\frac{dy}{\sin\left(\frac{y}{2}\right)}=-2\int\cos\left(\frac{x}{2}\right)dx$

$\Rightarrow \frac{1}{2}\int\text{cosec}\left(\frac{y}{2}\right)dy=-\int\cos\left(\frac{x}{2}\right)dx$

$\Rightarrow \frac{1}{2}\cdot\left[\frac{\log\left\{\text{cosec}\left(\frac{y}{2}\right)-\cot\left(\frac{y}{2}\right)\right\}}{\frac{1}{2}}\right]=-\frac{\sin\left(\frac{x}{2}\right)}{\frac{1}{2}}+C$

$\Rightarrow \log\left[\frac{1}{\sin\left(\frac{y}{2}\right)}-\frac{\cos\left(\frac{y}{2}\right)}{\sin\left(\frac{y}{2}\right)}\right]=-2\sin\left(\frac{x}{2}\right)+C$

$\Rightarrow \log\left[\frac{2\sin^2\left(\frac{y}{4}\right)}{2\sin\left(\frac{y}{4}\right)\cos\left(\frac{y}{4}\right)}\right]=-2\sin\left(\frac{x}{2}\right)+C$

$\left(\because 1-\cos x=2\sin^2\frac{x}{2} \text{ and } \sin x=2\sin x/2\ \cos x/2\right)$

$\Rightarrow \log\tan\left(\frac{y}{4}\right)=C-2\sin\left(\frac{x}{2}\right)$

126. ***(a)*** Given, $\frac{3-|x|}{4-|x|} \geq 0$

$\Rightarrow \quad 3-|x| \leq 0$ and $4-|x|<0$

or $\quad 3-|x| \geq 0$ and $4-|x|>0$

$\Rightarrow \quad |x| \geq 3$ and $|x|>4$

or $\quad |x| \leq 3$ and $|x|<4$

$\Rightarrow \quad |x|>4$ or $|x| \leq 3$

$\Rightarrow x \in (-\infty, -4) \cup [-3, 3] \cup (4, \infty)$

127. ***(a)*** $\frac{N}{x_1+x_2+x_3+x_4}$

$= \frac{1000x_1 + 100x_2 + 10x_3 + x_4}{x_1+x_2+x_3+x_4}$

$= 1000 - \left(\frac{900x_2 + 990x_3 + 999x_4}{x_1+x_2+x_3+x_4}\right)$

$\Rightarrow$ Maximum value is 1000.

Hence, answer is (a).

128. ***(c)*** $\because P(A \cap B) = P(A/B) \cdot P(B)$

$= 0.5 \times 0.2 = 0.1$

$\therefore P(A'/B') = \frac{P(A' \cap B')}{P(B')} = \frac{P(A \cup B)'}{P(B')}$

$= \frac{1-P(A \cup B)}{1-P(B)}$

$= \frac{1-P(A)-P(B)+P(A \cap B)}{1-0.2}$

$= \frac{1-0.6-0.2+0.1}{0.8} = \frac{3}{8}$

129. ***(d)*** Here, $N = \Sigma f = 20$

$Q_1 = \frac{(N+1)\text{th}}{4}$ observation

$= \left(\frac{21}{4}\right)$th observation

$= 3$

Similarly, $Q_3 = \frac{3(N+1)\text{th}}{4}$ observation

$= \left(\frac{63}{4}\right)$th observation

$= 5$

Now, quartile deviation $= \frac{1}{2}(Q_3 - Q_1)$

$= \frac{1}{2}(5-3) = 1$

130. ***(d)*** Given that, $\int f(x) \cos x\, dx = \frac{1}{2} f^2(x) + C$

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

$f(x)\cos x = \frac{1}{2} \cdot 2f(x) \cdot f'(x)$

$\Rightarrow \quad \cos x = f'(x) \Rightarrow \cos x = \frac{d}{dx}(f(x))$

$\int \cos x\, dx = f(x)$

$f(x) = \sin x + C$

131. ***(a)*** **Case 1** Taking 2 points from collinear points and one from non-collinear.

i.e., number of triangles so formed $= {}^6C_2 \times {}^4C_1$

$= \frac{6 \cdot 5}{1 \cdot 2} \times \frac{4}{1} = 60$

Case 2 Taking 1 point from collinear and two from non-collinear points

i.e., number of triangles so formed $= {}^6C_1 \times {}^4C_2$

$= \frac{6}{1} \times \frac{4 \cdot 3}{1 \cdot 2} = 36$

Case 3 All the three points from non-collinear points.

i.e., number of triangles so formed

$= {}^4C_3 = {}^4C_1 = \frac{4}{1} = 4$

Total number of triangles $= 60 + 36 + 4 = 100$

Alternatively Number of triangles

$= {}^{10}C_3 - {}^6C_3 = \frac{10 \cdot 9 \cdot 8}{1 \cdot 2 \cdot 3} - \frac{6 \cdot 5 \cdot 4}{1 \cdot 2 \cdot 3}$

$= 120 - 20 = 100$

Hence, option (a) is correct answer.

132. ***(d)*** $\frac{{}^8C_0}{6} - {}^8C_1 + {}^8C_2 \cdot 6 - {}^8C_3 \cdot 6^2 + {}^8C_4 \cdot 6^3 + \ldots + {}^8C_8 \cdot 6^7$

$= \frac{1}{6}[{}^8C_0 - {}^8C_1 \cdot 6^1 + {}^8C_2 \cdot 6^2 - {}^8C_3 \cdot 6^3 + \ldots + {}^8C_8 \cdot 6^8]$

$= \frac{1}{6}[1-6]^8 = \frac{1}{6} \times (-5)^8 = \frac{5^8}{6}$

Hence, the answer is (d).

133. ***(d)*** Let A denote the event that atleast one girl will be chosen and B be the event that exactly 2 girls will be chosen. We require $P(B/A)$.

Since, A denotes the event that atleast one girl will be chosen, A' denotes that no girl is chosen, *i.e.*, 4 boys are chosen.

Then, $P(A') = \frac{{}^8C_4}{{}^{12}C_4} = \frac{70}{495} = \frac{14}{99}$

$\Rightarrow \quad P(A) = 1 - \frac{14}{99} = \frac{85}{99}$

Now, $P(A \cap B) = P$ (2 boys and 2 girls)

$= \frac{{}^8C_2 \cdot {}^4C_2}{{}^{12}C_4} = \frac{28 \times 6}{495} = \frac{56}{165}$

$\therefore \quad P\left(\frac{B}{A}\right) = \frac{P(A \cap B)}{P(A)} = \frac{56 \times 99}{165 \times 85} = \frac{168}{425}$

134. ***(b)*** Here, we observe that

(a) $f(x)$ is a polynomial, so it is continuous in the interval $[0, 2]$.

(b) $f'(x) = 3x^2 - 6x + 2$ exists for all $x \in (0, 2)$.

So, $f(x)$ is differentiable for all $x \in (0, 2)$

(c) $f(0) = 0,\ f(2) = 2^3 - 3(2)^2 + 2(2) = 0$

$\therefore \quad f(0) = f(2)$

Thus, all the three conditions of Rolle's theorem are satisfied.

So, there must exist $c \in (0, 2)$ such that

$$f'(c) = 0$$

$$\Rightarrow f'(c) = 3c^2 - 6c + 2 = 0$$

$$\Rightarrow \quad c = 1 \pm \frac{1}{\sqrt{3}} \Rightarrow c \in (0, 2)$$

135. ***(a)*** Consider that, $I = \int \frac{4}{\sin^4 x + \cos^4 x}\, dx$

$$I = \int \frac{4}{\cos^4 x\,(\tan^4 x + 1)} dx$$

$$= \int \frac{4 \sec^4 x}{1 + \tan^4 x}\, dx$$

$$= 4 \int \frac{\sec^2 x\,(1 + \tan^2 x)}{1 + \tan^4 x}\, dx$$

Put $\tan x = t \Rightarrow \sec^2 x\, dx = dt$

$$I = 4\int \frac{1 + t^2}{1 + t^4}\, dt = 4 \int \frac{1 + 1/t^2}{t^2 + 1/t^2}\, dt$$

$$\Rightarrow \quad I = 4 \int \frac{1 + 1/t^2}{\left(t - \frac{1}{t}\right)^2 + 2}\, dt$$

Now, put $t - \frac{1}{t} = z \Rightarrow \left(1 + \frac{1}{t^2}\right) dt = dz$

$$\therefore \quad I = 4 \int \frac{dz}{z^2 + (\sqrt{2})^2} = \frac{4}{\sqrt{2}} \tan^{-1}\left(\frac{z}{\sqrt{2}}\right) + C$$

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

$\therefore \ a = 2\sqrt{2}$ and $b = \sqrt{2}$

136. ***(c)*** Given, $A = \begin{bmatrix} -5 & -8 & 0 \\ 3 & 5 & 0 \\ 1 & 2 & -1 \end{bmatrix}$

$$A^2 = \begin{bmatrix} -5 & -8 & 0 \\ 3 & 5 & 0 \\ 1 & 2 & -1 \end{bmatrix} \begin{bmatrix} -5 & -8 & 0 \\ 3 & 5 & 0 \\ 1 & 2 & -1 \end{bmatrix}$$

$$= \begin{bmatrix} 25 - 24 + 0 & 40 - 40 + 0 & 0 + 0 + 0 \\ -15 + 15 + 0 & -24 + 25 + 0 & 0 + 0 + 0 \\ -5 + 6 - 1 & -8 + 10 - 2 & 0 + 0 + 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I$$

As $A^2 = I$

$\therefore A$ is involutory.

137. ***(a)*** Given, $\frac{x^2}{16} + \frac{y^2}{9} = 1$

$$\therefore \quad e = \sqrt{1 - \frac{9}{16}} = \sqrt{\frac{16 - 9}{16}} = \sqrt{\frac{7}{16}} = \frac{\sqrt{7}}{4}$$

$\therefore$ Coordinates of foci are $(\pm \sqrt{7}, 0)$.

Since, centre of circle is $(0, 3)$ and passing through foci $(\pm \sqrt{7}, 0)$.

$$\therefore \quad \text{Radius of the circle} = \sqrt{(0 \pm \sqrt{7})^2 + (3 - 0)^2}$$

$$= \sqrt{7 + 9} = 4$$

Hence, option (a) is correct.

138. ***(d)*** The two normal vectors are $\mathbf{m} = 2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + \hat{\mathbf{k}}$ and $\mathbf{n} = \hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$

The line L is along, $\mathbf{m} \times \mathbf{n} = \begin{bmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 2 & 3 & 1 \\ 1 & 3 & 2 \end{bmatrix}$

$$= \hat{\mathbf{i}}(6 - 3) - \hat{\mathbf{j}}(4 - 1) + \hat{\mathbf{k}}(6 - 3)$$

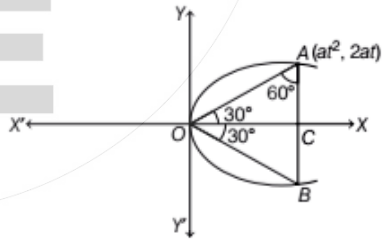
$$= 3\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 3\hat{\mathbf{k}} = 3(\hat{\mathbf{i}} - \hat{\mathbf{j}} + \hat{\mathbf{k}})$$

Now, the direction cosines of X-axis are $(1, 0, 0)$.

$$\therefore \quad \cos\alpha = \frac{3(\hat{\mathbf{i}} - \hat{\mathbf{j}} + \hat{\mathbf{k}}) \cdot \hat{\mathbf{i}}}{\sqrt{3^2(1^2 + 1^2 + 1^2)}\sqrt{1}} = \frac{3}{3\sqrt{3}} = \frac{1}{\sqrt{3}}$$

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

139. ***(a)*** In ΔOCA, $\tan 30° = \frac{AC}{OC}$



$$\Rightarrow \quad \frac{1}{\sqrt{3}} = \frac{2at}{at^2} \Rightarrow t = 2\sqrt{3}$$

Again, in ΔOCA,

$$OA = \sqrt{OC^2 + AC^2} = \sqrt{(at^2)^2 + (2at)^2}$$

$$= \sqrt{[(2\sqrt{3})^2]^2\, a^2 + 4a^2\,(2\sqrt{3})^2}$$

$$= \sqrt{192a^2} = 8a\sqrt{3}$$

Hence, option (a) is correct.

140. ***(a)*** Given, $f(x+y)=f(x)\cdot f(y)$

Put $x=y=0$, then $f(0)=1$

and put $y=-x$, then $f(0)=f(x)\,f(-x)$

$$\Rightarrow \quad f(-x)=\frac{1}{f(x)}$$

Now consider, $g(x)=\dfrac{f(x)}{1+\{f(x)\}^2}$

$$\Rightarrow \quad g(-x)=\frac{f(-x)}{1+\{f(-x)\}^2}=\frac{\frac{1}{f(x)}}{1+\left\{\frac{1}{f(x)}\right\}^2}$$

$$=\frac{f(x)}{1+\{f(x)\}^2}=g(x)$$

141. ***(a)*** Given $f(x)=(\tan^{-1}x)^2+\dfrac{2}{\sqrt{x^2+1}}$

$$f'(x)=\frac{2}{1+x^2}\left[\tan^{-1}x-\frac{x}{\sqrt{1+x^2}}\right]$$

Let $\quad g(x)=\tan^{-1}x-\dfrac{x}{\sqrt{x^2+1}}$

$$\Rightarrow \quad g'(x)=\frac{1}{1+x^2}\left[1-\frac{1}{\sqrt{x^2+1}}\right]>0 \text{ for all } x\in R$$

$\Rightarrow g(x)$ is increasing for all $x\in R$.

But $\quad g(0)=0 \Rightarrow g(x)>0$ for $x>0$

So, $\quad f'(x)>0$ for $x>0$

Hence, $f(x)$ is increasing in $(0,\infty)$.

142. ***(c)*** Clearly, $1+\sin x\geq 0$

$\therefore$ The given equation becomes

$$\cos x-\sin x=1$$

$$\Rightarrow \quad \cos x\cdot\frac{1}{\sqrt{2}}-\sin x\cdot\frac{1}{\sqrt{2}}=\frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad \cos\left(x+\frac{\pi}{4}\right)=\frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad x+\frac{\pi}{4}=\frac{\pi}{4},\frac{7\pi}{4},\frac{9\pi}{4},\frac{15\pi}{4}$$

$$\Rightarrow \quad x=0,\frac{3\pi}{2},2\pi,\frac{7\pi}{2}$$

$\because \quad 0\leq x\leq 3\pi$

$$\Rightarrow \quad x=0,\frac{3\pi}{2},2\pi$$

143. ***(a)*** Given, $\quad a^{\frac{1}{x}}=b^{\frac{1}{y}}=c^{\frac{1}{z}}$

Let $\quad a^{\frac{1}{x}}=b^{\frac{1}{y}}=c^{\frac{1}{z}}=k$

$\therefore \quad a=k^x,\ b=k^y,\ c=k^z$

$\because a, b, c$ are in GP.

Therefore, $\quad b^2=ac \Rightarrow (k^y)^2=k^x\cdot k^z$

$$\Rightarrow \quad k^{2y}=k^{x+z} \Rightarrow 2y=x+z$$

$\therefore x, y$ and z are in AP.

144. ***(d)*** Given that, $\quad 2l-m+2n=0 \quad \ldots(i)$

and $\quad lm+mn+nl=0 \quad \ldots(ii)$

From Eq. (i), $m=2(l+n)$ put in Eq. (ii),

$$2l(l+n)+2n(l+n)+nl=0$$

$$\Rightarrow \quad 2l^2+2nl+2nl+2n^2+nl=0$$

$$\Rightarrow \quad 2l^2+5nl+2n^2=0$$

$$\Rightarrow \quad 2l^2+4nl+nl+2n^2=0$$

$$\Rightarrow \quad 2l(l+2n)+n(l+2n)=0$$

$$\Rightarrow \quad (l+2n)(n+2l)=0$$

$$\Rightarrow \quad l=-2n \text{ and } n=-2l$$

If $\quad l=-2n$, then $m=2(-2n+n)=-2n$

and if $n=-2l$, then $m=2(l-2l)=-2l$

The DR's are $1,-2,-2$ and $-2,-2,1$.

Now, $1(-2)-(2)(-2)-2(1)=-2+4-2=0$

Hence, lines are perpendicular, so angle between them is $\pi/2$.

145. ***(d)*** Let m be the slope of required line.

$$\therefore \quad \left|\frac{m-(-1)}{1+m(-1)}\right|=1$$

$$\Rightarrow \quad \frac{m+1}{1-m}=\pm 1$$

$$\Rightarrow \quad m+1=1-m$$

and $\quad m+1=-1+m$

$$\Rightarrow \quad m=0 \text{ and } m=\infty$$

$\therefore$ Equation of line through $(1,1)$ is

$$y-1=0, x-1=0$$

Hence, option (d) is correct.

146. ***(a)*** Given curve is

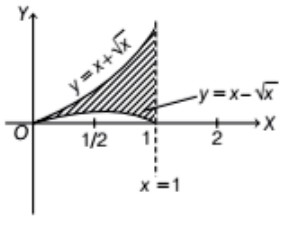
$$(y-x)^2=x^3$$

$$\Rightarrow \quad y-x=\pm x\sqrt{x}$$

$$\Rightarrow \quad y=x+x\sqrt{x} \quad \ldots(i)$$

$$\Rightarrow \quad y=x-x\sqrt{x} \quad \ldots(ii)$$

and $\quad x=1$



From the figure, required area

$$= \int_0^1 \{(x + x\sqrt{x}) - (x - x\sqrt{x})\}\, dx$$

$$= \int_0^1 2x\sqrt{x}\, dx = 2\int_0^1 x^{3/2}\, dx$$

$$= 2\left[\frac{x^{5/2}}{5/2}\right]_0^1 = \frac{4}{5}[1 - 0]$$

$$= \frac{4}{5} \text{ sq unit}$$

147. ***(c)*** $(x + iy)^{1/3} = 2 + 3i$

On cubing both sides, we get

$$x + iy = (2 + 3i)^3$$

$$\Rightarrow \quad x + iy = (2)^3 + (3i)^3 + 3 \times 2 \times 3i(2 + 3i)$$

$$\Rightarrow \quad x + iy = 8 - 27i + 18i(2 + 3i)$$

$$\Rightarrow \quad x + iy = 8 - 27i + 36i - 54$$

$$\Rightarrow \quad x + iy = -46 + 9i$$

On comparing real and imaginary both sides, we get

$$x = -46,\ y = 9$$

Then, $3x + 2y = 3(-46) + 2(9)$

$$= -138 + 18 = -120$$

148. ***(b)*** $n(A) = 40\%$ of $10000 = 4000$

$n(B) = 20\%$ of $10000 = 2000$

$n(C) = 10\%$ of $10000 = 1000$

$n(A \cap B) = 5\%$ of $10000 = 500$

$n(B \cap C) = 3\%$ of $10000 = 300$

$n(A \cap C) = 4\%$ of $10000 = 400$

$n(A \cap B \cap C) = 2\%$ of $10000 = 200$

To find $n[A \cap B^C \cap C^C]$

$$= n[A \cap (B \cup C)^C]$$

$$= n(A) - n[A \cap (B \cup C)]$$

$$= n(A) - [n(A \cap B) \cup n(A \cap C)]$$

$$= n(A) - [n(A \cap B) + n(A \cap C) - n(A \cap B \cap C)]$$

$$= 4000 - [500 + 400 - 200] = 3300$$

149. ***(d)*** Since, $\sin\theta = \dfrac{|\mathbf{a} \times \mathbf{b}|}{|\mathbf{a}||\mathbf{b}|} = \dfrac{8}{10} = \dfrac{4}{5}$

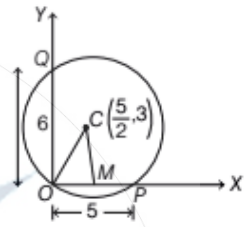
$$\therefore \quad \cos\theta = \pm\frac{3}{5}$$

$$\therefore \quad \mathbf{a} \cdot \mathbf{b} = |\mathbf{a}||\mathbf{b}|\cos\theta = 2 \times 5 \times \left(\pm\frac{3}{5}\right) = \pm 6$$

$$\Rightarrow \quad |\mathbf{a} \cdot \mathbf{b}| = 6$$

150. ***(a)*** From figure, we have

$$OP = 5,\ OQ = 6 \text{ and } OM = \frac{5}{2},\ CM = 3$$



$$\therefore \text{ In } \Delta OMC,\ OC^2 = OM^2 + MC^2$$

$$\Rightarrow \quad OC^2 = \left(\frac{5}{2}\right)^2 + (3)^2 \Rightarrow OC = \frac{\sqrt{61}}{2}$$

Thus, the required circle has its centre $\left(\dfrac{5}{2}, 3\right)$ and radius $\dfrac{\sqrt{61}}{2}$.

Hence, its equation is

$$\left(x - \frac{5}{2}\right)^2 + (y - 3)^2 = \left(\frac{61}{4}\right).$$

Hence, $\lambda = \dfrac{61}{4}$