BITSAT 2010 Question Paper

INSTRUCTIONS

- *This question paper contains total 150 questions divided into four parts:*

  Part I : Physics Q. No. 1 to 40

  Part II : Chemistry Q. No. 41 to 80

  Part III : Mathematics Q. No. 81 to 125

  Part IV : (A) English Proficiency Q. No. 126 to 140

  (B) Logical Reasoning Q. No. 141 to 150
- *All questions are multiple choice questions with four options, only one of them is correct.*
- *Each correct answer awarded 3 marks and –1 for each incorrect answer.*
- *Duration of paper 3 Hours*

PART - I : PHYSICS

1. If P represents radiation pressure, c represents speed of light and Q represents radiation energy striking a unit area per second, the non-zero integers x,y and z such that $P^xQ^yc^z$ is dimensionless, are.

(a) $x=1, y=1, z=-1$ (b) $x=1, y=-1, z=1$

(c) $x=-1, y=1, z=1$ (d) $x=1, y=1, z=1$

2. The position x of a particle varies with time (t) as $x = A t^2 - B t^3$. The acceleration at time t of the particle will be equal to zero. What is the value of t?

(a) $\frac{2A}{3B}$ (b) $\frac{A}{B}$ (c) $\frac{A}{3B}$ (d) zero

3. Two projectiles A and B are thrown with the same speed but angles are 40° and 50° with the horizontal. Then

(a) A will fall earlier

(b) B will fall earlier

(c) both will fall at the same time

(d) None of these

4. A body is travelling in a circle at a constant speed. It

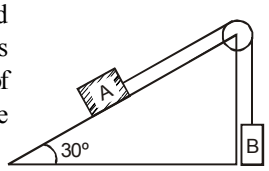
(a) has a constant velocity

(b) is not accelerated

(c) has an inward radial acceleration

(d) has an outward radial acceleration

5. Two blocks are connected over a massless pulley as shown in fig. The mass of block A is 10 kg and the coefficient of kinetic friction is 0.2. Block A slides down the incline at constant speed. The mass of block B in kg is:



(a) 3.5 (b) 3.3 (c) 3.0 (d) 2.5

6. A spring is compressed between two toy carts of mass m_1 and m_2. When the toy carts are released, the springs exert equal and opposite average forces for the same time on each toy cart. If v_1 and v_2 are the velocities of the toy carts and there is no friction between the toy carts and the ground, then :

(a) $v_1/v_2 = m_1/m_2$ (b) $v_1/v_2 = m_2/m_1$

(c) $v_1/v_2 = -m_2/m_1$ (d) $v_1/v_2 = -m_1/m_2$

7. The potential energy for a force field $\vec{F}$ is given by U (x,y) = cos (x + y). The force acting on a particle at position given by coordinates $(0, \pi/4)$ is –

(a) $-\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ (b) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$

(c) $\left(\frac{1}{2}\hat{i}+\frac{\sqrt{3}}{2}\hat{j}\right)$ (d) $\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{2}\hat{j}\right)$

8. A long string is stretched by 2 cm and the potential energy is V. If the spring is stretched by 10 cm, its potential energy will be

(a) V/25 (b) V/5 (c) 5V (d) 25V

9. The ratio of the accelerations for a solid sphere (mass 'm' and radius 'R') rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is :

(a) 5 : 7 (b) 2 : 3 (c) 2 : 5 (d) 7 : 5

10. A system consists of three particles, each of mass m and located at (1, 1), (2, 2) and (3, 3). The co-ordinates of the centre of mass are

(a) (1, 1) (b) (2, 2) (c) (3, 3) (d) (6, 6)

11. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

(a) R^n (b) $R^{\left(\frac{n-1}{2}\right)}$ (c) $R^{\left(\frac{n+1}{2}\right)}$ (d) $R^{\left(\frac{n-2}{2}\right)}$

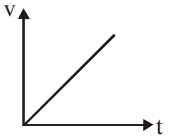
12. Two planets A and B have the same material density. If the radius of A is twice that of B, then the ratio of the escape velocity v_A/v_B is

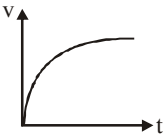
(a) 2 (b) $\sqrt{2}$ (c) $1/\sqrt{2}$ (d) 1/2

13. The upper end of a wire of diameter 12mm and length 1m is clamped and its other end is twisted through an angle of 30°. The angle of shear is

(a) 18° (b) 0.18° (c) 36° (d) 0.36°

14. A spherical ball is dropped in a long column of a viscous liquid. The speed (v) of the ball as a function of time (t) may be best represented by

(a) 

(b) 

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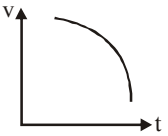
(d) 

15. Two mercury drops (each of radius r) merge to form a bigger drop. The surface energy of the bigger drop, if T is the surface tension, is

(a) $2^{5/3}\pi r^2T$ (b) $4\pi r^2T$

(c) $2\pi r^2T$ (d) $2^{8/3}\pi r^2T$

16. Two circular plates of radius 5 cm each, have a 0.01 mm thick water film between them. Then what will be the force required to separate these plate (S.T. of water = 73 dyne/cm) ?

(a) 125 N (b) 95 N (c) 115 N (d) 105 N

17. One kilogram of ice at 0°C is mixed with one kilogram of water at 80°C. The final temperature of the mixture is (Take specific heat of water = 4200 kJ/kg-°C, Latent heat of ice = 336 kJ/kg)

(a) 0°C (b) 40°C (c) 50°C (d) 60°C

18. In the equation PV^γ = constant, the value of γ is unity. Then the process is

(a) isothermal (b) adiabatic

(c) isobaric (d) irreversible

19. An ideal refrigerator has a freezer at a temperature of 13°C. The coefficient of performance of the engine is 5. The temperature of the air (to which heat is rejected) is

(a) 320°C (b) 39°C (c) 325 K (d) 325°C

20. 3 moles of an ideal gas at a temperature of 27°C are mixed with 2 moles of an ideal gas at a temperature 227°C, determine the equilibrium temperature of the mixture, assuming no loss of energy.

(a) 327°C (b) 107°C (c) 318°C (d) 410°C

21. A simple pendulum has time period 't'. Its time period in a lift which is moving upwards with acceleration 3 ms^{-2} is

(a) $t\sqrt{\frac{9.8}{12.8}}$ (b) $t\sqrt{\frac{12.8}{9.8}}$ (c) $t\sqrt{\frac{9.8}{6.8}}$ (d) $t\sqrt{\frac{6.8}{9.8}}$

22. A wave $y = a\sin(\omega t - kx)$ on a string meets with another wave producing a node at x = 0. Then the equation of the unknown wave is

(a) $y = a\sin(\omega t + kx)$ (b) $y = -a\sin(\omega t + kx)$

(c) $y = a\sin(\omega t - kx)$ (d) $y = -a\sin(\omega t - kx)$

23. A source of sound produces waves of wavelength 60 cm when it is stationary. If the speed of sound in air is 320 m s^{-1} and source moves with speed 20 m s^{-1}, the wavelength of sound in the forward direction will be nearest to

(a) 56 cm (b) 60 cm (c) 64 cm (d) 68 cm

24. A charge +q is at a distance L/2 above a square of side L. Then what is the flux linked with the surface?

(a) $\frac{q}{4\varepsilon_0}$ (b) $\frac{2q}{3\varepsilon_0}$ (c) $\frac{q}{6\varepsilon_0}$ (d) $\frac{6q}{\varepsilon_0}$

25. Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} *C* and 5×10^{-2} *C*, respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is

(a) 2×10^{-2} *C* (b) 3×10^{-2} *C*

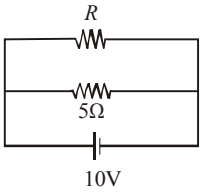
(c) 4×10^{-2} *C* (d) 1×10^{-2} *C*

26. In a region, the potential is represented by $V(x, y, z) = 6x - 8xy - 8y + 6yz$, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is :

(a) $6\sqrt{5}$ N (b) 30 N

(c) 24 N (d) $4\sqrt{35}$ N

27. The power dissipated in the circuit shown in the figure is 30 Watts. The value of *R* is



(a) 20 Ω (b) 15 Ω (c) 10 Ω (d) 30 Ω

28. Which of the following quantities do not change when a resistor connected to a battery is heated due to the current?

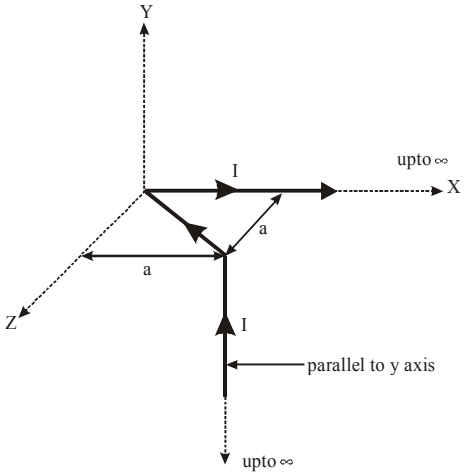
(a) Drift speed

(b) Resistivity

(c) Resistance

(d) Number of free electrons

29. The magnetic field at the origin due to the current flowing in the wire is –



(a) $-\frac{\mu_0 I}{8\pi a}(\hat{i}+\hat{k})$ (b) $\frac{\mu_0 I}{2\pi a}(\hat{i}+\hat{k})$

(c) $\frac{\mu_0 I}{8\pi a}(-\hat{i}+\hat{k})$ (d) $\frac{\mu_0 I}{4\pi a\sqrt{2}}(\hat{i}-\hat{k})$

30. The back emf induced in a coil, when current changes from 1 ampere to zero in one milli-second, is 4 volts, the self inductance of the coil is

(a) 1 henry (b) 4 henry

(c) 10^{-3} henry (d) 4×10^{-3} henry

31. Two solenoids of same cross-sectional area have their lengths and number of turns in ratio of 1 : 2. The ratio of self-inductance of two solenoids is

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 1 : 4

32. An alternating voltage $V = V_0 \sin \omega t$ is applied across a circuit. As a result, a current $I = I_0 \sin(\omega t - \pi/2)$ flows in it. The power consumed per cycle is

(a) zero (b) $0.5\, V_0 I_0$

(c) $0.707\, V_0 I_0$ (d) $1.414\, V_0 I_0$

33. A resistance R and inductance L and a capacitor C all are connected in series with an AC supply. The resistance of R is 16 ohm and for a given frequency, the inductive reactance of L is 24 ohm and capacitive reactance of C is 12 ohm. If the current in the circuit is 5 amp., find the potential difference across R, L and C.

(a) 30, 20, 50 volt (b) 40, 100, 60 volt

(c) 70, 110, 60 volt (d) 80, 120, 60 volt

34. The diameter of the objective of a telescope is a, its magnifying power is m and wavelength of light is λ, The resolving power of the telescope is:

(a) $(1.22\lambda)/a$ (b) $(1.22\, a)/\lambda$

(c) $\lambda m/(1.22\, a)$ (d) $a/(1.22\lambda)$

35. The photoelectric threshold of metal is 2000Å. The energy of the electrons ejected from the surface by ultraviolet light of wavelength 1500Å is

(a) 2.0 eV (b) 1.5 eV (c) 15 eV (d) 150 eV

36. A material particle with a rest mass m_0 is moving with a velocity of light c. Then the wavelength of the de Broglie wave associated with it is :

(a) $(h/m_0 c)$ (b) zero

(c) ∞ (d) $(m_0 c/h)$

37. Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975$ Å. Number of spectral lines in the resulting spectrum emitted will be

(a) 3 (b) 2 (c) 6 (d) 10

38. Which of the following is best nuclear fuel

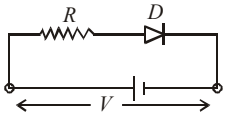
(a) thorium 236 (b) plutonium 239

(c) uranium 236 (d) neptunium 239

39. A transistor has a base current of 1 mA and emitter current 90 mA. The collector current will

(a) 90 mA (b) 1 mA (c) 89 mA (d) 91 mA

40. A d.c. battery of V volt is connected to a series combination of a resistor R and an ideal diode D as shown in the figure below. The potential difference across R will be



(a) $2V$ when diode is forward biased
(b) Zero when diode is forward biased
(c) V when diode is reverse biased
(d) V when diode is forward biased

PART - II : CHEMISTRY

41. The vapour density of ozone is
(a) 16 (b) 32 (c) 24 (d) 48

42. In redox reaction 1 g-eq of reducing agent requires P gm-eq. of oxidising agent. The value of P is
(a) 1 (b) 2
(c) 3
(d) Depends on reaction

43. Chloride ion and potassium ion are isoelectronic. Then :
(a) Their sizes are same
(b) Cl^- ion is bigger than K^+ ion
(c) K^+ ion is relatively bigger
(d) Their sizes depend on other cation and anion

44. Which of the following pairs has both members from the same period of periodic table :
(a) Na, Ca (b) Na, Cl
(c) Ca, Cl (d) Cl, Br

45. In the periodic table, with the increase in atomic number, the metallic character of an element
(a) decreases in a period and increases in a group
(b) increases in a period and decreases in a group
(c) increases both in a period and the group
(d) decreases in a period and the group

46. Which of the following statements is/are true?
1. PH_5 and $BiCl_5$ do not exist.
2. $p\pi - d\pi$ bond is present in SO_2.
3. I_3^+ has bent geometry.
4. SeF_4 and CH_4 have same shape.
(a) 1, 2, 3 (b) 1, 3 (c) 1, 3, 4 (d) 1, 2, 4

47. When the temperature is raised, the viscosity of liquid decreases this is because
(a) decreased volume of the solution.
(b) increased attraction between molecules.
(c) decreased covalent and hydrogen bond forces.
(d) increase in temperature increase the average kinetic energy of molecules which overcomes the attractive force between them.

48. At a constant volume the specific heat of a gas is 0.075 and its molecular weight is 40. The gas is:
(a) Monoatomic (b) Diatomic
(c) Triatomic (d) None of these

49. Which of these is least likely to act as Lewis base?
(a) F^- (b) BF_3 (c) PF_3 (d) CO

50. The K_{sp} of CuS, Ag_2S and HgS are 10^{-31}, 10^{-44} and 10^{-54} respectively. The solubility of these sulphides are in the order :
(a) $Ag_2S > CuS > HgS$
(b) $AgS > HgS > CuS$
(c) $HgS > Ag_2S > CuS$
(d) $CuS > Ag_2S > HgS$

51. In which of the following reactions, H_2O_2 is acting as a reducing agent?
(a) $H_2O_2 + SO_2 \rightarrow H_2SO_4$
(b) $2KI + H_2O_2 \rightarrow 2KOH + I_2$
(c) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$
(d) $Ag_2O + H_2O_2 \rightarrow 2Ag + H_2O + O_2$

52. Sodium peroxide in contact with moist air turns white due to formation of :
(a) Na_2CO_3 (b) Na_2O
(c) NaOH (d) $NaHCO_3$

53. Which of the following is similar to graphite
(a) B (b) BN (c) B_2H_6 (d) B_4C

54. The number of geometrical isomers of $CH_3-CH=CH-CH=CH-CH=CHCl$ is
(a) 2 (b) 4 (c) 6 (d) 8

55. According to IUPAC system, the correct name of the compound having the formula

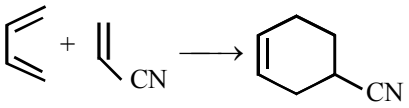
$$CH_3-\underset{\underset{CH_2}{\|}}{C}-CH_2-\underset{\underset{CH_3}{|}}{CH_2}$$

(a) 2-ethyl-3-methyl but-1-ene
(b) 2-methyl pent-3-ene
(c) 2-methyl but-1-ene
(d) None of these

56. Liebig's method is used for the estimation of
(a) Nitrogen
(b) Sulphur
(c) Carbon and hydrogen
(d) Halogens

57. Hyperconjugation involves
(a) $\sigma - \pi$ conjugation
(b) $\sigma - \pi$ delocalisation
(c) No bond resonance
(d) All

58. Name of following reaction is



(a) Claisen Condensation
(b) Diel's Alder reaction
(c) Dieckmann cyclisation
(d) Michael addition reaction

59. The unsaturated hydrocarbon which on ozonolysis gives one mole each of formaldehyde, acetaldehyde and methyl glyoxal (CH_3COCHO) is
(a) $CH_3 - CH = C(CH_3) - CH_3$
(b) $CH_2 = CH - CH_2 - CH = CH_2$
(c) $CH_2 = CH - C(CH_3) = CH - CH_3$
(d) $(CH_3)_2C = CH - CH_3$

60. Minamata disease is due to pollution of
(a) aresenic into the atmosphere
(b) organic waste into drinking water
(c) oil spill in water
(d) industrial waste mercury into fishing water

61. Phosphate pollution is caused by:
(a) Sewage and agricultural fertilizers.
(b) Weathering of phosphate rocks only.
(c) Agriculutral fertilizers only.
(d) Phosphate rocks and sewage.

62. Eutrophication causes reduction in
(a) Dissolved oxygen (b) Nutrients
(c) Dissolved salts (d) All of these

63. Coolant used in car radiator is aqueous solution of ethylene glycol. In order to prevent the solution from freezing at – 0.3°C. How much ethylene glycol must be added to 5 kg of water ? ($K_f = 1.86\ K\ Kg\ mol^{-1}$)
(a) 50 g (b) 55 g (c) 45 g (d) 40 g

64. Which of the following will form the cathode with respect to iron anode in an electrolyte cell?
(a) Mg (b) Al (c) Cu (d) Zn

65. The activation energy for a simple chemical reaction $A \rightarrow B$ is E_a in forward direction. The activation energy for reverse reaction
(a) is always less than E_a
(b) can be less than or more than E_a
(c) is always double of E_a
(d) is negative of E_a

66. The following data are for the decomposition of ammonium nitrite in aqueous solution :

Vol. of N_2 in cc	Time (min)
6.25	10
9.00	15
11.40	20
13.65	25
35.65	Infinity

The order of reaction is :
(a) Zero (b) One
(c) Two (d) Three

67. Which liberates ammonia when treated with water?
(a) Li_3N (b) Mg_3N_2
(c) $CaCN_2$ (d) All

68. The correct order of reactivity of halogens with alkalies is
(a) F > Cl > Br > I (b) F < Cl > Br < I
(c) F < Cl < Br < I (d) F < Cl < Br > I

69. In the manufacture of iron from haematite, limestone is added to act as :
(a) Flux (b) Slag
(c) A reducing agent (d) An oxidizing agent

70. Which of the following has square planar geometry?
(a) $[PtCl_4]^{2-}$ (b) $[NiCl_4]^{2-}$
(c) $[ZnCl_4]^{2-}$ (d) $[CoCl_4]^{2-}$

71. In which of the following conversions, phosphorus pentachloride is used as the reagent?
(a) $H_2C = CH_2 \longrightarrow CH_3CH_2Cl$
(b) $CH_3CH_2OH \longrightarrow CH_3CH_2Cl$
(c) $H_3C - O - CH_3 \longrightarrow CH_3Cl$
(d) $CH \equiv CH \longrightarrow CH_2 = CHCl$

72. Match List I (Reaction) with List II (Reagent) and select the correct answer using the codes given below the lists :

	List I		**List II**
I.	Etard reaction	A.	Alcoholic KOH
II.	Hydroxylation	B.	Anhydrous $AlCl_3$
III.	Dehydro-halogenation	C.	Chromyl chloride
IV.	Friedel-Crafts reaction	D.	Dilute alkaline $KMnO_4$

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

73. Which of the following will **not** form a yellow precipitate on heating with an alkaline solution of iodine?
(a) $CH_3CH(OH)CH_3$
(b) $CH_3CH_2CH(OH)CH_3$
(c) CH_3OH
(d) CH_3CH_2OH

74. Formic acid and acetic acid can be distinguished by:
(a) phenyl hydrazine (b) $NaHCO_3$
(c) tollen's reagent (d) none of these

75. When ethylamine react with sodium metal, the gas evolved is
(a) H_2 (b) C_2H_5 (c) N_2 (d) NH_3

76. The secondary structure of a protein refers to
(a) fixed configuration of the polypeptide backbone
(b) α-helical backbone
(c) hydrophobic interactions
(d) sequence of α-amino acids.

77. When H_2S gas is passed through the HCl containing aqueous solution of $CuCl_2$, $HgCl_2$, $BiCl_3$ and $CoCl_2$ it does not precipitate out
(a) CuS (b) HgS (c) Bi_2S_3 (d) CoS

78. Which one of the following statements is correct ?
(a) From a mixed precipitate of AgCl and AgI, ammonia solution dissolves only AgCl.
(b) Ferric ions give a deep green precipitate on adding potassium ferrocyanide solution.
(c) On boiling a solution having K^+, Ca^{2+} and HCO_3^- ions we get a precipitate of $K_2Ca(CO_3)_2$.
(d) Manganese salts give a violet borax bead test in the reducing flame.

79. Three separate samples of a solution of a single salt gave these results. One formed a white precipitate with excess ammonia solution, one formed a white precipitate with dil. HCl solution and one formed a black precipitate with H_2S. The salt could be
(a) $AgNO_3$ (b) $Pb(NO_3)_2$
(c) $Hg(NO_3)_2$ (d) $MnSO_4$

80. Experiment to study kinetics of the dissociation of hydrogen peroxide must be performed by group of two or three so that–
(a) when one is recording data other should be swirling flask at constant rate.
(b) experiment can be performed by one student only as outcomes are independent on rate of mixing of mixture 1 and 3.
(c) for safety purpose.
(d) none of these.

PART - III : MATHEMATICS

81. Let $A = \{x : x \in R, |x| < 1\}$;
$B = \{x : x \in R, |x-1| \geq 1\}$ and $A \cup B = R - D$, then the set D is
(a) $\{x : 1 < x \leq 2\}$ (b) $\{x : 1 \leq x < 2\}$
(c) $\{x : 1 \leq x \leq 2\}$ (d) None of these

82. If $12\cot^2\theta - 31\,\text{cosec}\,\theta + 32 = 0$, then the value of $\sin\theta$ is
(a) $\frac{3}{5}$ or 1 (b) $\frac{2}{3}$ or $\frac{-2}{3}$
(c) $\frac{4}{5}$ or $\frac{3}{4}$ (d) $\pm\frac{1}{2}$

83. $\tan 20° + \tan 40° + \sqrt{3}\tan 20°\tan 40°$ is equal to
(a) $\sqrt{3}/2$ (b) $\sqrt{3}/4$ (c) $\sqrt{3}$ (d) 1

84. The roots of the equation $x^2 - 2\sqrt{2}x + 1 = 0$ are
(a) Real and different
(b) Imaginary and different
(c) Real and equal
(d) Rational and different

85. If $\frac{1-i\alpha}{1+i\alpha} = A + iB$, then $A^2 + B^2$ equals to
(a) 1 (b) α^2 (c) –1 (d) $-\alpha^2$

86. In a polygon no three diagonals are concurrent. If the total number of points of intersection of diagonals interior to the polygon be 70 then the number of diagonals of the polygon is
(a) 20 (b) 28
(c) 8 (d) None of these

87. With 17 consonants and 5 vowels the number of words of four letters that can be formed having two different vowels in the middle and one consonant, repeated or different at each end is
(a) 5780 (b) 2890 (c) 5440 (d) 2720

88. The coefficient of x^{32} in the expansion of $\left(x^4 - \frac{1}{x^3}\right)^{15}$ is:

(a) ${}^{-15}C_3$ (b) ${}^{15}C_4$ (c) ${}^{-15}C_5$ (d) ${}^{15}C_2$

89. If m arithmetic means are inserted between 1 and 31 so that the ratio of the 7^{th} and $(m-1)^{th}$ means is 5 : 9, then find the value of m.

(a) 14 (b) 24 (c) 10 (d) 20

90. The reflection of the point (4, –13) in the line $5x + y + 6 = 0$, is

(a) (–1, –14) (b) (3, 4)
(c) (1, 2) (d) (–4, 13)

91. If the equations of the pairs of opposite sides of a parallelogram are $x^2 - 5x + 6 = 0$ and $y^2 - 6y + 5 = 0$, then equations of its diagonals are

(a) $x + 4y = 13, y = 4x - 7$
(b) $4x + y = 13, 4y = x - 7$
(c) $4x + y = 13, y = 4x - 7$
(d) $y - 4x = 13, y + 4x = 7$

92. If the line $2x - 1 = 0$ is the directrix of the parabola $y^2 - kx + 6 = 0$, then one of the values of k is

(a) –6 (b) 6 (c) 1/4 (d) –1/4

93. The line $ax + by = 1$ cuts ellipse $cx^2 + dy^2 = 1$ only once if

(a) $ca^2 + db^2 = 1$ (b) $\frac{c}{a^2} + \frac{d}{b^2} = 1$

(c) $\frac{a^2}{c} + \frac{b^2}{d} = 1$ (d) $ac^2 + bd^2 = 1$

94. Find the equation of chord of the circle $x^2 + y^2 = 8x$ bisected at the point (4, 3)

(a) $y = 3$ (b) $y = 1$ (c) $y = 6$ (d) $y = 7$

95. Find the value of $\lim_{x \to 0} \frac{\sqrt{(1+x^2)} - \sqrt{1-x^2}}{x^2}$

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

96. Mean of 25 observations was found to be 78.4. But later on it was found that 96 was misread 69. The correct mean is

(a) 79.24 (b) 79.48
(c) 80.10 (d) None of these

97. If the mean, mode and S.D. of a frequency distribution are 41,45 and 8 respectively, then its Pearson's coefficient of skewness is

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

98. A black die and a white die are rolled. Find the probability that the number shown by the black die will be more than twice that shown by the white die.

(a) 1/8 (b) 1/6 (c) 1/3 (d) 1/4

99. Let E = {1, 2, 3, 4} and F = {1, 2}. Then the number of onto functions from E to Fis

(a) 14 (b) 16 (c) 12 (d) 8

100. If $f(x) = \frac{x}{\sqrt{1+x^2}}$, then (fof of) (x) is

(a) $\frac{3x}{\sqrt{1+x^2}}$ (b) $\frac{x}{\sqrt{1+3x^2}}$

(c) $\frac{3x}{\sqrt{1-x^2}}$ (d) None of these

101. The value of $\cos^{-1}x + \cos^{-1}\left(\frac{x}{2} + \frac{1}{2}\sqrt{3-3x^2}\right)$; $\frac{1}{2} \le x \le 1$ is

(a) $-\frac{\pi}{3}$ (b) $\frac{\pi}{3}$ (c) $\frac{3}{\pi}$ (d) $-\frac{3}{\pi}$

102. If $A = \begin{bmatrix} 1 & 3 \\ 3 & 2 \\ 2 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & -2 \\ 0 & 5 \\ 3 & 1 \end{bmatrix}$ and $A + B - D = 0$ (zero matrix), then D matrix will be -

(a) $\begin{bmatrix} 0 & 2 \\ 3 & 7 \\ 6 & 5 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 2 \\ 3 & 7 \\ 5 & 6 \end{bmatrix}$

(c) $\begin{bmatrix} 0 & 1 \\ 3 & 7 \\ 5 & 6 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & -2 \\ -3 & -7 \\ -5 & -6 \end{bmatrix}$

103. The value of $\begin{vmatrix} 1 & 2 & 3 \\ -4 & 3 & 6 \\ 2 & -7 & 9 \end{vmatrix}$ is

(a) 213 (b –231 (c) 231 (d) 39

104. Let $f(x) = \begin{cases} ax^2 + 1, & x > 1 \\ x + a, & x \le 1 \end{cases}$. Then f(x) is derivable at x = 1, if

(a) a = 2 (b) a = 1 (c) a = 0 (d) a = 1/2

105. If a circular plate is heated uniformly, its area expands $3c$ times as fast as its radius, then the value of c when the radius is 6 units, is
(a) 4π (b) 2π (c) 6π (d) 3π

106. The function $f(x) = \tan x - 4x$ is strictly decreasing on
(a) $\left(-\frac{\pi}{3}, \frac{\pi}{3}\right)$ (b) $\left(\frac{\pi}{3}, \frac{\pi}{2}\right)$
(c) $\left(-\frac{\pi}{3}, \frac{\pi}{2}\right)$ (d) $\left(\frac{\pi}{2}, \pi\right)$

107. The slope of the tangent to the hyperbola $2x^2 - 3y^2 = 6$ at (3, 2) is
(a) -1 (b) 1 (c) 0 (d) 2

108. $\int 4\cos\left(x+\frac{\pi}{6}\right)\cos 2x.\cos\left(\frac{5\pi}{6}+x\right) dx$
(a) $-\left(x+\frac{\sin 4x}{4}+\frac{\sin 2x}{2}\right)+c$
(b) $-\left(x+\frac{\sin 4x}{4}-\frac{\sin 2x}{2}\right)+c$
(c) $-\left(x-\frac{\sin 4x}{4}+\frac{\sin 2x}{2}\right)+c$
(d) $-\left(x-\frac{\sin 4x}{4}+\frac{\cos 2x}{2}\right)+c$

109. If $I_m = \int_1^e (\ln x)^m dx$, where $m \in N$, then $I_{10} + 10\, I_9$ is equal to -
(a) e^{10} (b) $\frac{e^{10}}{10}$ (c) e (d) $e-1$

110. The area of the region bounded by the curve $y = x|x|$, x-axis and the ordinates $x = 1, x = -1$ is given by :
(a) zero (b) $\frac{1}{3}$ (c) $\frac{2}{3}$ (d) 1

111. What is the solution of $\frac{dy}{dx} + 2y = 1$ satisfying $y(0) = 0$?
(a) $y = \frac{1-e^{-2x}}{2}$ (b) $y = \frac{1+e^{-2x}}{2}$
(c) $y = 1 + e^x$ (d) $y = \frac{1+e^x}{2}$

112. The solution of differential equation $2x\frac{dy}{dx} - y = 3$ represents a family of
(a) circles (b) straight lines
(c) ellipses (d) parabola

113. If $(\vec{a}\times\vec{b})^2 + (\vec{a}.\vec{b})^2 = 676$ and $|\vec{b}| = 2$ then $|\vec{a}|$ is equal to
(a) 13 (b) 26
(c) 39 (d) None of these

114. Which one of the following is the unit vector perpendicular to both $\vec{a} = -\hat{i}+\hat{j}+\hat{k}$ and $\vec{b} = \hat{i}-\hat{j}+\hat{k}$?
(a) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (b) $\hat{k}$ (c) $\frac{\hat{j}+\hat{k}}{\sqrt{2}}$ (d) $\frac{\hat{i}-\hat{j}}{\sqrt{2}}$

115. With respect to a rectangular cartesian coordinate system, three vectors are expressed as : $\vec{a} = 4\hat{i}-\hat{j}, \vec{b} = -3\hat{i}+2\hat{j}$ and $\vec{c} = -\hat{k}$ where $\hat{i}, \hat{j}, \hat{k}$ are unit vectors, along the X, Y and Z-axis respectively. The unit vector $\hat{r}$ along the direction of sum of these vector is –
(a) $\hat{r} = \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k})$ (b) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i}+\hat{j}-\hat{k})$
(c) $\hat{r} = \frac{1}{3}(\hat{i}-\hat{j}+\hat{k})$ (d) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i}+\hat{j}+\hat{k})$

116. If the middle points of sides BC, CA & AB of triangle ABC are respectively D, E, F then position vector of centre of triangle DEF, when position vector of A, B, C are respectively $\hat{i}+\hat{j}$, $\hat{j}+\hat{k}$, $\hat{k}+\hat{i}$ is –
(a) $(1/3)(\hat{i}+\hat{j}+\hat{k})$ (b) $(\hat{i}+\hat{j}+\hat{k})$
(c) $2(\hat{i}+\hat{j}+\hat{k})$ (d) $(2/3)(\hat{i}+\hat{j}+\hat{k})$

117. The perpendicular distance of P(1, 2, 3) from the line $\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}$ is
(a) 7 (b) 5 (c) 0 (d) 6

118. The equation of the plane containing the line $\frac{x-x_1}{\ell} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ is $a(x-x_1)+b(y-y_1)+c(z-z_1) = 0$, then
(a) $ax_1 + by_1 + cz_1 = 0$ (b) $a\ell + bm + cn = 0$
(c) $\frac{a}{\ell} = \frac{b}{m} = \frac{c}{n}$ (d) $\ell x_1 + m y_1 + n z_1 = 0$

119. If mean of a poisson distribution of a random variable X is 2, then the value of $P(X > 1.5)$ is

(a) $\frac{3}{e^2}$ (b) $\frac{3}{e}$

(c) $1-\frac{3}{e}$ (d) $1-\frac{3}{e^2}$

120. If $P(A \cup B) = \frac{2}{3}$, $P(A \cap B) = \frac{1}{6}$ and $P(A) = \frac{1}{3}$ then

(a) A and B are independent events
(b) A and B are disjoint events
(c) A and B are dependent events
(d) None of these

121. If a flagstaff of 6 metres high placed on the top of a tower throws a shadow of $2\sqrt{3}$ metres along the ground, then the angle (in degrees) that the sun makes with the ground is

(a) 60° (b) 80°
(c) 75° (d) None of these

122. A wholesale merchant wants to start the business of cereal with ₹ 24000. Wheat is ₹ 400 per quintal and rice is ₹ 600 per quintal. He has capacity to store 200 quintal cereal. He earns the profit ₹ 25 per quintal on wheat and ₹ 40 per quintal on rice. If he store x quintal rice and y quintal wheat, then for maximum profit the objective function is

(a) $25x + 40y$ (b) $40x + 25y$

(c) $400x + 600y$ (d) $\frac{400}{40}x + \frac{600}{25}y$

123. The minimum value of $\frac{x^4 + y^4 + z^2}{xyz}$ for positive real number x, y, z is

(a) $\sqrt{2}$ (b) $2\sqrt{2}$ (c) $4\sqrt{2}$ (d) $8\sqrt{2}$

124. Let $f(x) = \frac{(e^x - 1)^2}{\sin\left(\frac{x}{a}\right)\log\left(1+\frac{x}{4}\right)}$ for $x \neq 0$,

and $f(0) = 12$. If f is continuous at $x = 0$, then the value of a is equal to

(a) 1 (b) –1 (c) 2 (d) 3

125. Which of the following functions is differentiable at $x = 0$?

(a) $\cos(|x|) + |x|$ (b) $\cos(|x|) - |x|$

(c) $\sin(|x|) + |x|$ (d) $\sin(|x|) - |x|$

PART - IV : ENGLISH

DIRECTIONS (Qs. 126 - 128): In the following questions, choose the alternative which can most appropriately replace the group of words italicised in the sentenc.

126. Despite being in the career of singing for the last 10 yr, he has not been able to earn fame on account of his *practice of borrowing ideas and words* from others and using them as his own.

(a) adaptation (b) pantomime
(c) imitation (d) plagiarism

127. Every person is not allowed to enter *the place where public*, government or historical records are kept

(a) scullery (b) pantry
(c) archives (d) coffer

128. The advertisement assured the public that the medicine would *give back* to the users, *their youthful vigour and appearance*.

(a) rejuvenate (b) restore
(c) replenish (d) render

DIRECTIONS (Qs. 129 - 131) : Choose the alternative which is most similar in meaning to the word given in capital letters.

129. PARAMOUR

(a) Lover (b) Companion
(c) Friend (d) Rival

130. REFECTORY

(a) Dining Room (b) Parlour
(c) Living Room (d) Restaurant

131. ASSENT

(a) Compromise (b) Judgement
(c) Agreement (d) Expression

DIRECTIONS (Qs. 132 & 133) : Choose the alternative which best expresses the meaning of the given idiom/ phrase.

132. To show one's teeth

(a) To ridicule
(b) To face difficulties
(c) To adopt a threatening attitude
(d) To be humble

133. To pour oil in troubled water

(a) To foment trouble
(b) To add to the trouble
(c) To instigate
(d) To calm a quarrel with soothing words

DIRECTIONS (Qs. 134 - 138): Rearrange the following six sentences (A), (B), (C), (D), (E), (F) in the proper sequence to form a meaningful paragraph; then answer the questions given below them.

(A) This is being done to ensure that when the cess is removed or merged ,the flexibility to impose higher rate on luxury goods is not taken away ,a senior finance ministry official told ET.

(B) This is only an enabling provision and the highest rate levied on goods will still be 28% (14% central GST and 14% state GST).The demerit and luxury goods will attract higher 28% rate plus cess.

(C) India has decided to peg the peak goods and services tax (GST) rate at40% in the legislation instead of 28%, giving it the flexibility to raise rates without having to reach out to parliament.

(D) "Some members of the council felt such an enabling provision was needed." the official privy to the development said.

(E) The GST council has proposed to peg the peak tax rate at 40% (20% central GST and 20% state GST) in the model GST law to preclude the requirement of approaching parliament or state assemblies for any change in future.

(F) This enabling provision will also allow the government to remove the cess at some stage and instead have a higher GST rate only, which will make for a neater GST.

134. Which sentence should come second in the paragraph?
(a) B (b) A (c) F (d) E

135. Which sentence shouldcome before the last ?
(a) F (b) E (c) D (d) A

136. Which sentence will come complete the passage ?
(a) C (b) A (c) D (d) B

137. Which sentence will be third after the rearrangement?
(a) F (b) E (c) B (d) D

138. Which sentence will start the passage?
(a) F (b) C (c) E (d) B

DIRECTIONS (Qs. 139 & 140): Pick out the most effective word from the given words to fill in the blanks to make the sentence meaningfully complete in the contest of the sentence.

139. A novel of real_____ must invent its own language, and this one does,
(a) impulsive (b) ambition
(c) intricate (d) abstruse

140. Information technology, and the hardware and software_____with the IT industry.
(a) amalgamation (b) associated
(c) regulated (d) use

DIRECTION (Q. 141): In the following question, select the related letter/word/number from the given alternatives.

141. EFJK : LMQR :: LMQR : ?
(a) EFJK (b) STXY (c) KJFE (d) YXTS

DIRECTION (Q. 142): In the following question, select the related letter/word/number from the given alternatives.

142. Mahatma Gandhi : Porbandar : : Pt. Jawaharlal Nehru : ?
(a) Allahabad (b) Calcutta
(c) New Delhi (d) Mumbai

DIRECTION (Q. 143): In the question below is given a statement followed by three assumptions numbered I, II and III. You have to consider the statement and the following assumptions, decide which of the assumptions is implicit in the statement and choose your answer accordingly.

143. Statement: The education of a student at collegiate level, not taking into account maintenance expenses, costs four hundred rupees a year. Collegiate education is thus drawing heavily upon the national resources of an impoverished community. So college education should be restricted to a brilliant few.

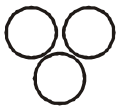
Assumptions:
I. Our resources are very limited.
II. Only a few students should be admitted to the colleges.
(a) Only assumption I is implicit
(b) Only assumption II is implicit
(c) Neither I nor II is implicit
(d) Both I and II are implicit

144. In a code language, if BANGED is coded as JJKQCC, then the word STRAY will be coded as
(a) DEUTV (b) DEUVT
(c) EFVWT (d) EFVVS

DIRECTION (Q. 145): In the following question, a series is given with one terms missing. Choose the correct alternative from the given ones that will complete the series:

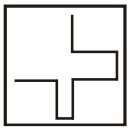
145. 2, 3, 7, 22, 155, ?
(a) 1706 (b) 1550 (c) 3411 (d) 3100

146. Which one of the following diagram represents the correct relationship among
Colour, Black and White.

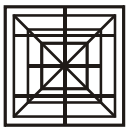
(a)  (b) 

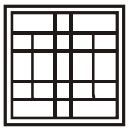
(c)  (d) 

147. Find out the alternative figure which contains figure (X) as its part.



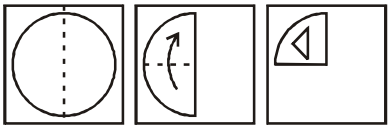
(X)

(a)  (b) 

(c)  (d) 

148. A piece of paper is folded and cut. From the figures given, indicate how it will appear when opened?

Question figures:



Answer figures:

(a)  (b) 

(c)  (d) 

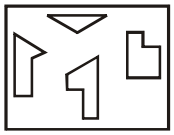
149. Identify the figure that completes the pattern.

(X)

(a)  (b) 

(c)  (d) 

150. Find out which of the figures (a), (b), (c) and (d) can be formed from the pieces given in figure (X).



(X)

(a)  (b) 

(c)  (d) 

SOLUTIONS

PART - I : PHYSICS

1. **(b)**

2. **(c)** Given that $x = At^2 - Bt^3$

$$\therefore \text{ velocity } = \frac{dx}{dt} = 2At - 3Bt^2$$

$$\text{and acceleration } = \frac{d}{dt}\left(\frac{dx}{dt}\right) = 2A - 6Bt$$

For acceleration to be zero $2A - 6Bt = 0$.

$$\therefore \quad t = \frac{2A}{6B} = \frac{A}{3B}$$

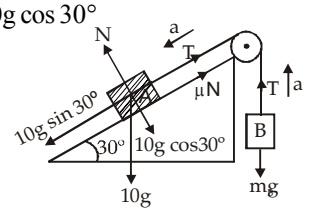
3. **(a)** $T = \dfrac{2u\sin\theta}{g}$, lesser is the value of θ, lesser is $\sin\theta$ and hence lesser will be the time taken. Hence A will fall earlier.

4. **(c)** Body moves with constant speed it means that tangential acceleration $a_T = 0$ & only centripetal acceleration a_C exists whose direction is always towards the centre or inward (along the radius of the circle).

5. **(b)** Considering the equilibrium of A, we get

$10a = 10g\sin 30° - T - \mu N$

where $N = 10g\cos 30°$



$$\therefore \ 10a = \frac{10}{2}g - T - \mu \times 10g\cos 30°$$

but $a = 0$, $T = m_B g$

$$0 = 5g - m_B g - \frac{0.2\sqrt{3}}{2} \times 10 \times g$$

$$\Rightarrow \ m_B = 3.268 \approx 3.3 \text{ kg}$$

6. **(c)** Applying law of conservation of linear momentum

$m_1v_1 + m_2v_2 = 0$,

$$\frac{m_1}{m_2} = -\frac{v_2}{v_1} \text{ or } \frac{v_1}{v_2} = -\frac{m_2}{m_1}$$

7. **(b)** $F_x = -\dfrac{\partial U}{\partial x} = \sin(x+y)$,

$$F_y = -\frac{\partial U}{\partial x} = \sin(x+y)$$

$$F_x = \sin(x+y)\big]_{(0,\pi/4)} = \frac{1}{\sqrt{2}},$$

$$F_y = \sin(x+y)\big]_{(0,\pi/4)} = \frac{1}{\sqrt{2}}$$

$$\therefore \ F = \frac{1}{\sqrt{2}}[\hat{i} + \hat{j}]$$

8. **(d)** $V = \dfrac{1}{2}k(x)^2 = \dfrac{1}{2}k(2)^2$ or $k = \dfrac{2V}{4} = \dfrac{V}{2}$

$$V' = \frac{1}{2}k(10)^2 = \frac{1}{2} \times \left(\frac{V}{2}\right)(10)^2 = 25V$$

9. **(a)** For solid sphere rolling without slipping on inclined plane, acceleration

$$a_1 = \frac{g\sin\theta}{1 + \dfrac{K^2}{R^2}}$$

For solid sphere slipping on inclined plane without rolling, acceleration

$a_2 = g\sin\theta$

Therefore required ratio $= \dfrac{a_1}{a_2}$

$$= \frac{1}{1 + \dfrac{K^2}{R^2}} = \frac{1}{1 + \dfrac{2}{5}} = \frac{5}{7}$$

10. **(b)** The coordinates of C.M of three particle are

$$x = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} \ \& \ y = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

here $m_1 = m_2 = m_3 = m$

$$\text{so } x = \frac{(x_1 + x_2 + x_3)m}{m + m + m} = 2,$$

$$y = \frac{(y_1 + y_2 + y_3)m}{m + m + m} = 2$$

so coordinates of C.M. of three particle are (2,2)

$V = 300$ m/s

11. (c) $F = KR^{-n} = MR\omega^2 \Rightarrow \omega^2 = KR^{-(n+1)}$

or $\omega = K'R^{\frac{-(n+1)}{2}}$

[where $K' = K^{1/2}$, a constant]

$\frac{2\pi}{T} \alpha\ R^{\frac{-(n+1)}{2}} \quad \therefore T\ \alpha\ R^{\frac{(n+1)}{2}}$

12. (a) $v_e = \sqrt{2gR} = \sqrt{\frac{2GM}{R^2}}R = \sqrt{\frac{2Gd\frac{4}{3}\pi R^3}{R^2}}R$

$= R\sqrt{2Gd\frac{4}{3}\pi}$

as $v_e \propto R$ for same density, $\frac{v_A}{v_B} = 2$

13. (b) $r\theta = \ell\phi \Rightarrow \phi = \frac{r\theta}{\ell} = \frac{6mm \times 30°}{1m} = 0.18°$

14. (b)

15. (d) $\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3 \Rightarrow R = 2^{1/3} r$

Surface energy of bigger drop,

$E = 4\pi R^2 T = 4 \times 2^{2/3}\pi r^2 T = 2^{8/3}\pi r^2 T$

16. (c) $F = \frac{2AT}{d} = \frac{2 \times \pi \times (0.05)^2 \times 73 \times 10^{-3}}{0.01 \times 10^{-3}}$

$= 36.5\ \pi \approx 115$ newton

17. (a)

18. (a) PV = constant represents isothermal process.

19. (b) $T_2 = 273 - 13 = 260$,

$K = \frac{T_2}{T_1 - T_2}; \quad 5 = \frac{260}{T_1 - 260}$

or $T_1 - 260 = 52; \quad T_1 = 312$ K,

$T_2 = 312 - 273 = 39°C$

20. (b) Energy possessed by the ideal gas at 27°C is

$E_1 = 3\left(\frac{3}{2}R \times 300\right) = \frac{2700\ R}{2}$

Energy possessed by the ideal gas at 227°C is

$E_2 = 2\left(\frac{3R}{2} \times 500\right) = 1500\ R$

If T be the equilibrium temperature, of the mixture, then its energy will be

$E_m = 5\left(\frac{3RT}{2}\right)$

Since, energy remains conserved,

$E_m = E_1 + E_2$

or $5\left(\frac{3RT}{2}\right) = \frac{2700R}{2} + 1500R$

or $T = 380$ K or 107°C

21. (a) $t \propto \frac{1}{\sqrt{9.8}}, \ t' \propto \frac{1}{\sqrt{12.8}}$

$\left(\because\ g' = 9.8 + 3 = 12.8\right)$

$\therefore \frac{t'}{t} = \sqrt{\frac{9.8}{12.8}} \Rightarrow t' = \sqrt{\frac{9.8}{12.8}}t$

22. (b) Equation of a wave

$y_1 = a \sin(\omega t - kx)$ ....(i)

Let equations of another wave may be,

$y_2 = a \sin(\omega t + kx)$ ....(ii)

$y_3 = -a \sin(\omega t + kx)$ ....(iii)

If Eq. (i) propagate with Eq. (ii), we get

$y = 2a \cos kx \sin \omega t$

If Eq. (i), propagate with Eq. (iii), we get

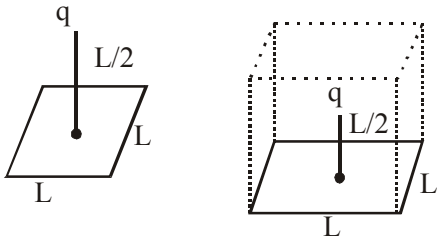
$y = -2a \sin kx \cos \omega t$

At x = 0, y = 0, wave produce node

So, Eq.(iii) is the equation of unknown wave

23. (a)

24. (c)



The given square of side L may be considered as one of the faces of a cube with edge L. Then given charge q will be considered to be placed at the centre of the cube. Then according to Gauss's theorem, the magnitude of the electric flux through the faces (six) of the cube is given by

$\phi = q/\varepsilon_0$

Hence, electric flux through one face of the cube for the given square will be

$$\phi' = \frac{1}{6}\phi = \frac{q}{6\varepsilon_0}$$

25. (b) $\frac{kx}{1\text{cm}} = \frac{k(Q-x)}{3\text{cm}}$

$3x = Q - x \Rightarrow 4x = Q$

$x = \frac{Q}{4} = \frac{4\times10^{-2}}{4}C = 1\times10^{-2}$

$Q' = \text{Q} - x = 3\times10^{-2}C$

26. (d) $\vec{\text{E}} = -\frac{\partial \text{V}}{\partial \text{x}}\hat{\text{i}} - \frac{\partial \text{V}}{\partial \text{y}}\hat{\text{j}} - \frac{\partial \text{V}}{\partial \text{z}}\hat{\text{k}}$

$= -[(6-8\text{y})\hat{\text{i}} + (-8\text{x}-8+6\text{z})\hat{\text{j}} + (6\text{y})\hat{\text{k}}]$

At (1, 1, 1), $\vec{\text{E}} = 2\hat{\text{i}} + 10\hat{\text{j}} - 6\hat{\text{k}}$

$\Rightarrow (\vec{\text{E}}) = \sqrt{2^2+10^2+6^2} = \sqrt{140} = 2\sqrt{35}$

$\therefore \quad \text{F} = \text{q}\vec{\text{E}} = 2\times2\sqrt{35} = 4\sqrt{35}$

27. (c) $P = \frac{V^2}{R_{eq}}$ ...(i)

$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{5} = \frac{5+R}{5R} \quad R_{eq} = \left(\frac{5R}{5+R}\right) \quad P = 30\text{ W}$

Substituting the values in equation (i)

$$30 = \frac{(10)^2}{\left(\frac{5R}{5+R}\right)} \Rightarrow R = 10\,\Omega$$

28. (d) Only number of free electrons is constant, other factors are temperature dependent.

29. (c) $\text{B}_{\text{OD}} = 0, \text{B}_{\text{OB}} = 0$

$\text{B}_{\text{AB}} = \frac{\mu_0 \text{I}}{4\pi\text{a}\sqrt{2}}[\cos45°(-\hat{\text{i}}) + \cos45°\hat{\text{k}}]$

$= \frac{\mu_0 \text{I}}{8\pi\text{a}}(-\hat{\text{i}} + \hat{\text{k}})$

30. (d) $\text{e} = -\text{L}\frac{\text{di}}{\text{dt}}$

But $\text{e} = 4\text{V}$ and $\frac{\text{di}}{\text{dt}} = \frac{0-1}{10^{-3}} = -1/10^{-3}$

$\therefore \quad \frac{-1}{10^{-3}}(-\text{L}) = 4 \Rightarrow \text{L} = 4\times10^{-3}$ henry

31. (b) From $\text{L} = \frac{\mu_0 \text{N}^2 \text{A}}{\text{l}} \alpha \frac{\text{N}^2}{\text{l}}$

we get, $\frac{\text{L}_1}{\text{L}_2} = \frac{(1/2)^2}{1/2} = \frac{1}{2}$

32. (a) The phase angle between voltage V and current I is $\pi/2$.

33. (d) $\text{V}_\text{R} = \text{iR} = 5\times16 = 80$ Volt

$\text{V}_\text{L} = \text{i}\times(\omega\text{L}) = 5\times24 = 120$ Volt

$\text{V}_\text{C} = \text{i}\times(1/\omega\text{C}) = 5\times12 = 60$ Volt

34. (d)

35. (a) $\text{E}_\text{k} = \frac{\text{hc}}{\text{e}}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = 2.0\,\text{eV}$

36. (b)

37. (c) Number of spectral lines $= \frac{\text{n}(\text{n}-1)}{2} = 6$

38. (b) Plutonium 239 is processed by breeder mechanism to be used as nuclear feul.

39. (c) $\text{I}_\text{C} = \text{I}_\text{E} - \text{I}_\text{B} = 90 - 1 = 89$ m A

40. (b) In forward biasing, the diode conducts. For ideal junction diode, the forward resistance is zero; therefore, entire applied voltage occurs across external resistance R i.e., there occurs no potential drop, so potential across R is V in forward biased.

PART - II : CHEMISTRY

41. (c) We know that,

Molecular weight of compound or molecules = 2 × V. D.

Vapour density (V. D.) of ozone molecules

$= \frac{\text{M. wt. of } \text{O}_3}{2} = \frac{48}{2} = 24.$

Hence, V. D. of O_3 is 24.

42. (a) In redox reaction,

g equivalent of reducing agent = g. equivalent of oxidising agent

Hence 1g equ. of reducing agent = P g equ. of oxidising agent.

43. (b)

44. (b) $_{11}\text{Na} \Rightarrow 2, 8, 1;\ _{17}\text{Cl} \Rightarrow 2, 8, 7$

These have same number of shells. Hence, they are the elements of the same period.

45. **(a)**

46. **(a)** All the three statements are correct.

47. **(b)**

48. **(a)** $q = \frac{c}{m}$

$\Rightarrow C_V = q \times m$

$= 0.075 \times 40$

$= 3.0 \text{ cal}$

$C_P - C_v = R$

$C_P = C_V + R$

$= 3 + 2 = 5$

$\frac{C_P}{C_V} = \frac{5}{3} = 1.66$

Monoatomic gas.

49. **(b)** BF_3 is Lewis acid (e^- pair acceptor)

50. **(a)** For CuS, solubility = $(10^{-31})^{1/2}$;

For $Ag_2S = \left(\frac{K_{sp}}{4}\right)^{\frac{1}{3}} = \left(\frac{10^{-44}}{4}\right)^{\frac{1}{3}}$ and

for $HgS = (10^{-54})^{\frac{1}{2}}$

51. **(d)** SO_2 changes to H_2SO_4 (O.N. changes from +4 to +6 oxidation)

$2KI \rightarrow I_2$ (O.S. changes from –1 to 0 oxidation)

$PbS \rightarrow PbSO_4$ (O.S. changes from –2 to +6 oxidation)

$Ag_2O \rightarrow 2Ag$ (O.S. changes from +1 to 0 reduction)

52. **(c)** $Na_2O_2 + H_2O \longrightarrow 2NaOH + \frac{1}{2}O_2$

53. **(b)** Graphite and boron nitride have similar structure.

54. **(d)** The given structure has three double bonds whose each carbon atom is differently substituted hence number of geometrical isomers will be $2^n = 2^{3'} = 8$, where *n* is the number of double bonds whose each carbon atom is differently substituted.

55. **(d)** $H_2\overset{1}{C} = \overset{2}{C}(\overset{CH_3}{|}) - \overset{3}{C}H_2 - \overset{4}{C}H_2 - \overset{5}{C}H_3$

2–Methylpent–1–ene

56. **(c)** **57.** **(d)**

58. **(b)** The given reaction is Diel's Alder reaction.

59. **(c)** $CH_2 \overset{\cdot\cdot}{=} CH - C(CH_3) \overset{\cdot\cdot}{=} CH - CH_3$

$\xrightarrow[ZnO/H_2O]{O_3} HCHO + CH_3CHO + CH_3COCHO$

60. **(d)** Minamata is caused by Hg poisoning.

61. **(a)** Phosphate pollution is caused by sewage and agricultural fertilizers.

62. **(a)** Eutrophication causes reduction in dissolved oxygen.

63. **(a)** $\Delta T_f = 0.3\,^\circ C$

$\Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$

$0.3 = \frac{1.86 \times W_B \times 1000}{62 \times 5000}$

$\therefore W_B = 50 \text{ g}$

The amount used should be more than 50 g.

64. **(a)** In electrolytic cell the cathode is of higher reduction potential.

65. **(b)** Since the nature of reaction (i.e. exothermic or endothermic) is not given, E_a for reverse reaction can be more or less.

66. **(b)** $NH_4NO_2 \longrightarrow N_2 + 2H_2O$

Volume of N_2 formed in successive five minutes are 2.75 cc, 2.40 cc and 2.25 cc which is in decreasing order. So rate of reaction is dependent on concentration of NH_4NO_2. As decrease is not very fast so it will be first order reaction.

67. **(d)** All nitrides react with H_2O to give NH_3 and $CaCN_2$ also react with H_2O

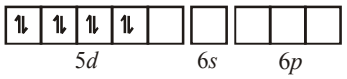
$CaNCN + 3H_2O \longrightarrow CaCO_3 + NH_3$

68. **(a)** Reactivity follows the order F > Cl > Br > I

69. **(a)** Limestone ($CaCO_3$) is mixed with Fe_2O_3 and it acts as flux to form slag ($CaSiO_3$).

70. **(a)** $[PtCl_4]^{2-}$ has square planar geometry.

Pt : $5d^9 6s^1$

Pt^{2+} = 

Two electrons are removed from 5*d* shell and 6*s* shell. So, hybridisation takes place is dsp^2 i.e. square planar geometry.

71. (b) When ethyl alcohol is treated with PCl_5, then ethyl chloride is formed.

$$CH_3CH_2-OH + PCl_5 \xrightarrow{\Delta} CH_3CH_2-Cl + HCl + POCl_3$$

72. (c)

73. (c) CH_3OH does not have $-CH(OH)CH_3$ group hence it will not form yellow precipitate with an alkaline solution of iodine (haloform reaction).

74. (c) Formic acid(HCOOH) has aldehydic group.

75. (a) When ethylamine is heated with sodium metal, then hydrogen gas is evolved.

$$2C_2H_5NH_2 + 2Na \longrightarrow 2C_2H_5\bar{N}HNa^+ + H_2\uparrow$$

76. (b) The secondary structure of a protein refers to the shape in which a long peptide chain can exist. There are two different conformations of the peptide linkage present in protein are α-helix and β-conformation. The α-helix always has a right handed arrangement.

In β-conformation all peptide chains are streched out to nearly maximum extension and then laid side by side held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as β-pleated shelt.

77. (d) CoS is not precipitated in acidic medium.

78. (a) Ammonia can dissolve ppt. of AgCl only due to formation of complex as given below:

$$AgCl + 2NH_3 \rightarrow [Ag(NH_3)_2]Cl$$

79. (b) $Pb(NO_3)_2 + 2NH_4OH \rightarrow Pb(OH)_2\downarrow + 2NH_4NO_3$ (white ppt)

$Pb(NO_3)_2 + 2HCl \rightarrow PbCl_2\downarrow + 2HNO_3$ (white ppt)

$Pb(NO_3)_2 + H_2S \rightarrow PbS\downarrow + 2HNO_3$ (black)

80. (a)

PART - III : MATHEMATICS

81. (b) $A = [x : x \in R, -1 < x < 1]$

$B = [x : x \in R : x-1 \le -1 \text{ or } x-1 \ge 1]$

$= [x : x \in R : x \le 0 \text{ or } x \ge 2]$

$\therefore\ A \cup B = R - D,$

where $D = [x : x \in R, 1 \le x < 2]$

82. (c) $12\cot^2\theta - 31\text{cosec}\,\theta + 32 = 0$

$\Rightarrow\ 12(\text{cosec}^2\theta - 1) - 31\text{cosec}\,\theta + 32 = 0$

$\Rightarrow\ 12\text{cosec}^2\theta - 31\text{cosec}\,\theta + 20 = 0$

$\Rightarrow\ 12\text{cosec}^2\theta - 16\,\text{cosec}\,\theta - 15\,\text{cosec}\,\theta + 20 = 0$

$\Rightarrow\ (4\text{cosec}\,\theta - 5)(3\text{cosec}\,\theta - 4) = 0$

$\Rightarrow\ \text{cosec}\theta = \frac{5}{4}, \frac{4}{3};\ \therefore \sin\theta = \frac{4}{5}, \frac{3}{4}$

83. (c) $\sqrt{3} = \tan 60° = \tan(40° + 20°)$

$$= \frac{\tan 40° + \tan 20°}{1 - \tan 40° \tan 20°}$$

$\therefore\ \sqrt{3} - \sqrt{3}\tan 40° \tan 20° = \tan 40° + \tan 20°$

Hence $\tan 40° + \tan 20° + \sqrt{3}\tan 40° \tan 20° = \sqrt{3}$

84. (a) The discriminant of the equation $(-2\sqrt{2})^2 - 4(1)(1) = 8 - 4 = 4 > 0$ and a perfect square, so roots are real and different but we can't say that roots are rational because coefficients are not rational therefore.

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

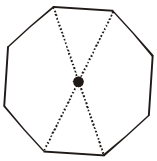
this is irrational $\therefore$ the roots are real and different.

85. (a) $A + iB = \frac{1 - i\alpha}{1 + i\alpha} \Rightarrow A - iB = \frac{1 + i\alpha}{1 - i\alpha}$

$$\Rightarrow (A + iB)(A - iB) = \frac{(1 - i\alpha)(1 + i\alpha)}{(1 + i\alpha)(1 - i\alpha)} = 1$$

$\Rightarrow A^2 + B^2 = 1$

86. (a) A combination of four vertices is equivalent to one interior poin of intersection of diagonals.



$\therefore$ No. of interior points of intersection
$= {}^{n}C_4 = 70$
$\Rightarrow n(n-1)(n-2)(n-3) = 5.6.7.8$
$\therefore n = 8$
So, number of diagonals $= {}^{8}C_2 - 8 = 20$

87. (a) The two letters, the first and the last of the four lettered word can be chosen in $(17)^2$ ways, as repetition is allowed for consonants. The two vowels in the middle are distinct so that the number of ways of filling up the two places is ${}^{5}P_2 = 20$.
The no. of different words $= (17)^2 . 20 = 5780$.

88. (b) We know by Binomial expansion, that $(x+a)^n$
$= {}^{n}C_0 x^n a^0 + {}^{n}C_1 x^{n-1}.a + {}^{n}C_2 x^{n-2} a^2$
$+ {}^{n}C_3 x^{n-3} a^3 + {}^{n}C_4 x^{n-4}. a^4 + ... + {}^{n}C_n x^0 a^n$

Given expansion is $\left(x^4 - \frac{1}{x^3}\right)^{15}$

On comparing we get n = 15, $x = x^4$, $a = \left(-\frac{1}{x^3}\right)$

$\therefore \left(x^4 - \frac{1}{x^3}\right)^{15} = {}^{15}C_0 (x^4)^{15}\left(-\frac{1}{x^3}\right)^0$

$+ {}^{15}C_1 (x^4)^{14}\left(-\frac{1}{x^3}\right) + {}^{15}C_2 (x^4)^{13}\left(-\frac{1}{x^3}\right)^2$

$+ {}^{15}C_3 (x^4)^{12}\left(-\frac{1}{x^3}\right)^3 + {}^{15}C_4 (x^4)^{11}\left(-\frac{1}{x^3}\right)^4 + ...$

$T_{r+1} = {}^{15}C_r (x^4)^{15-r} \cdot \left(-\frac{1}{x^3}\right)^r = -{}^{15}C_r x^{60-7r}$

$\Rightarrow x^{60-7r} = x^{32} \Rightarrow 60 - 7r = 32$
$\Rightarrow 7r = 28 \Rightarrow r = 4$
So, 5th term, contains x^{32}

$= {}^{15}C_4 (x^4)^{11}\left(-\frac{1}{x^3}\right)^4 = {}^{15}C_4 x^{44} x^{-12}$
$= {}^{15}C_4 x^{32}$.
Thus, coefficient of $x^{32} = {}^{15}C_4$.

89. (a) Let the means be $x_1, x_2, ...x_m$ so that $1, x_1, x_2, ...x_m, 31$ is an A.P. of $(m+2)$ terms.
Now, $31 = T_{m+2} = a + (m+1)d = 1 + (m+1)d$

$\therefore d = \frac{30}{m+1}$ Given : $\frac{x_7}{x_{m-1}} = \frac{5}{9}$

$\therefore \frac{T_8}{T_m} = \frac{a+7d}{a+(m-1)d} = \frac{5}{9}$

$\Rightarrow 9a + 63d = 5a + (5m-5)d$

$\Rightarrow 4.1 = (5m - 68)\frac{30}{m+1}$

$\Rightarrow 2m + 2 = 75m - 1020 \Rightarrow 73m = 1022$

$\therefore \quad m = \frac{1022}{73} = 14$

90. (a) Let Q(a, b) be the reflection of P$(4, -13)$ in the line $5x + y + 6 = 0$

Then the mid-point $R\left(\frac{a+4}{2}, \frac{b-13}{2}\right)$ lies on $5x + y + 6 = 0$

$\therefore 5\left(\frac{a+4}{2}\right) + \frac{b-13}{2} + 6 = 0$

$\Rightarrow 5a + b + 19 = 0$ ...(i)
Also PQ is perpendicular to $5x + y + 6 = 0$

Therefore $\frac{b+13}{a-4} \times \left(-\frac{5}{1}\right) = -1$

$\Rightarrow a - 5b - 69 = 0$ ..(ii)
Solving (i) and (ii), we get $a = -1$, $b = -14$

91. (c) Equations of the sides of the parallelogram are
$(x-3)(x-2) = 0$ and $(y-5)(y-1) = 0$
i.e. $x = 3, x = 2; y = 5, y = 1$
Hence its vertices are : A (2 ,1); B (3, 1); C (3, 5); D (2, 5)
Equation of the diagonal AC is

$y - 1 = \frac{4}{1}(x-2) \Rightarrow y = 4x - 7$

Equation of the diagonal BD is

$$y-1=\frac{4}{-1}(x-3)\Rightarrow 4x+y=13$$

92. (a) Given eq^n of parabola is $y^2 - kx + 6 = 0$

$$\Rightarrow y^2=kx-6\Rightarrow y^2=k\left(x-\frac{6}{k}\right)$$

Now, directrix, $x-\frac{6}{k}=-\frac{k}{4}$

$$\Rightarrow x=\frac{6}{k}-\frac{k}{4} \qquad \text{..... (i)}$$

But directrix is given $\Rightarrow x=\frac{1}{2}$ .... (ii)

$$\therefore \frac{6}{k}-\frac{k}{4}=\frac{1}{2}\Rightarrow 24-k^2=2k$$

$$\Rightarrow k^2+2k-24=0$$

$$\Rightarrow (k+6)(k-4)=0 \qquad \Rightarrow k=-6, k=4$$

93. (c) Clearly $ax+by=1$

i.e $y=-\frac{a}{b}x+\frac{1}{b}$ is tangent to

$$cx^2+dy^2=1\Rightarrow \frac{x^2}{\frac{1}{c}}+\frac{y^2}{\frac{1}{d}}=1$$

$$\therefore \left(\frac{1}{b}\right)^2=\left(\frac{1}{c}\right)\left(-\frac{a}{b}\right)^2+\left(\frac{1}{d}\right)$$

$$\Rightarrow 1=\frac{a^2}{c}+\frac{b^2}{d}$$

94. (a) $T=S_1\Rightarrow x(4)+y(3)-4(x+4)=16+9-32$

$$\Rightarrow 3y-9=0\Rightarrow y=3$$

95. (a) $$\lim_{x\to 0}\frac{\sqrt{1+x^2}-\sqrt{1-x^2}}{x^2}\cdot\frac{\sqrt{1+x^2}+\sqrt{1-x^2}}{\sqrt{1+x^2}+\sqrt{1-x^2}}$$

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

$$\Rightarrow \lim_{x\to 0}\frac{2x^2}{x^2\left(\sqrt{1+x^2}+\sqrt{1-x^2}\right)}=\frac{2}{\sqrt{1}+\sqrt{1}}=\frac{2}{2}=1$$

96. (b) Mean $\bar{x}=\frac{\Sigma x}{n}$ or $\Sigma x=n\bar{x}$

$\Sigma x=25\times 78.4=1960$

But this Σx is incorrect as 96 was misread as 69.

$\therefore$ correct $\Sigma x=1960+(96-69)=1987$

$$\therefore \text{ correct mean}=\frac{1987}{25}=79.48$$

97. (b) $-\frac{1}{2}$, We have $S_K=\frac{\text{Mean}-\text{Mode}}{\text{S.D.}}$

$$\frac{41-45}{8}=-\frac{1}{2}$$

98. (b) The number of favourable cases are shown below:

Number on white die	Number on black die
1	3
1	4
1	5
1	6
2	5
2	6

There are 6 favourable cases in which the number on black die is more than twice the number on the white die.

$\therefore m=6$

n = Total number of cases = 6×6

($\therefore$ with each die there are six possibilities)

$$\therefore \text{ Probability } p=\frac{m}{n}=\frac{6}{6\times 6}=\frac{1}{6}$$

99. (a) If set A has m elements and set B has n elements then number of onto functions from A to B is

$$\sum_{r=1}^{n}(-1)^{n-r}\ {}^nC_r\ r^m \text{ where } 1\le n\le m$$

Here $E=\{1,2,3,4\}, F=\{1,2\}$

$m=4, n=2$

$\therefore$ No. of onto functions from E to F

$$=\sum_{r=1}^{2}(-1)^{2-r}\ {}^2C_r(r)^4$$

$$=(-1)^2C_1+{}^2C_2(2)^4=-2+16=14$$

100. (b) $f(x)=\frac{x}{\sqrt{1+x^2}}$

$$(fof)(x)=\frac{\frac{x}{\sqrt{1+x^2}}}{\sqrt{1+\frac{x^2}{1+x^2}}}=\frac{x}{\sqrt{2x^2+1}}$$

$$(fofof)(x)=\frac{\frac{x}{\sqrt{2x^2+1}}}{\sqrt{1+\frac{x^2}{2x^2+1}}}=\frac{x}{\sqrt{1+3x^2}}$$

101. (b) Let $\cos^{-1}x=y$

$\Rightarrow x=\cos y$, so that $\frac{1}{2}\le x\le 1$ or $0\le y\le\frac{\pi}{3}$

and $\frac{x}{2}+\frac{1}{2}\sqrt{3-3x^2}=\frac{1}{2}\cos y+\frac{\sqrt{3}}{2}\sin y$

$=\cos\frac{\pi}{3}\cos y+\sin\frac{\pi}{3}\sin y=\cos\left(\frac{\pi}{3}-y\right)$

$\Rightarrow\cos^{-1}\left(\frac{x}{2}+\frac{1}{2}\sqrt{3-3x^2}\right)=\frac{\pi}{3}-y$

$\therefore$ the given expression is equal to

$y+\frac{\pi}{3}-y$, *i.e.*, $\frac{\pi}{3}$

102. (c) Let $D=\begin{bmatrix}a & b\\ c & d\\ e & f\end{bmatrix}$

$$\therefore A+B-C=\begin{bmatrix}1 & 3\\ 3 & 2\\ 2 & 5\end{bmatrix}+\begin{bmatrix}-1 & -2\\ 0 & 5\\ 3 & 1\end{bmatrix}-\begin{bmatrix}a & b\\ c & d\\ e & f\end{bmatrix}$$

$$\Rightarrow\begin{bmatrix}1-1-a & 3-2-b\\ 3+0-c & 2+5-d\\ 2+3-e & 5+1-f\end{bmatrix}=\begin{bmatrix}0 & 0\\ 0 & 0\\ 0 & 0\end{bmatrix}$$

$-a=0\Rightarrow a=0$, $1-b=0\Rightarrow b=1$,
$3-c=0\Rightarrow c=3$, $7-d=0\Rightarrow d=7$,
$5-e=0\Rightarrow e=5$, $6-f=0\Rightarrow f=6$,

$$\therefore D=\begin{bmatrix}0 & 1\\ 3 & 7\\ 5 & 6\end{bmatrix}$$

103. (c) $\begin{vmatrix}1 & 2 & 3\\ -4 & 3 & 6\\ 2 & -7 & 9\end{vmatrix}=1\begin{vmatrix}3 & 6\\ -7 & 9\end{vmatrix}-2\begin{vmatrix}-4 & 6\\ 2 & 9\end{vmatrix}+3\begin{vmatrix}-4 & 3\\ 2 & -7\end{vmatrix}$

$=1(3\times 9-6(-7))-2(-4\times 9-2\times 6)+3((-4)(-7)-3\times 2)$
$=(27+42)-2(-36-12)+3(28-6)=231$

104. (d) $Lf'(1)=\lim\limits_{h\to 0}\frac{f(1-h)-f(1)}{-h}$

$=\lim\limits_{h\to 0}\frac{(1-h+a)-(1+a)}{-h}=\lim\limits_{h\to 0}\frac{-h}{-h}=1$

$Rf'(1)=\lim\limits_{h\to 0}\frac{f(1+h)-f(1)}{h}$

$=\lim\limits_{h\to 0}\frac{[a(1+h)^2+1]-(1+a)}{h}$

$=\lim\limits_{h\to 0}(ah+2a)=2a$

Since $f'(1)$ exists, $\therefore Lf'(1)=Rf'(1)\Rightarrow a=1/2$

105. (a) Let A sq. units in the area measure when the radius is r units.
their $A=\pi r^2$
Differentiate both side *w.r.t* 't'

$\frac{dA}{dt}=2\pi r\frac{dr}{dt}$ ...(*i*)

We have, $\frac{dA}{dt}=3c\frac{dr}{dt}$

From eqn (i), we get

$3c.\frac{dr}{dt}=2\pi r.\frac{dr}{dt}\Rightarrow 3c=2\pi r$

Now, $c=\frac{2}{3}\pi(6)=4\pi$ when $r=6$

106. (a) $f(x)=\tan x-4x\Rightarrow f'(x)=\sec^2x-4$

When $\frac{-\pi}{3}<x<\frac{\pi}{3}$, $1<\sec x<2$

Therefore, $1<\sec^2x<4$

$\Rightarrow -3<(\sec^2x-4)<0$

Thus, for $\frac{-\pi}{3}<x<\frac{\pi}{3}$, $f'(x)<0$

Hence, f is strictly decreasing on $\left(\frac{-\pi}{3},\frac{\pi}{3}\right)$

107. (b) Differentiating the given equation of the curve

$4x - 6y.(dy/dx) = 0 \qquad \therefore dy/dx = 2x/3y$

$$\left(\frac{dy}{dx}\right)_{(3,2)} = \frac{2}{3}\cdot\frac{3}{2} = 1$$

108. (a) $\int 4\cos\left(x+\frac{\pi}{6}\right)\cos 2x.\cos\left(\frac{5\pi}{6}+x\right)dx$

$$= 2\int\left(\cos(2x+\pi)\cos\frac{2\pi}{3}\right)\cos 2x\,dx$$

$$= 2\int\left(-\cos 2x-\frac{1}{2}\right)\cos 2x\,dx$$

$$= \int(-2\cos^2 2x - \cos 2x)\,dx$$

$$= -\int(1+\cos 4x+\cos 2x)\,dx$$

$$= -x - \frac{\sin 4x}{x} - \frac{\sin 2x}{2} + c$$

109. (c) $I_{10} = \int_1^e 1.(\ln x)^{10}dx = \left[(\ln x)^{10}x\right]_1^e$

$$-\int_1^e 10(\ln x)^9.\frac{1}{x}.x\,dx = e - 0 - 10\int_1^e(\ln x)^9dx$$

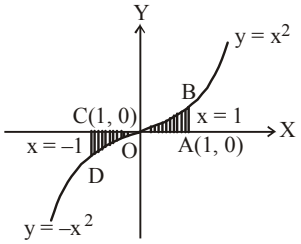
$= e - 10I_9 + 10I_9 = e$

110. (c) The area of the region bounded by the curve $y = f(x)$ and the ordinates $x = a$, $x = b$ is given by

$$\text{Area} = \left|\int_a^b y\,dx\right|$$

According to the question,

$$y = x|x| = \begin{cases} x^2, & x \ge 0 \\ -x^2, & x < 0 \end{cases}$$



Required area

= area of region OAB + area of region OCD

= 2 × Area of region OAB

$$= 2\int_0^1 x^2dx = \frac{2}{3}\text{ sq. units}$$

111. (a) $\frac{dy}{dx} + 2y = 1 \Rightarrow \frac{dy}{dx} = 1 - 2y$

$$\int\frac{dy}{1-2y} = \int dx \;-\frac{1}{2}\log|1-2y| = x + C$$

$$\text{at } x = 0,\ y = 0;\ -\frac{1}{2}\log 1 = 0 + C \Rightarrow C = 0$$

$$1 - 2y = e^{-2x} \Rightarrow y = \frac{1-e^{-2x}}{2}$$

112. (d) We have, $2x\frac{dy}{dx} = y + 3 \Rightarrow \frac{2}{y+3}dy = \frac{dx}{x}$

integrating, $2\ln(y+3) = \ln x + \ln c = \ln cx$

$\Rightarrow \ln(y+3)^2 = \ln cx \Rightarrow (y+3)^2 = cx$

which is a family of parabolas.

113. (a) $(\vec{a}\times\vec{b})^2 + (\vec{a}\cdot\vec{b})^2 = 676$

$$(|\vec{a}|.|\vec{b}|\sin\theta\hat{n})^2 + (|\vec{a}|\cdot|\vec{b}|\cos\theta)^2 = 676$$

$\Rightarrow a^2b^2\sin^2\theta + a^2b^2\cos^2\theta = 676 \quad [(\hat{n})^2 = 1]$

$$a^2b^2(\sin^2\theta + \cos^2\theta) = 676 \Rightarrow a^2 = \frac{676}{b^2} = \frac{676}{4}$$

$$|\vec{a}| = \sqrt{\frac{676}{4}} \Rightarrow |\vec{a}| = \frac{26}{2} \Rightarrow |\vec{a}| = 13$$

114. (a) According to question $a = -\hat{i} + \hat{j} + \hat{k}$ and $b = \hat{i} - \hat{j} + \hat{k}$

Then, $a \times b = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & 1 & 1 \\ 1 & -1 & 1 \end{vmatrix}$

$$= \hat{i}[1+1] - \hat{j}[-1-1] + \hat{k}[1-1] = 2(\hat{i}+\hat{j})$$

and $|a \times b| = \sqrt{4+4} = 2\sqrt{2}$

$$\therefore \text{Required unit vector} = \pm\frac{2(\hat{i}+\hat{j})}{2\sqrt{2}} = \pm\frac{\hat{i}+\hat{j}}{\sqrt{2}}$$

115. (a) $\vec{r} = \vec{a} + \vec{b} + \vec{c} = 4\hat{i} - \hat{j} - 3\hat{i} + 2\hat{j} - \hat{k} = \hat{i} + \hat{j} - \hat{k}$

$$\hat{r} = \frac{\vec{r}}{|r|} = \frac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{1^2+1^2+(-1)^2}} = \frac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{3}}$$

116. (d) The position vector of points D, E, F are respectively

$\frac{i+j}{2}+k$, $i+\frac{k+j}{2}$ and $\frac{i+k}{2}+j$

So, position vector of centre of ΔDEF

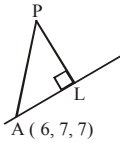
$$=\frac{1}{3}\left[\frac{i+j}{2}+k+i\,\frac{k+j}{2}+\frac{i+k}{2}+j\right]=\frac{2}{3}\,[i+j+k]$$

117. (a) The point A (6, 7, 7) is on the line . Let the perpendicular from P meet the line in L. Then

$$AP^2=(6-1)^2+(7-2)^2+(7-3)^2=66$$

Also AL = projection of AP on line

$$\left(\text{actual d.c.'s}\,\frac{3}{\sqrt{17}},\frac{2}{\sqrt{17}},\frac{-2}{\sqrt{17}}\right)$$



$$\Rightarrow (6-1).\frac{3}{\sqrt{17}}+(7-2).\frac{2}{\sqrt{17}}+(7-3)\frac{-2}{\sqrt{17}}$$

$$=\sqrt{17}$$

$\therefore$ $\perp$ distance d of P from the line is given by

$$d^2=AP^2-AL^2=66-17=49 \text{ so that } d=7$$

118. (b) If the given plane contains the given line then the normal to the plane, must be perpendicular to the line and the condition for the same is $a\ell+bm+cn=0$.

119. (d) Since, $P(X=r)=\frac{e^{-\lambda}\lambda^r}{r!}$ (where λ = mean)

$\therefore$ $P(X=r>1.5)=P(2)+P(3)+\ldots\infty$

$$=1-P(X=r\le 1)=1-P(0)-P(1)$$

$$=1-\left(e^{-2}+\frac{e^{-2}\times 2}{1!}\right)=1-\frac{3}{e^2}$$

120. (a) $P(A\cup B)=P(A)+P(B)-P(AB)$

$$\Rightarrow \frac{2}{3}=\frac{1}{3}+P(B)-\frac{1}{6}\Rightarrow P(B)=\frac{1}{2}$$

Now, P(AB) = P(A) P(B), A and B are independent events.

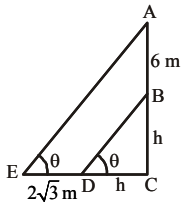
121. (a) Accordingly,

$$\tan\theta=\frac{h}{x}=\frac{h+6}{x+2\sqrt{3}}=\frac{6}{2\sqrt{3}}\Rightarrow\theta=60^\circ$$

[Since the triangles *AEC* and *BDC* are similar]

$h\cot\alpha=(h-100)\cot\beta$

$$\therefore h=\frac{100\cot\beta}{\cot\beta-\cot\alpha}$$



122. (b) For maximum profit, $z=40x+25y$.

123. (b) By A.M. $\ge$ G.M.

$x^4+y^4\ge 2x^2y^2$ and $2x^2y^2+z^2\ge\sqrt{8}\,xyz$.

$$\Rightarrow \quad \frac{x^4+y^4+z^2}{xyz}\ge\sqrt{8}$$

124. (d) $$\lim_{x\to 0}\frac{(e^x-1)^2}{\sin\left(\frac{x}{a}\right)\log\left(1+\frac{x}{4}\right)}$$

$$=\lim_{x\to 0}\frac{\frac{(e^x-1)^2}{x}\cdot x^2}{\frac{x}{a}\cdot\frac{\sin\left(\frac{x}{a}\right)}{\left(\frac{x}{a}\right)}\cdot\frac{\log\left(1+\frac{x}{4}\right)}{\frac{x}{4}}\cdot\frac{x}{4}}\Rightarrow 4a=12$$

$\Rightarrow a=3$

125. (d) $|x|$ is non-differentiable function at $x=0$ as L.H.D = –1 and R.H. D = 1

$\because$ $|x|=\begin{cases}x, & x\ge 0\\ -x, & x<0\end{cases}$

But cos $|h|$ is differentiable

$\therefore$ Any combination of two such functions will be non-differentiable. Hence option (a) and (b) are ruled out.

Now, consider $\sin|x|+|x|$

$$L'=\lim_{h\to 0}\frac{\sin|-h|+|-h|}{-h}=\lim_{h\to 0}\frac{\sin h}{-h}-1=-1-1$$

$$=-2$$

$$R'=\lim_{h\to 0}\frac{\sin|h|+|h|}{h}=\lim_{h\to 0}\frac{\sin h}{h}+1=1+1=2$$

Consider $\sin|x|-|x|$

$$L'=\lim_{h\to 0}\frac{\sin|-h|-|-h|}{-h}=\lim_{h\to 0}\frac{\sin h}{-h}+1=0$$

$$R' = \lim_{h\to 0}\frac{\sin|h|-|h|}{h} = \lim_{h\to 0}\frac{\sin h}{h} - 1 = 0$$

Hence, $\sin|x|-|x|$ is diffble at $x = 0$.

PART - IV : ENGLISH

126. (d) **127. (c)** **128. (a)** **129. (a)**
130. (a) **131. (c)** **132. (c)** **133. (d)**
134. (a) **135. (d)** **136. (c)** **137. (a)**
138. (b)

139. (b) Ambition-a cherished desire
Abstruse-hard to understand intricate-complex

140. (b) Amalgamation-joining of two organization to form one large organization
Regulated means controlled.

141. (b) As, EFJK → (+7) → LMQR
Similarly, LMQR → (+7) → STXY

142. (a) As, the birth place of Mahatma Gandhi was Porbandar. Similarly, the birth place of Pt. Jawaharlal Nehru was Allahabad.

143. (d) The use of the words 'impoverished community' in the statement makes I implicit while the phrase 'college education should be restricted to a brilliant few' makes II implicit.

144. (b)

145. (c) 2 → 3 → 7 → 22 → 155 → 3411
$2\times1+1$, $2\times3+1$, $3\times7+1$, $7\times22+1$, $22\times155+1$

146. (b) **147. (d)** **148. (a)** **149. (d)**
150. (c)