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BITSAT 2014 Question Paper with Answer Key

Birla Institute of Technology and Science Admission Test

BITSAT : SOLVED PAPER 2014

(memory based)

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. A rifle man, who together with his rifle has a mass of 100 kg, stands on a smooth surface and fires 10 shots horizontally. Each bullet has a mass 10 g and a muzzle velocity of 800 ms^{-1}. The velocity which the rifle man attains after firing 10 shots is

(a) 8 ms^{-1} (b) 0.8 ms^{-1}

(c) 0.08 ms^{-1} (d) – 0.8 ms^{-1}

2. A train accelerating uniformly from rest attains a maximum speed of 40 ms^{-1} in 20 s. It travels at the speed for 20 s and is brought to rest with uniform retardation in further 40 s. What is the average velocity during the period ?

(a) 80 m/s (b) 25 m/s

(c) 40 m/s (d) 30 m/s

3. A projectile is fired with a velocity u making an angle θ with the horizontal. What is the magnitude of change in velocity when it is at the highest point –

(a) u cos θ (b) u

(c) u sin θ (d) u cos θ – u

4. For the equation $F = A^a v^b d^c$, where F is the force, A is the area, v is the velocity and d is the density, the values of a, b and c are respectively

(a) 1, 2, 1 (b) 2, 1, 1 (c) 1, 1, 2 (d) 0, 1, 1

5. A person with his hand in his pocket is skating on ice at the rate of 10m/s and describes a circle of radius 50 m. What is his inclination to vertical: ($g = 10\ m/sec^2$)

(a) $\tan^{-1}(½)$ (b) $\tan^{-1}(1/5)$

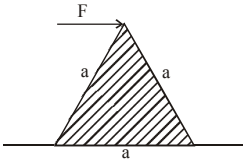
(c) $\tan^{-1}(3/5)$ (d) $\tan^{-1}(1/10)$

6. A small block of mass m is kept on a rough inclined surface of inclination θ fixed in a elevator. The elevator goes up with a uniform velocity v and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be :

(a) zero (b) $mgvt\ \cos^2\theta$

(c) $mgvt\ \sin^2\theta$ (d) $mgvt\ \sin 2\theta$

7. An equilateral prism of mass m rests on a rough horizontal surface with coefficient of friction μ. A horizontal force F is applied on the prism as shown in the figure. If the coefficient of friction is sufficiently high so that the prism does not slide before toppling, then the minimum force required to topple the prism is –

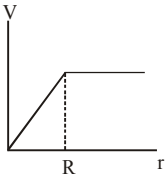


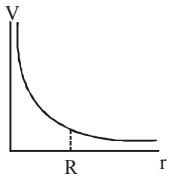
(a) $\frac{mg}{\sqrt{3}}$ (b) $\frac{mg}{4}$ (c) $\frac{\mu mg}{\sqrt{3}}$ (d) $\frac{\mu mg}{4}$

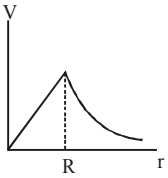
8. A spherically symmetric gravitational system of particles has a mass density $\rho = \begin{cases} \rho_0 & \text{for } r \le R \\ 0 & \text{for } r > R \end{cases}$

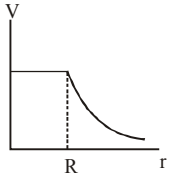
where r_0 is a constant. A test mass can undergo

circular motion under the influence of the gravitational field of particles. Its speed V as a function of distance r ($0 < r < \infty$) from the centre of the system is represented by

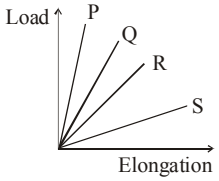
(a) 

(b) 

(c) 

(d) 

9. The load versus elongation graph for four wires is shown. The thinnest wire is



(a) *P* (b) *Q* (c) *R* (d) *S*

10. The work done in blowing a soap bubble of surface tension $0.06 \times Nm^{-1}$ from 2 cm radius to 5 cm radius is

(a) 0.004168 J (b) 0.003168 J
(c) 0.003158 J (d) 0.004568 J

11. The wavelength of radiation emitted by a body depends upon

(a) the nature of its surface
(b) the area of its surface
(c) the temperature of its surface
(d) All of the above

12. One mole of O_2 gas having a volume equal to 22.4 Litres at 0°C and 1 atmospheric pressure in compressed isothermally so that its volume reduces to 11.2 litres. The work done in this process is-

(a) 1672.5 J (b) 1728 J
(c) –1728 J (d) –1572.5 J

13. In a thermodynamic process, the pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas. If the initial internal energy of the gas was 30 J, then the final internal energy will be

(a) 2 J (b) 42 J
(c) 18 J (d) 58 J

14. In the kinetic theory of gases, which of these statements is/are true ?

(i) The pressure of a gas is proportional to the mean speed of the molecules.
(ii) The root mean square speed of the molecules is proportional to the pressure.
(iii) The rate of diffusion is proportional to the mean speed of the molecules.
(iv) The mean translational kinetic energy of a gas is proportional to its kelvin temperature.

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

15. Two balloons are filled one with pure he gas and other with air respectively. If the pressure and temperature of these balloons are same, then the number of molecules per unit volume is

(a) more in He gas filled balloon
(b) same in both balloons
(c) more in air filled balloon
(d) in the ratio 1 : 4

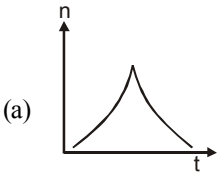
16. Two particles P and Q describe S.H.M. of same amplitude a, same frequency f along the same straight line. The maximum distance between the two particles is $a\sqrt{2}$.
The initial phase difference between the particle is –

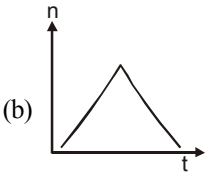
(a) zero (b) $\pi/2$ (c) $\pi/6$ (d) $\pi/3$

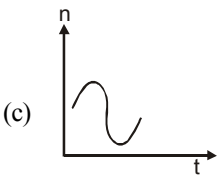
17. A tunnel has been dug through the centre of the earth and a ball is released in it. It executes S.H.M. with time period

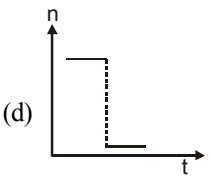
(a) 42 minutes (b) 1 day
(c) 1 hour (d) 84.6 minutes

18. A sound source, emitting sound of constant frequency, moves with a constant speed and crosses a stationary observer. The frequency (n) of sound heard by the observer is plotted against time (t). Which of the following graphs represents the correct variation ?

(a) 

(b) 

(c) 

(d) 

19. When a string is divided into three segments of length l_1, l_2, and l_3 the fundamental frequencies of these three segments are v_1, v_2 and v_3 respectively. The original fundamental frequency (v) of the string is

(a) $\sqrt{v} = \sqrt{v_1} + \sqrt{v_2} + \sqrt{v_3}$

(b) $v = v_1 + v_2 + v_3$

(c) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$,

(d) $\frac{1}{\sqrt{v}} = \frac{1}{\sqrt{v_1}} + \frac{1}{\sqrt{v_2}} + \frac{1}{\sqrt{v_3}}$

20. Two point dipoles $p\hat{k}$ and $\frac{p}{2}\hat{k}$ are located at (0, 0, 0) and (1m, 0, 2m) respectively. The resultant electric field due to the two dipoles at the point (1m, 0, 0) is

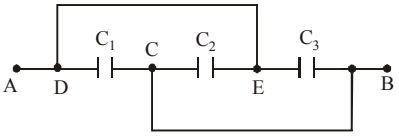
(a) $\frac{9p}{32\pi \in_0}\hat{k}$ (b) $\frac{-7p}{32\pi \in_0}\hat{k}$

(c) $\frac{7p}{32\pi \in_0}\hat{k}$ (d) None of these

21. Electric field in the region is given by $E = \left(\frac{M}{x^3}\right)\hat{i}$, then the correct expression for the potential in the region is [assume potential at infinity is zero]

(a) $\frac{M}{2x^2}$ (b) Mx^2 (c) $\frac{M}{3x^4}$ (d) $\frac{M}{x^2}$

22. Three capacitors $C_1 = 1\ \mu F$, $C_2 = 2\ \mu F$ and $C_3 = 3\ \mu F$ are connected as shown in figure, then the equivalent capacitance between points A and B is



(a) 3 μF (b) 4 μF (c) 5 μF (d) 6 μF

23. Two long coaxial and conducting cylinders of radius a and b are separated by a material of conductivity σ and a constant potential difference V is maintained between them, by a battery. Then the current, per unit length of the cylinder flowing from one cylinder to the other is –

(a) $\frac{4\pi\sigma}{\ln(b/a)}V$ (b) $\frac{4\pi\sigma}{(b+a)}V$

(c) $\frac{2\pi\sigma}{\ln(b/a)}V$ (d) $\frac{2\pi\sigma}{(b+a)}V$

24. A wire X is half the diameter and half the length of a wire Y of similar material. The ratio of resistance of X to that of Y is

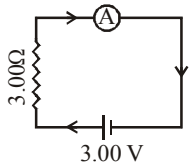
(a) 8 : 1 (b) 4 : 1 (c) 2 : 1 (d) 1 : 1

25. A narrow beam of protons and deuterons, each having the same momentum, enters a region of uniform magnetic field directed perpendicular to their direction of momentum. The ratio of the radii of the circular paths described by them is

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

(c) 2 : 1 (d) 1 : 3

26. For the circuit (figure), the current is to be measured. The ammeter shown is a galvanometer with a resistance $R_G = 60.00\Omega$ converted to an ammeter by a shunt resistance $r_s = 0.02\Omega$. The value of the current is



(a) 0.79 A (b) 0.29 A

(c) 0.99 A (d) 0.8 A

27. The susceptibility of a magnetism at 300 K is 1.2×10^{-5}. The temperature at which the susceptibility increases to 1.8×10^{-5} is

(a) 150 K (b) 200 K (c) 250 K (d) 20 K

28. A coil 10 turns and a resistance of 20Ω is connected in series with B.G. of resistance 30Ω. The coil is placed with its plane perpendicular to the direction of a uniform magnetic field of induction 10^{-2} T. If it is now turned through an angle of 60° about an axis in its plane. Find the charge induced in the coil. (Area of a coil = 10^{-2} m²)

(a) 2×10^{-5} C (b) 3.2×10^{-5} C

(c) 1×10^{-5} C (d) 5.5×10^{-5} C

29. Voltage V and current i in AC circuit are given by V = 50 sin (50 t) volt, $i = 50 \sin\left(50t + \frac{\pi}{3}\right)$ mA.

The power dissipated in the circuit is

(a) 5.0 W (b) 2.5 W

(c) 1.25 W (d) zero

30. Resolving power of the telescope will be more, if the diameter of the objective is

(a) larger

(b) smaller

(c) it does not depends on diameter

(d) None of these

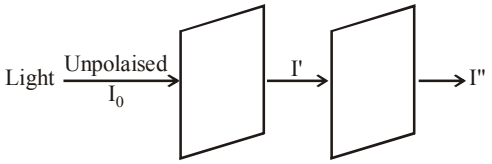
31. The magnifying power of a telescope is 9. When it is adjusted for parallel rays, the distance between the objective and the eye piece is found to be 20 cm. The focal length of lenses are

(a) 18 cm, 2 cm (b) 11 cm, 9 cm
(c) 10 cm, 10 cm (d) 15 cm, 5 cm

32. The angular size of the central maxima due to a single slit diffraction is (a → slit width)

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

33. Find the final intensity of light (I"), if the angle between the axes of two polaroids is 60°.

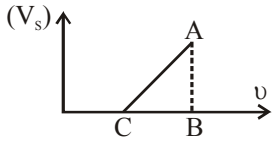


(a) $\frac{3I_0}{2}$ (b) $\frac{I_0}{2}$ (c) $\frac{I_0}{4}$ (d) $\frac{I_0}{8}$

34. The threshold wavelength of the tungsten is 2300 Å. If ultraviolet light of wavelength 1800 Å is incident on it, then the maximum kinetic energy of photoelectrons would be about –

(a) 1.49 eV (b) 2.2 eV (c) 3.0 eV (d) 5.0 eV

35. Graph betwen stopping potential for most energetic emitted photoelectrons (V_s) with frequency (υ) of incident radiation on metal is given below. Value of AB/BC, in graph is [where h = plank's constant, e = electronic charge]



(a) h (b) e (c) h/e (d) e/h

36. If hydrogen atom, an electron jumps from bigger orbit to smaller orbit so that radius of smaller orbit is one-fourth of radius of bigger orbit. If speed of electron in bigger orbit was v, then speed in smaller orbit is

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

37. A nucleus of uranium decays at rest into nuclei of thorium and helium. Then :

(a) the helium nucleus has less momentum than the thorium nucleus
(b) the helium nucleus has more momentum than the thorium nucleus
(c) the helium nucleus has less kinetic energy than the thorium nucleus
(d) the helium nucleus has more kinetic energy than the thorium nucleus

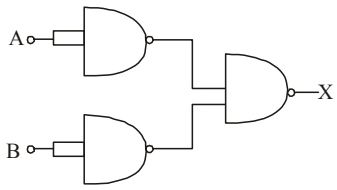
38. Let binding energy per nucleon of nucleus is denoted by E_{bn} and radius of nucleus is denoted as r. If mass number of nuclei A, B and 64 and 125 respectively then

(a) $r_A < r_B, E_{bnA} < E_{bnB}$
(b) $r_A > r_B, E_{bnA} > E_{bnB}$
(c) $r_A = \frac{4}{5} r_B, E_{bnA} < E_{bnB}$
(d) $r_A < r_B, E_{bnA} > E_{bnB}$

39. For a CE transistor amplifier, the audio signal voltage across the collector resistance of 2.0 kΩ is 2.0 V. Suppose the current amplification factor of the transistor is 100, What should be the value of R_B in series with V_{BB} supply of 2.0V if the dc base current has to be 10 times the signal current?

(a) 14 kΩ (b) 18 kΩ (c) 10 kΩ (d) 5 kΩ

40. The combination of gates shown below yields



(a) OR gate (b) NOT gate
(c) XOR gate (d) NAND gate

PART - II : CHEMISTRY

41. The formation of CO and CO_2 illustrates the law of

(a) reciprocal proportion
(b) conservation of mass
(c) multiple proportion
(d) constant composition

42. The wave number of the limiting line in Lyman series of hydrogen is 109678 cm^{-1}. The wave number of the limiting line in Balmer series of He^+ would be :

(a) 54839 cm^{-1} (b) 109678 cm^{-1}
(c) 219356 cm^{-1} (d) 438712 cm^{-1}

43. The valency shell of element A contains 3 electrons while the valency shell of element B contains 6 electrons. If A combines with B, the probable formula of the compound formed will be

(a) AB_2 (b) A_2B

(c) A_2B_3 (d) A_3B_2

44. The enthalpy of sublimation of aluminium is 330 kJ/mol. Its I[st], II[nd] and III[rd] ionization enthalpies are 580, 1820 and 2740 kJ respectively. How much heat has too be supplied (in kJ) to convert 13.5 g of aluminium into Al^{3+} ions and electrons at 298 k

(a) 5470 (b) 2735

(c) 4105 (d) 3765

45. Which one of the following pairs is isostructural (i.e., having the same shape and hybridization)?

(a) $\left[BCl_3 \text{ and } BrCl_3^-\right]$

(b) $\left[NH_3 \text{ and } NO_3^-\right]$

(c) $\left[NF_3 \text{ and } BF_3\right]$

(d) $\left[BF_4^- \text{ and } NH_4^+\right]$

46. N_2 and O_2 are converted into mono anions, N_2^- and O_2^- respectively. Which of the following statements is wrong ?

(a) In N_2, the N—N bond weakens

(b) In O_2, the O—O bond order increases

(c) In O_2, bond length decreases

(d) N_2^- becomes diamagnetic

47. If the enthalpy of vaporization of water is 186.5 $kJmol^{-1}$, the entropy if its vaporization will be :

(a) 0.5 $kJK^{-1}mol^{-1}$ (b) 1.0 $kJK^{-1}mol^{-1}$

(c) 1.5 $kJK^{-1}mol^{-1}$ (d) 2.0 $kJK^{-1}mol^{-1}$

48. The heats of neutralisation of CH_3COOH, HCOOH, HCN and H_2S are – 13.2, – 13.4, – 2.9 and – 3.8 kCal per equivalent respectively. Arrange the acids in increasing order of acidic strength.

(a) $HCOOH > CH_3COOH > H_2S > HCN$

(b) $CH_3COOH > HCOOH > H_2S > HCN$

(c) $H_2S > HCOOH > CH_3COOH > HCN$

(d) $HCOOH > H_2S > CH_3COOH > HCN$

49. K_c for the the reaction, $[Ag(CN)_2]^- \rightleftharpoons Ag^+ + 2CN^-$, the equillibrium constant at 25°C is 4.0×10^{-19}, then the silver ion concentration in a solution which was originally 0.1 molar in KCN and 0.03 molar in $AgNO_3$ is :

(a) 7.5×10^{18} (b) 7.5×10^{-19}

(c) 7.5×10^{19} (d) 7.5×10^{-18}

50. The ratio of oxidation states of Cl in potassium chloride to that in potassium chlorate is

(a) $\frac{+1}{5}$ (b) $\frac{-1}{5}$

(c) $\frac{-2}{5}$ (d) $\frac{+3}{5}$

51. Which of the following among alkali metal is most reactive ?

(a) Na (b) K

(c) Rb (d) Cs

52. Which of the following compounds has wrong IUPAC name?

(a) $CH_3-CH_2-CH_2-COO-CH_2CH_3$
→ Ethyl butanoate

(b) $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_2-CHO$
→ 3-Methyl-butanal

(c) $CH_3-\underset{\underset{OH}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CH_3$
→ 2-Methyl-3-butanol

(d) $CH_3-\underset{\underset{CH_3}{|}}{CH}-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$
→ 2-Methyl-3-pentanone

53. The compound which gives the most stable carbonium ion on dehydration is

(a) $CH_3CH(CH_3)CH_2OH$

(b) $(CH_3)_3COH$

(c) $CH_2=CHCH_2CH_2OH$

(d) $CH_3CHOHCH_2CH_3$

54. The correct order of increasing C - O bond length CO, CO_3^{2-}, CO_2 is:

(a) $CO < CO_2 < CO_3^{2-}$

(b) $CO_2 < CO_3^{2-} < CO$

(c) $CO < CO_3^{2-} < CO_2$

(d) $CO_3^{2-} < CO_3 < CO$

55. An organic compound A (C_4H_9Cl) on reaction with Na/diethyl ether gives a hydrocarbon which on monochlorination gives only one chloro derivative, then A is
(a) tert-butyl chloride
(b) sec-butyl chloride
(c) isobutyl chloride
(d) n-butyl chloride

56. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value:
(a) Slightly lower than that of rain water without thunderstorm.
(b) Slightly higher than that when the thunderstorm is not there.
(c) Uninfluenced by occurrence of thunderstorm.
(d) Which depends upon the amount of dust in air.

57. An elemental crystal has a density of 8570 kg/m^3. The packing efficiency is 0.68. The closest distance of approach between neighbouring atom is 2.86 Å. What is the mass of one atom approximately?
(a) 93 amu (b) 39 amu
(c) 63 amu (d) 29 amu

58. Identify the correct order of solubilty of Na_2S. CuS and ZnS in aqueous medium
(a) $CuS > ZnS > Na_2S$
(b) $ZnS > Na_2S > CuS$
(c) $Na_2S > CuS > ZnS$
(d) $Na_2S > ZnS > CuS$

59. In the cell reaction

$Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$,

$E^0_{cell} = 0.46$ V. By doubling the concentration of Cu^{2+}, E^0_{cell} is
(a) doubled
(b) halved
(c) increases but less than double
(d) decreases by a small fraction

60. Cu^+_{aq} is unstable in solution and undergoes simultaneous oxidation and reduction according to the reaction :

$2Cu^+(aq) \rightleftharpoons Cu^{2+}(aq) + Cu(s)$

choose correct E° for above reaction if

$E°_{Cu^{2+}} = 0.34$ V and $E°_{Cu^{2+}} = 0.15$ V

(a) –0.38 V (b) +0.49 V
(c) +0.38 V (d) –0.19 V

61. The reduction of peroxydisulphate ion by I^- ion is expressed by $S_2O_8^{2-} + 3I^- \rightarrow 2SO_4^{2-} + I_3^-$. If rate of disappearance of I^- is $9/2 \times 10^{-3}$ mol lit^{-1} s^{-1}, what is the rate of formation of $2SO_4^{2-}$ during same time?
(a) 3×10^{-3} mol Lit^{-1} s^{-1}
(b) 2×10^{-3} mol Lit^{-1} s^{-1}
(c) 10^{-3} mol Lit^{-1} s^{-1}
(d) 4×10^{-3} mol Lit^{-1} s^{-1}

62. A gaseous reaction $X_2(g) \longrightarrow Y + \frac{1}{2}Z(g)$
There is increase in pressure from 100 mm to 120 mm in 5 minutes. The rate of disappearance of X_2 is
(a) 8 mm min^{-1} (b) 2 mm min^{-1}
(c) 16 mm min^{-1} (d) 4 mm min^{-1}

63. Two substances R and S decompose in solution independently, both following first order kinetics. The rate constant of R is twice that of S. In an experiment, the solution initially contained 0.5 millimoles of R and 0.25 of S. The molarities of R and S will be equal just at the end of time equal to
(a) twice the half life of R
(b) twice the half life of S
(c) the half life of S
(d) the half life of R

64. The isoelectric-point of a colloidially dispersed material is the pH value at which
(a) the dispersed phase migrate in an electric field.
(b) the dispersed phase does not migrate in an electric field.
(c) the dispersed phase has pH equal to 7.
(d) the dispersed phase has pH equal to zero.

65. Which of the following halogens exhibit only one oxidation state in its compounds ?
(a) Bromine (b) Chlorine
(c) Fluorine (d) Iodine

66. Starch can be used as an indicator for the detection of traces of
(a) glucose in aqueous solution
(b) proteins in blood
(c) iodine in aqueous solution
(d) urea in blood

67. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species?

(a) $S < O < Cl < F$ (b) $Cl < F < S < O$

(c) $F < Cl < O < S$ (d) $O < S < F < Cl$

68. Which form coloured salts :

(a) Non-metals

(b) Metals

(c) p-block elements

(d) Transitional elements

69. The correct order of magnetic moments (spin only values in B.M.) is:

(a) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$

(b) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$

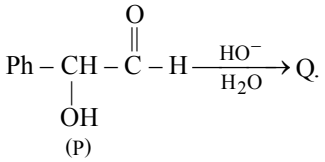
(c) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

(d) $[Fe(CN)_6]^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$

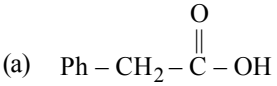
(Atomic nos. : Mn = 25, Fe = 26, Co = 27)

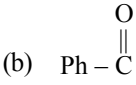
70. The number of double bonds in gammexane is :

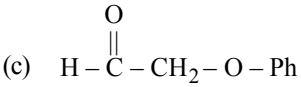
(a) 0 (b) 1 (c) 2 (d) 3

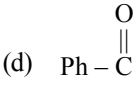
71. 

P and Q are isomers. Identify Q.

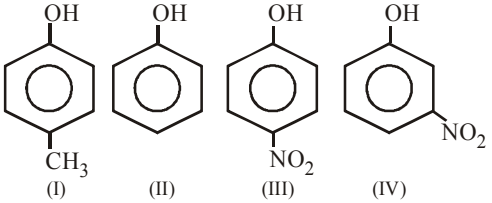
(a) 

(b) 

(c) 

(d) 

72. Consider the following phenols :



The decreasing order of acidity of the above phenols is

(a) III > IV > II > I (b) II > I > IV > III

(c) I > IV > II > III (d) III > IV > I > II

73. The ionization constant of phenol is higher than that of ethanol because :

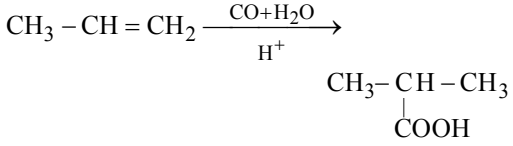
(a) Phenoxide ion is bulkier than ethoxide

(b) Phenoxide ion is stronger base than ethoxide

(c) Phenoxide ion is stabilized through delocalization

(d) Phenoxide ion is less stable than ethoxide

74. The reaction,



is known as:

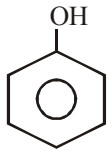
(a) Wurtz reaction

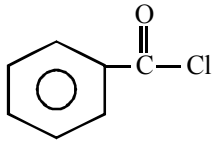
(b) Koch reaction

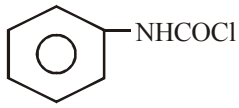
(c) Clemmensen reduction

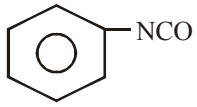
(d) Kolbe's reaction

75. Aniline reacts with phosgene and KOH to form

(a) 

(b) 

(c) 

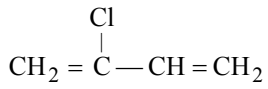
(d) 

76. Which one of the following monomers gives the polymer neoprene on polymerization ?

(a) $CF_2 = CF_2$

(b) $CH_2 = CHCl$

(c) $CCl_2 = CCl_2$

(d) 

77. Which of the following can possibly be used as analgesic without causing addiction and modification?
(a) morphine
(b) N-acetyl-para-aminophenol
(c) diazepam
(d) tetrahydrocatenol

78. Which among the following is not an antibiotic?
(a) Penicillin (b) Oxytocin
(c) Ofloxacin (d) Tetracycline

79. Which of the following ions can be separated by aq. NH_4OH in presence of NH_4Cl
(a) Al^{3+} and Fe^{3+} (b) Cr^{3+} and Al^{3+}
(c) Cu^{2+} and Al^{3+} (d) None of these

80. 3.92 g of ferrous ammonium sulphate react completely with 50 ml $\frac{N}{10}$ $KMnO_4$ solution. The percentage purity of the sample is
(a) 50 (b) 78.4 (c) 80 (d) 39.2

PART - III : MATHEMATICS

81. The set $(A \setminus B) \cup (B \setminus A)$ is equal to
(a) $[A \setminus (A \cap B)] \cap [B \setminus (A \cap B)]$
(b) $(A \cup B) \setminus (A \cap B)$
(c) $A \setminus (A \cap B)$
(d) $\overline{A \cap B} \setminus A \cup B$

82. The domain of the function
$f(x) = \log_2\left(-\log_{1/2}\left(1+\frac{1}{x^{1/4}}\right)-1\right)$ is
(a) $(0, 1)$ (b) $(0, 1]$ (c) $[1, \infty)$ (d) $(1, \infty)$

83. $\cos^2\left(\frac{\pi}{6}+\theta\right) - \sin^2\left(\frac{\pi}{6}-\theta\right) =$
(a) $\frac{1}{2}\cos 2\theta$ (b) 0
(c) $-\frac{1}{2}\cos 2\theta$ (d) $\frac{1}{2}$

84. The solution of $(2\cos x - 1)(3 + 2\cos x) = 0$ in the interval $0 \le x \le 2\pi$ is
(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{3}, \frac{5\pi}{3}$
(c) $\frac{\pi}{3}, \frac{5\pi}{3}, \cos^{-1}\left(-\frac{3}{2}\right)$ (d) None of these

85. $2^{3n} - 7n - 1$ is divisible by
(a) 64 (b) 36
(c) 49 (d) 25

86. The greatest positive integer, which divides $n(n+1)(n+2)(n+3)$ for all $n \in \mathbf{N}$, is
(a) 2 (b) 6 (c) 24 (d) 120

87. If $z = x + iy$, $z^{1/3} = a - ib$, then $\frac{x}{a} - \frac{y}{b} = k(a^2 - b^2)$ where k is equal to
(a) 1 (b) 2 (c) 3 (d) 4

88. $i^{57} + \frac{1}{i^{25}}$, when simplified has the value
(a) 0 (b) $2i$ (c) $-2i$ (d) 2

89. The complex number $z = z + iy$ which satisfies the equation $\left|\frac{z-3i}{z+3i}\right| = 1$, lies on
(a) the X-axis
(b) the straight line $y = 3$
(c) a circle passing through origin
(d) None of the above

90. The number of all three elements subsets of the set $\{a_1, a_2, a_3 \ldots a_n\}$ which contain a_3 is
(a) ${}^nC_3$ (b) ${}^{n-1}C_3$
(c) ${}^{n-1}C_2$ (d) None of these

91. In how many ways can a committee of 5 made out 6 men and 4 women containing atleast one woman?
(a) 246 (b) 222
(c) 186 (d) None of these

92. The coefficient of x^4 in the expansion of $(1 + x + x^2 + x^3)^{11}$, is
(a) 440 (b) 770 (c) 990 (d) 1001

93. If T_0, T_1, T_2.....T_n represent the terms in the expansion of $(x+a)^n$, then $(T_0 - T_2 + T_4 - .....)^2 + (T_1 - T_3 + T_5 - .....)^2 =$
(a) $(x^2 + a^2)$ (b) $(x^2 + a^2)^n$
(c) $(x^2 + a^2)^{1/n}$ (d) $(x^2 + a^2)^{-1/n}$

94. If the $(2p)^{th}$ term of a H.P. is q and the $(2q)^{th}$ term is p, then the $2(p + q)^{th}$ term is-
(a) $\frac{pq}{2(p+q)}$ (b) $\frac{2pq}{p+q}$
(c) $\frac{pq}{p+q}$ (d) $\frac{p+q}{pq}$

95. If $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in A. P., then $\left(\frac{1}{a}+\frac{1}{b}-\frac{1}{c}\right)\left(\frac{1}{b}+\frac{1}{c}-\frac{1}{a}\right)$ is equal to

(a) $\frac{4}{ac}-\frac{3}{b^2}$ (b) $\frac{b^2-ac}{a^2b^2c^2}$

(c) $\frac{4}{ac}-\frac{1}{b^2}$ (d) None of these

96. The product of n positive numbers is unity, then their sum is :

(a) a positive integer (b) divisible by n

(c) equal to $n+\frac{1}{n}$ (d) never less than n

97. If P_1 and P_2 be the length of perpendiculars from the origin upon the straight lines $x\sec\theta + y\,\text{cosec}\theta = a$ and $x\cos\theta - y\sin\theta = a\cos 2\theta$ respectively, then the value of $4P_1^2 + P_2^2$.

(a) a^2 (b) $2a^2$ (c) $a^2/2$ (d) $3a^2$

98. The angle of intersection of the two circles $x^2+y^2-2x-2y=0$ and $x^2+y^2=4$, is

(a) 30º (b) 60º (c) 90º (d) 45º

99. An arch of a bridge is semi-elliptical with major axis horizontal. If the length the base is 9 meter and the highest part of the bridge is 3 meter from the horizontal; the best approximation of the height of the arch. 2 meter from the centre of the base is

(a) 11/4 m (b) 8/3 m (c) 7/2 m (d) 2m

100. $\lim_{x\to 0}(\text{cosec}\,x)^{1/\log x}$ is equal to :

(a) 0 (b) 1

(c) $\frac{1}{e}$ (d) None of these

101. If M. D. is 12, the value of S.D. will be

(a) 15 (b) 12

(c) 24 (d) None of these

102. A bag contains 5 brown and 4 white socks. A man pulls out 2 socks. Find the probability that they are of the same colour.

(a) $\frac{4}{9}$ (b) $\frac{2}{9}$

(c) $\frac{5}{9}$ (d) $\frac{7}{9}$

103. Let $R = \{(3,3),(6,6),(9,9),(12,12),(6,12),(3,9),(3,12),(3,6)\}$ be a relation on the set $A = \{3,6,9,12\}$. Then, the relation is

(a) an equivalence relation

(b) reflexive and symmetric

(c) reflexive and transitive

(d) only reflexive

104. Let $f : R \to R$ be a function defined by $f(x) = \frac{x-m}{x-n}$, where $m \neq n$, then

(a) f is one-one onto (b) f is one-one into

(c) f is many-one onto (d) f is many-one into

105. Find the value of $\tan\left[2\tan^{-1}\frac{1}{5}-\frac{\pi}{4}\right]$

(a) $-1/3$ (b) $-7/17$ (c) $-1/2$ (d) $-1/4$

106. If $\begin{bmatrix}\alpha & \beta\\ \gamma & -\alpha\end{bmatrix}$ is square root of identity matrix of order 2 then –

(a) $1+\alpha^2+\beta\gamma=0$ (b) $1+\alpha^2-\beta\gamma=0$

(c) $1-\alpha^2+\beta\gamma=0$ (d) $\alpha^2+\beta\gamma=1$

107. The value of λ, for which the lines $3x-4y=13$, $8x-11y=33$ and $2x-3y+\lambda=0$ are concurrent is

(a) –1 (b) –7 (c) $\frac{1}{7}$ (d) 9

108. Let $f(x)=\begin{cases}(x-1)\sin\frac{1}{x-1} & \text{if } x\neq 1\\ 0 & \text{if } x=1\end{cases}$

Then which one of the following is true?

(a) f is differentiable at $x=0$ and $x=1$

(b) f is differentiable at $x=0$ but not at $x=1$

(c) f is differentiable at $x=1$ but not at $x=0$

(d) f is neither differentiable at $x=0$ nor at $x=1$

109. The interval in which the function $2x^3 + 15$ increases less rapidly than the function $9x^2-12x$, is –

(a) $(-\infty, 1)$ (b) $(1,2)$

(c) $(2,\infty)$ (d) None of these

110. The fuel charges for running a train are proportional to the square of the speed generated in miles per hour and costs ` 48 per hour at 16 miles per hour. The most economical speed if the fixed charges i.e. salaries etc. amount to ` 300 per hour is

(a) 10 (b) 20 (c) 30 (d) 40

111. Evaluate: $\int \frac{1}{1+3\sin^2 x+8\cos^2 x}dx$

(a) $\frac{1}{6}\tan^{-1}(2\tan x)+C$

(b) $\tan^{-1}(2\tan x)+C$

(c) $\frac{1}{6}\tan^{-1}\left(\frac{2\tan x}{3}\right)+C$

(d) None of these

112. $\int_0^{10} \frac{x^{10}}{(10-x)^{10}+x^{10}}dx$ is equal to

(a) 10 (b) 5 (c) 2 (d) $\frac{1}{2}$

113. The area bounded by the x-axis, the curve y= f(x) and the lines x =1, x =b, is equal to $\sqrt{b^2+1}-\sqrt{2}$ for all b > 1, then f(x) is

(a) $\sqrt{x-1}$ (b) $\sqrt{x+1}$

(c) $\sqrt{x^2+1}$ (d) $\frac{x}{\sqrt{1+x^2}}$

114. Solution of differential equation

$$x^2=1+\left(\frac{x}{y}\right)^{-1}\frac{dy}{dx}+\frac{\left(\frac{x}{y}\right)^{-2}\left(\frac{dy}{dx}\right)^2}{2!}+\frac{\left(\frac{x}{y}\right)^{-3}\left(\frac{dy}{dx}\right)^3}{3!}+\ldots \text{ is}$$

(a) $y^2=x^2(\ln x^2-1)+C$ (b) $y=x^2(\ln x-1)+C$

(c) $y^2=x(\ln x-1)+C$ (d) $y=x^2e^{x^2}+C$

115. If the middle points of sides BC, CA & AB of triangle ABC are respectively D, E, F then position vector of centre of triangle DEF, when position vector of A, B, C are respectively $\hat{i}+\hat{j}, \hat{j}+\hat{k}, \hat{k}+\hat{i}$ is

(a) $\frac{1}{3}(\hat{i}+\hat{j}+\hat{k})$ (b) $(\hat{i}+\hat{j}+\hat{k})$

(c) $2(\hat{i}+\hat{j}+\hat{k})$ (d) $\frac{2}{3}(\hat{i}+\hat{j}+\hat{k})$

116. The angle between any two diagonal of a cube is

(a) 45° (b) 60° (c) 30° (d) $\tan^{-1}(2\sqrt{2})$

117. Find the angle between the line $\frac{x+1}{2}=\frac{y}{3}=\frac{z-3}{6}$ and the plane 10x + 2y – 11z = 3.

(a) $\sin^{-1}\left(\frac{8}{21}\right)$ (b) $\sin^{-1}\left(\frac{5}{21}\right)$

(c) $\sin^{-1}\left(\frac{7}{21}\right)$ (d) $\sin^{-1}\left(\frac{1}{21}\right)$

118. The equation of the right bisector plane of the segment joining (2, 3, 4) and (6, 7, 8) is

(a) x + y + z + 15 = 0 (b) x + y + z – 15 = 0

(c) x – y + z – 15 = 0 (d) None of these

119. A bag contains *n* + 1 coins. It is known that one of these coins shows heads on both sides, whereas the other coins are fair. One coin is selected at random and tossed. If the probability that toss results in heads is $\frac{7}{12}$, then the value of *n* is.

(a) 3 (b) 4

(c) 5 (d) None of these

120. A coin is tossed 7 times. Each time a man calls head. Find the probability that he wins the toss on more occasions.

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

121. Consider $\frac{x}{2}+\frac{y}{4}\geq 1$ and $\frac{x}{3}+\frac{y}{2}\leq 1, x, y\geq 0$. Then number of possible solutions are :

(a) Zero (b) Unique

(c) Infinite (d) None of these

122. If $A=\begin{bmatrix}1 & 1\\ 1 & 1\end{bmatrix}$ then A^{100} :

(a) $2^{100}A$ (b) $2^{99}A$

(c) $2^{101}A$ (d) None of the above

123. If $\begin{vmatrix} p & q-y & r-z\\ p-x & q & r-z\\ p-x & q-y & r\end{vmatrix}=0$, then the value of $\frac{p}{x}+\frac{q}{y}+\frac{r}{z}$ is

(a) 0 (b) 1 (c) 2 (d) 4pqr

124. Through the vertex O of a parabola $y^2=4x$, chords OP and OQ are drawn at right angles to one another. The locus of the middle point of PQ is

(a) $y^2=2x+8$ (b) $y^2=x+8$

(c) $y^2=2x-8$ (d) $y^2=x-8$

125. Let $f(x) = \begin{cases} \frac{1-\sin^3 x}{3\cos^2 x}, & x < \frac{\pi}{2} \\ p, & x = \frac{\pi}{2} \\ \frac{q(1-\sin x)}{(\pi-2x)^2}, & x > \frac{\pi}{2} \end{cases}$

If $f(x)$ is continuous at $x = \frac{\pi}{2}$, $(p, q) =$

(a) $(1, 4)$ (b) $\left(\frac{1}{2}, 2\right)$

(c) $\left(\frac{1}{2}, 4\right)$ (d) None of these

PART - IV : ENGLISH

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

126. AUGMENT

(a) Increase (b) Decrease

(c) Save (d) Mention

127. CONSOLATION

(a) Comfort (d) Problem

(c) Sadness (d) Solution

128. AUXILIARY

(a) Chief (d) Supplemental

(c) Negligible (d) Separate

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

129. AUSPICIOUS

(a) Prosperous (b) Unfavourable

(c) Improper (d) New

130. RECOMPENSE

(a) Emolument (d) Reward

(c) Payment (d) Penalty

131. IMPEDE

(a) Block (b) Delay

(c) Push (d) Freeze

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

132. They <u>requested</u> me to follow them.

(a) ordered (b) urged

(c) asked (d) No improvement

133. She did not <u>believed</u> me.

(a) believing (b) believe to

(c) believe (d) No improvement

134. I am fine, what about <u>you</u>?

(a) your (b) your's

(c) yours (d) No improvement

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

135. They were afraid ..... the lion, so they dropped the idea of hunting in jungle.

(a) in (b) to

(c) from (d) of

136. Our company signed a profitable ..... last month.

(a) issue (d) agenda

(c) deal (d) paper

137. What is your ..... for tonight?

(a) Principle (b) Motto

(c) Plan (d) Objective

DIRECTIONS (Qs. 138 - 140): Arrange the following sentences in correct pattern and mark at the correct combination.

138. 1. Today we live in modern technology era.

P. We have a log of problems now.

Q. We want to get everything in one day.

R. Ancient time was quite pleasant.

S. We has no problems then.

6. Perhaps greed is the main cause for this.

(a) PQRS (b) PRSQ

(c) SRQP (d) RPQS

139. 1. He is a common man.

P. Yesterday our city saw a brutal crime.

Q. Police is trying to arrest innocent persons.

R. The criminals are well known.

S. Police as well as whole system in corrupt.

6. Police will arrest him as he is an easy target because of being a common man.

(a) PRSQ (b) PQSR

(c) PQRS (d) PSQR

140. 1. I want to change the room.

P. Last month I got a job.

Q. I had been living there for six months.

R. The office is far from the room.

S. I want to cut expenses of travelling.

6. Hopefully I will do this next week.

(a) PQRS (b) PRSQ

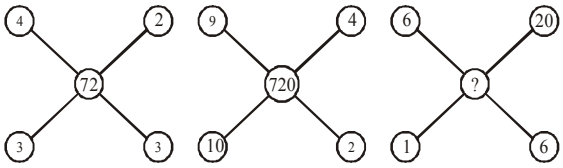
(c) QPRS (d) PQSR

141. In a certain code language, 'SAFER' is written as '5@3#2' and 'RIDE' is written as '2©%#', how would 'FEDS' be written in that code?

(a) 3#©5 (b) 3@%5

(c) 3#%5 (d) 3#%2

142. Find the missing number from the given response.



(a) 72 (b) 720 (c) 7200 (d) 38

143. If the first and second letters in the word DEPRESSION were interchanged, also the third and fourth letters, the fifth and the sixth letters and so on, then which of the following would be seventh letter from the right.

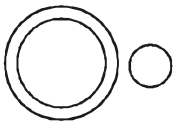
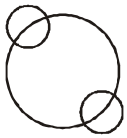
(a) O (b) P (c) R (d) S

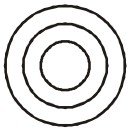
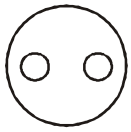
144. Today is Thrusday. The day after 59 days will be

(a) Sunday (b) Monday

(c) Tuesday (d) Wednesday

145. Which of the following represents coal mines, factories and fields?

(a)  (b) 

(c)  (d) 

146. Find out the missing term in the series.

1, 8, 27, ? , 125, 216

(a) 52 (b) 58 (c) 64 (d) 65

147. If '+' means '×', '–' means '+', '×' means '÷' and '÷' means '–', then $6 - 9 + 8 \times 3 \div 20 = ?$

(a) –2 (b) 6 (c) 10 (d) 12

148. Here are some words translated from an artificial language.

mallon piml means blue light

mallon tifl means blue berry

arpan tifl means rasp berry

Which word could means 'light house'?

(a) tiflmallon (b) pimlarpan

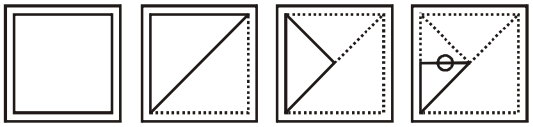
(c) mallonarpan (d) pimldoken

149. What is the water image of below figure?

(a)  (b) 

(c)  (d) 

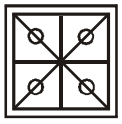
150. A piece of paper is folded and penched as shown in the figure below



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

How will it appear when unfolded?

(a)  (b) 

(c)  (d) 

SOLUTIONS

PART - I : PHYSICS

1. (b) According to law of conservation of momentum,

$$100v = -\frac{10}{1000} \times 10 \times 800$$

i.e., $v = 0.8\ ms^{-1}$.

2. (b) (i) $v = u + at_1$

$40 = 0 + a \times 20$

$a = 2\ m/s^2$

$v^2 - u^2 = 2as$

$40^2 - 0 = 2 \times 2\ s_1$

$s_1 = 400\ m$

(ii) $s_2 = v \times t_2 = 40 \times 20 = 800\ m$

(iii) $v = u + at$

$0 = 40 + a \times 40$

$a = -1\ m/s^2$

$0^2 - 40^2 = 2(-1)s_3$

$s_3 = 800\ m$

Total distance travelled $= s_1 + s_2 + s_3$

$= 400 + 800 + 800 = 2000\ m$

Total time taken $= 20 + 20 + 40 = 80\ s$

Average velocity $= \frac{2000}{80} = 25\ m/s$

3. (c) Initially $u = \cos\theta\,\hat{i} + u\sin\theta\,\hat{j}$.

At highest point $v = u\cos\theta\,\hat{i}$

$\therefore$ difference is $u \sin\theta$.

4. (a) $[MLT^{-2}] = [L^{2a}] \times [L^bT^{-b}][M^cL^{-3c}]$

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

Comparing powers of M, L and T, on both sides, we get

$c = 1, 2a + b - 3c = 1, -b = -2$ or $b = 2$

Also, $2a + 2 - 3(1) = 1 \Rightarrow 2a = 2$ or $a = 1$

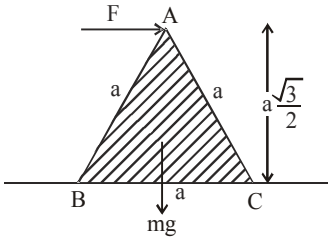
$\therefore$ This is 1, 2, 1

5. (b) Since surface (ice) is frictionless, so the centripetal force required for skating will be provided by inclination of boy with the vertical and that angle is given as

$\tan\theta = \frac{v^2}{rg}$ where v is speed of skating & r is radius of circle in which he moves.

6. (c)

7. (a) The tendency of rotation will be about the point C.



For minimum force, the torque of F about C has to be equal to the torque of mg about C.

$\therefore \quad F\left(a\frac{\sqrt{3}}{2}\right) = mg\left(\frac{a}{2}\right) \Rightarrow F = \frac{mg}{\sqrt{3}}$

8. (c) **9. (d)**

10. (b) $\Delta W = S \times \Delta A = 0.06 \times 4\pi\left(r_2^2 - r_1^2\right)$

$= 0.003168\ J$

11. (d) **12. (d)**

13. (c) Given $\Delta Q = -20\ J, W = -8\ J$

Using Ist law $\Delta Q = \Delta U + \Delta W$

$\Rightarrow \Delta Q = -20 + 8 = -12\ J$

$Uf = -12 + 30 = 18\ J$

14. (d)

15. (b) Assuming the balloons have the same volume, as pV= nRT. If P, V and T are the same, n the number of moles present will be the same, whether it is He or air.

Hence, number of molecules per unit volume will be same in both the balloons.

16. (b) $x_1 = a\sin(\omega t + \phi_1),\ x_2 = a\sin(\omega t + \phi_2)$

$$\Rightarrow \quad |x_1 - x_2| = 2a\sin\left(\omega t + \frac{\phi_1 + \phi_2}{2}\right)\cos\left(\frac{\phi_1 - \phi_2}{2}\right)$$

To maximize $|x_1 - x_2| : \sin\left(\omega t + \frac{\phi_1 + \phi_2}{2}\right) = 1$

$$\Rightarrow \quad a\sqrt{2} = 2a \times 1 \times \cos\left(\frac{\phi_1 - \phi_2}{2}\right)$$

$$\Rightarrow \quad \frac{1}{\sqrt{2}} = \cos\left(\frac{\phi_1 - \phi_2}{2}\right) \Rightarrow \frac{\pi}{4} = \frac{\phi_1 - \phi_2}{2}$$

$$\Rightarrow \phi_1 - \phi_2 = \frac{\pi}{2}$$

17. (d) $T = 2\pi\sqrt{\frac{R}{g}} = 2\pi\sqrt{\frac{64 \times 10^6}{9.8}}$

$$= 2 \times \frac{22}{7} \times \frac{8 \times 10^3}{7 \times \sqrt{2}}$$

$$= \frac{\sqrt{2} \times 22 \times 8 \times 1000}{49 \times 60} \text{ min} = 84.6 \text{ min}$$

18. (d)

19. (c) Fundamental frequency is given by

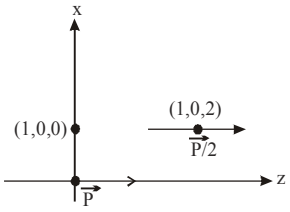
$$v = \frac{1}{2l}\sqrt{\frac{T}{\mu}} \Rightarrow v \propto \frac{1}{l} \Rightarrow P \propto \frac{1}{v}$$

Since, P divided into l_1, l_2 and l_3 segments

Here $l = l_1 + l_2 + l_3$

So $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$

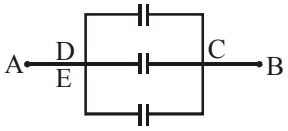
20. (b)



The given point is at axis of $\frac{\vec{P}}{2}$ dipole and at equatorial line of $\vec{p}$ dipole so that field at given point.

21. (a) $V = -\int_{\infty}^{x} E.dr = -\int_{\infty}^{x} \frac{M}{x^3} dx = \frac{M}{2x^2}$

22. (d) $C_{eq} = (1 + 2 + 3)\mu F = 6\ \mu F$



23. (c) $V = \int_a^b E.d\ell = \frac{\lambda}{2\pi\varepsilon_0 r} \ln\left(\frac{b}{a}\right)$ .....(1)

Now, $I = \sigma \int \vec{E}.\overrightarrow{dA} = \sigma \int \frac{\lambda}{2\pi\varepsilon_0 r}.2\pi dr = \frac{\sigma\lambda}{\varepsilon_0}$

From (1): $I = \frac{2\sigma\pi\varepsilon_0}{\varepsilon_0 \ln(b/a)} = \frac{2\pi\sigma}{\ln(b/a)} v$

24. (c) $R \propto \frac{\ell}{D^2} \Rightarrow \frac{Rx}{Ry} = \frac{2}{1}$

25. (b) Since, the radius of circular path of a charged particle in magnetic field is $r = \frac{mv}{qB} = \frac{\rho}{qB}$

Now, the radius of circular path of charged particle of given momentum ρ and magnetic field B is given by $r \propto \frac{1}{q}$

But charge on both charged particles, protons and deuterons, is same. Therefore,

$$\frac{r_\rho}{r_D} = \frac{q_D}{q_\rho} = \frac{1}{1}$$

26. (c) $R_G = 60.00\Omega$, shunt resistance, $r_s = 0.02\Omega$

Total resistance in the circuit is $R_G + 3 = 63\Omega$

Hence, $I = 3/63 = 0.048$ A

Resistance of the galvanometer converted to an ammeter is,

$$\frac{R_G r_s}{R_G + r_s} = \frac{60\Omega \times 0.02\Omega}{(60 + 0.02)\Omega} = 0.02\Omega$$

Total resistance in the circuit $= 0.02 + 3 = 3.02\Omega$

Hence, $I = 3/3.02 = 0.99$ A

27. (b) $\chi = \frac{C}{T}$

$$\Rightarrow \frac{\chi_1}{\chi_2} = \frac{T_2}{T_1} \Rightarrow \frac{1.2 \times 10^{-5}}{1.8 \times 10^{-5}} = \frac{T_2}{300}$$

$$\Rightarrow T_2 \Rightarrow \frac{12}{18} \times 300 = 200 \text{ K}$$

28. (c) Given : $n = 10$ turns, $R_{coil} = 20\Omega$, $R_G = 30\Omega$,

Total resistance in the circuit $= 20 + 30 = 50\Omega$.

$A = 10^{-2}\text{ m}^2$, $B = 10^{-2}$ T, $\phi_1 = 0°$, $\phi_2 = 60°$

$$q = \frac{\phi_1 - \phi_2}{R} = \frac{BnA\cos\theta_1 - BnA\cos\theta_2}{R}$$

$$= \frac{BnA(\cos 0 - \cos 60)}{R} = \frac{BnA(1 - 0.5)}{R}$$

$$= \frac{0.5 \times 10^{-2} \times 10 \times 10^{-2}}{50} = \frac{50 \times 10^{-5}}{50}$$

$= 1 \times 10^{-5}$ C (Charge induced in a coil)

29. (c) Given $V = 50 \sin(50\,t)$ V

Maximum voltage, $V_0 = 50$ V,

$$i = \left(50t + \frac{\pi}{3}\right) \text{mA}.$$

Maximum current, $i_0 = 50\text{ mA} = 50 \times 10^{-3}$ A

Power dissipated, $P = \frac{i_0}{\sqrt{2}} \times \frac{V_0}{\sqrt{2}}$

$$= \frac{50 \times 50 \times 10^{-3}}{2} = \frac{2500 \times 10^{-3}}{2} = 1.25 \text{ W}$$

30. (a)

31. (a) $\frac{f_0}{f_e} = 9$, $\therefore f_0 = 9 f_e$

Also $f_0 + f_e = 20$ ($\because$ final image is at infinity)

$9 f_e + f_e = 20$, $f_e = 2$ cm, $\therefore f_0 = 18$ cm

32. (b) Angular size of central maxima is

$$2\times\left(\frac{\lambda}{a}\right)=\frac{2\lambda}{a}$$

33. (d) From the first polaroid

$$I'=\frac{I_0}{2}$$

From second polaroid

$$I''=I'\cos^2\theta=\frac{I_0}{2}\cos^2(60°)$$

$$=\frac{I_0}{2}\times\left(\frac{1}{2}\right)^2=\frac{I_0}{8}$$

34. (a) $K_{max}=h\nu-h\nu_0=hc\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$

$$1.24\times10^{-6}\left(\frac{10^8}{18}-\frac{10^8}{23}\right)=1.49\,eV$$

35. (c)

36. (d) Radius of the orbit , $r_n\propto n^2$

$$\frac{r_{n\,big}}{r_{n\,small}}=\frac{n_{big}^2}{n_{small}^2}=\frac{4}{1}\qquad\text{(given)}$$

$$\Rightarrow\quad\frac{n_{big}}{n_{small}}=2$$

$$\Rightarrow\quad\frac{n_{small}}{n_{big}}=\frac{1}{2}$$

Velocity of electron in n^{th} orbit

$$v_n\propto\frac{1}{n}$$

$$\frac{v_{n\,big}}{v_{n\,small}}=\frac{n_{small}}{n_{big}}=\frac{1}{2}$$

$\Rightarrow v_{n\,small}=2(v_{n\,big})=2v$

37. (d) In an explosion a body breaks up into two pieces of unequal masses both part will have numerically equal momentum and lighter part will have more velocity.

$U\rightarrow Th+He$

$$KE_{Th}=\frac{P^2}{2m_{Th}},\ KE_{He}=\frac{P^2}{2m_{He}}$$

sinc m_{He} is less so KE_{He} will be more.

38. (d) $r=r_0(A)^{1/3}$

r increases with increasing A mass number

So, $r_A<r_B$ as mass number of A is smaller

E_{bn} decreases with increasing A for A > 56, ^{56}Fe has highest E_{bn} value.

So, E_{bn} for A = 64 is larger as compared to E_{bn} for nucleus with A = 125

$E_{bnA}>E_{bnB}$

39. (a) The output ac voltage is 2.0 V. So, the ac collector current $i_C=2.0/2000=1.0$ mA.

The signal current through the base is, therefore given by

$i_B=i_C/\beta=1.0\,mA/100=0.010\,mA$.

The dc base current has to be $10\times0.010=0.10$ mA.

$R_B=(V_{BB}-V_{BE})/I_B$.

Assuming $V_{BE}=0.6$ V, $R_B=(2.0\,.\,0.6)/0.10=14\,k\Omega$.

40. (a) The final boolean expression is,

$$X=\overline{(\overline{A}.\overline{B})}=\overline{\overline{A}}+\overline{\overline{B}}=A+B\Rightarrow\text{OR gate}$$

PART - II : CHEMISTRY

41. (c) Formation of CO and CO_2 illustrates the law of multiple proportion that is constant mass of C reacts with different masses of oxygen. These masses here bears simple ratio of 1 : 2.

42. (b) $R_H=109678\,cm^{-1}$

Wave number of the limiting line in Balmer series of He^+

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

$$=109678\times(2)^2\left[\frac{1}{(2)^2}-\frac{1}{\infty}\right]$$

$=109678\,cm^{-1}$

43. (c) The element A is ns^2p^1 and B is ns^2p^4. They can form compound of the type A_2B_3.

44. (b) Heat needed too be supplied per mol = 330 + 580 + 1820 + 2740 = 5470 kJ

$$\text{No. of mols of Al taken}=\frac{13.5}{27}=0.5\text{ mol}$$

Heat required = 0.5 × 5470 kJ = 2735 kJ

45. (d) BF_4^- hybridisation sp^3, tetrahedral structure.

NH_4^+ hybridisation sp^3, tetrahedral structure.

46. (b) We know that in O_2 bond, the order is 2 and in O_2^- bond, the order is 1.5. Therefore the wrong statements is (b).

47. (a) Given enthalpy of vaporization,

$\Delta H = 186.5\,kJ\,mol^{-1}$

Boiling point of water

$= 100°C = 100 + 273 = 373K$

Entropy change,

$$\Delta S = \frac{\Delta H}{T} = \frac{186.5\,kJ\,mol^{-1}}{373K}$$

$$= 0.5\,kJ\,mol^{-1}K^{-1}$$

48. (a) The greater the (negative value) of heat of neutralisation, the more is the strength of the acid. Hence,

$HCOOH > CH_3COOH > H_2S > HCN$

49. (d)

$$\underset{0.1\ (0.1-0.06)}{2KCN} + \underset{0.03\ 0}{AgNO} \rightleftharpoons \underset{0\ (0.03)}{\left[Ag(CN)_2\right]^-} + \underset{0\ (0.03)}{KNO_3} + \underset{0\ (0.03)}{K^+}$$

$$\therefore \underset{0.03}{\left[Ag(CN)_2\right]^-} \rightleftharpoons \underset{a}{Ag^+} + \underset{0.04(\text{left from KCN})}{2CN}$$

$$(0.03-a) \qquad a \qquad (0.04+a)$$

$0.04 \approx 0.04$

$$\therefore \quad K_c = 4 \times 10^{-19} = \frac{(0.04)^2 \times a}{0.03}$$

$a = 7.5 \times 10^{-18}$

50. (b) KCl $x = -1$ potassium chloride

$KClO_3$ $+1 + x - 6 = 0$, $x = +5$ potassium chlorate.

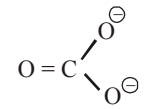
$$\therefore \text{ Ratio of oxidation state of Cl} = \frac{-1}{5}$$

51. (d) Amongst alkali metals, Cs is most reactive because of its lowest IE.

52. (c)

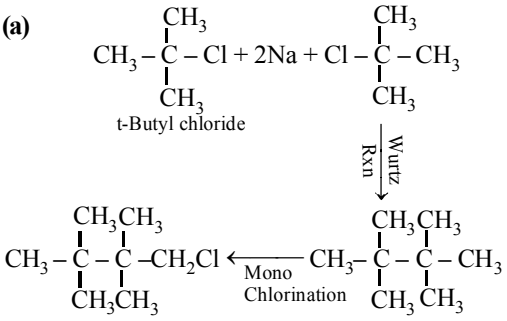
53. (b) $\underset{\text{tertiary alcohol}}{(CH_3)_3C-OH} \xrightarrow[-H_2O]{+H^+} \underset{\substack{3° \text{ carbocation} \\ \text{(more stable)}}}{(CH_3)_3C^+}$

54. (a) $C \equiv O$ has lowest bond length due to highest bond order. O = C = O has second lowest bond length due to double bond.



has highest has bond length due to lowest bond order which is due to resonance.

55. (a)



56. (a) Normal rain water has pH 5.6. Thunderstorm results in the formation NO and HNO_3 which lowers the pH.

57. (a) The packing efficiency = 0.68, means the given lattice is BCC.

The closest distance of approach = 2r

$2r = 2.86\,Å = a\sqrt{3}$

$$\text{or } a = \frac{2 \times 2.86}{\sqrt{3}} = 3.30\,Å$$

Let atomic weight of the element = a

$$\therefore \quad \frac{2 \times 9}{36 \times 10^{23} \times (3.3)^3 \times 10^{-24}} = 8.57$$

$a = 8.57 \times 3 \times (3.3)^3 \times 0.1$

$= 92.39 \simeq 93$ amu

58. (d) The correct order of solublity of sulphides is $Na_2S > ZnS > CuS$

59. (d)

60. (c) $2Cu^+ \longrightarrow Cu^{+2} + Cu$

$2e^- + Cu^{+2} \longrightarrow Cu\ ;\ E_1^\circ = 0.34V;$ ...(i)

$e^- + Cu^{+2} \longrightarrow Cu^+\ ;\ E_2^\circ = 0.15V;$ ...(ii)

$Cu^+ + e^- \rightarrow Cu;\ E_3^\circ = ?$ ... (iii)

Now, $\Delta G_1^\circ = -nFE_1^\circ = -2 \times 0.34F$

$\Delta G_2^\circ = -1 \times 0.15F$, $\Delta G_3^\circ = -1 \times E_3^\circ F$

Again, $\Delta G_1^\circ = \Delta G_2^\circ + \Delta G_3^\circ$

$$\Rightarrow -0.68F = -0.15F - E_3^\circ F$$

$$0 \Rightarrow E_3^\circ = 0.68 - 0.15 = 0.53V$$

$$E_{cell}^\circ = E_{cathode}^\circ (Cu^+ / Cu) - E_{anode}^\circ (Cu^{+2} / Cu^+)$$

$$= 0.53 - 0.15 = 0.38\ V.$$

61. (a) $\frac{1}{2}\frac{d[SO_4^{2-}]}{dt} = \frac{1}{3}\left(-\frac{d(I^-)}{dt}\right)$

$$\frac{1}{2} \times \frac{d[SO_4^{2-}]}{dt} = \frac{1}{3} \times \frac{9}{2} \times 10^{-3}$$

$$\therefore \quad \frac{d[SO_4^{2-}]}{dt} = 3 \times 10^{-3} \text{ mol Lit}^{-1}\text{ s}^{-1}$$

62. (a) The increase in pressure shows the increase in conc. of Z. Rate of appearance of Z =

$$\frac{120-100}{5} = 4 \text{ mm min}^{-1}$$

Rate of disappearance of X_2 = 2 × rate of appearance of Z

$= 2 \times 4 \text{ mm min}^{-1} = 8 \text{ mm min}^{-1}$

63. (a)

Substance R	Substance S
2k	k rate constant
$t_{½}$	$2\,t_{½}$ Half life period

$T = n \times t_{1/2}$

where n = number of half life period

$$\text{Amount of R left} = \frac{0.5}{(2)^{T/t_{½}}};$$

$$\text{Amount of S left} = \frac{0.25}{(2)^{T/2t_{½}}}$$

$$\text{Equating both } \frac{0.5}{0.25} = \frac{(2)^{T/t_{1/2}}}{(2)^{T/2t_{1/2}}}$$

or $2 = (2)^{T/t_{1/2}}$

$\therefore$ $T = 2t_{1/2}$. $2t_{1/2}$ is half life of S and twice the half-life of R

64. (b) At isoelectric point there is no migration of dispersed phase in an electric field.

65. (c) Fluorine, since it is the most electronegative element.

66. (c) I_2 gives blue colour with starch.

67. (d) The amount of energy released when an electron is added to an isolated gaseous atom to produce a monovalent anion is called electron gain enthalpy.

Electron affinity value generally increase on moving from left to right in a period however there are exceptions of this rule in the case of those atoms which have stable configuration. These atoms resist the addition of extra electron, therefore the low value of electron affinity

$$\underset{-1.48}{O} < \underset{-2.0}{S} < \underset{-3.6}{F} < \underset{-3.8}{Cl}$$

On the other hand Cl, because of its comparatively bigger size than F, allow the addition of an extra electron more easily.

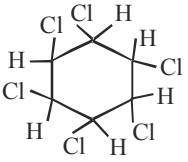
68. (d) Most of the transition metal compounds (ionic as well as covalent) are coloured both in the solid state and in aqueous solution in contrast to the compounds of *s* and *p*-block elements due to the presence of incomplete *d*-subshell.

69. (c) Number of unpaired electrons in central atom

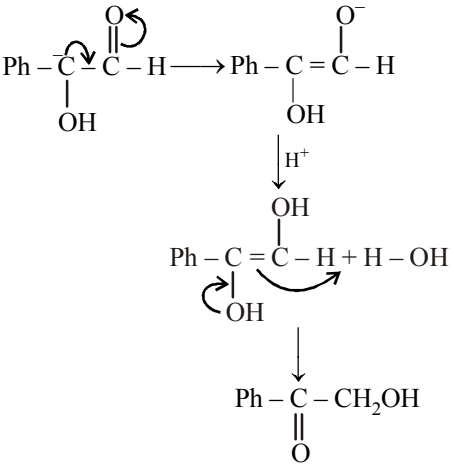
$$\underset{\text{zero}}{[Fe(CN)_6]^{4-}}, \underset{\text{three}}{[CoCl_4]^{2-}}, \underset{\text{five}}{[MnCl_4]^{2-}}$$

The greater the number of unpaired electrons, the higher the value of magnetic moment

70. (a) Gammexane is $C_6H_6Cl_6$ or (6, 6, 6). It is a saturated compound so no double bond is there in it.



71. (d)

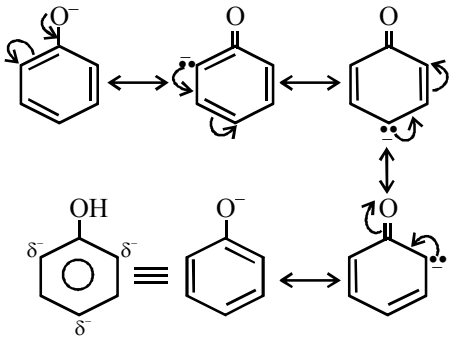


72. **(a)** Electron withdrawing group ($-NO_2$) increases the acidity while electron releasing group ($-CH_3$, $-H$) decreases acidity. Also effect will be more if functional group is present at para position than ortho and meta position.

73. **(c)** The acidic nature of phenol is due to the formation of stable phenoxide ion in solution

$$C_6H_5OH + H_2O \rightleftharpoons \underset{\text{Phenoxide ion}}{C_6H_5O^-} + H_3O^+$$

The phenoxide ion is stable due to resonance.



The negative charge is delocalized in the benzene ring which is a stabilizing factor in the phenoxide ion and increase acidity of phenol. wheras no resonance is possible in alkoxide ions (RO^-) derived from alcohol. The negative charge is localized on oxygen atom. Thus, alcohols are not acidic.

74. **(b)**

75. **(d)** $C_6H_5NH_2 + COCl_2 \longrightarrow C_6H_5NH.COCl$

$$+ HCl \xrightarrow{\Delta} C_6H_5NCO + HCl$$

76. **(d)** $\underset{\text{Chloroprene}}{nCH_2 = CH - \overset{Cl}{\overset{|}{C}} = CH_2} \xrightarrow{K_2S_2O_8}$

$$\underset{\text{Neoprene}}{+\left(CH_2 - CH = \overset{Cl}{\overset{|}{C}} - CH_2\right)_n}$$

77. **(b)**

78. **(b)** Oxytocin is a hormone (nanopetide) which contracts uterus after the child birth and produces lactation in the mammary glands.

79. **(c)** Cu^{2+} is of group II and Al^{3+} is of group III of cation analysis.

80. **(a)** Eq of $KMnO_4$ used $= \dfrac{50 \times 1}{1000 \times 10} = 0.005$

$\therefore$ Eq of FAS reacted $= 0.005$

$\therefore$ weight of FAS needed

$= 0.005 \times 392 = 1.96$ g

Thus percentage purity of FAS is 50%

PART - III : MATHEMATICS

81. **(b)** Given set can be written as

$(A - B) \cup (B - A) = (A \cup B) - (A \cap B)$

(By definition of symmetric difference)

Hence, $(A \setminus B) \cup (B \setminus A) = (A \cup B) \setminus (A \cap B)$

82. **(a)** $f(x)$ is defined if

$$-\log_{1/2}\left(1 + \frac{1}{x^{1/4}}\right) - 1 > 0$$

$$\Rightarrow \log_{1/2}\left(1 + \frac{1}{x^{1/4}}\right) < -1$$

$$\Rightarrow 1 + \frac{1}{x^{1/4}} > \left(\frac{1}{2}\right)^{-1}$$

$$\Rightarrow \frac{1}{x^{1/4}} > 1$$

$$\Rightarrow 0 < x < 1$$

83. **(a)** $\cos^2\left(\dfrac{\pi}{6} + \theta\right) - \sin^2\left(\dfrac{\pi}{6} - \theta\right)$

$$= \cos\left(\frac{\pi}{6} + \theta + \frac{\pi}{6} - \theta\right)\cos\left(\frac{\pi}{6} + \theta - \frac{\pi}{6} + \theta\right)$$

$$= \cos\frac{2\pi}{6}\cos 2\theta = \frac{1}{2}\cos 2\theta$$

84. **(b)** We have $(2\cos x - 1)(3 + 2\cos x) = 0$

If $2\cos x - 1 = 0$, then $\cos x = \dfrac{1}{2}$

$\therefore \quad x = \pi/3, 5\pi/3$

If $3 + 2\cos x = 0$, the $\cos x = -3/2$ which is not possible.

85. **(c)** $2^{3n} - 7n - 1$ Taking $n = 2$;

$2^6 - 7 \times 2 - 1$

$= 64 - 15 = 49$

Therefore this is divisible by 49.

86. **(c)** The product of r consecutive integers is divisible by r ! . Thus n (n+ 1) (n + 2) (n + 3) is divisible by 4 ! = 24.

87. (d) $z^{1/3} = a - ib \Rightarrow z = (a - ib)^3$

$\therefore \quad x + iy = a^3 + ib^3 - 3ia^2b - 3ab^2.$

$\Rightarrow x = a^3 - 3ab^2 \Rightarrow \frac{x}{a} = a^2 - 3b^2$

and $\quad y = b^3 - 3a^2b \Rightarrow \frac{y}{b} = b^2 - 3a^2$

So, $\frac{x}{a} - \frac{y}{b} = 4(a^2 - b^2)$

88. (a) $i^{57} + \frac{1}{i^{25}} = (i^4)^{14}.i + \frac{1}{(i^4)^6.i}$

$= i + \frac{1}{i} \quad (\because i^4 = 1) \; = i - i\left(\because \frac{1}{i} = -i\right)$

$= 0$

89. (a) $\left|\frac{z-3i}{z+3i}\right| = 1 \Rightarrow |z - 3i| = |z + 3i|$

[if $|z - z_1| = |z + z_2|$, then it is a perpendicular bisector of z_1 and z_2]

Hence, perpendicular bisector of (0, 3) and $(0, -3)$ is X–axis.

90. (c) The number of three elements subsets containing a_3 is equal to the number of ways of selecting 2 elements out of n – 1 elements. So, the required number of subsets is ${}^{n-1}C_2$.

91. (a) A committee of 5 out of 6 + 4= 10 can be made in ${}^{10}C_5 = 252$ ways.

If no woman is to be included, thennumber of ways = ${}^5C_5 = 6$

$\therefore$ the required number = 252 –6 = 246

92. (c) We have coefficient of x^4 in $(1 + x + x^2 + x^3)^{11}$

= coefficient of x^4 in $(1 + x^2)^{11} (1 + x)^{11}$

= coefficient of x^4 in $(1 + x)^{11}$ + coefficient of x^2 in

$11.(1 + x)^{11}$ + constant term is ${}^{11}C_2.(1 + x)^{11}$

$= {}^{11}C_4 + 11.{}^{11}C_2 + {}^{11}C_2 = 990.$

93. (b) From the given condition, replacing a by ai and $-ai$ respectively, we get

$(x + ai)^n = (T_0 - T_2 + T_4 - .....) + i(T_1 - T_3 + T_5 - ....)$ .....(i)

and

$(x - ai)^n = (T_0 - T_2 + T_4 - .....) - i(T_1 - T_3 + T_5 - ....)$ .....(ii)

Multiplying (ii) and (i) we get required result i.e.,

$(x^2 + a^2)^n = (T_0 - T_2 + T_4 - ....)^2 + (T_1 - T_3 + T_5 - ....)^2$

94. (d) If a is the first term and d is the common difference of the associated A.P.

$\frac{1}{q} = \frac{1}{a} + (2p - 1)d, \; \frac{1}{p} = \frac{1}{a} + (2q - 1)d$

$\Rightarrow d = \frac{1}{2pq}$

If h is the $2(p + q)^{th}$ term $\frac{1}{h} = \frac{1}{a} + (2p + 2q - 1)d$

$= \frac{1}{q} + \frac{1}{p} = \frac{p+q}{pq}$.

95. (a) $\frac{1}{a} - \frac{1}{b} = \frac{1}{b} - \frac{1}{c}$

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

$= \left(\frac{2}{a} - \frac{1}{b}\right)\left(\frac{2}{c} - \frac{1}{b}\right) = \frac{4}{ac} - \frac{1}{b}\left(\frac{2}{a} + \frac{2}{c}\right) + \frac{1}{b^2}$

$= \frac{4}{ac} - \frac{2}{b}\left(\frac{2}{b}\right) + \frac{1}{b^2} = \frac{4}{ac} - \frac{3}{b^2}$

96. (d) Since, product of n positive number is unity.

$\Rightarrow x_1 x_2 x_3 ..... x_n = 1$ ..(i)

Using A.M. $\geq$ GM

$\Rightarrow \quad \frac{x_1 + x_2 + ... + x_n}{n} \geq (x_1 x_2 .....x_n)^{\frac{1}{n}}$

$\Rightarrow \quad x_1 + x_n + ... + x_n \geq n \; (1)^{\frac{1}{n}}$ [From eq^n (i)]

97. (a) We have P_1 = length of perpendicular from (0, 0) on $x \sec\theta + y \operatorname{cosec}\theta = a$

i.e. $P_1 = \left|\frac{a}{\sqrt{\sec^2\theta + \operatorname{cosec}^2\theta}}\right| = |a \sin\theta \cos\theta|$

$= \left|\frac{a}{2}\sin 2\theta\right|$ or $2P_1 = |a \sin 2\theta|$

P_2= Length of the perpendicular from (0, 0) on

$x \cos\theta - y \sin\theta = a \cos 2\theta$

$P_2 = \left|\frac{a\cos 2\theta}{\sqrt{\cos^2\theta + \sin^2\theta}}\right| = |a \cos 2\theta|$

Now, $4P_1^2 + P_2^2 = a^2 \sin^2 2\theta + a^2 \cos^2 2\theta = a^2$.

98. (d) Here circles are

$x^2 + y^2 - 2x - 2y = 0$ ...(1)

$x^2 + y^2 = 4$ ...(2)

Now, $C_1(1, 1), r_1 = \sqrt{1^2 + 1^2} = \sqrt{2}$

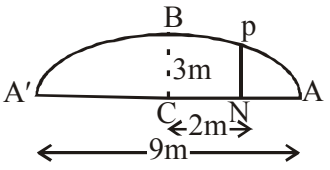
$C_2(0, 0), r_2 = 2$

If θ is the angle of intersection then

$$\cos\theta = \frac{r_1^2 + r_2^2 - (c_1c_2)^2}{2r_1r_2}$$

$$= \frac{2+4-(\sqrt{2})^2}{2.\sqrt{2}.2.} = \frac{1}{\sqrt{2}} \Rightarrow \theta = 45^\circ$$

99. (b)



The equation of the ellipse is

$$\frac{x^2}{\left(\frac{9}{2}\right)^2} + \frac{y^2}{9} = 1.$$

Where centre is assumed as origin and base as x-axis. Put $x = 2$, we get

$$\frac{16}{81} + \frac{y^2}{9} = 1 \Rightarrow y = \frac{\sqrt{65}}{3} \approx \frac{8}{3}\text{m}$$

(approximately)

100. (c) Let $y = \lim_{x\to 0}(\text{cosec}\, x)^{1/\log x}$

Taking log on both sides, we get

$$\log y = \lim_{x\to 0} \frac{\log \text{cosec}\, x}{\log x} \left[\frac{\infty}{\infty}\text{ form}\right]$$

$$= \lim_{x\to 0} \frac{-\cot x}{1/x} \quad \text{(By L' Hospital rule)}$$

$$= -\lim_{x\to 0} \frac{x}{\tan x} \qquad \left(\because \cot x = \frac{1}{\tan x}\right)$$

$$\Rightarrow \log y = -1$$

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

Hence, required limit $= \frac{1}{e}$

101. (a) We know that $\text{Q.D} = \frac{5}{6} \times M.D. = \frac{5}{6} \times 12 = 10$

$$\therefore \text{S.D} = \frac{3}{2} \times Q.D. = \frac{3}{2} \times 10 \Rightarrow S.D. = 15.$$

102. (a) Let A ≡ event of two socks being brown.
B ≡ event of two socks being white.

Then $\text{P (A)} = \frac{{}^5C_2}{{}^9C_2} = \frac{5.4}{9.8} = \frac{5}{18}$, P(B)

$$= \frac{{}^4C_2}{{}^9C_2} = \frac{4.3}{9.8} = \frac{3}{18}$$

Now, since A and B are mutually exclusive events, so required probability

$$= \text{P (A)} + \text{P (B)} = \frac{5}{18} + \frac{3}{18} = \frac{4}{9}$$

103. (c) $(3,3), (6,6), (9,9), (12,12), \in R$.
R is not symmetric as $(6, 12) \notin R$ but $(12, 6) \in R$.
R is transitive as the only pair which needs verification is $(3, 6)$ and $(6, 12) \in R$.
$\Rightarrow \quad (3, 12) \in R$

104. (b) Let $f : R \to R$ be a function defined by

$$f(x) = \frac{x-m}{x-n}$$

For any $(x, y) \in R$
Let $f(x) = f(y)$

$$\Rightarrow \frac{x-m}{x-n} = \frac{y-m}{y-n} \Rightarrow x = y$$

$\therefore$ f is one – one
Let $\alpha \in R$ such that $f(x) = \alpha$

$$\Rightarrow \alpha = \frac{x-m}{x-n} \quad \Rightarrow (x-n)\alpha = x-m$$

$$\Rightarrow x\alpha - n\alpha = x-m$$

$$\Rightarrow x\alpha - x = n\alpha - m$$

$$\Rightarrow x(\alpha - 1) = n\alpha - m$$

$$\Rightarrow x = \frac{n\alpha - m}{\alpha - 1}. \text{ for } \alpha = 1,\ x \notin R$$

So, f is not onto.

105. (b) $2\tan^{-1}\frac{1}{5} = \tan^{-1}\frac{1}{5} + \tan^{-1}\frac{1}{5}$

$$= \tan^{-1}\frac{\frac{1}{5}+\frac{1}{5}}{1-\frac{1}{5}.\frac{1}{5}} = \tan^{-1}\frac{2/5}{24/25} = \tan^{-1}\frac{5}{12}$$

$$= \tan\left(2\tan^{-1}\frac{1}{5} - \frac{\pi}{4}\right) = \tan\left(\tan^{-1}\frac{5}{12} - \frac{\pi}{4}\right)$$

$$= \frac{\tan\left(\tan^{-1}\frac{5}{12}\right) - \tan\frac{\pi}{4}}{1+\tan\left(\tan^{-1}\frac{5}{12}\right)\tan\frac{\pi}{4}} = \frac{-\frac{7}{12}}{\frac{17}{12}} = -\frac{7}{17}$$

106. (d) $\begin{bmatrix}\alpha & \beta \\ \gamma & -\alpha\end{bmatrix} = \sqrt{I_2}$;

$$\begin{bmatrix}\alpha & \beta \\ \gamma & -\alpha\end{bmatrix}\begin{bmatrix}\alpha & \beta \\ \gamma & -\alpha\end{bmatrix} = \begin{bmatrix}1 & 0 \\ 0 & 1\end{bmatrix}$$

$$\Rightarrow \alpha^2 + \beta\gamma = 1$$

107. (b) For concurrency of 3 lines the determinant of coefficients of equations should be 0.

i.e., $\begin{vmatrix} 3 & -4 & -13 \\ 8 & -11 & -33 \\ 2 & -3 & \lambda \end{vmatrix} = 0$

$\Rightarrow 3(-11\lambda - 99) + 4(8\lambda + 66) - 13(-24 + 22) = 0$

$\Rightarrow -33\lambda - 297 + 32\lambda + 264 + 312 - 286 = 0$

$\Rightarrow -\lambda - 583 + 576 = 0 \Rightarrow \lambda = -7$

108. (b) We have; $f(x) = \begin{cases} (x-1)\sin\left(\frac{1}{x-1}\right) & \text{if } x \neq 1 \\ 0 & \text{if } x = 1 \end{cases}$

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

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

which does not exist.

$\therefore f$ is not differentiable at $x = 1$

Also

$$f'(0) = \sin \frac{1}{(x-1)} - \frac{x-1}{(x-1)^2} \cos\left(\frac{1}{x-1}\right) \Bigg]_{x=0}$$

$$= -\sin 1 + \cos 1$$

$\therefore f$ is differentiable at $x = 0$

109. (b) Let $f(x) = 2x^3 + 15$ and $g(x) = 9x^2 - 12x$ then $f'(x) = 6x^2 \ \forall \ x \in R$

$\therefore f(x)$ is increasing function $\forall \ x \in R$

Also, $g'(x) > 0 \Rightarrow 18x - 12 > 0 \Rightarrow x > \frac{2}{3}$

Thus, $f(x)$ and $g(x)$ both increases for $x > \frac{2}{3}$

Let $F(x) = f(x) - g(x)$, $F'(x) < 0$

($\because$ f (x) increases less rapidly than the function g (x))

$\Rightarrow 6x^2 - 18x + 12 < 0 \Rightarrow 1 < x < 2$

110. (d) Let the speed of the train be v and distance to be covered be s so that total time taken is s/v hours. Cost of fuel per hour = kv^2 (k is constant)

Also $48 = k.\ 16^2$ by given condition $\therefore k = \frac{3}{16}$

$\therefore$ Cost to fuel per hour $\frac{3}{16}v^2$.

Other charges per hour are 300.

Total running cost,

$$C = \left(\frac{3}{16}v^2 + 300\right)\frac{s}{v} = \frac{3s}{16}v + \frac{300s}{v}$$

$$\frac{dC}{dv} = \frac{3s}{16} - \frac{300s}{v^2} = 0 \Rightarrow v = 40$$

$\frac{d^2C}{dv^2} = \frac{600s}{v^3} > 0 \ \therefore v = 40$ results in minimum running cost

111. (c) $I = \int \frac{1}{1 + 3\sin^2 x + 8\cos^2 x} dx$

Dividing the numerator and denominator by $\cos^2 x$, we get

$$I = \int \frac{\sec^2 x}{\sec^2 x + 3\tan^2 x + 8} dx = \int \frac{\sec^2 x}{4\tan^2 x + 9} dx$$

Putting $\tan x = t \Rightarrow \sec^2 x\, dx = dt$, we get

$$I = \int \frac{dt}{4t^2 + 9} = \frac{1}{4}\int \frac{dt}{t^2 + (3/2)^2} = \frac{1}{4} \times \frac{1}{3/2} \tan^{-1}\left(\frac{t}{3/2}\right) + C$$

$$\Rightarrow I = \frac{1}{6}\tan^{-1}\left(\frac{2t}{3}\right) + C = \frac{1}{6}\tan^{-1}\left(\frac{2\tan x}{3}\right) + C$$

112. (b) Let $I = \int_0^{10} \frac{x^{10}}{(10-x)^{10} + x^{10}} dx$ ...(1)

$$I = \int_0^{10} \frac{(10-x)^{10}}{(10-x)^{10} + x^{10}} dx \quad ...(2)$$

Adding (1) and (2), we get

$$2I = \int_0^{10} dx \Rightarrow 2I = 10 \Rightarrow I = 5$$

113. (d) Given $\int_1^b f(x)dx = \sqrt{b^2 + 1} - \sqrt{2}$

Differentiate with respect to b

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

114. (a) $x^2 = e^{\left(\frac{x}{y}\right)^{-1}\left(\frac{dy}{dx}\right)} \Rightarrow x^2 = e^{\left(\frac{y}{x}\right)\left(\frac{dy}{dx}\right)}$

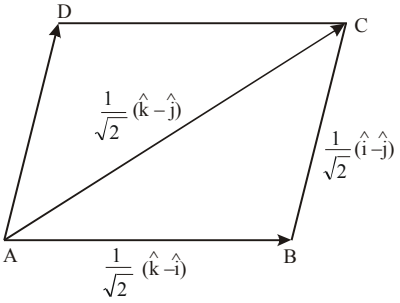
$\Rightarrow \ln x^2 = \frac{y}{x}\frac{dy}{dx}$ or $\int x \ln x^2 dx = \int y\, dy$

Put $x^2 = t \Rightarrow 2x\, dx = dt \ \therefore \ \frac{1}{2}\int \ln t\, dt = \frac{y^2}{2}$

$C + t \ln t - t = y^2$ or $y^2 = x^2 (\ln x^2 - 1) + C$

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

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

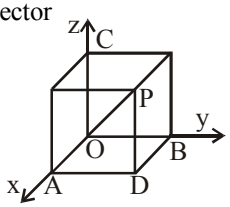


So, position vector of centre of ΔDEF

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

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

116. (d) for a unit cube unit vector along the diagonal



$$OP = \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$$

unit vector along the diagonal

$$CD = \frac{1}{\sqrt{3}}(\hat{i}+\hat{j}-\hat{k})$$

$$\therefore\ \cos\theta = \frac{1}{3}(1+1-1) = \frac{1}{3} \quad \therefore\ \tan\theta = 2\sqrt{2}$$

117. (a) Let θ be the angle between the line and the normal to the plane. Converting the given equations into vector form, we have

$$\vec{r} = (-\hat{i}+3\hat{k})+\lambda\,(2\hat{i}+3\hat{j}+6\hat{k}) \text{ and}$$

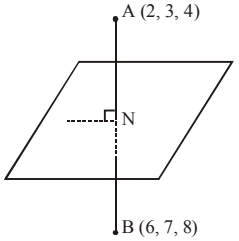
$$\vec{r}.(10\hat{i}+2\hat{j}-11\hat{k}) = 3$$

Here, $\vec{b} = 2\hat{i}+3\hat{j}+6\hat{k}$ and $\vec{n} = 10\hat{i}+2\hat{j}-11\hat{k}$

$$\sin\phi = \left|\frac{(2\hat{i}+3\hat{j}+6\hat{k}).(10\hat{i}+2\hat{j}-11\hat{k})}{\sqrt{2^2+3^2+6^2}\sqrt{10^2+2^2+11^2}}\right|$$

$$= \left|\frac{-40}{7\times 15}\right| = \left|\frac{-8}{21}\right| = \frac{8}{21} \quad \text{or} \quad \phi = \sin^{-1}\left(\frac{8}{21}\right)$$

118. (b) If the given points be A (2, 3, 4) and B (6, 7, 8), then their mid-point N(4, 5, 6) must lie on the plane. The direction ratios of AB are 4, 4, 4, i.e. 1, 1, 1.



∴ The required plane passes through N (4, 5, 6) and is normal to AB. Thus its equation is

$$1(x-4)+1(y-5)+1(z-6) = 0 \Rightarrow x+y+z = 15$$

119. (c) Let E_1 denote the event "a coin with head on both sides is selected" and E_2 denotes the event " a fair coin is selected". Let A be the event " he toss, results in heads".

$$\therefore\ P(E_1) = \frac{1}{n+1},\ P(E_2) = \frac{n}{n+1} \text{ and}$$

$$P\left(\frac{A}{E_1}\right) = 1,\ P\left(\frac{A}{E_2}\right) = \frac{1}{2}$$

$$\therefore P(A) = P(E_1)P\left(\frac{A}{E_1}\right) + P(E_2)P\left(\frac{A}{E_2}\right)$$

$$\Rightarrow \frac{7}{12} = \frac{1}{n+1}\times 1 + \frac{n}{n+1}\times\frac{1}{2}$$

$$\Rightarrow 14n+14 = 24+12n \Rightarrow n = 5$$

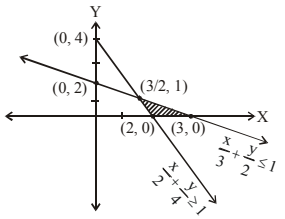
120. (b) The man has to win at least 4 times.

∴ Reqd. probability =

$$= {}^7C_4\left(\frac{1}{2}\right)^4.\left(\frac{1}{2}\right)^3 + {}^7C_5\left(\frac{1}{2}\right)^5.\left(\frac{1}{2}\right)^2 + {}^7C_6\left(\frac{1}{2}\right)^6.\frac{1}{2} + {}^7C_7\left(\frac{1}{2}\right)^7$$

$$= ({}^7C_4+{}^7C_5+{}^7C_6+{}^7C_7).\ \frac{1}{2^7} = \frac{64}{2^7} = \frac{1}{2}$$

121. (c) Consider $\frac{x}{2}+\frac{y}{4}\geq 1$, $\frac{x}{3}+\frac{y}{2}\leq 1$, $x, y \geq 0$ convert them into equation and solve them and draw the graph of these equations we get y = 1 and x = 3/2



From graph region is finite but numbers of possible solutions are infinite because for different values of x and y we have different or infinite no. of solutions.

122. (b) Let $A = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

$$A^2 = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = 2\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} = 2A$$

$$A^3 = 2^2\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix},\ A^4 = 2^3\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

$$A^3 = 2^2A, \qquad A^4 = 2^3A$$

$$\therefore\ A^n = 2^{n-1}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

$$\Rightarrow\ A^{100} = 2^{100-1}A \ \therefore\ A^{100} = 2^{99}A$$

123. (c) $\begin{vmatrix} p & q-y & r-z \\ p-x & q & r-z \\ p-x & q-y & r \end{vmatrix} = 0$

Apply $R_1 \to R_1 - R_3$ and $R_2 \to R_2 - R_3$, we get

$$\begin{vmatrix} x & 0 & -z \\ 0 & y & -z \\ p-x & q-y & r \end{vmatrix} = 0$$

$$\Rightarrow x[yr + z(q-y)] - z[0 - y(p-x)] = 0$$

[Expansion along first row]

$$\Rightarrow xyr + zxq + yzp = 2xyz \Rightarrow \frac{p}{x} + \frac{q}{y} + \frac{r}{z} = 2$$

124. (c) Given parabola is $y^2 = 4x$ ...(1)

Let $P \equiv \left(t_1^2, 2t_1\right)$ and $Q \equiv \left(t_2^2, 2t_2\right)$

$$\text{Slope of OP} = \frac{2t_1}{t_1^2} = \frac{2}{t_1} \text{ and slope of OQ} = \frac{2}{t_2}$$

$$\text{Since OP} \perp \text{OQ},\ \therefore\ \frac{4}{t_1t_2} = -1 \text{ or } t_1t_2 = -4 \quad ...(2)$$

Let R (h, k) be the middle point of PQ, then

$$h = \frac{t_1^2 + t_2^2}{2} \quad ...(3) \quad \text{and} \quad k = t_1 + t_2 \quad ...(4)$$

From (4), $k^2 = t_1^2 + t_2^2 + 2t_1t_2 = 2h - 8$ [From (2) and (3)]

Hence locus of R (h, k) is $y^2 = 2x - 8$.

125. (c) $$f[(\pi/2)^-] = \lim_{h\to 0}\frac{1-\sin^3[(\pi/2)-h]}{3\cos^2[(\pi/2)-h]}$$

$$= \lim_{h\to 0}\frac{1-\cos^3 h}{3\sin^2 h} = \frac{1}{2}$$

$$f[(\pi/2)^+] = \lim_{h\to 0}\frac{q[1-\sin\{(\pi/2)+h\}]}{[\pi - 2\{(\pi/2)+h\}]^2}$$

$$= \lim_{h\to 0}\frac{q(1-\cosh)}{4h^2} = \frac{q}{8}$$

$$\therefore\ p = \frac{1}{2} = \frac{q}{8} \Rightarrow p = \frac{1}{2}, q = 4.$$

PART - IV : ENGLISH

126. (a) Augment means make greater, so increase is the correct option.

127. (a) Consolation means 'comfort received by a person after a loss or disappointment', so comfort is correct option.

128. (b) Auxiliary means 'providing additional help', so supplemental is correct option.

129. (b) Auspicious means 'favourable', so 'unfavourable' is best opposite word for it.

130. (d) Recompense means 'reward given for loss, so 'penalty' is the correct opposite word for it.

131. (c) Impede means 'hinder' or 'obstruct', so 'push' is correct opposite word for it.

132. (b) Here a sense of command is depicted in sentence, so we should use 'ordered' for proper meaning of sentence.

133. (c) Sentence is in past tense and V_1 is used in those sentence which contain 'did', so option (c) is correct.

134. (d) No improvement is needed as sentence is right.

135. (d) Afraid agrees with preposition 'of', so option (d) is correct.

136. (c) Normally, company signs a contract or deal, so use of 'deal' is proper here.

137. (c) The question gives a sense of query about normal routine of some special/specific day, so use of 'plan' is more proper here.

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

142. (b) From the given responses,

$4 \times 2 \times 3 \times 3 = 72$

$9 \times 4 \times 2 \times 10 = 720$

Similarly, $6 \times 20 \times 1 \times 6 = \boxed{720}$

143. (b) Since, consecutive two letters are interchanged. Therefore,

DE	PR	ES	SI	ON
↓	↓	↓	↓	↓
ED	R	P	SE	IS	NO

7^{th} from Right.

144. (a) Every day of week repeats after seven days.

Hence, $59 = 7 \times 8 + 3 = 56 + 3$

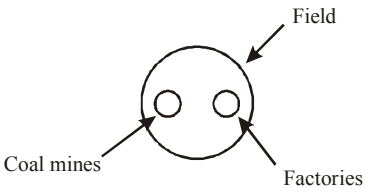
$\therefore$ It will be Thursday after 56 days.

$\therefore$ 57th day = Thursday $\Rightarrow$ 58th day = Friday

59th day = Saturday $\Rightarrow$ 60th day = Sunday

$\therefore$ It will be Sunday after 59 days.

145. (b)



Both coal mines and factories are located in the fields.

146. (c) From the given series,

$1^3 \rightarrow 1$

$2^3 \rightarrow 8$

$3^3 \rightarrow 27$

$\boxed{4^3 \rightarrow 64}$

$5^3 \rightarrow 125$

$6^3 \rightarrow 216$

Therefore, 64 will come in place of questions mark.

147. (c) Interchanging the symbols as given in the above question, the above equation becomes.

$$6 + 9 \times 8 \div 3 - 20 = 6 + 9 \times \frac{8}{3} - 20$$

$$= 6 + 24 - 20 = 10$$

148. (d) **149. (b)** **150. (b)**