SOLVED PAPER – 2012 (COMEDK)

Instructions

- There are 180 questions in all. The number of questions in each section is as given below.

Sections	No. of Questions
Section I : Physics	1-60
Section II : Chemistry	61-120
Section III : Mathematics	121-180

- All the questions are Multiple Choice Questions having four options out of which **ONLY ONE** is correct.
- Candidates will be awarded 1 mark for each correct answer. There will be no negative marking for incorrect answer.
- Time allotted to complete this paper is 3 hrs.

PHYSICS

1. The number of neutrons in $_{92}U^{235}$ nucleus is

a. 327 ***b.*** 235
c. 143 ***d.*** 92

2. Reverse saturation current of a diode

a. is independent of temperature
b. increases with increase in temperature
c. decreases with increase in temperature
d. may increase or decrease with increase in temperature depending on the semiconductor

3. A radioactive sample has a half-life of 10 min. If 64 nuclei are contained in the sample the number of nuclei that would decay after, 50 min is

a. 2 ***b.*** 5
c. 59 ***d.*** 62

4. The carrier of electromagnetic interaction is

a. gluon ***b.*** photon
c. meson ***d.*** graviton

5. The output of NOT gate when its input is 0

a. is 1 ***b.*** is 0
c. can be 0 or 1 ***d.*** is 0 and 1

6. LCD stands for

a. Light Carrying Diode
b. Liquid Crystal Display
c. Long Crystal Display
d. Light Crystal Display

7. Which of the following statement is false?

a. Sound and light waves exhibit interference.
b. Sound and light waves exhibit diffraction.
c. Light wave exhibits polarisation, while sound wave does not.
d. Sound wave exhibits polarisation, while light wave does not.

8. The correct relation between S, θ, L and C for an optically active solution is

a. $S = \theta LC$ ***b.*** $\theta = SLC$
c. $L = \theta SC$ ***d.*** $C = \theta LS$

9. An inductor and a resistor are connected to an AC supply of 50 V and 50 Hz. If the voltage across the resistor is 40 V, then the voltage across the inductor will be

a. 10 V ***b.*** 20 V
c. 30 V ***d.*** 60 V

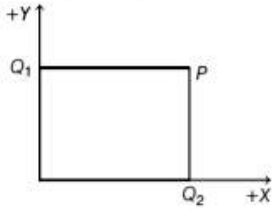
10. A 10μF capacitor is charged to 10 V and disconnected from the battery. If another uncharged 10μF capacitor is connected across it in parallel, then the voltage across the combination will be

a. 5V ***b.*** 10V ***c.*** 20V ***d.*** Zero

11. When two light nuclei fuse to form a relatively heavier nucleus, then the specific binding energy of the product nucleus is

a. lower than that of the reacting nuclei
b. equal to that of the reacting nuclei
c. greater than that of the reacting nuclei
d. equal to exactly half of either of the reacting nuclei

12. Two point charges $Q_1 = 2\,\mu C$ and $Q_2 = 1\,\mu C$ are placed as shown. The coordinates of the point P are (2 cm, 1 cm). The electric intensity vector at P subtends an angle θ with the positive X-axis. The value of θ is given by



a. $\tan\theta = 1$ ***b.*** $\tan\theta = 2$
c. $\tan\theta = 3$ ***d.*** $\tan\theta = 4$

13. The direction of the force on a current carrying conductor held perpendicular to an uniform magnetic field is given by

a. Fleming's right hand rule
b. Ampere's swimming rule
c. Maxwell's right hand cork screw rule
d. Fleming's left hand rule

14. A convex lens of focal length F is placed in contact with a concave lens of focal length F. The equivalent focal length of the combination is

a. infinity ***b.*** $F/2$ ***c.*** $2F$ ***d.*** zero

15. If $x = at + bt^2$, where x is measured in metre and t in second, then the dimension of (b/a) is

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

16. A particle is moving eastward with a velocity $5\ ms^{-1}$. In 10 s the velocity changes to $5\ ms^{-1}$ northwards. The average acceleration in this time is

a. $\frac{1}{\sqrt{2}}\ ms^{-2}$, towards North-West
b. $\frac{1}{2}\ ms^{-2}$, towards North-West
c. $\frac{1}{\sqrt{2}}\ ms^{-2}$, towards North-East
d. $\frac{1}{2}\ ms^{-2}$, towards North-East

17. A mass of 0.1 kg is hung at the 20 cm mark from a 1m rod weighing 0.25 kg pivoted at its centre. The rod will not topple if

a. No other mass is attached to the rod
b. 0.15 kg is hung at 80 cm mark
c. 0.15 kg is hung at 70 cm mark
d. 0.10 kg is hung at 70 cm mark

18. Which of the following cannot be explained on the basis of Bernoulli's principle?

a. Lift on an aircraft's wing
b. Ink filler
c. Swing of a cricket ball
d. Atomizer

19. The layer in the Earth's atmosphere which reflects radio waves from the Earth, thus helping radio communication is

a. stratosphere ***b.*** mesosphere
c. troposphere ***d.*** ionosphere

20. The reaction of the floor on an object placed on the floor of an elevator is maximum when elevator

a. is stationary
b. accelerates upwards
c. cable snaps and it falls freely towards the Earth
d. accelerates downwards

21. A particle is projected at an angle of 30° with the horizontal with a momentum p. At the highest point its momentum is

a. $\frac{\sqrt{3}}{4}p$ ***b.*** $\frac{2}{\sqrt{3}}p$
c. p ***d.*** $\frac{1}{2}p$

22. A block of mass 0.1 kg is held against a wall by applying a horizontal force of 5 N on it. If μ_s between the wall and the block is 0.5, the magnitude of the frictional force acting on the block is

a. 0.98 N ***b.*** 0.49 N
c. 4.9 N ***d.*** 2.5 N

23. A ring rolls down an inclined plane. The ratio of the rotational kinetic energy to translational kinetic energy is

a. 1 : 3 ***b.*** 1 : 1
c. 3 : 1 ***d.*** 2 : 1

24. If 120 J of work is done in 2 min by a water pump, then the power of the pump is

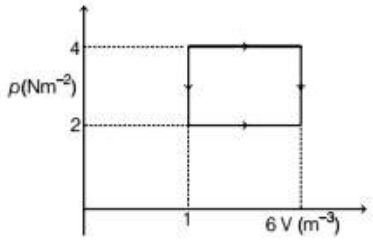
a. 14.4 kW ***b.*** 240 W ***c.*** 60 W ***d.*** 1 W

25. Assuming, $g_{(\text{Moon})} = \left(\frac{1}{6}\right) g_{\text{Earth}}$ and $D_{(\text{Moon})} = \left(\frac{1}{4}\right) D_{\text{Earth}}$, where g and D are the acceleration due to gravity and diameter respectively, the escape velocity from the Moon is

a. $\frac{11.2}{24}$ kms^{-1} ***b.*** $11.2 \times \sqrt{24}$ kms^{-1}

c. $\frac{11.2}{\sqrt{24}}$ kms^{-1} ***d.*** 11.2×24 kms^{-1}

26. The work done in taking an ideal gas through one cycle of operation as shown in the indicator diagram below



a. 10^{-5} J ***b.*** 10^{-3} J

c. 10^{-2} J ***d.*** 10 J

27. The ratio of speed of sound in hydrogen to that in oxygen at the same temperature is

a. 1 : 4 ***b.*** 4 : 1 ***c.*** 1 : 1 ***d.*** 16 : 1

28. A black body at a temperature T radiates energy at the rate of E Wm^{-2}. If the temperature is decreased by T / 2, then the energy radiated will be

a. E / 4 ***b.*** E / 16 ***c.*** E / 8 ***d.*** E / 32

29. A particle executes simple harmonic motion with amplitude A. The distance moved by the particle in one oscillation is

a. zero ***b.*** A ***c.*** $2A$ ***d.*** $4A$

30. A capacitor of 10 μF is connected to a 10 V cell. The maximum charge on the capacitor will be

a. 1 μC ***b.*** 10 μC

c. 100 μC ***d.*** 1000 μC

31. A wire of uniform cross-section has a resistance R. It is cut into ten equal parts. The parts are connected in parallel between two points A and B. The effective resistance between A and B will be

a. 0.01 R ***b.*** 0.1 R ***c.*** R ***d.*** 10 R

32. Wires made of iron and silicon are cooled from 50°C to 30°C, then

a. resistance of both wires decreases

b. resistance of both wires increases

c. resistance of iron increases and that of silicon decreases

d. resistance of iron decreases and that of silicon increases

33. In a meter bridge a copper coil is connected in the right gap and a resistance of 10 Ω in the left gap. The balance point is obtained at 0.2 m. The resistance of the coil is

a. 40 Ω ***b.*** 5 Ω ***c.*** 20 Ω ***d.*** 2.5 Ω

34. Two identical concentric coils X and Y carrying currents in the ratio 1 : 2 are arranged in mutually perpendicular planes. If the magnetic field due to coil X is B, then the net field at their common centre is

a. B ***b.*** $2B$ ***c.*** $3B$ ***d.*** $\sqrt{5}B$

35. Which of the following is based on mechanical effect of electric current?

a. AC dynamo ***b.*** DC dynamo

c. AC or DC motor ***d.*** Electric geyser

36. According to Faraday's law of electromagnetic induction an emf is induced in a coil, if

a. electric flux links with the coil

b. magnetic flux links with the coil

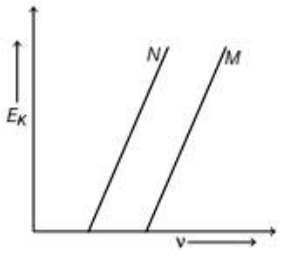
c. magnetic flux linked with the coil changes

d. electric flux linked with the coil changes

37. The current in a coil changes from 1 mA to 5 mA in 4 milli second. If the coefficient of self-induction of the coil is 10 mH, then the magnitude of the self-induced emf is

a. 10 mV ***b.*** 5 mV ***c.*** 2.5 mV ***d.*** 1 mV

38. The graph of kinetic energy of photoelectron *versus* frequency of incident radiation is shown for two metals M and N. We may definitely conclude



a. work function of M > work function of N

b. work function of M < work function of N

c. work function of M = work function of N

d. at the threshold frequency of M the kinetic energy of the photoelectron emitted by M is more than that emitted by N

39. Choose the wrong statement.

a. Alpha particles can be scattered by Gold nucleus.

b. X-ray can be diffracted by crystals.

c. UV-radiation can cause photoelectric effect.

d. Electrons cannot be diffracted by crystals.

40. In the case of the Bohr atom model if E_K and U are the kinetic and potential energies of an electron in an orbit, then

a. $E_K + U = 0$ ***b.*** $E_K - U = 0$

c. $2E_K + U = 0$ ***d.*** $E_K + 2U = 0$

41. The ratio of the magnetic fields at the centre of a circular coil carrying current to that at a point whose distance is half of the radius of the coil is

a. $2\sqrt{5} : 8$ ***b.*** $5\sqrt{5} : 8$

c. $5\sqrt{5} : 4$ ***d.*** $2\sqrt{5} : 4$

42. The difference between the wavelengths of the stokes line and anti-stokes lines in the Raman spectrum of H-Br molecule is 100Å. If the wavelength of the anti-stokes line is 5000 Å, then the wavelength of the incident radiation is

a. 5050 Å ***b.*** 4950 Å ***c.*** 5100 Å ***d.*** 4900 Å

43. Optical pumping means transferring electrons

a. from ground state to metastable state

b. from metastable state to a higher excited state

c. from a state higher than the metastable state to the metastable state

d. from a state lower than the metastable state to a state higher than the metastable state

44. An open pipe immersed in water to half its length. The ratio of the fundamental frequency of the pipe before and after immersion in water is

a. 1 : 2 ***b.*** 1 : 1 ***c.*** 1 : 3 ***d.*** 1 : 4

45. Assuming, $R = 8.3$ J mol^{-1} K^{-1} and $\gamma = 1.4$ the values of C_p and C_V of a gas are

a. 29.05 J mol^{-1} K^{-1}, 20.75 J mol^{-1} K^{-1}

b. 20.75 J mol^{-1} K^{-1}, 29.05 J mol^{-1} K^{-1}

c. 16.60 J mol^{-1} K^{-1}, 8.300 J mol^{-1} K^{-1}

d. 8.300 J mol^{-1} K^{-1}, 16.60 J mol^{-1} K^{-1}

46. A star A is 100 times brighter than star B. Then, $m_B - m_A$ the difference in their apparent magnitudes is

a. 100 ***b.*** 0.01 ***c.*** 5 ***d.*** 0.2

47. A monochromatic ray of light enters into a glass slab ($n = 1.5$) along the normal to the surface.The angle of deviation of the refracted ray is

a. 90° ***b.*** 45° ***c.*** 30° ***d.*** 0°

48. A ray of light passing from glass to water is incident on the glass-water interface at 65°. If the critical angle for the pair of media is 63°.

a. The ray will emerge into water with a deviation of 2° from the normal

b. The ray will be refracted into water with a deviation of 2°

c. The ray will be totally internally reflected back into glass with a deviation of 50°

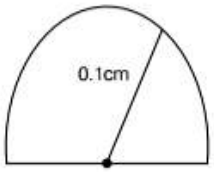
d. The ray will be totally internally reflected back into glass with a deviation of 2°

49. An equilateral prism is kept in the minimum deviation position. If the angle of incidence of a monochromatic ray at a refracting face is 49° 30′, then the angle of minimum deviation of the ray will be

a. 39° ***b.*** 49°30′

c. 40°30′ ***d.*** 51°

50. A glass hemisphere of radius 0.1 cm and refractive index 1.5 is placed over a spot on a table and the spot is viewed from above. The spot appears to be



a. 0.1 m above the top surface of the hemisphere

b. 0.1 m below the top surface of the hemisphere

c. 0.033 m above the top surface of the hemisphere

d. exactly on the top surface of the hemisphere

51. Photoelectric effect and Raman effect can be explained on the basis of

a. Newton's corpuscular theory of light

b. Huygens wave theory of light

c. Maxwell's electromagnetic theory of light

d. Planck's quantum theory of light

52. In an interference pattern the ratio of the intensity of light at the bright fringe to that at the dark fringe is 9 : 1. Then, the ratio of the amplitudes of the two interfering waves

a. 3 : 1 ***b.*** 2 : 1 ***c.*** 1 : 4 ***d.*** 5 : 4

53. Diffraction effects are more easily detected in the case of sound waves than light waves because

a. sound waves are longitudinal

b. sound waves have smaller wavelength

c. sound waves have larger wavelength

d. sound waves are transverse

54. If θ is the polarising angle for a medium in which the speed of light is v, then according to Brewster's law

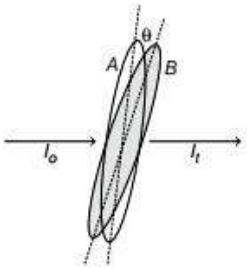
a. $\theta = \sin^{-1}(c/v)$

b. $\theta = \tan^{-1}(c/v)$

c. $\theta = \cos^{-1}(c/v)$

d. $\theta = \sin^{-1}(v/c)$

55. Two polaroid A and B are kept with their transmission axes at an angle θ with respect to one another. If the transmitted intensity of light $I_t = 0.75\ I_0$, where I_0 is the intensity of light incident on the system, then θ is



a. 30° ***b.*** 45° ***c.*** 60° ***d.*** 90°

56. The electric force between two point charges separated by a certain distance in air is F. The distance at which they should be placed in a medium of relative permittivity k, so that the force remains the same, is

a. d ***b.*** $\frac{d}{k}$ ***c.*** kd ***d.*** $\frac{d}{\sqrt{k}}$

57. A positively charged particle is released from rest in a region of uniform electric field. The particle will move

a. with constant speed

b. with constant velocity

c. with constant acceleration

d. with variable acceleration

58. Two charges q and $-2q$ are separated by a distance d. If the electric intensity at the site of q is E, then the electric field at the site of $-2q$ is

a. E ***b.*** $E/2$

c. $-2E$ ***d.*** $-E/2$

59. Choose the correct statement.

a. A p-type semiconductor is positively charged.

b. The Boolean expression $1 \cdot 0 = 0$.

c. The majority carrier in n-type semiconductor is hole.

d. A transistor cannot be used as a switch.

60. "Plum pudding" model of an atom was proposed by

a. C.V. Raman ***b.*** N. Bohr

c. E. Rutherford ***d.*** J.J. Thomson

CHEMISTRY

61. Which of the following is not a protein?

a. Wool ***b.*** Cellulose

c. Hair ***d.*** Nail

62. Which of the following is not true for the adsorption of a gas on a solid?

a. Increase in temperature favors adsorption

b. Enthalpy change is negative

c. Adsorption is more specific

d. Entropy change is negative

63. Peptisation is a process in which

a. precipitate becomes true solution

b. true solution becomes a suspension

c. a colloid gets coagulated

d. a suspension gets converted into a colloid

64. The mole fraction of benzene in a solution containing 39% by mass in an organic solvent of molecular mass 122 is

a. 0.5 ***b.*** 0.6

c. 0.4 ***d.*** 0.35

65. $Zn(s) + Cl_2\ (1\ atm) \longrightarrow Zn^{2+} + 2Cl^-;\ E^\circ = 2.0\ V$

To increase the emf of the above cell

a. $[Zn^{2+}]$ should be increased

b. $[Zn^{2+}]$ should be decreased

c. $[Cl^-]$ should be increased

d. partial pressure of Cl_2 should be decreased

66. Two ions A^+ and B^- have radii 104 and 200 pm respectively, in a cubic close packed crystal of compound AB. The coordination number of A^+ is

a. 4 ***b.*** 8

c. 6 ***d.*** 3

67. The mass of a non-volatile solute of molar mass 60 g mol^{-1} that should be dissolved in 126 g of water to reduce its vapour pressure to 99% will be

a. 2.8 g ***b.*** 5.6 g

c. 8.4 g ***d.*** 4.2 g

68. The pH of boiling water is 6.4. This implies that boiling water is

a. slightly basic ***b.*** slightly acidic
c. neutral ***d.*** amphoteric

69. The spin only magnetic moment of Ni^{2+} (in BM) in aqueous solution will be

a. 1.73 ***b.*** 2.84 ***c.*** 3.42 ***d.*** 2.25

70. An organic compound which produces a bluish green flame when heated on a copper wire is

a. benzaldehyde ***b.*** aniline
c. chlorobenzene ***d.*** benzoic acid

71. Phenol can be distinguished from ethyl alcohol using

a. Na ***b.*** $AlCl_3$
c. NaOH ***d.*** $FeCl_3$

72. The time required for 100% completion of zero order reaction is

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

73. The EAN of central metal atom in $[Co(NH_3)_6]Cl_3$ is
[Atomic number of Co = 27]

a. 34 ***b.*** 35 ***c.*** 36 ***d.*** 32

74. The alcohol obtained during the hydrolysis of ground nut oil is

a. glycol ***b.*** butan-1-ol
c. pentan-2-ol ***d.*** propane 1, 2, 3-triol

75. Which one of the following ores is concentrated by froth floatation process?

a. Magnesite ***b.*** Magnetite
c. Galena ***d.*** Malachite

76. Which of the following electron transitions in the H-atom will release the largest amount of energy?

a. $n = 3$ to $n = 2$ ***b.*** $n = 2$ to $n = 1$
c. $n = 5$ to $n = 2$ ***d.*** $n = 6$ to $n = 2$

77. An electron having spin quantum number of $s = \frac{-1}{2}$ and magnetic quantum number, $m = +3$ can be present in

a. both *s*-orbital and *p*-orbital
b. only *p*-orbital
c. only *f*-orbital
d. both *d*-orbital and *f*-orbital

78. The atomic number of the element with highest ionisation energy among the following is

a. Z = 16 ***b.*** Z = 14
c. Z = 13 ***d.*** Z = 15

79. Number of atoms in 560 cm^3 of oxygen at STP is

a. $\frac{1}{20} \times 6.022 \times 10^{23}$ ***b.*** $\frac{1}{40} \times 6.022 \times 10^{23}$
c. $\frac{1}{16} \times 6.022 \times 10^{23}$ ***d.*** $\frac{1}{32} \times 6.022 \times 10^{23}$

80. The volume of CO_2 (in cm^3) liberated at STP, when 1.06 g of anhydrous sodium carbonate is treated with excess of dilute HCl is [atomic mass of Na = 23]

a. 112 ***b.*** 224 ***c.*** 56 ***d.*** 2240

81. The oxidation number of oxygen is **–** 1 in

a. NO_2 ***b.*** PbO_2
c. Na_2O_2 ***d.*** MnO_2

82. The heat of formation of $H_2O(l)$ is **–** 286 kJ. The heat of formation of $H_2O(g)$ is likely to be

a. – 286 kJ ***b.*** + 286 kJ
c. – 341 kJ ***d.*** – 242.8 kJ

83. The temperature of one mole of an ideal gas increases from 298 K to 308 K, when it absorbs 200 J of heat at constant volume. The change in the internal energy of the gas is

a. 200 J ***b.*** 140 J
c. – 200 J ***c.*** – 140 J

84. 100 mL of $\frac{N}{5}$ HCl was added to 1 g of pure $CaCO_3$. What would remain after the reaction?

a. 0.5 g of $CaCO_3$
b. Neither $CaCO_3$ nor HCl
c. 50 mL of HCl
d. 25 mL of HCl

85. The RMS velocity of CH_4, He and SO_2 are in the ratio of

a. 16 : 4 : 64 ***b.*** 2 : 1 : 4
c. 2 : 4 : 1 ***d.*** 1 : 4 : 2

86. A negative catalyst will

a. lower the activation energy of the reaction
b. does not alter the activation energy of the reaction
c. provide a new and easy path to the reaction
d. increases the activation energy of the reaction

87. The number of σ and π-bonds in pent-2-yne is

a. 12 and 2 ***b.*** 11 and 2
c. 13 and 2 ***d.*** 12 and 3

88. In Lassaigne's test for nitrogen in an organic compound, the blue colouration is due to the formation of

a. ferro-ferricyanide ***b.*** ferric-ferrocyanide
c. potassium ferrocyanide ***d.*** potassium ferrocyanide

89. The organic compound obtained during the addition of HBr to propene in the presence of peroxide catalyst is

a. 2-bromopropane ***b.*** 2-bromopropene
c. 1-bromopropane ***d.*** 1-bromopropene

90. On passing H_2S into a solution containing both Zn^{2+} and Cu^{2+} in acidic medium, only CuS gets precipitated. This is because

a. K_{sp} of CuS < K_{sp} of ZnS
b. K_{sp} of CuS = K_{sp} of ZnS
c. K_{sp} of CuS > K_{sp} of ZnS
d. CuS is more stable than ZnS

91. The volume of H_2 obtained at STP, when Mg obtained by passing a current of 0.5 A through molten $MgCl_2$ for 32.2 min is treated with excess of dilute HCl is approximately [Equivalent mass of Mg = 12]

a. 56 cm^3 ***b.*** 28 cm^3
c. 5.6 cm^3 ***d.*** 112 cm^3

92. Markownikoff 's rule is applicable to

a. $C_3H_6 + HBr$ ***b.*** $C_2H_4 + HCl$
c. $C_3H_6 + Cl_2$ ***d.*** $C_2H_4 + HBr$

93. The reaction of ethene is the presence of H^+ can be example for

a. $-I$-effect ***b.*** $+E$-effect
c. $-E$-effect ***d.*** $+I$-effect

94. $CH_3—CN \xrightarrow{\text{Dil. HCl}} A \xrightarrow{LiAlH_4} B \xrightarrow{PCl_5} C \xrightarrow{\text{Alc. KOH}} D$. The product D in the above sequence of reactions is

a. acetaldehyde ***b.*** ethyne
c. ethene ***d.*** acetyl chloride

95. An organic compound is optically active if, it

a. is planar
b. is super imposable on its mirror image
c. contains chiral centres
d. is non-super imposable on its mirror image

96. Identify the electrophile in the following.

a. $R—NH_2$ ***b.*** NH_3
c. $AlCl_3$ ***d.*** CN_6

97. The ionisation constant of phenol is more than that of ethanol because

a. phenoxide ion is a stronger base than ethoxide ion
b. phenoxide ion is stabilised by resonance
c. ethoxide ion is stabilised by resonance
d. phenoxide ion is aromatic while ethoxide ion is aliphatic

98. The product C in the following sequence of chemical reaction is

$CH_3—COOH \xrightarrow{Ca(OH)_2} A \xrightarrow{\text{Heat}} B \xrightarrow{NH_2OH} C$

a. acetaldoxime ***b.*** formaldoxime
c. ethane nitrile ***d.*** acetoxime

99. Which of the following statements is not true?

a. Acetic acid is stronger than chloro acetic acid.
b. Formic acid is the strongest of all aliphatic monocarboxylic acids.
c. Benzoic acid is stronger acid than acetic acid.
d. Propanoic acid is weaker than acetic acid.

100. Maximum number of molecules of methyl iodide that can react with one molecule of methyl amine is

a. 4 ***b.*** 3 ***c.*** 2 ***d.*** 1

101. The amine which will not liberate nitrogen with nitrous acid is

a. ethyl amine ***b.*** methyl amine
c. dimethyl amine ***d.*** 2-amino propane

102. Which of the following is aromatic?

a. Lysine ***b.*** Proline
c. Serine ***d.*** Tyrosine

103. The mass of hydrogen in gram required to completely saturate 1 mole of triolein is

a. 6 ***b.*** 3
c. 2 ***d.*** 9

104. $CH_3—CH_2—OH \xrightarrow{A}$ $CH_3—CH_2—Cl \xrightarrow{B} CH_2 = CH_2$. A and B in this sequence of reactions are

a. KOH (*aq*) and PCl_5 ***b.*** PCl_5 and KOH (*aq*)
c. Cl_2 and KOH (*alc*) ***d.*** PCl_5 and KOH (*alc*)

105. The enthalpy of neutralisation of HCl and NaOH is x kJ. The heat evolved, when 500 mL of 2N HCl is mixed with 250 mL of 4 N NaOH will be

a. x ***b.*** $\frac{x}{2}$ ***c.*** $\frac{x}{4}$ ***d.*** $\frac{2x}{3}$

106. $A + B \rightleftharpoons C + D$

The initial concentrations of A and B are equal. At equilibrium, the concentration of C is twice that of A. The equilibrium constant of the reaction is

a. $\frac{9}{4}$ ***b.*** 4 ***c.*** $\frac{1}{9}$ ***d.*** $\frac{4}{9}$

107. The dissociation of lime stone in the slag zone of the blast furnace is
a. exothermic accompanied by increase in entropy
b. endothermic accompanied by decrease in entropy
c. endothermic accompanied by increase in entropy
d. exothermic with no change in entropy

108. Which of the following is not true for concentrated H_2SO_4?
a. Sulphonating agent ***b.*** Oxidising agent
c. Dehydrating agent ***d.*** Deliquescent in nature

109. Which of the following noble gases has the highest van der Waals' force of attraction?
a. Ar ***b.*** Ne ***c.*** Xe ***d.*** He

110. Which one of the following metal ions is coloured?
a. Ti^+ ***b.*** Cu^+ ***c.*** V^{4+} ***d.*** Zn^{2+}

111. Coordination number of nickel in $[Ni(C_2O_4)_3]^{4-}$ is
a. 3 ***b.*** 12 ***c.*** 6 ***d.*** 4

112. IUPAC name of $[CrCl_2(NH_3)_4]NO_3$ is
a. tetraamminedichlorochromium (I) nitrate
b. dichlorotetraamminechromium (III) nitrate
c. tetraamminedichlorochromium (IV) nitrate
d. tetraamminedichlorochromium (III) nitrate

113. Decomposition of NH_3 on the surface of platinum has a rate constant of 2.5×10^{-4} mol $dm^{-3}s^{-1}$ at 350 K. The order of the reaction is
a. 0 ***b.*** 1 ***c.*** 1/2 ***d.*** 2

114. The rate equation of a gaseous reaction is given by $r = k[A][B]$. If the volume of the reaction vessel is suddenly reduced to 1/2 of the initial volume, the reaction rate relating to the original rate will be
a. $\frac{1}{4}$ ***b.*** 4 ***c.*** $\frac{1}{2}$ ***d.*** 2

115. The reduction potential of an electrode can be increased by
a. increasing the area of the electrode
b. decreasing the temperature
c. increasing the temperature
d. decreasing the concentration of metal ions

116. An electric current is passed through silver and water voltameters connected in series. The cathode of the silver voltameter weighed 0.054 g more at the end of electrolysis. The volume of O_2 evolved at the anode of water voltameter is
a. 5.6 cm^3 ***b.*** 11.2 cm^3
c. 22.4 cm^3 ***d.*** 28 cm^3

117. The pH of a mixture of 10 mL of 0.1 M H_2SO_4. 5 mL of 0.2 N HCl and 5 mL of 0.1 M $Ca(OH)_2$ is
a. 1 ***b.*** 0.5 ***c.*** 0 ***d.*** 1.5

118. The conjugate acid of NH_2^- is
a. NH_4^+ ***b.*** NH_3 ***c.*** NH_2OH ***d.*** NH^-

119. Phenyl isocyanide is formed when chloroform is treated with alcoholic potassium hydroxide and
a. benzaldehyde ***b.*** aniline
c. phenol ***d.*** nitrobenzene

120. Which of the following does not undergo aldol condensation reaction?
a. CH_3—CHO ***b.*** $ClCH_2$—CHO
c. C_6H_5—CHO ***d.*** $CHCl_2$—CHO

MATHEMATICS

121. If the area of the circle $7x^2 + 7y^2 - 7x + 14y + k - 0$ is 12π sq units, then the value of k is
a. $\frac{-43}{4}$ ***b.*** $\frac{-301}{4}$ ***c.*** -16 ***d.*** ± 4

122. A man running a race-course notes that the sum of the distances from the two flag posts from him is always 10 m and the distance between the flag posts is 8 m. The equations of the path traced by the man is given by
a. $\frac{x^2}{9} + \frac{y^2}{25} = 1$ ***b.*** $\frac{x^2}{9} + \frac{y^2}{16} = 1$
c. $\frac{x^2}{25} + \frac{y^2}{9} = 1$ ***d.*** $\frac{x^2}{16} + \frac{y^2}{25} = 1$

123. The number of common tangents to the circles $x^2 + y^2 - 2x - 4y + 1 = 0$ and $x^2 + y^2 - 12x - 16y + 91 = 0$ is
a. 1 ***b.*** 2 ***c.*** 3 ***d.*** 4

124. Equation of the chord of the circle $x^2 + y^2 + 4x - 6y - 9 = 0$ bisected at (0, 1) is
a. $y - 1 = x$ ***b.*** $y + 1 = x$
c. $y + 1 = 2x$ ***d.*** $y - 1 = 3x$

125. The angle between two asymptotes of the hyperbola $\frac{x^2}{25} - \frac{y^2}{16} = 1$ is

a. $\tan^{-1}\frac{4}{5}$ ***b.*** $2\tan^{-1}\frac{4}{5}$

c. $2\tan^{-1}\frac{5}{4}$ ***d.*** $\pi - 2\tan^{-1}\frac{4}{5}$

126. The parametric equation of a parabola is $x = t^2 + 1, y = 2t + 1$. The cartesian equation of its directrix is

a. $y = 0$ ***b.*** $x = -1$

c. $x = 0$ ***d.*** $x - 1 = 0$

127. If $|\mathrm{a} \times \mathrm{b}| = 5$ and $|\mathrm{a} \cdot \mathrm{b}| = 3$, then $|\mathrm{a}|^2 |\mathrm{b}|^2$ is equal to

a. 16 ***b.*** 31 ***c.*** 25 ***d.*** 34

128. The direction cosines of the vector $2\hat{\mathrm{i}} + \hat{\mathrm{j}} - 2\hat{\mathrm{k}}$ is equal to

a. $\frac{2}{3}, \frac{1}{3}, -\frac{2}{3}$ ***b.*** $\frac{2}{3}, \frac{1}{3}, \frac{2}{3}$

c. $\frac{1}{3}, \frac{2}{3}, -\frac{2}{3}$ ***d.*** $\frac{2}{3}, \frac{2}{3}, \frac{1}{3}$

129. If $1, \omega, \omega^2$ are the cube roots of unity, then $(3 + 3\omega^2 + 5\omega)^6 - (2 + 6\omega^2 + 2\omega)^3$ is equal to

a. 32 ***b.*** 64 ***c.*** 0 ***d.*** -1

130. If $\int_{\log 2}^{x} \frac{dy}{\sqrt{e^y - 1}} = \frac{\pi}{6}$, then x is equal to

a. $\log_e 4$ ***d.*** $\log_e 2$ ***c.*** 4 ***d.*** 2

131. $\int_{-8}^{8} (\sin^{93} x + x^{295}) dx =$

a. 1 ***b.*** -1 ***c.*** 0 ***d.*** $\frac{8}{3}$

132. Area of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ is given by

a. 25π sq units ***b.*** 20π sq units

c. 4π sq units ***d.*** 5π units

133. The order of the differential equation

$$\left[1 + \left(\frac{dy}{dx}\right)^5\right]^{\frac{2}{3}} = \frac{d^3y}{dx^3}$$

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

134. The solution of $\frac{dy}{dx} - 1 = e^{x-y}$ is

a. $e^{x-y} + x = c$ ***b.*** $e^{-(x-y)} + x = c$

c. $e^{-(x-y)} = x + c$ ***d.*** $e^{x-y} = x + c$

135. If $\sin^{-1}\left(\frac{2p}{1+p^2}\right) - \cos^{-1}\left(\frac{1-q^2}{1+q^2}\right) = \tan^{-1}\left(\frac{2x}{1+x^2}\right)$, then the value of x is equal to

a. $\frac{p+q}{1+pq}$ ***b.*** $\frac{p-q}{1-pq}$

c. $\frac{p-q}{pq-1}$ ***d.*** $\frac{p-q}{1+pq}$

136. The unit vector in the direction of the vector $\mathrm{a} + 2\mathrm{b} - \mathrm{c}$ is equal to

a. $\frac{\mathrm{a} + 2\mathrm{b} - \mathrm{c}}{\sqrt{6}}$ ***b.*** $\frac{\mathrm{a} + 2\mathrm{b} - \mathrm{c}}{2}$

c. $\frac{\mathrm{a} + 2\mathrm{b} - \mathrm{c}}{4}$ ***d.*** $\frac{\mathrm{a} + 2\mathrm{b} - \mathrm{c}}{6}$

137. Identify the false statement.

a. A non-empty subset H of group G is a subgroup of G if and only if for every $a, b \in H \rightarrow a \cdot b^{-1} \in H$

b. The intersection of two subgroups of a group G is again a subgroup.

c. A group of order three is not abelian

d. If in a group F, $(ab)^2 = a^2b^2, \forall\ a, b \in G$ then G is abelian

138. If $y = \tan^{-1}\left(\frac{1}{1+x+x^2}\right) + \tan^{-1}\left(\frac{1}{x^2+3x+3}\right) + \tan^{-1}\left(\frac{1}{x^2+5x+7}\right) + \ldots +$ upto n terms then, $\frac{dy}{dx}$ at $x = 0$ and $n = 1$ is equal to

a. $\frac{1}{2}$ ***b.*** $-\frac{1}{2}$

c. 0 ***d.*** $\frac{1}{3}$

139. If $\cot\alpha \cot\beta = 2$, then $\frac{\cos(\alpha+\beta)}{\cos(\alpha-\beta)}$ is equal to

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

c. $\frac{1}{3}$ ***d.*** $\tan\alpha \tan\beta$

140. If ω is a cube root of unity, then the value of determinant $\begin{vmatrix} 1+\omega & \omega^2 & \omega \\ \omega^2+\omega & -\omega & \omega^2 \\ 1+\omega^2 & \omega & \omega^2 \end{vmatrix}$ is equal to

a. $1 + \omega$ ***b.*** $1 - \omega$

c. 0 ***d.*** ω^2

141. If the tangent to the curve $2y^3 = ax^2 + x^3$ at the point (a, a) cuts off intercepts α and β on the coordinate axes, where $\alpha^2 + \beta^2 = 61$, then the value of a is equal to

a. 25 *b.* 36
c. ± 30 *d.* ± 40

142. Length of the subtangent at (a, a) on the curve $y^2 = \frac{x^2}{2a + x}$ is equal to

a. $\frac{18}{5}$ *b.* $\frac{18a}{5}$
c. $-\frac{18a^2}{5}$ *d.* $\frac{18a^2}{5}$

143. The function $f(x) = 5 + 36x + 3x^2 - 2x^3$ is increasing in the interval

a. $(-2, 3)$ *b.* $(2, 3)$
c. $[2, 3)$ *d.* $(2, 3]$

144. Divide 20 into two parts such that the product of one part and the cube of the other is maximum. The two parts are

a. (12, 8) *b.* (15, 5)
c. (10, 10) *d.* (2, 18)

145. The number of positive divisors of 4896 is

a. 32 *b.* 34
c. 36 *d.* 38

146. The last digit of $583! + 7^{291}$ is

a. 1 *b.* 2
c. 0 *d.* 3

147. $\int x^x (1 + \log x)\, dx =$

a. $x^x + C$ *b.* $x^{-x} + x$
c. $x \log x + x$ *d.* $\log x + x$

148. If $\int \frac{xe^x}{(1+x)^2}\, dx = e^x f(x) + c$, then $f(x)$ is equal to

a. $\frac{1}{(1+x)^2}$ *b.* $\frac{x}{(1+x)}$
c. $\frac{1}{1+x}$ *d.* $\frac{x}{(1+x)^2}$

149. $\int_0^{\pi/2} \frac{\sin 2t}{\sin^4 t + \cos^4 t}\, dt =$

a. π *b.* $\frac{\pi}{3}$ *c.* $\frac{\pi}{4}$ *d.* $\frac{\pi}{2}$

150. If $4^{\log_9 3} + 9^{\log_2 4} = 10^{\log_x 83}$, then x is equal to

a. 10 *b.* 4
c. -10 *d.* -4

151. If $p = 3^{\frac{1}{3}} \cdot 3^{\frac{2}{9}} \cdot 3^{\frac{3}{27}} \ldots \infty$, then $p^{\frac{4}{3}} =$

a. $3^{\frac{1}{4}}$ *b.* 3
c. 9 *d.* $3^{\frac{3}{4}}$

152. If α, β, γ are the roots of the equation $x^3 - 3x^2 + 2x - 1 = 0$, then the value of $(1-\alpha)(1-\beta)(1-\gamma)$ is

a. 1 *b.* 2
c. -1 *d.* -2

153. The middle term in the expansion of $(1 + x)^{2n}$ is

a. $\frac{1 \cdot 3 \cdot 5 \ldots (2n-1)}{n} x^n$
b. $\frac{1 \cdot 3 \cdot 5 \ldots (2n-1)}{n!} 2^{n-1} x^n$
c. $\frac{1 \cdot 3 \cdot 5 \ldots (2n)}{n!} x^n$
d. $\frac{1 \cdot 3 \cdot 5 \ldots (2n-1)}{n!} 2^n x^n$

154. If $p \to (\sim q \vee r)$ is false, then the truth values of p, q and r are

a. T, T, F *b.* T, F, T
c. F, T, T *d.* F, F, T

155. If $\frac{2}{9!} + \frac{2}{3!7!} + \frac{1}{5!5!} = \frac{2^a}{b!}$, where $a, b \in N$, then the ordered pair (a, b) is

a. (10, 9) *b.* (10, 7)
c. (9, 10) *d.* (5, 10)

156. $\tan 10^\circ \tan 20^\circ \tan 30^\circ \tan 40^\circ \tan 50^\circ \tan 60^\circ \tan 70^\circ \tan 80^\circ =$

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

157. If $\tan\theta = \frac{m}{n}$, then $n \cos 2\theta + m \sin 2\theta$ is equal to

a. n *b.* n^2
c. $\frac{n}{m}$ *d.* $\frac{m^2}{n^2}$

158. If $\frac{b+c}{11} = \frac{c+a}{12} = \frac{a+b}{13}$, then $\cos A$ is equal to

a. $\frac{5}{7}$ *b.* $\frac{1}{5}$ *c.* $\frac{2}{5}$ *d.* $\frac{1}{7}$

159. If $a = \cos 2\alpha + i \sin 2\alpha$, $b = \cos 2\beta + i \sin 2\beta$, then $\sqrt{\frac{a}{b}} + \sqrt{\frac{b}{a}} =$

a. $2i\sin(\alpha - \beta)$ *b.* $2i\sin(\alpha + \beta)$
c. $2\cos(\alpha + \beta)$ *d.* $2\cos(\alpha - \beta)$

160. If $y = \log\left[\tan\left(\frac{\pi}{4} + \frac{x}{2}\right)\right]$, then $\frac{dy}{dx} =$

a. $\sec x$ ***b.*** $\sin x$

c. $\operatorname{cosec} x$ ***d.*** $\sec\frac{x}{2}$

161. If $y = \sin^2\left(\tan^{-1}\sqrt{\frac{1-x^2}{1+x^2}}\right)$, then $\frac{dy}{dx} =$

a. x ***b.*** $-x$

c. 1 ***d.*** -1

162. If $\sqrt{\frac{x}{y}} + \sqrt{\frac{y}{x}} = \sqrt{a}$, then $y.\frac{dx}{dy} =$

a. $\frac{x}{y}$ ***b.*** $\frac{y}{x}$

c. x ***d.*** 0

163. If $x = \frac{1-t}{1+t}$, $y = \frac{2t}{1+t}$, then $\frac{d^2y}{dx^2} =$

a. $\frac{2t}{(1+t)^2}$ ***b.*** $\frac{1}{(1+t)^4}$

c. $\frac{2t}{(1+t)^3}$ ***d.*** 0

164. In the group $G = \{1, 5, 7, 11\}$ under $\otimes_{12}$ the value of $7 \otimes_{12} 11^{-1}$ is equal to

a. 5 ***b.*** 7

c. 11 ***d.*** 1

165. Which of the following is a subgroup of the group $G = \{1, 2, 3, 4, 5, 6\}$ under $\otimes 7$?

a. $\{2, 6, 1\}$ ***b.*** $\{1, 2, 4\}$

c. $\{5, 4, 2\}$ ***d.*** $\{2, 3, 1\}$

166. If $A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$, $B = (\text{adj } A)$ and $C = 5A$, then $\frac{|C|}{|\text{adj } B|}$ is equal to

a. 25 ***b.*** -1 ***c.*** 5 ***d.*** -5

167. If $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & 4 \end{bmatrix}$, $B = \begin{bmatrix} 7 \\ 16 \\ 22 \end{bmatrix}$, $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$ and $AX = B$, then z is equal to

a. 1 ***b.*** -1 ***c.*** -3 ***d.*** 3

168. If $A = \begin{bmatrix} 1 & \log_b a \\ \log_a b & 1 \end{bmatrix}$, then $|A|$ is equal to

a. 0 ***b.*** $\log_a b$ ***c.*** -1 ***d.*** $\log_b a$

169. If a vertex of traingle is (3, 3) and the mid-points of two sides through this vertex are $\left(2, \frac{3}{2}\right)$ and $\left(4, \frac{3}{2}\right)$, then the centroid of the triangle is given by

a. (1, 3) ***b.*** (3, 0) ***c.*** (3, 1) ***d.*** (0, 3)

170. The image of the point (2, 4) on the line $x + y - 10 = 0$ is

a. (4, 8) ***b.*** (6, 5)

c. (6, 8) ***d.*** (0, 10)

171. If the sum of the slopes of the lines given by $x^2 - 4pxy + 8y^2 = 0$ is three times their product, then p has the value

a. $\frac{1}{4}$ ***b.*** 4 ***c.*** 3 ***d.*** $\frac{3}{4}$

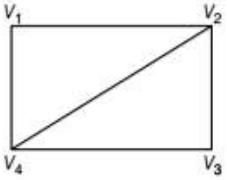
172. $\lim_{x \to 0}\left(\frac{1+5x^2}{1+3x^2}\right)^{\frac{1}{x^2}} =$

a. e^2 ***b.*** e ***c.*** $\frac{1}{e}$ ***d.*** $\frac{5}{3}$

173. If $f(x) = \begin{cases} \frac{e^x - 1}{4x} & \text{for } x \neq 0 \\ \frac{k+x}{4} & \text{for } x = 0 \end{cases}$ is continuous at $x = 0$, then $k =$

a. 5 ***b.*** 3 ***c.*** 2 ***d.*** 0

174. The non-adjacent vertex in the graph is



a. V_1V_2 ***b.*** V_4V_3 ***c.*** V_2V_4 ***d.*** V_1V_3

175. $\sin\left[2\cos^{-1}\cot\left(2\tan^{-1}\frac{1}{2}\right)\right]$ is equal to

a. $\frac{3\sqrt{7}}{8}$ ***b.*** $\frac{5\sqrt{7}}{8}$ ***c.*** $\frac{5\sqrt{7}}{2}$ ***d.*** $\frac{3\sqrt{7}}{2}$

176. The multiplicative inverse of $\frac{3+4i}{4-5i}$ is

a. $\left(\frac{-8}{25}, \frac{31}{25}\right)$ ***b.*** $\left(\frac{-8}{25}, \frac{-31}{25}\right)$

c. $\left(\frac{8}{25}, \frac{-31}{25}\right)$ ***d.*** $\left(\frac{-8}{25}, \frac{31}{5}\right)$

177. The general solution of
$\tan x - \sin x = 1 - \tan x \cdot \sin x$

a. $x = n\pi + \frac{\pi}{4}$ and or $x = n\pi + (-1)^n\left(\frac{-\pi}{2}\right)$

b. $x = \frac{n\pi}{4} - \frac{\pi}{4}$ and or $x = n\pi + (-1)^n\left(-\frac{\pi}{2}\right)$

c. $x = n\pi + \frac{\pi}{4}$

d. $x = n\pi + \frac{\pi}{6}$ and or $\pi = n\pi + (-1)^n\left(-\frac{\pi}{2}\right)$

178. The angle between the circles
$x^2 + y^2 + 4x + 2y + 1 = 0$ and
$x^2 + y^2 - 2x + 6y - 6 = 0$ is

a. $\frac{\pi}{6}$ ***b.*** $\frac{\pi}{3}$ ***c.*** $\frac{\pi}{2}$ ***d.*** $\cos^{-1}\left(\frac{7}{16}\right)$

179. If $|a| = 2, |b| = 7$ and $a \times b = 3\hat{i} + 2\hat{j} + 6\hat{k}$, then the angle between a and b is

a. $\frac{\pi}{3}$ ***b.*** $\frac{\pi}{6}$ ***c.*** $\frac{\pi}{2}$ ***d.*** $\frac{\pi}{4}$

180. The domain of the function
$f(x) = \log(1 - x) + \sqrt{x^2 - 1}$

a. $(-\infty, -1)$
b. $(-\infty, -1]$
c. $(-\infty, 2]$
d. $(-\infty, 0)$

ANSWERS

Physics

1. (c)	2. (b)	3. (d)	4. (b)	5. (a)	6. (b)	7. (d)	8. (b)	9. (c)	10. (a)
11. (c)	12. (b)	13. (d)	14. (a)	15. (d)	16. (a)	17. (c)	18. (b)	19. (d)	20. (b)
21. (*)	22. (a)	23. (b)	24. (d)	25. (c)	26. (d)	27. (b)	28. (b)	29. (d)	30. (c)
31. (a)	32. (d)	33. (a)	34. (d)	35. (c)	36. (c)	37. (a)	38. (a)	39. (d)	40. (c)
41. (b)	42. (a)	43. (d)	44. (b)	45. (a)	46. (c)	47. (d)	48. (c)	49. (a)	50. (*)
51. (d)	52. (b)	53. (c)	54. (b)	55. (a)	56. (d)	57. (c)	58. (b)	59. (b)	60. (d)

Chemistry

61. (b)	62. (a)	63. (d)	64. (b)	65. (b)	66. (c)	67. (d)	68. (c)	69. (b)	70. (c)
71. (d)	72. (a)	73. (c)	74. (d)	75. (c)	76. (b)	77. (c)	78. (d)	79. (a)	80. (b)
81. (c)	82. (d)	83. (a)	84. (b)	85. (c)	86. (d)	87. (a)	88. (b)	89. (c)	90. (a)
91. (d)	92. (a)	93. (b)	94. (c)	95. (d)	96. (c)	97. (b)	98. (d)	99. (a)	100. (a)
101. (c)	102. (d)	103. (a)	104. (d)	105. (a)	106. (b)	107. (c)	108. (a)	109. (c)	110. (c)
111. (c)	112. (d)	113. (b)	114. (b)	115. (b)	116. (d)	117. (a)	118. (b)	119. (b)	120. (c)

Mathematics

121. (b)	122. (c)	123. (d)	124. (a)	125. (b)	126. (c)	127. (d)	128. (a)	129. (c)	130. (a)
131. (c)	132. (b)	133. (c)	134. (c)	135. (d)	136. (a)	137. (c)	138. (b)	139. (c)	140. (*)
141. (c)	142. (d)	143. (a)	144. (b)	145. (c)	146. (d)	147. (a)	148. (c)	149. (d)	150. (a)
151. (b)	152. (c)	153. (d)	154. (a)	155. (c)	156. (d)	157. (a)	158. (b)	159. (d)	160. (a)
161. (b)	162. (c)	163. (d)	164. (a)	165. (b)	166. (*)	167. (d)	168. (a)	169. (c)	170. (c)
171. (d)	172. (a)	173. (b)	174. (d)	175. (a)	176. (b)	177. (a)	178. (d)	179. (b)	180. (b)

Note (*) None of the option is correct.

HINTS & SOLUTIONS

Physics

1. *(c)* The atomic mass or mass number of an atom ${}_{Z}X^{A}$ is given by

$$A = Z + N$$

where, A = mass number, Z = atomic number and N = number of neutrons.

For, ${}_{92}U^{235}$, $A = 235$ and $Z = 92$

$$N = A - Z = 235 - 92 = 143$$

2. *(b)* With the rise of temperature, the density of minority charge carriers increases due to breaking of some covalent bonding in a semiconductor in reverse biased condition. So, the reverse saturation current increases.

3. *(d)* Given, $t_{1/2} = 10$ min , $N_0 = 64$, $t = 50$ min

The number of half-lives in 50 min,

$$n = \frac{t}{t_{1/2}} = \frac{50}{10} = 5$$

In 5 half-lives, number of nuclei left undecayed,

$$N = N_0\left(\frac{1}{2}\right)^n = 64 \times \left(\frac{1}{2}\right)^5 = \frac{64}{32} = 2$$

$\therefore$ Number of nuclei decayed $= N_0 - N = 64 - 2 = 62$

4. *(b)* Photons of different energies carries the electromagnetic spectrum of all rays. They have no mass and travels at the speed of light.

5. *(a)* The NOT gate is also called invertor as it reverses the input in its output i.e.,

Input (A)	Output ($Y = \overline{A}$)
1	0
0	1

6. *(b)* LCD stands for Liquid Crystal Display. It is a special thin flat panel display or other electronically modulated optical device that uses the light modulating properties of liquid crystals combined with polarisers. Liquid crystal do not emit light directly, instead using a backlight or reflector to produce images in colour or monochromatic.

7. *(d)* Polarisation is the property of wave to oscillates in more than one orientation. The sound waves always oscillates in the direction of wave propagation, so polarisation is not possible in them. While light can be polarised.

8. *(b)* For an optically active solution, the angle through which a plane polarised light is rotated, is given as

$$\theta = SLC$$

where, S = correction factor, L = path length and C = concentration of solution.

9. *(c)* Given, $V_S = 50$ V, $V_R = 40$ V

For an L-R circuit,

$$V_S = \sqrt{V_R^2 + V_L^2}$$

$$\Rightarrow \quad V_L = \sqrt{V_S^2 - V_R^2}$$

$$= \sqrt{50^2 - 40^2}$$

$$= \sqrt{2500 - 1600} = \sqrt{900} = 30 \text{ V}$$

10. *(a)* Common potential difference for a parallel combination of capacitors, is

$$V_C = \frac{V_1C_1 + V_2C_2}{C_1 + C_2}$$

Given, $V_2 = 0, V_1 = 10$ V,

$$C_1 = C_2 = 10\mu\text{F} = 10 \times 10^{-6}\text{F}$$

$$\therefore \quad V_C = \frac{10 \times 10 \times 10^{-6}}{(10 + 10) \times 10^{-6}}$$

$$= \frac{100}{20} = 5 \text{ V}$$

11. *(c)* In fusion of two lighter nuclei to form a relatively heavier nucleus, energy is released. So, the binding energy of the stable product nucleus must be greater than that of the reacting nuclei.

12. *(b)* Given, $Q_1 = 2\mu\text{C} = 2 \times 10^{-6}\text{C}$

$$Q_2 = 1\mu\text{C} = 1 \times 10^{-6}\text{C}$$

The electric field intensity at a point P due to a point charge is given by

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

$$\Rightarrow \quad E \propto \frac{Q}{r^2}$$

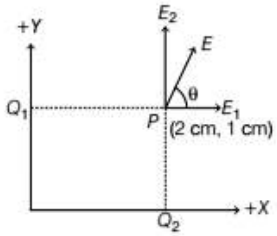
$\therefore$ Ratio of electric fields due to Q_1 and Q_2 at point P is

$$\frac{E_1}{E_2} = \frac{Q_1}{r_1^2} \times \frac{r_2^2}{Q_2}$$

$$= \frac{2 \times 10^{-6}}{(2 \times 10^{-2})^2} \times \frac{(1 \times 10^{-2})^2}{1 \times 10^{-6}} = \frac{1}{2}$$

Here, E_1 is along X-axis and E_2 is along Y-axis. So, the resultant field E have angle θ with X-axis as

$$\tan\theta = \frac{E_2}{E_1} = 2$$



13. *(d)* The direction of force on a current carrying conductor held perpendicular to an uniform magnetic field is given by Fleming's left hand rule.

It states that "If we hold the thumb, forefinger and middle finger of the left hand perpendicular to each other such that the fore finger points in the direction of magnetic field, the middle finger points in the direction of current, then the thumb shows the direction of force on the conductor."

14. *(a)* Given, $f_1 = F$ and $f_2 = -F$

The equivalent focal length of combination of two lenses is

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F} + \frac{1}{-F} = 0$$

or $$f = \frac{1}{0} = \infty \qquad \text{(infinity)}$$

15. *(d)* Given, $x = at + bt^2$

Here, x is measured in metre (m) and t is in second (s).

So, for dimensional consistency of equation,

Dimensions of $a = [a] = \frac{[x]}{[t]} = \frac{[\mathrm{L}]}{[\mathrm{T}]} = [\mathrm{LT}^{-1}]$

Similarly, for b, $[b] = \frac{[x]}{[t^2]} = \frac{[\mathrm{L}]}{[\mathrm{T}^2]} = [\mathrm{LT}^{-2}]$

$\therefore$ Dimensions of $\left[\frac{b}{a}\right] = \frac{[\mathrm{LT}^{-2}]}{[\mathrm{LT}^{-1}]} = [\mathrm{T}^{-1}]$

16. *(a)* Given, $u = 5\ \mathrm{ms}^{-1}$, Eastwards

$v = 5\ \mathrm{ms}^{-1}$, Northwards

and $\Delta t = 10\ \mathrm{s}$

Change in velocity $|\Delta v| = \sqrt{u^2 + v^2}$

$$= \sqrt{5^2 + 5^2} = 5\sqrt{2}\,\mathrm{ms}^{-1}$$

Direction of Δv,

$$\tan\theta = \frac{v}{u} = \frac{-5}{5} = -1$$

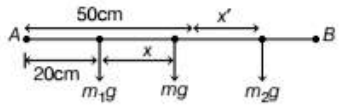
(taking eastward direction positive)

$\Rightarrow$ $\theta = 135°$

$\therefore$ Average acceleration,

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}}\,\mathrm{ms}^{-2}, \text{ towards North-West}$$

17. *(c)* Given, $m = 0.1$ kg



Let x be the position of mass of 0.1 kg from its centre and x' be the position of second mass m_2 that must be suspended to the other end to prevent the rod from toppling. So,

$$x = 50 - 20 = 30\ \mathrm{cm} = 0.3\ \mathrm{m}$$

The rod will not topple if net torque on it is zero. So, balancing the moments about its centre, we get

$$m_1 g x = m_2 g x'$$

$\Rightarrow$ $m_2 x = 0.1 \times 0.3 = 0.03$ kg-m

From options, it is possible only in case of (c).

$$m_2 = 0.15\ \mathrm{kg}$$

$$x' = \frac{0.03}{0.15} = 0.2\ \mathrm{m} = 20\ \mathrm{cm}$$

$\therefore$ The second mass of 0.15 kg should be hanged at $(50 + 20 =)$ 70 cm mark.

18. *(b)* Ink filler works on the principle of both surface tension and pump. Vacuum in the pen pulls the ink in the bottle to the pen. This ink travels in the pen tip through small openings due to surface tension.

19. *(d)* Ionosphere is the ionised part of Earth's atmosphere, which reflects the radiowaves due to total internal reflection towards earth, thus it helps in radio communication.

20. *(b)* The reaction of the floor on an object placed on the floor of an elevator is maximum, when the elevator accelerates upwards. In this case, normal reaction on it is

$$N = m(g + a)$$

where, m = mass of object,

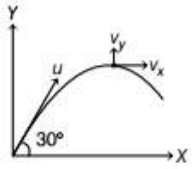
g = gravitational acceleration

and a = acceleration of elevator.

21. *(*)* Let m be the mass of particle and u be its initial velocity, then

Initial momentum, $p = mu$ ...(i)

At highest point,



$$v_x = u\cos\theta = u\cos 30°$$

$$= \frac{\sqrt{3}}{2}u$$

$$v_y = 0$$

$\therefore$ Momentum at highest point is

$$p' = mv_x = mu\left(\frac{\sqrt{3}}{2}\right)$$

$$= \frac{\sqrt{3}}{2}p \qquad \text{[using Eq. (i)]}$$

22. *(a)* Since, the block is at rest, the upward frictional force is equal to the weight or gravitational pull of the Earth i.e.,

$$F_S = w = mg = 0.1 \times 9.8 = 0.98\ \mathrm{N}$$

23. *(b)* The rotational kinetic energy of a ring is

$$K_R = \frac{1}{2}I\omega^2$$

For a ring, $I = MR^2$ and $\omega = \frac{v}{R}$

$$\therefore \quad K_R = \frac{1}{2}(MR^2)\times\left(\frac{v}{R}\right)^2 = \frac{1}{2}Mv^2$$

Also, translational kinetic energy, $K_T = \frac{1}{2}Mv^2$

$\therefore\ K_R = K_T$ or $K_R : K_T = 1 : 1$

24. *(d)* Given, work done, $W = 120$ J

Time, $t = 2\,\text{min} = 2\times 60 = 120$ s

$$\therefore \text{Power} = \frac{\text{Work done}}{\text{Time}} = \frac{W}{t} = \frac{120}{120} = 1\ \text{W}$$

25. *(c)* As we know, escape velocity, $v_e = \sqrt{2gR}$

Let v_m be escape velocity from moon and v_e be the escape velocity from Earth. Then,

$$\frac{v_m}{v_e} = \sqrt{\frac{2\times g_m \times R_m}{2\times g_e \times R_e}}$$

$$= \sqrt{\frac{g_m \times D_m}{g_e \times D_e}} \qquad (\because D = 2R)$$

$$= \sqrt{\frac{g_e}{6}\times\frac{D_e}{4}\Big/ g_e D_e} = \frac{1}{\sqrt{24}}$$

$$\therefore \quad v_m = \frac{v_e}{\sqrt{24}} = \frac{11.2}{\sqrt{24}}\,\text{km/s} \quad (\because v_e = 11.2\,\text{km/s})$$

26. *(d)* As work done in a cycle is equal to the area enclosed by the cycle.

$\therefore$ Work done, $W = \Delta p \times \Delta V$

$$= (4-2)\times(6-1) = 10\ \text{J}$$

27. *(b)* Speed of sound in a gas, $v = \sqrt{\frac{RT}{M}}$

Both, hydrogen and oxygen gas are diatomic. At same temperature,

$$v \propto \frac{1}{\sqrt{M}}$$

$$\therefore \quad \frac{v_H}{v_O} = \sqrt{\frac{M_O}{M_H}} = \sqrt{\frac{32}{2}} = \sqrt{16} = 4 \text{ or } 4:1$$

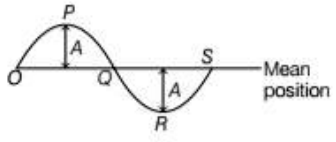
28. *(b)* According to Stefan's law,

Energy radiated $E \propto T^4$

$$\therefore \quad \frac{E'}{E} = \frac{T'}{T} = \frac{\left(\frac{T}{2}\right)^4}{T^4} = \frac{1}{2^4} = \frac{1}{16}$$

or $$E' = \frac{E}{16}$$

29. *(d)* The motion of particle in one oscillation is shown below



In moving from $O \to P$ distance moved is A. Similarly, for $P \to Q$, $Q \to R$ and $R \to S$, distance moved is A in each case.

$\therefore$ Total distance moved in one oscillation $= 4A$

30. *(c)* Given, $C = 10\mu\text{F} = 10\times 10^{-6}\,\text{F}$

$V = 10$ V

Change, $q = C\times V = 10\times 10^{-6}\times 10$

$= 10^{-4}$ C

$= 100\times 10^{6}$ C

$= 100\,\mu\text{C}$

31. *(a)* When a wire of resistance R is cut into 10 equal parts, then resistance of each part,

$$R' = \frac{R}{10} = 0.1R$$

Equivalent resistance of parallel combination of resistors, is

$$R_{eq} = \frac{R'}{10} = \frac{0.1R}{10} = 0.01R$$

32. *(d)* The conductors have positive temperature coefficient, while semiconductors have negative temperature coefficient. So, when iron and silicon wires are cooled from 50°C to 30°C, the resistance of iron decreases, while that of silicon increases.

33. *(a)* Given, $P = 10\,\Omega$, $l = 0.2$ m

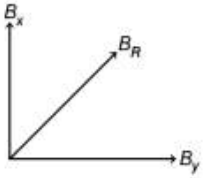
In balanced condition of meterbridge,

$$\frac{P}{Q} = \frac{l}{(1-l)}$$

$$\Rightarrow \quad \frac{10}{Q} = \frac{0.2}{1-0.2} = \frac{0.2}{0.8}$$

$$\Rightarrow \quad Q = 40\,\Omega$$

34. *(d)* As two coils are mutually perpendicular, so the field produced by them will also be perpendicular to each other as shown



The two coils are identical, so magnetic field,

$$B \propto I$$

or $$\frac{B_x}{B_y} = \frac{I_x}{I_y} = \frac{1}{2}$$

$$\Rightarrow \quad B_y = 2B_x$$

$\therefore \quad B_x = B$, then $B_y = 2B$

$$\therefore \text{Resultant field, } B_R = \sqrt{B_x^2 + B_y^2}$$

$$= \sqrt{B^2 + (2B)^2}$$

$$= \sqrt{5}B$$

35. *(c)* AC or DC motor is an electrical device which is used to convert an electrical energy into mechanical energy.

36. *(c)* According to the Faraday's law of electromagnetic induction, whenever the magnetic flux linked with a coil changes continuously with time, an emf is induced in the coil.

Its magnitude is equal to the rate of change of magnetic flux i.e.,

$$e = N\frac{d\phi}{dt}$$

where, N is the number of turns in the coil.

37. *(a)* Given, $I_1 = 1\,\text{mA} = 1\times10^{-3}\,\text{A}$

$I_2 = 5\,\text{mA} = 5\times10^{-3}\,\text{A}$

$t = 4\,\text{ms} = 4\times10^{-3}\,\text{s}$

$L = 10\,\text{m H} = 10\times10^{-3}\,\text{H}$

$\therefore$ Self-induced emf, $|e| = L\dfrac{dI}{dt}$

$$= 10\times10^{-3}\times\frac{(5-1)\times10^{-3}}{4\times10^{-3}} = 10\,\text{mV}$$

38. *(a)* Work function of a metal,

$$W = h\nu_0$$

where, h = Planck's constant

ν_0 = threshold frequency.

As, the threshold frequency of metal M is more than that of metal N, so work function of M is more than that of N, while their kinetic energies are equal.

39. *(d)* Electron wave is used in place of X-rays to study crystals of larger dimensions in electron crystallography. So, they can be diffracted.

40. *(c)* According to Bohr's atomic model,

Kinetic energy K or $E_K = \dfrac{U}{2}$

where, U = potential energy.

which is negative.

$\therefore$ $2E_K + U = 0$

41. *(b)* The magnetic field due to a circular coil carrying current at its axis is

$$B_x = \frac{\mu_0}{4\pi}\cdot\frac{2\pi Nir^2}{(x^2+r^2)^{3/2}} \quad \ldots(\text{i})$$

At centre of coil, $B_c = \dfrac{\mu_0}{4\pi}\dfrac{2\pi Ni}{r}$ $\ldots(\text{ii})$

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

$$\frac{B_c}{B_x} = \frac{(x^2+r^2)^{3/2}}{r\times r^2}$$

At, $x = \dfrac{r}{2}, \dfrac{B_c}{B_x} = \dfrac{\left(\dfrac{r^2}{4}+r^2\right)^{3/2}}{r^3} = \dfrac{\left(\dfrac{5}{4}\right)^{3/2}r^3}{r^3} = \dfrac{5\sqrt{5}}{8}$

or $5\sqrt{5} : 8$

42. *(a)* Stokes lines are the radiation of certain wavelengths present in the line spectra, that is associated with the phenomena of fluorescence and the Raman effect. Anti-stokes lines are produced due to already excited atoms or molecules. These lines are symmetrical about the main lines and the wavelength of anti-stokes lines is less than the main line. So, if the difference between wavelengths of stokes line and corresponding anti-stokes line is 100Å, then the difference between anti-stokes line and main line is 50 Å. Therefore, wavelength of incident radiation is 5050 Å.

43. *(d)* Optical pumping is a process in which light is used to raise electrons from a lower energy state in an atom than the metastable state to a higher energy state than the metastable state.

44. *(b)* Let L_o be the length of air column in pipe. After immersion,

$$L_c = \frac{L_o}{2}$$

Fundamental frequency in open pipe, $f_o = \dfrac{v}{2L_o}$

Fundamental frequency in closed pipe, $f_c = \dfrac{v}{4L_c}$

$\therefore$ $\dfrac{f_o}{f_c} = \dfrac{\dfrac{v}{2L_o}}{\dfrac{v}{4L_c}} = 2\left(\dfrac{L_c}{L_o}\right) = 2\left(\dfrac{L_o}{2L_o}\right) = 1:1$

45. *(a)* Given, $\gamma = 1.4 = \dfrac{C_p}{C_V}$

$\Rightarrow$ $C_p = 1.4C_V$

Also, $R = C_p - C_V = 8.3$ (given)

$\Rightarrow$ $1.4C_V - C_V = 8.3$

or $C_V = \dfrac{8.3}{0.4} = 20.75\,\text{Jmol}^{-1}\text{K}^{-1}$

$C_p = 1.4C_V = 1.4\times20.75$

$= 29.05\,\text{Jmol}^{-1}\text{K}^{-1}$

46. *(c)* Given, $\dfrac{I_A}{I_B} = 100$

Using magnitude equation,

$$m_B - m_A = -2.5\log\left(\frac{I_B}{I_A}\right)$$

$$= -2.5\log\left(\frac{1}{100}\right) = -2.5\times-2 = 5$$

47. *(d)* When a ray of light enters a glass slab along the normal to the surface, it passes straight without deviation. So, angle of deviation is zero (0°).

48. *(c)* Given, $i = 65°$ and $i_c = 63°$

Since, $i > i_c$, so the ray undergo total internal reflection.

The angle of deviation, $d = \pi - 2i$

$= 180° - 2(65°) = 180° - 130° = 50°$

49. *(a)* Given, $i = 49°30'$, $A = 60°$ (equilateral prism)

At minimum deviation position, angle of deviation is

$D = 2i - A = 2(49°30') - 60° = 99° - 60° = 39°$

50. *(*)* Here, $R = -0.1$ cm, $\mu_g = 1.5$

$\therefore \quad u = -0.1$ cm

From refraction formula,

$$\frac{\mu_a - \mu_g}{R} = \frac{\mu_a}{v} - \frac{\mu_g}{u}$$

$$\Rightarrow \quad \frac{1 - 1.5}{-0.1} = \frac{1}{v} - \frac{1.5}{(-0.1)} \qquad (\because \mu_a = 1)$$

$$\Rightarrow \quad 5 = \frac{1}{v} + 15$$

$$\Rightarrow \quad v = -\frac{1}{10} = -0.1 \text{ cm}$$

Here, negative sign shows that the image will be seen on the same size as that of object.

∴The spot appears to be 0.1 cm below the top surface or exactly at the original position.

51. *(d)* Photoelectric effect and Raman effect can be explained on the basis of Planck's quantum theory of light. These verify the particle nature of light.

52. *(b)* Given, $\frac{I_{max}}{I_{min}} = 9$

Since, intensity $\propto$ (amplitude)^2

$$\therefore \quad \frac{A_{max}}{A_{min}} = \frac{a_1 + a_2}{a_1 - a_2} = \sqrt{\frac{9}{1}} = \frac{3}{1}$$

$$\Rightarrow \quad a_1 + a_2 = 3a_1 - 3a_2$$

$$\Rightarrow \quad 2a_1 = 4a_2$$

$$\therefore \quad a_1 : a_2 = 2 : 1$$

53. *(c)* Since, sound waves have higher wavelength, which are comparable to the dimension of interfering objects. So, diffraction effect can easily be detected in sound waves than light waves.

54. *(b)* According to Brewster's law,

$$\mu = \tan\theta_p$$

where, μ = refractive index $= \frac{c}{v}$

and θ_p = polarising angle $= \theta$

$$\therefore \quad \theta = \tan^{-1}\mu = \tan^{-1}\left(\frac{c}{v}\right)$$

55. *(a)* For two polaroids placed at an axis making angle θ with each other, then according to law of malus, the intensity of transmitted light is

$$I_t = I_0 \cos^2\theta$$

Here, $I_t = 0.75 I_0$

$$\Rightarrow \quad 0.75 I_0 = I_0 \cos^2\theta$$

$$\Rightarrow \quad \cos^2\theta = 0.75 = \frac{3}{4}$$

$$\Rightarrow \quad \theta = \cos^{-1}\sqrt{\frac{3}{4}} = \cos^{-1}\left(\frac{\sqrt{3}}{2}\right)$$

$$\therefore \quad \theta = 30°$$

56. *(d)* Let d be the distance in air between two point charges and d_m be the distance between them in medium.

According to question,

$$F = F_m$$

$$\Rightarrow \quad \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{d^2} = \frac{1}{4\pi\varepsilon_0 k}\frac{q_1 q_2}{d_m^2}$$

$$\Rightarrow \quad d^2 = k d_m^2$$

$$\Rightarrow \quad d_m = \frac{d}{\sqrt{k}}$$

57. *(c)* The force on a charged particle in an electric field is

$$F = qE$$

Also, $F = ma$

$$\Rightarrow \quad a = \frac{F}{m} = \frac{qE}{m}$$

As q and m are constant for a positively charged particle and the electric field is also uniform. So, the particle move with constant acceleration.

58. *(b)* Electric field intensity at a point due to a charge q is given by

$$E = \frac{F}{q}$$

As, the force between the charges is mutual, so the electric field intensity due to charge $-2q$ is

$$E' = \frac{F}{|-2q|} = \frac{1}{2}\frac{F}{q} = \frac{E}{2}$$

59. *(b)* As per Boolean postulates,

$$1 \cdot A = A$$

$$\Rightarrow \quad 1 \cdot 1 = 1 \text{ and } 1 \cdot 0 = 0$$

p-type semiconductor is electrically neutral. The majority charge carriers in *n*-type semiconductor are electrons.

A transistor can be used as a switch.

60. *(d)* J. J. Thomson gave the first ideal regarding structure of atom. According to him, "an atom is a solid sphere in which entire positive charge is distributed and negative charge or electrons are embedded like seeds in watermelon."

It is also called plum pudding model of an atom.

61. *(b)* Cellulose is not a protein. It is a carbohydrate consisting of 3,000 or more glucose unit, while wool, hair and nails are proteins.

62. *(a)* Adsorption of a gas on a solid is exothermic process as during this process condensation of gas take place.
According to Le-Chatelier principle, increase in temperature favors desorption.
Option (a) is not a true statement.

63. *(d)* Peptisation is a method of preparation of colloids in which a suspension gets converted into a colloid on stirring with a peptising agent.

64. *(b)* Given, 39% by mass of organic solvent in benzene
$\therefore$ 39 g of organic solvent in 100 g solution.
or
39 g of organic solvent in 100 − 39 = 61 g benzene.
Now, molar mass of organic solvent = 122 g/mol
Molar mass of benzene $(C_6H_6) = 12\times 6 + 6 = 78$ g/mol
$\therefore$ Moles of benzene $(n_B) = \dfrac{61}{78}$
Moles of organic solvent $(n_O) = \dfrac{39}{122}$
Mole fraction of benzene $= \dfrac{n_B}{n_B + n_O} = \dfrac{\frac{61}{78}}{\frac{61}{78}+\frac{39}{122}} = 0.6$

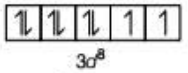
65. *(b)* According to Nernst equation for a cell
$Zn(s) + Cl_2(1atm) \longrightarrow Zn^{2+} + 2Cl^-; \quad E^\circ = 2V$
$$E = E^\circ - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cl^-]^2}$$
$\therefore$ As $[Zn^{2+}]$ decreases E_{cell} of cell increases.

66. *(c)* $r^+_{A^+} = 104$ pm
$r^-_{B^-} = 200$ pm
Radius ratio $\dfrac{r^+_{A^+}}{r^-_{B^-}} = \dfrac{104}{200} = 0.52$
$\because$ It lies between (0.414 to 0.732).
$\therefore$ Coordination number of A^+ is 6.

67. *(d)* Given, molar mass of solute, $\mu_2 = 60$ g/mol
Mass of water $(W_1) = 126$ g
Molar mass of water $(M_1) = 18$ g/mol
$p_{Solution}(p_s) = 0.99p^\circ$
Relative lowering of vapour pressure
$$\frac{p^\circ - p_s}{p^\circ} = \frac{W_2}{M_2}\frac{M_1}{W_1}$$
$$\frac{p^\circ - 0.99p^\circ}{p^\circ} = \frac{W_2\times 18}{60\times 126} = \frac{0.1p^\circ}{p^\circ} = \frac{W_2\times 18}{60\times 126}$$
$$\Rightarrow \quad W_2 = \frac{60\times 126}{18\times 100} = 4.2\text{ g}$$

68. *(c)* The pH of boiling water is 6.4. This implies that boiling water is neutral. When water is boiled, then concentration of hydrogen ion and hydroxide ion increases with same extent.

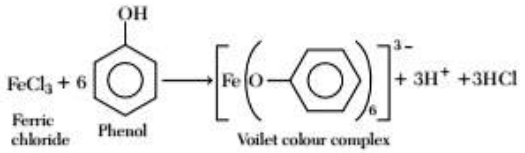
69. *(b)* Electronic configuration of Ni = $[Ar]\,3d^8\,4s^2$
$Ni^{2+} = [Ar]3d^8$



$\therefore$ Number of unpaired electrons = 2
$\therefore$ Magnetic moment $(\mu) = \sqrt{n(n+2)}$
$= \sqrt{2(2+2)} = \sqrt{8} = 2.84.$

70. *(c)* An organic compound containing halogen produces a bluish green flame when heated on a copper wire. This test is called Beilstein's test.
$\therefore$ Chlorobenzene will produce bluish green flame when heated on copper wire.

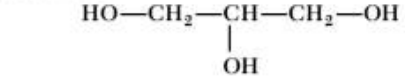
71. *(d)* Phenol can be distinguished from ethyl alcohol using $FeCl_3$ because phenol gives voilet colour compound with $FeCl_3$. While, alcohol do not give voilet colour.



72. *(a)* For zero order of reaction,
$$\text{Rate}, \frac{-dx}{dt} = k$$
$$\therefore \quad dt = \frac{-dx}{k}$$
On integration,
$$\int_0^T dt = -\int_a^0 \frac{dx}{k}$$
$$T = \frac{a}{k}$$

73. *(c)* EAN of central atom in $[Co(NH_3)_6]Cl_3$
$= Z - (ON) + 2\times(CN)$
where, Z = atomic number
ON = oxidation number
CN = coordination number
ON of Co $\Rightarrow$ $x + 6\times 0 - 3 = 0$
$\therefore \quad x = 3$
CN = 6
$\therefore$ EAN = 27 − 3 + 2×6 = 36

74. *(d)* The alcohol obtained during the hydrolysis of ground nut oil is propane 1, 2, 3- triol.
It's structure is



75. *(c)* Froth floatation method is used to concentrate sulphide ores.

Galena is sulphide ore with formula PbS.

∴ Galena is concentrated by froth floatation process.

76. *(b)* The energy for electron transition is

$$E = -13.6Z^2\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]$$

$$\therefore \quad E \propto \left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

For $n = 2$ to $n = 1$ value of E is highest.

$$E_2 = 13.6 \times (0.75) = 10.2$$

For $n = 6$ to $n = 2$

$$E = -13.6\left(\frac{1}{36} - \frac{1}{4}\right)$$

$$= 13.6 \times \frac{8}{36} = 3.02$$

It is less than E_2.

∴ For electron transition $n = 2$ to $n = 1$, energy released is maximum.

77. *(c)* Magnetic quantum number, $m = +3$

As $m = +l$ to $-l$

∴ $l = 3$ for f-orbital.

78. *(d)* The electronic configuration is

(a) $Z = 16 : 1s^2 2s^2 2p^6 3s^2 3p^4$

(b) $Z = 14 : 1s^2 2s^2 2p^6 3s^2 3p^2$

(c) $Z = 13 : 1s^2 2s^2 2p^6 3s^2 3p^1$

(d) $Z = 15 : 1s^2 2s^2 2p^6 3s^2 3p^3$

∵ For Z = 15, p-orbital has stable half-filled configuration.

∴ It will have highest ionisation energy.

79. *(a)* Moles of oxygen $= \frac{\text{volume (in cm}^3)}{22400 \text{ cm}^3} = \frac{560}{22400}$ mol

1 molecule of oxygen = 2 atoms of oxygen

∴ Number of atoms of oxygen

$$= 6.022 \times 10^{23} \times \frac{560}{22400} \times 2$$

$$= \frac{1}{20} \times 6.022 \times 10^{23}$$

80. *(b)* $\underset{1 \text{ mol}}{Na_2CO_3} + \underset{\text{(dil.)}}{2HCl\ (\text{dil.})} \longrightarrow \underset{1 \text{ mol}}{2NaCl} + CO_2 + H_2O$

$= 1.06$ g $= 22400$ cm^3

1.06 g Na_2CO_3 gives = 22400 cm^3 of CO_2

∴ 1.06 g gives $= \frac{1.06 \times 22400}{106} = 224$ cm^3 of CO_2

81. *(c)* General oxidation state of oxygen is (−2). But in peroxide, it's oxidation state is (−1).

∴ The oxidation number of oxygen is −1 in Na_2O_2.

$$2 \times 1 + 2x = 0$$

$$x = -1$$

82. *(d)* The heat of formation of $H_2O(g)$ will be less than the heat of formation of $H_2O(l)$, as heat of condensation is not included in formation of H_2O in gases state i.e.

$$H_2(g) + \frac{1}{2}O_2(g) \xrightarrow{\Delta H_1} H_2O(g) \xrightarrow{\Delta H_2} H_2O(l)$$

$$\therefore \quad |\Delta H_{f_{(H_2O)_l}}| = |\Delta H_1 + \Delta H_2| = 286 \text{ kJ}$$

But $\quad |\Delta H_{f_{(H_2O)_g}}| = |\Delta H_1| < 286$ kJ

$$\therefore \quad \Delta H_{f_{(H_2O)_g}} = -242.8 \text{ kJ}$$

83. *(a)* According to first law of thermodynamics

$\Delta Q + \Delta W = \Delta U$

$\Delta W = 0$, then $\Delta Q = \Delta U$ {∵ Volume is constant}

$\Delta Q = 200$ J

$\Delta U = 200$ J

84. *(b)* Number of moles of $CaCO_3 = \frac{W}{M} = \frac{1}{100}$

$= 0.01$ mol

∴ Molar mass of $CaCO_3 = 100$ g mol^{-1}

100 mL of $\frac{N}{5}HCl = \frac{100}{1000} \times \frac{1}{5} = 0.02$ mol

The reaction is

$$\underset{1 \text{ mole}}{CaCO_3} + \underset{2 \text{ moles}}{2HCl} \longrightarrow CaCl_2 + CO_2 + H_2O$$

∴ 0.01 mole of $CaCO_3$ reacts with 0.02 mole of HCl.

∴ Both are completely consumed in the given reaction.

85. *(c)* $v_{rms} = \sqrt{\frac{3RT}{M}}$

$v_{rms} \propto \frac{1}{\sqrt{M}}$, where M = molecular mass

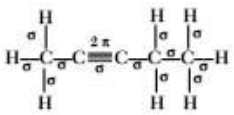
$$\Rightarrow v_{rms_{(CH_4)}} : v_{rms_{(He)}} : v_{rms_{(SO_2)}}$$

$$\Rightarrow \quad \frac{1}{\sqrt{16}} : \frac{1}{\sqrt{4}} : \frac{1}{\sqrt{64}} \quad \Rightarrow \quad \frac{1}{4} : \frac{1}{2} : \frac{1}{8}$$

$$\Rightarrow \quad 2 : 4 : 1$$

86. *(d)* A negative catalyst will increases the activation energy of the reaction.

87. *(a)* Pent-2-yne is



∴ σ-bonds = 12 and π-bonds = 2

88. *(b)* The blue colouration is due to formation of ferric ferrocyanide, $Fe_4[Fe(CN)_6]_3$ in Lassaigne's test for nitrogen.

89. *(c)* The addition of HBr to propene in presence of peroxide follows Kharash effect.

$$\underset{\text{Propene}}{CH_3—CH=CH_2} + HBr \xrightarrow{\text{Peroxide}} \underset{\text{1-bromopropane}}{CH_3—CH_2—CH_2—Br}$$

90. *(a)* On passing H_2S into a solution containing Zn^{2+} and Cu^{2+} ions, ZnS and CuS are formed.

The solubility product of CuS is less than that of ZnS.

$\therefore$ CuS get precipitated.

91. *(d)* $I = 0.5$ A

$t = 32.2 \times 60 = 1932.0$ s

$\therefore$ Mg obtained $= ZIt = \frac{12}{96500} \times 0.5 \times 1932.0$

$= 0.12012$ g

$Mg + 2HCl \longrightarrow MgCl_2 + H_2\uparrow$

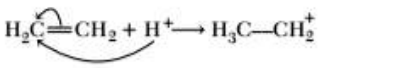
24g of Mg gives = 22400 cm^3 of H_2

0.12012 g Mg gives $= \frac{22400}{24} \times 0.12012 = 112\ cm^3$

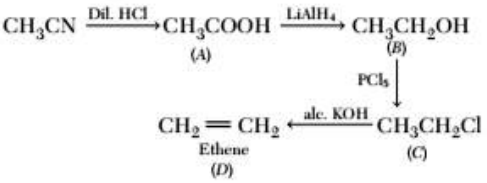
92. *(a)* According to Markownikoff 's rule, addition of HBr to alkene take place such that a stable carbocation is formed.

It is applicable to propene.

93. *(b)* The reaction of ethene in the presence of H^+ is an example of $+E$-effect as complete transfer of multiple bonded electron take place towards attacking reagent.



94. *(c)* The complete reaction is as follows



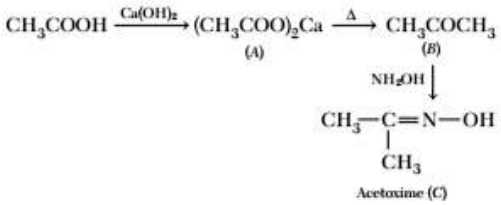
95. *(d)* An organic compound is optically active if, it is non-super imposable on its mirror image.

96. *(c)* $AlCl_3$ is an example of Lewis acid. It is an electron acceptor.

Hence, it is an example of electrophile.

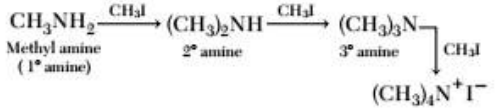
97. *(b)* Ionisation constant (K_a) of phenol is more than that of ethanol because phenol is more acidic than alcohol. On ionisation, phenol gives phenoxide ion which is stabilised due to resonance.

98. *(d)* The complete reaction is as follows



99. *(a)* Statement (a) is incorrect and can be corrected as, chloro acetic acid is stronger than acetic acid due to $-I$-effect of chloro group which leads to stabilisation of carboxylate ion.

100. *(a)* The reaction of methyl iodide and methyl amine is as follows



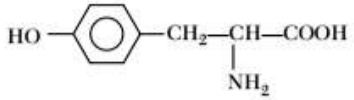
$\therefore$ 4 molecules of methyl iodide can react with one molecule of methyl amine.

101. *(c)* Only aliphatic primary amines react with nitrous acid to give alcohols with the evolution of N_2 gas.

$R—NH_2 + HONO \xrightarrow{273-278\,K} R—OH + N_2 + H_2O$

$\because$ Dimethyl amine is a secondary amine, it will not give N_2 gas.

102. *(d)* Tyrosine is aromatic in nature. It's structure is

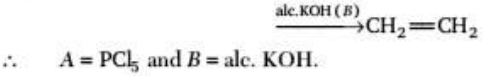


103. *(a)* One mole of triolein contain three double bonds. Hence, during hydrogenation, it adds three moles of hydrogen.

One mole of hydrogen = 2g.

$\therefore$ Three moles of hydrogen = 6 g.

104. *(d)* The reaction is as follows,



$\therefore$ $A = PCl_5$ and B = alc. KOH.

105. *(a)* Number of gram equivalent of HCl

$= N_1V_1 = 2 \times \frac{500}{1000} = 1$

No. of gram equivalent of NaOH

$= N_2V_2 = 4 \times \frac{250}{1000} = 1$

$\because$ Both NaOH and HCl are one gram equivalents.

$\therefore$ Heat evolved during reaction is equal to enthalpy of neutralisation i.e. x kJ.

106. *(b)*

	A	+	B	$\rightleftharpoons$	C	+	D
Initially	x		x		0		0
At equilibrium	y		y		$2y$		$2y$

Equilibrium constant

$$k = \frac{[C][D]}{[A][B]} = \frac{2y \times 2y}{y \times y} = 4$$

107. *(c)* Dissociation of lime stone is an endothermic reaction. Hence, entropy increases in this reaction.

$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)\ ;\ \Delta H = +Q$ kJ

Lime stone

108. *(a)* Sulphuric acid (H_2SO_4) is hygroscopic in nature, it absorbs atmospheric moisture without changing physical state. It is not deliquescent in nature.

$\therefore$ Option (a) is not true.

109. *(c)* van der Waals' force of attraction increase with increase in atomic mass. On going down the group atomic mass increases.

$\therefore$ Xe has the highest van der Waals' force of attraction.

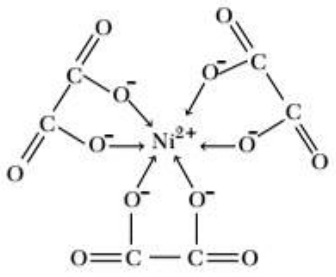
110. *(c)* Atomic number of V is 23.

Electronic configuration of V $= [Ar]4s^2 3d^3$

$$V^{4+} = [Ar]3d^1$$

$\because$ It contains one unpaired electron, hence it is coloured. While Ti^+, Cu^+ and Zn^{2+} do not have unpaired electron.

111. *(c)* Oxalate $(C_2O_4^{2-})$ is an example of bidendate ligand. Three oxalate ligands form six coordinate bond around Ni^{2+} ion. Hence, coordination number is 6.



112. *(d)* Oxidation number of Cr in $[CrCl_2(NH_3)_4]NO_3$

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

$$x = 3$$

IUPAC name of $[CrCl_2(NH_3)_4]NO_3$ is tetraamminedichlorochromium (III) nitrate.

113. *(b)* Unit of rate constant of nth order

$$(k) = \left(\frac{\text{mol}}{\text{dm}^3}\right)^{1-n} \text{s}^{-1}$$

for zero order $(n) = 0$

$\therefore$ $k = \text{mol dm}^{-3}\,\text{s}^{-1}$

$\therefore$ The order of reaction is 1st.

114. *(b)* The concentration of gaseous $\propto \frac{1}{\text{volume}}$

$\therefore$ If volume of vessel is reduced of initial volume to half then concentration increases to two-times.

$\therefore$ $[A'] = 2[A]$

$[B'] = 2[B]$

Initially, $r = k[A][B]$

After reduction of volume, $r_1 = k_2[A']2[B']$

$$r_1 = 4k[A'][B'] \quad (k_2 = k)$$

$$r_1 = 4r$$

$\therefore$ Rate increases to 4 times of original rate.

115. *(b)* The reduction potential of an electrode can be increased by increase in $[M^{n+}]$ or decrease in temperature.

$$M^{n+} + ne^- \longrightarrow M \qquad \text{(Reduction)}$$

$$E = E^\circ - \frac{RT}{nF}\ln\frac{[M]}{[M^{n+}]}$$

116. *(d)* According to Faraday second law,

$$\frac{W_{Ag}}{W_{O_2}} = \frac{E_{Ag}}{E_{O_2}}$$

$$\frac{0.054}{W_{O_2}} = \frac{108}{8}$$

$$W_{O_2} = \frac{0.054}{108}\times 8 = 4\times10^{-3}\text{ g}$$

$\therefore$ 32 g of oxygen (O_2) at STP liberates 22400 cm^3.

$\therefore$ 4×10^{-3} g of oxygen will liberate

$$= \frac{4\times10^{-3}\times22400}{32} = 2.8\text{cm}^3$$

117. *(a)* Millimoles of $H^+ = N_1V_1 + N_2V_2$

$$10\times0.1\times2 + 5\times0.2 = 2 + 1 = 3$$

Millimoles of $OH^- = N_3V_3$

$$= 0.1\times5\times2 = 1$$

$\therefore$ After neutralisation millimoles of H^+ left

$$= 3 - 1 = 2$$

$\therefore$ Concentration of H^+

$$= \frac{\text{moles of } H^+}{\text{volumes of solution}}$$

$$= \frac{2}{10+5+5} = \frac{2}{20} = 0.1$$

$\therefore$ $\text{pH} = -\log[H^+] = -\log(10^{-1}) = 1$

118. *(b)* Conjugate acid NH_3 is obtained by addition of H^+ ion to the base NH_2^- is

$$\underset{\text{Base}}{NH_2^-} + H^+ \longrightarrow \underset{\substack{\text{Conjugate}\\ \text{acid}}}{NH_3}$$

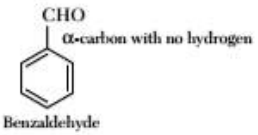
119. *(b)* Phenyl isocyanide is obtained from the carbylamine reaction as follows :

$$\underset{\text{Aniline}}{C_6H_5NH_2} + \underset{\text{Chloroform}}{CHCl_3} + \underset{\substack{\text{Potassium}\\ \text{hydroxide}}}{3KOH} \longrightarrow \underset{\substack{\text{Phenyl}\\ \text{isocyanide}}}{C_6H_5NC} + 3KCl + 3H_2O$$

120. *(c)* Aldol condensation is a characteristic reaction of aldehyde having α-hydrogen atom :

Benzaldehyde do not contain any α-hydrogen atom.

$\therefore$ It do not undergoes aldol condensation reaction.



Benzaldehyde

121. *(b)* We have,

$$7x^2 + 7y^2 - 7x + 14y + k = 0$$

$$x^2 + y^2 - x + 2y + \frac{k}{7} = 0$$

Here, $C \equiv \left(\frac{1}{2}, -1\right)$

and $r = \sqrt{\frac{1}{4} + 1 - \frac{k}{7}}$

$$r = \sqrt{\frac{5}{4} - \frac{k}{7}}$$

Given that, Area = 12π sq. unit

$\Rightarrow$ $12\pi = \pi\left(\frac{5}{4} - \frac{k}{7}\right)$

$\Rightarrow$ $12 = \frac{5}{4} - \frac{k}{7} \Rightarrow 12 = \frac{35 - 4k}{28}$

$\Rightarrow$ $336 = 35 - 4k$

$\Rightarrow$ $4k = -301 \Rightarrow k = -\frac{301}{4}$

122. *(c)* Given that, $SP + S'P = 10$

$\Rightarrow$ $2a = 10 \Rightarrow a = 5$

and $2ae = 8$

$ae = 4$

$\because$ $b^2 = a^2(1 - e^2)$

$= a^2 - (ae)^2$

$= 25 - 16 = 9$

Hence, required equation is

$$\frac{x^2}{25} + \frac{y^2}{9} = 1$$

123. *(d)* We have,

$$x^2 + y^2 - 2x - 4y + 1 = 0$$

and $x^2 + y^2 - 12x - 16y + 91 = 0$

Here, $C_1 \equiv (1, 2)$ and $r_1 = \sqrt{1 + 4 - 1} = 2$

and $C_2 \equiv (6, 8)$ and $r_2 = \sqrt{36 + 64 - 91} = 3$

Now, $C_1C_2 = \sqrt{25 + 36} = \sqrt{61}$

Here, $r_1 + r_2 = 5 < \sqrt{61}$

So, circle are far apart.

Hence, number of common tangents is 4.

124. *(a)* Given, equation of circle is

$$x^2 + y^2 + 4x - 6y - 9 = 0$$

Here, $T = S_1$

$x(0) + y(1) + 2(x + 0) - 3(y + 1) - 9 = 0 + 1 + 0 - 6 - 9$

$\Rightarrow y + 2x - 3y - 3 - 9 = 1 - 15$

$\Rightarrow$ $2x - 2y - 12 = 1 - 15$

$\Rightarrow$ $2x - 2y + 2 = 0$

$\Rightarrow$ $x - y + 1 = 0$

125. *(b)* Given, equation of hyperbola is $\frac{x^2}{25} - \frac{y^2}{16} = 1$

Here, $a^2 = 25 \Rightarrow a = 5$

$b^2 = 16 \Rightarrow b = 4$

Now, $\theta = 2\tan^{-1}\left(\frac{b}{a}\right) = 2\tan^{-1}\left(\frac{4}{5}\right)$

126. *(c)* Given that, $x = t^2 + 1 \Rightarrow x - 1 = t^2$

and $y = 2t + 1 \Rightarrow y - 1 = 2t$

Now, $(y - 1)^2 = 4t^2 = 4(x - 1)$

$(y - 1)^2 = 4(x - 1)$

So, $x - 1 = -1$

$\Rightarrow$ $x = 0$

127. *(d)* We have, $|\mathbf{a} \times \mathbf{b}| = 5$

and $|\mathbf{a} \cdot \mathbf{b}| = 3$

$\because$ $|\mathbf{a} \times \mathbf{b}|^2 = |\mathbf{a}|^2 |\mathbf{b}|^2 - (\mathbf{a} \cdot \mathbf{b})^2$

$\Rightarrow$ $25 = |\mathbf{a}|^2 |\mathbf{b}|^2 - 9$

$\Rightarrow |\mathbf{a}|^2 |\mathbf{b}|^2 = 34$

128. *(a)* Let $\mathbf{a} = 2\hat{i} + \hat{j} - 2\hat{k}$

So, $|\mathbf{a}| = \sqrt{4 + 1 + 4} = \sqrt{9} = 3$

So, direction cosines of vector are $\frac{2}{3}, \frac{1}{3}, -\frac{2}{3}$.

129. *(c)* We have,

$(3 + 3\omega^2 + 5\omega)^6 - (2 + 6\omega^2 + 2\omega)^3$

$= [3(1 + \omega^2) + 5\omega]^6 - [2(1 + \omega) + 6\omega^2]^3$

$= [3(-\omega) + 5\omega]^6 - [2(-\omega^2) + 6\omega^2]^3$

$= (2\omega)^6 - (4\omega^2)^3$

$= 2^6\omega^6 - 64\omega^6$

$= 64 - 64 = 0$

130. *(a)* We have,

$$\int_{\log 2}^{x} \frac{1}{\sqrt{e^y - 1}}\, dy = \frac{\pi}{6}$$

Let $\sqrt{e^y - 1} = t$

$\Rightarrow$ $e^y - 1 = t^2$

$\Rightarrow$ $e^y = 1 + t^2$

$\Rightarrow$ $e^y dy = 2t\, dt$

$\Rightarrow$ $(1 + t^2)\, dy = 2t\, dt$

$\Rightarrow$ $dy = \frac{2t}{(1 + t^2)}\, dt$

Now, $\int_{1}^{\sqrt{e^x - 1}} \frac{2t}{(1 + t^2) \times t}\, dt = \frac{\pi}{6}$

$$\Rightarrow \int_1^{\sqrt{e^x-1}} \frac{dt}{1+t^2} = \frac{\pi}{12}$$

$$\Rightarrow [\tan^{-1} t]_1^{\sqrt{e^x-1}} = \frac{\pi}{12}$$

$$\Rightarrow \tan^{-1}\sqrt{e^x-1} - \frac{\pi}{4} = \frac{\pi}{12}$$

$$\Rightarrow \tan^{-1}\sqrt{e^x-1} = \frac{\pi}{3}$$

$$\Rightarrow \tan(\tan^{-1}\sqrt{e^x-1}) = \tan\left(\frac{\pi}{3}\right)$$

$$\Rightarrow \sqrt{e^x-1} = \sqrt{3}$$

$$\Rightarrow e^x - 1 = 3 \Rightarrow e^x = 4$$

$$\Rightarrow x = \log 4$$

131. *(c)* Since, $(\sin^{93} x + x^{295})$ is a odd function.

So, $\int_{-8}^{8} (\sin^{93} x + x^{295})\, dx = 0$

132. *(b)* We have,

$$\frac{x^2}{25} + \frac{y^2}{16} = 1$$

Here, $a^2 = 25 \Rightarrow a = 5$

$b^2 = 16 \Rightarrow b = 4$

So, required area $= \pi ab$

$= \pi(5)(4)$

$= 20\pi$ sq units

133. *(c)* Given, differential equation is

$$\left[1 + \left(\frac{dy}{dx}\right)^5\right]^{\frac{2}{3}} = \frac{d^3y}{dx^3}$$

Here, highest derivative is $\frac{d^3y}{dx^3}$.

So, order = 3

134. *(c)* Given, differential equation is

$$\frac{dy}{dx} - 1 = e^{x-y}$$

Put $x - y = t$

$$\Rightarrow 1 - \frac{dy}{dx} = \frac{dt}{dx}$$

So, given equation becomes,

$$-\frac{dt}{dx} = e^t$$

$$-e^{-t}\, dt = dx$$

Integrating both sides, we get

$$e^{-t} = x + c$$

$$e^{-(x-y)} = x + c$$

135. *(d)* We have,

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

$$\Rightarrow 2\tan^{-1} p - 2\tan^{-1} q = 2\tan^{-1} x$$

$$\Rightarrow 2(\tan^{-1} p - \tan^{-1} q) = 2\tan^{-1} x$$

$$\Rightarrow \tan^{-1} p - \tan^{-1} q = \tan^{-1} x$$

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

$$\Rightarrow x = \frac{p-q}{1+pq}$$

136. *(a)* Given that, a + 2b − c

So, required unit vector $= \frac{a + 2b - c}{\sqrt{1+4+1}} = \frac{a + 2b - c}{\sqrt{6}}$

137. *(c)* It is a false option because every group of order 3 is abelian because it is closed as well.

138. *(b)* We have,

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

When $n = 1$, then

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

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

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

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

$$\left.\frac{dy}{dx}\right|_{x=0} = \frac{1}{1+(0+1)^2} - \frac{1}{1+(0)^2}$$

$$= \frac{1}{1+1} - \frac{1}{1} = \frac{1}{2} - 1 = -\frac{1}{2}$$

139. *(c)* We have,

$\cot\alpha \cot\beta = 2$

Now, $\frac{\cos(\alpha+\beta)}{\cos(\alpha-\beta)} = \frac{\cos\alpha\cos\beta - \sin\alpha\sin\beta}{\cos\alpha\cos\beta + \sin\alpha\sin\beta}$

$= \frac{\cot\alpha\cot\beta - 1}{\cot\alpha\cot\beta + 1} = \frac{2-1}{2+1} = \frac{1}{3}$

140. *(*)* We have, $\begin{vmatrix} 1+\omega & \omega^2 & \omega \\ \omega^2+\omega & -\omega & \omega^2 \\ 1+\omega^2 & \omega & \omega^2 \end{vmatrix}$

$= \begin{vmatrix} 1+\omega+\omega^2 & \omega^2 & \omega \\ \omega^2 & -\omega & \omega^2 \\ 1+\omega+\omega^2 & \omega & \omega^2 \end{vmatrix}$ $(C_1 \to C_1 + C_2)$

$= \begin{vmatrix} 0 & \omega^2 & \omega \\ \omega^2 & -\omega & \omega^2 \\ 0 & \omega & \omega^2 \end{vmatrix}$

$= 0 - \omega^2(\omega^4 - 0) + \omega(\omega^3 - 0)$

$= -\omega^6 + \omega^4$

$= -1 + \omega$ $[\because \omega^3 = 1]$

$= \omega - 1$

141. *(c)* Given, equation of curve is

$$2y^3 = ax^2 + x^3$$

$$\Rightarrow \quad 6y^2 \frac{dy}{dx} = 2ax + 3x^2$$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{2ax + 3x^2}{6y^2}$$

$$\Rightarrow \quad \left.\frac{dy}{dx}\right|_{(a,\,a)} = \frac{2a^2 + 3a^2}{6a^2} = \frac{5a^2}{6a^2} = \frac{5}{6}$$

So, x-intercept $= -\frac{a}{5} = \alpha$

and y-intercept $= \frac{a}{6} = \beta$

$\because \quad \alpha^2 + \beta^2 = 61$

$$\Rightarrow \quad \frac{a^2}{25} + \frac{a^2}{36} = 61$$

$$\Rightarrow \quad \frac{61a^2}{36 \times 25} = 61$$

$$\Rightarrow \quad a^2 = 36 \times 25$$

$$\Rightarrow \quad a = \pm 6 \times 5 = \pm 30$$

142. *(d)* $y^2 = \frac{x^2}{2a+x}$

$$2y\frac{dy}{dx} = \frac{2x}{2a+x} - \frac{x^2}{(2a+x)^2}$$

At (a, a), $\left(\frac{dy}{dx}\right)_{(a,\,a)} = \frac{5}{18a}$

Length of subtangent at $(x_1, y_1) = \frac{y_1}{\left(\frac{dy}{dx}\right)_{(x_1, y_1)}}$

$\therefore$ Length of subtangent at $(a, a) = \frac{a}{\left(\frac{dy}{dx}\right)_{(a,\,a)}} = \frac{18a^2}{5}$

143. *(a)* Given, $f(x) = 5 + 36x + 3x^2 - 2x^3$

$\Rightarrow \quad f'(x) = 36 + 6x - 6x^2$

$= -6(x^2 - x - 6)$

$= -6(x^2 - 3x + 2x - 6)$

$= -6(x-3)(x+2)$

For increasing function, $f'(x) > 0$

$\Rightarrow \quad (x-3)(x+2) < 0$

$\Rightarrow \quad x < 3$ and $x > -2$

$\Rightarrow \quad -2 < x < 3$

Hence, function $f(x)$ is increasing in $(-2, 3)$ interval.

144. *(b)* According to question,

$$x + y = 20 \qquad \ldots (i)$$

and $p = xy^3 = (20 - y)y^3$ [by Eq. (i)]

$$p = 20y^3 - y^4$$

$$\Rightarrow \quad \frac{dp}{dy} = 60y^2 - 4y^3$$

$$\Rightarrow \quad \frac{d^2p}{dy^2} = 120y - 12y^2$$

Now, $\frac{dp}{dy} = 0 \Rightarrow 60y^2 - 4y^3 = 0$

$\Rightarrow \quad 60y^2 = 4y^3$

$\Rightarrow \quad 4y = 60 \Rightarrow y = 15$

$\therefore \quad x = 5$

Hence, two parts are (15, 5).

145. *(c)* We have, $4896 = 2^5 \times 3^2 \times 17^1$

So, $T(a) = (1+5)(1+2)(1+1) = 36$

146. *(d)* We have, $583! \equiv 0 \pmod{10}$

and $7^2 = -1 \pmod{10}$

So, $(7^2)^{145} \cdot 7^1 = (-1)^{145} \cdot 7^1 \pmod{10}$

$\Rightarrow \quad 7^{291} = -7 \pmod{10} \equiv 3 \pmod{10}$

So, $583! + 7^{291} = 3 \pmod{10}$

Hence, last digit is 3.

147. *(a)* We have, $I = \int x^x(1 + \log x)dx$

Let $x^x = t$

$$\Rightarrow \quad \frac{dt}{dx} = x^x \log x + x^x$$

$$\Rightarrow \quad \frac{dt}{dx} = x^x(1 + \log x)$$

$$\Rightarrow \quad dt = x^x(1 + \log x)\,dx$$

Now, $I = \int dt$

$= t + C = x^x + C$

148. *(c)* We have, $I = \int \frac{xe^x}{(1+x)^2}\,dx$

$= \int \frac{(x+1-1)}{(x+1)^2} e^x\,dx$

$$= \int \left[\frac{1}{x+1} - \frac{1}{(x+1)^2} \right] e^x \, dx$$

$$= e^x \frac{1}{(1+x)} + C$$

On comparing, we get

$$f(x) = \frac{1}{1+x}$$

149. *(d)* We have,

$$I = \int_0^{\pi/2} \frac{\sin 2t}{\sin^4 t + \cos^4 t} \, dt$$

$$= \int_0^{\pi/2} \frac{2\sin t \cos t}{\sin^4 t + \cos^4 t} \, dt$$

$$= \int_0^{\pi/2} \frac{2\tan t \sec^2 t}{(\tan^2 t)^2 + 1} \, dt$$

Put $\tan^2 t = x$

$(2\tan t \sec^2 t)\, dt = dx$

$$\therefore \qquad I = \int_0^{\infty} \frac{1}{1+x^2} \, dx = [\tan^{-1} x]_0^{\infty} = \frac{\pi}{2}$$

150. *(a)* We have,

$$4^{\log_9 3} + 9^{\log_2 4} = 10^{\log_x 83}$$

$$\Rightarrow \quad 4^{\frac{1}{2}\log_3 3} + 9^{2\log_2 2} = 10^{\log_x 83}$$

$$\Rightarrow \quad 2 + 81 = 10^{\log_x 83}$$

$$\Rightarrow \quad 83 = 10^{\log_x 83}$$

$$\Rightarrow \quad \log_{10} 83 = \log_x 83$$

$$\Rightarrow \quad x = 10$$

151. *(b)* We have,

$$p = 3^{\frac{1}{3}} \cdot 3^{\frac{2}{9}} \cdot 3^{\frac{3}{27}}$$

$$= 3^{\frac{1}{3}\left[1 + \frac{2}{3} + \frac{3}{9} + \ldots \infty\right]}$$

$$= 3^{\frac{1}{3}\left[\frac{a}{1-r} + \frac{ar}{(1-r)^2}\right]}$$

$$= 3^{\frac{1}{3}\left[\frac{1}{1-\frac{1}{3}} + \frac{1 \cdot \frac{1}{3}}{\left(1-\frac{1}{3}\right)^2}\right]}$$

$$= 3^{\frac{1}{3}\left[\frac{3}{2} + \frac{3}{4}\right]}$$

$$= 3^{\frac{1}{3}\left[\frac{12+6}{8}\right]} = 3^{\frac{1}{3}\left(\frac{18}{8}\right)} = 3^{\frac{3}{4}}$$

Now, $p^{4/3} = \left(3^{\frac{3}{4}}\right)^{\frac{4}{3}}$

$$= 3^{\frac{3}{4} \times \frac{4}{3}} = 3^1 = 3$$

152. *(c)* We have,

$$x^3 - 3x^2 + 2x - 1$$

So, $\alpha + \beta + \gamma = 3$

$\alpha\beta + \beta\gamma + \gamma\alpha = 2$

$\alpha\beta\gamma = 1$

Now, $(1-\alpha)(1-\beta)(1-\gamma)$

$= 1 - (\alpha + \beta + \gamma) + (\alpha\beta + \beta\gamma + \gamma\alpha) - \alpha\beta\gamma$

$= 1 - 3 + 2 - 1 = -1$

153. *(d)* The middle term in the expansion of $(1+x)^{2n}$ is $\left(\frac{2n}{2} + 1\right)$th term i.e. $(n+1)$ th term.

$$= \frac{(2n)!}{n!\,n!} x^n$$

$$= \frac{2n(2n-1)(2n-2)\ldots 3 \cdot 2 \cdot 1}{\{n(n-1)(n-2)\ldots 3 \cdot 2 \cdot 1\}^2} x^n$$

$$= \frac{(2n(2n-2)(2n-4)\ldots 4.2\}\ \{(2n-1)(2n-3)\ldots(3\cdot 1)\}}{\{n(n-1)(n-2)\ldots 3 \cdot 2 \cdot 1\}^2} x^n$$

$$= \frac{2^n \{n(n-1)(n-2)\ldots 3 \cdot 2 \cdot 1\}\ \{((2n-1)(2n-3)\ldots 3 \cdot 1\}}{\{n(n-1)(n-2)\ldots 3 \cdot 2 \cdot 1\}^2} x^n$$

$$= \frac{2^n \{(2n-1)(2n-3)\ldots 3 \cdot 1\}}{\{n(n-1)(n-2)\ldots 3 \cdot 2 \cdot 1\}} x^n$$

$$= \frac{(2n-1)(2n-3)\ldots 3 \cdot 1}{n!} x^n 2^n$$

154. *(a)* Given that, $p \to (\sim q \vee r)$ is false.

$\Rightarrow (\sim q \vee r)$ is false and p is true.

$\Rightarrow q$ is true, r is false and p is true.

155. *(c)* We have,

$$\frac{2}{9!} + \frac{2}{3!7!} + \frac{1}{5!5!} = \frac{2^a}{b!}$$

$$\Rightarrow \frac{1}{9!}\left[2 + \frac{2 \cdot 8 \cdot 9}{3!} + \frac{6 \cdot 7 \cdot 8 \cdot 9}{5!}\right] = \frac{2^a}{b!}$$

$$\Rightarrow \frac{1}{9!}\left[2 + 24 + \frac{126}{5}\right] = \frac{2^a}{b!}$$

$$\Rightarrow \frac{1}{9!}\left[26 + \frac{126}{5}\right] = \frac{2^a}{b!}$$

$$\Rightarrow \frac{1}{9!}\left[\frac{256}{5}\right] = \frac{2^a}{b!}$$

$$\Rightarrow \frac{1}{9!}\frac{256 \times 2}{5 \times 2} = \frac{512}{10!} = \frac{2^9}{10!} = \frac{2^a}{b!} \Rightarrow a = 9 \text{ and } b = 10$$

156. *(d)* $\tan 10° \tan 20° \tan 30° \tan 40° \tan 50° \tan 60° \tan 70° \tan 80°$

$$= \tan 10° \tan 20° \left(\frac{1}{\sqrt{3}}\right) \tan 40° \tan(90° - 40°)$$

$(\sqrt{3}) \tan(90° - 20°) \tan(90° - 10°)$

$= \tan 10° \tan 20° \tan 40° \cot 40° \cot 20° \cot 10°$

$= 1$

157. *(a)* We have, $\tan\theta = \frac{m}{n}$

Now, $n\cos 2\theta + m\sin 2\theta$

$$= n\left[\frac{1-\tan^2\theta}{1+\tan^2\theta}\right] + m\left[\frac{2\tan\theta}{1+\tan^2\theta}\right]$$

$$= n\left[\frac{1-\frac{m^2}{n^2}}{1+\frac{m^2}{n^2}}\right] + m\left[\frac{2\frac{m}{n}}{1+\frac{m^2}{n^2}}\right]$$

$$= n\left[\frac{n^2-m^2}{n^2+m^2}\right] + \left[\frac{\frac{2m^2}{n}\times n^2}{n^2+m^2}\right]$$

$$= n\left(\frac{n^2-m^2}{m^2+n^2}\right) + \frac{2m^2n}{n^2+m^2} = \frac{n(n^2-m^2)+2m^2n}{(m^2+n^2)}$$

$$= \frac{n[n^2-m^2+2m^2]}{(m^2+n^2)} = \frac{n(n^2+m^2)}{(m^2+n^2)} = n$$

158. *(b)* Let $\frac{b+c}{11} = \frac{c+a}{12} = \frac{a+b}{13} = k$

$\Rightarrow\ b+c = 11k,\ c+a = 12k,\ a+b = 13k$

Now, $2(a+b+c) = 36k$

$$a+b+c = 18k$$

So, $a = 7k$

$b = 6k$

and $c = 5k$

Now, $\cos A = \frac{b^2+c^2-a^2}{2bc}$

$$= \frac{36k^2+25k^2-49k^2}{2(30k^2)} = \frac{12k^2}{60k^2} = \frac{1}{5}$$

159. *(d)* We have, $a = \cos 2\alpha + i\sin 2\alpha$

and $b = \cos 2\beta + i\sin 2\beta$

$$\frac{a}{b} = \frac{Cis\,2\alpha}{Cis\,2\beta} = Cis(2\alpha - 2\beta)$$

So, $\sqrt{\frac{a}{b}} = Cis(\alpha-\beta) = \cos(\alpha-\beta) + i\sin(\alpha-\beta)$

and $\sqrt{\frac{b}{a}} = \cos(\alpha-\beta) - i\sin(\alpha-\beta)$

Now, $\sqrt{\frac{a}{b}} + \sqrt{\frac{b}{a}} = \cos(\alpha-\beta) + i\sin(\alpha-\beta)$

$+ \cos(\alpha-\beta) - i\sin(\alpha-\beta) = 2\cos(\alpha-\beta)$

160. *(a)* We have,

$$y = \log\left[\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)\right]$$

So, $\frac{dy}{dx} = \frac{1}{\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)} \cdot \sec^2\left(\frac{\pi}{4}+\frac{x}{2}\right)\cdot\frac{1}{2}$

$$= \frac{1}{2\sin\left(\frac{\pi}{4}+\frac{x}{2}\right)\cos\left(\frac{\pi}{4}+\frac{x}{2}\right)}$$

$$= \frac{1}{\sin\left[2\left(\frac{\pi}{4}+\frac{x}{2}\right)\right]} = \frac{1}{\cos x} = \sec x$$

161. *(b)* We have, $y = \sin^2\left[\tan^{-1}\sqrt{\frac{1-x^2}{1+x^2}}\right]$

Put $x^2 = \cos\theta$

So, $y = \sin^2\left[\tan^{-1}\sqrt{\frac{1-\cos\theta}{1+\cos\theta}}\right]$

$$= \sin^2\left[\tan^{-1}\left(\tan\frac{\theta}{2}\right)\right]$$

$$= \sin^2\frac{\theta}{2} = \frac{1-\cos\theta}{2} = \frac{1-x^2}{2}$$

$$\frac{dy}{dx} = \frac{-2x}{2} = -x$$

162. *(c)* We have,

$$\sqrt{\frac{x}{y}} + \sqrt{\frac{y}{x}} = \sqrt{a}$$

$$\left(\sqrt{\frac{x}{y}} + \sqrt{\frac{y}{x}}\right)^2 = a$$

$$\frac{x}{y} + \frac{y}{x} + 2 = a$$

Differentiating both sides w.r.t. x,

$$\frac{y - x\frac{dy}{dx}}{y^2} + \frac{x\frac{dy}{dx} - y}{x^2} = 0$$

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

$$\Rightarrow \quad xy^2\frac{dy}{dx} - y^3 = -x^2y + x^3\frac{dy}{dx}$$

$$\Rightarrow \quad \frac{dy}{dx}(xy^2 - x^3) = -x^2y + y^3$$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{y(y^2-x^2)}{x(y^2-x^2)}$$

$$\Rightarrow \quad \frac{dy}{dx} = \frac{y}{x}$$

Now, $y\cdot\frac{dx}{dy} = y.\frac{x}{y} = x$

163. *(d)* We have, $x = \frac{1-t}{1+t}$

$$\frac{dx}{dt} = \frac{-(1+t)-(1-t)}{(1+t)^2} = \frac{-2}{1+t^2} \text{ and } y = \frac{2t}{1+t}$$

$$\frac{dy}{dt} = \frac{(1+t)2 - 2t}{(1+t)^2} = \frac{2}{(1+t)^2}$$

Now, $\quad \frac{dy}{dx} = \frac{dy/dt}{dx/dt} = -1$

and $\quad \frac{d^2y}{dx^2} = 0$

164. *(a)* Clearly, $11^{-1} = 11 \qquad [\because 11 \otimes_{12} 11 = 1]$

So, $7 \otimes_{12} 11^{-1} = 7 \otimes_{12} 11 = 5$

165. *(b)* Option (c) cannot be subgroup as identity '1' is not present.

Option (d) cannot be a subgroup of $2 \otimes_7 3 = 6 \notin \{1, 2, 3\}$.

Option (a) cannot be a subgroup as $2 \otimes_7 6 = 5 \notin \{2, 6, 1\}$.

So, option (b) is a subgroup.

166. *(*)* We have,

$$A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$$

Now, $|A| = \begin{vmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{vmatrix}$

$= 3(-3+4) + 3(2-0) + 4(-2-0)$

$= 3 + 6 - 8 = 1$

Now, $\frac{|C|}{|\text{adj } B|} = \frac{|5A|}{|B|^{3-1}} = \frac{5^3|A|}{|B|^2} = \frac{5^3|A|}{|\text{adj } A|^2}$

$= \frac{5^3|A|}{(|A|^2)^2} = \frac{5^3|A|}{|A|^4} = \frac{5^3}{|A|^3}$

$= \frac{5^3}{1^3} = 5^3$

167. *(d)* We have, $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 1 & 3 & 4 \end{bmatrix}$, $B = \begin{bmatrix} 7 \\ 16 \\ 22 \end{bmatrix}$

$$X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

Now, $AX = B$

$x + y + z = 7 \qquad \ldots$ (i)

$x + 2y + 3z = 16 \qquad \ldots$ (ii)

$x + 3y + 4z = 22 \qquad \ldots$ (iii)

Subtracting Eq. (i) from Eq. (ii), we get

$y + 2z = 9 \qquad \ldots$ (iv)

Subtracting Eq. (iii) from Eq. (ii), we get

$y + z = 6 \qquad \ldots$ (v)

Subtracting Eq. (v) from Eq. (iv), we get

$z = 3$

168. *(a)* We have, $A = \begin{bmatrix} 1 & \log_b a \\ \log_a b & 1 \end{bmatrix}$

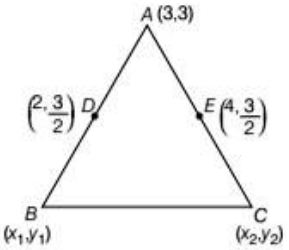
Now, $|A| = \begin{vmatrix} 1 & \log_b a \\ \log_a b & 1 \end{vmatrix}$

$= 1 - \log_a b \log_b a$

$= 1 - \log_a b \times \frac{1}{\log_a b} \left\{ \because \log_b a = \frac{1}{\log_a b} \right\}$

$= 1 - 1 = 0$

169. *(c)* Let the vertices of ΔABC are $A(3, 3)$, $B(x_1, y_1)$ and $C(x_2, y_2)$.



Now, $\frac{x_1 + 3}{2} = 2$ and $\frac{y_1 + 3}{2} = \frac{3}{2}$

$x_1 + 3 = 4$ and $y_1 + 3 = 3$

$x_1 = 1$ and $y_1 = 0$

So, $\quad B \equiv (1, 0)$

and $\quad \frac{x_2 + 3}{2} = 4$ and $\frac{y_2 + 3}{2} = \frac{3}{2}$

$x_2 + 3 = 8$ and $y_2 + 3 = 3$

$x_2 = 5$ and $y_2 = 0$

So, $\quad C \equiv (5, 0)$

Hence, centroid $= \left(\frac{3+1+5}{3}, \frac{3+0+0}{3} \right)$

$= \left(\frac{9}{3}, \frac{3}{3} \right) = (3, 1)$

170. *(c)* Let the image of point $(2, 4) = (h, k)$, then

$$\frac{h - x_1}{a} = \frac{k - y_1}{b} = \frac{-2(ax_1 + by_1 + c)}{a^2 + b^2}$$

$$\frac{h-2}{1} = \frac{k-4}{1} = \frac{-2(2+4-10)}{1^2 + 1^2}$$

$$\frac{h-2}{1} = \frac{k-4}{1} = \frac{-2(-4)}{2}$$

$$\frac{h-2}{1} = \frac{k-4}{1} = 4$$

$h - 2 = 4$ and $k - 4 = 4$

$h = 6$ and $k = 8$

So, $(h, k) = (6, 8)$

171. *(d)* Given, equation of line is $x^2 - 4pxy + 8y^2 = 0$

On comparing with $ax^2 + 2hxy + by^2 = 0$

$\Rightarrow \qquad a = 1, b = 8, 2h = -4p$

Given that, $m_1 + m_2 = 3m_1m_2$

$$\Rightarrow \quad -\frac{2h}{b} = \frac{3a}{b}$$

$$\Rightarrow \quad -2h = 3a$$

$$\Rightarrow \quad 4p = 3a$$

$$\Rightarrow \quad p = \frac{3a}{4}$$

$$\Rightarrow \quad p = \frac{3}{4} \qquad [\because a = 1]$$

172. *(a)* $\lim\limits_{x \to 0}\left(\frac{1+5x^2}{1+3x^2}\right)^{\frac{1}{x^2}}$

$$= \lim_{x \to 0} \frac{(1+5x^2)^{\frac{1}{5x^2}\cdot 5}}{(1+3x^2)^{\frac{1}{3x^2}\cdot 3}} = \frac{e^5}{e^3} = e^{5-3} = e^2$$

173. *(b)* $\because$ $f(x)$ is continuous at $x = 0$

So, $\lim\limits_{x \to 0} f(x) = f(0)$

$$\Rightarrow \quad \lim_{x \to 0} \frac{e^{3x-1}}{4x} = \frac{k+0}{4}$$

$$\Rightarrow \quad \frac{1}{4}\lim_{x \to 0} 3\left(\frac{e^{3x}-1}{3x}\right) = \frac{k}{4}$$

$$\Rightarrow \quad 3\lim_{x \to 0} \frac{e^{3x}-1}{3x} = k \Rightarrow 3 \times 1 = k \Rightarrow k = 3$$

174. *(d)* Non-adjacent vertex are not connected through edge.

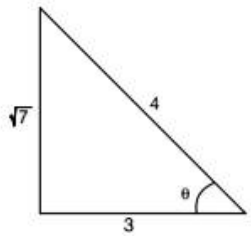
$\therefore$ V_1V_3 is correct option.

175. *(a)* $\sin\left[2\cos^{-1}\left\{\cot\left(\tan^{-1}\frac{1}{1-\frac{1}{4}}\right)\right\}\right]$

$$= \sin\left[2\cos^{-1}\left\{\cot\left(\tan^{-1}\frac{4}{3}\right)\right\}\right]$$

$$= \sin\left[2\cos^{-1}\frac{3}{4}\right] = \sin 2\theta$$

$$\left[\text{where, } \cos\theta = \frac{3}{4} \text{ and } \theta = \cos^{-1}\frac{3}{4}\right]$$



$$= 2\sin\theta\cos\theta = 2\frac{\sqrt{7}}{4}\cdot\frac{3}{4} = \frac{3\sqrt{7}}{8}$$

176. *(b)* $\frac{3+4i}{4-5i}$

Now, multiplicative inverse is

$$\frac{4-5i}{3+4i} \times \frac{3-4i}{3-4i}$$

$$= \frac{(4-5i)(3-4i)}{9+16}$$

$$= \frac{12-16i-15i+20i^2}{25} = \frac{-8-31i}{25} = \left(-\frac{8}{25}, -\frac{31}{25}\right)$$

177. *(a)* $\tan x - \sin x = 1 - \tan x \sin x$

$$\Rightarrow \tan x + \tan x \sin x = 1 + \sin x$$

$$\tan x(1+\sin x) - (1+\sin x) = 0$$

$$(1+\sin x)(\tan x - 1) = 0$$

$$\Rightarrow \quad \tan x - 1 = 0 \quad \text{or} \quad 1 + \sin x = 0$$

$$\tan x = 1 = \tan\frac{\pi}{4} \quad \text{or} \quad \sin x = -1 = \sin\left(-\frac{\pi}{2}\right)$$

$$x = n\pi + \frac{\pi}{4} \quad \text{or} \quad x = n\pi + (-1)^n\left(-\frac{\pi}{2}\right)$$

178. *(d)* Let θ be the angle of intersection of two given circles having centres $(-g, -f) = (-2, -1)$ and $(-g_1, -f_1) = (1, -3)$ respectively, then

$$\cos\theta = \left|\frac{-2gg_1 - 2ff_1 + c + c_1}{2\sqrt{g^2+f^2-c}\sqrt{g_1^2+f_1^2-c_1}}\right|$$

$$= \left|\frac{-2(2)(-1) - 2(1)(3) + 1 - 6}{2\sqrt{4+1-1}\sqrt{1+9+6}}\right|$$

$$= \left|\frac{4-6-5}{2(2)(4)}\right| = \left(\frac{7}{6}\right)$$

$$\theta = \cos^{-1}\left(\frac{7}{16}\right)$$

179. *(b)* We have, $|\mathbf{a}| = 2, |\mathbf{b}| = 7$

and $\mathbf{a} \times \mathbf{b} = 3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 6\hat{\mathbf{k}}$

So, $|\mathbf{a} \times \mathbf{b}| = \sqrt{9+4+36} = \sqrt{49} = 7$

Since, $|\mathbf{a} \times \mathbf{b}| = |\mathbf{a}||\mathbf{b}|\sin\theta\,|\hat{\mathbf{n}}|$

$$\Rightarrow \quad 7 = (2)(7)\sin\theta \cdot 1 \quad [\because |\hat{\mathbf{n}}| = 1]$$

$$\Rightarrow \quad \sin\theta = \frac{1}{2} \Rightarrow \sin\theta = \sin\frac{\pi}{6} \Rightarrow \quad \theta = \frac{\pi}{6}$$

180. *(b)* We have, $f(x) = \log(1-x) + \sqrt{x^2-1}$

$\log(1-x)$ is defined if $1 - x > 0 \Rightarrow x < 1$

$$\Rightarrow \quad x \in (-\infty, -1) \qquad \ldots (i)$$

and $\sqrt{x^2-1}$ is defined if $x^2 - 1 \geq 0$

$$\Rightarrow \quad x^2 \geq 1$$

$$\Rightarrow \quad x \geq 1 \text{ or } x \leq -1 \qquad \ldots (ii)$$

By Eqs. (i) and (ii), required domain is $(-\infty, -1]$.