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 : (A) English Proficiency Q. No. 81 to 95

  (B) Logical Reasoning Q. No. 96 to 105

  Part IV : Mathematics Q. No. 106 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.

PART - I : PHYSICS

1. Four point charges $-Q$, $-q$, $2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is :

(a) $Q = -q$ (b) $Q = -\frac{1}{q}$

(c) $Q = q$ (d) $Q = \frac{1}{q}$

- Duration of paper-3 Hours

2. Two long parallel wires carry equal current i flowing in the same direction are at a distance 2d apart. The magnetic field B at a point lying on the perpendicular line joining the wires and at a distance x from the midpoint is –

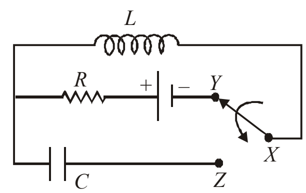
$\mu\, id$ $\mu_0 ix$

(a) $\pi(d + x)$ (b) $\pi(d^2 - x^2)$

(c) $\mu_0 ix$ (d) $(d^2 + x^2)$

$\mu\, id$

$(d^2 + x^2)$

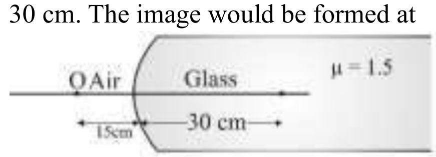


(a) $\frac{E}{R\sqrt{LC}}$ (b) $\frac{ER}{2\sqrt{LC}}$

(c) $\frac{E\sqrt{LC}}{2R}$ (d) $\frac{E\sqrt{LC}}{R}$

3. In the circuit shown, the symbols have their usual meanings. The cell has emf E. X is initially joined to Y for a long time. Then, X is joined to Z. The maximum charge on C at any later time will be

4. A point object O is placed in front of a glass rod having spherical end of radius of curvature 30 cm. The image would be formed at



(a) 30 cm left (b) infinity

(c) 1 cm to the right (d) 18 cm to the left

5. In Young's double slit experiment, λ = 500nm, d = 1mm, D = 1m. Minimum distance from the central maximum for which intensity is half of the maximum intensity is

(a) 2.5×10^{-4} m (b) 1.25×10^{-4} m

(c) 0.625×10^{-4} m (d) 0.3125×10^{-4} m

6. What is the voltage gain in a common emitter amplifier, where input resistance is 3 W and load resistance 24 W, b = 0.6 ?

(a) 8 . 4 (b) 4 . 8 (c) 2 . 4 (d)480

7. The acceleration due to gravity on the surface of the moon is 1/6 that on the surface of earth and the diameter of the moon is one-fourth that of earth. The ratio of escape velocities on earth and moon will be

$\frac{\sqrt{6}}{2}$ (a)(b) $\sqrt{24}$ (c) 3 (d) $\frac{\sqrt{3}}{2}$

8. Given $\vec{P} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{Q} = -\hat{j}\ 2\hat{k}$. The magnitude of their resultant is

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

9. A particle of mass m executes simple harmonic motion with amplitude *a* and frequency n. The average kinetic energy during its motion from the position of equilibrium to the end is

(a) $2\pi^2 ma^2 n^2$ (b) $\pi^2 ma^2 n^2$

(c) $\frac{1}{4} ma^2 n^2$ (d) $4\pi^2 ma^2 n^2$

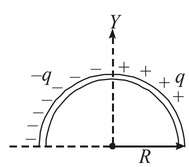
10. The dipole moment of the given charge distribution is

(a) $-\frac{4Rq}{\pi}\hat{i}$

(b) $\frac{4Rq}{\pi}\hat{i}$

(c) $-\frac{2Rq}{\pi}\hat{i}$

(d) $\frac{2Rq}{\pi}\hat{i}$



11. At a place, if the earth¢s horizontal and vertical components of magnetic fields are equal, then the angle of dip will be

(a) 30° (b) 90° (c) 45° (d)0°

12. The third line of Balmer series of an ion equivalnet to hydrogen atom has wavelength of 108.5 nm. The ground state energy of an electron of this ion will be

(a) 3.4 eV (b) 13.6 eV

(c) 54.4 eV (d) 122.4 eV

13. The binding energy per nucleon of ^{10}X is 9 MeV and that of ^{11}X is 7.5 MeV where X represents an element. The minimum energy required to remove a neutron from ^{11}X is

(a) 7.5 MeV (b) 2.5 MeV

(c) 8 MeV (d) 0.5 MeV

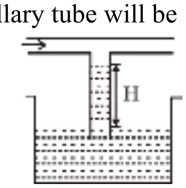
14. If C, the velocity of light, g the acceleration due to gravity and P the atmospheric pressure be the fundamental quantities in MKS system, then the dimensions of length will be same as that of

(a) $\frac{C}{g}$ (b) $\frac{C}{P}$ (c) PCg (d) $\frac{C^2}{g}$

15. Figure shows a capillary rise H. If the air is blown through the horizontal tube in the direction as shown then rise in capillary tube will be

(a) = H (b) > H (c) < H

(d) zero



16. A boy running on a horizontal road at 8 km/h finds the rain falling vertically. He increases his speed to 12 km/h and finds that the drops makes 30° with the vertical. The speed of rain with respect to the road is

(a) $4\sqrt{7}$ km/h (b) $9\sqrt{7}$ km/h

(c) $12\sqrt{7}$ km/h (d) $15\sqrt{7}$ km/h

17. A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant the bullet leaves the barrel of the gun, the monkey drops. Pick the correct statement regarding the situation.

(a) The bullet will never hit the monkey
(b) The bullet will always hit the monkey
(c) The bullet may or may not hit the monkey
(d) Can't be predicted

18. A particle of mass m_1 moving with velocity v collides with a mass m_2 at rest, then they get embedded. Just after collision, velocity of the system

(a) increases (b) decreases
(c) remains constant (d) becomes zero

19. The ratio of the specific heats of a gas is $\frac{C_p}{C_v} = 1.66$, then the gas may be

(a) CO_2 (b) He (c) H_2 (d) NO_2

20. Two oscillators are started simultaneously in same phase. After 50 oscillations of one, they get out of phase by p, that is half oscillation. The percentage difference of frequencies of the two oscillators is nearest to

(a) 2% (b) 1% (c) 0.5% (d) 0.25%

21. A juggler keeps on moving four balls in the air throwing the balls after intervals. When one ball leaves his hand (speed = 20 ms^{-1}) the position of other balls (height in m) will be (Take g = 10 ms^{-2})

(a) 10, 20, 10 (b) 15, 20, 15
(c) 5, 15, 20 (d) 5, 10, 20

22. If a stone of mass 0.05 kg is thrown out a window of a train moving at a constant speed of 100 km/ h then magnitude of the net force acting on the stone is

(a) 0.5 N (b) zero (c) 50 N (d) 5 N

23. A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is

(a) MV (b) 1.5 MV (c) 2 MV (d) zero

24. A hoop rolls down an inclined plane. The fraction of its total kinetic energy that is associated with rotational motion is

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

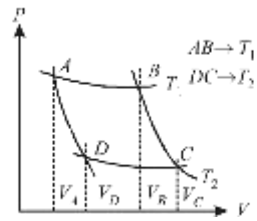
25. Infinite number of masses, each 1 kg are placed along the x-axis at $x = \pm 1m, \pm 2m, \pm 4m, \pm 8m, \pm 16m$ ..... the magnitude of the resultant gravitational potential in terms of gravitational constant G at the orgin ($x = 0$) is

(a) $G/2$ (b) G (c) $2G$ (d) $4G$

26. Water of volume 2 litre in a container is heated with a coil of 1 kW at 27°C. The lid of the container is open and energy dissipates at rate of 160 J/s. In how much time temperature will rise from 27°C to 77°C? [Given specific heat of water is 4.2 kJ/kg]

(a) 8 min 20 s (b) 6 min2 s
(c) 7 min (d) 14 min

27. In the following P-V diagram of an ideal gas, two adiabates cut two isotherms at T_1 = 300K and T_2 = 200K. The value of V_A = 2 unit, V_B = 8 unit, V_C = 16 unit. Find the value of V_D.



(a) 4 unit (b) < 4 unit
(c) > 5 unit (d) 5 unit

28. The mass of H_2 molecule is 3.32×10^{-24} g. If 10^{23} hydrogen molecules per second strike 2 cm^2 of wall at an angle of 45° with the normal, while moving with a speed of 10^5 cm/s, the pressure exterted on the wall is nearly.

(a) 1350 N/m^2 (b) 2350 N/m^2
(c) 3320 N/m^2 (d) 1660 N/m^2

29. The wavelength of two waves are 50 and 51 cm respectively. If the temperature of the room is 20°C then what will be the number of beats produced per second by these waves, when the speed of sound at 0°C is 332 m/s?

(a) 24 (b) 14
(c) 10 (d) None of these

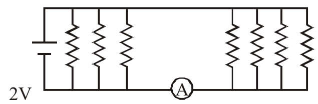
30. The figure shows the interference pattern obtained in a double-slit experiment using light of wavelength 600nm. 1, 2, 3, 4 and 5 are marked on five fringes. The third order bright fringe is

(a) 2 (b) 3 (c) 4 (d) 5

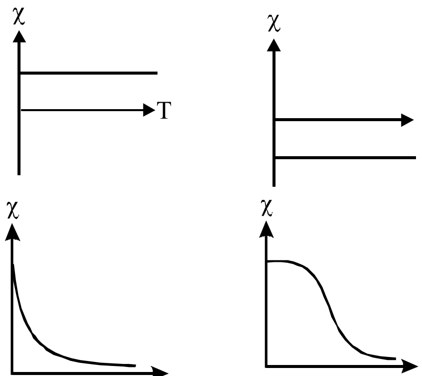
31. Electric potential at any point is $V = -5x + 3y + \sqrt{5}z$, then the magnitude of the electric field is

(a) $3\sqrt{2}$ (b) $4\sqrt{2}$ (c) $5\sqrt{2}$ (d) 7

32. Seven resistances, each of value 20 W, are connected to a 2 V battery as shown in the figure.
The ammeter reading will be



(a) 1/10 A (b) 3/10 A (c) 4/10 A (d) 7/10 A. **33.** The variation of magnetic susceptibility (c) with temperature for a diamagnetic substance is best represented by



(a)

OT

O(b)

(c)(d)

OT OT

34. A copper rod of length ℓ rotates about its end with angular velocity w in uniform magnetic field B. The emf developed between the ends of the rod if the field is normal to the plane of rotation is

(a) $B\text{w}\ell^2$ (b) $\frac{1}{2}B\text{w}\ell^2$

(c) $2B\text{w}\ell^2$ (d) $\frac{1}{4}B\text{w}\ell^2$

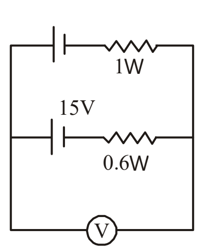
35. A 10V battery with internal resistance 1W and a 15V battery with internal resistance 0.6 W are connected in parallel to a voltmeter (see figure). The reading in the voltmeter will be close to :

(a) 12.5 V

(b) 24.5 V

(c) 13.1 V

(d) 11.9 V



36. 10 forks are arranged in increasing order of frequency in such a way that any two nearest tuning forks produce 4 beats/sec. The highest frequency is twice of the lowest. Possible highest and the lowest frequencies (in Hz) are

(a) 80 and 40 (b) 100 and 50

(c) 44 and 22 (d) 72 and 36

37. A charged particle enters in a uniform magnetic field with a certain velocity. The power delivered to the particle by the magnetic field depends on

(a) force exerted by magnetic field and velocity of the particle.

(b) angular speed w and radius r of the circular path.

(c) angular speed w and acceleration of the particle.

(d) None of these

38. A resistor and an inductor are connected to an ac supply of 120 V and 50 Hz. The current in the circuit is 3 A. If the power consumed in the circuit is 108 W, then the resistance in the circuit is

(a) 12 W (b) 40 W

(c) $\sqrt{(52' \text{W}25)}$ (d) 360 W

39. In an electron gun, the potential difference between the filament and plate is 3000 V. What will be the velocity of electron emitting from the gun?

(a) 3×10^8 m/s (b) 3.18×10^7 m/s

(c) 3.52×10^7 m/s (d) 3.26×10^7 m/s

40. A radioactive substance with decay constant of $0.5 s^{-1}$ is being produced at a constant rate of 50 nuclei per second. If there are no nuclei present initially, the time (in second) after which 25 nuclei will be present is

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

PART - II : CHEMISTRY

41. The 25 mL of a 0.15 M solution of lead nitrate, $Pb(NO_3)_2$ reacts with all of the aluminium sulphate, $Al_2(SO_4)_3$, present in 20 mL of a solution. What is the molar concentration of the $Al_2(SO_4)_3$?

$$3Pb(NO_3)_2(aq) + Al_2(SO_4)_3(aq) \longrightarrow 3PbSO_4(s) + 2Al(NO_3)_3(aq)$$

(a) 6.25×10^{-2} M (b) 2.421×10^{-2} M
(c) 0.1875 M (d) None of these

42. 100 mL O_2 and H_2 kept at same temperature and pressure. What is true about their number of molecules (a) $N_{O_2} > N_{H_2}$
(b) $N_{O_2} < N_{H_2}$
(c) $N_{O_2} = N_{H_2}$
(d) $N_{O_2} + N_{H_2} = 1$ mole

43. If the Planck's constant h = 6.6×10^{-34} Js, the de Broglie wavelength of a particle having momentum of 3.3×10^{-24} kg ms $^{-1}$ will be
(a) 0.002 Å (b) 0.5 Å (c) 2 Å (d)500 Å

44. Amongst the elements with following electronic configurations, which one of them may have the highest ionization energy?
(a) [Ne] $3s^23p^2$ (b) [Ar] $3d^{10}4s^24p^3$
(c) [Ne] $3s^23p^1$ (d) [Ne] $3s^23p^3$

45. Which of the following is the correct and increasing order of lone pair of electrons on the central atom?
(a) $IF_7 < IF_5 < ClF_3 < XeF_2$
(b) $IF_7 < XeF_2 < ClF_2 < IF_5$
(c) $IF_7 < ClF_3 < XeF_2 < IF_5$
(d) $IF_7 < XeF_2 < IF_5 < ClF_3$

46. According to molecular orbital theory which of the following statement about the magnetic character and bond order is correct regarding O_2^+
(a) Paramagnetic and Bond order < O_2
(b) Paramagnetic and Bond order > O_2
(c) Diamagnetic and Bond order < O_2
(d) Diamagnetic and Bond order > O_2

47. If V is the volume of one molecule of gas under given conditions, the van der Waal's constant *b* is
(a) 4 V (b) $\frac{4V}{N_0}$
(c) $\frac{N_0}{4V}$ (d) $4VN_0$

48. For vaporization of water at 1 atmospheric pressure, the values of ΔH and ΔS are 40.63 $kJmol^{-1}$ and 108.8 JK^{-1} mol^{-1}, respectively. The temperature when Gibbs energy change (ΔG) for this transformation will be zero, is:
(a) 293.4 K (b) 273.4 K
(c) 393.4 K (d) 373.4 K

49. For the reaction taking place at certain temperature

$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$, if equilibrium pressure is 3X bar then $\Delta_rG°$ would be
(a) – RT ln 9 – 3RT ln X
(b) RT ln 4 – 3RT ln X
(c) – 3RT ln X
(d) None of these

50. The pH of 0.1 M solution of the following salts increases in the order :
(a) NaCl < NH_4Cl < NaCN < HCl (b) HCl < NH_4Cl < NaCl < NaCN (c) NaCN < NH_4Cl < NaCl < HCl
(d) HCl < NaCl < NaCN < NH_4Cl

51. When N_2O_5 is heated at certain temperature, it dissociates as

$N_2O_5(g) \rightleftharpoons N_2O_3(g) + O_2(g)$; K_c = 2.5. At the same time N_2O_3 also decomposes as :

$N_2O_3(g) \rightleftharpoons N_2O(g) + O_2(g)$. If initially 4.0 moles of N_2O_5 are taken in 1.0 litre flask and allowed to dissociate. Concentration of O_2 at equilibrium is 2.5 M. Equilibrium concentration of N_2O_5 is :
(a) 1.0 M (b) 1.5 M
(c) 2.166 M (d) 1.846 M

52. Consider the reactions (A) $H_2O_2 + 2HI \rightarrow I_2 + 2H_2O$
(B) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$
Which of the following statements is

correct about H_2O_2 with reference to these reactions? Hydrogen peroxide is ______ .

(a) an oxidising agent in both (A) and (B)
(b) an oxidising agent in (A) and reducing agent in (B)
(c) a reducing agent in (A) and oxidising agent in (B)
(d) a reducing agent in both (A) and (B)

53. Following are colours shown by some alkaline earth metals in flame test. Which of the following are not correctly matched?

	Metal	**Colour**
(i)	Calcium	Apple green
(ii)	Strontium	Crimson
(iii)	Barium	Brick red

(a) (i) and (iii) (b) (i) only
(c) (ii) only (d) (ii) and (iii)

54. Beryllium shows diagonal relationship with aluminium. Which of the following similarity is incorrect ?

(a) Be forms beryllates and Al forms aluminates
(b) $Be(OH)_2$ like $Al(OH)_3$ is basic.
(c) Be like Al is rendered passive by HNO_3.
(d) Be_2C like Al_4C_3 yields methane on hydrolysis.

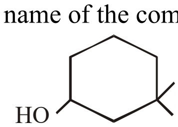
55. An element X occurs in short period having configuration $ns^2\ np^1$. The formula and nature of its oxide is

(a) XO_3, basic (b) XO_3, acidic
(c) X_2O_3, amphoteric (d) X_2O_3, basic

56. Which of the following is strongest nucleophile

(a) Br^- (b) $:OH^-$
(c) :CN- (d) C H $\bar{O}$:2 5

57. The IUPAC name of the compound is

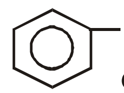


(a) 3, 3-dimethyl - 1- cyclohexanol
(b) 1, 1-dimethyl-3-hydroxy cyclohexane (c) 3, 3-dimethyl-1-hydroxy cyclohexane
(d) 1, 1-dimethyl-3-cyclohexanol

58. Which of the following will have a meso-isomer also? (a) 2, 3- Dichloropentane

(b) 2, 3-Dichlorobutane
(c) 2-Chlorobutane
(d) 2-Hydroxypropanoic acid

59. In a set of reactions, ethylbenzene yielded a product D.

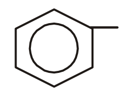


CH CH_{23}¾¾¾®KMnOKOH 4

B ¾¾®FeClBr23

C ¾¾¾®C H OH_2 5H+ D

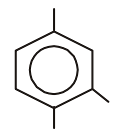
(a)



CH_2 – CH – COOC H_2 5

Br

(b)



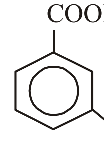
Br

Br

CH_2 COOC H 2 5

(c)

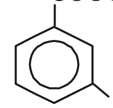
COOH



OCH CH_2 3

(d)

COOCH 2 5



Br

60. Identify the incorrect statement from the following:

(a) Ozone absorbs the intense ultraviolet radiation of the sun.
(b) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes.
(c) Ozone absorbs infrared radiation.

(d) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.

61. Each edge of a cubic unit cell is 400 pm long. If atomic mass of the element is 120 and its density is 6.25 g/cm^3, the crystal lattice is : (use $N_A = 6 \times 10^{23}$)

(a) primitive (b) body centered
(c) face centered (d) end centered

62. Chloroform, $CHCl_3$, boils at 61.7 °C. If the K_b for chloroform is 3.63°C/molal, what is the boiling point of a solution of 15.0 kg of $CHCl_3$ and 0.616 kg of acenaphthalene, $C_{12}H_{10}$?

(a) 61.9 (b) 62.0
(c) 52.2 (d) 62.67

63. pH of a 0.1 M monobasic acid is found to be 2. Hence, its osmotic pressure at a given temperature TK is

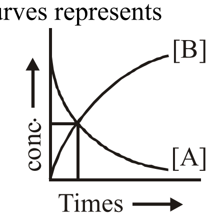
(a) 0.1 RT (b) 0.11 RT
(c) 1.1 RT (d) 0.01 RT **64.** On passing a current of 1.0 ampere for 16 min and 5 sec through one litre solution of $CuCl_2$, all copper of the solution was deposited at cathode. The strength of $CuCl_2$ solution was (Molar mass of Cu= 63.5; Faraday constant = 96,500 Cmol^{-1})

(a) 0.01 N (b) 0.01 M
(c) 0.02 M (d) 0.2 N

65. A 100.0 mL dilute solution of Ag^+ is electrolysed for 15.0 minutes with a current of 1.25 mA and the silver is removed completely. What was the initial [Ag^+]?

(a) 2.32×10^{-1} (b) 2.32×10^{-4}
(c) 2.32×10^{-3} (d) 1.16×10^{-5}

66. The accompanying figure depicts a change in concentration of species A and B for the reaction A ® B, as a function of time. The point of inter section of the two curves represents



(a) $t_{1/2}$ (b) $t_{3/4}$
(c) $t_{2/3}$
(d) Data insufficient to predict

67. The rate constant of a reaction is 1.5×10^{-3} at 25°C and 2.1×10^{-2} at 60°C. The activation energy is

35 2.1 10´ –2

(a) 333 R loge 1.5 10´ –2

(b) $\frac{298 \times 333}{35}$ R log$_e$ $\frac{21}{1.5}$

(c) $\frac{298 \times 333}{35}$ R log$_e$ 2.1

(d) $\frac{298 \times 333}{35}$ R log$_e$ $\frac{2.1}{1.5}$

68. Freundlich equation for adsorption of gases (in amount of x g) on a solid (in amount of m g) at constant temperature can be expressed as

(a) $\log \frac{x}{m} = \log p + \frac{1}{n} \log K$

(b) $\log \frac{x}{m} = \log K + \frac{1}{n} \log p$

(c) $\frac{x}{m} \mu p^{n}$

(d) $\frac{x}{m} = \log p + \frac{1}{n} \log K$

69. Which of the following feature of catalysts is described in reactions given below? (i) CO g 2H g( )+ 2 ( )¾¾¾¾¾¾¾¾®Cu/ZnO Cr O- 2 3 CH OH g3 ( )

(ii) CO g( )+ H2 (g)¾¾®^{Cu} HCHO g( )

(iii) CO g 3H g( )+ 2 ( )¾¾®^{Ni} CH g H O g4( )+ 2 ( )

(a) Activity (b) Selectivity
(c) Catalytic promoter (d) Catalytic poison

70. Which of the following is not a member of chalcogens?

(a) O (b) S (c) Se (d)Po

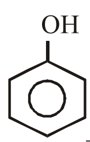
71. Pick out the wrong statement.

(a) Nitrogen has the ability to form *p*p-*p*p bonds with itself.
(b) Bismuth forms metallic bonds in elemental state.
(c) Catenation tendency is higher in nitrogen when compared with other elements of the same group.
(d) Nitrogen has higher first ionisation enthalpy when compared with other elements of the same group.

72. Which of the following element do not form complex with EDTA?
(a) Ca (b) Mg (c) Be (d)Sr

73. Which one of the following cyano complexes would exhibit the lowest value of paramagnetic behaviour ?
(a) $[Co(CN)]_6{}^{3-}$ (b) $[Fe(CN)]_6{}^{3-}$
(c) $[Mn(CN)]_6{}^{3-}$ (d) $[Cr(CN)]_6{}^{3-}$
(At. Nos : Cr = 24, Mn = 25, Fe = 26, Co = 27)

74. When an aqueous solution of copper (II) sulphate is saturated with ammonia, the blue compound crystallises on evaporation. The formula of this blue compound is:
(a) $[Cu(NH_3)_4]SO_4 . H_2O$ (square planar)
(b) $[Cu(NH_3)_4]SO_4$ (Tetrahedral)
(c) $[Cu(NH_3)_6]SO_4$ (Octahedral)
(d) $[Cu(SO_4)(NH_3)_5]$ (Octahedral)

75.  $\xrightarrow{NaOH}$ [X] $\xrightarrow{CH_2 = CHCH\,Cl_2}$ [Y]

Here [Y] is a
(a) single compound
(b) mixture of two compounds
(c) mixture of three compounds (d) no reaction is possible **76.** Following compounds are given:
(1) CH_3CH_2OH (2) CH_3COCH_3
(3) CH_3 -CHOH (with CH_3 attached below) (4) $CH\ OH_3$

Which of the above compound(s), on being warmed with iodine solution and NaOH, will give iodoform?
(a) (1) and (2) (b) (1), (3) and (4)
(c) only (2) (d) (1), (2) and (3)

77. Arrange the following alcohols in increasing order of their reactivity towards the reaction with HCl.
$(CH_3)_2CH$-OH (1), $(CH_3)_3C$-OH (2), $(C_6H_5)_3C$-OH (3)
(a) $1 < 2 < 3$ (b) $2 < 1 < 3$
(c) $3 < 1 < 2$ (d) $2 < 3 < 1$

78. Thirty percent of the bases in a sample of DNA extracted from eukaryotic cells is adenine. What percentage of cytosine is present in this DNA?
(a) 10% (b) 20%
(c) 30% (d) 40%

79. The blue colour of snail is due to presence of
(a) Albumin (b) Haemocyanin
(c) Globulins (d) Fibrinogen

80. Which of the following is a diamine?
(a) Dopamine (b) Histamine
(c) Meprobamate (d) Chlorphenamine

PART - III (A): ENGLISH PROFICIENCY

81. Choose the word which is most similar in meaning to the word 'Optimistic'.
(a) Favourable (b) Gloomy
(c) Hopeful (d) Rude

82. Choose the word which is most opposite in meaning to the word 'Drowsy'.
(a) Sleepy (b) Nodding
(c) Yawning (d) Wakeful

Direction (83-85): Which of the following phrases (I), (II), and (III) given below each sentence should replace the phrase printed in bold letters to make the sentence grammatically correct? Choose the best option among the five given alternatives that reflect the correct use of phrase in the context of the grammatically correct sentence. If the sentence is correct as it is, mark (d) i.e., "No correction required" as the answer.

83. He is really feeling under the weather today; he has a terrible cold.
(I) feeling like the weather
(II) feeling over the weather
(III) feeling in the weather
(a) Only (I) is correct
(b) Only (III) is correct
(c) Only (II) is correct
(d) No correction required

84. By working part-time and looking after his old mother, he managed to get the best for both worlds.
(I) the best at both worlds
(II) the best of both worlds
(III) the best on both worlds
(a) Only (I) is correct
(b) Only (II) is correct
(c) Only (III) is correct
(d) No correction required

85. Hey, Nanny, speak about the devil and you are here.
(I) speak at the devil
(II) speak on the devil
(III) speak of the devil
(a) Only (I) is correct
(b) Only (II) is correct
(c) Only (III) is correct
(d) No correction required

DIRECTION (86-90): Read the following passage carefully and answer the questions given below it.

The likelihood of at least 600,000 deaths being caused annually in India by fine particulate matter pollution in the air is cause for worry, even if the data released by the World Health Organisation are only a modelled estimate. The conclusion that so many deaths could be attributed to particulate matter 2.5 micrometres or less in size is, of course, caveated, since comprehensive measurement of PM2.5 is not yet being done and the linkages between pollution, disease and deaths need further study. What is not in doubt is that residents in many urban areas are forced to breathe unhealthy levels of particulates, and the smallest of these - PM10 and less - can penetrate and get lodged deep in the lungs. The WHO Global Burden of Disease study has been working to estimate pollution-linked health impacts, such as stroke and ischaemic heart disease, acute lower respiratory infection and chronic obstructive pulmonary disease. Data on fine particulates in India show that in several locations the pollutants come from burning of biomass, such as coal, fuel wood, farm litter and cow dung cakes. In highly built-up areas, construction debris, road dust and vehicular exhaust add to the problem. The Prime Minister launched an Air Quality Index last year aimed at improving pollution control. The new data, which the WHO says provide the best evidence available on the terrible toll taken by particulates, should lead to intensified action. A neglected aspect of urban air pollution control is the virtual discarding of the Construction and Demolition Waste Management Rules, notified to sustainably manage debris that is dumped in the cities, creating severe particulate pollution. The Environment Ministry has highlighted the role that debris can play as a resource. Municipal and government contracts are, under the rules, required to utilise up to 20 per cent materials made from construction and demolition waste, and local authorities must place containers to hold debris. This must be implemented without delay. Providing cleaner fuels and scientifically designed cookstoves to those who have no option but to burn biomass, would have a big impact on reducing particulate matter in the northern and eastern States, which are the worst-hit during winter, when biomass is also used for heating. Greening the cities could be made a mission, involving civil society, with a focus on landscaping open spaces and paving all public areas to reduce dust. These measures can result in lower PM10 and PM2.5 levels. Comprehensive measurement of these particulates is currently absent in many cities, a lacuna that needs to be addressed.

86. According to the WHO Global Burden of Disease study which of the following is/are pollution linked health impacts?
(I) Infection of the lower respiratory system
(II) Chronic obstructive pulmonary disease
(III) Stroke and ischaemic heart disease
(a) Only (I) (b) Only (III)

(c) Both (I) and (II) (d) All of the above

87. The conclusion regarding the deaths attributed to particulate matter 2.5 micrometers is considered to be caveated because
- (a) Measurement of all aspects of PM2.5 has been done comprehensively
- (b) Measurement of all aspects of PM2.5 is not radical
- (c) Relation between pollution, disease and death is complete
- (d) None of these

88. Which of the following is/are not true in the context of the passage?
- (a) Eastern and Southern states are worst hit in winter by burning of biomass.
- (b) The smallest particulate matter PM2.5 penetrates and gets lodged in lungs.
- (c) Data on fine particulates in India show that in several locations the pollutants come from the smoke emitted by vehicles.
- (d) None is true

89. As per the given passage, which of the following is/are the measures for lowering particulate matter in the atmosphere?
- (I) Making cleaner fuels available
- (II) Landscaping open areas
- (III) Providing cooking stoves designedscientifically

(a) Only (I) (b) Both (I) and (II)
(c) All of the above (d) None of these

90. If sentence (B) "The Finance Ministry's warning to potential investors in bitcoin and other cryptocurrencies has come at a time when a new, seemingly attractive investment area has opened up that few have enough information about." is the first sentence, what is the order of other sentences after rearrangement?
- (A) One of the main reasons for this volatility isspeculation and the entry into the market of a large number of people lured by the prospect of quick and easy profits.
- (B) The Finance Ministry's warning to potential investors in bitcoin and other cryptocurrencies has come at a time when a new, seemingly attractive investment area has opened up that few have enough information about.
- (C) A number of investors, daunted by the high price of bitcoin, have put their money into less well-established and often spurious cryptocurrencies, only to lose it all.
- (D) Investment in bitcoin and othercryptocurrencies increased tremendously in India over the past year, but most new users know close to nothing of the technology, or how to verify the genuineness of a particular cryptocurrency.
- (E) The price of bitcoin, the most popular of all cryptocurrencies, not only shot up by well over 1000% over the course of the last year but also fluctuated wildly.
- (F) The government's caution comes on top of three warnings issued by the Reserve Bank of India since 2013.

(a) CDEFA (b) EAFDC
(c) DCAEF (d) ECDAF

91. If sentence (C) "Clinical trials involving human subjects have long been a flashpoint between bioethicists and clinical research organisations (CROs) in India." is the first sentence, what is the order of other sentences after rearrangement?
- (A) Such over-volunteering occurs morefrequently in bioequivalence studies, which test the metabolism of generics in healthy subjects.
- (B) Landmark amendments to the Drugs and Cosmetics Act in 2013 led to better protection of vulnerable groups such as illiterate people, but more regulation is needed to ensure truly ethical research.
- (C) Clinical trials involving human subjects have long been a flashpoint between bioethicists and clinical research organisations (CROs) in India.
- (D) The big problem plaguing clinical researchis an over-representation of low-income groups among trial subjects.
- (E) While CROs have argued that more rules will stifle the industry, the truth is that ethical science is often better science.

(F) Sometimes CROs recruit them selectively, exploiting financial need and medical ignorance; at other times people overvolunteer for the money.

(a) ABDFE (b) BDEAF
(c) DFAEB (d) BEDFA

DIRECTION (92-93): Read the sentence to find out whether there is any grammatical error or idiomatic error in it. The error, if any, will be in one part of the sentence. The letter of that part is the answer. If there is no error, the answer is (d). (Ignore errors of punctuation, if any.)

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92. Despite being (a)/ a good teacher, (b)/ he has no influence on his pupil. (c)/ No error (d)

93. Yesterday, when we were returning from the party, (a)/ our car met with an accident, (b)/ but we were fortunate to reach our home safely. (c)/ No error (d)

94. A group of sheep is known as :

(a) bunch (b) herd
(c) band (d) fleet

95. A group of trees is known as:

(a) grove (b) parliament
(c) heap (d) hedge

PART - III (B) : LOGICAL REASONING

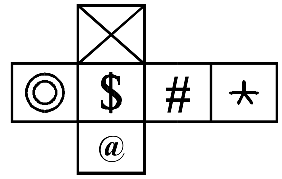
96. In a code language, if REGAINS is coded as QDFZHMR, then the word PERIODS will be coded as -

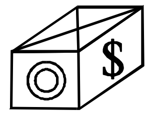
(a) ODQNHCR (b) ODDQHCR
(c) ODQHNCR (d) ODQHNRC

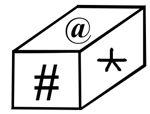
97. If 5 # 6 = 121 and 10 # 8 = 324, then find the value of 23 # 14 = ?

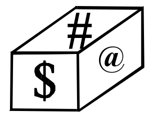
(a) 1369 (b) 1349 (c) 1331 (d) 725

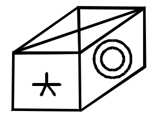
98. Which of the following cube in the answer figure cannot be made based on the unfolded cube in the question figure?



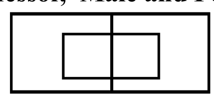
(a) 

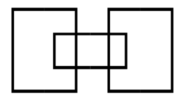
(b) 

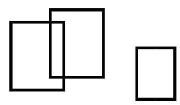
(c) 

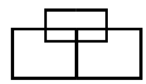
(d) 

99. Which one of the following diagram represents the correct relationship among **Professor, Male and Female.**

(a) 

(b) 

(c) 

(d) 

100. Select the related letter/word/ number from the given alternatives. Distance : Odometer :: ? : Barometer

(a) Humidity (b) Pressure
(c) Thickness (d) Wind

101. Find the odd word/letters/ number pair/number from the given alternatives.

(a) 24 -1614 (b) 270 - 569
(c) 120 - 4325 (d) 162 - 6930

102. Choose the correct alternatives from the given ones that will complete the series.

L_N O_ _MLLM_ OO_ML

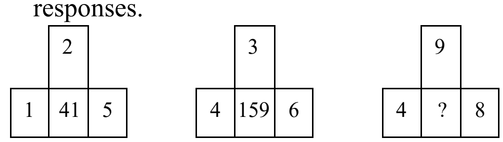
(a) MNNNO (b) MONNO
(c) MONON (d) MONNN

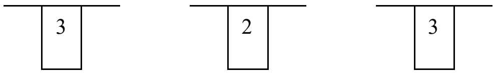
103. Choose the correct alternatives from the given ones that will complete the series.

22, 26, 53, 69, 194, ?

(a) 230 (b) 260 (c) 250 (d) 245

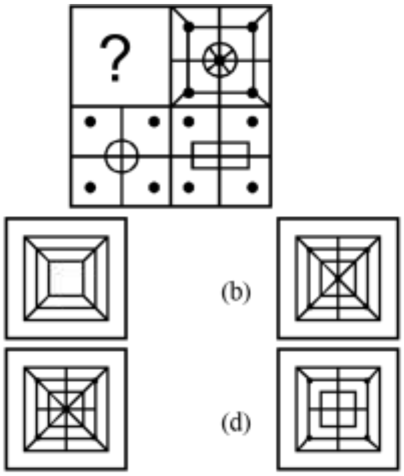
104. Select the missing number from the given responses.





(a) 888 (b) 788 (c) 848 (d) 842

105. Identify the figure that will complete the pattern.



PART - IV : MATHEMATICS

106. The domain of the function $f(x)=\sqrt{x^2-[x]^2}$,

(a) (c)

where [x] denotes the greatest integer less than or equal to x, is

(a) (0, ¥) (b) (-¥, 0)

(c) (-¥, ¥) (d) None of these

107. If msinq= nsin(q+ a2) then tan(q+a) is m + n

a (b) m + n tanq (a) tan

m - n m - n

m +n a (d) m + n cot q ——

(c) cot

m -n m - n

108. Number of solutions of equation sin9q = sinq in the interval [0,2]p is

(a) 16 (b) 17 (c) 18 (d) 15

109. A pole stands vertically inside a triangular park ABC. If the angle of elevation of the top of the pole from each corner of the park is same, then the foot of the pole is at the

(a) centroid (b) circumcentre

(c) incentre (d) orthocentre

110. Let A, B, and C are the angles of a plain triangle

and tan A = 1, tan B = 2. Then tan C is equal

2 3 2 3 2 to

(a) 7/9 (b) 2/9 (c) 1/3 (d) 2/3

111. If the amplitude of $z-2-3i$ is p/4, then the locus of $z=x+iy$ is

(a) $x\ y+\ -\ =1\ 0$ (b) $x\ y-\ -\ =1\ 0$ (c) $x\ y+\ +\ =1\ 0$ (d) $x\ y-\ +\ =1\ 0$

112. The roots of the equation $x^4-2x^3+=x\ 380$ are :

(a) 5, - 4, $\frac{1\pm5\sqrt{-3}}{2}$

(b) - 5, 4, $\frac{-1\pm5\sqrt{-3}}{2}$

(c) 5, 4, $\frac{-1\pm5\sqrt{-3}}{2}$

(d) - -5, 4, $\frac{1\pm5\sqrt{-3}}{2}$

113. Roots of the equation $x^2+bx-=c\ 0$ $(b\ c,>0)$ are

(a) Both positive (b) Both negative

(c) Of opposite sign (d) None of these

114. In how many ways can 12 gentlemen sit around a round table so that three specified gentlemen are always together?

(a) 9! (b) 10! (c) 3! 10! (d) 3! 9!

115. The number of ways in which first, second and third prizes can be given to 5 competitors is

(a) 10 (b) 60 (c) 15 (d) 125

116. The coefficient of x^3 in the expansion of

æç x -

_1 ö÷7

is : è x ø

(a) 14 (b) 21 (c) 28 (d)35

117. If x > 0, the 1 + log 2 x (loge2 x)2 + ...=
e +
1! 2!

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

118. If *a*, *b*, *c* are in G.P., then

(a) a^2, b^2, c^2 are in G.P.

(b) $a^2(b+ c\ c), ^2(a +b\ b), ^2(a +c)$ are in G.P. *ab*

c

(c) , , are in G.P. *b c c a a b*+ +
+

(d) None of these

119. The locus of the point of intersection of the lines

x = aæçç11+-tt22 ö÷÷ø and y = 12+att2 represent (t being è a parameter)

(a) circle (b) parabola

(c) ellipse (d) hyperbola

120. The equation of the circle which passes through the point (4, 5) and has its centre at (2, 2) is

(a) (x – 2) + (y – 2) = 13

(b) $(x - 2)^2 + (y - 2)^2 = 13$ (c) $(x)^2 + (y)^2 = 13$

(d) $(x - 4)^2 + (y - 5)^2 = 13$

121. Eccentricity of ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ if it passes through point (9, 5) and (12, 4) is

(a) $\sqrt{3/4}$ (b) $\sqrt{4/5}$

(c) $\sqrt{5/6}$ (d) $\sqrt{6/7}$

122. Consider the equation of a parabola $y^2 + 4ax = 0$, where a > 0 which of the following is/are correct? (a) Tangent at the vertex is x = 0

(b) Directrix of the parabola is x = 0

(c) Vertex of the parabola is not at the origin (d) Focus of the parabola is at (a, 0)

1+ + +23 ¼*n*

123. The value of lim *n*2 +100 is equal to :

n®¥

(a) ¥ (b) $\frac{1}{2}$ (c) 2 (d)0

124. xlim®0 $\sqrt{\frac{x-\sin x}{x+\sin x^2}}$ is equal to

(a) 1 (b) 0

(c) ¥ (d) None of these

125. The probability of getting 10 in a single throw of three fair dice is :

(a) $\frac{1}{6}$ (b) $\frac{1}{8}$ (c) $\frac{1}{9}$ (d) $\frac{1}{5}$

126. Number of solutions of the equation

$\tan^{-1}(1+ +x)\ \tan^{-1}(1- =x)$ $\frac{p}{2}$ are

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

(d)0 é1 2 2 ù

1 ê2 1 -2 ú ú is an orthogonal matrix,

127. If A = ê
3
êëa 2 b úû

then

(a) a = – 2, b = – 1 (b) a = 2, b = 1

(c) a = 2, b = – 1 (d) a = – 2, b = 1

128. The points represented by the complex numbers

1 + *i*, – 2 + 3*i*, $\frac{5}{3}$ *i* on the argand plane are

(a) vertices of an equilateral triangle

(b) vertices of an isosceles triangle

(c) collinear

(d) None of these

é3 - 2 4 ù

129. If matrix A = ê ê1 2 -1 ú ú and êë0 1

1 úû

A^{-1} = __1 adj(A) , then *k* is k

(a) 7 (b) – 7 (c) 15 (d)– 11

130. If x, y, z are complex numbers, and

| 0 - y - z |
D= y 0 - x then D is
z x –0

(a) purely real (b) purely imaginary

(c) complex (d) 0

131. If f(x) = sin x, when xis rational ü

= cos x, when xisirrational ý þ Then the

function is

(a) discontinuous at x = np + p/4

(b) continuous at x = np + p/4

(c) discontinuous at all x (d) none of these

ì ï1,when2 0 < *x* £3 3 4p p

132. If f (x) = ï2sin _x,when < <x p î9 4

(a) *f* (x) is continuous at x = 0

(b) *f* (x) is continuous at x = p

(c) *f* (x) is continuous at *x* = 3p 4

(d) *f* (x) is discontinuous at *x* = 3p

133. The value of c in (0, 2) satisfying the mean value theorem for the function f(x) = $x(x – 1)^2$, x Î [0, 2] is equal to

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

x x+1 d y^2

134. If *y* = ___*x*+1+ *x* , then ___*dx*2 at *x* = 1

is equal to

(a) $\frac{7}{4}$ (b) $\frac{7}{8}$ (c) $\frac{1}{4}$ (d) $\frac{-7}{8}$

æ*d y d x*^{2} ö æ ^{2} ö

135. Let *y* = *e*2*x*. Then çè*dx*2 ÷ çø è*dy*2 ÷ø is

(a) 1 (b) e^{-2x}

(c) 2*e*–2*x* (d) –2*e*–2*x*

136. A ball is dropped from a platform 19.6m high. Its position function is – (a) x = – $4.9t^2$ + 19.6 (0 £ t £ 1)

(b) x = – $4.9t^2$ + 19.6 (0 £ t £ 2)

(c) x = – $9.8t^2$ + 19.6 (0 £ t £ 2) (d) x = – $4.9t^2$ – 19.6 (0 £ t £ 2)

b

√xdx

137. The value of the integral Ò is: √

a x + + -a b x

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

(c) p / 2 (d) b – a

$e^{x2}(2x + x)^3$

138. Ò ______(3+ x)2 2 dx is equal to :

ex2 1 ex2

(a) ______2 +k (b) _ ______2

(3+ x)2 2 + k

(3+ x)

(c) _ ______1 ex22 2 + k (d) _ ______12

(3e+xx)22 + k 4 (3+ x)

139. If $\int_0^a f(2a - x)dx = m$ and $\int_0^a f(x)dx = n$, then $\int_0^{2a} f(x)dx$ is equal to

(a) 2m + n (b) m + 2n

(c) m – n (d) m + n

140. An integrating factor of the differential equation $\sin x \frac{dy}{dx} + 2y\cos x = 1$ is

(a) $\sin^2 x$ (b) $\frac{2}{\sin x}$

(c) log |sin x| (d) $\frac{1}{\sin^2 x}$

141. The expression satisfying the differential equation $(x^2 - 1)\frac{dy}{dx} + 2xy = 1$ is

(a) $x y^2 - xy^2 = c$

(b) $(y^2 - 1)x = y + c$

(c) $(x^2 - 1)y = x + c$

(d) none of these

142. Let $\vec{a} = \hat{i} - \hat{k}$, $\vec{b} = x\hat{i} + \hat{j} + (1 - x)\hat{k}$ and $\vec{c} = y\hat{i} + x\hat{j} + (1 + x - y)\hat{k}$. Then $[\vec{a}\ \vec{b}\ \vec{c}]$ depends on

(a) only y (b) only x

(c) both x and y (d) neither x nor y

143. If $\hat{i} + \hat{j}$, $\hat{j} + \hat{k}$, $\hat{i} + \hat{k}$ are the position vectors of the vertices of a triangle ABC taken in order, then ∠A is equal to

(a) $\frac{\pi}{2}$ (b) $\frac{\pi}{5}$ (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{3}$

144. The projection of line joining (3, 4, 5) and (4, 6, 3) on the line joining (–1, 2, 4) and (1, 0, 5) is

(a) $\frac{4}{3}$ (b) $\frac{2}{3}$ (c) $\frac{8}{3}$ (d) $\frac{1}{3}$

145. Which of the following statements is correct?

(a) Every L.P.P. admits an optimal solution.

(b) A L.P.P. admits a unique optimal solution.

(c) If a L.P.P. admits two optimal solutions, it has an infinite number of optimal solutions.

(d) The set of all feasible solutions of a L.P.P. is not a convex set.

146. If the constraints in a linear programming problem are changed then (a) The problem is to be re-evaluated.

(b) Solution is not defined.

(c) The objective function has to be modified.

(d) The change in constraints is ignored.

147. In a binomial distribution, the mean is 4 and variance is 3. Then its mode is :

(a) 5 (b) 6

(c) 4 (d) None of these

148. The sum $1 + \frac{1+a}{2!} + \frac{1+a+a^2}{3!} + \ldots \infty$ is equal to

(a) e^a (b) $\frac{e^a - e}{a - 1}$

(c) $(a - 1)e^a$ (d) $(a + 1)e^a$

149. The Boolean expression ~ (p ∨ q) ∨ (~ p ∧ q) is equivalent to :

(a) p (b) q (c) ~q (d) ~p

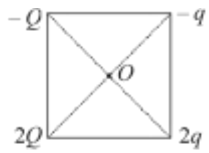
150. If in a frequency distribution, the mean and median are 21 and 22 respectively, then its mode is approximately

(a) 25.5 (b) 24.0 (c) 22.0 (d) 20.5

SOLUTIONS

PART - I : PHYSICS

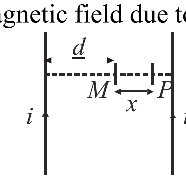
1. **(a)** Let the side length of square be 'a' then potential at centre O is



$$V = \frac{k(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{k(-q)}{\frac{a}{\sqrt{2}}} + \frac{k(2q)}{\frac{a}{\sqrt{2}}} + \frac{k(2Q)}{\frac{a}{\sqrt{2}}} = 0$$

$= -Q - q + 2q + 2Q = 0$ Þ$Q + q = 0$ (Given) $Q = -q$

2. **(b)** The magnetic field due to two wires at P



$B_1 = \frac{\mu_0 i}{2\pi(d + x)}$; $B_2 = \frac{\mu_0 i}{2\pi(d - x)}$

Both the magnetic fields act in opposite direction.

m0*i* é 1 - 1 ùúû

\ $B = B_2 - B_1 = 2$p êë$d - x$ $d + x$

= m20p*i* éêë*d* +*dx*2 --*dx*2+ *x*ùûú = p(*d*m20-*ixx*2).

3. **(d)** Current in inductor = $\frac{E}{R}$

\ its energy = $\frac{1LE^2}{2R^2}$

Same energy is later stored in capacitor

$\frac{Q^2}{2C} = \frac{1LE^2}{2R^2}$ Þ $= Q \frac{E}{R}\sqrt{LC}$

4. **(a)** Using, $\frac{m}{v} - \frac{1}{u} = \frac{m-1}{R}$

or $\frac{1.5}{v} - \frac{1}{-15} = \frac{1.5 - 1}{+30}$

\ $v = -30$ cm

5. **(c)**

6. **(b)** Voltage gain, $A_v = \beta \frac{R_L}{R_i} = 0.6 \times \frac{24}{3}$ = 4.8

7. **(b)** $v_e = \sqrt{2g_e R_e}$; $v_m = \sqrt{2g_m R_m}$

$\frac{v_e}{v_m} = \sqrt{\frac{g_e R_e}{g_m R_m}} = \sqrt{\frac{g_e R_e}{g_e/6\ R_e/4}} = \sqrt{24}$

8. **(b)**

$|\vec{P} + \vec{Q}| = |2\hat{i} - 3\hat{j} + 4\hat{k} + \hat{j} - 2\hat{k}| = |2\hat{i} - 2\hat{j} + 2\hat{k}|$

$= \sqrt{2^2 + 2^2 + 2^2} = 2\sqrt{3}$

9. **(b)** The kinetic energy of a particle executing S.H.M. is given by

$K = \frac{1}{2} ma^2 \omega^2 \sin^2 \omega t$

Now, average K.E. = $\langle K \rangle = \langle \frac{1}{2} m\omega^2 a^2 \sin^2 \omega t \rangle$

$= \frac{1}{2} m\omega^2 a^2 \langle \sin^2 \omega t \rangle$

= $\frac{1}{2} m\omega^2 a^2 \left(\frac{1}{2}\right)$ $\left(\because \langle \sin^2\theta \rangle = \frac{1}{2}\right)$

$= \frac{1}{4} m\text{w}^2{}^2 a = \frac{1}{4} ma^2 (2\text{pn})^2$ (Q w= pn2)

or, $< K > = \text{p}^2 ma^2{}^2\text{n}$

10. **(b)**

11. **(c)** tanq= $\frac{B_V}{B_H}$ =1 \ q = 45°

12. **(c)** For third line of Balmer series $n_1 = 2$, $n_2 = 5$

\ _1 = RZ2 ëên1 12 - n1 22 úûùgives Z2 = (n22 n n-12

2n) R122 l l ë

On putting values Z = 2

From

E =-13.62Z2 =-13.6(2)(1)2 2 =-54.4 eV n

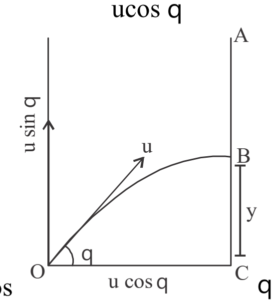
13. **(b)**

14. **(d)** Cg2 = LTLT2 --22 =[ ]L

15. **(b)** Due to increase in velocity, pressure will be low above the surface of water.

16. **(a)**

OC = $\frac{x}{u\cos q}$



17. **(b)** t = ucos q

AC = x tan q

BC = distance travelled by bullet in time t, vertically. y = u sin q t – $\frac{1}{2}$ gt^2

AB = x tan q – (u sin qt – $\frac{1}{2}$ gt^2)

= x tan q – (usinq × $\frac{x}{u\cos q}$ – $\frac{1}{2}$ gt^2)

Þ distance trevelled by monkey

= x tan q – x tan q + $\frac{1}{2}$ gt^2 = $\frac{1}{2}$ gt^2

(\ bullet will always hit the monkey)

18. **(b)**

19. **(b)** Let 'n' be the degree of freedom g =

CCp = çè 2 +1ö R = æ çè1+ _n 2ö ÷ø = 1.66 æ n

÷ ø

væ öç ÷è øn2 R

= =53 æçè1+ _23 ö÷ø Þ n

= 3 Þ gas must be monoatomic.

20. **(b)** Phase change p in 50 oscillations. Phase change 2p in 100 oscillations. So frequency different ~ 1 in 100.

21. **(b)** Time taken by same ball to return to the hands of juggler is = $\frac{2u}{g} = \frac{2 \times 20}{10}$ = 4 s. So he is throwing the balls after each 1 s. Let at some instant he is throwing ball number 4. Before 1 s of it he throws ball. So height of ball 3 : $h_3 = 20 \times 1 - \frac{1}{2} 10(1)^2$ = 15 m

Before 2s, he throws ball 2. So height of ball 2 : $h_2 = 20 \times 2 - \frac{1}{2} 10(2)^2$ = 20 m

Before 3 s, he throws ball 1. So height of ball 1 : $h_1 = 20 \times 3 - \frac{1}{2} 10(3)^2$ = 15 m

22. **(a)** After the stone is thrown out of the moving train, the only force acting on it is the force of gravity i.e. its weight.

\ F = mg = 0.05 × 10 = 0.5 N.

23. **(c)** Impulse experienced by the body = MV – (–MV) = 2MV.

24. **(a)**

25. **(c)** $x = 0 \quad 1 \quad 2 \quad 4 \quad 8$

$GM \quad$ æ1 + + + +1 $\quad 1 \quad 1$

......¥ö÷ø

$V = - \quad = -G$çè1 2 $\quad 4$

$8\,r$

$= -G$æçè1-1 1/2ö÷ø = – 2G

26. **(a)** Heat gained by the water = (Heat supplied by the coil) – (Heat dissipated to environment)

Þ $\quad mc\,\Delta q = P_{\text{Coil}}\,t - P_{\text{Loss}}\,t$

Þ $2 \times 4.2 \times 10^3 \times (77 - 27) = 1000\,t - 160\,t$

Þ$t = \dfrac{4.2 \times 10^5}{840} = 500$ s = 8 min 20 s

27. **(a)**

28. **(b)**

29. **(b)** $l_1 = 50$ cm. $l_2 = 51$ cm.

vµ T Þ v1 = T2 = 273 + 20 v2 T1 $\quad$ 273

Þ v_2 = 319.23. n =1 vl2 1 =

319.230.50 = 640 Hz.

n =2lv2 2 = 51319.23´10-2 = 625.94 = 626 Hz.

No. of beats = n -n =2 $\quad$ 1 14 Hz

30. **(a)**

31. **(d)** $E_x = -$ rv = – r $(-5x + 5y + 15z)$ = 5 rx $\quad$ rx

E_y = rv = –3, E_z = – 15 ry

Now, $E = \sqrt{E_x^2 + E_y^2 + E_z^2} = 7$

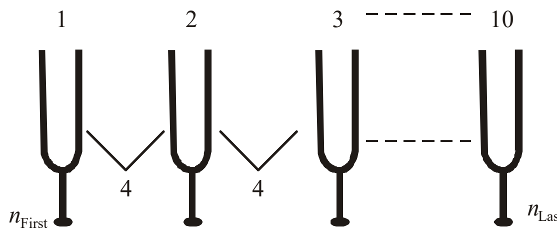
32. **(c)** **33.** **(b)** **34.** **(b)**

35. **(c)** As the two cells oppose each other hence, the effective emf in closed circuit is 15 – 10 = 5 V and net resistance is 1 + 0.6 = 1.6 Ω (because in the closed circuit the internal resistance of two cells are in series.

Current in the circuit, $I = \dfrac{\text{effective emf}}{\text{total resistance}} = \dfrac{5}{1.6}$ A The potential difference across voltmeter will be same as the terminal voltage of either cell. Since the current is drawn from the cell of15 V

$\therefore V_1 = E_1 - Ir_1 = 15 - \dfrac{5}{1.6} \times 0.6 = 13.1$V

36. **(d)**



Using $n_{\text{Last}} = n_{\text{First}} + (N - 1)x$ where N = Number of tuning forks in series x = beat frequency between two successive forks

Þ $2n = n + (10 - 1) \times 4$ Þ $n = 36$ Hz

37. **(d)** Power = $\dfrac{\text{work done}}{\text{time}}$

As no work is done by magnetic force on the charged particle because magnetic force is perpendicular to velocity, hence power delivered is zero.

38. **(a)** In an ac circuit, a pure indcutor does not consume any power. Therefore, power is consumed by the resistor only.

$\therefore$ P = $I^2 R_v$ or 108 = $(3)^2$ R or R = 12 Ω

39. **(d)** V = 3000 volt.

– 1 $\quad$ 2 = eV Þ

v =

2eV

mv

2

$\sqrt{m}$

$\therefore$ v = 2 $\sqrt{1.6 \times 10^{-19} \times 3000 / 9.1 \times 10^{-31}}$

= 32.6 × 10^6 = 3.26 × 10^7 m/s.

40. **(d)** $\frac{dN}{dt} = 50 - 0.5N \Rightarrow \int_0^N \frac{dN}{50-0.5N} = \int_0^t dt$

$N = (100(1 - e^{-t/2})) = 25$ t = 2 ln (4/3)

PART - II : CHEMISTRY

41. **(a)** Molar mass of $Pb(NO_3)_2$ = 25 × 0.15 = 3.75 m. moles

Molar mass of $Al_2(SO_4)_3 = \frac{1}{3} \times 3.75 = M \times 20$

M = 0.0625 = 6.25 × 10^{-2} M

42. **(c)** This is Avogadro's hypothesis.

According to this, equal volume of all gases contain equal no. of molecules under similar condition of temperature and pressure.

43. **(c)** $\lambda = \frac{h}{p} = \frac{6.6 \times 10^{-34}}{3.3 \times 10^{-24}} = 2 \times 10^{-10}$ m = 2Å

44. **(d)** The smaller the atomic size, larger is the value of ionisation potential. Further the atoms having half filled or fully filled orbitals are comparatively more stable, hence more energy is required to remove the electron from such atoms.

45. **(a)** The number of lone pairs of electrons on central atom in various given species are

Species	Number of lone pairs on central atom
IF_7	nil
IF_5	1
ClF_3	2
XeF_2	3

Thus the correct increasing order is

$IF_7 < IF_5 < ClF_3 < XeF_2$

46. **(b)** $O_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \begin{Bmatrix} \pi 2p_x^2 \\ \pi 2p_y^2 \end{Bmatrix}, \begin{Bmatrix} \pi^* 2p_x^1 \\ \pi^* 2p_y^1 \end{Bmatrix}$

Bond order = $\frac{10-6}{2}$ = 2

(two unpaired electrons in antibonding molecular orbital)

$O_2^+ : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \begin{Bmatrix} \pi 2p_x^2 \\ \pi 2p_y^2 \end{Bmatrix}, \begin{Bmatrix} \pi^* 2p_x^1 \\ \pi^* 2p_y^0 \end{Bmatrix}$

Bond order = $\frac{10-5}{2}$ = 2.5

(One unpaired electron in antibonding molecular orbital)

Hence O_2 as well as O_2^+ both are paramagnetic,

and bond order of O_2^+ is greater than that of O_2.

47. **(d)** van der Waals's constant b = 4 times the actual volume of 1 mole molecules = 4 VN_0

48. **(d)** $H_2O(\ell) \xrightleftharpoons{1atm} H_2O(g)$

$\Delta H = 40630\ J\ mol^{-1}$

$\Delta S = 108.8\ JK^{-1}\ mol^{-1}$

$\Delta G = \Delta H - T\Delta S$ When $\Delta G = 0$, $\Delta H - T\Delta S = 0$

$$T = \frac{\Delta H}{\Delta S} = \frac{40630 Jmol^{-1}}{108.8 Jmol^{-1}} = 373.4\ K$$

49. **(d)** $\Delta G° = -RT \ln K_P$; $K_P = (2X)^2\ X = 4X^3$

$\Delta G° = -RT \ln (4X^3)$

$\Delta G° = -RT \ln 4 - 3RT \ln X$

50. **(b)**

(i) $\underset{0.1\ M}{HCl} \longrightarrow \underset{0.1\ M}{H^+} + Cl^-$

$\therefore [H^+] = 0.1$ M pH $= -\log [H^+] = -\log 0.1 = 1$ (ii) NaCl is a salt of strong acid and strong base so it is not hydrolysed and hence its pH is 7. (iii) $NH_4Cl + H_2O \rightleftharpoons NH_4OH + HCl$ $\therefore$ The solution is acidic and its pH is less than that of 0.1 M HCl.

(iv) $NaCN + H_2O \rightleftharpoons NaOH + HCN$ $\therefore$ The solution is basic and its pH is more than that of 0.1 M HCl.

$\therefore$ Correct order for increase in pH is $HCl < NH_4Cl < NaCl < NaCN$.

51. **(d)** $\underset{4-x}{N_2O_5} \rightleftharpoons \underset{x-y}{N_2O_3} + \underset{x+y}{O_2}$

$\underset{x-y}{N_2O_3} \rightleftharpoons \underset{y}{N_2O} + \underset{y+x}{O_2}$

$\because [O_2] = x + y = 2.5$ for N_2O_5, $K_c = [N_2O_5]$

$[O_2] / [N_2O_5]$ and $2.5 = \frac{(x+y)(x-y)}{4-x}$

$\therefore\ x = 2.166$

$[N_2O_5] = 4 - x = 1.846$

52. **(b)**

53. **(a)** Calcium gives brick red colour and barium gives apple green colour in flame test.

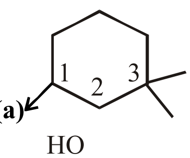
54. **(b)** The $Be(OH)_2$ and $Al(OH)_3$ are amphoteric in nature.

55. **(c)** $ns^2\ np^1$ is the electronic configuration of III A period. $X_2O_3 (Al_2O_3)$ is an amphoteric oxide.

56. **(c)** The strength of nucleophile depends upon the nature of alkyl group R on which nucleophile has to attack and also on the nature of solvent. The order of strength of nucleophiles follows the order :

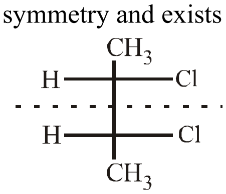
$CN^- > I^- > C_6H_5O^- > OH^- > Br^- > Cl^-$

57. **(a)**



IUPAC name – 3, 3-Dimethyl -1-cyclohexanol

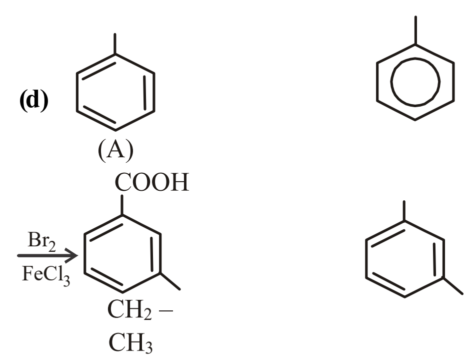
58. **(b)** The compound has two similar assymmetric C-atoms. It has plane of symmetry and exists in *meso* form.



plane of symmetry

Meso - 2, 3 dichlorobutane

(d)



59. $\longrightarrow$ ($KMnOKOH_4$)

(B)

$COOC_2H_5$

$\longrightarrow C\ H\ OH_2H_5+$

BrBr

(C) (D)

Volume(in litre) 1

60. **(c)** The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun. Depletion of ozone is caused by oxides of nitrogen

N_2O + hn ¾¾® NO + N

reactive nitric oxide

NO + O_3 ¾¾® NO_2 + O_2

O_3 + hn ¾¾® O_2 + O

NO_2 + O ¾¾® NO + O_2

$2O_3$ + hn ¾¾® $3O_2$ (Net reaction) The presence of oxides of nitrogen increase the decomposition of O_3.

61. **(b)** d = N aZM3 Þ 6.25 = 23Z 120´

´´(4 10-8)3

A 6 10´

62. **(d)**DTb =Kb.m Þ 3.63´ 0.616/15415 ´1000;

T_b = 61.7 + 0.968

= 62.67° C

63. **(b)** pH = 2

[H^+] = 0.01 M = *Cx* = 0.1x x = 0.1 i = 1 + x = 1.1

π= i n RT = iMRT =1.1 0.1´ RT = 0.11RT V

st Law, W = q

64. (a) By Faraday's I

E 96500

(where q = it = charge of ion) we know that no of equivalent

= W = it = 1 965´ = 1

E 96500 96500 100

(where i = 1 A, t = 16×60+5 = 965 sec.)

Since, we know that

Normality = no.of equivalent = $\frac{1}{100}$ = 0.01 N

65. **(d)** No. of moles of

Ag+ = 15´60 1.25 10´ ´-3 ´1 = 0.0116 × 10–3

96,500 1

\ éëAg+ùû = 1.16 ´10-5 = 1.16 ´10-4

$\frac{100}{1000}$

66. (a) The intersection point indicates the half life of the reactant A when it is converted to B.

67. **(b)** T_1 = 273 + 25 = 298 K

T_2 = 273 + 60 = 333 K

log k2 = Ea æç T – TT T21 21 ö÷ø k1

2.3R è k1

R

loge 2 = Ea æç T –T2

è T T1 2 ø

or 1ö÷ k

loge 1.5 102.1 10´´

–3–2 = ERa çèæ

33335´298ö÷ø

$\frac{298\times333}{35}$ 21

\ E_a = × *R* × $\log_e$ 1.5

68. **(b)** According to Freundlich equation,

x 1/n or x

=Kp1/n µ p

m m

or log x = log $Kp^{1/n}$ or log x = log K+ 1 log p

m m n

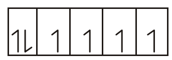
69. **(b)** Given reactions shows that the selectivity of different catalysts for some reactants is different.

70. **(d)** chalcogens are defined as ore-forming elements.

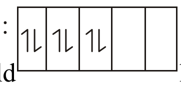
71. **(c)** Catenation tendency is higher in phosphorus when compared with other elements of same group.

72. **(c)** Be is the only group 2 element that does not form a stable complex with $[EDTA]^{4-}$. Mg^{2+} and Ca^{2+} have the greatest tendency to form complexes with $[EDTA]^{4-}$.

73. **(a)** Co^{3+} :

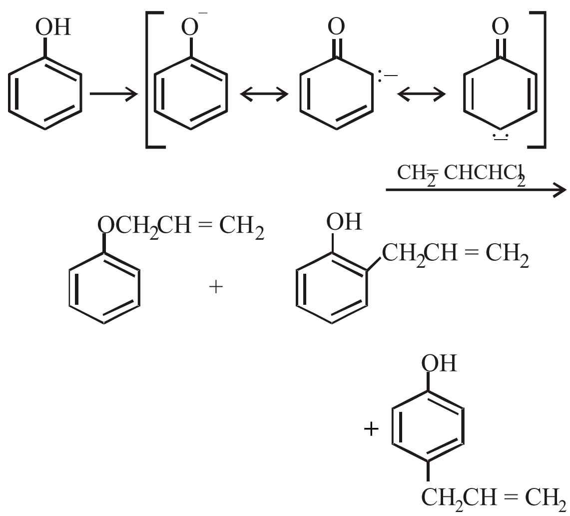


$[Co(CN)_6]^{3-}$:



CN^- is a strong field ligand and it causes pairing of electrons; as a result number of unpaired electrons in Co^{3+} becomes zero and hence it has lowest value of paramagnetic behaviour.

74. **(a)** 75. **(c)**



76. **(d)** Among the given compounds only CH_3OH does not give iodoform reaction.

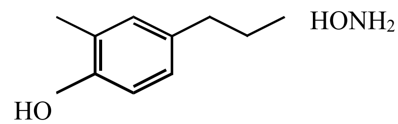
77. **(a)** Alkylhalide formation in the reaction of alcohol with HCl undergoes S_N1 reaction in which formation of the carbocation as intermediate occurs. Stability of carbocation is greatest for $(C_6H_5)_3C^+$ due to resonance effect, and stability of tertiary carbocation is greater than the secondary carbocation hence the option (a) shows the correct order.

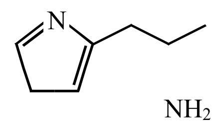
78. **(b)** If 30 percent of DNA is adenine, then by Chargaff's rule 30 percent will be thymine. The remaining 40 percent of the DNA is cytosine and guanine. Since the ratio of cytosine to guanine must be equal, then each accounts for 20 percent of the bases.

79. **(b)** Most snail blood is blueish in color. This is because their blood cells use haemocyanin, which gets its blue color from the copper that is part of its structure.

80. **(c)** diamines are those compounds which contain two amino groups.

Dopamine -



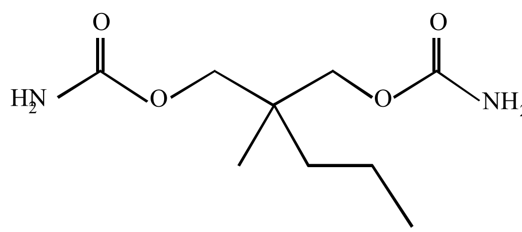


Histamine -

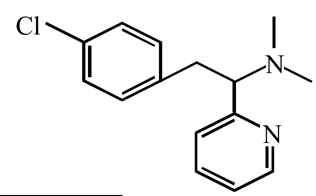
N

H Histamine (HA)

Meprobamate -



Chlorphenamine-



PART - III (A): ENGLISH PROFICIENCY

81. **(c)** Optimistic means hopeful and confident about the future.

82. **(d)** Drowsy means sleepy and lethargic. Therefore, option (d) is the correct antonym of it. Rest of the options are its synonyms.

83. **(d)** The phrase used in the sentence is grammatically correct hence, it doesn't require any correction. The meaning of the phrase' under the weather' is to feel ill.

84. **(b)** The correct phrase to be used is 'get the best of both worlds' which means a win-win situation.

85. **(c)** The correct phrase to be used is 'speak of the devil'. This phrase is said when a person appears just after being mentioned.

86. **(d)** **87. (b)** **88. (d)** **89.** **(d)**

90. **(b)** The first sentence talks about the fact that only few investors have idea about bitcoins and other cryptocurrencies (which seems an attractive investment area), so, the finance ministry has warned the potential investors about it. Sentence E will follow the first sentence because it says that 'bitcoin not only shot up well over by 1000%......' which justifies 'attractive investment area' and forms a link. Now, we are left with only option (b) and (d) to choose from. When we consider the sentence F, we can see that this line seems to be a part somewhere in the middle of the paragraph, also, the first line starts with a warning, therefore, it must justify the consequences of the investment in bitcoins and other cryptocurrencies which is justified by sentence C. Hence, option (b) is the correct choice.

91. **(d)** After reading all the sentences carefully, we see that sentence A and F should go one after another as both talk about 'over-volunteer'. Moreover, sentence A will follow sentence F because of the presence of the word 'such' which signifies that the subject of the sentence has already been discussed in the previous sentence. So, we have option (c), (d) and (e) to choose from. Considering sentence D which talks about 'a big problem', we find that it can't be the second sentence as no problem of any sort has been dealt in the first sentence, so, option (c) and (e) gets eliminated. Hence, by elimination method, we can conclude that option (d) is the correct choice.

92. **(c)** Replace the preposition 'on' with 'over' to make the sentence grammatically correct.

93. **(d)** Replace the adverb 'safely' with the adjective 'safe' to make the sentence.
Grammatically correct.

94. **(b)** **95. (a)**

PART - III (B) : LOGICAL REASONING

96. **(c)** According to question,

<u>REGAINS</u> <u>QDFZHMR</u>

–1

Similarly, <u>PERIODS</u> **<u>ODQHNCR</u>**

–1

97. **(a)** According to question,

$(5 + 6)^2 = 121$

$(10 + 8)^2 = 324$

$(23 + 14)^2 =$ **1369**

98. **(b)** **99.** **(a)**

100. **(b)** Distance is measured by odometer. Similarly, **Pressure** is measured by Barometer.

101. **(d)** According to question, 24 = 1 × 6 ×1 × 4

270 = 5 × 6 × 9

120 = 4 × 3 × 2 × 5

162 ¹ 6 × 9 × 3 × 0 = 0

102. **(d)** According to question, L **M** N O /**O** **N** M L/ L M **N** O/ O **N** M L **103.**
(a) The pattern is :

22 26 53 69 194
230

+2² +3³ +4² +5³ +6²

104. **(a)** The pattern is :

$(1 \times 2 \times 3 \times 5) + (1 + 2 + 3 + 5) = 41$

$(3 \times 4 \times 2 \times 6) + (3 + 4 + 2 + 6) = 159$

$(9 \times 8 \times 3 \times 4) + (9 + 8 + 3 + 4) =$

888 105. (c)

PART - IV : MATHEMATICS

106. **(d)** f(x) is defined if x^2 -[x^2] ³ 0 Þ x^2 ³ $[x]^2$, which is true for all positive real x and all negative integers x.

107. **(a)** m = sin(q+ a2)
n sinq

Þ mm -±11 = sin(sin(q+ a +q+ a -22))
sinsin qq

\ m + n = ______________ 2sin(q+a)cosa = tan(q+a)cota m - n 2cos(q+a)sina

108. **(b)** sin 9q = sin q Þ 9q = p+ -n (1)^{n}q

If n =2m *then* 9q=2mp+qÞq= ___mp
4 If n = 2m +1 *then* 9q = (2m+1)p-q p
Þ q = (2m +1) 10 The values

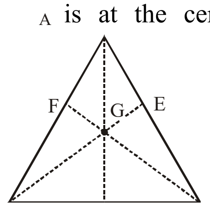
belonging to [0, p] are q=0, p , p, 3p,

p, 7p, 3p,9p,

10 4 10 2 10 4 10

p, 11p,5p,13p,3p,17p,7p,19p,2p
10 4 10 2 10 4 10

109. **(a)** The foot of the pole A is at the centroid. Because centroid is the point of intersection of medians AD, BE and CF, which are B



D C

the lines joining a vertex with the mid point of opposite side.

110. **(a)** A + B + C = p \ tanæçè A+B2 ö÷ø = tanèæçp2 – __C2ö÷ø

A B 1 2

Þ tan 2 + tan 2 = cot C Þ 3 + 3 = =9 cot C

1 2

1– tan A.tan B 2 1– . 7 2

2 2 3 3

\ tan C = 7.
2 9

111. **(d)** z - 2-3i = x+ iy - 2-3i = (x - 2)+i y(- 3) tan-1çèæ xy--23ø÷ö = p4 Þ xy--23 = tan p4 = 1

Þ $x - y + 1 = 0$

112. **(a)** Given equation is $x^4 - 2x^3 + x - 380 = 0$

Þ (x^2 - x - 20)(x^2 - x +19) = 0

Þ (x - 5)(x + 4)(x^2 - x +19) = 0

Hence, the required roots of the equation are

5, - 4, $\frac{1\pm 5\sqrt{-3}}{2}$.

113. **(c)** Since b, c > 0 Therefore a +b = - <b 0 and ab=- <c 0

Since product of the roots is –ve therefore roots must be of opposite sign.

114. **(d)** It is obvious by fundamental property of circular permutations.

115. **(b)** First prize can be given in 5 ways. Then second prize can be given in 4 ways and the third prize in 3 ways (Since a competitior cannot get two prizes) and hence the no. of ways. = 5 × 4 ×3 = 60 ways

116. **(b)** Given, æçè x - __1x ö÷ø^7 and the (r + 1)th term in the

expansion of (r x + a)^n is T$_{(r+1)}$ = ^{n}C$_r$(x)$^{n-r}$

a

\ (r + 1)th term in expansion of

$\left(x-\frac{1}{x}\right)^7 = {}^7C_r(x)^{7-r}\left(-\frac{1}{x}\right)^r$

$= {}^7C_r(x)^{7-2r}(-1)^r$

Since x^3 occurs in T_{r+1}

$\therefore$ $7 - 2r = 3 \Rightarrow r = 2$ thus the coefficient of x^3 $= {}^7C_2(-1)^2$

$= \frac{7\times 6}{2\times 1} = 21.$

117. (d) $1 + \frac{\log_{e^2} x}{1!} + \frac{\left(\log_{e^2} x\right)^2}{2!} + \ldots\ldots +$

$= e^{\log_{e^2} x} = e^{\frac{1}{2}\log_e x} = e^{\log_e \sqrt{x}} = \sqrt{x}$

118. (a) $\because$ a, b, c are in G.P.

$\therefore \frac{b}{a} = \frac{c}{b} \Rightarrow \frac{b^2}{a^2} = \frac{c^2}{b^2} \Rightarrow a^2, b^2, c^2$ are in G.P.

119. (a) To eliminate the parameter t, square and add the equations, we have $x^2 + y^2 = a^2\left(\frac{1-t^2}{1+t^2}\right)^2 + \frac{4a^2t^2}{(1+t^2)^2}$

$= \frac{a^2}{(1+t^2)^2}\left[(1-t^2)^2 + 4t^2\right]$

$= \frac{a^2(1+t^2)^2}{(1+t^2)^2} = a^2$

Which is the equation of a circle.

120. (b) As the circle is passing through the point (4, 5) and its centre is (2, 2) so its radius is

$\sqrt{(4-2)^2 + (5-2)^2} = \sqrt{13}.$

$\therefore$ The required equation is :

$(x-2)^2 + (y-2)^2 = 13$

121. (d) We have $\frac{81}{a^2} + \frac{25}{b^2} = 1$ .... (1)

$\frac{144}{a^2} + \frac{16}{b^2} = 1$ .... (2)

From eq. (2) – eq. (1) :

$\frac{63}{a^2} - \frac{9}{b^2} = 0 \Rightarrow \frac{b^2}{a^2} = \frac{1}{7}$

$e = \sqrt{1-\frac{1}{7}} = \sqrt{\frac{6}{7}}$

122. (a) Equation of parabola is $y^2 = -4ax$. Its focus is at $(-a, 0)$.

123. (b) Consider $\lim_{n\to\infty}\frac{1+2+3+\ldots+n}{n^2+100}$

$= \lim_{n\to\infty}\frac{n(n+1)}{2(n^2+100)}$

(By using sum of n natural number $1 + 2 + 3 + \ldots + n = \frac{n(n+1)}{2}$)

Take n^2 common from N^r and D^r.

$= \lim_{n\to\infty}\frac{n^2\left(1+\frac{1}{n}\right)}{2n^2\left(1+\frac{100}{n^2}\right)} = \frac{1}{2}$

124.(b) $\lim_{x\to 0}\sqrt{\frac{x-\sin x}{x+\sin^2 x}} = \lim_{x\to 0}\sqrt{\frac{1-\frac{\sin x}{x}}{1+\frac{\sin^2 x}{x}}}$

$= \lim_{x\to 0}\sqrt{\frac{1-\frac{\sin x}{x}}{1+\left(\frac{\sin x}{x}\right)\sin x}} = \sqrt{\frac{1-1}{1+1\times 0}} = 0$

125. (b) Exhaustive no. of cases $= 6^3$; 10 can appear on three dice either as distinct number as following (1, 3, 6) ; (1, 4, 5); (2, 3, 5) and each can occur in 3! ways. Or 10 can appear on three dice as repeated digits as following (2, 2, 6), (2, 4, 4), (3, 3, 4) and each can occur in $\frac{3!}{2!}$ ways.

\ No. of favourable cases = 3´3! + 3´$\frac{3!}{2!}$ = 27

126. **(c)** $\tan^{-1}(1+x) + \tan^{-1}(1-x) = $ _p

2 Þ tan^{-}

$^{1}(1+x)$ = p2 - tan$^{-1}(1-x)$ Þ tan$^{-1}(1+x)$

= cot$^{-1}(1-x)$

Þ tan$^{-1}(1+x)$ = tan^{-1} æçè1____-1 x ö÷ø

1

Þ 1+ =x ____

1- x

Þ 1 – x^2 = 1 Þ x = 0

127. **(a)** As A is an orthogonal matrix, AA^T = I

é1 2 2 ù é1 2 aù é1 0 0ù

1 ê

Þ _ ê2 1-2úú × _13 êê2 1 2úú = êê01 0úú

3

êëa 2 b ûú êë2 -2 búû

êë0 0 1úû é1 2 2 ù

é1 2 aù é1 0 0ù

Þ _19 ê ê2 1 -2ú ê ú ê2 1 2ú ú = ê ê0 1 0ú ú êëa 2

b ú êû ë2 -2 búû êë0 0 1úû é 9 0 a + +4 2b

ù ê ú

Þ ê 0 9 2a + -2 2bú ê ëa + +4 2b 2a + -2 2b a^2 +

+4 b^2 ú û

é9 0 0ù

= ê ê0

9

0 ú

ú

êë0

0

9ú

û

Þ a + 4 + 2b = 0, 2a + 2 – 2b = 0 and a^2 + 4 + b^2 = 9

Þ a + 2b + 4 = 0, a – b + 1 = 0 and a^2 + b^2 = 5

Þ a = – 2, b = – 1

128. **(c)** Let $z_1 = 1 + i$, $z_2 = -2 + 3i$

and z_3 = | 0 + $\frac{5}{3}i$ | = | 11 |

x_1 y_1

1 1

Then x_2 y_2 1-2 3 1 x_3 y_3 10 5/3 1

= 1 3çèæ -_53÷øö+1(2) 1+ çèæ-310ø÷ö= +

-43 2 10__3 = 4 6 10+ -3 =0

é3 -2 4 ù

129. **(c)** If A = ê1 2 - 1ú êë0 1 1 úû

and A^{-1} = _1 adj(A) ...(i) k

Also, we know A^{-1} = $\frac{\text{adj(A)}}{|\text{A}|}$ ...(ii)

\ By comparing (i) and (ii) | A | = k

3 -2 4
0 1 1
Þ | A |=1 2 -1
= 3 (2 + 1) + 2 (1 + 0) + 4 (1 – 0) = 9 + 2 + 4 = 15

130. **(b)** We have

0 -y -z 0 y z
D = y 0 -x = -y 0 x z x 0 - -z
x 0

[Interchanging rows and columns]

0 - -y z
= (1)- ^{3} y 0 -x = -D z x 0
[Taking –1 common from each row]

\ $\bar{D}$+D= Þ0 2Re(D =) 0

\ D is purely imaginary.

131. **(b)** The function can be continuous only at those points for which

sin x = cosx Þ = p+x n $\frac{p}{4}$

132. **(c)** Here f æç è $\frac{3p}{4}$ ö÷ ø=1 and x® plim$_{3/4^-}$ $f x( )$ = 1

x® plim$_{3/4^+}$ $f x( )$ = $h$lim 2sin®0 9^2 æ ç è $\frac{3p}{4}$+h÷ ø ö

= 2sin $\frac{p}{6}$ =1

Hence f (x) is continuous at x = $\frac{3p}{4}$.

133. **(b)** f(x) = x (x – 1)^2 ; x Î [0, 2]

f ¢(c) = $\frac{f(b) - f(a)}{b - a}$; f(2) = 2, f(1)

= 0 f ¢(x) = 3x^2 – 4x + 1 Þ f ¢(c) = 3c^2 – 4c +
1

Thus, 3c^2 – 4c + 1 = $\frac{f(2) - f(0)}{2 - 0}$

= 22 00

=1 Þ c = $\frac{4}{3}$

134. **(a)** Given expression can be written as

y = 1 – x1+1+ +1 1x Þ $dy$$dx$ = 1 2 - x12
(1+ x)

$d y$2 = – 2 (1 + x)$^{-3}$ + 2x^{-3} = -2 3 + x23
dx2 (1+ x)

Now, $d y$2 = -2 3 + (1)23 = -82 +

2 = $\frac{7}{4}$ dx2 x=1 (1+1)

135. **(d)** y = e^{2x} \ dx = 2e^{2x} and $d y$22 = 4e^{2x} dy dx
dx 1 1
= ^{2x} = 2 y
dy 2e

$d x$2 =- 12 =-12e^{-4x}
\ dy2 2y

\ $d y$ $d x$ dx dy2 . 2 = 4e^{2x} çèæ -e-2xö =-2e^{-2x}

2 2

2e2

x ÷ ø

d x^2

136. **(b)** We have, a = 2 =-9.8

dt

The initial conditions are x (0) = 19.6 and v (0) = 0

dx

So, v = ___ = -9.8t + v(0) = -9.8t dt

\ x = – 4.9t² + x (0) = – 4.9t² + 19.6

Now, the domain of the function is restricted since the ball hits the ground after a certain time. To find this time we set x = 0 and solve for t.

0 = – 4.9t² + 19.6 Þ t = 2

b x dx

137. **(b)** Given, I = Òa √ x + √ a + -b x .... (i)

Note : Òbf (x)dx =Òbf(a + -b

x)dx a a

Ò b a + -b x dx ....(ii)

\ I = a a + - +b x x

Add (i) and (ii),

b x dx b a + -b x dx

2I = Òa x + + -a b x + Òa a + - +b x

x

=Òabxa+ + -+ + +ba xb x dxx

=Òab1.dx = [x]ba

b-a

2I = b – a \ I = ____

2

138. **(d)** Put x² = t Þ 2x dx = dt

I = Ò eX2(3(2++xx2 2²))xdx = 12 Òet (3(2++t)t)2 dt

= 12 Ò e (3t(3++ -t)t 21) dt = 12 Òet

éêêë31+ t - (3+1t)2 ùúúû dt

= 12 e .t 3+1 t + k éêëê∵ d æçè 31+

tö÷ø = (3+-1t)2

ùúúû dt

1 ex2

= ____22 +k

3+x

139. **(d)** Put x = 2a – t so that dx = – dt when x = a, t = a and when x = 2a, t = 0

2 a a

Ò f(x)dx =Ò f(x)dx +Ò f(2a-t)dt = +n

m

0 0 0

140. **(a)** Given differential equation is

$$\sin x\frac{dy}{dx} + 2y\cos x = 1$$

$$\Rightarrow \frac{dy}{dx} + 2y\frac{\cos x}{\sin x} = \frac{1}{\sin x}$$

$$\Rightarrow \frac{dy}{dx} + (2\cot x\, y) = \operatorname{cosec} x$$

I.F = $e^{\int 2\cot x\,dx}$

$= e^{2\log(\sin x)} = \sin^2 x$

141. **(c)** Rewrite the given differential equation as follows :

dy 2x 1

+ 2 -1 y = x2 -1 , which is a linear form dx x

The integrating factor I.F.

2x

= eò x2-1dx = eℓn(x2-1) = x2 -1

Thus multiplying the given equation by $(x^2 - 1)$,

we get $(x^2 - 1) \frac{dy}{dx} + 2xy = 1$

$\Rightarrow \frac{d}{dx}[y(x^2 - 1)] = 1$

On integrating we get $y(x^2 - 1) = x + c$

142. (d) $\vec{a} = -\hat{i} + \hat{k}$, $\vec{b} = x\hat{i} + \hat{j} + (1 - x)\hat{k}$ and $\vec{c} = y\hat{i} + x\hat{j} + (1 + x - y)\hat{k}$

$[\vec{a}\ \vec{b}\ \vec{c}] = \vec{a} \cdot \vec{b} \times \vec{c} = \begin{vmatrix} -1 & 0 & 1 \\ x & 1 & 1-x \\ y & x & 1+x-y \end{vmatrix}$

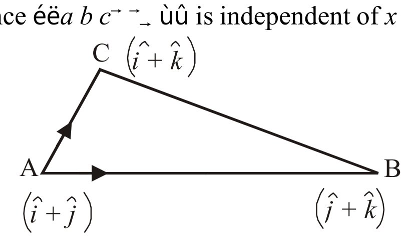
$= -1\left[1 + x - y - x + x^2\right] + 1\left[x^2 - y\right]$

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

$= -1$

Hence $[\vec{a}\ \vec{b}\ \vec{c}]$ is independent of x and y both.

143.(d)



Now, $\vec{AC} = \hat{k} - \hat{j}$ and $\vec{AB} = \hat{k} - \hat{i}$

Let θ be the angle between $\vec{AC}$ and $\vec{AB}$.

$\cos\theta = \frac{0 + 0 + 1}{\sqrt{2}\sqrt{2}} = \frac{1}{2} \Rightarrow \theta = 60° = \frac{\pi}{3}$

144. (a) Let A = (3, 4, 5), P = (–1, 2, 4)

B = (4, 6, 3) and Q = (1, 0, 5)

$\therefore$ Dr's of line AB are (4 – 3), (6 – 4), (3 – 5)

= 1, 2, –2

and Dr's of line PQ are (1 + 1), (0 – 2), (5 – 4)

= 2, –2, 1

$\therefore$ Dc's of line PQ = $\frac{2}{\sqrt{2^2 + (-2)^2 + 1}}, \frac{-2}{3}, \frac{1}{3}$

$= \frac{2}{3}, \frac{-2}{3}, \frac{1}{3}$

$\therefore$ Projection of line segment AB on the line PQ

is $\left|(1)\left(\frac{2}{3}\right) + (2)\left(\frac{-2}{3}\right) + (-2)\left(\frac{1}{3}\right)\right| = \frac{4}{3}$

145. (c) 146. (a)

147. (c) In Binomial distribution, Mean = np, Variance = npq and the mode is r if for x = r, the probability function p(x) is maximum. Given np = 4 and npq = 3

$\therefore q = \frac{3}{4}$ and $p = 1 - q = 1 - \frac{3}{4} = \frac{1}{4}$

Also, $n = \frac{4}{p} = \frac{4}{1/4} = 16$

Now, $(n + 1)p = (16 + 1)\frac{1}{4} = \frac{17}{4} = 4 + \frac{1}{4}$

$\Rightarrow$ The distribution will have unique mode (unimodal) & the mode = 4

148. (b) The given series is

$1 + \frac{1 + \alpha}{2!} + \frac{1 + \alpha + \alpha^2}{3!} + \frac{1 + \alpha + \alpha^2 + \alpha^3}{4!} + ...$

Here, $T_n = \frac{1 + \alpha + \alpha^2 + \alpha^3 + ...\text{to } n \text{ terms}}{n!}$

= (11(1-a)n = 1æççè1-n!an ö÷÷ø

-a)(n!) 1-a

\T$_1$ +T$_2$ +T$_3$ +.....to ¥

= 1 éê1-a +1-a^2 + 1-a^3 +....to ¥ùú

1-a ëê 1! 2! 3! úû

= 1-1a éêêëæççè1!1 + 2!1 + 3!1

+....to¥ö÷÷øæççè1!^{a} + ^{a}2!^{2} + ^{a}3!^{3}

+....to ¥ö÷÷øùúúû

= $\frac{1}{1-a}$[(e- -1) (e^a -1)]

= $\frac{e - e^a}{1-a}$ = $\frac{e^a - e}{a-1}$

149. (d) □ (pÚq)Ú(□ pÙq)

(□ pÙ □ q)Ú(□ pÙq)

Þ□ pÙ(□ q Úq)

Þ Ù º□ pt □ p

150. (b) We know that,

Mode = 3 Median – 2 Mean = 3(22) –2(21)

= 66 – 42 = 24