SOLVED PAPER
(memory based)

VITEEE 2024

GENERAL INSTRUCTIONS

- This question paper contains total 125 questions divided into four parts :
  Part I : Physics Q. No - 1 to 35
  Part II : Chemistry Q. No - 36 to 70
  Part III : Mathematics Q. No - 71 to 110
  Part IV : Aptitude Test Q. No - 111 to 120
  Part V : English Q. No - 121 to 125
- All questions are multiple choice questions with four options, only one of them is correct.
- For each correct response, the candidate will get 1 mark.
- There is no negative marking for the wrong answer.
- The test is of 2½ hours duration.

PART - I (PHYSICS)

1. Force between two point charges q_1 and q_2 placed in vacuum at 'r' cm apart is F. Force between them when placed in a medium having dielectric K = 5 at 'r/5' cm apart will be:
(a) F/25 (b) 5F (c) F/5 (d) 25F

2. A parallel plate capacitor has 1μF capacitance. One of its two plates is given + 2μC charge and the other plate, +4μC charge. The potential difference developed across the capacitor is :
(a) 3 V (b) 1 V (c) 5 V (d) 2 V

3. A body of mass M at rest explodes into three pieces, in the ratio of masses 1 : 1 : 2. Two smaller pieces fly off perpendicular to each other with velocities of 30 ms^{-1} and 40 ms^{-1} respectively. The velocity of the third piece will be :
(a) 15 ms^{-1} (b) 25 ms^{-1} (c) 35 ms^{-1} (d) 50 ms^{-1}

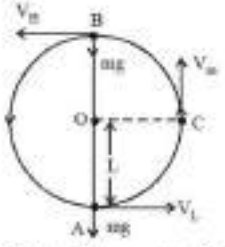
4. A charge particle moving in magnetic field B, has the components of velocity along B as well as perpendicular to B. The path of the charge particle will be
(a) helical path with the axis perpendicular to the direction of magnetic field B
(b) straight along the direction of magnetic field B
(c) helical path with the axis along magnetic field B
(d) circular path

5. In meter bridge or Wheatstone bridge for measurement of resistance, the known and the unknown resistance are interchanged. The error so removed is
(a) end correction
(b) index error
(c) due to temperature effect
(d) random error

6. Spherical insulating ball and a spherical metallic ball of same size and mass are dropped from the same height. Choose the correct statement out of the following {Assume negligible air friction}
(a) Time taken by them to reach the earth's surface will be independent of the properties of their materials
(b) Insulating ball will reach the earth's surface earlier than the metal ball
(c) Both will reach the earth's surface simultaneously
(d) Metal ball will reach the earth's surface earlier than the insulating ball.

7. Two objects A and B are placed at 15 cm and 25 cm from the pole in front of a concave mirror having radius of curvature 40 cm. The distance between images formed by the mirror is
(a) 60 cm (b) 40 cm (c) 160 cm (d) 100 cm

8. A bob of mass 'm' is suspended by a light string of length 'L'. It is imparted a minimum horizontal velocity at the lowest point A such that it just completes half circle reaching the top most position B. The ratio of kinetic energies $\frac{(K.E.)_A}{(K.E.)_B}$ is:



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

9. Considering a group of positive charges, which of the following statements is correct?
   (a) Net potential of the system cannot be zero at a point but net electric field can be zero at that point.
   (b) Net potential of the system at a point can be zero but net electric field can't be zero at that point.
   (c) Both the net potential and the net field can be zero at a point.
   (d) Both the net potential and the net electric field cannot be zero at a point.

10. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately
   (a) 310nm (b) 400nm (c) 540nm (d) 220nm

11. Magnetic field at the centre of a circular coil of radius r, through which a current I flows is
   (a) directly proportional to r
   (b) inverseley proportional to I
   (c) directly proportional to I
   (d) directly proprotional to I^2

12. The refractive index of a prism with apex angle A is cot A/2. The angle of minimum deviation is :
   (a) $\delta_m = 180° - 4A$ (b) $\delta_m = 180° - 3A$
   (c) $\delta_m = 180° - 2A$ (d) $\delta_m = 180° - A$

13. If $\vec{A} = 4\hat{i} + 3\hat{j}$ and $\vec{B} = 3\hat{i} + 4\hat{j}$ then cosine of angle between $\vec{A}$ and $\vec{A} + \vec{B}$ is
   (a) $\frac{9\sqrt{2}}{5}$ (b) $\frac{7}{5\sqrt{2}}$ (c) $\frac{5\sqrt{2}}{49}$ (d) $\frac{5\sqrt{2}}{28}$

14. Two light beams of intensities in the ratio of 9 : 4 are allowed to interfere. The ratio of the intensity of maxima and minima will be :
   (a) 2:3 (b) 16:81 (c) 25:169 (d) 25:1

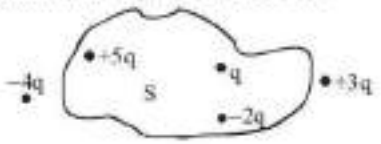
15. A heavy box of mass 50 kg is moving on a horizontal surface. If co-efficient of kinetic friction between the box and horizontal surface is 0.3 then force of kinetic friction is :
   (a) 14.7N (b) 147N (c) 1.47N (d) 1470N

16. When unpolarized light is incident at an angle of 60° on a transparent medium from air. The reflected ray is completely polarized. The angle of refraction in the medium is
   (a) 30° (b) 60° (c) 90° (d) 45°

17. The waves emitted when a metal target is bombarded with high energy electrons are
   (a) Microwaves (b) X-rays
   (c) Infrared rays (d) Radio waves

18. Two bodies of mass 4 g and 25 g are moving with equal kinetic energies. The ratio of magnitude of their linear momentum is :
   (a) 3:5 (b) 5:4 (c) 2:5 (d) 4:5

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



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

20. Mass numbers of two nuclei are in the ratio of 4:3. Their nuclear densities will be in the ratio of
   (a) 4:3 (b) $\left(\frac{3}{4}\right)^{\frac{1}{3}}$ (c) 1:1 (d) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

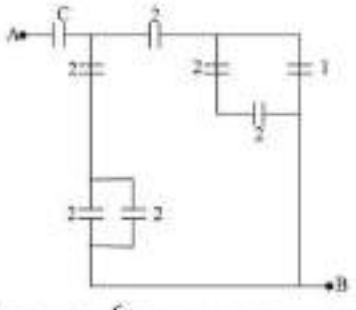
21. Under the same load, wire A having length 5.0 m and cross section 2.5×10^{-5} m² stretches uniformly by the same amount as another wire B of length 6.0 m and a cross section of 3.0×10^{-5} m² stretches. The ratio of the Young's modulus of wire A to that of wire B will be:
   (a) 1:4 (b) 1:1 (c) 1:10 (d) 1:2

22. A current of 10 A exists in a wire of cross-sectional area of 5 mm² with a drift velocity of 2×10^{-3} ms^{-1}. The number of free electrons in each cubic meter of the wire is
   (a) 2×10^{25} (b) 2×10^{23}
   (c) 625×10^{25} (d) 2×10^{6}

23. A long straight wire of circular cross–section (radius a) is carrying steady current I. The current I is uniformly distributed across this cross–section. The magnetic field is
   (a) Zero in the region r < a and inversely proportional to r in the region r > a
   (b) Inversely proportional to r in the region r < a and uniform throughout in the region r > a
   (c) Directly proportional to r in the region r < a and inversely proportional to r in the region r > a
   (d) Uniform in the region r < a and inversely proportional to distance r from the axis, in the region r > a

24. A small ball of mass M and density ρ is dropped in a viscous liquid of density ρ_0. After some time, the ball falls with a constant velocity. What is the viscous force on the ball?
   (a) $F = Mg\left(1 - \frac{\rho_0}{\rho}\right)$ (b) $F = Mg\left(1 + \frac{\rho}{\rho_0}\right)$
   (c) $F = Mg\left(1 + \frac{\rho_0}{\rho}\right)$ (d) $F = Mg(1 + \rho\rho_0)$

25. In the circuit shown, find C if the effective capacitance of the whole circuit is to be 0.5 μF. All values in the circuit are in μF.



   (a) $\frac{7}{11}$ μF (b) $\frac{6}{5}$ μF (c) 4 μF (d) $\frac{7}{10}$ μF

26. Choose the correct option from the following options given below :

(a) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net-force.

(b) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model

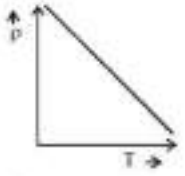
(c) A classical atom based on Rutherford's model is doomed to collapse.

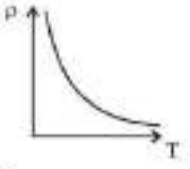
(d) The positively charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model.

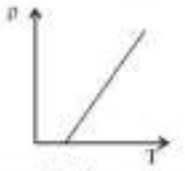
27. A cylinder of height 20 m is completely filled with water. The velocity of efflux of water (in ms^{-1}) through a small hole on the side wall of the cylinder near its bottom is

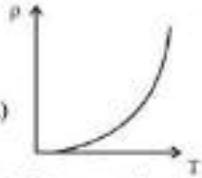
(a) 10 (b) 20 (c) 25.5 (d) 5

28. The resistivity (ρ) of semiconductor varies with temperature. Which of the following curve represents the correct behaviour

(a) 

(b) 

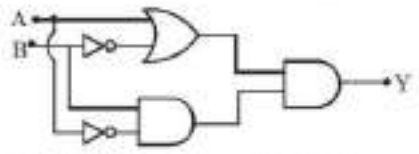
(c) 

(d) 

29. Two parallel, long wires are kept 0.20 m apart in vacuum, each carrying current of x A in the same direction. If the force of attraction per meter of each wire is 2×10^{-6} N, then the value of x is approximately:

(a) 1 (b) 2.4 (c) 1.4 (d) 2

30. The output Y of following circuit for given inputs is :



(a) $A \cdot B(A + B)$ (b) $A \cdot B$

(c) 0 (d) $\bar{A} \cdot B$

31. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$.

(a) 4Ω and 6Ω are in parallel with 2Ω and 8Ω in series

(b) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series

(c) 2Ω and 6Ω are in parallel with 4Ω and 8Ω in series

(d) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

32. Two cells of same emf but different internal resistances r_1 and r_2 are connected in series with a resistance R. The value of resistance R, for which the potential difference across second cell is zero, is

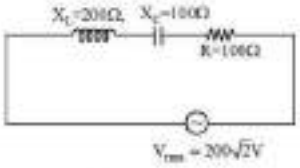
(a) $r_2 - r_1$ (b) $r_1 - r_2$ (c) r_1 (d) r_2

33. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°C will be :

(Given gas constant R = 8.3 JK^{-1}–mol^{-1})

(a) 249 J (b) 415 J (c) 498 J (d) 830 J

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



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

35. At what temperature a gold ring of diameter 6.230 cm be heated so that it can be fitted on a wooden bangle of diameter 6.241 cm? Both the diameters have been measured at room temperature (27 °C).

(Given: coefficient of linear thermal expansion of gold $\alpha_s = 1.4 \times 10^{-5} K^{-1}$)

(a) 125.7°C (b) 91.7°C

(c) 425.7°C (d) 152.7°C

PART - II (CHEMISTRY)

36. The wavelength (in cm) of second line in the Lyman series of hydrogen atomic spectrum is (Rydberg constant = R cm^{-1})

(a) $\left(\frac{8R}{9}\right)$ (b) $\left(\frac{9}{8R}\right)$ (c) $\left(\frac{4}{3R}\right)$ (d) $\left(\frac{3R}{4}\right)$

37. Polarisibility of halide ions increases in the order

(a) F^-, I^-, Br^-, Cl^- (b) Cl^-, Br^-, I^-, F^-

(c) I^-, Br^-, Cl^-, F^- (d) F^-, Cl^-, Br^-, I^-

38. The statement that is not correct for periodic classification of elements is:

(a) the properties of elements are periodic function of their atomic numbers.

(b) non-metallic elements are less in number than metallic elements.

(c) for transition elements, the 3*d*-orbitals are filled with electrons after 3*p*-orbitals and before 4*s*-orbitals.

(d) the first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.

39. PCl_5 is dissociating 50% at 250°C at a total pressure of P atm. If equilibrium constant is K_p, then which of the following relation is numerically correct ?

(a) $K_p = 3P$ (b) $P = 3K_p$

(c) $P = \frac{2K_p}{3}$ (d) $K_p = \frac{2P}{3}$

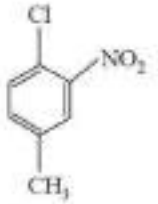
40. Which of the following statement is false ?
(a) Cannizzaro reaction is given by aldehydes in presence of alkali.
(b) Aldol condensation is given by aldehydes in presence of alkali.
(c) Aldol condensation is given by aldehydes and ketones in presence of acids.
(d) None of the above.

41. How many electrons are involved in the following redox reaction?

$$Cr_2O_7^{2-} + Fe^{2+} + C_2O_4^{2-} \rightarrow Cr^{3+} + Fe^{3+} + CO_2 \text{ (Unbalanced)}$$

(a) 3 (b) 4 (c) 6 (d) 5

42. The IUPAC name for

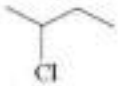


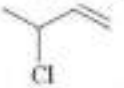
(a) 1-chloro-2-nitro-4-methylbenzene
(b) 1-chloro-4-methyl-2-nitrobenzene
(c) 2-chloro-1-nitro-5-methylbenzene
(d) m-nitro-p-chlorotoluene

43. The decreasing order of reactivity towards dehydrohalogenation (E_1) reaction of the following compounds is:

(A) 

(B) 

(C) 

(D) 

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

44. Specific conductance of 0.1 M HNO_3 is 6.3×10^{-2} ohm^{-1} cm^{-1}. The molar conductance of the solution is
(a) 100 ohm^{-1} cm^2 mol^{-1}
(b) 515 ohm^{-1} cm^2 mol^{-1}
(c) 630 ohm^{-1} cm^2 mol^{-1}
(d) 6300 ohm^{-1} cm^2 mol^{-1}

45. Which of the following compounds does not show Lassaigne's test for nitrogen ?
(a) Urea (b) Hydrazine
(c) Phenylhydrazine (d) Azobenzene

46. The strongest acid among the following is –
(a) Salicylic acid
(b) *m*-hydroxybenzoic acid
(c) *p*-hydroxybenzoic acid
(d) Benzoic acid

47. At 25°C and 1 atm pressure, the enthalpy of combustion of benzene (1) and acetylene (g) are –3268 kJ mol^{-1} and –1300 kJ mol^{-1}, respectively. The change in enthalpy for the reaction $3\,C_2H_2(g) \rightarrow C_6H_6(l)$, is
(a) +324 kJ mol^{-1} (b) +632 kJ mol^{-1}
(c) –632 kJ mol^{-1} (d) –732 kJ mol^{-1}

48. How many conformations are possible for ethane ?
(a) 2 (b) 3
(c) infinite (d) one

49. For which one of the following sets of four quantum numbers, an electron will have the heighest energy?

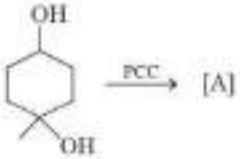
	n	l	m	s
(a)	3	2	1	1/2
(b)	4	2	–1	1/2
(c)	4	1	0	–1/2
(d)	5	0	0	–1/2

50. Using VSEPR theory, predict the species which has square pyramidal shape
(a) $SnCl_2$ (b) CCl_4
(c) SO_3 (d) BrF_5

51. Which of the following relation is not correct?
(a) $\Delta H = \Delta U - P\Delta V$ (b) $\Delta U = q + W$
(c) $\Delta S_{sys} + \Delta S_{surr} \geq 0$ (d) $\Delta G = \Delta H - T\Delta S$

52. The acidic, basic and amphoteric oxides, respectively, are:
(a) Na_2O, SO_3, Al_2O_3 (b) Cl_2O, CaO, P_4O_{10}
(c) N_2O_5, Li_2O, Al_2O_3 (d) MgO, Cl_2O, Al_2O_3

53. 100 mL of 0.04 N HCl aqueous solution is mixed with 100 mL of 0.02 N NaOH solution. The pH of the resulting solution is:
(a) 1.0 (b) 1.7
(c) 2.0 (d) 2.3

54. 

[A] will show
(a) Br_2 water test (b) Tollen's test
(c) Victor maeyer test (d) Lucas test

55. The value of van't Hoff factors for KCl, NaCl and K_2SO_4 respectively are .....
(a) 2, 2 and 2 (b) 2, 2 and 3
(c) 1, 1 and 2 (d) 1, 1 and 1

56. A first order reaction is half completed in 45 minutes. How long does it need 99.9% of the reaction to be completed
(a) 5 hours (b) 7.5 hours
(c) 10 hours (d) 20 hours

57. The greater the valence of the flocculating ion added, the greater is its power to cause precipitation of a colloid. This rule is
(a) Hund's rule (b) Pauling rule
(c) Henry's rule (d) Hardy – Schulze rule

58. The number of hydrogen bonds formed by a water molecule at normal conditions is
(a) 1 (b) 2 (c) 3 (d) 4

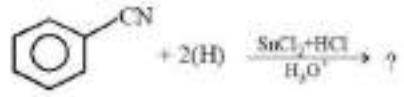
59. Element not showing variable oxidation state is :
(a) Bromine (b) Iodine
(c) Chlorine (d) Fluorine

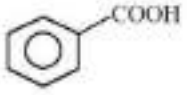
60. Which of the following arrangements does not represent the correct order of the property stated against it ?
(a) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: paramagnetic behaviour
(b) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size
(c) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: stability in aqueous solution
(d) Sc < Ti < Cr < Mn : number of oxidation states

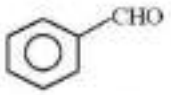
61. Lanthanoid which has the smallest size in +3 state is
(a) Tb (b) Er
(c) Ce (d) Lu

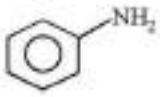
62. 'Oxidation number of H in NaH, CaH_2 and LiH, respectively is
(a) +1, +1, –1 (b) –1, +1, + 1
(c) +1, + 1, + 1 (d) –1, –1, –1

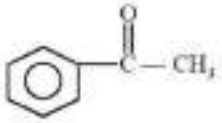
63. Product of the following reaction is



(a) 

(b) 

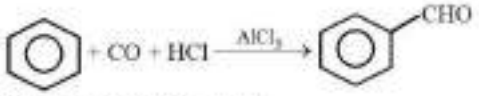
(c) 

(d) 

64. Which of the following alkyl halides will undergo S_N1 reaction most readily?
(a) $(CH_3)_3C—F$ (b) $(CH_3)_3C—Cl$
(c) $(CH_3)_3C—Br$ (d) $(CH_3)_3C—I$

65. Phenol does not undergo nucleophilic substitution reaction easily due to:
(a) acidic nature of phenol
(b) partial double bond character of C-OH bond
(c) partial double bond character of C-C bond
(d) instability of phenoxide ion

66. The reaction



(a) Rosenmund's reaction
(b) Stephen's reaction
(c) Cannizzaro's reaction
(d) Gatterman-Koch reaction

67. Hoffmann bromamide degradation reaction is shown by .....
(a) $ArNH_2$ (b) $ArCONH_2$
(c) $ArNO_2$ (d) $ArCH_2NH_2$

68. Which of the following acids is a vitamin?
(a) Aspartic acid
(b) Ascorbic acid
(c) Adipic acid
(d) Saccharic acid

69. Intermolecular forces in nylon-6, 6 are
(a) dipole-dipole interactions
(b) hydrogen bonding
(c) van der Waal's forces
(d) ionic bonds

70. Which of the following does not form a chelate ?
(a) EDTA (b) Oxalate
(c) Pyridine (d) Ethylenediamine

PART - III (MATHEMATICS)

71. Let $n(A) = m$ and $n(B) = n$, if the number of subsets of A is 56 more than of subsets of B, then $m + n$ is equal to
(a) 9 (b) 13
(c) 8 (d) 10

72. If $f(x) = \cos^{-1}\left(\frac{\sqrt{2x^2+1}}{x^2+1}\right)$, then range of $f(x)$ is
(a) $[0, \pi]$ (b) $\left(0, \frac{\pi}{4}\right]$
(c) $\left(0, \frac{\pi}{3}\right]$ (d) $\left[0, \frac{\pi}{2}\right)$

73. A, P, B are 3×3 matrices. If $|-B| = 5$, $|BA^T| = 15$, $|P^T AP| = -27$, then one of the values of $|P|$ is
(a) 3 (b) -5
(c) 9 (d) 6

74. If $f(x)$ defined as given below, is continuous on R, then the value of $a + b$ is equal to

$$f(x) = \begin{cases} \sin x, & x \le 0 \\ x^2 + a, & 0 < x < 1 \\ bx + 3, & 1 \le x \le 3 \\ -3, & x > 3 \end{cases}$$

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

75. Let $f(x) = \begin{cases} 3 - x & \text{if} \quad x < -3 \\ 6 & \text{if} \quad -3 \le x \le 3 \\ 3 + x & \text{if} \quad x > 3 \end{cases}$. Let α be the number of points of discontinuity of f and β be the number of points where f is not differentiable. Then $\alpha + \beta =$
(a) 6 (b) 3
(c) 2 (d) 0

76. $\frac{d}{dx}\left\{\sin^2\left(\cot^{-1}\sqrt{\frac{1+x}{1-x}}\right)\right\}$ is equal to

(a) 0 (b) $\frac{1}{2}$

(c) $\frac{-1}{2}$ (d) -1

77. The number of students who take both the subjects mathematics and chemistry is 30. This represents 10% of the enrolment in mathematics and 12% of the enrolment in chemistry. How many students take at least one of these two subjects?

(a) 520 (b) 490

(c) 560 (d) 480

78. If A and B are the two real values of k for which the system of equations $x + 2y + z = 1$, $x + 3y + 4z = k$, $x + 5y + 10z = k^2$ is consistent, then $A + B =$

(a) 3 (b) 4

(c) 5 (d) 7

79. The radius of the base of a cone is increasing at the rate of 3 cm/minute and the altitude is decreasing at the rate of 4 cm/minute. The rate of change of lateral surface when the radius = 7 cm and altitude = 24 cm, is

(a) 54π cm^2/min (b) 7π cm^2/min

(c) 27π cm^2/min (d) None of these

80. The maximum area of a right angled triangle with hypotenuse h is

(a) $h^2/2\sqrt{2}$ (b) $h^2/2$

(c) $h^2/\sqrt{2}$ (d) $h^2/4$

81. If $f(x)$ is continuous and $\int_0^9 f(x)dx = 4$, then the value of the integral $\int_0^3 x \cdot f(x^2)dx$ is

(a) 2 (b) 18

(c) 16 (d) 4

82. The area bounded by $y - 1 = -|x|$ and $y + 1 = |x|$ is

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

(c) 2 (d) 0

83. Let the vectors $\overrightarrow{AB} = 2\hat{i} + 2\hat{j} + \hat{k}$ and $\overrightarrow{AC} = 2\hat{i} + 4\hat{j} + 4\hat{k}$ be two sides of a triangle ABC. If G is the centroid of ΔABC, then $\frac{22}{7}\left(\overline{AG}\right)^2 + 5 =$

(a) 25 (b) 38

(c) 47 (d) 52

84. If the two lines l_1 : $\frac{x-2}{3} = \frac{y+1}{-2}$, z = 2 and l_2 : $\frac{x-1}{1} = \frac{2y+3}{\alpha} = \frac{z+5}{2}$ perpendicular, then an angle between the lines l_2 and l_3 : $\frac{1-x}{3} = \frac{2y-1}{-4} = \frac{z}{4}$ is :

(a) $\cos^{-1}\left(\frac{29}{4}\right)$ (b) $\sec^{-1}\left(\frac{29}{4}\right)$

(c) $\cos^{-1}\left(\frac{2}{29}\right)$ (d) $\cos^{-1}\left(\frac{2}{\sqrt{29}}\right)$

85. If $f(x) = \ln\left(\frac{x^2+e}{x^2+1}\right)$, then range of $f(x)$ is

(a) (0, 1) (b) (0, 1]

(c) [0, 1) (d) {0, 1}

86. $f(x) = \frac{\log(\pi + x)}{\log(e + x)}$ is

(a) increasing in $[0, \infty)$

(b) decreasing in $[0, \infty)$

(c) decreasing in $\left[0, \frac{\pi}{e}\right]$ and increasing in $\left[\frac{\pi}{e}, \infty\right)$

(d) increasing in $\left[0, \frac{\pi}{e}\right]$ and decreasing in $\left[\frac{\pi}{e}, \infty\right)$

87. $\int_{-\pi}^{\pi} x^2(\sin x)dx =$

(a) π^2 (b) $\frac{\pi^2}{2}$

(c) 0 (d) $2\pi^2$

88. The solution of the differential equation $x^4\frac{dy}{dx} + x^3y + \text{cosec}(xy) = 0$ is equal to :

(a) $2\cos(xy) + x^{-2} = c$

(b) $2\cos(xy) + y^{-2} = c$

(c) $2\sin(xy) + x^{-2} = c$

(d) $2\sin(xy) + y^{-2} = c$

89. If the solution of $\left(1 + 2e^{\frac{x}{y}}\right)dx + 2e^{\frac{x}{y}}\left(1 - \frac{x}{y}\right)dy = 0$ is $\left(x + \lambda ye^{\frac{x}{y}}\right) = c$, ($c$ is an arbitrary constant), then λ is

(a) 1 (b) 2

(c) 3 (d) None of these

90. The probability distribution of a random variable is given below

$X = x$	0	1	2	3	4	5	6	7
$P(X = x)$	0	K	2K	2K	3K	K^2	$2K^2$	$7K^2 + K$

Then, $P(0 < x < 5)$ is equal to

(a) $\frac{1}{10}$ (b) $\frac{3}{10}$

(c) $\frac{8}{10}$ (d) $\frac{7}{10}$

91. The length of the perpendicular from the point $(1, -2, 5)$ on the line passing through $(1, 2, 4)$ and parallel to the line $x + y - z = 0$ and $x - 2y + 3z - 5 = 0$ is:

(a) $\sqrt{\frac{21}{2}}$ (b) $\sqrt{\frac{9}{2}}$

(c) $\sqrt{\frac{73}{2}}$ (d) 1

92. The range of $2|\sin x + \cos x| - \sqrt{2}$ is

(a) $\left[-\sqrt{2}, \sqrt{2}\right]$ (b) $\left[-3\sqrt{2}, \sqrt{2}\right]$

(c) $\left(-3\sqrt{2}, \sqrt{2}\right)$ (d) None of these

93. $\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \left(\frac{x + \frac{\pi}{4}}{2 - \cos 2x}\right) dx$ is equal to

(a) $\frac{8\pi\sqrt{3}}{5}$ (b) $\frac{2\pi\sqrt{3}}{9}$

(c) $\frac{4\pi^2\sqrt{3}}{9}$ (d) $\frac{\pi^2}{6\sqrt{3}}$

94. A and B are independent events of a random experiment if and only if

(a) $P(A \mid B) \neq P(A \cap B)$

(b) $P(A \mid B) = P(B \mid A)$

(c) $P(A \mid B) \neq P(A \mid B^C)$

(d) $P(A \mid B) = P(A \mid B^C)$

95. The equation of a common tangent to the parabolas $y = x^2$ and $y = -(x - 2)^2$ is

(a) $y = 4(x - 2)$ (b) $y = 4(x - 1)$

(c) $y = 4(x + 1)$ (d) $y = 4(x + 2)$

96. Negation of the statement $(p \wedge r) \rightarrow (r \vee q)$ is

(a) $\sim(p \wedge r) \rightarrow \sim(r \vee q)$

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

(c) $(p \wedge r) \wedge (r \wedge q)$

(d) $(p \wedge r) \wedge (\sim r \wedge \sim q)$

97. The number of different permutations of all the letters of the word 'PERMUTATION' such that any two consecutive letters in the arrangement are neither both vowels nor both identiacal is

(a) $63 \times 6! \times 5!$ (b) $57 \times 5! \times 5!$

(c) $33 \times 6! \times 5!$ (d) $7 \times 7! \times 5!$

98. The coefficients of x^{50} in $(1 + x)^{101}(1 - x + x^2)^{100}$ is.....

(a) 1 (b) -1

(c) 0 (d) 2

99. $\frac{1}{q+r}, \frac{1}{r+p}, \frac{1}{p+q}$ are in A.P. then,

(a) p, q, r are in A.P

(b) p^2, q^2, r^2 are in A.P

(c) $\frac{1}{p}, \frac{1}{q}, \frac{1}{r}$ are in A.P

(d) $p + q + r$ are in A.P

100. The coordinates of the foot of perpendicular from the point $(2, 3)$ on the line $y = 3x + 4$ is given by

(a) $\left(\frac{37}{10}, \frac{-1}{10}\right)$ (b) $\left(\frac{-1}{10}, \frac{37}{10}\right)$

(c) $\left(\frac{10}{37}, -10\right)$ (d) $\left(\frac{2}{2}, -\frac{1}{3}\right)$

101. The circle touching the y-axis at a distance 4 units from the origin and cutting off an intercept 6 from x-axis is

(a) $x^2 + y^2 \pm 10x - 8y + 16 = 0$

(b) $x^2 + y^2 \pm 5x - 8y + 16 = 0$

(c) $x^2 + y^2 \pm 5x - 2y - 8 = 0$

(d) $x^2 + y^2 \pm 2x - y - 12 = 0$

102. The points A(4, – 2, 1), B(7, – 4, 7), C (2, – 5, 10) and D(– 1, – 3, 4) are the vertices of a

(a) tetrahedron (b) parallelogram

(c) rhombus (d) square

103. If A, B, C, D are the angles of a quadrilateral, then

$$\frac{\tan A + \tan B + \tan C + \tan D}{\cot A + \cot B + \cot C + \cot D} =$$

(a) cot A cot B cot C cot D

(b) tan A tan B tan C tan D

(c) – tan A tan B tan C tan D

(d) – cot A cot B cot C cot D

104. Let $z \neq 1$ be a complex number and let $\omega = x + iy, y \neq 0$. If $\frac{\omega - \bar{\omega}z}{1 - z}$ is purely real, then $|z|$ is equal to

(a) $|\omega|$ (b) $|\omega|^2$

(c) $\frac{1}{|\omega|^2}$ (d) 1

105. If the roots of $(a^2 + b^2)\, x^2 - 2\,(bc + ad)\, x + c^2 + d^2 = 0$ are equal, then

(a) $\frac{a}{b} = \frac{c}{d}$ (b) $\frac{a}{c} + \frac{b}{d} = 0$

(c) $\frac{a}{d} = \frac{b}{c}$ (d) $a + b = c + d$

106. $\lim_{x \to 0} \frac{35^x - 7^x - 5^x + 1}{(e^x - e^{-x}) \ell n(1 - 3x)} =$

(a) $\frac{\ell n 35}{6}$ (b) $-\frac{\ell n 35}{6}$

(c) $\frac{\ell n 2}{6}$ (d) $\frac{\ell n (5).\ell n 7}{-6}$

107. If $z_r = \cos\frac{r\pi}{n^2} + i \sin\frac{r\pi}{n^2}$, where r = 1, 2, 3, ... n, then the value of $\lim_{n \to \infty} z_1 z_2 z_3 ... z_n$ is

(a) 0 (b) $e^{-\frac{i\alpha}{2}}$

(c) $e^{\frac{i\alpha}{2}}$ (d) $e^{i\alpha}$

108. Let $f(x)$ be a polynomial function satisfying

$f(x) \cdot f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right)$. If $f(4) = 65$ and l_1, l_2, l_3 are in GP, then $f'(l_1), f'(l_2), f'(l_3)$ are in

(a) AP (b) GP

(c) Both (d) None of these

109. In four schools B_1, B_2, B_3, B_4 the percentage of girls students is 12, 20, 13, 17 respectively. From a school selected at random, one student is picked up at random and it is found that the student is a girl. The probability that the school selected is B_2, is

(a) $\frac{6}{31}$ (b) $\frac{10}{31}$

(c) $\frac{13}{62}$ (d) $\frac{17}{62}$

110. For real numbers x and y, we define xRy iff $x - y + \sqrt{5}$ is an irrational number. Then, relation R is

(a) reflexive (b) symmetric

(c) transitive (d) None of these

PART - IV (APTITUDE TEST)

DIRECTIONS (Qs. 111-113) : *These questions are to be answered on the basis of the pie chart given below showing how a person's monthly salary is distributed over different expense heads.*

111. For a person, whose monthly salary is Rs 6,000 p.m., how many items are there on which he has to spend more than ₹ 1,000 p.m ?

(a) 1 (b) 2

(c) 3 (d) 4

112. The annual saving for such a person will be approximately:

(a) ₹ 5,000 (b) ₹ 10, 000

(c) ₹ 15, 000 (d) ₹ 16, 560

113. The monthly salary for a person who follows the same expense pattern, but has a petrol expense of Rs 500 p.m., is

(a) ₹ 2,500 (b) ₹ 3, 000

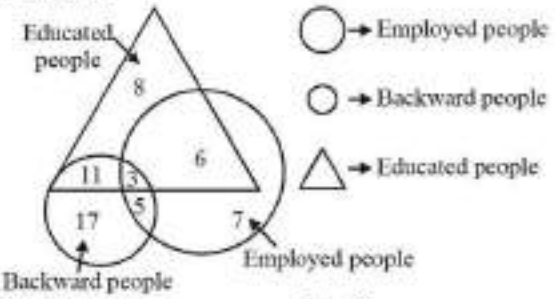
(c) ₹ 5, 000 (d) ₹ 6,500

114. If NATION is coded as 467234 and EARN be coded as 1654 then ATTENTION should be coded as :-

(a) 432769561 (b) 956143654

(c) 766412743 (d) 677147234

115. In the following figure, how many educated people are employed ?



(a) 18 (b) 20

(c) 15 (d) 9

116. A man is facing west. He runs 45° in the clockwise direction and then another 180° in the same direction and then 270° in the anticlockwise direction. Which direction is he facing now?

(a) South (b) North-west

(c) West (d) South-west

117. A is the brother of B. A is the brother of C. To find what is the relation between B and C. What minimum information from the following is necessary?

(i) Gender of C (ii) Gender of B

(a) Only (i) (b) Only (ii)

(c) Either (i) or (ii) (d) both (i) and (ii)

118. In a class of 20 students, Alisha's rank is 15th from the top. Manav is 4 ranks above Alisha. What is Manav's rank from the bottom ?

(a) 10th (b) 11th

(c) 9th (d) 12th

119. In this question, there are three statements followed by conclusions numbered I and II. You have to take the given statements to be true even if they seem to be at variance from commonly known facts and then decide which of the given conclusions logically follow from the three statements.

Statements: All books are ledgers.
All pens are keys.
Some pens are books.

Conclusions: I Some ledgers are keys.
II. Some keys are books.

(a) if only conclusion I follows.

(b) if only conclusion II follows.

(c) if neither I nor II follows.

(d) if both I and II follow.

120. If it was a Friday on 1 January 2016, what was the day of the week on 31 December 2016?

(a) Saturday (b) Friday

(c) Monday (d) Sunday

PART - V (ENGLISH)

DIRECTIONS (Qs. 121-125) : *Read the passage carefully and choose the best answer to each question out of the four alternatives.*

"People very often complain that poverty is a great evil and that it is not possible to be happy unless one has a lot of money. Actually, this is not necessarily true. Even a poor man, living in a small hut with none of the comforts and luxuries of life, may be quite contented with his lot and achieve a measure of happiness. On the other hand, a very rich man, living in a palace and enjoying everything that money can buy, may still be miserable, if, for example, he does not enjoy good health or his only son has taken to evil ways. Apart from this, he may have a lot of business worries which keep him on tenterhooks most of the time. There is a limit to what money can buy and there are many things which are necessary for a man's happiness and which money cannot procure.

Real happiness is a matter of the right attitude and the capacity of being contented with whatever you have is the most important ingredient of this attitude".

121. The phrase "on tenterhooks" means:

(a) in a state of thoughfulness

(b) in a state of anxiety

(c) in a state of sadness

(d) in a state of forgetfulness

122. It is true that:

(a) money alone can give happiness

(b) money always gives happiness

(c) money seldom gives happiness

(d) money alone cannot give happiness

123. A rich man's life may become miserable if he:

(a) has evil son, bad health and business worries

(b) does not enjoy good health

(c) has business worries

(d) has business worries and his only son has taken to evil ways

124. Which of the following is the most appropriate title to the passage?

(a) Poverty, a great evil

(b) The key of happiness

(c) Contentment, the key of happiness

(d) Money and contentment

125. Which of the following statement is true?

(a) Only a poor but contented man can be happy

(b) A poor but contented man can never be happy

(c) A poor but contented man can be happy

(d) A poor but contented man is always happy

SOLUTIONS

PART - I (PHYSICS)

1. **(b)** Electrostatic force acting between two point charges in vacuum

$$F = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$$

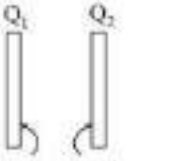
Electrostatic force acting between two point charges in a medium of dielectric constant K is

$$F = \frac{1}{4\pi(K\epsilon_0)}\frac{q_1q_2}{(r')^2} = \frac{25}{4\pi(5\epsilon_0)}\frac{q_1q_2}{(r)^2}$$

$$\Rightarrow F' = 5F$$

2. **(b)** $V = \frac{Q}{C}$

By Gauss law



Charge on inner plates = $\left|\frac{Q_1-Q_2}{2}\right|$ $\frac{Q_1-Q_2}{2}$ $\frac{(Q_1-Q_2)}{2}$

So, $V = \left(\frac{Q_1-Q_2}{2C}\right) - \left(\frac{4-2}{2\times1}\right) = -1$ V

3. **(b)** By law of conservation of momentum

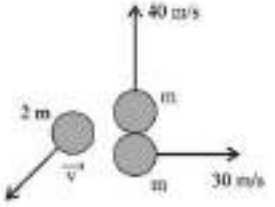
$|\vec{P}_i| = |\vec{P}_f|$

$0 = m(30\hat{i} + 40\hat{j}) + 2m\vec{v}$

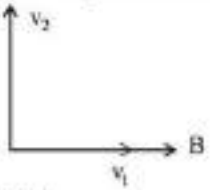
$\vec{v} = -15\hat{i} - 20\hat{j}$

So, $|\vec{v}| = \sqrt{-15^2 + (-20)^2}$

$= \sqrt{625} = 25$ m/s.



4. **(c)** Let v_1 is component of velocity parallel to the magnetic field and v_2 is the component of velocity perpendicular to the magnetic field.



Due to component v_1,
magnetic force $F = qv_1B\sin\theta = 0$ ($\because \theta = 0$)
So v_1 remains unchanged but due to component v_2 magnetic force act towards centre i.e. moving it circular $F = qvB \sin 90 = qvB$. So path is helical with the axis parallel to magnetic field B.

5. **(a)** In meter bridge experiment, it is assumed that the resistance of the L shaped plate is negligible, but actually it is not so. The error created due to this is called end error. To remove this the resistance box and the unknown resistance must be interchanged and then the mean reading must be taken.

6. **(b)** When metal ball is passing through magnetic field, eddy current will produce and it will oppose the motion, so it will take more time.

7. **(c)** For A, u = –15 cm, f = – 20 cm

So, $\frac{1}{V_A} + \frac{1}{-15} = \frac{1}{-20} \Rightarrow \frac{1}{V_A} = \frac{1}{15} - \frac{1}{20}$

$\Rightarrow \frac{1}{V_A} = \frac{20-15}{300} \Rightarrow \frac{1}{V_A} = \frac{5}{300} \Rightarrow V_A = \frac{300}{5} = 60$ cm

For B, u = – 25 cm, f = – 20 cm

So, $\frac{1}{V_B} + \frac{1}{-25} = \frac{1}{-20} \Rightarrow \frac{1}{V_B} = -\frac{1}{20} + \frac{1}{25}$

$\Rightarrow \frac{1}{V_B} = \frac{-5}{500} \Rightarrow V_B = -100$ cm

So, distance between image of A and B are (100 – (–60)) cm
i.e. 160 cm

8. **(b)** Applying energy conservation between points A & B

$\frac{1}{2}mV_L^2 = \frac{1}{2}mV_H^2 + mg(2L)$

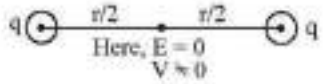
For complete circle,

$V_L = \sqrt{5gL}$

$\therefore V_H = \sqrt{gL}$

$\frac{(K.E)_A}{(K.E)_B} = \frac{\frac{1}{2}mV_L^2}{\frac{1}{2}mV_H^2} = \frac{\frac{1}{m}\left(\sqrt{5gL}\right)^2}{\frac{1}{2}m\left(\sqrt{gL}\right)^2} = \frac{5}{1}$

9. **(a)** For a group of positive charge, net potential at any point is never zero but electric field can be zero.



10. **(a)** For the longest wavelength to emit photo electron

$\frac{hc}{\lambda} = \phi \Rightarrow \lambda = \frac{hc}{\phi} \Rightarrow \lambda = \frac{6.63\times10^{-34}\times3\times10^8}{4\times1.6\times10^{-19}} = 310$ nm

11. **(c)** Field at the center of a circular coil of radius r is

$$B = \frac{\mu_0 I}{2r}$$

12. **(c)** Refraction index of the material of the prism

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\Rightarrow \cot\frac{A}{2} - \frac{\cos\frac{A}{2}}{\sin\frac{A}{2}} = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}} \quad \left[\because \mu = \cot\frac{A}{2}\right]$$

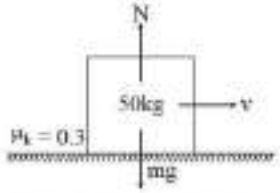
$$\Rightarrow \sin\left(\frac{\pi}{2} - \frac{A}{2}\right) = \sin\left(\frac{A+\delta_m}{2}\right) \Rightarrow \frac{\pi}{2} - \frac{A}{2} = \frac{A}{2} + \frac{\delta_m}{2}$$

$$\Rightarrow \delta_m = \pi - 2A$$

13. **(b)**

14. **(d)** $\frac{I_{max}}{I_{min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2} = \frac{(\sqrt{9}+\sqrt{4})^2}{(\sqrt{9}-\sqrt{4})^2} = \frac{25}{1}$

15. **(b)**



$F_k = \mu_k N = 0.3 \times 50 \times 9.8 = 147\ N \quad [\because N = mg]$

16. **(a)** From Brewster's law

$\mu = \tan i_p$

$\Rightarrow \mu = \tan 60^\circ = \sqrt{3}$

Using Snell's law of refraction $\mu = \frac{\sin i}{\sin r}$

$$\Rightarrow \sin r = \frac{\sin i}{\mu} = \frac{\sin 60^\circ}{\sqrt{3}} = \frac{\sqrt{3}}{2} \times \frac{1}{\sqrt{3}}$$

$$\Rightarrow r = \sin^{-1}\left(\frac{1}{2}\right) = 30^\circ$$

17. **(b)** X rays are emitted when target metal is bombarded with high energy electron.

18. **(c)** Using, $P = \sqrt{2mE}$

Here $E_1 = E_2 \Rightarrow \frac{P_1^2}{2m_1} = \frac{P_2^2}{2m_2} \Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{25}} = \frac{2}{5}$

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

Here, q = charge inside the closed surface

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

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

20. **(c)** Radius of nucleus, $R = R_0 A^{\frac{1}{3}}$ ...(i)

Density of nucleus $= \frac{\text{Mass of nucleus}}{\text{volume of nucleus}}$

$\rho = \frac{m \times A}{\frac{4}{3}\pi R^3}$ Here m = mass of proton or neutron

from equation (i), we have

$$\rho = \frac{m \times A}{\frac{4}{3}\pi R_0^3 A} \Rightarrow \rho \propto A^0$$

Hence density of nucleus is independent of mass number.

21. **(b)** We have

$\Delta l_A = \Delta l_B$

$$\Rightarrow \frac{Fl_A}{Y_A A_1} = \frac{Fl_B}{Y_B A_2} \Rightarrow \frac{5}{\gamma_A \times 2.5 \times 10^{-5}} = \frac{6}{\gamma_B \times 3 \times 10^{-5}}$$

$$\Rightarrow \frac{Y_A}{Y_B} = \frac{15 \times 10^{-5}}{15 \times 10^{-5}} = \frac{1}{1}$$

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

$$\Rightarrow n = \frac{I}{AeV_d} = \frac{10}{5 \times 10^{-6} \times 1.6 \times 10^{-19} \times 2 \times 10^{-3}}$$

$$= 625 \times 10^{25}$$

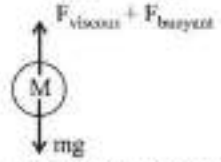
23. **(c)** Using Ampere's circuital law, magnetic field for long straight wire of circular cross-section is given by

$B = \frac{\mu_0 Ir}{2\pi a^2}$ (For $r \angle a$) $\therefore B \propto r$

For $r > a$

$B = \frac{\mu_0 I}{2\pi r} \quad \therefore B \propto \frac{1}{r}$

24. **(a)**



At terminal velocity, ball move with constant velocity

$\therefore F_{net} = 0$

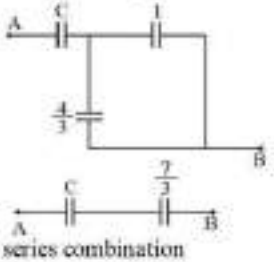
$\Rightarrow F_{viscous} + F_{buoyant} =$ Weight of ball

$\Rightarrow F_{viscous} + \rho_0 Vg = \rho Vg$

$\Rightarrow F_{viscous} = \rho Vg - \rho_0 Vg = (\rho - \rho_0)\, Vg$

$$= \rho Vg\left(1 - \frac{\rho_0}{\rho}\right) = Mg\left(1 - \frac{\rho_0}{\rho}\right)$$

25. **(a)**



For series combination

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \Rightarrow \frac{\frac{7C}{3}}{\frac{7}{3}+C} = \frac{1}{2} \Rightarrow 14C = 7 + 3C \Rightarrow C = \frac{7}{11}\mu F$$

26. **(c)** In Rutherford model, e^- revolve around the nucleus in circular path. Now, according to classical theory of electromagnetism, an accelerating charge radiates energy in form of EM waves and here motion of e^- is circular so it is also accelerated, therefore it will radiate energy and finally collapse to nucleus.

27. **(b)** Given, Height of cylinder, h=20 cm Acceleration due to gravity, $g=10\ ms^{-2}$

Velocity of efflux $v=\sqrt{2gh}$

Where h is the height of the free surface of liquid from th e hole

$\Rightarrow v=\sqrt{2\times10\times20}=20\ m/s$

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

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

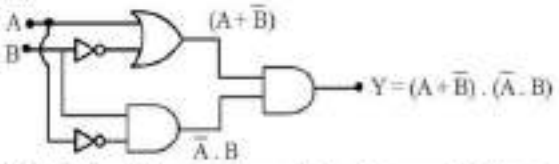
With increase in temperature, number density n increases and relaxation time τ decreases. But n is dominant over τ. Hence, resistivity (ρ) decreases.

29. **(c)** We know that

$$\frac{F}{l}=\frac{\mu_0}{2\pi}\frac{I_1I_2}{d}$$

$$\Rightarrow 2\times10^{-6}=2\times10^{-7}\times\frac{x^2}{0.2}\Rightarrow 2=x^2\Rightarrow x=\sqrt{2}=1.4$$

30. **(c)**



Substituting different values of A and B, we get following truth table

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

Hence, output is always zero.

31. **(d)**

32. **(a)** We have,

$$i=\frac{E_{net}}{R_{net}}=\frac{2E}{R+r_1+r_2}$$

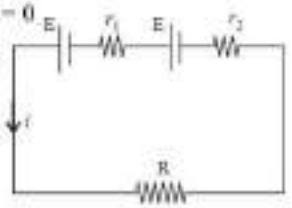
As. P.d across second cell = 0

$\Rightarrow E-ir_2=0\ [\because V=E-iR]$

$$\Rightarrow E-\frac{2Er_2}{R+r_1+r_2}=0$$

$$\Rightarrow R+r_1+r_2-2r_2=0$$

$$\Rightarrow R=r_2-r_1$$



33. **(c)** Number of moles of gas, $n=\frac{44.8}{22.4}=2$

$\Delta Q=nC_V\,\Delta T\ [\because V=\text{constant}\Rightarrow C=C_V]$

$$=2.\frac{3}{2}R\times20=60R=60\times8.3=498\ J.$$

34. **(a)** Given,

Capacitive reactance, $X_C=100\ \Omega$

Inductive reactance, $X_L=200\ \Omega$

Resistance, $R=100\ \Omega$

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

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

RMS value of current,

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

35. **(d)** We know that

$\Delta l=l_0\alpha\Delta T$

$\Rightarrow (6.241-6.230)=6.230\times1.4\times10^{-5}\times\Delta T$

$\Rightarrow 0.011=6.230\times1.4\times10^{-5}\times\Delta T$

$\Rightarrow \Delta T=126.1$

$\Rightarrow T_f-27=126.1$

$\Rightarrow T_f=153.11\ ^\circ C.$

So nearest option is (d).

PART - II (CHEMISTRY)

36. **(a)** $\bar{\upsilon}=\frac{1}{\lambda}=R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

For second line in lyman series

$n_2=3$

$$\therefore \frac{1}{\lambda}=R\left[\frac{1}{1^2}-\frac{1}{3^2}\right]=R\left[\frac{1}{1}-\frac{1}{9}\right]=\frac{8R}{9}$$

37. **(d)** In case of anions having same charge as the size of anion increases, polarisibility of anion also increases.

38. **(c)** In case of transition element, the order of filling of electrons in various orbital is $3p<4s<3d$. Thus, $3d$ orbital is filled only when $4s$ orbital gets completely filled.

39. **(b)**

	PCl_5	$\rightleftharpoons$	PCl_3	+	Cl_2
Moles at equilibrium	$\frac{1}{2}$		$\frac{1}{2}$		$\frac{1}{2}$
Mole fraction at equilibrium	$\frac{1}{3}$		$\frac{1}{3}$		$\frac{1}{3}$
Partial pressure at equilibrium	$\frac{P}{3}$		$\frac{P}{3}$		$\frac{P}{3}$

$$K_p=\frac{\frac{P}{3}\times\frac{P}{3}}{P/3}=\frac{P}{3}\Rightarrow P=3K_p$$

40. **(d)** Cannizzaro reaction is given by aldehydes having no α-hydrogen atom in the presence of conc. alkali. Aldol condensation is given by aldehydes and ketones having at least one α-atom in presence of alkali or in presence of acids.

41. **(a)** The reaction given is

$$Cr_2O_7^{2-}+Fe^{2+}+C_2O_4^{2-}\longrightarrow Cr^{3+}+Fe^{3+}+CO_2$$

$$\overset{+6}{Cr}O_7^{2-}\longrightarrow 2Cr^{3+}$$

On balancing

$14H^+ + Cr_2O_7^{2-} + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$ ....(i)

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ ....(ii)

$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$ ....(iii)

On adding all three equations, we get

$Cr_2O_7^{2-} + Fe^{2+} + C_2O_4^{2-} + 14H^+ + 3e^- \longrightarrow 2Cr^{3+} + Fe^{3+} + 2CO_2 + 7H_2O$

Hence the total no. of electrons involved in the reaction = 3

42. **(b)** For tri or higher substituted benzene derivatives, the compounds are named by identifying substituent positions on the ring by following the lowest locant rule.

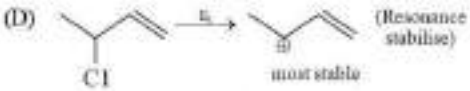
43. **(a)** E_1 reaction proceeds via carbocation formation, therefore greater the stability of carbocation, faster will be the E_1 reaction.

(A)

(B)

(C)

(D)



Thus correct decreasing order of the given halides towards dehydrohalogenation by E_1 is:

D > B > C > A

44. **(c)** Molar conductance of solution is related to specific conductance as follows :

$$\wedge_m = \kappa \times \frac{1000}{C} \quad \text{....(a)}$$

$$\wedge_m = (6.3 \times 10^{-2}\ \text{ohm}^{-1}\text{cm}^{-1}) \times \frac{1000}{(0.1\text{mol/cm}^3)}$$

$= 6.3 \times 10^{-2} \times 10^4\ \text{ohm}^{-1}\text{cm}^2\text{mol}^{-1} = 630\ \text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$

45. **(b)** Hydrazine (NH_2NH_2) does not contain carbon and hence on fusion with Na metal, it cannot form NaCN; consequently hydrazine does not show Lassaigne's test for nitrogen.

46. **(a)** Salicylic acid, because it stabilizes the corresponding salicylate ion by intramolecular H-bonding.

47. **(c)** $\Delta_r H = \Sigma\Delta_c H\,(\text{Reactant}) - \Sigma\Delta_c H\,(\text{Product})$

$= 3 \times (-1300) - (-3268) = -632\ \text{kJ mol}^{-1}$

48. **(c)** A conformation is defined as the relative arrangement of atoms or groups around a central atom, obtained by the free rotation of one part of the molecule with respect to rest of the molecule. For a complete rotation of 360°, one part may rotate through any degree say 0.1°, 0.5°, 1° etc. giving rise to infinite number of relative arrangements of group (atom) around a central atom, keeping other part fixed.

49. **(b)** The sub-shell are $3d$, $4d$, $4p$ and $5s$, $4d$ has highest energy as $n + \ell$ value is maximum for this.

50. **(d)** In BrF_5 molecule, there are 5 bond pair and one lone pair of electrons with the central atom.

51. **(a)** $H = U + PV$ (By definition)

$\Delta H = \Delta U + \Delta(PV)$ at constant pressure

$\Delta H = \Delta U + P\Delta V$

52. **(c)** Generally, non-metal oxides are acidic in nature and metal oxides are basic in nature, Al_2O_3 is amphoteric.

53. **(c)** Number of meq. of the acid = $0.04 \times 100 = 4$

Number of meq. of the base = $0.02 \times 100 = 2$

$\therefore$ Number of meq. of the acid left on mixing = $4 - 2 = 2$

Total volume of the solution = 200 mL

$\therefore$ No. of meq of the acid present in 1000 mL of the solution = 10

or No. of eq. of the acid in 1000 mL of the solution

$$= \frac{10}{1000} = 0.01$$

Since the acid is monobasic and completely ionises in solution

0.01 N HCl = 0.01 M HCl

Thus $[H^+] = 0.01$

$\therefore$ $pH = -\log(0.01) = -(-2) = 2$

54. **(d)** [A] is 

55. **(b)** Number of total ions present in the solution is known as van't Hoff factor (i).

for KCl, $i = 2$

for NaCl, $i = 2$

for K_2SO_4, $i = 3$

56. **(b)** $k = \frac{0.693}{45}\text{min}^{-1} = \frac{2.303}{t_{99.9\%}}\log\frac{a}{a - 0.999a}$ or

$$t_{99.9\%} = \frac{2.303 \times 45}{0.693}\log 10^3 = 448\ \text{min} = 7.5\ \text{hrs}$$

57. **(d)** Hardy- Schulze rule explains the factors that affect the coagulation or precipitation by an electrolyte.

58.

59. **(d)** Fluorine does not show variable oxidation state as it is the most electronegative element and shows only –1 state.

60. **(a)** $V = 3d^3 4s^2$; $V^{2+} = 3d^3 = 3$ unpaired electrons

$Cr = 3d^5 4s^1$; $Cr^{2+} = 3d^4 = 4$ unpaired electrons

$Mn = 3d^5 4s^2$; $Mn^{2+} = 3d^5 = 5$ unpaired electrons

$Fe = 3d^6 4s^2$; $Fe^{2+} = 3d^6 = 4$ unpaired electrons

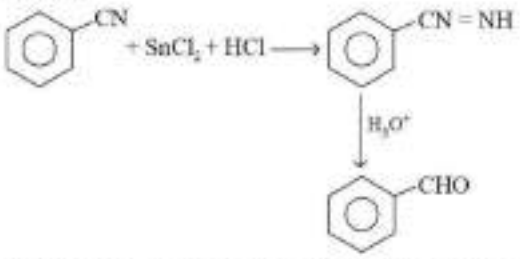
Hence the correct order of paramagnetic behaviour

$V^{2+} < Cr^{2+} = Fe^{2+} < Mn^{2+}$

61. **(d)** On going from left to right in lanthanoid series ionic, size decreases *i.e.*,
$Ce^{3+} > Tb^{3+} > Er^{3+} > Lu^{3+}$.

62. **(d)** Oxidation number of hydrogen when it is bonded to metals in binary compounds is -1.

63. **(b)**

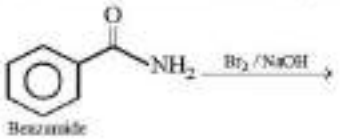


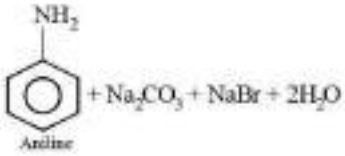
64. **(d)** All compounds are tertiary alkyl but bond formed between carbon and iodine (C — I) is weakest bond due to higher difference in size of carbon and iodine.

65. **(b)** Due to partial double bond character of C–OH bond.

66. **(d)** This reaction proceeds in the presence of anhydrous $AlCl_3$ or CuCl.

67. **(b)** Hoffmann bromamide degradation reaction:





68. **(b)** Ascorbic acid is the chemical name of vitamin C.

69. **(b)** Nylon – 6, 6 has strong intermolecular H-bonding.

70. **(c)** Pyridine (C_5H_5N:) is a neutral unidentate ligand.

PART - III (MATHEMATICS)

71. **(a)** Since, total possible subsets of sets A and B are 2^m and 2^n, respectively.
According to given condition,
$2^m - 2^n = 56$
$\Rightarrow 2^n (2^{m-n} - 1) = 2^3 \times (2^3 - 1)$
On comparing both sides, we get
$2^n = 2^3$ and $2^{m-n} = 2^3$
$\Rightarrow n = 3$ and $m - n = 3$
$\Rightarrow m = 6$ and $n = 3$
Now, $m + n = 6 + 3 = 9$

72. **(d)** $f(x) = \cos^{-1}\left(\frac{\sqrt{2x^2+1}}{x^2+1}\right)$

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

$f(x) = \sin^{-1}\left[\sin^{-1}\left(1 - \frac{1}{0+1}\right), \sin^{-1}\left(1 - \frac{1}{\infty+1}\right)\right]$

or $f(x) \in \left[0, \frac{\pi}{2}\right)$

73. **(a)** We are given that A, P, B are 3×3 matrices and $|-B| = 5$, $|BA^T| = 15$, $|P^TAP| = -27$

$\because \quad |-B| = 5 \Rightarrow |B| = (-1)^3 \times 5 \Rightarrow |B| = -5$

$\left|BA^T\right| = |B| \cdot \left|A^T\right| = -5 \times \left|A^T\right| \Rightarrow 15 = (-5)\left|A^T\right|$

$\Rightarrow \quad \left|A^T\right| = -3$

$\because \quad |P^TAP| = -27 \Rightarrow |P^T| \cdot |A| \cdot |P| = -27$

$\Rightarrow \quad |P^T| \cdot (-3)\,|P| = -27 \quad \{\because \quad |A| = |A^T|\}$

$\Rightarrow \quad (-3)\,|P|^2 = -27 \Rightarrow |P|^2 = 9 \Rightarrow \quad |P| = \pm 3$

74. **(c)** Here, $f(x)$ is continuous on R.
At $x = 0$,

$\Rightarrow f(0) = \lim_{x \to 0^+} f(x) = \lim_{x \to 0^-} f(x)$

$f(0) = \sin 0 = 0$

$\lim_{x \to 0^+} f(x) = \lim_{x \to 0^+} (x^2 + a) = a$

$\lim_{x \to 0^-} f(x) = \lim_{x \to 0^-} (\sin x) = 0 \quad [\because a = 0]$

Now, At $x = 3$,

$f(3) = \lim_{x \to 3^+} f(x) = \lim_{x \to 3^-} f(x)$

$f(3) = b(3) + 3 = 3b + 3$

$\lim_{x \to 3^+} f(x) = -3$

$3b + 3 = -3 \Rightarrow b = -2$
$a + b = 0 - 2 = -2$

75. **(c)** $f(x) = \begin{cases} 3 - x & \text{if} \quad x < -3 \\ 6 & \text{if} \quad -3 \le x \le 3 \\ 3 + x & \text{if} \quad x > 3 \end{cases}$

Firstly check continuity of $f(x)$
At $x = -3$

L.H.L. $= \lim_{h \to 0} f(-3 - h) = \lim_{h \to 0} 3 - (-3 - h) = 6$

R.H.L. $= \lim_{h \to 0} f(-3 + h) = 6$

$f(-3) = 6$
$\Rightarrow$ $f(x)$ is continuous at $x = -3$
At $x = 3$

L.H.L. $= \lim_{h \to 0} f(3 - h) = 6$

$$\text{R.H.L} = \lim_{h\to 0} f(3+h) = \lim_{h\to 0} 3+(3+h) = 6$$

$f(3) = 6$

$\Rightarrow$ $f(x)$ is continuous at $x = 3$

$\Rightarrow$ $f(x)$ is continuous everywhere

$\Rightarrow$ [illegible]

Now check differentiability of $f(x)$ at $x = -3$

L.H.D $= -1$, R.H.D $= 0$

$\Rightarrow$ $f(x)$ is not differentiable at $x = -3$

Now check differentiability of $f(x)$ at $x = 3$

L.H.D $= 0$ R.H.D $= 1$

$\Rightarrow$ $f(x)$ is not differentiable at $x = 3$

$\Rightarrow$ [illegible]

$\Rightarrow$ [illegible]

$\Rightarrow$ Option (c) is correct.

76. **(c)** Let $x = \cos^2\theta$

Now, $\dfrac{d}{dx}\left\{\sin^2\left(\cot^{-1}\sqrt{\dfrac{1+x}{1-x}}\right)\right\}$

$= \dfrac{d}{dx}\left\{\sin^2\left(\cot^{-1}\sqrt{\dfrac{1+\cos 2\theta}{1-\cos 2\theta}}\right)\right\}$

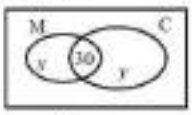
$= \dfrac{d}{dx}\{\sin^2(\cot^{-1}(\cot\theta))\}$

$= \dfrac{d}{dx}\sin^2\theta$

$= \dfrac{d}{dx}\left(\dfrac{1-\cos 2\theta}{2}\right) = \dfrac{d}{dx}\left(\dfrac{1-x}{2}\right)$

$= \dfrac{d}{dx}\left(\dfrac{1}{2} - \dfrac{x}{2}\right) = -\dfrac{1}{2}$

77. **(a)** Let the number of students who take only Math be x and only Chemistry be y.



So, from the Venn diagram, we have total number of students who take Math $= x + 30$ and take Chemistry $= y + 30$.

According to question, we have

$$30 = \frac{10}{100}(x+30)$$

$\Rightarrow$ $x = 270$ and $30 = \dfrac{12}{100}(30+y)$

$\Rightarrow$ $y = 220$

$x + y + 30 = 270 + 220 + 30 = 520.$

78. **(a)** We have given that,

$x + 2y + z = 1 \qquad x + 3y + 4z = k$

$x + 5y + 10z = k^2$

$$\therefore \quad \Delta = \begin{vmatrix} 1 & 2 & 1 \\ 1 & 3 & 4 \\ 1 & 5 & 10 \end{vmatrix}$$

$= 1(30 - 20) - 2(10 - 4) + 1(5 - 3) = 10 - 12 + 2 = 0$

$\Rightarrow \Delta = 0$

$\therefore$ Given system of equation is consistent.

Therefore, $\Delta_1 = 0$

$$\Delta_1 = \begin{vmatrix} 1 & 2 & 1 \\ k & 3 & 4 \\ k^2 & 5 & 10 \end{vmatrix} = 0$$

$1(30 - 20) - 2(10k - 4k^2) + (5k - 3k^2) = 0$

$10 - 20k + 8k^2 + 5k - 3k^2 = 0$

$5k^2 - 15k + 10 = 0 \Rightarrow k^2 - 3k + 2 = 0$

$\Rightarrow (k-2)(k-1) = 0 \Rightarrow k = 2, 1$

Hence, the real values of k i.e.

$A = 2$ and $B = 1$

$A + B = 2 + 1 = 3$

79. **(a)** Let r, l and h denote respectively the radius, slant height and height of the cone at any time t.

Then, $l^2 = r^2 + h^2$

$$\Rightarrow \quad 2l\frac{dl}{dt} = 2r\frac{dr}{dt} + 2h\frac{dh}{dt}$$

$$\Rightarrow \quad l\frac{dl}{dt} = r\frac{dr}{dt} + h\frac{dh}{dt}$$

$$\Rightarrow \quad l\frac{dl}{dt} = 7\times 3 + 24\times(-4)\text{ R}$$

$$\left[\because \frac{dh}{dt} = -4 \text{ and } \frac{dr}{dt} = 3\right]$$

$$\Rightarrow \quad l\frac{dl}{dt} = -75$$

Where $r = 7$ and $h = 24$, we have

$l^2 = 7^2 + 24^2$

$\Rightarrow \quad l = 25$

$$\therefore \quad l\frac{dl}{dt} = -75 \Rightarrow \frac{dl}{dt} = -3$$

Let S denote the lateral surface area.

Then,

$$\frac{dS}{dt} = \pi\frac{d(rl)}{dt} = \pi\left[\frac{dr}{dt}l + r\frac{dl}{dt}\right]$$

$= \pi\{3\times + 7\times(-3)\} = 54\pi \text{ cm}^2/\text{min}.$

80. **(d)** Let a right angled triangle OAB, with h hypoteneous

Let $\angle OAB = \theta$

now $OA = h\cos\theta$ and $OB = h\sin\theta$

$\Rightarrow$ Area $= \dfrac{1}{2}\times OA\times OB = \dfrac{1}{4}h^2(2\sin\theta\cos\theta) = \dfrac{1}{4}h^2\sin 2\theta$

For maximum $\theta = 45^\circ \Rightarrow \dfrac{1}{4}h^2$

81. **(a)** $I = \int_0^3 x \cdot f(x^2)\,dx$

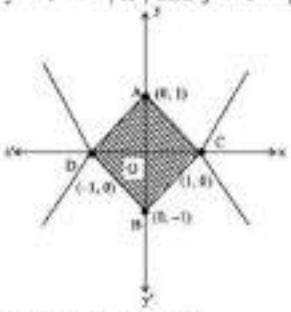
Put $x^2 = t$

$\Rightarrow \quad 2x \cdot dx = dt$

$\Rightarrow \quad I = \frac{1}{2}\int_0^9 f(t)\,dt = \frac{1}{2} \cdot 4 = 2$

82. **(c)** The given curves are

$y - 1 = -|x|$ and $y + 1 = |x|$



Here, $AC = \sqrt{1+1} = \sqrt{2}$

Area of ACBD = 4 Area of AOC

$= 4 \times \frac{1}{2} \times OA \times OC = 4 \times \frac{1}{2} \times 1 \times 1 = 2$

83. **(b)** Given vectors are $\overrightarrow{AB} = 2\hat{i} + 2\hat{j} + \hat{k}$

and $\overrightarrow{AC} = 2\hat{i} + 4\hat{j} + 4\hat{k}$

Centroid G of triangle has position vector $\overrightarrow{AG}$ can be obtained by putting A as O, B as $2\hat{i} + 2\hat{j} + \hat{k}$ and C as $2\hat{i} + 4\hat{j} + 4\hat{k}$.

So, $\overrightarrow{AG} = \frac{\vec{O} + B + C}{3} = \frac{0 + 2\hat{i} + 2\hat{j} + \hat{k} + 2\hat{i} + 4\hat{j} + 4\hat{k}}{3}$

$\overrightarrow{AG} = \frac{4\hat{i} + 6\hat{j} + 5\hat{k}}{4}$

Now, $\frac{22}{7} \times |\overrightarrow{AG}|^2 + 5 = 33 + 5 = 38$

84. **(b)** Given lines l_1, l_2 and l_3 are

$l_1 : \frac{x-2}{3} = \frac{y+1}{-2} = \frac{z-2}{0}$

$l_2 : \frac{x-1}{1} = \frac{y+\frac{3}{2}}{\frac{\alpha}{2}} = \frac{z+5}{2}$

$l_3 : \frac{x-1}{-3} = \frac{y-\frac{1}{2}}{-2} = \frac{z-0}{4}$

$l_1 \perp l_2 \Rightarrow \frac{|3 - \alpha + 0|}{\sqrt{13}\sqrt{1 + \frac{\alpha^2}{4} + 4}} = 0 \Rightarrow \alpha = 3$

angle between l_2 & l_3

$\cos\theta = \frac{\left|1 \times (-3) + (-2)\left(\frac{\alpha}{2}\right) + 2 \times 4\right|}{\sqrt{1 + 4 + \frac{\alpha^2}{4}}\sqrt{9 + 16 + 4}}$

$\cos\theta = \frac{|-3 - \alpha + 8|}{\sqrt{5 + \frac{\alpha^2}{4}}\sqrt{29}}$

put $\alpha = 3$

$\cos\theta = \frac{2}{\sqrt{\frac{29}{4}}\sqrt{29}} = \frac{4}{29}$

$\theta = \cos^{-1}\left(\frac{4}{29}\right) \Rightarrow \theta = \sec^{-1}\left(\frac{29}{4}\right)$

85. **(b)** $f(x) = \ln\left(\frac{x^2 + e}{x^2 + 1}\right) = \ln\left(\frac{x^2 + 1 - 1 + e}{x^2 + 1}\right)$

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

Clearly range is (0, 1]

86. **(b)** We have $e < \pi$ and

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

$= \frac{(e+x)\log(e+x) - (\pi + x)\log(\pi + x)}{(\pi + x)(e+x)\{\log(e+x)\}^2}$

In $[0, \infty)$, denominator > 0 and numerator < 0, since, $e + x < \pi + x$.

Hence, f(x) is decreasing in $[0, \infty)$.

87. **(c)** $\int_{-\pi}^{\pi} x^2 (\sin x)\,dx$

$x^2 (\sin x)$ is an odd function

By property of odd & even function

For $f(-x) = -f(x)$ then $\int_{-a}^{a} f(x)dx = 0$

$\Rightarrow \quad \int_{-\pi}^{\pi} x^2 (\sin x)\,dx = 0$

88. **(a)** We have $x^4 \frac{dy}{dx} + x^3 y + \text{cosec}(xy) = 0$

$\Rightarrow x^3\left[x\frac{dy}{dx} + y\right] + \text{cosec}(xy) = 0$

If $u = xy \Rightarrow \frac{du}{dx} = y + x\frac{dy}{dx}$

$\therefore$ Differential equation becomes

$x^3 \frac{du}{dx} + \text{cosec}\, u = 0 \quad \Rightarrow -\sin u\, du = x^{-3}dx$

Now, integrate of getting equation,

$\Rightarrow \int -\sin u\, du = \int x^{-3} dx$

$\Rightarrow x^{-2} + 2\cos u = c \quad \Rightarrow x^{-2} + 2\cos(xy) = c$

89. **(b)** The appearance of $\frac{x}{y}$ in the given equation

suggests the substitution $\frac{x}{y} = u$

$\Rightarrow dx = u dy + y du$

So, the given equation can be written as $(1 + 2e^u)$

$(u dy + y du) + 2e^u (1 - u) dy = 0$, which is a variable separable form.

$\Rightarrow \frac{(1 + 2e^u)}{u + 2e^u} du + \frac{dy}{y} = 0$

$\Rightarrow \int \left(\frac{1 + 2e^u}{u + 2e^u} \right) du + \int \frac{dy}{y} = 0$

$\Rightarrow \log | u + 2e^u | + \log | y | = \log | c |$

$\Rightarrow (u + 2e^u) y = c$

$\Rightarrow (x + 2ye^{x/y}) = c$; comparing with given general solution, we get $\lambda = 2$.

90. **(c)** As we know, $\sum_{i=1}^{8} P(x_i) = 1$

$0 + K + 2K + 2K + 3K + K^2 + 2K^2 + 7K^2 + K = 1$

$9K + 10K^2 = 1$

$10K^2 + 9K - 1 = 0$

$10K^2 + 10K - K - 1 = 0$

$10K(K + 1) - 1(K + 1) = 0$

$(K + 1)(10K - 1) = 0$

$\therefore \quad K = -1, \frac{1}{10}$

As the probability cannot be negative. So K must be greater than 0.

$\therefore \quad K = \frac{1}{10}$

$P(0 < x < 5) = P(X = 1) + P(X = 2) + P(X = 3) + P(X = 4)$

$= K + 2K + 2K + 3K = 8K$

$= \frac{8}{10}$

91. **(a)** Given lines are $x + y - 5 = 0$ & $x - 2y + 3z - 5 = 0$

Direction ratio of line $= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & -1 \\ 1 & -2 & 3 \end{vmatrix} = \hat{i} - 4\hat{j} - 3\hat{k}$

$=$ Equation of line: $= \frac{x-1}{1} = \frac{x-2}{-4} = \frac{x-4}{-3} = \lambda$

Distance of perpendicular from point $(1, -2, 5)$.

Point P $(1 + \lambda, 2 - 4\lambda, 4 - 3\lambda)$ and Q $(1, 2, 4)$.

$\overrightarrow{PQ} \cdot (\hat{i} - 4\hat{j} - 3\hat{k}) = 0, \ \lambda = \frac{1}{2}$.

Then, point $p\left(\frac{1}{2}, 2, \frac{-5}{2} \right)$

So, $\vec{PQ} = \sqrt{\frac{21}{2}}$

92. **(a)** $-\sqrt{2} \le \sin x + \cos x \le \sqrt{2}$

$\Rightarrow 0 \le |\sin x + \cos x| \le \sqrt{2}$

$\Rightarrow -\sqrt{2} \le 2|\sin x + \cos x| - \sqrt{2} \le \sqrt{2}$

93. **(d)** Given, $I = \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{x + \frac{\pi}{4}}{2 - \cos 2x} dx$

$I = \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{x}{2 - \cos 2x} dx + \frac{\pi}{4} \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{1}{2 - \cos 2x} dx$

Let, $I_1 = \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{x}{2 - \cos 2x} dx$

$\because f(-x) = \frac{-x}{2 - \cos 2(-x)}$

$= \frac{-x}{2 - \cos 2x} = -f(x)$

$f(x)$ is an odd function. Thus, $I_1 = 0$

Let $I_1 = \frac{\pi}{4} \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{1}{2 - \cos 2x} dx$

$g(-x) = \frac{\pi}{4(2 - \cos 2(-x))}$

$= \frac{\pi}{4(2 - \cos 2x)} = g(x)$

$\therefore \quad g(x)$ is an even function

Thus, $I_2 = 2 \times \frac{\pi}{4} \int_0^{\frac{\pi}{4}} \frac{dx}{2 - \cos 2x}$

Now, $I = I_2 = \frac{\pi}{4} \int_0^{\frac{\pi}{4}} \frac{dx}{2 - \frac{1 - \tan^2 x}{1 + \tan^2 x}}$

$I = \frac{\pi}{4} \int_0^{\frac{\pi}{4}} \frac{\sec^2 x}{1 + 3\tan^2 x} dx$

Put $\tan x = t \Rightarrow \sec^2 x \, dx = dt$

$\Rightarrow \quad I = \frac{\pi}{4} \int_0^1 \frac{dt}{1 + 3t^2} = \frac{\pi}{2} \times \frac{1}{\sqrt{3}} \left| \tan^{-1} \sqrt{3} t \right|_0^1$

$I = \frac{\pi}{2\sqrt{3}} \left| \tan^{-1}\left(\sqrt{3}\right) - \tan^{-1}(0) \right| = \frac{\pi^2}{6\sqrt{3}}$

94. **(d)** Given that A and B are independent events.

$\therefore \quad P(A \cap B) = P(A) \cdot P(B)$

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A) \cdot P(B)}{P(B)} = P(A) \qquad ...(i)$$

And $$P(B|A) = \frac{P(B \cap A)}{P(A)} = \frac{P(B) \cdot P(A)}{P(A)} = P(B)$$

$$P(A|B^c) = \frac{P(A \cap B^c)}{P(B^c)} = \frac{P(A) - P(A \cap B)}{P(B^c)}$$

$$= \frac{P(A) - P(A) \cdot P(B)}{P(B^c)} = \frac{P(A)[1 - P(B)]}{P(B^c)}$$

$$P(A|B^c) = \frac{P(A) \cdot P(B^c)}{P(B^c)} = P(A) \qquad ...(ii)$$

From eqns. (i) and (ii)

$P(A|B) = P(A|B^c)$

95. **(b)** Equation of tangent of parabola $y = x^2$ be

$tx = y + at^2$ ...(i)

$$y = tx - \frac{t^2}{4}$$

Solve with $y = -(x-2)^2$

$$tx - \frac{t^2}{4} = -(x-2)^2$$

$$x^2 + x(t-4) - \frac{t^2}{4} + 4 = 0$$

Here, Discriminant = 0.

$$(t-4)^2 - 4 \cdot \left(4 - \frac{t^2}{4}\right) = 0 \Rightarrow t^2 - 4t = 0 \Rightarrow t = 0 \text{ or } t = 4$$

Put value of t in eq. (i), then $y = 4(x-1)$.

96. **(d)** We know that $\sim(p \to q) = p \wedge \sim q$

$\therefore \sim((p \wedge r) \to (r \vee q)) = (p \wedge r) \wedge [\sim(r \vee q)]$

$= (p \wedge r) \wedge (\sim r \wedge \sim q)$

97. **(b)** The letters other than vowels are: PRMTTN

Number of permutations with no two vowels together is

$$\frac{6!}{2!} \times {}^7C_5 \times 5!$$

Further among these permutations the number of cases in which T's are together is $5! \times {}^6C_5 \times 5!$

So the required number

$$= \frac{6!}{2!} {}^7C_5 \times 5! - 5! \times {}^6C_5 \times 5! = 57 \times (5!)^2$$

98. **(c)** Given expression is

$(1+x)^{101}(1-x+x)^{100}$

$= (1+x)[(1+x)(1-x+x^2)]^{100}$

$= (1+x)(1+x^3)^{100}$

= coefficient of x^{50} in $(1+x)(1+x^3)^{100}$

= coefficient of x^{50} in $(1+x^3)^{100}$

+ coefficient of x^{49} in $(1+x^3)^{100}$

In the expansion of $(1+x^3)^{100}$

Since 50 and 49 are not multiple of 3.

So, coefficient of x^{50} and 49 in the expansion of $(1+x^3)^{100}$ is 0.

Coefficient of x^{50} in

$(1+x)^{100}(1-x+x^2)]^{101}$ is 0.

99. **(b)** $1/(q+r), 1/(r+p), 1/(p+q)$ are in A.P.

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

$\Rightarrow q^2 - p^2 = r^2 - q^2 \Rightarrow p^2, q^2, r^2$ are in A.P.

100. **(b)** Let the coordinates of foot of perpendicular from the point P (2, 3) (say) on line $y = 3x + 4$ be A (α, β).

Slope of AP, $m_1 = \frac{\beta - 3}{\alpha - 2}$

Slope of given line, $m_2 = 3$

Since, both are perpendicular.

$\therefore \quad m_1 \times m_2 = -1$

$$\Rightarrow \frac{\beta - 3}{\alpha - 2} \times 3 = -1$$

$\Rightarrow 3\beta = -\alpha + 11$ ...(i)

Also, the point A (α, β) is on the given line.

So, A (α, β) satisfy the equation of the line.

$\therefore \quad \beta = 3\alpha + 4$ ...(ii)

On solving (i) and (ii), we get

$$\alpha = -\frac{1}{10}, \beta = \frac{37}{10}$$

So, coordinates of foot of perpendicular are $\left(\frac{-1}{10}, \frac{37}{10}\right)$.

101. **(a)** The given situation is possible with the 2 circles.

Considering centre at C_1, then x-intercept

= PQ = 6

y-intercept = 0

for $x^2 + y^2 + 2gx + 2fy + c = 0$ ... (i)

x-intercept $= 2\sqrt{g^2 - c} = 6$, $g^2 - c = 9$

y-intercept $= 2\sqrt{f^2 - c} = 0$, $f^2 = c$

PB = 1/2 PQ = 3

$OA = C_1B = 4$

In ΔPC_1B

$PC_1 = = \sqrt{C_1B^2 + PB^2} = \sqrt{3^2 + 4^2}$

$PC_1 = 5$

radius $= \sqrt{g^2 + f^2 - c} = 5$

$g^2 + f^2 - c = 25$

$f^2 = c$, $g^2 = 25 \Rightarrow g = \pm 5$

$g^2 - c = 9$

$f^2 + 9 = 25$, $f = \pm 4$

and $c = f^2 = 16$

Equation of circle is

$x^2 + y^2 \pm 10x \pm 8y + 16 = 0$

In given option correct is

$x^2 + y^2 \pm 10x - 8y + 16 = 0$

102. (b) Here, the mid-point of AC is

$\left(\frac{4+2}{2}, \frac{-2-5}{2}, \frac{1+10}{2}\right) = \left(3, -\frac{7}{2}, \frac{11}{2}\right)$ and that of BD is

$\left(\frac{7-1}{2}, \frac{-4-3}{2}, \frac{7+4}{2}\right) = \left(3, -\frac{7}{2}, \frac{11}{2}\right)$.

So, the diagonals AC and BD bisect each other.

$\Rightarrow$ ABCD is a parallelogram.

As $|AB| = \sqrt{3^2 + 2^2 + 6^2} = 7$ and

$|AD| = \sqrt{5^2 + 1^2 + 3^2} = \sqrt{35} \neq |AB|$.

Therefore, ABCD is not a rhombus and naturally, it cannot be a square.

103. (b) $A + B + C + D = 2\pi$

$\therefore \quad A + B = 2\pi - (C + D)$

$\therefore \quad \tan(A + B) = \tan[2\pi - (C + D)]$

$= -\tan(C + D)$

$\Rightarrow \quad \frac{\tan A + \tan B}{1 - \tan A \tan B} = -\frac{\tan C + \tan D}{1 - \tan C \tan D}$

$\Rightarrow$ (tan A + tan B) (1 − tan C tan D)

= − (1 − tan A tan B) (tan C + tan D)

$\Rightarrow$ tanA + tanB − tan A tan C tan D − tan B tan C tan D = − [(tan C + tan D − tan A tan B tan C − tan A tan B tan D)]

$\Rightarrow$ tan A + tan B + tan C + tan D

= tan A tan B tan C + tan A tan C tan D + tan A tan B tan D + tan B tan C tan D

Dividing both sides by tan A tan B tan C tan D, we get

$\frac{\tan A + \tan B + \tan C + \tan D}{\tan A \tan B \tan C \tan D}$

$= \frac{1}{\tan D} + \frac{1}{\tan B} + \frac{1}{\tan C} + \frac{1}{\tan A}$

= cot D + cot B + cot C + cot A

$\Rightarrow \quad \frac{\sin A + \tan B + \tan C + \tan D}{\cot A + \cot B + \cot C + \cot D}$

= tan A tan B tan C tan D.

104. (d) Let $\omega = x + iy$

If $\frac{\omega - \bar{\omega}z}{1 - z}$ is real, then $\frac{x + iy - (x - iy)z}{1 - z}$ is real

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

$\Rightarrow z = -1 \because y \neq 0$ and $1 - z \neq 0 \ \therefore |z| = 1$.

105. (a) Since, roots are equal

$\therefore \ \{2(bc + ad)\}^2 = 4(a^2 + b^2)(c^2 + d^2)$

$\Rightarrow 4b^2c^2 + 4a^2d^2 + 8abcd = 4a^2c^2 + 4a^2d^2 + 4b^2c^2 + 4b^2d^2$

$\Rightarrow 4a^2d^2 + 4b^2c^2 - 8abcd = 0$

$\Rightarrow 4(ad - bc)^2 = 0$

$\Rightarrow ad = bc \quad \Rightarrow \frac{a}{b} = \frac{c}{d}$

106. (d) $L = \lim_{x \to 0} \frac{35^x - 7^x - 5^x + 1}{(e^x - e^{-x}) \ln(1 - 3x)}$

$= \lim_{x \to 0} \frac{(1 - 7^x)(1 - 5^x)e^x}{(e^{2x} - 1) \ln(1 - 3x)}$

$L = \frac{(\ln 5)(\ln 7)}{-6}$

107. (c) $z_r = \cos\frac{r\alpha}{n^2} + i\sin\frac{r\alpha}{n^2} \quad z_1 = \cos\frac{\alpha}{n^2} + i\sin\frac{\alpha}{n^2}$;

$z_2 = \cos\frac{2\alpha}{n^2} + i\sin\frac{2\alpha}{n^2}$;... $\Rightarrow z_n = \cos\frac{n\alpha}{n^2} + i\sin\frac{n\alpha}{n^2}$

consider $\lim_{n \to \infty}(z_1 z_2 z_3 \ldots\ldots z_n)$

$= \lim_{n \to \infty}\left[\cos\left\{\frac{\alpha}{n^2}(1 + 2 + 3 + \ldots + n)\right\} + i\sin\left\{\frac{\alpha}{n^2}(1 + 2 + 3 + \ldots + n)\right\}\right]$

$= \lim_{n \to \infty}\left[\cos\left\{\frac{\alpha n(n+1)}{2n^2}\right\} + i\sin\left\{\frac{\alpha n(n+1)}{2n^2}\right\}\right]$

$= \lim_{n \to \infty}\left[\cos\left\{\frac{\alpha\left(1 + \frac{1}{n}\right)}{2}\right\} + i\sin\left\{\frac{\alpha\left(1 + \frac{1}{n}\right)}{2}\right\}\right]$

$= \cos\frac{\alpha}{2} + i\sin\frac{\alpha}{2} = e^{\frac{i\alpha}{2}}$

108. (b) Since, $f(x)$ is a polynomial function satisfying

$f(x) \cdot f\left(\frac{1}{x}\right) = f(x) + f\left(\frac{1}{x}\right)$,

$\therefore f(x) = x^n + 1$ or $f(x) = -x^n + 1$

If $f(x) = -x^n + 1$, then $f(4) = -4^n + 1 \neq 65$

So, $f(x) = x^n + 1$ Since, $f(4) = 65 \ \therefore 4^n + 1 = 65$

$\Rightarrow n = 3 \ \therefore f(x) = x^3 + 1 \Rightarrow f'(x) = 3x^2$

$\therefore f'(l_1) = 3l_1^2, \ f'(l_2) = 3l_2^2, \ f'(l_3) = 3l_3^2$

Since, l_1, l_2, l_3 are in GP.

$\therefore f'(l_1), \ f'(l_2), \ f'(l_3)$ are also in GP.

109. (b) Total no. of students in four schools

= 12 + 20 + 13 + 17 = 62.

Now, one student is selected at random.
$\therefore$ Total outcomes $= {}^{62}C_1$
Now, no. of students in school $B_2 = 20$.
No. of ways to select a student from $B_2 = {}^{20}C_1$.

$\therefore$ Required probability $= \dfrac{{}^{20}C_1}{{}^{62}C_1} = \dfrac{20}{62} = \dfrac{10}{31}$

110. (a) $x \in R \Rightarrow x - x + \sqrt{5} = \sqrt{5}$ is an irrational number.

$\therefore (x, x) \in R$

So, R is reflexive.

$(\sqrt{5}, 1) \in R$ because $\sqrt{5} - 1 + \sqrt{5} = 2\sqrt{5} - 1$

which is an irrational number.

But $(1, \sqrt{5}) \notin R$

$\therefore R$ is not symmetric.

We have, $(\sqrt{5}, 1), (1, 2\sqrt{5}) \in R$ because

$\sqrt{5} - 1 + \sqrt{5} = 2\sqrt{5} - 1$

If $1 - 2\sqrt{5} + \sqrt{5} = 1 - \sqrt{5}$ are irrational numbers.

Also, $(\sqrt{5}, 2\sqrt{5}) \in R$ and $\sqrt{5} - 2\sqrt{5} + \sqrt{5} = 0$

which is not an irrational numbers.

$\therefore (\sqrt{5}, 2\sqrt{5}) \notin R$

So, R is not transitive.

PART - IV (APTITUDE TEST)

111. (b) On two items, savings and house rent, he has to invest more than Rs 1000.

112. (d) Savings per month = 6000 × 23% = Rs 1380
Annual savings = 1380 × 12 = Rs 16,560

113. (c) 10% = 500 $\Rightarrow$ 100% = Rs. 5000

114. (d)

N	A	T	I	O	N
4	6	7	2	3	4

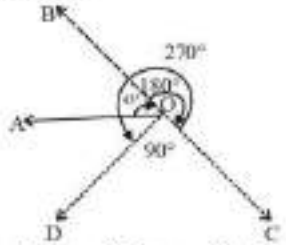
E	A	R	N
1	6	5	4

A	T	T	E	N	T	I	O	N
6	7	7	1	4	7	2	3	4

115. (d) 3 + 6 = 9

116. (d) Clearly, the man initially faces in the direction OA. On moving 45° clockwise, he faces in the direction OB. On further moving 180° clockwise, he faces in the direction OC. Finally, on moving 270° anticlockwise, he faces in the direction OD, which is South-west.

Hence, the answer is (d)



117. (d) Without knowing the sex of C, we can't be determined whether B is sister of C or B is brother of C. Similarly without knowing the sex of B we can't be determined whether C is sister of B or C is brother of B. Therefore, both (i) and (ii) are necessary.

118. (a) Manav's rank from the top = 15 – 4 = 11th.
Manav's rank from the bottom
= 20 + 1 – 11 = 10th

119. (d) Some pens are books.
Some books are pens. (conversion) (I-type)

All pens are keys. (A-type)
Some books are keys.
(I + A = I-type conclusion)
Some keys are books.
(Conversion)
$\therefore$ II follows.
Some pens are books. (I-type)

All books are ledgers. (A-type)
Some pens are ledgers.
(I + A = I-type)
Some ledgers are pens. (conversion) (I-type)

All pens are keys. (A-type)
Some ledgers are keys.
(I + A = I-type)
$\therefore$ I follows.

120. (a) Year 2016 'was a leap year'.
$\therefore$ Number of days in 2016 = 366.
= 52 weeks + 2 odd days
Now, 1st January 2016 was Friday
So, 30th December, 2016 was also Friday.
Hence, 31th December, 2016 was Saturday.

PART - V (ENGLISH)

121. (b) The phrase 'on tenterhooks' means a state of suspense or agitation because of uncertainity about a future event.

122. (d) The passage clearly shows that money alone can't give happiness.

123. (a) All these three points given in the option are discussed in the passage.

124. (c) 'Contentment, the key of happiness' suits the best as the title of the passage.

125. (c) This fact is clearly mentioned in the passage.