BITSAT 2013 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. The velocity and acceleration vectors of a particle undergoing circular motion are $\vec{v} = 2\hat{i}\ m/s$ and $\vec{a} = 2\hat{i} + 4\hat{j}\ m/s^2$ respectively at an instant of time. The radius of the circle is –

(a) 1m (b) 2m (c) 3m (d) 4m

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

(a) $4t = 6 + 0.6t^2$ (b) $1.2t^2 = 4t$

(c) $4t^2 = 1.2t$ (d) $6 + 4t = 0.2t^2$

3. Wave pulse can travel along a tense string like a violin spring. A series of experiments showed that the wave velocity V of a pulse depends on the following quantities, the tension T of the string, the cross-section area A of the string and then as per unit volume ρ of the string. Obtain an expression for V in terms of the T, A and ρ using dimensional analysis.

(a) $V = k\sqrt{\frac{T}{A\rho}}$ (b) $V = k\sqrt{\frac{T}{A}}$

(c) $V = k\sqrt{\frac{A\rho}{T}}$ (d) None of these

4. A body is projected, making an acute angle with the horizontal. If angle between velocity $\vec{v}$ and acceleration $\vec{g}$ is θ, then

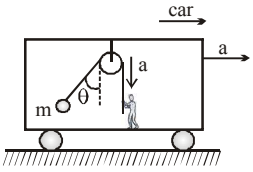
(a) $\theta = 90^\circ$ (b) $\theta = 0^\circ$

(c) $90^\circ < \theta < 0^\circ$ (d) $0^\circ < \theta < 180^\circ$

5. The minimum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is

(a) 60 (b) 30 (c) 15 (d) 25

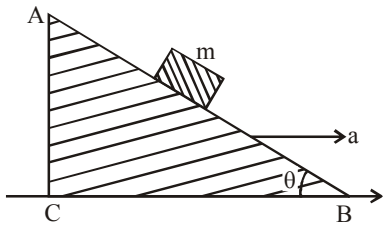
6. A bob is hanging over a pulley inside a car through, a string. The second end of the string is in the hand of a person standing in the car. The car is moving with constant acceleration 'a' directed horizontally as shown in figure. Other end of the string is pulled with constant acceleration 'a' vertically. The tension in the string is equal to –



(a) $m\sqrt{g^2 + a^2}$ (b) $m\sqrt{g^2 + a^2} - ma$

(c) $m\sqrt{g^2 + a^2} + ma$ (d) $m(g + a)$

7. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration 'a' towards the right. The relation between a and θ for the block to remain stationary on the wedge is



(a) $a = \dfrac{g}{\text{cosec}\,\theta}$ (b) $a = \dfrac{g}{\sin\theta}$

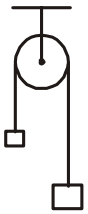
(c) $a = g\tan\theta$ (d) $a = g\cos\theta$

8. A 3.628 kg freight car moving along a horizontal rail road spur track at 7.2 km/hour strikes a bumper whose coil springs experiences a maximum compression of 30 cm in stopping the car. The elastic potential energy of the springs at the instant when they are compressed 15 cm is

(a) 12.1×10^4 J (b) 121×10^4 J

(c) 1.21×10^4 J (d) 1.21×10^6 J

9. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking g = 10 m/s^2, find the work done **(in joules)** by the string on the block of mass 0.36 kg during the first second after the system is released from rest.



(a) 4 J (b) 2 J (c) 8 J (d) 10 J

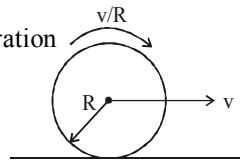
10. Two rings of radius R and nR made of same material have the ratio of moment of inertia about an axis passing through centre is 1 : 8. The value of n is

(a) 2 (b) $2\sqrt{2}$ (c) 4 (d) 1/2

11. A particle of mass 'm' is projected with a velocity v making an angle of 30° with the horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height 'h' is

(a) $\dfrac{\sqrt{3}}{2}\dfrac{mv^2}{g}$ (b) zero (c) $\dfrac{mv^3}{\sqrt{2g}}$ (d) $\dfrac{\sqrt{3}}{16}\dfrac{mv^3}{g}$

12. A disc is performing pure rolling on a smooth stationary surface with constant angular velocity as shown in figure. At any instant, for the lower most point of the disc –



(a) velocity is v, acceleration is zero

(b) velocity is zero, acceleration is zero

(c) velocity is v, acceleration is v^2/R

(d) velocity is zero, acceleration is v^2/R

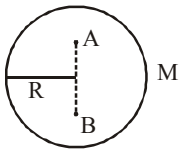
13. There is a shell of mass M and density of the shell is uniform. The work done to take a point mass from point A to B is [AB = r]

(a) $\dfrac{GmM}{r}$

(b) $\dfrac{GmM}{R}$

(c) $-\dfrac{GmM}{r}$

(d) zero



14. A cube is subjected to a uniform volume compression. If the side of the cube decreases by 2% the bulk strain is

(a) 0.02 (b) 0.03 (c) 0.04 (d) 0.06

15. A ball whose density is 0.4×10^3 kg/m^3 falls into water from a height of 9 cm. To what depth does the ball sink ?

(a) 2 cm (b) 6 cm (c) 4.5 cm (d) 2.25 cm

16. Figure shows a copper rod joined to a steel rod. The rods have equal length and equal cross-sectional area. The free end of the copper rod is kept at 0ºC and that of steel rod is kept at 100ºC. Find the temperature of the junction of the rod. Conductivity of copper = 390 W/mºC. Conductivity of steel = 46 W/m ºC

(a) 18.01ºC (b) 26ºC (c) 10.6ºC (d) 20ºC

17. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q ?

(a) $Q/4\pi R^2\sigma$ (b) $(Q/4\pi R^2\sigma)^{-1/2}$

(c) $(4\pi R^2 Q/\sigma)^{1/4}$ (d) $(Q/4\pi R^2\sigma)^{1/4}$

18. A thermodynamical system is changed from state (P_1, V_1) to (P_2, V_2) by two different process, the quantity which will remain same will be

(a) ΔQ (b) ΔW

(c) $\Delta Q + \Delta W$ (d) $\Delta Q - \Delta W$

19. A Carnot's heat engine works between the temperatures 427°C and 27°C. What amount of heat should it consume per second to deliver mechanical work at the rate of 1.0 kW?

(a) 0.417 kcal/s (b) 4.17 kcal/s

(c) 41.7 kcal/s (d) 0.212 kcal/s

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

(a) p/8 (b) p (c) 2 p (d) 8p

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

(a) 37% (b) 11% (c) 33% (d) 15.5%

22. Two gases occupy two containers A and B the gas in A, of volume 0.10m^3, exerts a pressure of 1.40 MPa and that in B of volume 0.15m^3 exerts a pressure 0.7 MPa. The two containers are united by a tube of negligible volume and the gases are allowed to intermingle. Then if the temperature remains constant, the final pressure in the container will be (in MPa)

(a) 0.70 (b) 0.98 (c) 1.40 (d) 210

23. An instantaneous displacement of a simple harmonic oscillator is $x = A\cos(\omega t + \pi/4)$. Its speed will be maximum at time

(a) $\pi/4\omega$ (b) $\pi/2\omega$ (c) π/ω (d) $2\pi/\omega$

24. Two waves of wavelengths 99 cm and 100 cm both travelling with velocity 396 m/s are made to interfere. The number of beats produced by them per second is

(a) 1 (b) 2 (c) 4 (d) 8

25. If equation of transverse wave is $y = x_0 \cos 2\pi\left(nt - \frac{x}{\lambda}\right)$. Maximum velocity of particle is twice of wave velocity, if λ is-

(a) $\pi/2x_0$ (b) $2\pi x_0$ (c) πx (d) πx_0

26. Three equal charges (q) are placed at corners of an equilateral triangle of side a. The force on any charge is

(a) zero (b) $\sqrt{3}\,\frac{Kq^2}{a^2}$

(c) $\frac{Kq^2}{\sqrt{3}a^2}$ (d) $3\sqrt{3}\,\frac{Kq^2}{a^2}$

27. Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are connected together. When the positive ends are also connected, the decrease in energy of the combined system is –

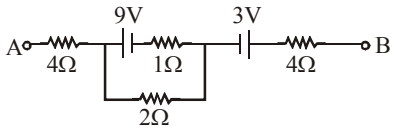
(a) $\frac{1}{4}C(V_1^2 - V_2^2)$ (b) $\frac{1}{4}C(V_1^2 + V_2^2)$

(c) $\frac{1}{4}C(V_1 - V_2)^2$ (d) $\frac{1}{4}C(V_1 + V_2)^2$

28. What should be the characteristic of fuse wire?

(a) High melting point, high specific resistance.
(b) Low melting point, low specific resistance.
(c) High melting point, low specific resistance.
(d) Low melting point, high specific resistance.

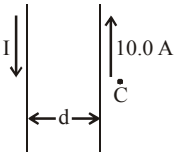
29. In the circuit shown in figure potential difference between points A and B is 16 V. the current passing through 2Ω resistance will be



(a) 2.5 A (b) 3.5 A (c) 4.0 A (d) zero

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

(a) 10.0 A
(b) 30.0 A
(c) 8.0 A
(d) 18.0 A



31. A uniform electric field and uniform magnetic field are acting along the same direction in a certain region. If an electron is projected in the region such that its velocity is pointed along the direction of fields, then the electron

(a) will turn towards right of direction of motion
(b) speed will decrease
(c) speed will increase
(d) will turn towards left direction of motion

32. Eddy currents are produced when

(a) a metal is kept in varying magnetic field
(b) a metal is kept in steady magnetic field
(c) a circular coil is placed in a magnetic field
(d) through a circular coil, current is passed

33. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area A = 10 cm^2 and length = 20 cm. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is

($\mu_0 = 4\pi \times 10^{-7}\,Tm\,A^{-1}$)

(a) $2.4\pi \times 10^{-5}$ H (b) $4.8\pi \times 10^{-4}$ H
(c) $4.8\pi \times 10^{-5}$ H (d) $2.4\pi \times 10^{-4}$ H

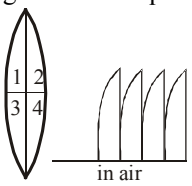
34. The ratio of secondary and primary turns of step-up transformer is 4 : 1. If a current of 4 A is applied to the primary, the induced current in secondary will be

(a) 8 A (b) 2 A (c) 1 A (d) 0.5 A

35. Which of the following electromagnetic radiations has the smallest wavelength?
(a) Ultraviolet rays (b) X-rays
(c) γ-rays (d) Microwaves

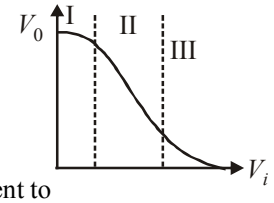
36. When light is refracted, which of the following does not change ?
(a) Wavelength (b) Frequency
(c) Velocity (d) Amplitude

37. The given lens is broken into four parts and rearranged as shown. If the initial focal length is f then after rearrangement the equivalent focal length is –
(a) f
(b) $f/2$
(c) $f/4$
(d) $4f$

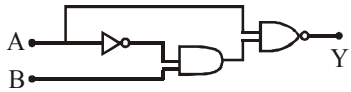


38. In Young's double slit experiment 10th order maximum is obtained at the point of observation in the interference pattern for $\lambda = 7000$ Å. If the source is replaced by another one of wavelength 5000 Å then the order of maximum at the same point will be –
(a) 12 th (b) 14 th (c) 16 th (d) 18 th

39. Transfer characteristics [output voltage (V_0) vs input voltage (V_1)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used
(a) in region (III)
(b) both in region (I) and (III)
(c) in region (II)
(d) in region (I)



40. The circuit is equivalent to



(a) AND gate (b) OR gate
(c) Not gate (d) None of these

PART - II : CHEMISTRY

41. How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0M HNO_3? The concentrated acid is 70% HNO_3.
(a) 90.0 g conc. HNO_3
(b) 70.0 g conc. HNO_3
(c) 54.0 g conc. HNO_3
(d) 45.0 g conc. HNO_3

42. The Bohr orbit radius for the hydrogen atom ($n = 1$) is approximately 0.530 Å. The radius for the first excited state ($n = 2$) orbit is (in Å)
(a) 0.13 (b) 1.06 (c) 4.77 (d) 2.12

43. The screening effect of d-electrons is
(a) Equal to p-electrons
(b) Much more than p-electrons
(c) Same as f-electrons
(d) Less than p-electrons.

44. When the first ionisation energies are plotted against atomic number, the peaks are occupied by
(a) Alkali metals
(b) Rare gases
(c) Halogens
(d) Transition elements

45. The ions O^{2-}, F^-, Na^+, Mg^{2+} and Al^{3+} are isoelectronic. Their ionic radii show :
(a) A decrease from O^{2-} to F^- and then increase from Na^+ to Al^{3+}
(b) A significant increase from O^{2-} to Al^{3+}
(c) A significant decrease from O^{2-} to Al^{3+}
(d) An increase from O^{2-} to F^- and then decrease from Na^+ to Al^{3+}

46. Using MOT, which of the following pairs denote paramagnetic species?
(a) B_2 and C_2 (b) B_2 and O_2
(c) N_2 and C_2 (d) O_2 and O_2^{2-}

47. Increasing order of rms velocities of H_2, O_2, N_2 and HBr is
(a) $H_2 > O_2 > N_2 > HBr$
(b) $HBr < O_2 < N_2 < H_2$
(c) $H_2 > N_2 < O_2 > HBr$
(d) $HBr > N_2 < O_2 < H_2$

48. For the dissociation reaction,
$H_2(g) \rightarrow 2H(g)$ $\Delta H = 162$ Kcal,
heat of atomisation of H is
(a) 81 Kcal (b) 162 Kcal
(c) 208 Kcal (d) 218 Kcal

49. The enthalpy of combustion of 2 moles of benzene at 27°C differs from the value determined in bomb calorimeter by
(a) – 2.494 kJ (b) 2.494 kJ
(c) – 7.483 kJ (d) 7.483 kJ

50. If 1.0 mole of I_2 is introduced into 1.0 litre flask at 1000 K, at equilibrium ($K_c = 10^{-6}$), which one is correct?

(a) $[I_2(g)] > [I^-(g)]$

(b) $[I_2(g)] < [I^-(g)]$

(c) $[I_2(g)] = [I^-(g)]$

(d) $[I_2(g)] = \frac{1}{2}[I^-(g)]$

51. For the reaction

$CO(g) + (1/2)O_2(g) \longrightarrow CO_2(g)$, K_p / K_c is

(a) RT (b) $(RT)^{-1}$

(c) $(RT)^{-1/2}$ (d) $(RT)^{1/2}$

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

(a) +6 (b) $\frac{+3}{2}$

(c) $\frac{+5}{2}$ (d) -2

53. When same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide solution, the ratio of volumes of hydrogen evolved is:

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 9 : 4

54. The alkali metals form salt-like hydrides by the direct synthesis at elevated temperature. The thermal stability of these hydrides decreases in which of the following orders ?

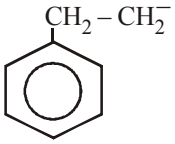
(a) CsH > RbH > KH > NaH > LiH

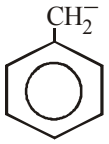
(b) KH > NaH > LiH > CsH > RbH

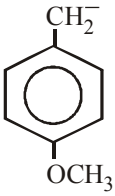
(c) NaH > LiH > KH > RbH > CsH

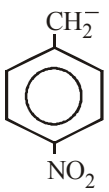
(d) LiH > NaH > KH > RbH > CsH

55. The most stable carbanion among the following is :

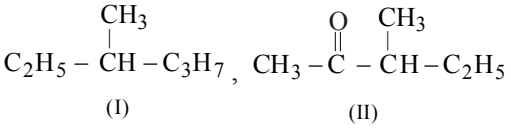
(a) 

(b) 

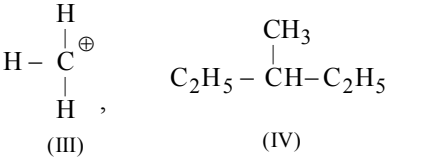
(c) 

(d) 

56. Among the following four structures I to IV,



(I) (II)



(III) (IV)

it is true that

(a) only I and II are chiral compounds.

(b) only III is a chiral compound.

(c) only II and IV are chiral compounds.

(d) all four are chiral compounds.

57. The number of enantiomers of the compound $CH_3CHBrCHBrCOOH$ is

(a) 0 (b) 1 (c) 3 (d) 4

58. Which one of the following reactions is expected to readily give a hydrocarbon product in good yields ?

(a) $RCOOK \xrightarrow[\text{oxidation}]{\text{Electrolytic}}$

(b) $RCOO^-Ag^+ \xrightarrow{Br_2}$

(c) $CH_3CH_3 \xrightarrow[h\upsilon]{Cl_2}$

(d) $(CH_3)_3CCl \xrightarrow{C_2H_5OH}$

59. What will be the main product when acetylene reacts with hypochlorous acid?

(a) Trichloroacetaldehyde

(b) Acetaldehyde

(c) Dichloroacetaldehyde

(d) Chloro acetaldehyde

60. The greenhouse effect is because of the

(a) presence of gases, which in general are strong infrared absorbers, in the atmosphere.

(b) presence of CO_2 only in the atmosphere.

(c) presence of O_3 and CH_4 in the atmosphere.

(d) N_2O and chlorofluorohydrocarbons in the atmosphere.

61. Due to Frenkel defect, the density of ionic solids

(a) decreases (b) increases

(c) does not change (d) changes

62. Equal weights of NaCl and KCl are dissolved separately in equal volumes of solutions. Molarity of the two solutions will be :
(a) Equal
(b) That of NaCl will be less than that of KCl
(c) That of NaCl will be more than that of KCl solution
(d) That of NaCl will be about half of that of KCl solution

63. A current of 2.0 A passed for 5 hours through a molten metal salt deposits 22.2 g of metal (At wt. = 177). The oxidation state of the metal in the metal salt is
(a) +1 (b) +2 (c) +3 (d) +4

64. The electrolytic cells, one containing acidified ferrous chloride and another acidified ferric chloride are connected in series. The ratio of iron deposited at cathodes in the two cells when electricity is passed through the cells will be
(a) 3 : 1 (b) 2 : 1 (c) 1 : 1 (d) 3 : 2

65. Velocity constant of a reaction at 290 K was found to be 3.2×10^{-3}. At 300 K it will be
(a) 1.28×10^{-2} (b) 9.6×10^{-3}
(c) 6.4×10^{-3} (d) 3.2×10^{-4}

66. At high pressure, the entire surface gets covered by a monomolecular layer of the gas follows
(a) three-halved order (b) second-order
(c) first-order (d) zero-order

67. Which of the following is incorrect with respect to property indicated ?
(a) E.N : F > Cl > Br
(b) E.A : Cl > F > Br
(c) Oxidising power : $F_2 > Cl_2 > Br_2$
(d) Bond energy : $F_2 > Cl_2 > Br_2$

68. Strong reducing behaviour of H_3PO_2 is due to
(a) presence of one –OH group and two P–H bonds
(b) high electron gain enthalpy of phosphorus
(c) high oxidation state of phosphorus
(d) presence of two –OH groups and one P–H bond

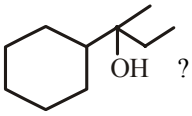
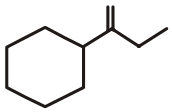
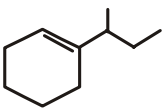
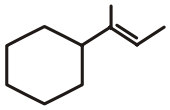
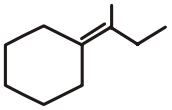
69. The pair in which both species have same magnetic moment (spin only value) is :
(a) $[Cr(H_2O)_6]^{2+}, [CoCl_4]^{2-}$
(b) $[Cr(H_2O_6)^{2+}, [Fe(H_2O)_6]^{3+}$
(c) $[Mn(H_2O)_6)^{2+}, [Cr(H_2O)_6]^{2+}$
(d) $[CoCl_4)^{2-}, [Fe(H_2O)_6]^{2+}$

70. Which of the following is less acidic among the given halogen compounds?
(a) CHF_3 (b) CHI_3
(c) $CHCl_3$ (d) $CHBr_3$

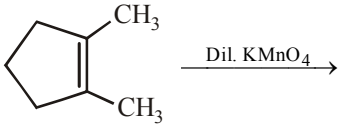
71. In a S_N2 substitution reaction of the type

$$R-Br + Cl^- \xrightarrow{DMF} R-Cl + Br^-$$

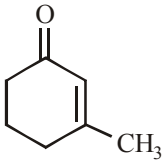
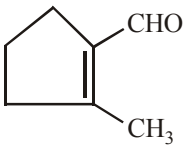
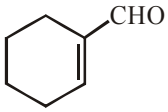
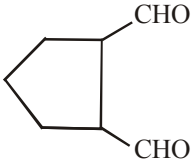
which one of the following has the highest relative rate ?
(a) $CH_3-CH_2-CH_2Br$
(b) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2Br$
(c) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2Br$
(d) CH_3CH_2Br

72. Which of the following is not the product of dehydration of  ?
(a) 
(b) 
(c) 
(d) 

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



$$A \xrightarrow{HIO_4} B \xrightarrow{OH^-} C$$

(a) 
(b) 
(c) 
(d) 

74. Nucleophilic addition reaction will be most favoured in

(a) $(CH_3)_2C=O$

(b) CH_3CH_2CHO

(c) CH_3CHO

(d) $CH_3-CH_2-CH_2\overset{\overset{O}{\|}}{C}-CH_3$

75. Identify the prdouct C in the series

$$CH_3CN \xrightarrow{Na/C_2H_5OH} A \xrightarrow{HNO_2} B \xrightarrow{Cu/573K} C$$

(a) CH_3COOH (b) CH_3CH_2NHOH

(c) CH_3CONH_2 (d) CH_3CHO

76. When NH_3 is passed over heated metal A, its amide is formed. The metal is

(a) Mg (b) K (c) Al (d) Pb

77. Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories ?

(a) An enzyme (b) A hormone

(c) A co-enzyme (d) An antibiotic

78. Which statement is incorrect about peptide bond?

(a) C–N bond length in proteins is longer than usual C–N bond length.

(b) Spectroscopic analysis shows planar structure of $-\overset{\overset{O}{\|}}{C}-NH-$ bond.

(c) C–N bond length in proteins is smaller than usual C–N bond length.

(d) None of these

79. A mixture of chlorides of copper, cadmium, chromium, iron and aluminium was dissolved in water acidified with HCl and hydrogen sulphide gas was passed for sufficient time. It was filtered, boiled and a few drops of nitric acid were added while boiling. To this solution ammonium chloride and sodium hydroxide were added and filtered. The filterate shall give test for.

(a) Sodium and iron

(b) Sodium and aluminium

(c) Aluminium and iron

(d) Sodium, iron, cadmium and Al

80. Volume of 3% solution of sodium carbonate necessary to neutralise a litre of 0.1 N sulphuric acid

(a) 176.66 ml (b) 156.6 ml

(c) 116.0 ml (d) 196.1 ml

PART - III : MATHEMATICS

81. A class has 175 students. The following data shows the number of students obtaining one or more subjects. Mathematics 100, Physics 70, Chemistry 40; Mathematics and Physics 30, Mathematics and Chemistry 28, Physics and Chemistry 23; Mathematics, Physics and Chemistry 18. How many students have offered Mathematics alone?

(a) 35 (b) 48 (c) 60 (d) 22

82. If $x\sin^3\theta + y\cos^3\theta = \sin\theta\cos\theta$ and $x\sin\theta = y\cos\theta$, then $x^2 + y^2 =$

(a) 1 (b) 2

(c) 0 (d) None of these

83. If $\cos 7\theta = \cos\theta - \sin 4\theta$, then the general value of θ is

(a) $\frac{n\pi}{6}, \frac{n\pi}{3} + (-1)^n \frac{\pi}{18}$

(b) $\frac{n\pi}{3}, \frac{n\pi}{3} + (-1)^n \frac{\pi}{18}$

(c) $\frac{n\pi}{4}, \frac{n\pi}{3} \pm \frac{\pi}{18}$

(d) $\frac{n\pi}{4}, \frac{n\pi}{3} + (-1)^n \frac{\pi}{18}$

84. If the real part of $\frac{\bar{z}+2}{\bar{z}-1}$ is 4, $z \neq 1$, then the locus of the point representing z in the complex plane is

(a) a straight line parallel to x-axis

(b) a straight line equally inclined to axes

(c) a circle with radius 2

(d) a circle with radius $\frac{1}{2}$

85. If α and β are the roots of $x^2 - x + 1 = 0$, then the equation whose roots are α^{100} and β^{100} are

(a) $x^2 - x + 1 = 0$ (b) $x^2 + x - 1 = 0$

(c) $x^2 - x - 1 = 0$ (d) $x^2 + x + 1 = 0$

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

(a) $[-3, 3] \cup (-\infty, -4) \cup (4, \infty)$

(b) $(-\infty, -4) \cup (4, \infty)$

(c) $(-\infty, -3) \cup (4, \infty)$

(d) $(-\infty, -3) \cup (3, \infty)$

87. If x satisfies $|3x-2|+|3x-4|+|3x-6| \geq 12$, then

(a) $0 \leq x \geq \frac{8}{3}$ (b) $x \geq \frac{8}{3}$ or $\frac{-4}{3}$

(c) $x \leq 0$ or $x \geq \frac{8}{3}$ (d) $x \geq 2$ only

88. In how many ways can 5 boys and 5 girls be seated at a round table so that no two girls may be together ?

(a) 4! (b) 5! (c) 4! + 5! (d) 4! × 5!

89. A box contains two white balls, three black balls and four red balls. In how many ways can three balls be drawn from the box if at least one black ball is to be included in the draw?

(a) 64 (b) 129

(c) 84 (d) None of these

90. The coefficient of the middle term in the expansion of $(2+3x)^4$ is :

(a) 6 (b) 5! (c) 8! (d) 216

91. If $C_0, C_1, C_2, \ldots\ldots\ldots\ldots C_n$ denote the binomial coefficients in the expansion of $(1+x)^n$, then the value of

$C_0 + (C_0 + C_1) + (C_0 + C_1 + C_2) + \ldots.$

$+ (C_0 + C_1 + \ldots.. + C_{n-1})$

(a) $n.2^{n-1}$ (b) $n.2^n$

(c) $(n-1).2^{n-1}$ (d) $(n-1).2^n$

92. The sum of the series

$1 + 2.2 + 3.2^2 + 4.2^3 + \ldots. + 100.2^{99}$ is

(a) $100.2^{100} + 1$ (b) $99.2^{100} + 1$

(c) $99.2^{100} - 1$ (d) $100.2^{100} + 1$

93. The quadratic equation whose roots are the x and y intercepts of the line passing through (1, 1) and making a triangle of area A with the co-ordinate axes is

(a) $x^2 + Ax + 2A = 0$

(b) $x^2 - 2Ax + 2A = 0$

(c) $x^2 - Ax + 2A = 0$

(d) None of these

94. If $4a^2 + b^2 + 2c^2 + 4ab - 6ac - 3bc = 0$, the family of lines $ax + by + c = 0$ is concurrent at one or the other of the two points-

(a) $\left(-1, -\frac{1}{2}\right), (-2, -1)$

(b) $(-1, -1), \left(-2, -\frac{1}{2}\right)$

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

(d) $(1, 2), \left(\frac{1}{2}, -1\right)$

95. A pair of tangents are drawn from the origin to the circle $x^2 + y^2 + 20(x + y) + 20 = 0$, then the equation of the pair of tangent are

(a) $x^2 + y^2 - 5xy = 0$

(b) $x^2 + y^2 + 2x + y = 0$

(c) $x^2 + y^2 - xy + 7 = 0$

(d) $2x^2 + 2y^2 + 5xy = 0$

96. An ellipse has *OB* as semi minor axis, *F* and *F'* its focii and the angle *FBF'* is a right angle. Then the eccentricity of the ellipse is

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{2}$ (c) $\frac{1}{4}$ (d) $\frac{1}{\sqrt{3}}$

97. If the line $2x - 3y = k$ touches the parabola $y^2 = 6x$, then find the value of k.

(a) –15/4 (b) –27/4 (c) –1/4 (d) –3/4

98. S and T are the foci of an ellipse and B is an end of the minor axis. If STB is an equilateral triangle, then the eccentricity of the ellipse is

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) $\frac{2}{3}$

99. Let $f(x) = (x^5 - 1)(x^3 + 1), g(x) = (x^2 - 1)(x^2 - x + 1)$ and let h(x) be such that $f(x) = g(x)h(x)$. Then $\lim_{x \to 1} h(x)$ is

(a) 0 (b) 1 (c) 3 (d) 5

100. In the truth table for the statement $(p \wedge q) \rightarrow (q \vee \sim p)$, the last column has the truth value in the following order is

(a) TTFF (b) FTTT

(c) TFTT (d) TTTT

101. If the value of mode and mean is 60 and 66 respectively, then the value of median is

(a) 70 (b) 64 (c) 90 (d) 50

102. Find the variance of the data given below

Size of item	3.5	4.5	5.5	6.5	7.5	8.5	9.5
Frequency	3	7	22	60	85	32	8

(a) 1.29 (b) 2.19

(c) 1.32 (d) None of these

103. Let R be the relation on the set R of all real numbers, defined by aRb If $|a-b| \le 1$. Then, R is
(a) reflexive and symmetric only
(b) reflexive and transitive only
(c) equivalence
(d) None of the above

104. The greatest and least values of $(\sin^{-1} x)^2 + (\cos^{-1} x)^2$ are respectively

(a) $\frac{\pi^2}{4}$ and 0 (b) $\frac{\pi}{2}$ and $\frac{-\pi}{2}$

(c) $\frac{5\pi^2}{4}$ and $\frac{\pi^2}{8}$ (d) $\frac{\pi^2}{4}$ and $\frac{-\pi^2}{4}$

105. The value of

$$\cos\left[\frac{1}{2}\cos^{-1}\left(\cos\left(\sin^{-1}\frac{\sqrt{63}}{8}\right)\right)\right] \text{ is} -$$

(a) 3/16 (b) 3/8 (c) 3/4 (d) 3/2

106. The determinant $\begin{vmatrix} 1 & (x-3) & (x-3)^2 \\ 1 & (x-4) & (x-4)^2 \\ 1 & (x-5) & (x-5)^2 \end{vmatrix}$ vanishes for

(a) 3 values of x (b) 2 values of x
(c) 1 values of x (d) No value of x

107. If the lines $\ell x + my + n = 0$, $mx + ny + \ell = 0$ and $nx + \ell y + m = 0$ are concurrent then

(a) $\ell + m + n = 0$ (b) $\ell - m - n = 0$
(c) $\ell + m - n = 0$ (d) $m + n - \ell = 0$

108. If $y = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots\infty$, then $\frac{dy}{dx}$ is equal to

(a) x (b) 1
(c) y (d) None of these

109. If $f(x) = \begin{cases} \frac{x^2+3x-10}{x^2+2x-15}, & \text{when } x \ne -5 \\ a, & \text{when } x = -5 \end{cases}$

is continuous at $x = -5$, then the value of 'a' will be

(a) 3/2 (b) 7/8 (c) 8/7 (d) 2/3

110. The equation of all lines having slope 2 which are tangent to the curve $y = \frac{1}{x-3}, x \ne 3$, is

(a) $y = 2$ (b) $y = 2x$
(c) $y = 2x + 3$ (d) None of these

111. The function $f(x) = (x(x-2))^2$ is increasing in the set

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

112. If $a^2x^4 + b^2y^4 = c^4$, then the maximum value of xy is

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

113. $\int \frac{(x^2-1)}{(x^2+1)\sqrt{x^4+1}}dx$ is equal to

(a) $\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}x}\right)+c$

(b) $\frac{1}{\sqrt{2}}\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}x}\right)+c$

(c) $\frac{1}{\sqrt{2}}\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}}\right)+c$

(d) None of these

114. Evaluate $\int_0^{\pi/2} \frac{\sin x}{1+\cos^2 x}dx$

(a) $\pi/2$ (b) $\pi/4$ (c) $\pi/3$ (d) π

115. Area intercepted by the curves $y = \cos x$, $x \in [0, \pi]$ and $y = \cos 2x$, $x \in [0, \pi]$, is

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

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

(a) $\log \tan y + \sin x = C$

(b) $\log \tan \frac{y}{2} + 2\sin x = C$

(c) $\tan \frac{y}{2} + \log \sin x = C$

(d) None of these

117. The solution to the differential equation $\frac{dy}{dx} = \frac{yf'(x) - y^2}{f(x)}$ where $f(x)$ is a given function is

(a) $f(x) = y(x+c)$ (b) $f(x) = cxy$
(c) $f(x) = c(x+y)$ (d) $yf(x) = cx$

118. If $\vec{a}, \vec{b}, \vec{c}$ are three unit vectors such that $\vec{a}+\vec{b}+\vec{c}=\vec{0}$, where $\vec{0}$ is null vector, then $\vec{a}.\vec{b}+\vec{b}.\vec{c}+\vec{c}.\vec{a}$ is :

(a) -3 (b) -2 (c) $-\frac{3}{2}$ (d) 0

119. If vectors $2i-j+k$, $i+2j-3k$ and $3i+aj+5k$ are coplanar, then the value of a is

(a) 2 (b) –2 (c) –1 (d) –4

120. The coordinates of the point where the line through the points A (3, 4, 1) and B (5, 1, 6) crosses the XY-plane are

(a) $\left(\frac{13}{5}, \frac{23}{5}, 0\right)$ (b) $\left(-\frac{13}{5}, \frac{23}{5}, 0\right)$

(c) $\left(\frac{13}{5}, -\frac{23}{5}, 0\right)$ (d) $\left(-\frac{13}{5}, \frac{-23}{5}, 0\right)$

121. Find the angle between the two planes $2x+y-2z=5$ and $3x-6y-2z=7$.

(a) $\cos^{-1}(4/21)$ (b) $\cos^{-1}(2/21)$

(c) $\cos^{-1}(1/21)$ (d) $\cos^{-1}(5/21)$

122. For $k = 1, 2, 3$ the box B_k contains k red balls and $(k+1)$ white balls. Let $P(B_1)=\frac{1}{2}, P(B_2)=\frac{1}{3}$ and $P(B_3)=\frac{1}{6}$. A box is selected at random and a ball is drawn from it. If a red ball is drawn, then the probability that it has come from box B_2, is

(a) $\frac{35}{78}$ (b) $\frac{14}{39}$ (c) $\frac{10}{13}$ (d) $\frac{12}{13}$

123. The probability of India winning a test match against West Indies is 1/2. Assuming independence from match to match, the probability that in a 5 match series India's second win occurs at the third test, is –

(a) 2/3 (b) 1/2 (c) 1/4 (d) 1/8

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

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

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

125. A shopkeeper wants to purchase two articles A and B of cost price ` 4 and ` 3 respectively. He thought that he may earn 30 paise by selling article A and 10 paise by selling article B. He has not to purchase total articles worth more than ` 24. If he purchases the number of articles of A and B, x and y respectively, then linear constraints are

(a) $x \geq 0, y \geq 0, 4x+3y \leq 24$

(b) $x \geq 0, y \geq 0, 30x+10y \leq 24$

(c) $x \geq 0, y \geq 0, 4x+3y \geq 24$

(d) $x \geq 0, y \geq 0, 30x+40y \geq 24$

PART - IV : ENGLISH

DIRECTIONS (Qs. 126 - 128): Out of the four alternatives, choose the one which express the correct meaning of the word.

126. SAGACIOUS

(a) Shameless (b) Wise

(c) Powerless (d) Foolish

127. REMEDIAL

(a) Corrective (d) Proficient

(c) Damaging (d) Optional

128. RETICENT

(a) Confident (d) Sad

(c) Truthful (d) Secretive

DIRECTIONS (Qs. 129 - 131): Choose the word opposite is meaning to the given word.

129. FIDELITY

(a) Faith (b) Devotedness

(c) Allegiance (d) Treachery

130. INFRANGIBLE

(a) Complecated (d) Breakable

(c) Weird (d) Software

131. PROGENY

(a) Kid (b) Parent

(c) Friend (d) Enemy

DIRECTIONS (Qs. 132 - 134): A part of sentence is underlined. Below are given alternatives to the underlined part (a), (b), (c) and (d) which may improve the sentence. Choose the correct alternative.

132. It was not possible to <u>drag</u> any conclusion so he left the case.

(a) Fetch (b) Find

(c) Draw (d) No improvement

133. I am looking after my pen which is missing.
(a) Looking for (b) Looking in
(c) Looking back (d) No improvement

134. "Mind your language !" he shouted.
(a) change (b) inspect
(c) hold (d) No improvement

DIRECTIONS (Qs. 135 - 137): Fill in the blanks.

135. I ..... to go there when I was student.
(a) liked (b) used
(c) prefer (d) denied

136. She was angry ..... me.
(a) at (d) about
(c) with (d) in

137. You should not laugh ..... the poor.
(a) on (b) at
(c) with (d) over

DIRECTIONS (Qs. 138 - 140): In the questions below, each passage consists of six sentences. The first and sixth sentence are given in the beginning. The middle four sentences in each have been removed and jumbled up. These are labeled as P, Q, R and S. Find out people order for the four sentences.

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

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

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

141. In a certain code language 'DOME' is written as '8943' and 'MEAL' is written as '4321'. What group of letters can be formed for the code '38249'?
(a) EOADM (b) MEDOA
(c) EMDAO (d) EDAMO

142. Find the missing number from the given response.

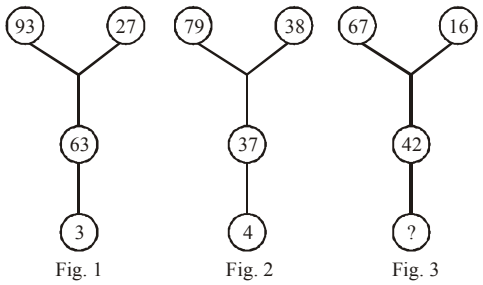
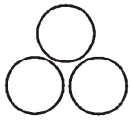
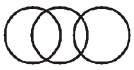


Fig. 1 Fig. 2 Fig. 3

(a) 5 (b) 6 (c) 8 (d) 9

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

(a)  (b) 

(c)  (d) 

144. Sushma walks 20m towards north. Then she turns right and walks 30m. Now, she turns right and walks 35m. Now turning left, she walks 15m. Again, she turns left and moves 15m. Finally, she turns left and walks 15m. In which direction and how far is she from her original position.
(a) 15m East (b) 30 m East
(c) 15m West (d) 45 m West

145. In a classroom, there are 5 rows and 5 children A, B, C, D and E are seated one behind the other in 5 separate rows as follows.
- A is sitting behind C but in front of B.
- C is sitting behind E and D is sitting in front of E.
- The order in which they are sitting from the first row to the last is

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

146. Which of the following will fill the series?
2, 9, 28, ? , 126
(a) 64 (b) 65 (c) 72 (d) 56

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

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

(a) + and – (b) × and ÷

(c) ÷ and – (d) ÷ and +

148. **Assertion: [A]** India is a democratic country.
Reason: [R] India has a constitution of its own. Choose the correct alternative from the given options.

(a) Both (A) and (R) are true and (R) is correct explanation of (A).

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

(c) (A) is true (R) is false.

(d) (A) is false (R) is true.

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

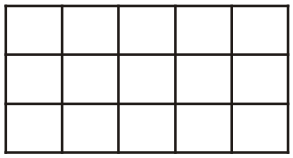
(a) 

(b) 

(c) 

(d) 

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



(a) 24 (b) 25 (c) 26 (d) 27

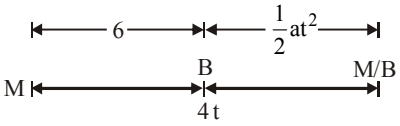
SOLUTIONS

PART - I : PHYSICS

1. **(a)** It can be observed that component of acceleration perpendicular to velocity is $a = 4\ m/s^2$

$$\therefore \text{radius} = \frac{v^2}{a_c} = \frac{(2)^2}{4} = 1 \text{ metre}$$

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



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

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

3. **(a)** Let $V = kT^a A^b \rho^c$,

k = dimensional constant

Writing dimension on both we side

$[LT^{-1}] = [MLT^{-2}]^a [L^2]^b [ML^{-3}]^c$

$= [M^{a+c} L^{a+2b-3c} T^{-2a}]$

Comparing power on both sides we have

$a + c = 0,\ \ a + 2b - 3c = 1,\ \ -2a = -1$

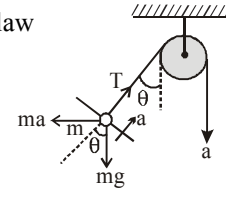
$$\therefore \quad a = \frac{1}{2},\ c = -\frac{1}{2} \Rightarrow b = -\frac{1}{2} \ \therefore V = k\sqrt{\frac{T}{A\rho}}$$

4. **(d)** Here velocity is acting upwards when projectile is going upwards and acceleration is downwards. The angle θ between $\vec{v}$ and $\vec{a}$ is more than 0° and less than 180°.

5. **(b)** The condition to avoid skidding,

$v = \sqrt{\mu r g} = \sqrt{0.6 \times 150 \times 10} = 30$ m/s.

6. **(c)** Applying Newton's law along string

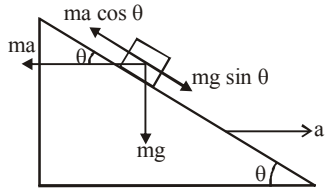


$$\Rightarrow T - m\sqrt{g^2 + a^2} = ma$$

or $T = m\sqrt{g^2 + a^2} + ma$

7. **(c)** Let the mass of block is m. It will remains stationary if forces acting on it are in equilibrium. i.e., ma cos θ = mg sin θ

$\Rightarrow a = g \tan\theta$



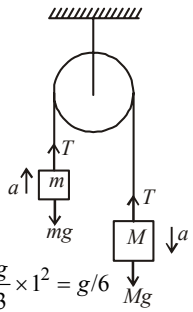
Here ma = Pseudo force on block,

mg = weight.

8. **(c)**

9. **(c)** Given $m = 0.36$ kg, $M = 0.72$ kg.

The figure shows the forces on m and M. When the system is released, let the acceleration be a. Then



$T - mg = ma$

$Mg - T = Ma$

$$\therefore \quad a = \frac{(M-m)g}{M+m} = g/3$$

and $T = 4\,mg/3$

For block m :

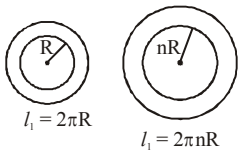
$u = 0,\ a = g/3,\ t = 1,\ s = ?$

$$s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times \frac{g}{3} \times 1^2 = g/6$$

$\therefore$ Work done by the string on m is

$$\vec{T}.\vec{s} = Ts = 4\frac{mg}{3} \times \frac{g}{6} = \frac{4 \times 0.36 \times 10 \times 10}{3 \times 6} = 8\,\text{J}$$

10. **(a)** Ratio of moment of inertia of the rings



$$\frac{I_1}{I_2} = \left(\frac{M_1}{M_2}\right)\left(\frac{R_1}{R_2}\right)^2$$

$$= \left(\frac{\lambda l_1}{\lambda l_2}\right)\left(\frac{R_1}{R_2}\right)^2 = \left(\frac{2\pi R}{2\pi nR}\right)\left(\frac{R}{nR}\right)^2$$

(λ = linear density of wire = constant)

$$\Rightarrow \quad \frac{I_1}{I_2} = \frac{1}{n^3} = \frac{1}{8} \qquad \text{(given)}$$

$\therefore \quad n^3 = 8 \Rightarrow n = 2$

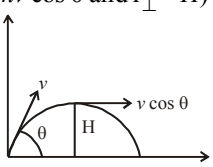
11. **(d)** Angular momentum $L_0 = pr_\perp$

($\because$ linear momentum $p = mv\cos\theta$ and $r_\perp = H$)

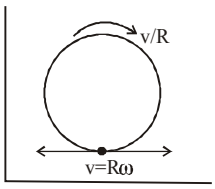
$\Rightarrow L_0 = mv\cos\theta H$

$$= mv\frac{\sqrt{3}}{2} \cdot \frac{v^2 \sin^2 30°}{2g}$$

$$= \frac{\sqrt{3}\,mv^3}{16g}$$



12. **(d)** As the disc is in combined rotation and translation, each point has a tangential velocity and a linear velocity in the forward direction. From figure v_{net} (for lowest point) $= v - R\omega = v - v = 0$ and acceleration



$$= \frac{v^2}{R} + 0 = \frac{v^2}{R}$$

(since linear speed is constant)

13. **(d)** Gravitaional field inside the shell is zero, so no work required.

14. **(d)** **15.** **(b)**

16. **(c)** Heat current in first rod (copper)

$$= \frac{390 \times A(0-\theta)}{\ell}$$

Here θ is temperature of the junction and A & ℓ are area and length of copper rod.

Heat current in second rod (steel)

$$= \frac{46 \times A(\theta - 100)}{\ell}$$

In series combination, heat current remains same. So,

$$\frac{390 \times A(0-\theta)}{\ell} = \frac{46 \times A(\theta - 100)}{\ell}$$

$-390\,\theta = = 46\,\theta - 4600$

$436\,\theta = 4600 \Rightarrow \theta = 10.6^{\circ}C$

17. **(d)** Stefan's law for black body radiation

$Q = \sigma e A T^4$

$$T = \left[\frac{Q}{\sigma(4\pi R^2)}\right]^{1/4}$$

Here $e = 1$

$A = 4\pi R^2$

18. **(d)** For all process

$\Delta U = \Delta Q - \Delta W$

does not change as it depends on initial final states.

19. **(a)** The efficiency of the heat engine is

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \left(\frac{273 + 27K}{273 + 427K}\right) = \frac{4}{7}$$

But $\eta = \frac{W}{Q_1}$

$$\therefore Q_1 = \frac{W}{\eta} = \frac{1.0kW}{4/7} = 1.75kW = 0.417\ kcal/s$$

Thus, the engine would require 417 cal of heat per second, to deliver the requisite amount of work.

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

We can write, $p_1V = n_1RT_1$ and $p_2V = n_2RT_2$

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

$$\Rightarrow p_2 = 2p$$

21. **(d)** We know, $V_{rms} = \sqrt{\frac{3RT}{M}}$

$\Rightarrow$ % increase in

$$V_{rms} = \frac{\sqrt{\frac{3RT_2}{M}} - \sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_1}{M}}} \times 100$$

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

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

$$= \frac{20 - 17.32}{17.32} \times 100 = 15.5\%$$

22. **(b)** We know that

$P_AV_A = n_ART$, $P_BV_B = n_BRT$

and $P_f(V_A + V_B) = (n_A + n_B)RT$

$P_f(V_A + V_B) = P_AV_A + P_BV_B$

$$\therefore P_f = \left(\frac{P_AV_A + P_BV_B}{V_A + V_B}\right)$$

$$= \frac{1.4 \times 0.1 + 0.7 \times 0.15}{0.1 + 0.15}\ MPa = 0.98\ MPa$$

23. **(a)** Velocity, $v = \frac{dx}{dt} = -A\,\omega \sin(\omega t + \pi/4)$

Velocity will be maximum, when

$\omega t + \pi/4 = \pi/2$ or $\omega t = \pi/2 - \pi/4 = \pi/4$

or $t = \pi/4\omega$

24. **(c)** Velocity of wave $v = n\lambda$

where n = frequency of wave $\Rightarrow n = \frac{v}{\lambda}$

$$n_2 = \frac{v_2}{\lambda_2} = \frac{396}{100 \times 10^{-2}} = 396\ Hz$$

no. of beats $= n_1 - n_2 = 4$

25. **(d)** $y = x_0 \cos 2\pi\left(nt - \frac{x}{\lambda}\right)$

$y = x_0 \cos\frac{2\pi}{\lambda}(vt - x)$ $\quad [\because v = n\lambda]$

$\left(\frac{dy}{dt}\right)_{max} = x_0 \times \frac{2\pi}{\lambda}\,v = 2v$(given) $\therefore \lambda = \pi x_0$

26. (b) $F_{net} = \sqrt{F^2 + F^2 + 2F^2\cos 60°} = \sqrt{3}F$

27. (a) Initial energy of combined system

$$U_1 = \frac{1}{2}CV_1^2 + \frac{1}{2}CV_2^2$$

Final common potential, $V = \frac{V_1 + V_2}{2}$,

Final energy of system,

$$U_2 = 2 \times \frac{1}{2}C\left(\frac{V_1 + V_2}{2}\right)^2$$

Hence loss of energy = $U_1 - U_2$

$$= \frac{1}{4}C\left(V_1 - V_2\right)^2$$

28. (d) Fuse wire should be such that it melts immediatley when strong current flows through the circuit. The same is possible if its melting point is low and resistivity is high.

29. (b) $\therefore 4i_1 + 2(i_1 + i_2) - 3 + 4i_1 = 16V$ ...(i)

Using Kirchhoff's second law in the closed loop we have

$9 - i_2 - 2(i_1 + i_2) = 0$ ...(ii)

Solving equations (i) and (ii), we get

$i_1 = 1.5\,A$ and $i_2 = 2\,A$

$\therefore$ current through 2W resistor = 2 + 1.5 = 3.5 A.

30. (b) The magnetic field at C due to first conductor is $B_1 = \frac{\mu_0}{2\pi}\frac{I}{3d/2}$ (since, point C is separated by $d + \frac{d}{2} = \frac{3d}{2}$ from 1st conductor). The direction of field is perpendicular to the plane of paper and directed outwards.

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

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

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

$$B_1 = B_2$$

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

On solving I = 30.0 A

31. (b) $\vec{v}$ and $\vec{B}$ are in same direction so that magnetic force on electron becomes zero, only electric force acts. But force on electron due to electric field is opposite to the direction of velocity.

32. (a)

33. (d) $M = \frac{\mu_0 N_1 N_2 A}{\ell}$

$$= \frac{4\pi \times 10^{-7} \times 300 \times 400 \times 100 \times 10^{-4}}{0.2}$$

$$= 2.4\pi \times 10^{-4}\,H$$

34. (c) $\frac{I_S}{I_P} = \frac{N_P}{N_S} = \frac{1}{4} \Rightarrow I_S = \frac{1}{4} \times 4 = 1\,A$

35. (c)

36. (b) Frequency does not change on refraction.

37. (b) Cutting a lens in transverse direction doubles their focal length i.e. 2*f*.

Using the formula of equivalent focal length,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \frac{1}{f_4}$$

We get equivalent focal length as *f*/2.

38. (b) $n_1\lambda_1 = n_2\lambda_2$

$10 \times 7000 = n_2 \times 5000 \Rightarrow n_2 = 14$

39. (b) I $\rightarrow$ ON

II $\rightarrow$ OFF

In II[nd] state it is used as a amplifier it is active region.

40. (b) $Y = A + (\bar{A}.B) = (A + \bar{A}).(A + B)$

$= A + B$

$\Rightarrow$ OR gate

PART - II : CHEMISTRY

41. (d) $\text{Molarity (M)} = \frac{\text{wt} \times 1000}{\text{mol. wt.} \times \text{vol (mL)}}$

$2 = \frac{\text{wt.}}{63} \times \frac{1000}{250}$

$\text{wt.} = \frac{63}{2}\,g$

$\text{wt. of 70\% acid} = \frac{100}{70} \times 31.5 = 45\,g$

42. (d) Radius of hydrogen atom = 0.530 Å, Number of excited state (*n*) = 2 and atomic number of hydrogen atom (Z) = 1. We know that the Bohr radius.

$(r) = \frac{n^2}{Z} \times \text{Radius of atom} = \frac{(2)^2}{1} \times 0.530$

$= 4 \times 0.530 = 2.12$ Å

43. (d) The screening effect of inner electron of the nucleus causes the decrease in ionization potential, therefore the order of the screening effect is

$$f < d < p < s$$

Hence, the screening effect of *d*-electron is less than *p*-electron.

44. (b) Rare gases; as the e^- is to be removed from stable configuration.

45. (c) Amongst isoelectronic species, ionic radii of anion is more than that of cations. Further size of anion increase with increase in –ve charge and size of cation decrease with increase in + ve charge. Hence ionic radii decreases from O^- to Al^{3+}.

46. (b) B_2 and O_2 are paramagnetic due to presence of unpaired electron. MO electronic configuration of B_2 is :

$$\sigma 1s^2\, \sigma^* 1s^2\, \sigma 2s^2\, \sigma^* 2s^2\, \pi 2p_x^1 = \pi 2p_y^1$$

MO electorn i.e. configuration of O_2 is :

$$\sigma 1s^2\, \sigma^* 1s^2\, \sigma 2s^2\, \sigma^* 2s^2 \sigma 2p_z^2\, \pi 2p_x^2$$

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

47. (b) RMS velocity of molecules depends on mass. If mol. wt. increases, rms velocity of melocules decreases.

$$\text{rms} \propto \frac{1}{\sqrt{\text{m.wt}}}$$

The order of increasing m. wt. is

$$H_2 < N_2 < O_2 < HBr$$

Order of V_{rms} of molecules.

$$HBr < O_2 < N_2 < H_2 .$$

48. (a) $\Delta H = \Delta H_{(product)} - \Delta H_{(reactant)}$

$$162 = 2 \times \Delta H_H - \Delta H_{H_2}$$

$$\Delta H_H = \frac{162}{2} \quad (\because \Delta H_{H_2} = 0)$$

$$\Delta H_H = 81 \text{ Kcal}$$

49. (c) By bomb calorimeter we get ΔE.

$$2C_6H_6(l) + 15\,O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(l)$$

$$\Delta H - \Delta E = \Delta nRT$$

$$= (12 - 15) \times 8.314 \times 300 = -7.483 \text{ kJ}$$

50. (b) $I_2 \rightleftharpoons 2I^-$

$1 - x \qquad 2x$

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

It shows that $(1 - x) < 2x$

51. (c) $K_p = K_c(RT)^{\Delta n}$;

$$\Delta n = 1 - \left(1 + \frac{1}{2}\right) = 1 - \frac{3}{2} = -\frac{1}{2}$$

$$\therefore \quad \frac{K_p}{K_c} = (RT)^{-1/2}$$

52. (c) $Na_2S_4O_6$

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

$$4x - 10 = 0$$

$$x = \frac{10}{4} = \frac{+5}{2}$$

Oxidation state of S is $= \frac{+5}{2}$

53. (a) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

$\therefore$ Ratio of volumes of H_2 evolved is 1 : 1

54. (d) The stability of alkali metal hydrides decreases from Li to Cs. It is due to the fact that M–H bonds becomes weaker with increase in size of alkali metals as we move down the group from Li to Cs. Thus the order of stability of hydrides is

$LiH > NaH > KH > RbH > CsH$

55. (d) $-NO_2$ group, being strong electron withdrawing, disperses the –ve charge, hence stabilizes the concerned carbanion.

56. (a) A chiral object or structure has four different groups attached to the carbon.

57. (d) The structure $CH_3\overset{*}{C}HBr\overset{*}{C}HBrCOOH$ has two different chiral carbon atoms, hence number of enantiomers (optically active forms) is $2^n = 2^2 = 4$

58. (a) Electrolysis of a concentrated aqueous solution of either sodium or potassium salts of saturated carboxylic acids yields higher alkane at anode.

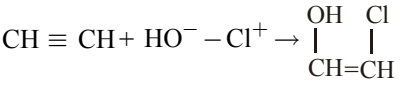
$$2RCOOK \xrightarrow[\text{Oxidation}]{\text{Electrolytic}} \underset{\text{Anode}}{2RCOO^-} + \underset{\text{Cathode}}{2K^+}$$

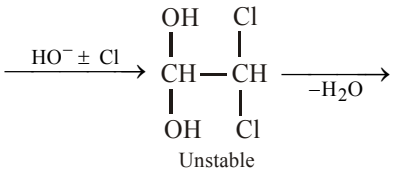
At anode $2RCOO^- \rightarrow 2RCOO + 2e^- \longrightarrow R{-}R + 2CO_2$

At Cathode $2K^+ + 2e^- \rightarrow 2K$

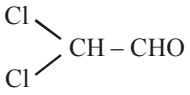
$$2K + H_2O \rightarrow 2KOH + H_2 \uparrow$$

(Kolbe's Method)

59. (c) $CH \equiv CH + HO^- - Cl^+ \rightarrow$ 



Unstable



2 , 2-Dichloro -acetaldehyde

60. (a) Green house gases such as CO_2, ozone, methane, the chlorofluoro carbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.

61. (c) No change in density.

62. (c) When equal weights of different solutes are present in equal volumes of solution the molarity is inversely related to molecular mass of the solute. Mol. mass of NaCl is less than KCl. Hence, molarity of NaCl solution will be more.

63. (c) $m = \frac{E.wt \times Q}{96500}$;

$$\therefore \text{ E.wt} = \frac{m \times 96500}{Q}$$

$$= \frac{22.2 \times 96500}{2 \times 5 \times 60 \times 60} = 60.3$$

$$\text{Oxidation state} = \frac{\text{At wt.}}{\text{Eq. wt.}} = \frac{177}{60.3} = 3$$

64. (d) At cathodes : $Fe^+ + 2e^- \longrightarrow Fe$;

$Fe^{3+} + 3e^- \longrightarrow Fe$

$$(E_{Fe})_1 = \frac{\text{At. wt.}}{2}; \quad (E_{Fe})_2 = \frac{\text{At. wt.}}{3}$$

$$\text{Hence, } \frac{(E_{Fe})_1}{(E_{Fe})_2} = \frac{3}{2}$$

65. (c) The velocity constant doubles for every 10°C rise in temperature.

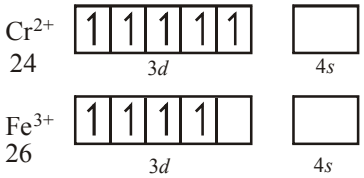
66. (d) At high pressure the extent of adsorption follows zero order kinetics.

67. (d) F_2 is expected to have highest bond energy but the correct decreasing order is $Cl_2 > Br_2 > F_2$ because of fluorine atom has very small size due to which there is a high inter electronic repulsion between two fluorine atoms so the bond between two fluorine gets weaker and need less energy.

68. (a) The acids which contain P–H bond have strong reducing properties. Thus H_3PO_2 acid is good reducing agent as it contains two P–H bonds. For example, it reduces $AgNO_3$ to metallic silver.

$$4\,AgNO_3 + 2H_2O + H_3PO_2 \longrightarrow$$
$$4Ag + 4HNO_3 + H_3PO_4$$

69. (b) $[Cr(H_2O)_6]^{2+}$ Cr is in Cr^{2+} form



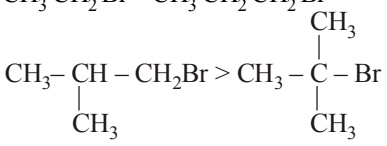
In $[Fe(H_2O)]^{2+}$ Fe^{2+} form. Both will have 4 unpaired electrons.

70. (a) Due to stronger–I-effect of F than that of Cl, CHF_3 should be more acidic than $CHCl_3$. But actually reverse is true.

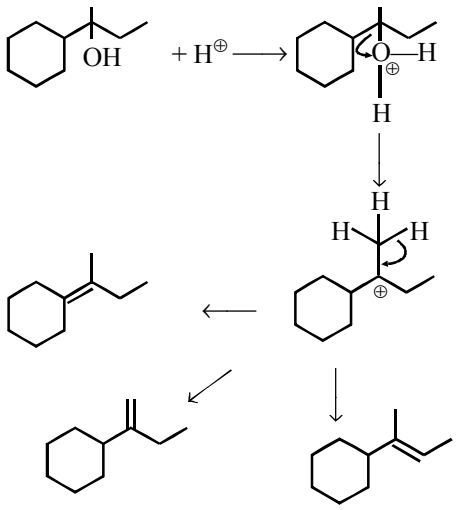
This is due to : CCl_3^- left after the removal of a proton from $CHCl_3$ is stabilised due to presence of *d*-orbitals in Cl than: CF_3^- left after the removal of a proton from CHF_3 which is not stabilised due to the absence of *d*-orbitals on F.

71. (d) S_N2 mechanism is followed in case of primary and secondary halides i.e., S_N2 reaction is favoured by small groups on the carbon atom attached to halogens so

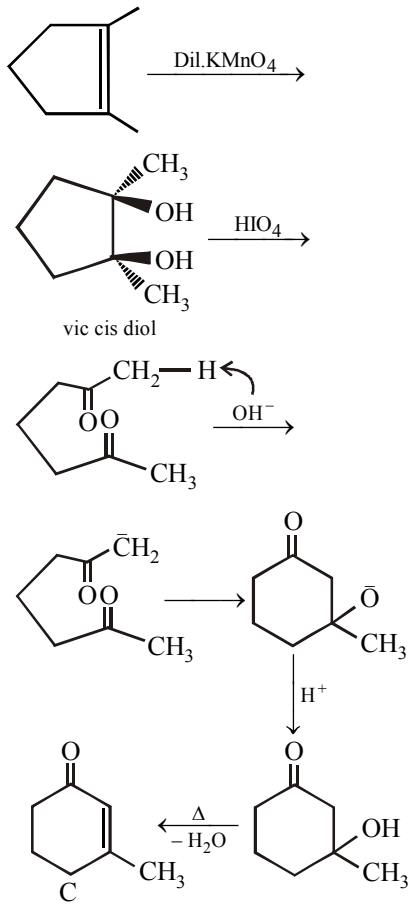
$$CH_3CH_2Br > CH_3CH_2CH_2Br >$$



72. (b)



73. (a)



74. (c) Aldehydes are more reactive than ketones due to +I effect of $-CH_3$ group. There are two $-CH_3$ group in acetone which reduces +ve charge density on carbon atom of carbonyl group. More hindered carbonyl group becomes less reactive. So in the given case CH_3CHO is the right choice.

75. (d) $CH_3CN \xrightarrow{Na/C_2H_5OH} \underset{(A)}{CH_3CH_2NH_2} \xrightarrow{HNO_2} \underset{(B)}{CH_3CH_2OH} \xrightarrow[573\ K]{Cu} \underset{(C)}{CH_3CHO}$

76. (b) When Potassium is treated with ammonia, then potassium amide is obtained.

$$K + NH_3 \longrightarrow \underset{\text{Pot. amide}}{KNH_2} + \frac{1}{2}H_2$$

77. (b) Insulin is a biochemically active peptide harmone secreted by pancreas.

78. (a) Due to resonance,

, C – N bond acquires some double bond character, hence shorter in length.

79. (b) CuS and CdS are precipitated by H_2S. Hydroxide of Al will pass into the solution in the form of $NaAlO_2$ being amphoteric in nature. Hence filtrate will give test for sodium and aluminium.

80. (a) Normality of 3% Na_2CO_3.

$$N = \frac{3\times1000}{53\times100} = 0.566\ N$$

For H_2SO_4 sol. $N_1 = 0.1$, $V_1 = 100$ mL

For Na_2CO_3 sol. $N_2 = 0.566$.

Now apply $N_1V_1 = N_2V_2$

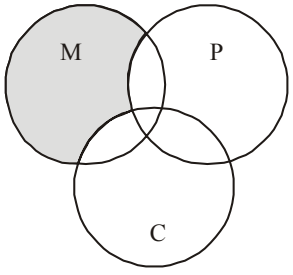
$$V_2 = \frac{N_1V_1}{N_2} = \frac{0.1\times1000\ mL}{0.566} = 176.66mL$$

PART - III : MATHEMATICS

81. (c) n (M alone)

$= n(M) - n(M\cap C) - n(M\cap P) + n(M\cap C\cap P)$

$= 100 - 28 - 30 + 18 = 60$



82. **(a)** $x\sin^3\theta + y\cos^3\theta = \sin\theta\cos\theta$ ....(i)

and $x\sin\theta = y\cos\theta$ ...(ii)

Equation (i) may be written as

$x\sin\theta.\sin^2\theta + y\cos^3\theta = \sin\theta\cos\theta$

$\Rightarrow y\cos\theta\sin^2\theta + y\cos^3\theta = \sin\theta\cos\theta$

$\Rightarrow y\cos\theta(\sin^2\theta + \cos^2\theta) = \sin\theta\cos\theta$

$\Rightarrow y\cos\theta = \sin\theta\cos\theta \ \therefore \ y = \sin\theta$ ...(iii)

Putting the value of y from (iii) in (ii), we get

$x\sin\theta = \sin\theta.\cos\theta \Rightarrow x = \cos\theta$ ...(iv)

Squaring (iii) and (iv) and adding , we get

$x^2 + y^2 = \cos^2\theta + \sin^2\theta = 1$

83. **(d)** $\cos 7\theta = \cos\theta - \sin 4\theta$

$\Rightarrow \sin 4\theta = \cos\theta - \cos 7\theta$

$\Rightarrow \sin 4\theta = 2\sin 4\theta \sin 3\theta$

$\Rightarrow \sin 4\theta(1 - 2\sin 3\theta) = 0$

$\therefore \sin 4\theta = 0 \ or \ \sin 3\theta = \frac{1}{2}$

$\Rightarrow 4\theta = n\pi \ or \ 3\theta = n\pi + (-1)^n \frac{\pi}{6}$

$\Rightarrow \theta = \frac{n\pi}{4} \ or \ \frac{n\pi}{3} + (-1)^n \frac{\pi}{18}$

84. **(d)** Real part of $\frac{\bar{z}+2}{\bar{z}-1}$ is given by

$$\frac{1}{2}\left[\frac{\bar{z}+2}{\bar{z}-1} + \left(\frac{\bar{z}+2}{\bar{z}-1}\right)\right] = 4$$

$$\Rightarrow \frac{\bar{z}+2}{\bar{z}-1} + \frac{z+2}{z-1} = 8$$

$$\Rightarrow z\bar{z} - \bar{z} + 2z - 2 + z\bar{z} + 2\bar{z} - z - 2 = 8(z\bar{z} - \bar{z} - z + 1)$$

$$\Rightarrow z\bar{z} - \frac{3}{2}z - \frac{3}{2}\bar{z} + 2 = 0 \quad \text{..... (i)}$$

Comparing with the equation

$z\bar{z} + \bar{a}z + a\bar{z} + b = 0$, we get $a = -\frac{3}{2}$ and $b = 2$. Thus, the locus of z given by the equation

(i) is a circle with centre $\frac{3}{2}$ and radius $= \frac{1}{2}$

85. **(d)** We have $x^3 + 1 \equiv (x+1)(x^2 - x + 1)$.

Therefore, α and β are the complex cube roots of -1 so that we may take $\alpha = -\omega$ and $\beta = -\omega^2$, where $\omega \neq 1$ is a cube root of unity.

Thus $\alpha^{100} = (-\omega)^{100} = \omega$ and $\beta^{100} = (-\omega^2)^{100} = \omega^2$, so that the required equation is $x^2 + x + 1 = 0$.

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

$\Rightarrow 3 - |x| \leq 0 \text{ and } 4 - |x| < 0$

or $3 - |x| \geq 0 \text{ and } 4 - |x| < 0$

$\Rightarrow |x| \geq 3 \text{ and } |x| > 4$

or $|x| \leq 3 \text{ and } |x| < 4$

$\Rightarrow |x| > 4 \text{ or } |x| \leq 3$

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

87. **(c)** Dividing R at $\frac{2}{3}$, $\frac{4}{3}$ and 2, analyse 4 cases.

When $x \leq \frac{2}{3}$, the inequality becomes

$2 - 3x + 4 - 3x + 6 - 3x \geq 12.$

implying $-9x \geq 0 \Rightarrow x \leq 0.$

when $x \geq 2$ the ineqality becomes

$3x - 2 + 3x - 4 + 3x - 6 \geq 12,$

Implying $9x \geq 24 \Rightarrow x \geq 8/3$

The inequality in invalid in the other two sections.

$\therefore$ either $x \leq 0$ or $x \geq 8/3$

88. **(d)** Leaving one seat vacant between two boys, 5 boys may be seated in 4! ways. Then at remaining 5 seats, 5 girls any sit in 5! ways. Hence the required number = 4! × 5!

89. **(a)** Atleast one black ball can be drawn in the following ways

(i) one black and two other colour balls $= {}^3C_1 \times {}^6C_2 = 3 \times 15 = 45$

(ii) two black and one other colour balls $= {}^3C_2 \times {}^6C_1 = 3 \times 6 = 18$

(iii) All the three are black $= {}^3C_3 \times {}^6C_0 = 1$

$\therefore$ Req. no. of ways = 45 + 18 + 1 = 64

90. **(d)** When exponent is n then total number of terms are n + 1. So, total number of terms in $(2 + 3x)^4 = 5$

Middle term is 3rd. $\Rightarrow \ T_3 = {}^4C_2(2)^2 . (3x)^2$

$$= \frac{4 \times 3 \times 2 \times 1}{2 \times 1 \times 2} \times 4 \times 9x^2 = 216x^2$$

91. (a) $C_0+(C_0+C_1)+(C_0+C_1+C_2)+\ldots\ldots\ldots\ldots$
$+(C_0+C_1+\ldots\ldots\ldots\ C_{n-1})$
$= nC_0+(n-1)C_1+(n-2)C_2+\ldots\ldots C_{n-1}$

$= C_1+2C_2+3C_3+4C_4\ldots\ldots nC_n = n.2^{n-1}$

92. (b) Let $S=1+2.2+3.2^2+4.2^2+\ldots.+100.2^{99}$ ....(i)
It is an arithmetico - geometric series.
On multiplying Eq. (i) by 2 and then subtracting it from Eq. (i), we get

$$S = 1+2.2+3.2^2+4.2^3+\ldots+100.2^{99}$$
$$\underline{2S = \underline{1.2}+\underline{2.2^2}+\underline{3.2^3}+\ldots+\underline{99.2^{99}}+\underline{100.2^{100}}}$$
$$-S = 1+2+2^2+2^3\ldots+2^{99}-100.2^{100}$$

$$\Rightarrow\quad -S=\frac{1(2^{100}-1)}{2-1}-100.2^{100}$$
$$\Rightarrow\quad -S = 2^{100}-1-100.2^{100}$$
$$\Rightarrow\quad -S = -1-99.2^{100}$$
$$\Rightarrow\quad S = 99.2^{100}+1$$

93. (b) Equation of the line making intercepts a and b on the axes is $\frac{x}{a}+\frac{y}{b}=1$.
Since, it passes through (1, 1)

$$\Rightarrow \frac{1}{a}+\frac{1}{b}=1 \qquad \ldots.(i)$$

Also the area of the triangle formed by the line and the axes is A.

$$\therefore \frac{1}{2}ab = A \Rightarrow ab = 2A \qquad \ldots.(ii)$$

From eqs. (i) and (ii), we get, $a+b=2A$
Hence, a and b are the roots of the eq.

$$x^2-(a+b)x+ab=0 \Rightarrow x^2-2Ax+2A=0$$

94. (a) $4a^2+b^2+2c^2+4ab-6ac-3bc$
$\equiv (2a+b)^2-3(2a+b)\,c+2c^2=0$
$\Rightarrow (2a+b-2c)(2a+b-c)=0 \Rightarrow c=2a+b$

or $c=a+\frac{1}{2}b$

The equation of the family of lines is

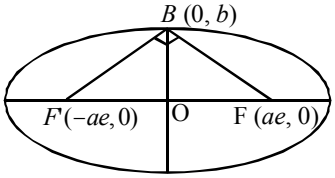
$$a(x+2)+b(y+1)=0 \text{ or } a(x+1)+b\left(y+\frac{1}{2}\right)=0$$

giving the point of concurrence (–2, –1) or $\left(-1,-\frac{1}{2}\right)$.

95. (d) Equation of pair of tangents is given by $SS_1=T^2$,
or $S=x^2+y^2+20(x+y)+20$, $S_1=20$,
$T=10(x+y)+20=0$
$\therefore\quad SS_1=T^2$
$\Rightarrow\quad 20(x^2+y^2+20(x+y)+20)=10^2$
$(x+y+2)^2$
$\Rightarrow\quad 4x^2+4y^2+10xy=0 \Rightarrow 2x^2+2y^2+5xy=0$

96. (a) $\because \angle FBF' = 90° \Rightarrow FB^2+F'B^2=FF'^2$

$$\therefore \left(\sqrt{a^2e^2+b^2}\right)^2+\left(\sqrt{a^2e^2+b^2}\right)^2=(2ae)^2$$
$$\Rightarrow 2(a^2e^2+b^2)=4a^2e^2 \Rightarrow e^2=\frac{b^2}{a^2} \ldots(i)$$



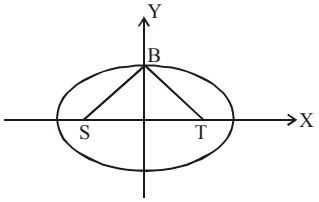
Also, $e^2=1-b^2/a^2=1-e^2$
(By using equation (i))
$\Rightarrow 2e^2=1 \Rightarrow e=\frac{1}{\sqrt{2}}$.

97. (b) Given $x=\frac{3y+k}{2}$ ..... (1)
and $y^2=6x$ ..... (2)

$$\Rightarrow\quad y^2=6\left(\frac{3y+k}{2}\right)$$

$\Rightarrow y^2=3(3y+k) \Rightarrow y^2-9y-3k=0$ .....(3)
If line (1) touches parabola (2) then roots of quadratic equation (3) is equal
$\therefore (-9)^2=4\times 1\times(-3k) \Rightarrow k=-27/4$

98. (c) Let eq. of ellipse be $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$,
S is (–ae, 0), T is (ae, 0) and B is (0, b).



$$\Rightarrow SB=\sqrt{(0+ae)^2+b^2}$$
Also $SB^2=ST^2 \Rightarrow 4a^2e^2=a^2e^2+b^2$

$\Rightarrow 3a^2e^2 = a^2(1-e^2) = a^2 - a^2e^2$

$\Rightarrow 4a^2e^2 = a^2 \Rightarrow e^2 = \frac{1}{4} \Rightarrow e = \frac{1}{2}$

99. (d) Given $f(x) = g(x)\,h(x)$

$\Rightarrow h(x) = \frac{f(x)}{g(x)}$

$\Rightarrow \lim_{x\to 1} h(x) = \lim_{x\to 1} \frac{f(x)}{g(x)}$

$\Rightarrow \lim_{x\to 1} \frac{(x^5-1)(x^3+1)}{(x^2-1)(x^2-x+1)}$

$= \lim_{x\to 1} \frac{x^5-1^5}{x-1} = 5\times 1^4 = 5$

100. (d) T T T T

101. (b) Mode = 3 Median – 2 Mean

$\therefore$ Median $= \frac{1}{3}(\text{mode} + 2\,\text{mean}) = \frac{1}{3}(60 + 2\times 66) = 64$

102. (c)

Occurance(x_i)	Frequency (f_i)	Freq* (x_i)	(x_i-mean)	(x_i-mean)^2	$f_i(x_i$-mean)^2
3.5	3	10.5	–3.59	12.887	38.661
4.5	7	31.5	–2.59	6.707	46.952
5.5	22	121	121	2.528	55.609
6.5	60	390	–0.59	0.348	20.876
7.5	85	637.5	0.41	0.168	14.298
8.5	32	272	1.41	1.988	63.632
9.5	8	76	2.41	5.809	46.47
Total	217	1538.5	-	-	286.498

Variance $\sigma^2 = \frac{\Sigma f_i (x_i - \bar{x})^2}{\Sigma f_i} = \frac{286.49}{217}$

$= 1.32$

103. (a) Since, $|a-a| = 0 \le 1, \text{so } aRa, \forall\, a \in R$

$\therefore$ R is reflexive.

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

$\therefore$ R is symmetric.

But R is not transitive as

$1R2, 2R3$ but $1 \not R 3$

$[\because |1-3| = 2 > 1]$

104. (c) We have, $(\sin^{-1}x)^2 + (\cos^{-1}x)^2$

$= (\sin^{-1}x + \cos^{-1}x)^2 - 2\sin^{-1}x.\cos^{-1}x$

$= \frac{\pi^2}{4} - 2\sin^{-1}x\left(\frac{\pi}{2} - \sin^{-1}x\right)$

$= \frac{\pi^2}{4} - \pi\sin^{-1}x + 2(\sin^{-1}x)^2$

$= 2\left[(\sin^{-1}x)^2 - \frac{\pi}{2}\sin^{-1}x + \frac{\pi^2}{8}\right]$

$= 2\left[\left(\sin^{-1}x - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{16}\right]$

Thus, the least value is $2\left(\frac{\pi^2}{16}\right)$ i.e. $\frac{\pi^2}{8}$

and the greatest value is

$2\left[\left(\frac{-\pi}{2} - \frac{\pi}{4}\right)^2 + \frac{\pi^2}{16}\right]$ i.e. $\frac{5\pi^2}{4}$.

105. (c) The given trigonometric ratio

$= \cos\left[\frac{1}{2}\left(\cos\left(\cos^{-1}\frac{1}{8}\right)\right)\right]$

$= \cos\left(\frac{1}{2}\cos^{-1}\frac{1}{8}\right)$

$= \sqrt{\frac{1+\cos\left(\cos^{-1}\frac{1}{8}\right)}{2}} = \frac{3}{4}$

106. (d) The given determinant vanishes, i.e.,

$$\begin{vmatrix} 1 & x-3 & (x-3)^2 \\ 1 & x-4 & (x-4)^2 \\ 1 & x-5 & (x-5)^2 \end{vmatrix} = 0$$

Expanding along C_1, we get

$(x-4)(x-5)^2 - (x-5)(x-4)^2 - \{(x-3)(x-5)^2$

$-(x-5)(x-3)^2\} + (x-3)(x-4)^2$

$-(x-4)(x-3)^2 = 0$

$\Rightarrow (x-4)(x-5)(x-5-x+4)$

$-(x-3)(x-5)(x-5-x+3)$

$+(x-3)(x-4)(x-4-x+3) = 0$

$\Rightarrow -(x-4)(x-5)+2(x-3)(x-5)-(x-3)(x-4)=0$

$\Rightarrow -x^2+9x-20+2x^2-16x+30-x^2+7x-12=0$

$\Rightarrow -32+30=0 \Rightarrow -2=0$

Which is not possible, hence no value of x satisfies the given condition.

107. (a) Since the lines are concurrent, so

$$\begin{vmatrix} \ell & m & n \\ m & n & \ell \\ n & \ell & m \end{vmatrix} = 0 \Rightarrow 3\ell mn - \ell^3 - m^3 - n^3 = 0$$

$\Rightarrow (\ell+m+n)(\ell^2+m^2+n^2-\ell m-mn-n\ell)=0$

$\Rightarrow \ell+m+n=0\ [\because \ell^2+m^2+n^2>\ell m+mn+n]$

108. (c) $y=e^x \Rightarrow \dfrac{dy}{dx}=e^x=y$

109. (b) $\lim\limits_{x\to -5} f(x)=\dfrac{(x-2)(x+5)}{(x+5)(x-3)}=\dfrac{-7}{-8}=\dfrac{7}{8}$

110. (d) The equation of the given curve is

$y=\dfrac{1}{x-3}, x\neq 3$.

The slope of the tangent to the given curve at any point (x, y) is given by $\dfrac{dy}{dx}=\dfrac{-1}{(x-3)^2}$

For tangent having slope 2, we must have

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

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

which is not possible as square of a real number cannot be negative.

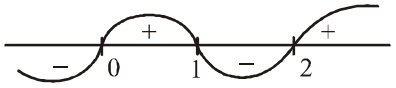
Hence, there is no tangent to the given curve having slope 2.

111. (c) Here, $f(x)=(x(x-2))^2$

$\Rightarrow f'(x)=4x(x-2)(x-1)$

For f(x) as increasing, $f'(x)>0$

So, $4x(x-1)(x-2)>0 \Rightarrow x(x-1)(x-2)>0$



From the above figure required interval is, $(0,1)\cup(2,\infty)$

112. (d) If the sum of two positive quantities is a constant, then their product is maximum, when they are equal.

$\therefore a^2x^4.b^2y^2$ is maximum when

$$a^2x^4=b^2y^4=\frac{1}{2}(a^2x^4=\frac{1}{2}(a^2x^4+b^2y^4)=\frac{c^4}{2}$$

$\therefore$ maximum value of

$a^2x^4.b^2y^4=\dfrac{c^4}{2}\cdot\dfrac{c^4}{2}=\dfrac{c^8}{4}$

Maximum value of $xy=\left(\dfrac{c^8}{4a^2b^2}\right)^{1/4}=\dfrac{c^2}{\sqrt{2ab}}$

113. (b) $$I=\int \frac{x^2\left(1-\frac{1}{x^2}\right)dx}{x^2\left(x+\frac{1}{x}\right)\left(x^2+\frac{1}{x^2}\right)^{1/2}}$$

Let $x+\dfrac{1}{x}=p \Rightarrow \left(1-\dfrac{1}{x^2}\right)dx=dp$

$$I=\int\frac{dp}{p\sqrt{p^2-2}}=\frac{1}{\sqrt{2}}\sec^{-1}\frac{p}{\sqrt{2}}$$

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

114. (b) Let $I=\int\limits_0^{\pi/2}\dfrac{\sin x}{1+\cos^2 x}dx$

Let $\cos x = t$ and $-\sin x\,dx = dt$.

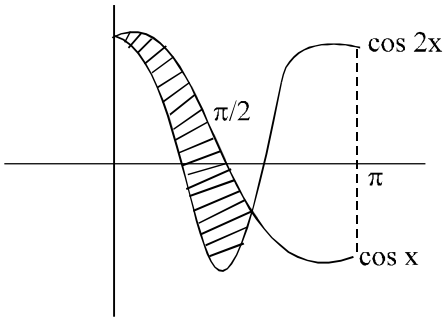
Now, $x=0 \Rightarrow t=\cos 0=1$ and

$x=\dfrac{\pi}{2} \Rightarrow t=\cos\dfrac{\pi}{2}=0$

$$\therefore \quad I=\int_1^0\frac{\sin x}{1+t^2}\left(\frac{-dt}{\sin x}\right)=-\int_1^0\frac{dt}{1+t^2}$$

$$=\left[\tan^{-1}t\right]_1^0=-\left[0-\frac{\pi}{4}\right]=\frac{\pi}{4}$$

115. (d)



$$\text{Area}=\int_0^{2\pi/3}(\cos x-\cos 2x)dx=\frac{3\sqrt{3}}{4}$$

116. (b) The equation is,

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

$$\Rightarrow \frac{dy}{\sin y} + 2\cos x dx = 0$$

$$\Rightarrow \int \cos ec\, y\, dy + 2\int \cos x\, dx = C$$

$$\Rightarrow \log \tan \frac{y}{2} + 2\sin x = C$$

117. (a) We have $\frac{dy}{dx} = \frac{f'(x)}{f(x)} y - \frac{y^2}{f(x)}$

$$\Rightarrow \frac{dy}{dx} - \frac{f'(x)}{f(x)} y = -\frac{y^2}{f(x)}$$

Divide by y^2: $y^{-2}\frac{dy}{dx} - y^{-1}\frac{f'(x)}{f(x)} = -\frac{1}{f(x)}$

Put $y^{-1} = z \Rightarrow -y^{-2}\frac{dy}{dx} = \frac{dz}{dx}$

$$-\frac{dz}{dx} - \frac{f'(x)}{f(x)}(z) = -\frac{1}{f(x)}$$

$$\Rightarrow \frac{dz}{dx} + \frac{f'(x)}{f(x)} z = \frac{1}{f(x)}$$

$$\text{I.F.} = e^{\int \frac{f'(x)}{f(x)} dx} = e^{\log f(x)} = f(x)$$

$\therefore$ The solution is

$$z\big(f(x)\big) = \int \frac{1}{f(x)}\big(f(x)\big)dx + c$$

$$\Rightarrow y^{-1}(f(x)) = x + c \Rightarrow f(x) = y(x + c)$$

118. (c) We have $\vec{a} + \vec{b} + \vec{c} = \vec{0}$

$$\therefore |\vec{a} + \vec{b} + \vec{c}| = 0 \Rightarrow |\vec{a} + \vec{b} + \vec{c}|^2 = 0$$

$$\Rightarrow |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2$$

$$+2(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}) = 0$$

$$\Rightarrow 1 + 1 + 1 + 2(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}) = 0$$

$$\Rightarrow \vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a} = -\frac{3}{2}$$

119. (d) If given vectors are coplanar, then there exists two scalar quantities x and y such that

$$2\hat{i} - \hat{j} + \hat{k} = x(\hat{i} + 2\hat{j} - 3\hat{k}) + y(3\hat{i} + a\hat{j} + 5\hat{k}) \quad .....(1)$$

Comparing coefficient of $\hat{i}, \hat{j}$ and $\hat{k}$ on both sides of (1)

we get $x + 3y = 2$, $2x + ay = -1$, $-3x + 5y = 1$ ...(2)

Solving first and third equations, we get

$x = 1/2$, $y = 1/2$

Since the vectors are coplanar, therefore these values of x and y will satisfy the equation

$2x + ay = -1$

$\therefore$ $2(1/2) + a(1/2) = -1 \Rightarrow a = -4$

120. (a) Equation of the line through the given points is $\frac{x-3}{5-3} = \frac{y-4}{1-4} = \frac{z-1}{6-1}$

$$\Rightarrow \frac{x-3}{2} = \frac{y-4}{-3} = \frac{z-1}{5}$$

Any point on this line can be taken as $(3 + 2\lambda, 4 - 3\lambda, 1 + 5\lambda)$

If this point lies on XY-plane then the z-coordinate is zero

$$\Rightarrow 1 + 5\lambda = 0 \Rightarrow \lambda = -\frac{1}{5}$$

Thus the required coordinates of the point are

$$\left(3 - \frac{2}{5}, 4 - 3\left(-\frac{1}{5}\right), 0\right) \equiv \left(\frac{13}{5}, \frac{23}{5}, 0\right)$$

121. (a) The angle between two planes is the angle between their normals. From the equation of the planes, the normal vectors are

$\vec{N}_1 = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{N}_2 = 3\hat{i} - 6\hat{j} - 2\hat{k}$

Therefore, $\cos\theta = \left|\frac{\vec{N}_1.\vec{N}_2}{|\vec{N}_1||\vec{N}_2|}\right|$

$$= \left|\frac{(2\hat{i} + \hat{j} - 2\hat{k}).(3\hat{i} - 6\hat{j} - 2\hat{k})}{\sqrt{4+1+4}\sqrt{9+36+4}}\right| = \left(\frac{4}{21}\right)$$

Hence, $\theta = \cos^{-1}\left(\frac{4}{21}\right)$

122. (b) In a box, $B_1 = 1R, 2W$; $B_2 = 2R, 3W$ and $B_3 = 3R, 4W$

Also, given that, $P(B_1) = \frac{1}{2}, P(B_2) = \frac{1}{3}$ and $P(B_3) = \frac{1}{6}$

$$\therefore \quad P\left(\frac{B_2}{R}\right) = \frac{P(B_2)P\left(\frac{R}{B_2}\right)}{P(B_1)P\left(\frac{R}{B_1}\right) + P(B_2)P\left(\frac{R}{B_2}\right) + P(B_3)P\left(\frac{R}{B_3}\right)}$$

$$= \frac{\frac{1}{3}\times\frac{2}{5}}{\frac{1}{2}\times\frac{1}{3} + \frac{1}{3}\times\frac{2}{5} + \frac{1}{6}\times\frac{3}{7}} = \frac{\frac{2}{15}}{\frac{1}{6} + \frac{2}{15} + \frac{1}{14}} = \frac{14}{39}.$$

123. (c) The sample space is [LWW, WLW]

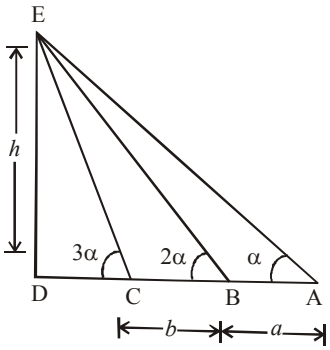
$\therefore$ P (LWW) + P (WLW)

= Probability that in 5 match series, it is India's second win

= P (L) P (W) P (W) + P (W) P (L) P (W)

$$= \frac{1}{8} + \frac{1}{8} = \frac{2}{8} = \frac{1}{4}$$

124. (c)



Let ED = h, $\angle EAB = \alpha$

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

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

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

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

$\Rightarrow \quad AB = EB = a$

Similarly, $\angle EBC = \alpha$

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

$\Rightarrow \quad \dfrac{b}{\sin\alpha} = \dfrac{a}{\sin 3\alpha} \quad \Rightarrow \dfrac{a}{b} = \dfrac{\sin 3\alpha}{\sin 3\alpha}$

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

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

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

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

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

$\Rightarrow \quad h = 2a\sqrt{\dfrac{3b-a}{4b}}, \sqrt{1 - \dfrac{3b-a}{4b}}$

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

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

125. (a) $x, y \geq 0$ and $4x + 3y \leq 24$.

PART - IV: ENGLISH

126. (b) Sagacious means 'judicious', so 'wise' is correct answer.

127. (a) Remedial means 'reformative', so 'corrective' is correct answer.

128. (d) Reticent means 'quiet' so 'secretive' is correct answer.

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

130. (b) Infrangible means 'strong', so 'breakable' is correct antonym.

131. (b) Progeny means 'child', so 'parent' is correct antonym.

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

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

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

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

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

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

138. (c) **139. (b)** **140. (a)** **141. (d)**

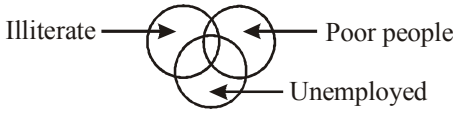
142. (d) From fig. 1, $93 - (27 + 63) = 93 - 90 = 3$

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

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

Hence, option (d) is correct.

143. (b)



Hence, option (b) is correct.

144. (b)

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

1st ⟶ D
2nd ⟶ E
3rd ⟶ C
4th ⟶ A
5th ⟶ B

146. (b) The given series follows the pattern

$1^3 + 1 = 2$

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

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

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

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

147. (d) Interchanging symbols ÷ and + as given in option (d), we get

$3 + 5 \times 8 \div 2 - 10$

$= 3 + 5 \times \dfrac{8}{2} - 10 = 3 + 20 - 10 = 13$

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

149. (b) **150. (c)**