Subject	Topic	Mock Test – 09	Date
C + M + P	Complete Syllabus	CET – 12 – CT C1220230510	10th May 2023

Max. Marks: 180 **Duration: 3 Hours**

1. **This paper consists of 180 questions with 3 parts of Chemistry, Mathematics and Physics**

   - **Chemistry:** *(Q. No. 1 to 60) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*
   - **Mathematics:** *(Q. No. 61 to 120) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*
   - **Physics:** *(Q. No. 121 to 180) Multiple Choice Questions with one correct answer. A correct answer carries 1 Mark. No Negative marks.*

2. **The OMR sheet for 200 questions is to be used**

3. **Use of calculators and log tables is prohibited**

4. **Darken the appropriate bubble using a pen in the OMR sheet provided to you. Once entered, the answer cannot be changed. Any corrections or modifications will automatically draw a penalty of 1 mark**

5. **No clarification will be entertained during the examination. Doubts in the paper can be reported to the coordinator after the exam**

6. **If the details in the OMR Sheet are not filled, If the OMR sheet is mutilated, torn, white Ink used, the circles filled and scratched, then the OMR sheet will not be graded**

   All the best!!

Useful Data

At. Wt.:

$N = 14;\ O = 16;\ H = 1;\ S = 32;\ Cl = 35.5;\ Mn = 55;\ Na = 23;\ C = 12;\ Ag = 108;\ K = 39;\ Fe = 56;\ Pb = 207$

Physical Constants:

$h = 6.626 \times 10^{-34}\,\text{Js},\ \text{N}_\text{a} = 6.022 \times 10^{23}\,\text{mol}^{-1},\ \text{c} = 2.998 \times 10^{8}\,\text{m s}^{-1},\ \text{m}_\text{e} = 9.1 \times 10^{-31}\,\text{kg},\ R = 8.314\ \text{J mol}^{-1}\ \text{K}^{-1}$

Chemistry

Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

1. If one atom of an element A weighs $6.644\times10^{-23}g$, then number of gram-atom in 20 kg of it is

   Options:

   (a) 500

   (b) 20

   (c) 1000 (d) 2000

   Sol: Atomic weight of A = weight of one atom $\times$ Avogadro's constant

   $=6.644\times10^{-23}\times6.023\times10^{23}=40g$

   Number of gram-atoms (moles) in $20kg=\frac{\text{weight in } g}{\text{Atomic weight}}=\frac{20\times1000}{40}=500$

   Ans: (a)

2. The uncertainity in the momentum of an electonis $1.0\times10^{-5}kg\ ms^{-1}$. The uncertainty in its position will be $\left(h=6.62\times10^{-34}kg\ m^2s^{-1}\right)$

   Options:

   (a) $1.05\times10^{-28}m$

   (b) $1.0510^{-26}m$

   (c) $5.27\times10^{-30}m$

   (d) $5.25\times10^{-28}m$

   Sol: We know, $\Delta x\cdot\Delta p=\frac{h}{4\pi}\approx5.25\times10^{-35}$

   $\Delta x=\frac{5.25\times10^{-35}}{1.0\times10^{-5}}=5.25\times10^{-30}m$

   Ans: (c)

3. The order of first ionisation energies of the elements $Li,\ Be,\ B,\ Na$ is

   Options:

   (a) $Li>Be>B>Na$

   (b) $Be>B>Li>Na$

   (c) $Na>Li>B>Be$

   (d) $Be>Li>B>Na$

   Sol: Ionisation energy increases from left to right $(Li\rightarrow B)$ and decreases from top to bottom in periodic table. But Be $\left(1s^22s^2\right)$ has higher ionisation energy than $B\left(1s^22s^22p^1\right)$ due to fully filled $s-$ orbital electronic configuration.

   Ans: (b)

4. The hybridisation of xenon in XeF_2 is

Options:

(a) sp^3

(b) sp^2

(c) sp^3d

(d) sp^3d^2

Sol: Total number of valence electrons $=8+2\times7=22$

$\frac{22}{8}=2(Q_1)+6(R_1),\ \frac{6}{2}=3(Q_2)+0(R_2)$

$X=Q_1+Q_2+R_2=2+3=5$

Hence, hybridisation is sp^3d .

Ans: (c)

5. H_2O is dipolar, whereas BeF_2 is not. It is because

Options:

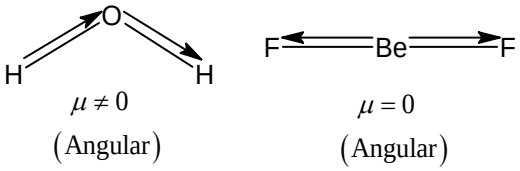
(a) H_2O is angular and BeF_2 is linear

(b) The electronegativity of F is greater than that of O .

(c) H_2O involves hydrogen bonding whereas BeF_2 is a discrete molecule

(d) H_2O is linear and BeF_2 is angular

Sol:



$\mu\neq0$ (Angular) $\mu=0$ (Angular)

Ans: (a)

6. Equal masses of methane and hydrogen are mixed in an empty container at $25°C$. The fraction of the total pressure exerted by hydrogen is

Options:

(a) 1/2

(b) 8/9

(c) 1/9

(d) 16/17

Sol: Let wg of each methane (CH_4 , molecular weight 16) and hydrogen (H_2 , mol. Weight 2) are mixed

Mole fraction of $H_2\left(x_{H_2}\right)=\frac{n_{H_2}}{n_{CH_4}+n_{H_2}}=\frac{\frac{w}{2}}{\frac{w}{16}+\frac{w}{2}}=\frac{w}{2}\times\frac{16}{9w}=\frac{8}{9}$

Partial pressure $\propto$ mole fraction

$\therefore \frac{8}{9}$ fraction of total pressure is exerted by hydrogen.

Ans: (b)

7. Standard enthalpy and standard entropy changes for the oxidation of ammonia at $298K$ are $-382.64\,kJ\ mol^{-1}$ and $-145.6\ JK^{-1}\ mol^{-1}$ respectively. Standard Gibb's energy change for the same reaction at $298\ K$ is

Options:

(a) $-523.2\ kJ\ mol$

(b) $-221.1\,kJ\ mol$

(c) $-339.3\,kJ\ mol$

(d) $-439.3\,kJ\ mol$

Sol: Applying $\Delta G = \Delta H - T\Delta S$

$\Delta H = -382.64\ kJ\ mol^{-1},\ T = 298\ K,$

$\Delta S = -145.6\ JK^{-1}mol^{-1} = -0.1456\ kJ\ K^{-1}mol^{-1}$

$\Delta G = -382.64 - 298\times(-0.1456) = -33.93\ kJ\ mol^{-1}$

Ans: (c)

8. Heat of neutralization of a strong acid by a strong base is a constant value because

Options:

(a) Salt formed does not hydrolyse

(b) Only H^+ and OH^- ions react in every case

(c) The strong base and strong acid react completely

(d) The strong base and strong acid react in aqueous solution

Sol: For example: $Na^+ + OH^- + H^+ + Cl^- \rightarrow Na^+ + Cl^- + H_2O$

i.e., $H^+ + OH^- \rightarrow H_2O$

Thus heat of neutralization of a strong acid with strong base is constant.

Ans: (b)

9. $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)} + CO_{2(g)}$. If equilibrium pressure is 3 atm for the above reaction, K_p for the reaction is

Options:

(a) 4

(b) $\frac{4}{27}$

(c) $\frac{1}{27}$

(d) 27

Sol:

$$NH_4COONH_{2(s)} \rightleftharpoons 2NH_{2(g)} + CO_{2(g)}$$

Pressure at equilibrium $\quad 2p \quad p$

It is given that $2p + p = 3$ atm

$\therefore\ p = 1$ atm

$K_p = p^2_{NH_3} \times p_{CO_2} = (2)^2 \times 1 = 4$

Ans: (a)

10. Why only As^{3+} gets precipitated as As_2S_3 and not Zn^{2+} as ZnS when H_2S is passed through an acidic solution containing As^{3+} and Zn^{2+}?

Options:

(a) Solubility product of As_3S_3 is less than that of ZnS

(b) Enough As^{3+} are present in acidic medium

(c) Zinc salt does not ionise in acidic medium

(d) Solubility product changes in presence of an acid

Sol: K_{sp} of $As_2S_3 < ZnS$ in acidic solution.

Ans: (a)

11. Which of the following species do not show disproportionation reaction?

Options:

(a) ClO^-

(b) ClO_2^-

(c) ClO_3^-

(d) ClO_4^-

Sol: ClO_4^- does not disproportionate because in this oxoanion chlorine is present in its highest oxidation state that is, $+7$. The disproportionation reactions for the other three oxoanions of chlorine are as follows

$$\overset{+1}{3ClO^-} \longrightarrow \overset{-1}{2Cl^-} + \overset{+5}{ClO_3^-}$$

$$\overset{+3}{3ClO_2^-} \xrightarrow{h\nu} \overset{+5}{2ClO_3^-} + \overset{-1}{Cl^-}$$

$$\overset{+5}{4ClO_3^-} \longrightarrow \overset{-1}{Cl^-} + \overset{+7}{3ClO_4^-}$$

Ans: (d)

12. Which of the following metals form saline hydrides?

Options:

(a) Li

(b) Be

(c) Al

(d) Mg

Sol: Active metals like alkali and alkaline earth metals form saline ionic hydrides except Be and Mg.

Ans: (a)

13. Which of the following statements is false for alkali metals?

Options:

(a) Lithium is the strongest reducing agent

(b) Oxides of sodium are amphoteric in nature

(c) Li^+ is exceptionally small

(d) All alkali metals give blue solution in liquid ammonia

Sol: Oxides of sodium are basic in nature.

Ans: (b)

14. Which of the following statements is correct with respect to the property of elements with increase in atomic number in the carbon family (group 14)?

Options:

(a) Their metallic character decrease

(b) The stability of $+2$ oxidation state increases

(c) Their ionization energy increases

(d) Their atomic size decreases

Sol:

Stability of $+2$ oxidation state in carbon family increases with increases in atomic number due to inert pair effect.

Ans: (b)

15. Which of the following is least stable?

Options:

(a) $CH_3-CH_2\overset{+}{C}H_2$

(b) $CH_3-\overset{+}{C}H-CH_2-CH_3$

(c) $CH_3-\overset{+}{\underset{\displaystyle CH_3}{\underset{|}{C}}}-CH_3$

(d) $CH_3-\overset{CH_3}{\underset{CH_3}{\underset{|}{\overset{|}{C}}}}-\overset{+}{C}H-C_6H_5$

Sol: 1° carbocation is least stable because of less $+I$ effect

Ans: (a)

16. The IUPAC name of the compound,

$CH_3-\underset{OH}{\underset{|}{C}}=CH-CH_2-COOH$ is

Options:

(a) Hydroxypentenoic acid

(b) 4-Hydroxypent-3-enoic acid

(c) 2-Hydroxypent-4-enoic acid

(d) 4-Hydroxy-4-methylpent-3-eonic acid

Sol:

$\overset{5}{C}H_3-\overset{4}{\underset{OH}{\underset{|}{C}}}=\overset{3}{C}H-\overset{2}{C}H_2-\overset{1}{C}OOH$

4-Hydroxpent-3-enoic acid

Ans: (b)

17. The order of reactivity of halogen in aliphatic substitution reaction is

Options:

(a) $Br_2 > Cl_2 > F_2$

(b) $Cl_2 > Br_2 > F_2$

(c) $F_2 > Cl_2 > Br_2$

(d) $F_2 > Br_2 > Cl_2$

Sol: Order of reactivity of halogens in aliphatic substitution reaction is $F_2 > Cl_2 > Br_2$.

Ans: (c)

18. Silver forms ccp lattice and X-ray studies of its crystals show that the edge length of its unit cell is $408.6\ pm$. The density of silver (Atomic mass $= 108\ u$) is

Options:

(a) $10.6\ g\ cm^{-3}$

(b) $12.5\ g\ cm^{3}$

(c) $5\ g\ cm^{-2}$

(d) $15.7\ g\ cm^{-3}$

Sol: Since the lattice is ccp the number of silver atoms per unit cell $= Z = 4$

Molar mass of silver $= 108\ g\ mol^{-1}$

Edge length of unit cell $= a = 408\ pm$

Density, $d = \frac{Z}{a^3} \cdot \frac{M}{N_A} = \frac{4 \times 108}{(408)^3 \times 6.022 \times 10^{23} \times 10^{-30}} = 10.56\ g/cm^3 \approx 10.6\ g/cm^3$

Ans: (a)

19. Which of the following is an amorphous solid?

Options:

(a) Naphthalene

(b) Copper

(c) Cellophane

(d) Benzoic acid

Sol: Cellophane is an amorphous solid and other solids are crystalline.

Ans: (c)

20. An electron trapped in an anion site in a crystal is called

Options:

(a) F-centre

(b) Frenkel defect

(c) Schoottky defect

(d) Interstrital defect

Sol: $F-$centres are electrons trapped anion sites which are responsible for colour.

Ans: (a)

21. A mixture of two completely miscible non-ideal liquids which distils as such without change in its composition at a constant temperature like a pure liquid. This mixture is known as

Options:

(a) Binary liquid mixture

(b) Azeotropic mixture

(c) Eutectic mixture (d) Ideal mixture

Sol: Azeotropes have a definite composition and boil like a pure liquid.

Ans: (b)

22. The osmotic pressure of 6.84% (mass/volume) solution of cane sugar at $300\ K$ (molecular weight of sugar $=342$) is

Options:

(a) 4 atm

(b) 4.926 atm

(c) 3.55 atm

(d) 2.45 atm

Sol: 5% (mass-volume) solution means $5g$ of sugar dissolved in $100mL$ water.

$$\pi = \frac{n}{V}RT = \frac{6.84}{342} \times \frac{1000}{100} \times 0.0821 \times 300 = 4.926 \text{ atm}$$

Ans: (b)

23. The boiling point of benzene is $353.3\,K$. When $1.80\ g$ of a non-volume solute was dissolved in $90\ g$ of benzene, the boiling point is raised to $354.1\ K$ given that K_b for benzene is $2.52\ K\ kg\ mol^{-1}$, the molar mass of the solute is

Options:

(a) $15\ g\ mol$

(b) $20\ g\ mol$

(c) $25\ g\ mol$

(d) $63\ g\ mol$

Sol: $M_2 = \dfrac{1000 \times w_2 \times K_b}{\Delta T_b \times w_1} = \dfrac{1000 \times 1.8 \times 2.52}{0.8 \times 90} \quad [\because \Delta T_b = 354.11\ K - 353.23K = 0.88K] = 63\ g\ mol^{-1}$

Ans: (d)

24. $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$ $E^{\circ}_{\text{cell}} = 0.46$ V. The equilibrium constant of above reaction is

Options:

(a) $K_c = 4.92 \times 10^{25}$

(b) $K_c = 2.5 \times 10^{18}$

(c) $K_c = 3.92 \times 10^{15}$

(d) $K_c = 7.5 \times 10^{12}$

Sol: $E^{\circ}_{(\text{cell})} = \dfrac{0.059V}{2} \log K_c = 0.46V$ or

$$\log K_c = \frac{0.46V \times 2}{0.059V} = 15.6$$

$$K_c = 3.98 \times 10^{15}$$

Ans: (c)

25. Λ_m° for $NaCl$, HCl and $NaAc$ are 126.4, 425.9 and 91.0 $S\ cm^2\ mol^{-1}$ respectively. $\Lambda°$ for HAc is

Options:

(a) 285 $S\ cm^{-2}\ mol^{-1}$

(b) 400 $S\ cm^{-2}\ mol^{-1}$

(c) 390.5 $S\ cm^{-2}\ mol^{-1}$

(d) 125 $S\ cm^{-2}\ mol^{-1}$

Sol: $\Lambda^\circ_{m(HAc)} = \lambda^\circ_{H^+} + \lambda^\circ_{Ac^-} = \lambda^\circ_{H^+} + \lambda^\circ_{Cl^-} + \lambda^\circ_{AC^-} + \lambda^\circ_{Na^+} - \lambda^\circ_{Cl^-} - \lambda^\circ_{Na^+}$

$= \Lambda^\circ_{m(HCl)} + \Lambda^\circ_{m(NaAC)} - \Lambda^\circ_{m(NaCl)} = (425.9 + 91.0 - 126.4)\ S\ cm\ mol^{-1}$

$= 390.5\ S\ cm^2\ mol^{-1}$

Ans: (c)

26. Which of the following will not displace hydrogen?

Options:

(a) Pb

(b) Sn

(c) Ba

(d) Hg

Sol: Mercury lies below hydrogen in the electrochemical series so it will not displace hydrogen from acids.

Ans: (d)

27. What is the order of a reaction which has a rate expression, rate $= K[A]^{3/2}[B]^{-1}$?

Options:

(a) 1

(b) 2

(c) $3/2$

(d) $1/2$

Sol: Order: $\frac{3}{2} + (-1) = \frac{1}{2}$ i.e. half order.

Ans: (d)

28. The following data were obtained during the first order thermal decomposition of $A_{(g)}$ at constant volume:

$A_{(g)} \rightarrow B_{(g)} + C_{(g)}$

S. No.	Time/s	Total pressure/(atm)
1.	0	0.5
2.	100	0.512

The rate constant is

Options:

(a) $2.3\times10^{-4}s^{-1}$

(b) $4.8\times10^{-4}s^{-1}$

(c) $3\times10^{-4}s^{-1}$

(d) $8\times10^{-4}s^{-1}$

Sol: $k=\frac{2.303}{100}\log\frac{0.5}{2\times0.5-0.512}$

$=\frac{2.303}{100}\log1.024=\frac{2.303}{100}\times10^{-2}=2.3\times10^{-4}$

Ans: (a)

29. Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes. If the decomposition is a first order reaction, the rate constant of the reaction is

Options:

(a) $1.92\times10^{-4}s^{-1}$

(b) $3\times10^{-2}s^{-1}$

(c) $5\times10^{-3}s^{-1}$

(d) $4.75\times10^{-4}s^{-1}$

Sol:

For a first order reaction, $k=\frac{0.693}{t_{1/2}}=\frac{0.693}{60}=1.155\times10^{-2}\ \text{min}^{-1}$

Or $k=\frac{0.693}{60\times60}=1.925\times10^{-4}s^{-1}$

Ans: (a)

30. The following statements relate to the adsorption of gases on a solid surface. Identify the incorrect statement among them

Options:

(a) Enthalpy of adsorption in negative

(b) Entropy of adsorption is negative

(c) On adsorption, the residual forces on the surface are increased

(d) On adsorption decrease in surface energy appears as heat

Sol: After adsorption there is decrease in the residual forces due to bond formation. ΔG, ΔH and ΔS, all are negative in the case of adsorption.

Ans: (c)

31. The coagulation power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphite sol increases in the order

Options:

(a) $Al^{3+} < Na^+ < Ba^{2+}$

(b) $Al^{3+} < Ba^{2+} < Na^+$

(c) $Na^+ < Ba^{2+} < Al^{3+}$

(d) $Ba^{2+} < Na^+ < Al^{3+}$

Sol:

For a negatively charged sol, like As_2S_3, greater the positive charge on cations, greater is the coagulation isotherm.

Ans: (c)

32. NH_3 has a much higher boiling point than PH_3 because

Options:

(a) NH_3 has a larger molecular weight

(b) NH_3 undergoes pyramidal inversion

(c) NH_3 forms hydrogen bonds

(d) NH_3 contains ionic bonds whereas PH_3 contains covalent bonds

Sol: NH_3 possesses intermolecular $H-$bonding and thus shows higher boiling point than PH_3.

Ans: (c)

33. A metal X on heating in nitrogen gas gives Y. Y on treatment with H_2O gives a colourless gas, which when passed through $CuSO_4$ solution gives a blue colour. Y is

Options:

(a) $Mg(NO_3)_2$

(b) Mg_3N_2

(c) NH_3

(d) MgO

Sol: Due to unavailability of d – orbitals, nitrogen forms only NCl_3, not NCl_5.

Ans: (a)

34. Which of the following bonds has highest energy?

Options:

(a) $Se-Se$

(b) $Te-Te$

(c) $S-S$

(d) $O-O$

Sol: $S-S$ bond is the strongest bond, $O-O$ bond is weaker than $S-S$ because of strong interelectronic repulsions due to small size.

Ans: (c)

35. Which of the following hydrides is most acidic?

Options:

(a) H_2Te

(b) H_2Se

(c) H_2O

(d) H_2S

Sol: Acidic character of hydrides of group 16 elements increases down the group because of the weakening of $M-H$ bond strength.

Ans: (a)

36. What is the oxidation number of sulphur in $Na_2S_4O_6$?

Options:

(a) 2/3

(b) 3/2

(c) 3/5

(d) 5/2

Sol: Fluorine has highest reduction potential value.

Ans: (a)

37. Which one of the following reacts with conc H_2SO_4 ?

Options:

(a) Au

(b) Ag

(c) Pt

(d) Pb

Sol: Since bond energy for Cl_2 is maximum, it must have the strongest bond. $F-F$ bond is weaker than $Cl-Cl$ bond because of inter electronic repulsions taking place in small sized fluorine

Ans: (c)

38. The ease of liquefaction of noble gases decreases in the order

Options:

(a) $He > Ne > Ar > Kr > Xe$

(b) $Xe > Kr > Ar > Ne > He$

(c) $Kr > Xe > He > Ar > Ne$

(d) $Ar > Kr > Xe > He > Ne$

Sol: Easy of liquefaction of noble gases increases down the group since van der Waals forces of attraction increases down the group with increasing atomic size. Thus, $Xe > Kr > Ar > Ne > He$.

Ans: (b)

39. Which of the following will be colourless in aqueous solution

I. Ti^{3+} II. V^{3+} III. Cu^{+}

IV. Mn^{2+} V. Co^{2+} VI. Sc^{3+}

Options:

(a) (I), (II), (IV)

(b) (III) and (V)

(c) (II), (IV) and (VI)

(d) (III) and (VI)

Sol: $Ti^{3+} - 3d^1 4s^0$ 1 unpaired electrons

$V^{3+} - 3d^2 4s^0$ 2 unpaired electrons

$Cu^{+} - 3d^{10} 4s^0$ No unpaired electrons

$Mn^{2+} - 3d^5 4s^0$ 5 unpaired electrons

$Co^{3+} - 3d^7 4s^0$ 3 unpaired electrons

$Sc^{3+} - 3d^0 4s^0$ No unpaired electrons

Ans: (d)

40. Magnetic moment of Cr^{2+} is nearest to

Options:

(a) Fe^{2+}

(b) Mn^{2+}

(c) Co^{2+}

(d) Ni^{2+}

Sol:

$Cr^{2+} = 3d^4$, No of unpaired electrons $(n) = 4$

Magnetic moment $= \sqrt{n(n+2)}BM = \sqrt{4(4+2)} = \sqrt{24} = 4.89\ BM$

$Fe^{2+} = 3d^6$, No of unpaired electrons $(n) = 4$

Magnetic moment $= \sqrt{4(4+2)}BM = \sqrt{24} = 4.89\ BM$

$Mn^{2+} = 3d$, No of unpaired electrons $(n) = 5$

Magnetic moment $= \sqrt{5(5+2)}BM$

$Co^{2+} = 3d^7$, No of unpaired electrons $(n) = 3$

Magnetic moment $= \sqrt{3(3+2)}BM = \sqrt{15} = 3.87\ BM$

$Ni^{2+} = 3d^8$, No of unpaired electrons $(n) = 2$

Magnetic moment $= \sqrt{2(2+2)}BM = \sqrt{8} = 2.82\ BM$

Ans: (a)

41. The lanthanide contraction is responsible for the fact that

Options:

(a) Zr and Y have about the same radius

(b) Zr and Hf have about the same radius

(c) Zr and Nb have similar oxidation state

(d) cannot be predicted

Sol:

Due to lanthanide contraction, the elements of second and third i.e. Zr and Hf transition series resemble more with each other than the elements of first and second transition series

Ans: (b)

42. The oxidation state of Co in $\left[Co\left(H_2O\right)\left(CN\right)\left(en\right)_2\right]^{2+}$ is

Options:

(a) +2

(b) +3

(c) −3

(d) −2

Sol:

$x+\left(-1\right)=+2$

$x=+3$

Ans: (b)

43. Amongst the following the most stable complex is

Options:

(a) $\left[Fe\left(H_2O\right)_6\right]^{3+}$

(b) $\left[Fe\left(NH_3\right)_6\right]^{3+}$

(c) $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$

(d) $\left[FeCl_6\right]^{3-}$

Sol: Since $C_2O_4^{2-}$ is a bidentate ligand, it forms the most stable complex.

Ans: (c)

44. The IUPAC name of $K_2\left[Ni\left(CN\right)_4\right]$ is

Options:

(a) Potassium tetracyanidonickelate (II)

(b) Potassium tetracyanidonickelate (III)

(c) Potassium tetracyanidonickle (II)

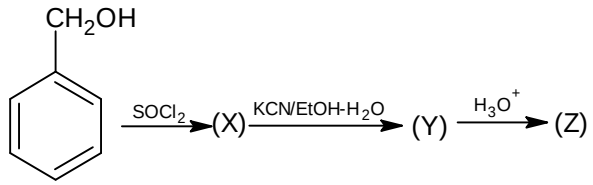
(d) Potassium tetracyanidonickle (III)

Sol:

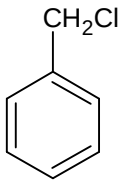
Potassium tetracyanidonickelate (II)

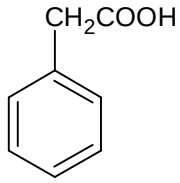
Ans: (a)

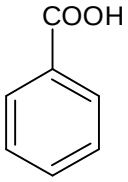
45. Identify Z in the following sequence of reactions

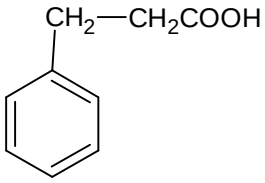


Options:

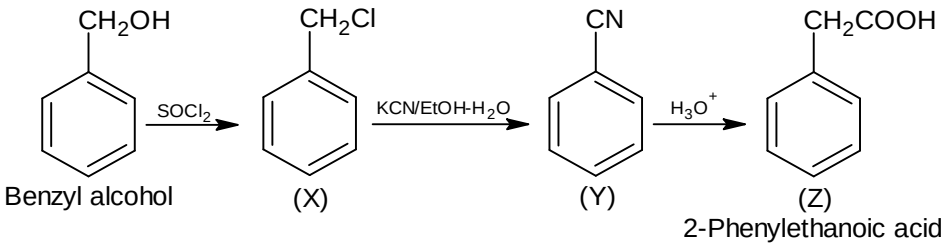
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (b)

46. Which of the following represents the correct order of increasing boiling points?

Options:

(a) 1-Chloropropane<1-Chlorobutane< Chloropropane

(b) 2- Chloropropane <1-Chloropropane<1-Chlorobutane

(c) 2-Chloropropane <1-Chlorobutane<1-Chloropropane

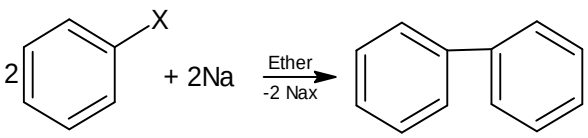
(d) 1-Chlorobutane< 2- Chloropropane<1-Chloroporpane

Sol: Amongst molecules with same mass, it is the size of the molecule that determines the boiling point. Branched compounds are more compact and therefore have less surface area as compared to their straight chain counterparts and thus have lower boiling point. The correct order of increasing boiling point is

2- Chloropropane <1-Chloropropane<1-Chlorobutane

Ans: (b)

47. The reaction



is called

Options:

(a) Wurtz Fitting reaction

(b) Fittig reaction

(c) Wurtz reaction

(d) Friedel-Crafts reaction

Sol: Fittig reaction

Ans: (b)

48. Arrange the following compounds in increasing order of solubility in water

(I). Pentan-1-ol (II) $n-$Butane (III) Pentanal (IV) Ethoxyethane

Options:

(a) (III)<(IV)<(I)<(II)

(b) (IV)<(II)<(III)<(I)

(c) (II)<(IV)<(III)<(I)

(d) (II)<(III)<(IV)<(I)

Sol:

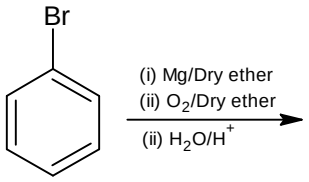
Carboxylic acids are more soluble in H_2O than corresponding alcohols, aldehydes and hydrocarbons.

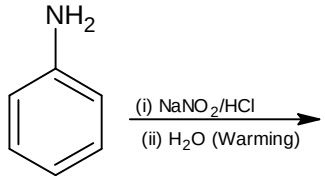
$$\underset{\text{II}}{n-\text{butane}} < \underset{\text{IV}}{\text{ethoxyethane}} < \underset{\text{III}}{\text{pentanal}} < \underset{\text{I}}{\text{pentan-1-ol}}$$

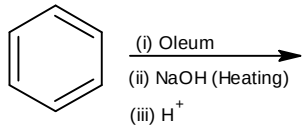
Ans: (c)

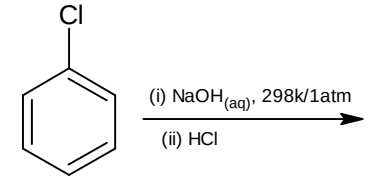
49. Which of the following reactions will not yield phenol?

Options:

(a) 

(b) 

(c) 

(d) 

Sol: Chlorobenzene does not undergo hydrolysis on treatment with aq. $NaOH$ at $298\ K$. all the remaining three options are correct.

Ans: (d)

50. On boiling with concentrated HBr, ethyl phenyl ether will give

Options:

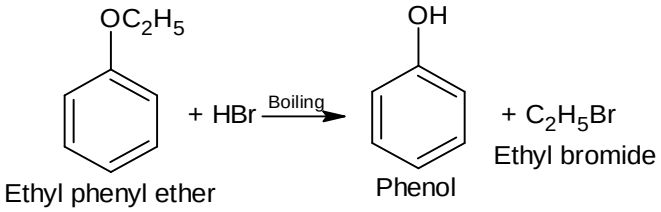
(a) Phenol and ethyl bromide

(b) Bromobenzene and ethanol

(c) Phenol and ethane

(d) Bromobenzene and ethane

Sol:



Ans: (a)

51. Which is the most suitable reagent for the following conversion?

$CH_2 = CHCH_2 - OH \longrightarrow CH_2 = CH - CHO$

Options:

(a) $K_2Cr_2O_7$ in acidic medium

(b) DIBAL-H

(c) PCC

(d) $O_3/H_2O - Zn$ dust

Sol: $\underset{\text{Allyl alcohol}}{CH_2CHCH_2OH} \xrightarrow[CH_2Cl_2]{C_5H_5\overset{+}{N}HCrO_3Cl^-(PCC)} \underset{\text{Prop-2-enal}}{CH_2 = CH - CHO}$

Ans: (c)

52. Arrange the following compounds in the increasing order of ease of hydrogen bond formation

I. $CH_2CH_2CH_2CHO$ II. $CH_3CH_2CH_2CH_2OH$

III. $C_2H_5 - O - C_2H_5$ IV. $CH_3CH_2CH_2COOH$

Options:

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

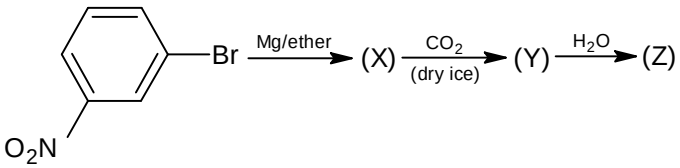
(c) III<II<IV<I (d) IV<III<II<I

Sol: The overall increasing order of ease of hydrogen bond formation is

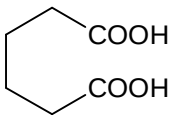
III<I<II<IV

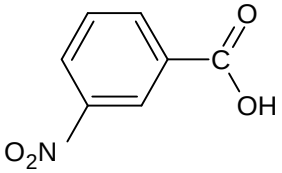
Ans: (b)

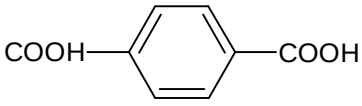
53. What is Z in the following sequence of reactions?

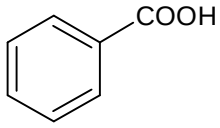


Options:

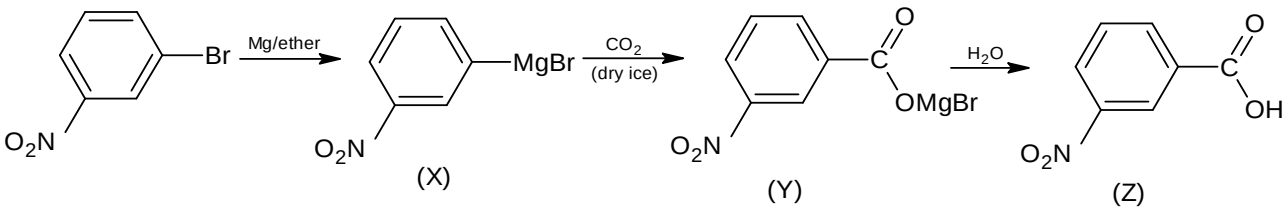
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (b)

54. In Clemmensen reduction carbonyl compound is treated with

Options:

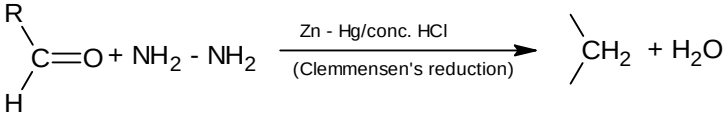
(a) Zinc amalgam + HCl

(b) Sodium amalgam + HCl

(c) Zinc amalgam + nitric acid

(d) Sodium amalgam + HNO_3

Sol:



Ans: (a)

55. What is the decreasing order of basicity of primary, secondary and tertiary ethyl amines and NH_3 ?

Options:

(a) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2 NH > (C_2H_5)_3 N$

(b) $(C_2H_5)_3 N > (C_2H_5)_2 NH > C_2H_5NH_2 > NH_3$

(c) $(C_2H_5)_2 NH > C_2H_5NH_2 > (C_2H_5N) > NH_3$

(d) $(C_2H_5)_2 NH > (C_2H_5)_3 N > C_2H_5NH_2 > NH_3$

Sol:

In case of ethylamines, the combined effect of inductive effect, steric effect and solvation effect gives the order of basic strength as:

$\underset{(2^\circ)}{(C_2H_5)_2 NH} > \underset{(3^\circ)}{(C_2H_5)_3 N} > \underset{(1^\circ)}{C_2H_5NH_2} > NH_3$

Ans: (d)

56. What is Z in the following sequence of reactions?

$$C_6H_5NH_2 \xrightarrow{(CH_3CO)_2O} X \xrightarrow{Br_2/CCl_4} Y \xrightarrow[H^+]{HOH} Z$$

Options:

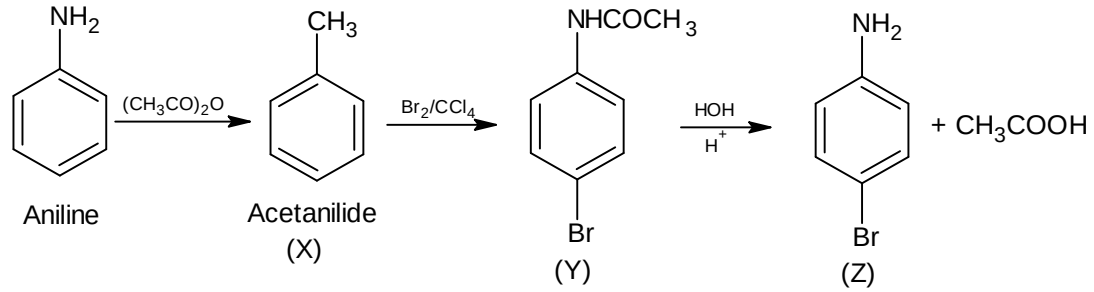
(a) p – Bromoacetopheone

(b) Bromoacetophenone

(c) p – Bromoacetanilide

(d) o – Bromoacetanilide

Sol:



Ans: (a)

57. C_3H_9N represent

Options:

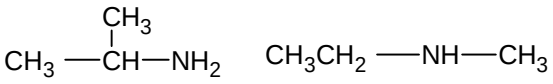
(a) Primary amine

(b) Secondary amine

(c) Tertiary amine

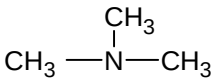
(d) All of these

Sol: C_3H_9N : $CH_3CH_2CH_2NH_2$ or



1° amine

2° amine



3° amine

Ans: (d)

58. The rapid interconversion of $\alpha-D-$ glucose and $\beta-D-$ glucose in solution is known as

Options:

(a) Surcose

(b) Glucose

(c) Fructose

(d) Maltose

Sol: Spontaneous rapid interconversion of $\alpha-D-$ glucose in solution is known as mutarotation.

Ans: (d)

59. The pH value of the solution in which a particular amino acid does not migrate under the incluence of an electric field is called the

Options:

(a) Eutectic point

(b) Yielding point

(c) Neutralisation point

(d) Isoelectric point

Sol: Isoelectric point is the pH of a solution in which a particular amino acid does not migrate under the influence of electric field.

Ans: (d)

60. Which of the following statements is not correct regarding the DNA?

Options:

(a) It has double stranded β – helix structure

(b) It controls the synthesis of proteins

(c) It has the unique property of replication

(d) It chiefly occurs in the nucleus of cell

Sol: DNA has α -helix structure.

Ans: (a)

Mathematics

Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

61. A set A has 9 elements. Then the number of subsets of A having atmost 7 elements is

Options:

(a) 46

(b) 502

(c) 503

(d) 511

Sol: $n\left[P(A)\right]=2^9=512$

No. of subsets having 8 or 9 elements is ${}^9C_8+1$ i.e.. $9+1=10$

$\therefore$ Required $=512-10=502$

Ans: (b)

62. On the set of Z of integers define a relation R by a R b if $|a-b|\le 3$. Then R is

Options:

(a) an equivalence relation

(b) reflexive, symmetric but not transitive

(c) symmetric, transitive, but not reflexive

(d) symmetric but neither reflexive not transitive.

Sol: $|a-a|=0\le 3; |a-b|\le 3\Rightarrow |b-a|\le 3; |5-3|\le 3$ and $|3-1|\le 3$ but $|5-1|\not\le 3$

Ans: (b)

63. The function $f:R\to R$ defined by $f(x)=4+3\cos x$ is

Options:

(a) bijective

(b) one-one but not onto

(c) onto but not one-one

(d) neither one-one nor onto

Sol: $f(0)=f(2\pi)\therefore f$ is not one-one

$f(x)\ne 0\in R\because 4+3\cos x\ne 0\therefore f$ is not onto

Ans: (d)

64. In $(Q_{-1}, *)$, where $*$ is defined by $a*b = a+b+ab \ \forall a,b \in Q_{-1}$, then $2^{-1} * 3^{-1} =$

Options:

(a) $-\frac{11}{10}$

(b) $-\frac{11}{12}$

(c) $\frac{11}{12}$

(d) $\frac{12}{11}$

Sol: $2^{-1}*3^{-1} = (2*3)^{-1} = (2+3+6)^{-1} = \frac{-11}{11+1} = \frac{-11}{12}$

Ans: (b)

65. If $m = \sin x + \cos x$ and $n = \sec x + \cos ecx$ then n in terms of m is

Options:

(a) $\frac{m}{m^2-1}$

(b) $\frac{2m}{1-m^2}$

(c) $\frac{2m}{m^2-1}$

(d) $\frac{m}{1-m^2}$

Sol: $m^2 = (\sin x + \cos x)^2 = 1 + 2\sin x \cos x \Rightarrow m^2 - 1 = 2\sin x \cos x$

$\therefore \frac{2m}{m^2-1} = \frac{2(\sin x + \cos x)}{2\sin x \cos x} = \frac{1}{\cos x} + \frac{1}{\sin x} = \sec x + \cos ecx$

Ans: (c)

66. In a right angled triangle $ABC, \sin^2 A + \sin^2 B - \cos^2 C =$

Options:

(a) $\frac{3}{2}$

(b) 2

(c) $\frac{5}{2}$

(d) 1

Sol: If $B = 90°, \sin B = 1, C = 90° - A \ \therefore \sin^2 A + \sin^2 C = 1$

$\therefore \sin^2 A + \sin^2 B + \sin^2 C = 2 \Rightarrow \sin^2 A + \sin^2 B + 1 - \cos^2 C = 2 \Rightarrow G.E. = 1$

Ans: (d)

67. If $\sin A+\sin B+\sin C=3$, then $\cos 2A+\cos 2B+\cos 2C=$

Options:

(a) 3

(b) -3

(c) 1 (d) -1

Sol: Clearly $A=B=C=\frac{\pi}{2}$ $\therefore G.E.=\cos\pi+\cos\pi+\cos\pi=-3$

Ans: (b)

68. The value of $\frac{\cos 3}{2\cos 2-1}$ is

Options:

(a) 1

(b) cos1

(c) sin1

(d) 0

Sol: $\frac{\cos 3\theta}{2\cos 2\theta-1}=\frac{4\cos^3\theta-3\cos\theta}{2\left(2\cos^2\theta-1\right)-1}=\frac{\cos\theta\left(4\cos^2\theta-3\right)}{4\cos^2\theta-3}=\cos\theta$; put $\theta=1$

Ans: (b)

69. If $\sin x-\sin y=\frac{1}{2}$ and $\cos x-\cos y=\frac{1}{3}$ then $\cos(x+y)=$

Options:

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

(c) $-\frac{5}{13}$ (d) $\frac{5}{13}$

Sol: $\sin x-\sin y=2\sin\left(\frac{x-y}{2}\right).\cos\left(\frac{x+y}{2}\right)=\frac{1}{2}$

$\cos x-\cos y=-2\sin\left(\frac{x-y}{2}\right).\sin\left(\frac{x+y}{2}\right)=\frac{1}{3}$

Dividing, we get $\tan\left(\frac{x+y}{2}\right)=\frac{-\frac{1}{3}}{\frac{1}{2}}=-\frac{2}{3}$.

$\therefore$ from sub-multiple angle formula, we get, $\cos(x+y)=\frac{1-\left(-\frac{2}{3}\right)^2}{1+\left(-\frac{2}{3}\right)^2}=\frac{9-4}{9+4}=\frac{5}{13}$

Ans: (d)

70. If $1+\cos x+\cos^2 x+\ldots\ldots=4+2\sqrt{3}$, then $x=$

Options:

(a) $2n\pi\pm\frac{\pi}{6}$

(b) $n\pi+(-1)^n\frac{\pi}{6}$

(c) $2n\pi\pm\frac{\pi}{3}$

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

Sol: $\frac{1}{1-\cos x}=4+2\sqrt{3}\Rightarrow 1-\cos x=\frac{1}{4+2\sqrt{3}}=\frac{4-2\sqrt{3}}{4}=1-\frac{\sqrt{3}}{2}$

$\Rightarrow\cos x=\frac{\sqrt{3}}{2}\therefore x=2n\pi\pm\frac{\pi}{6}$

Ans: (a)

71. The second, third and sixth terms of an *A.P.* Which are distinct consecutive terms of a *G.P* the common ratio of the *G.P* is

Options:

(a) 1

(b) -1

(c) 3

(d) -3

Sol: $a+d,a+2d,a+5d$ are in *G.P*

$(a+2d)^2=(a+d)(a+5d)\Rightarrow 4ad+4d^2=6ad+5d^2\Rightarrow d^2=-2ad\Rightarrow d=0$ or $d=-2a$

When $d\neq 0$, we have $-a,-3a,-9a$

$\therefore$ the common ratio is 3

Ans: (c)

72. Let $z_1=1-i,z_2=1+i$ and $z_3=-2$, then $z_1^3+z_2^3+z_3^3=$

Options:

(a) -4

(b) -12

(c) $3-3i$

(d) -6

Sol:

$z_1+z_2+z_3=0\qquad\therefore z_1^3+z_2^3+z_3^3=3z_1z_2z_3=3(-2)(1+i)(1-i)=-12$

Ans: (b)

73. In triangle $PQR, \angle R = \frac{\pi}{2}$. If $\tan\left(\frac{P}{2}\right)$ and $\tan\left(\frac{Q}{2}\right)$ are the roots of the eqaution $ax^2 + bx + c = 0$, then

Options:

(a) $a + b = c$

(b) $b + c = a$

(c) $a + c = b$

(d) $b = c$

Sol: $\tan\frac{P}{2} + \tan\frac{Q}{2} = -\frac{b}{a}; \tan\frac{P}{2}.\tan\frac{Q}{2} = \frac{c}{a}; R \Rightarrow \frac{\pi}{2} \Rightarrow P + Q = \frac{\pi}{2}$

$$1 = \tan\left(\frac{P}{2} + \frac{Q}{2}\right) = \frac{\tan\frac{P}{2} + \tan\frac{Q}{2}}{1 - \tan\frac{P}{2}.\tan\frac{Q}{2}} \Rightarrow \left(1 - \tan\frac{P}{2}.\tan\frac{Q}{2}\right) = \tan\frac{P}{2} + \tan\frac{Q}{2}$$

$\therefore 1 - \frac{c}{a} = -\frac{b}{a} \Rightarrow a - c = -b$ i.e. $a + b = c$

Ans: (a)

74. The contrapositive of the statement : "If $2^2 = 5$, then I get first class" is

Options:

(a) If I do not get a first class, then $2^2 = 5$

(b) If I do not get a first class, then $2^2 \neq 5$

(c) If I get a first class, then $2^2 = 5$

(d) If I get a first class, then $2^2 \neq 5$

Sol: Contrapositive for $p \to q$ is $\sim q \to \sim p$

Ans: (b)

75. The number of ways in which the letters of the word MOBILE can be arranged so that consonants always occupy odd places is

Options:

(a) 12

(b) 36

(c) 72

(d) 144

Sol: There are 3 vowels and 3 consonants and there are 3 odd places and 3 even places.

$\therefore$ Required $= 3! \times 3! = 36.$

Ans: (b)

76. If ${}^{2n}C_n + {}^{2n}C_{n-1} = 400$, then ${}^{2n+2}C_{n+1}$ equals

Options:

(a) 200

(b) 400

(c) 600 (d) 800

Sol: ${}^{2n}C_n + {}^{2n}C_{n-1} = 400 \Rightarrow {}^{2n+1}C_n = 400$

${}^{2n+1}C_n + {}^{2n+1}C_{n+1} = {}^{2n+2}C_{n+1} \Rightarrow 400 + 400 = {}^{2n+2}C_{n+1}$

Ans: (d)

77. If $\begin{bmatrix} -2 & 5 \\ 3 & -1 \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\begin{bmatrix} 3 \\ -1 \end{bmatrix}$, then (x, y) is

Options:

(a) $(1, 2)$

(b) $(-1, 2)$

(c) $(1, -2)$ (d) $(2, 1)$

Sol: $-2x + 5y = 1; 3x - y = 5; x = 2, y = 1$

Ans: (d)

78. If $AB = A$ and $BA = B$, then $B^2 + B =$

Options:

(a) $2A$

(b) 0

(c) $2I$

(d) $2B$

Sol: $B^2 = BB = (BA)B = B(AB) = BA = B \quad \therefore B^2 + B = 2B$

Ans: (d)

79. If $A = [2 \; -3 \; 4], B = \begin{bmatrix} 3 \\ 2 \\ 2 \end{bmatrix}, X = [1 \; 2 \; 3]$ and $Y = \begin{bmatrix} 2 \\ 3 \\ 4 \end{bmatrix}$, then $AB + XY =$

Options:

(a) $[20]$

(b) $[24]$

(c) $[22]$

(d) $[28]$

Sol: $AB = [6 - 6 + 8] = [8]; XY = [2 + 6 + 12] = [20] \therefore AB + XY = [28]$

Ans: (d)

80. Let $A=\begin{pmatrix}200 & 50\\ 10 & 2\end{pmatrix}, B=\begin{pmatrix}50 & 40\\ 2 & 3\end{pmatrix}$. Then the value of determinant of the product matrix AB is

Options:

(a) 460

(b) 2000

(c) -7000

(d) 3000

Sol: Use $|AB|=|A|\,|B|$

Ans: (c)

81. If $A=\begin{vmatrix}x & 1 & 1\\ 1 & x & 1\\ 1 & 1 & x\end{vmatrix}$ and $B=\begin{vmatrix}x & 1\\ 1 & x\end{vmatrix}$, then $\frac{dA}{dx}=$

Options:

(a) $3B+1$

(b) $3B$

(c) $-3B$

(d) $1-3B$

Sol: $A=x\left(x^2-1\right)-1(x-1)+1(1-x)=x^3-x-x+1+1-x=x^3-3x+2$

$B=x^2-1;\frac{dA}{dx}=3x^2-3=3B$

Ans: (b)

82. If $A=\begin{bmatrix}1 & -2 & 2\\ 0 & 2 & -3\\ 3 & -2 & 4\end{bmatrix}$, then A adj (A) is equal to

Options:

(a) $\begin{bmatrix}8 & 0 & 0\\ 0 & 8 & 0\\ 0 & 0 & 8\end{bmatrix}$

(b) $\begin{bmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0 & 0\end{bmatrix}$

(c) $\begin{bmatrix}5 & 1 & 1\\ 1 & 5 & 1\\ 1 & 1 & 5\end{bmatrix}$

(d) $\begin{bmatrix}5 & 0 & 0\\ 0 & 5 & 0\\ 0 & 0 & 5\end{bmatrix}$

Sol: $A\,(\text{adj}\,A)=|A|I;|A|=(8-6)+2(0+9)+2(0-6)=8$

Ans: (a)

83. The vectors $\vec{a}, \vec{b}$ *and* $(\vec{a}-\vec{b})$ have same magnitude. Then the angle between the vectors $\vec{a}$ and $\vec{b}$ is

Options:

(a) 30°

(b) 150°

(c) 60°

(d) 120°

Sol: $|\vec{a}-\vec{b}|^2 = |\vec{a}|^2 + |\vec{b}|^2 - 2|\vec{a}||\vec{b}|\cos\theta$

$m^2 = m^2 + m^2 - 2m\,.\,m.\cos\theta \Rightarrow \cos\theta = \frac{1}{2} \quad \therefore \theta = 60°$

Ans: (c)

84. The area of the parallelogram with $\vec{a}$ and $\vec{b}$ as adjacent sides is 20 sq. units. Then the area of the parallelogram having $7\vec{a}+5\vec{b}$ and $8\vec{a}+11\vec{b}$ as adjacent sides is

Options:

(a) 2960 sq. units

(b) 740 sq. units

(c) 1340 sq. units

(d) 3400 sq. units

Sol: $= \left|(7\vec{a}+5\vec{b})\times(8\vec{a}+11\vec{b})\right|$

$= \left|\vec{0}+(77-40)\vec{a}\times\vec{b}+\vec{0}\right| = 37\left|\vec{a}\times\vec{b}\right| = 37\times 20 = 740$

Ans: (b)

85. If the vectors $(x-1)\vec{a}+\vec{b}$ and $(3x+2)\vec{a}-2\vec{b}$ are collinear vectors, then $x =$

Options:

(a) 1

(b) $-\frac{2}{3}$

(c) 2

(d) 0

Sol: $3x+2 = -2(x-1)$

Ans: (d)

86. The angle between the lines $2x = 3y = -z$ and $6x = -y = -4z$ is

Options:

(a) 90°

(b) 0°

(c) 30°

(d) 45°

Sol:

The symmetric form of the first line is $\frac{x}{3}=\frac{y}{2}=\frac{z}{-6}$

Hence its direction ratios are $3, 2, -6$

Similarly the symmetric from of $6x=-y=-4z$ is $\frac{x}{2}=\frac{y}{-12}=\frac{z}{-3}$, (dividing by 12)

Hence this line has direction ratios $2, -12, -3$

Now, $\cos\theta=\frac{3(2)+2(-12)-6(-3)}{\sqrt{9+4+36}\sqrt{4+44+9}}=\frac{6-24+18}{7\sqrt{157}}=0 \quad \therefore \theta=90°$

Ans: (a)

87. A line makes angles $\frac{3\pi}{17}$ and $\frac{11\pi}{34}$ with the positive directions of $x-$axis and $z-$axis. Then the sine of the angle made by the line with $y-$axis is

Options:

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

(b) 1

(c) 0

(d) $\frac{\sqrt{3}}{2}$

Sol:

$\sin^2\alpha+\sin^2\beta+\sin^2\gamma=2:\alpha+\gamma=\frac{3\pi}{17}+\frac{11\pi}{34}=\frac{\pi}{2}\Rightarrow\sin^2\alpha+\sin^2\gamma=1$

$\therefore \sin^2\beta=1\Rightarrow\sin\beta=1(\because \sin\beta \text{is} + \text{ve}) \quad \therefore (2)$ is the correct answer.

Ans: (b)

88. The equation of the plane passing through the intersection of the planes $2x+y=0$ and $y+z=0$ and passing through $(1, 2, -1)$ is

Options:

(a) $2x-3y-4z=0$

(b) $2x+3y+4z=6$

(c) $2x+2y+z=6$

(d) $x+2y-3z=0$

Sol:

$2x+y+\lambda(y+z)=0; 2+2+\lambda(2-1)=0\Rightarrow\lambda=-4$

$\therefore 2x+y-4y-4z=0$ i.e. $2x-3y-4z=0$

Ans: (a)

89. $x=0, y=0, 2x-y=2$ and $x+3y-8=0$ are the sides of a quadrilateral. Then the product of the slopes of the diagonal is

Options:

(a) -6

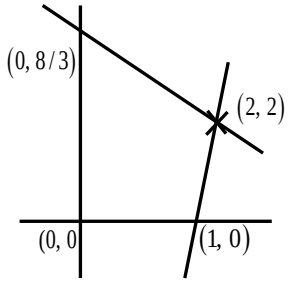
(b) $-\frac{2}{3}$

(c) $-\frac{8}{3}$

(d) $-\frac{3}{8}$

Sol: Slope of diagonals are $\frac{2}{2}$ and $\frac{0-\frac{8}{3}}{1-0}=-\frac{8}{3}$

Hence their product $=-\frac{8}{3}$



Ans: (c)

90. The point on the circle $x^2+y^2-80x-60y+2100=0$ which is nearest to origin is

Options:

(a) $(24, 18)$

(b) $(18, 24)$

(c) $(20, 25)$

(d) $\left(15, \frac{45}{4}\right)$

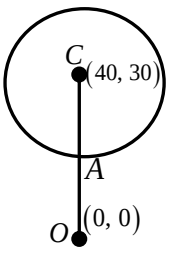
Sol: Centre is $C(40, 30)$

$r=\sqrt{40^2+30^2-2100}=10\sqrt{25-21}=20$

$\therefore OC=50; OA=30$

$\therefore A$ divides OC internally in the ratio $3:2$

$\therefore A=\left(\frac{3(40)+0}{5}, \frac{3(30)+0}{5}\right)=(24, 18)$



Ans: (a)

91. The standard deviation of $x_1, x_2, x_3, x_4, \ldots x_n$ is 6. The variance of $2x_1, +3, 2x_2+3, 2x_3+3, \ldots, 2x_n+3$ is

Options:

(a) 12

(b) 36

(c) 144

(d) 225

Sol:

$\sigma^2 = 36; \sigma_y^2 = 4 \times 36 = 144$

Ans: (c)

92. The solution of $\frac{6x}{4x-1} < \frac{1}{2}$ is

Options:

(a) $x < -\frac{1}{8}$

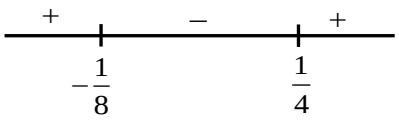
(b) $-\frac{1}{8} < x < \frac{1}{4}$

(c) $x < \frac{1}{8}$ and $x > \frac{1}{4}$

(d) $x > \frac{1}{8}$

Sol: $\frac{6x}{4x-1} - \frac{1}{2} < 0$

$\therefore \frac{12x-4x+1}{2(4x-1)} < 0$



$\frac{8x+1}{4x-1} < 0$

$-\frac{1}{8} < x < \frac{1}{4}$

Ans: (b)

93. If the minimum value of an objective function $Z = ax + by$ occurs at two points $(3, 4)$ and $(4, 3)$, then

Options:

(a) $a + b = 0$

(b) $a = b$

(c) $3a = b$

(d) $a = 3b$

Sol: $3a + 4b = 4a + 3b \Rightarrow a = b$

Ans: (b)

94. $\lim_{x\to a}\frac{a\sin x - x\sin a}{ax^2 - xa^2} =$

Options:

(a) $\frac{\cos a - 1}{a^2}$

(b) $\frac{a\cos a - a}{a^2}$

(c) $\frac{1}{2}$ (d) $\frac{a\cos a - \sin a}{a^2}$

Sol: $L = \lim_{x\to a}\frac{a\cos x - \sin a}{2ax - a^2} = \frac{a\cos a - \sin a}{a^2}$

Ans: (d)

95. $\lim_{x\to\infty}\frac{(n+1)!+n!}{(n+2)!-n!} =$

Options:

(a) 1

(b) n

(c) $(n+1)(n+2)$

(d) 0

Sol:

Required $= \lim_{x\to\infty}\frac{n![n+1+1]}{[n!(n+2)(n+1)-1]} = \lim_{x\to\infty}\frac{n+2}{n^2+3n+1} = 0$

Ans: (d)

96. If $f(x) = x^2 + \frac{1}{x^2}$ and $(g\ o\ f)(x) = x^6 + \frac{1}{x^6}$, then $g''(1) =$

Options:

(a) 0

(b) 3

(c) 6 (d) 1

Sol: Use $a^3 + b^3 = (a+b)^3 - 3ab(a+b)$ to get $g(x) = x^3 - 3x$

$g'(x) = 3x^2 - 3$ $g''(x) = 6x$ $g''(1) = 6$

Ans: (c)

97. The derivative of $\sin^{-1}\sqrt{x}$ w.r.t. $\cos^{-1}\sqrt{1-x}$ is

Options:

(a) 1

(b) 0

(c) –1 (d) $\frac{1}{2}$

Sol: $\cos^{-1}\sqrt{1-x^2} = \sin^{-1} x \;\; \therefore \; \cos^{-1}\sqrt{1-x} = \sin^{-1}\sqrt{x}$

Ans: (a)

98. If $xy = \tan(xy)$, then $\frac{dy}{dx} =$

Options:

(a) $\frac{y}{x}$

(b) $\frac{x}{y}$

(c) $-\frac{y}{x}$

(d) $-\frac{x}{y}$

Sol: $xy = \tan xy$

$\therefore \frac{d}{dx}(xy) = \frac{d}{dx}(\tan xy) \qquad y + x\frac{dy}{dx} = \sec^2(xy)\left(y + x\frac{dy}{dx}\right)$

$\Rightarrow y + x\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\frac{y}{x}$

Ans: (c)

99. If $f(x) = \min\{x^2, 2x\}$, then $f'(-1) + f(1) =$

Options:

(a) 0

(b) 4

(c) −2

(d) 2

Sol: Near $x = -1, \quad f(x) = 2x$ and near $x = 1, \quad f(x) = x^2$

$\therefore f'(-1) = 2$ and $f'(1) = 2.1 = 2 \qquad \therefore$ Required $= 2 + 2 = 4$

Ans: (b)

100. $\int \frac{\sec x}{\sec x - \tan x} dx =$

Options:

(a) $\sec x - \tan x$

(b) $\sec x + \tan x$

(c) $\tan x - \sec x$

(d) $-(\sec x + \tan x)$

Sol: $I = \int \frac{\sec x(\sec x + \tan x)}{\sec^2 x - \tan^2 x} dx = \int(\sec^2 x + \sec x \tan x) dx = \sec x + \tan x + c$

Ans: (b)

101. $\int \frac{\cos x}{\sin(a+x)} dx =$

Options:

(a) $\log \sin(a+x)$

(b) $\cos a . \log \sin(a+x) - x \cos a$

(c) $\cos a \log \sin(a+x) - \cos a$

(d) $\cos a . \log \sin(a+x) + x \sin a$

Sol: $\frac{\cos x}{\sin(x+a)} = \frac{\cos[(x+a)-a]}{\sin(x+a)} = \frac{\cos(x+a)\cos a + \sin(x+a)\sin a}{\sin(x+a)}$

Ans: (d)

102. $\int_0^1 \frac{x^2+x+2}{(1+x^2)(1+x)} dx =$

Options:

(a) $\log 2 + \frac{\pi}{2}$

(b) $\log 2 - \frac{\pi}{4}$

(c) $\frac{1}{2}\log 2 + \frac{\pi}{4}$

(d) $\log 2 + \frac{\pi}{4}$

Sol:

$I = \int_0^1 \frac{(1+x^2)+(1+x)}{(1+x^2)(1+x)} dx = \int_0^1 \left[\frac{1}{1+x} + \frac{1}{1+x^2}\right] dx$

$= \left[\log(1+x) + \tan^{-1} x\right]_0^1 = \log 2 + \frac{\pi}{4}$

Ans: (d)

103. $\int_0^{\frac{\pi}{2}} e^{\cos x} \sin 2x \, dx =$

Options:

(a) $2(1-e)$

(b) 2

(c) –2

(d) $2(1+e)$

Sol:

$I = \int_0^{\frac{\pi}{2}} e^{\cos x}.2\sin x\cos x.dx$; put $\cos x = t$

$I = \int_1^0 e^t\, 2t(-dt) = -2\left[(t)\left(e^t\right)-(1)\left(e^t\right)\right]\Big|_1^0 = -2\left[(0-1)-(e-e)\right] = 2$

Ans: (b)

104. $\int_1^e \left[(\log x)^5 + 5(\log x)^4\right]dx =$

Options:

(a) $-e$

(b) e

(c) $\frac{1}{e}$ (d) 1

Sol: Put $t = \log x \Rightarrow x = e^t$ $\therefore dx = e^t\ dt$

When $x \in [1, e], t \in [0, 1]$ $\therefore I = \int_0^1 \left(t^5 + 5t^4\right)e^t\ dt = e^t t^5\Big|_0^1 = e$

Or use if $I_n = \int (\log x)^n\ dx$, then $I_n + n\ .\ I_{n-1} = x(\log x)^n$

Ans: (b)

105. $\int \frac{dx}{1-10\sin^2 x} =$

Options:

(a) $\frac{1}{6}\log\frac{3+\tan x}{3-\tan x}+C$

(b) $\frac{1}{6}\log\frac{1-3\tan x}{1+3\tan x}+C$

(c) $\frac{1}{6}\log\frac{1+3\tan x}{1-3\tan x}+C$

(d) $\frac{1}{6}\log\frac{3-\tan x}{3+\tan x}+C$

Sol: $I = \int \frac{dx}{1-10\sin^2 x}$; divide Nr. And Dr. by $\cos^2 x$

$= \int \frac{\sec^2 x}{\sec^2 x - 10\tan^2 x}dx = \int \frac{\sec^2 x}{1-9\tan^2 x}dx = \frac{1}{3}\int \frac{d(3\tan x)}{1-(3\tan x)^2} = \frac{1}{3}.\frac{1}{2\times 1}\log\frac{1+3\tan x}{1-3\tan x}+C$

Ans: (c)

106. The area of the region enclosed between the curves $y = x^2 - x$ and $y = x$ is

Options:

(a) $\frac{11}{3}$

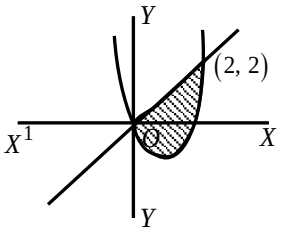
(b) $\frac{2}{3}$

(c) $\frac{4}{3}$

(d) $\frac{13}{3}$

Sol: $y = x^2 - x$ and $y = x$; solving, $x = 0$ and $x = 2$

$$\therefore \text{Area} = \int_0^2 \left(x - \left(x^2 - x\right)\right) dx = \left[x^2 - \frac{x^3}{3}\right]_0^2 = 4 - \frac{8}{3} = \frac{4}{3}$$



Ans: (c)

107. The area of the region bounded by the curve $y = x^2$ and $y = |x|$ is

Options:

(a) $\frac{1}{6}$

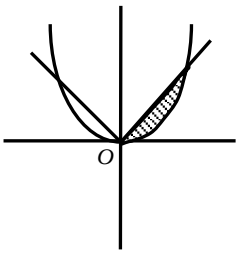
(b) $\frac{1}{3}$

(c) $\frac{2}{3}$

(d) $\frac{4}{3}$

Sol:

$$2\int_0^1 \left(x - x^2\right) dx = 2\left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = \frac{1}{3}$$



Ans: (b)

108.If $\frac{dy}{dx} = y+3 > 0$ and $y(0) = 2$, then $y(\log 2)$ is equal to

Options:

(a) 5

(b) 13

(c) –2

(d) 7

Sol: $\frac{dy}{y+3} = dx \Rightarrow \log(y+3) = x + c$

$\Rightarrow y+3 = e^{x+c} = ke^{x}$

$\Rightarrow 2+3 = k.e^{0} \Rightarrow k = 5$

$\therefore y+3 = 5e^{x}$

$\therefore y(\log 2)+3 = 5e^{\log 2} = 10$

$\therefore y(\log 2) = 7$

Ans: (d)

109.The solution of the D.E. $x\,dy - y\,dx + x^2(x\,dy + y\,dx) = 0$ is

Options:

(a) $xy - \frac{y}{x} = c$

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

(c) $xy + \frac{y}{x} = c$

(d) $xy + \frac{x}{y} = c$

Sol: Rearrange the terms : $\frac{x\,dy - y\,dx}{x^2} + (x\,dy + y\,dx) = 0$

i.e. $d\left(\frac{y}{x}\right) + d(xy) = 0 \Rightarrow \frac{y}{x} + xy = c$

Ans: (c)

110. If $\sin^{-1}x+\sin^{-1}y+\sin^{-1}z=\frac{2\pi}{3}$, then $\cos^{-1}x+\cos^{-1}y+\cos^{-1}z=$

Options:

(a) $\frac{5\pi}{6}$

(b) $\frac{5\pi}{3}$

(c) $\frac{\pi}{3}$ (d) $\frac{4\pi}{3}$

Sol: $\sin^{-1}x+\cos^{-1}x=\frac{\pi}{2}\Rightarrow$ (Given) + (Required) $=\frac{3\pi}{2}$

$\therefore$ Required $=\frac{3\pi}{2}-\frac{2\pi}{3}=\frac{9\pi-4\pi}{6}=\frac{5\pi}{6}$

Ans: (a)

111. $\sin^2\left(\cos^{-1}\frac{1}{3}\right)+\cos^2\left(\sin^{-1}\frac{1}{3}\right)=$

Options:

(a) 1

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

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

(d) $\frac{16}{9}$

Sol: G.E. $=\left[1-\cos^2\left(\cos^{-1}\frac{1}{3}\right)\right]+\left[1-\sin^2\left(\sin^{-1}\frac{1}{3}\right)\right]=\left(1-\frac{1}{9}\right)+\left(1-\frac{1}{9}\right)$

$=2-\frac{2}{9}=\frac{16}{9}$

Ans: (d)

112. If $\sin^{-1}\left(\frac{3\sin 2\theta}{5+4\cos 2\theta}\right)=\frac{\pi}{2}$, then $\tan\theta=$

Options:

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

(b) 1

(c) 3

(d) –1

Sol: $\frac{3\sin 2\theta}{5+4\cos 2\theta}=\sin\frac{\pi}{2}=1\Rightarrow 3\sin 2\theta=5+4\cos 2\theta$

$\therefore\ 3\left(\frac{2\tan\theta}{1+\tan^2\theta}\right)=5+4\left(\frac{1-\tan^2\theta}{1+\tan^2\theta}\right)$

$6\tan\theta=5+5\tan^2\theta+4-4\tan^2\theta \quad \therefore \tan^2\theta-6\tan\theta+9=0\Rightarrow \tan=3$

Ans: (c)

113. A coin is tossed three times in succession. If E is the event that there are at least two heads and F is the event in which first throw is a head, then $P(E/F)=$

Options:

(a) $\frac{3}{4}$

(b) $\frac{3}{8}$

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

(d) $\frac{1}{8}$

Sol:

$P(E)=\frac{4}{8}=\frac{1}{2}$ [$\because$ favourable cases are $THH,\ HTH,\ HHT,\ HHH$]

$P(F)=\frac{4}{8}=\frac{1}{2}$ [$\because$ favourable cases are $HTH,\ HHT,\ HTT,\ HHH$]

$P(E\cap F)=\frac{3}{8} \qquad \therefore P(E/F)=\frac{P(E\cap F)}{P(F)}=\frac{\frac{3}{8}}{\frac{1}{2}}=\frac{3}{4}$

Ans: (a)

114. In a box there are 2 red, 3 black, and 4 white balls. Out of these, three balls are drawn together. The probability of these being of same colour is

Options:

(a) $\frac{1}{84}$

(b) $\frac{1}{21}$

(c) $\frac{5}{84}$

(d) $\frac{2}{21}$

Sol:

Total number of cases $= {}^{9}C_3 = \frac{9.8.7}{6} = 84$

Total number of favourable cases $= {}^{3}C_3 + {}^{4}C_3 = 1 + 4 = 5$

$\therefore$ Required probability $= \frac{5}{84}$

Ans: (c)

115. A bag $'A'$ contains 3white and 2 black balls. A bag $'B'$ contains 2 white and 4 black balls. First a bag is chosen and then a ball is drawn. What is the probability that is a white ball?

Options:

(a) $\frac{7}{12}$

(b) $\frac{7}{15}$

(c) $\frac{8}{15}$

(d) $\frac{5}{11}$

Sol: Probability of choosing the first bag and then a white ball from it $= \frac{1}{2} \cdot \frac{3}{5} = \frac{3}{10}$

Probability of choosing the second bag and drawing a white ball from it $= \frac{1}{2} \cdot \frac{2}{6} = \frac{1}{6}$

These two events are mutually exclusive

Required is the probability of one of then happening

$= P(A \cup B) = P(A) + P(B) = \frac{3}{10} + \frac{1}{6} = \frac{7}{15}$

Ans: (b)

116. 6 boys and 6 girls sit in a row at random. The probability that all the girls sit together is

Options:

(a) $\frac{1}{432}$

(b) $\frac{12}{431}$

(c) $\frac{1}{132}$

(d) None of these

Sol: $P(A) = \frac{\lfloor 7 \times \lfloor 6}{\lfloor 12} = \frac{6!}{8 \times 9 \times 10 \times 11 \times 12} = \frac{1}{11 \times 12} = \frac{1}{132}$

Ans: (c)

117.Seven white balls and three black balls are randomly placed in a row. The probability that two black are placed not adjacently is

Options:

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

(b) $\frac{7}{15}$

(c) $\frac{2}{15}$

(d) $\frac{1}{3}$

Sol:

$n(S)=10!\,;\, n(A)=7!\,.\,{}^{8}P_{3}$

$\therefore P(A)=\frac{7!{}^{8}P_{3}}{10!}=\frac{8.7.6}{10.9.8}=\frac{7}{15}$

Ans: (b)

118.The angles of a triangle are in $A.P.$ and difference between two of its angles is $60°$, then

$\sin A\sin B\sin C=$

Options:

(a) $\frac{\sqrt{3}}{2}$

(b) $\frac{\sqrt{3}}{4}$

(c) 1

(d) $\sqrt{3}$

Sol: One of the angle must be $60°$; the two angles are $30°$ and $90°$

$\therefore \sin A\sin B\sin C=\frac{1}{2},\frac{\sqrt{3}}{2}=\frac{\sqrt{3}}{4}$

Ans: (b)

119.The domain of the function $f(x)=\sqrt{2x-1}+\sqrt{3-2x}$ is

Options:

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

(b) $\left(-\infty,\frac{3}{2}\right)$

(c) $\left(\frac{1}{2},\frac{3}{2}\right)$

(d) $\left[\frac{1}{2},\frac{3}{2}\right]$

Sol: $\sqrt{2x-1}$ is real if $x \geq \frac{1}{2}$ and $\sqrt{3-2x}$ is real if $x \leq \frac{3}{2}$

Hence $f(x)$ is real if $x \geq \frac{1}{2}$ and $x \leq \frac{3}{2}$ i.e. if $x \in \left[\frac{1}{2}, \frac{3}{2}\right]$

Ans: (d)

120. If two angles of a triangle are $\cot^{-1}\frac{6}{5}$ and $\cot^{-1}11$, then the third angle is

Options:

(a) $\frac{\pi}{2}$

(b) $\frac{\pi}{3}$

(c) $\frac{3\pi}{5}$

(d) $\frac{3\pi}{4}$

Sol: $\tan\frac{5}{6} + \tan^{-1}\frac{1}{11}$

$= \tan^{-1}\left(\frac{\frac{5}{6}+\frac{1}{11}}{1-\frac{5}{6}.\frac{1}{11}}\right) = \tan^{-1}\left(\frac{55+6}{66-5}\right) = \frac{\pi}{4}$

$\therefore$ Third angle $= \pi - \frac{\pi}{3} = \frac{3\pi}{4}$

Ans: (d)

Physics

Multiple Choice Questions with one correct answer. A correct answer carries 1 mark. No negative mark. 60 x 1 = 60

121. If C be the capacitance and V be the electric potential, then the dimensional formula of CV^2 is

Options:

(a) $\left[M^1L^2T^{-2}A^0\right]$

(b) $\left[M^1L^1T^{-2}A^{-1}\right]$

(c) $\left[M^0L^1T^{-2}A^0\right]$

(d) $\left[M^1L^{-3}T^1A^{-1}\right]$

Sol: Energy stored in a capacitor is $U=\frac{1}{2}CV^2$

$\therefore \left[CV^2\right]=[U]=\left[M^1L^2T^{-2}A^0\right]$

Ans: (a)

122. The velocity time graph of a particle comes out to be a non-linear curve. The motion is

Options:

(a) uniform velocity motion

(b) uniformly accelerated motion

(c) non-uniform accelerated motion

(d) nothing can be said about the motion

Sol: Slope of velocity-time graph gives the acceleration of a particle.

If the velocity-time graph of the particle comes out to be a non-linear curve, then the slope $\left(=\frac{dv}{dt}\right)$ of the graph is not constant. Hence, the motion is non-uniformly accelerated motion.

Ans: (c)

123. If $(\text{range})^2$ is 48 times $(\text{maximum height})^2$, then angle of projection is

Options:

(a) 45°

(b) 60°

(c) 75°

(d) 30°

Sol: According to question, $R^2=48H^2$

$$\left(\frac{u^2\sin 2\theta}{g}\right)^2=48\left[\frac{u^2\sin^2\theta}{2g}\right]^2$$

$$\left[\frac{u^2\times 2\times\sin\theta\times\cos\theta}{g}\right]^2=48\left[\frac{u^2\sin^2\theta}{2g}\right]^2$$

$4\cos^2\theta = 12\sin^2\theta$

$\tan^2\theta = \frac{1}{\sqrt{3}}$ or $\theta = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) = 30°$

Ans: (d)

124. A rocket of mass 120 kg is moving vertically up at 600 m/s such that gas is escaping at the rate of 1 kg per second. Find out acceleration of the rocket.

Options:

(a) 2 m/s^2

(b) 5 m/s^2

(c) 6 m/s^2

(d) 10 m/s^2

Sol: Thurst, $F = u\frac{dm}{dt}$

$\therefore$ Acceleration of the rocket, $a = \frac{F}{M} = \frac{u}{M}\frac{dm}{dt}$

Here, $M = 120$ kg, $\frac{dm}{dt} = 1$ kg/s, $u = 600$ m/s

$\therefore a = \frac{600 \text{ m/s} \times 1 \text{ kg/s}}{120 \text{ kg}} = 5 \text{ m/s}^2$

Ans: (b)

125. A 2 kg mass lying on a table is displaced in the horizontal direction through 50 cm. The work done by normal reaction will be

Options:

(a) 10 J

(b) 0

(c) 100 erg

(d) 100 J

Sol: Normal reaction on the mass by the table is perpendicular to the horizontal displacement. Hence work done by normal reaction will be zero.

Ans: (b)

126. A light rod of length l has two, masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is

Options:

(a) $\frac{m_1 m_2}{m_1 + m_2} l^2$

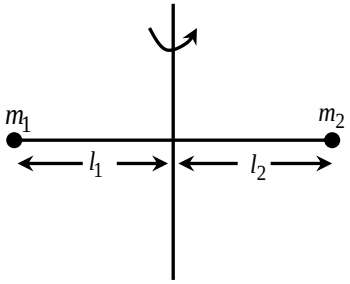
(b) $\frac{m_1 + m_2}{m_1 m_2} l^2$

(c) $(m_1 + m_2) l^2$

(d) $\sqrt{m_1 m_2}\, l^2$

Sol: Here. $l_1 + l_2 = l$

Centre of mass of the system,



$$l_1 = \frac{m_1 \times 0 + m_2 \times l}{m_1 + m_2} = \frac{m_2 l}{m_1 + m_2}$$

$$l_2 = l - l_1 = \frac{m_1 l}{m_1 + m_2}$$

Required moment of inertia of the system,

$$I = m_1 l_1^2 + m_2 l_2^2$$

$$= \left(m_1 m_2^2 + m_2 m_1^2\right) \frac{l^2}{(m_1 + m_2)^2}$$

$$= \frac{m_1 m_2 (m_1 + m_2) l^2}{(m_1 + m_2)^2} = \frac{m_1 m_2}{m_1 + m_2} l^2$$

Ans: (a)

127. The stress-strain graph of a material is shown in the figure. The region in which the material is elastic is

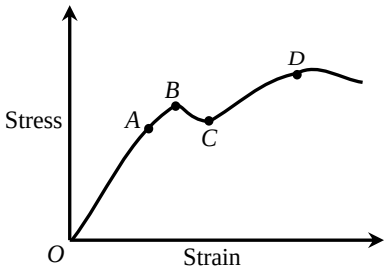
Options:

(a) OA

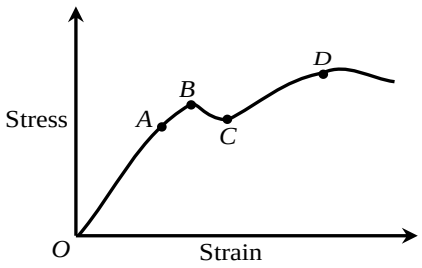
(b) OB

(c) OC

(d) AC



Sol: The material is elastic in the region OA because in this region, the stree-strain graph is linear and Hooke's law is obeyed.



Ans: (a)

128.Two solids P and Q float in water. It is observed that P floats with half of its volume immersed and Q floats with $\left(\frac{2}{3}\right)^{\text{rd}}$ of its volume immersed. The ratio of densities of P and Q is

Options:

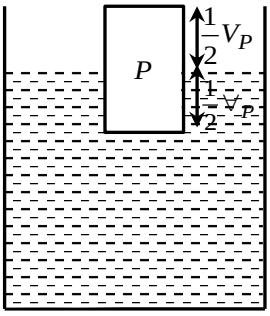
(a) $\frac{4}{3}$

(b) $\frac{3}{4}$

(c) $\frac{2}{3}$

(d) $\frac{3}{2}$

Sol: For solid P,



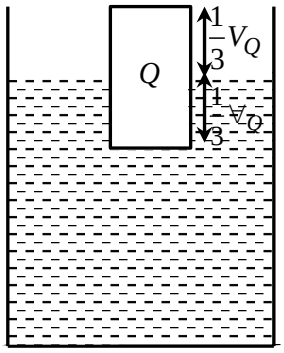
Let V_P and ρ_p volume and density of solid P respectively.

As the solid P is floating in water.

$\therefore$ weight of P = weight of water displaced by P

Or $V_P\rho_P g = \frac{V_P}{2}\rho_{\text{water}} g$

Or $\rho_P = \frac{1}{2}\rho_{\text{water}}$ … (i)



Similarly, for solid Q

$V_Q\rho_Q g = \frac{2}{3}V_Q\rho_{\text{water}} g$

Or $\rho_Q = \frac{2}{3}\rho_{\text{water}}$ … (ii)

Divide (i) by (ii), we get

$\frac{\rho_P}{\rho_Q} = \frac{3}{4}$

Ans: (b)

129.The quantities of heat required to raise the temperature of two copper spheres of radii r_1 and r_2 $(r_1 = 1.5r_2)$ through 1K are in the ratio of

Options:

(a) $\frac{27}{8}$

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

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

Sol: here, $r_1 = 1.5r_2 = \frac{3}{2}r_2$

Quantity of heat required to raise the temperature of copper sphere of radius r_1 through 1 K is

$Q_1 = m_1 S_{\text{copper}} \Delta T$

$= \left(\frac{4}{3}\pi r_1^3 \rho_{\text{Copper}}\right) \times S_{\text{Copper}} \times 1$

$= \frac{4}{3}\pi r_2^3 \rho_{\text{copper}} S_{\text{Copper}}$ … (i)

Quantity of heat required to raise the temperature of copper sphere of radius r_2 through 1K is

$Q_2 = m_2 S_{\text{copper}} \Delta T = \frac{4}{3}\pi r_2^3 \rho_{\text{copper}} \times S_{\text{copper}} \times 1$

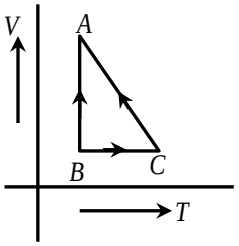
$= \frac{4}{3}\pi r_2^3 \rho_{\text{copper}} S_{\text{copper}}$ … (ii)

Divide (i) by (ii), we get

$\frac{Q_1}{Q_2} = \left(\frac{r_1}{r_2}\right)^3 = \left(\frac{3}{2}\right)^3 = \frac{27}{8}$

Ans: (a)

130. One mole of an ideal gas is taken from A to B from B to C and then back to A. The variation of its volume with temperature for that change is as shown. Its pressure at A is P_0, volume is V_0. Then, the internal energy



Options:

(a) at A is more than at B

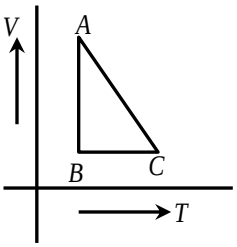
(b) at C is less than at B

(c) at B is more than at A

(d) at A and B are eqaul

Sol: The internal energy of an ideal gas is only dependent upon its temperature.

From the graph,



The ideal gas at same temperature at A and B.

$\therefore$ the internal energies at A and B are equal

Or $U_A = U_B$

Ans: (d)

131. The mean free path or molecules of a gas, $(\text{radius } r)$ is inversely proportional to

Options:

(a) r^3

(b) r^2

(c) r (d) $\sqrt{r}$

Sol: Mean free path, $\lambda = \dfrac{1}{\sqrt{2}n\pi d^2}$

Where n is the number density and d is the diameter of the molecule.

As $d = 2r$ $\therefore$ $\lambda = \dfrac{1}{4\sqrt{2}n\pi r^2}$ or $\lambda \propto \dfrac{1}{r^2}$

Ans: (b)

132. A 10 kg metal block is attached to a spring of spring constant 1000 N m^{-1}. A block is displaced from equilibrium position by 10 cm and released. The maximum acceleration of the block is

Options:

(a) 200 m s^{-2}

(b) 10 m s^{-2}

(c) 0.1 m s^{-2}

(d) 100 m s^{-2}

Sol: Here, Amplitude, $A = 10 \text{ cm} = 0.1 \text{ m}$

Spring constant, $k = 1000 \text{ N m}^{-1}$

Mass, $m = 10 \text{ kg}$

Maximum acceleration of the block is

$$a_{\max} = \omega^2 A = \frac{kA}{m} \qquad \left(\because \omega = \sqrt{\frac{k}{m}}\right)$$

$$= \frac{1000 \text{ N m}^{-1} \times 0.1 \text{m}}{10 \text{ kg}} = 10 \text{ m s}^{-2}$$

Ans: (b)

133. Sound waves transfer

Options:

(a) Only energy not momentum

(b) Energy

(c) Momentum

(d) Both energy and momentum

Sol: Sound waves transfer both energy and momentum

Ans: (d)

134. A stone weight is $100\,\text{N}$ on the surface of the earth. The ratio of its weight at a height of half the radius of the earth to a depth of half the radius of the earth will be approximately

Options:

(a) 3.6

(b) 2.2

(c) 1.8 (d) 0.9

Sol: Weight of a mass depends on the acceleration due to gravity (g)

Acceleration due to gravity at height $h\left(=\frac{R}{2}\right)$ from the surface of earth,

$$g_h = \frac{g}{\left(1+\frac{h}{R}\right)^2} = \frac{g}{\left(1+\frac{R/2}{R}\right)^2} = \frac{4}{9}g \qquad \ldots \text{(i)}$$

Acceleration due to gravity at depth $d\left(=\frac{R}{2}\right)$ from the surface of earth

$$g_d = g\left(1-\frac{d}{R}\right) = g\left(1-\frac{R/2}{R}\right) = g\left(1-\frac{1}{2}\right) = \frac{g}{2} \qquad \ldots \text{(ii)}$$

Required ratio $= \frac{W_h}{W_d} = \frac{mg_h}{mg_d} = \frac{\frac{4}{9}g}{\frac{g}{2}} = \frac{8}{9} = 0.9$

Ans: (d)

135. Water rises in plant fibres due to

Options:

(a) capillarity

(b) viscosity

(c) fluid pressure

(d) osmosis

Sol: Water rises in plant fibres due to capillarity

Ans: (a)

136. If a charge on the body is $1\,\text{nC}$, then how many electrons are removed from the body?

Options:

(a) 6.25×10^{27}

(b) 1.6×10^{19}

(c) 6.25×10^{28}

(d) 6.25×10^{9}

Sol: Charge on the body is

$q = ne$

$\therefore$ No. of electrons removed from the body is

$$n = \frac{q}{e} = \frac{1\times10^{9}C}{1.6\times10^{-19}C} = 6.25\times10^{9}$$

Ans: (d)

137. The potential of the electric field produced by a point charge at any point (x, y, z) is given by $V = 3x^2 + 5$, where, x, y, z are in metres and V is in volts. The intensity of the electric field at $(-2, 1, 0)$ is

Options:

(a) $+17\ \text{Vm}^{-1}$

(b) $-17\ \text{Vm}^{-1}$

(c) $+12\ \text{Vm}^{-1}$

(d) $-12\ \text{Vm}^{-1}$

Sol: $V = 3x^2 + 5$

$\therefore \frac{dV}{dx} = 6x$ or, $E = -\frac{dV}{dx} = -6x$

Intensity of the electric field at $x = -2$

$E = -6(-2) = 12\ \text{Vm}^{-1}$

Ans: (c)

138. A spherical conductor of radius $2\ \text{cm}$ is uniformly charged with $3\ \text{nC}$. What is the electric field at a distance of $3\ \text{cm}$ from the centre of the sphere?

Options:

(a) $3\times10^{4}\ \text{Vm}^{-1}$

(b) $3\times10^{6}\ \text{Vm}^{-1}$

(c) $3\times10^{-4}\ \text{Vm}^{-1}$

(d) $3\ \text{Vm}^{-1}$

Sol: Here, $Q = 3\ \text{nC} = 3\times10^{-9}\ \text{C}$

$R = 2\ \text{cm} = 2\times10^{-2}\ \text{m}$

At a point $3\ \text{cm}$ from the Centre,

i.e., $r = 3\ \text{cm} = 3\times10^{-2}\ \text{m}$

Electric field, $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} = \frac{9\times10^9\times3\times10^{-9}}{\left(3\times10^{-2}\right)^2} = 3\times10^4 \text{ Vm}^{-1}$

Ans: (a)

139. Pick out the statement which is incorrect.

Options:

(a) The electric field lines forms closed loop

(b) Field lines never intersect

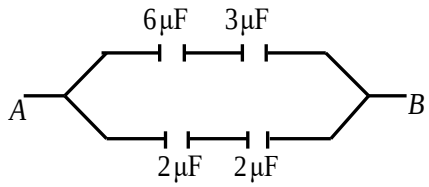
(c) The tangent drawn to a line of force represents the direction of electric field

(d) A negative test charge experiences a force opposite to the direction of the field

Sol: The electric field lines do not form closed loop. All other statements are correct.

Ans: (a)

140. The equivalent capacitance between A and B as shown in figure is



Options:

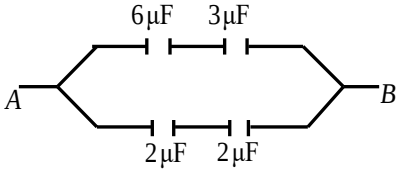
(a) $\frac{25}{26}$ μF

(b) 1 μF

(c) 3 μF

(d) $\frac{3}{4}$ μF

Sol: The equivalent capacitance between A and B is



$C_{eq} = \frac{6\times3}{6+3} + \frac{2\times2}{2+2} = 3\ \mu\text{F}$

Ans: (c)

141. If $\vec{E}_{ax}$ and $\vec{E}_{eq}$ represents electric field at a point on the axial and equatorial line of a dipole of dipole length $2a$. If points are at a distance r from the centre of the dipole, for $r >> a$

Options:

(a) $\vec{E}_{ax} = \vec{E}_{eq}$

(b) $\vec{E}_{ax} = -\vec{E}_{eq}$

(c) $\vec{E}_{ax} = -2\vec{E}_{eq}$

(d) $\vec{E}_{ax} = 2\vec{E}_{eq}$

Sol: $\vec{E}_{ax} = \frac{1}{4\pi\varepsilon_0}\frac{2\vec{p}}{r^3};\ \vec{E}_{eq} = \frac{-1}{4\pi\varepsilon_0}\frac{\vec{p}}{r^3} = -\frac{\vec{E}_{ax}}{2}$

$\therefore\ \vec{E}_{ax} = -2\vec{E}_{eq}$

Ans: (c)

142. An electric dipole consists of two opposite charges, each of magnitude $1.0\ \mu C$ separated by a distance of $2.0\,cm$. The dipole is placed in an external field of $10^5\ N\ C^{-1}$. The maximum torque on the dipole is

Options:

(a) 0.2×10^{-3} Nm

(b) 1×10^{-3} Nm

(c) 2×10^{-3} Nm

(d) 4×10^{-3} Nm

Sol: The maximum torque on the dipole in an external electric field is given by

$\tau = pE = q(2a)\times E$

Here, $q = 1\mu C = 10^{-6}C,\ 2a = 2\ cm = 2\times10^{-2}$ m,

$E = 10^5\ NC^{-1}, \tau = ?$

$\therefore\ \tau = 10^{-6}\times2\times10^{-2}\times10^5 = 2\times10^{-3}$ Nm

Ans: (c)

143. Two infinite parallel metal planes, contain electric charges with charge densities $+\sigma$ and $-\sigma$ respectively and they are separated by a small distance in air. If the permittivity of air is ε_0, then the magnitude of the field between the two planes with its direction will be

Options:

(a) σ/ε_0 towards the positively charged plane

(b) σ/ε_0 towards the negatively charged plane

(c) σ/ε_0 towards the positively charged plane

(d) 0 and towards any direction

Sol:

The electric field between the two planes is,

$E = E_1 + E_2 = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$

$E = \frac{\sigma}{\varepsilon_0}$ towards the negatively charged plane.

Ans: (b)

144. A $50\ \text{cm}$ long wire and $1\ \text{mm}^2$ cross-sectional area carries a current of $4\ \text{A}$ when connected to a $2\ \text{V}$ battery. The resistivity of the wire is

Options:

(a) $2\times10^{-7}\ \Omega\text{m}$

(b) $5\times10^{-7}\ \Omega\text{m}$

(c) $4\times10^{-6}\ \Omega\text{m}$

(d) $1\times10^{-6}\ \Omega\text{m}$

Sol:

$$\rho = R\frac{A}{l} = \frac{V}{I}\frac{A}{l} = \frac{2}{4}\times\frac{10^{-6}}{0.5} = 10^{-6}\ \Omega\text{m}$$

Ans: (d)

145. A metallic wire of cross sectional area $4\ \text{mm}^2$ carries a current of $3.2\ \text{A}$. If 5×10^{26} number of charge carries per unit volume flow across the wire, then their drift velocity (in m s^{-1}) is

Options:

(a) 1

(b) **0.1**

(c) 0.01

(d) 10

Sol: Here, Cross-sectional area of wire,

$A = 4\ \text{mm}^2 = 4\times10^{-6}\ \text{m}^2$

Current flowing through the wire, $I = 3.2\ \text{A}$

Number of charge carriers per unit volume of the wire (number density), $n = 5\times10^{26}\ \text{m}^{-3}$

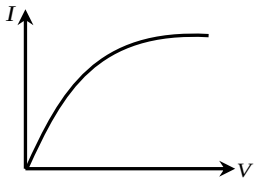
The drift velocity is

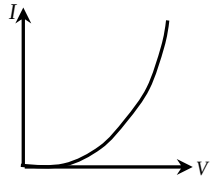
$$v_d = \frac{I}{neA} = \frac{(3.2\text{A})}{\left(5\times10^{26}\ \text{m}^{-3}\right)\left(1.6\times10^{-19}\ \text{C}\right)\left(4\times10^{-6}\ \text{m}^2\right)} = 0.01\ \text{m s}^{-1}$$

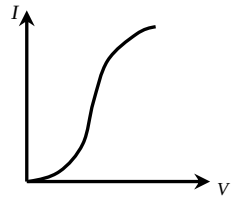
Ans: (c)

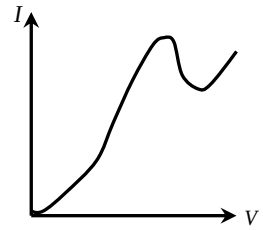
146. The variation between $V-I$ is shown by the following four graphs,. Which is the $V-I$ graph for heating filament?

Options:

(a) 

(b) 

(c) 

(d) 

Sol: As the current in heater filament increases, it gets more heated, hence its temperature increases and thereby its resistance increases. Due to which the current will decrease. Hence the variation of V and I for heater filament will as shown in fig.(a)

Ans: (a)

147. A metal wire is subjected to a constant potential difference. When the temperature of the metal wire increases, the drift velocity of the electron in it

Options:

(a) increases and the thermal velocity of the electron increases

(b) decreases and the thermal velocity of the electron increases

(c) increases and the thermal velocity of the electron decreases

(d) decreases and the thermal velocity of the electron decreases

Sol: When the temperature increases, resistance increases. As the e.m.f applied is the same, the current density decreases, so the drift velocity decreases. But the rms velocity of the electron due to thermal motion is proportional to $\sqrt{T}$. Hence the thermal velocity increases.

Ans: (b)

148. Three electric bulbs with same voltage ratings of 100 volts but wattage ratings of 40, 60 and 100 watts respectively, are connected in series across a volt supply line. If their brightness are B_1, B_2, B_3 respectively, then

Options:

(a) $B_1 > B_2 > B_3$

(b) $B_1 > B_2 < B_3$

(c) $B_1 = B_2 = B_3$

(d) bulbs will burn out due to the high voltage supply

Sol:

Resistance of a bulb $= \frac{(\text{Rated voltage})^2}{\text{rated power}}$

For a given voltage, $R \propto \frac{1}{P}$

$\therefore \ R_{40} > R_{60} > R_{100}$

Rate of heat produced, $H = I^2R$

When the bulbs are connected in series, the current flowing through each bulb is same.

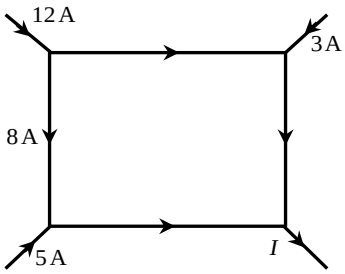
$\therefore \ H \propto R$

As $R_{40} > R_{60} > R_{100}$

$\therefore \ H_{40} > H_{60} > H_{100} \Rightarrow B_1 > B_2 > B_3$

Ans: (a)

149. Figure shows a network of currents. The magnitude of currents is shown here. The current I will be



Options:

(a) 10 A

(b) 3 A

(c) 13 A

(d) 20 A

Sol: Applying Kirchoff's first law,

$I = 12 + 3 + 5 = 20$ A

Ans: (d)

150. A charged particle is moving along a magnetic field line. The magnetic force on the particle is

Options:

(a) along its velocity

(b) opposite to its velocity

(c) perpendicular to its velocity

(d) zero

Sol: The magnetic force on a charged particle in a uniform magnetic field depends on angle between velocity and magnetic field.

As $\vec{F} = q\left(\vec{v} \times \vec{B}\right) \Rightarrow \vec{F} = 0 \qquad \left(\vec{v} \| \vec{B}\right)$

Ans: (d)

151. A proton beam enters a magnetic field of 10^{-4} Wb m^{-2} normally. If the specific charge of the proton is 10^{11} C kg^{-1} and its velocity is 10^{9} $m s^{-1}$, then the radius of the described circle will be

Options:

(a) 10 m

(b) 1 m

(c) 0.1 m

(d) 100 m

Sol: When the proton beam enters the magnetic field B normally, it describes a circular path of radius r given by $r = \frac{mv}{eB} = \frac{v}{\frac{e}{m}B}$

Where $\frac{e}{m}$ is the specific charge of the proton and v is its velocity.

Here, $v = 10^{9}\ m s^{-1}, \frac{e}{m} = 10^{11}$ C kg^{-1} $\qquad B = 10^{-4}$ Wb m^{-2}

$\therefore\ r = \frac{10^{9}\ \text{m s}^{-1}}{\left(10^{11}\ \text{C kg}^{-1}\right)\left(10^{-4}\ \text{Wb m}^{-2}\right)} = 100$ m

Ans: (d)

152. A charged particle with a velocity 2×10^{3} $m s^{-1}$ passes undeflected through electric field and magnetic fields which are mutually perpendicular to each other. The magnetic field is 1.5 T. The magnitude of electric field will be

Options:

(a) $1.5 \times 10^{3} N C^{-1}$

(b) 2×10^{3} N C^{-1}

(c) 3×10^{3} N C^{-1}

(d) 1.33×10^{3} N C^{-1}

Sol: As the charged particle passes undeflected through cross electric and magnetic fields

$\therefore\ qE = qvB,$ or $E = vB$

Here, $v = 2 \times 10^{3} m s^{-1}$, $B = 1.5$ T

$\therefore\ E = \left(2 \times 10^{3}\ \text{m s}^{-1}\right)(1.5\text{T}) = 3 \times 10^{3}$ N C^{-1}

Ans: (c)

153. Magnetic field at a distance r from an infinitely long straight conductor, carrying a steady current, varies as

Options:

(a) $\frac{1}{r^2}$

(b) $\frac{1}{r}$

(c) $\frac{1}{r^3}$

(d) $\frac{1}{\sqrt{r}}$

Sol: Magnetic field due to an infinitely long straight conductor carrying steady current at a distance r from it is given by $B = \frac{\mu_0 2I}{4\pi r}$ or $B \propto \frac{1}{r}$

Ans: (b)

154. At certain place, the horizontal component of earth's magnetic field is 3.0 G and the angle dip at that place is $30°$. The magnetic field of earth at that location

Options:

(a) 4.5 G

(b) 5.1 G

(c) 3.5 G

(d) 6.0 G

Sol: Given $B_H = B\cos\theta = 3$ G, $\theta = 30°$

$$B = \frac{B_H}{\cos 30°} = \frac{3}{\sqrt{3}/2} = 2\sqrt{3} = 3.5 \text{ G}$$

Ans: (c)

155. The magnetic dipole moment of a current loop is independent of

Options:

(a) magnetic field in which it is lying

(b) number of turns

(c) area of the loop

(d) current in the loop

Sol: Current loop acts as a magnetic dipole. Its magnetic moment is given by

$M = NIA$

Where N = number of turns, I = current in a loop,

A = area of the loop.

Form the above relation, we can conclude that magnetic dipole moment of a current loop is independent of magnetic field in which it is lying.

Ans: (a)

156. A solenoid has core of a material with relative permeability 500 and its windings carry a current of 1 A. The number of turns of the solenoid is 500 per metre. The magnetization of the material is nearly

Options:

(a) $2.5\times10^{3}\ \text{A m}^{-1}$

(b) $2.5\times10^{5}\ \text{A m}^{-1}$

(c) $2.0\times10^{3}\ \text{A m}^{-1}$

(d) $2.0\times10^{5}\ \text{A m}^{-1}$

Sol: Here, $n=500$ turns/m $\quad I=1$ A, $\mu_r=500$

Magnetic intensity, $H=nI=500\,\text{m}^{-1}\times1\ \text{A}\ =500\,\text{A m}^{-1}$

As $\mu_r=1+\chi$

Where χ is the magnetic susceptibility of the material or $\chi=(\mu_r-1)$

Magnetization, $M=\chi H=(\mu_r-1)H=(500-1)\times500\ \text{A m}^{-1}$

$=499\times500\ \text{A m}^{-1}=2.495\times10^{5}\ \text{A m}^{-1}$

$=2.5\times10^{5}\ \text{A m}^{-1}$

Ans: (b)

157. The normal magnetic flux passing through a coil changes with time according to the equation $\phi=6t^2-5t+1$. What is the magnitude of the induced current at $t=0.5$s if resistance of coil is $10\,\Omega$?

Options:

(a) 1.2 A

(b) 0.8 A

(c) 0.6 A

(d) 0.1 A

Sol: Here, Magnetic flux, $\phi=6t^2-5t+1$

Resistance, $R=10\ \Omega$

The induced emf is $\varepsilon=\dfrac{d\phi}{dt}=-\dfrac{d}{dt}\left(6t^2-5t+1\right)=-(12t-5)$

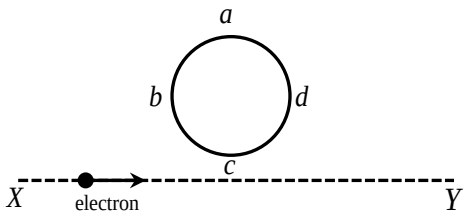
At $t=0.5$s

$\varepsilon=-(6-5)=-1$ V

$\therefore$ induced current, $I=\left|\dfrac{\varepsilon}{R}\right|=\dfrac{1}{10}=0.1$A

Ans: (d)

158. An electron moves on a straight line path XY as shown. The $abcd$ is a coil adjacent to the path of electron. What will be the direction of current, if any, induced in the coil?



Options:

(a) The current will reverse its direction as the electron goes past the coil

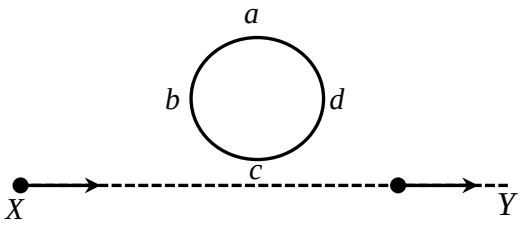
(b) No current will be induced

(c) The direction of induced current will be along the path $abcd$

(d) The direction of induced current will be along the path $adcb$

Sol:

When the electron moves from X to Y, the flux linked with the coil $abcd$ (which is into the page) will first increase and then decrease as the electron passes by. So the induced current in the coil will be first anticlockwise and will reverse its direction (i.e. will become clockwise) as the electron goes past the coil.



Ans: (a)

159. The rms value of current in a $50\,\text{Hz}$ AC circuit is $6\,\text{A}$. The average value of AC current over a cycle is

Options:

(a) $6\sqrt{2}$

(b) $\frac{3}{\pi\sqrt{2}}$

(c) Zero

(d) $\frac{6}{\pi\sqrt{2}}$

Sol: Average value of AC current over a cycle is zero.

Ans: (c)

160. In an LCR circuit, at resonance

Options:

(a) the impedance is maximum

(b) the current leads the voltage by $\pi/2$

(c) the current and voltage are in phase

(d) the current is minimum

Sol: In an LCR circuit, the phase difference (ϕ) between current and voltage is

$$\tan\phi = \frac{X_C - X_L}{R}$$

At resonance, $X_C = X_L$

$\therefore \tan\phi = 0 \quad or \quad \phi = \tan^{-1}(0) = 0°$

Thus the current and voltage are in phase

The current is maximum and the impedance is minimum at resonance in an LCR circuit.

Ans: (c)

161. A current of $5\,\text{A}$ is flowing at $220\,\text{V}$ in the primary coil of a transformer. If the voltage produced in the secondary coil is $2200\,\text{V}$ and 50% of power is lost, then the current in the secondary will be

Options:

(a) $0.25\,\text{A}$

(b) $0.5\,\text{A}$

(c) $2.5\,\text{A}$

(d) $5\,\text{A}$

Sol: Given the power output is 50% of the input power, i.e. $I_s V_s = (1/2) I_p V_p.$

Also given $I_p = 5\,\text{A}, V_p = 220\,\text{V}$ and $V_s = 2200\,\text{V}$

$$\therefore I_s = \frac{1}{2}\frac{I_p V_p}{V_s} \Rightarrow I_s = \frac{1}{2} \times \frac{5\,\text{A} \times 220\,\text{V}}{2200\,\text{V}}$$

$\therefore I_s = 0.25\,\text{A}$

Ans: (a)

162. A vessel of height $2d$ is half-filled with a liquid of refractive index $\sqrt{2}$ and the other half with a liquid of refractive index n. (The given liquids are immiscible). Then the apparent depth of the inner surface of the bottom of the vessel (neglecting the thickness of the bottom of the vessel) will be

Options:

(a) $\frac{n}{d\left(n+\sqrt{2}\right)}$

(b) $\frac{d\left(n+\sqrt{2}\right)}{n\sqrt{2}}$

(c) $\frac{\sqrt{2}n}{d\left(n+\sqrt{2}\right)}$

(d) $\frac{nd}{d+\sqrt{2}n}$

Sol: $\mu = \frac{\text{Real depth}}{\text{Apparent depth}} = \frac{d}{x}$

$\therefore$ Due to first liquid, $\sqrt{2} = \frac{d}{x_1}$ or $x_1 = \frac{d}{\sqrt{2}}$

And due to the second liquid, $n = \frac{d}{x_2}$ or $x_2 = \frac{d}{n}$

$\therefore$ Total apparent depth $= x_1 + x_2 = \frac{d}{\sqrt{2}} + \frac{d}{n}$

Total apparent depth $= \frac{d\left(n+\sqrt{2}\right)}{n\sqrt{2}}$

Ans: (b)

163. The speed of light in medium M_1, and M_2 are 1.5×10^8 m s^{-1} and 2×10^8 m s^{-1} respectively. A ray travels from medium M_1 to the medium M_2 with an angle of incidence θ. The ray suffers total internal reflection. Then the value of the angle of incidence θ is

Options:

(a) $> \sin^{-1}\left(\frac{3}{4}\right)$

(b) $< \sin^{-1}\left(\frac{3}{4}\right)$

(c) $= \sin^{-1}\left(\frac{2}{3}\right)$

(d) $\leq \sin^{-1}\left(\frac{2}{3}\right)$

Sol: Given, $v_1 = 1.5\times10^8$ m s^{-1}

$v_2 = 2.0\times10^8\ \text{m s}^{-1}$

Refractive index for medium M_1 is

$$\mu_1 = \frac{c}{v_1} = \frac{3\times10^8\ \text{ms}^{-1}}{1.5\times10^8\ \text{ms}^{-1}} = 2$$

Refractive index for medium M_2 is

$$\mu_2 = \frac{c}{v_2} = \frac{3\times10^8\ \text{ms}^{-1}}{2.0\times10^8\ \text{ms}^{-1}} = \frac{3}{2}$$

If θ is the angle of incidence and C is the critical angle, then for total internal reflection

$\sin\theta > \sin C$, But $\sin C = \frac{\mu_2}{\mu_1}$

$\therefore \quad \sin\theta > \frac{\mu_2}{\mu_1} > \frac{3/2}{2}$ or $\theta > \sin^{-1}\left(\frac{3}{4}\right)$

Ans: (a)

164. Radii of curvature of a converging lens are in the ratio $1:2$. Its focal length is $6\,\text{cm}$ and refractive index is 1.5. Then its radii of curvature are _____ respectively

Options:

(a) 9 cm and 18 cm

(b) 6 cm and 12 cm

(c) 3cm and 6 cm

(d) 4.5 cm and 9 cm

Sol: Let $R_1 = R \therefore R_2 = 2R$

According to lens maker's formula

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Here, $f = 6$ cm, $\mu = 1.5$

$R_1 = R, R_2 = -2R$

$$\therefore \frac{1}{6} = (1.5-1)\left(\frac{1}{R} - \frac{1}{-2R}\right) = 0.5\left(\frac{1}{R} + \frac{1}{2R}\right)$$

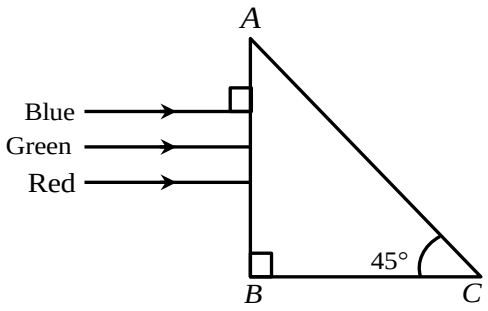
$$\frac{1}{6} = 0.5\left(\frac{3}{2R}\right) \text{ or } \frac{1}{6} = \frac{1.5}{2R}$$

$$R = \frac{1.5 \times 6}{2} = 4.5 \text{ cm}$$

$\therefore R_1 = 4.5\,\text{cm}, R_2 = 9$ cm

Ans: (d)

165. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive index of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively The prism will



Options:

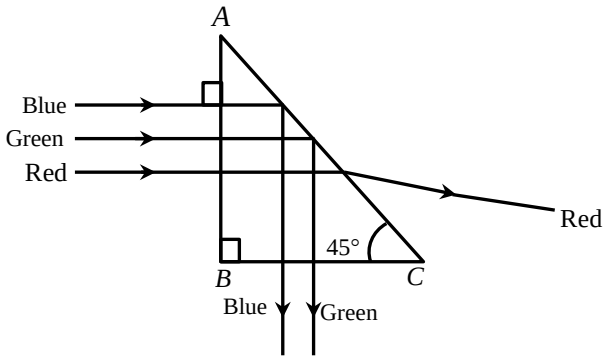
(a) not separate the three colours at all

(b) separate the red colour part from the green and blue colours

(c) separate the blue colour part from the red and green colours

(d) separate all the three colours from one another

Sol: As beam of light is incident normally on the face AB of the right angled prism ABC, so on refraction occurs at face AB and it passes straight and strikes the face AC at an for total incidence $i = 45°$.



For total refraction to take place at face AC,

$i > i_c$ or $\sin i > \sin i_c$

Where i_c is the critical angle.

But as here $i = 45°$ and $\sin i_c = \frac{1}{\mu}$

$\therefore \sin 45° > \frac{1}{\mu}$ or $\frac{1}{\sqrt{2}} > \frac{1}{\mu}$ or $\mu > \sqrt{2} = 1.414$

As $\mu_{red}\ (=1.39) < \mu(=1.414)$ while $\mu_{green}\ (=1.44)$ and $\mu_{blue}\ (=1.47)$

$> \mu(=1.414)$, so only red colour will be transmitted through face AC while green and blue colours will suffer total internal reflection. So the prism will separate red colour from the green and blue colours as shown in the following figure.

Ans: (b)

166. Rainbow is a phenomenon due to

Options:

(a) dispersion alone

(b) refraction alone

(c) reflection alone

(d) combined effect of dispersion, refraction and reflection

Sol: The rainbow is an example of the dispersion of sunlight by the water drops in the atmosphere. This is a phenomenon due to combined effect of dispersion, refraction and reflection of sunlight by spherical water droplets of rain.

Ans: (d)

167. Wavefront is the locus of all point, where the particles of the medium vibrate with the same

Options:

(a) phase

(b) amplitude

(c) frequency

(d) period

Sol: Wavefront is the locus of all points, where the particles of the medium vibrate with the same phase.

Ans: (a)

168. To observe diffraction, the size of the obstacle

Options:

(a) should be $\lambda/2$, where λ is the wavelength

(b) should be of the order of wavelengths

(c) has no relation to wavelength

(d) should be much larger that the wavelength

Sol: To observe diffraction, the size of the obstacle should be of the order of wavelength.

Ans: (b)

169. Maximum velocity of the photoelectron emitted by a metal is $1.8\times10^{6}\ \mathrm{m\,s^{-1}}$. Take the value of specific charge of the electron is $1.8\times10^{11}\ \mathrm{C\,kg^{-1}}$. Then the stopping potential (in volt) is

Options:

(a) 1

(b) 3

(c) 9

(d) 6

Sol: As $\frac{1}{2}mv_{\max}^2 = eV_S$

Where $v_{\max}$ is the maximum velocity of the electron and V_S is the stopping potential.

$V_S = \frac{1}{2}\frac{m}{e}v_{\max}^2$

Here, $\frac{e}{m} = 1.8\times10^{11}\ \mathrm{C\ kg^{-1}}, v_{\max} = 1.8\times10^{6}\ \mathrm{m\,s^{-1}}$

$\therefore\ V_S = \frac{1}{2}\times\frac{1}{1.8\times10^{11}}\times\left(1.8\times10^{6}\right)^2 = 9\,\mathrm{V}$

Ans: (c)

170. When a piece of metal is illuminated by a monochromatic light of wavelength λ, then stopping potential is $3V_s$. When same surface is illuminated by light of wavelength 2λ, then stopping potential becomes $V_{s.}$ The value of threshold wavelength for photoelectric emission will be

Options:

(a) $(4\lambda)/3$

(b) 6λ

(c) 4λ

(d) 8λ

Sol: $h\upsilon = W_0 + KE(\max)$

$\frac{hc}{\lambda} = W_0 + 3eV_s$ … (i)

$\frac{hc}{2\lambda} = W_0 + eV_s$ … (ii)

Eqns (i) –Eqns (ii)

$\therefore \quad \frac{hc}{\lambda} - \frac{hc}{2\lambda} = \frac{hc}{2\lambda} = 2eV_s \quad \therefore \quad \frac{hc}{\lambda} = 4eV_s$ … (iii)

$\therefore \; W_0 = eV_s$ … (iv)

Now $\lambda_0 = \frac{hc}{W_0} = \frac{hc}{eV_s} = \frac{4\lambda eV_s}{eV_s}$

$\lambda_0 = 4\lambda$

Ans: (c)

171. Rutherford's atomic model could account for

Options:

(a) stability of atoms

(b) origin of spectra

(c) the positively charged central core of an atom

(d) concept of stationery orbits

Sol: According to Rutherford's atomic model the entire positive charge and most of the mass of the atom is concentrated in a small volume called the nucleus with electrons revolving around the nucleus just as planets revolve around the sun.

Ans: (c)

172. The amount of energy required to separate a hydrogen atom into a proton and an electron is

Options:

(a) $1.36\,\text{eV}$

(b) $13.6\ \text{eV}$

(c) $0.136\,\text{eV}$

(d) $136\ \text{eV}$

Sol: $E_n = -\frac{Rhc}{n^2} = \frac{Rhc}{n^2 e}\text{eV}$

$E_{n=1} = \frac{1.09\times10^7 \times 6.63\times10^{-34}\times3\times10^8}{(1)^2\times1.6\times10^{-19}}\text{eV} = 13.6\text{eV}$

$13.6\,\text{eV}$ energy is required to separate a hydrogen atom into a proton and an electron

Ans: (b)

173. An electron of a stationery hydrogen atom makes the transition from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be

(m = mass of hydrogen atom, R = Rydberg constant and h = Planck's constant)

Options:

(a) $\frac{24hR}{25m}$

(b) $\frac{25hR}{24m}$

(c) $\frac{25m}{24hR}$ (d) $\frac{24m}{25hR}$

Sol: According to Rydberg formula $\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$

Here, $n_f = 1, n_i = 5 \quad \therefore \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{5^2}\right] = R\left[\frac{1}{1} - \frac{1}{25}\right] = \frac{24}{25}R$

According to conservation of linear momentum, we get, momentum of photon = momentum of atom

$\frac{h}{\lambda} = mv$ or $v = \frac{h}{m\lambda} = \frac{h}{m}\left(\frac{24R}{25}\right) = \frac{24hR}{25m}$

Ans: (a)

174. The volume of a nucleus is directly proportional to

Options:

(a) A

(b) A^3

(c) $\sqrt{A}$

(d) $A^{1/3}$

Sol: Radius of nucleus $R = R_0 A^{1/3}$ where

$R_0 = 1.2 \times 10^{-15}$ m

And A is the mass number of nucleus.

$\therefore$ volume of nucleus $= \frac{4}{3}\pi R^3 = \left(\frac{4}{3}\pi R_0^3\right)A$

$\therefore$ volume if proportional to A.

Ans: (a)

175. A force between two protons is same as the force between proton and neutron. The nature of the force is

Options:

(a) electrical force

(b) weak nuclear force

(c) gravitational force

(d) strong nuclear force

Sol: The strong nuclear force binds protons and neutrons in a nucleus. It acts equally between proton-proton, neutron-neutron and proton-neutron.

Ans: (d)

176. In which of the following statements, the obtained impure semiconductor is of $p-$type?

Options:

(a) Germanium is doped with bismuth

(b) Silicon is doped with antimony

(c) Germanium is doped with gallium

(d) Silicon is doped with phosphorus

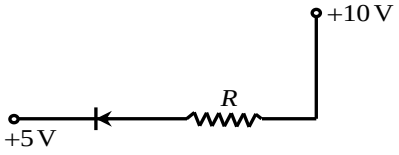
Sol: $p-$type semiconductor is obtained when silicon (Si) or germanium (Ge) is doped with a trivalent impurity like, boron (B), aluminium (Al), gallium (Ga) etc.

$n-$type semiconductor is obtained when silicon (Si) or germanium (Ge) is doped with a pentavalent impurity like arsenic (As), antimony (Sb), bismuth (Bi) etc.

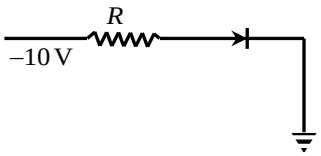
Ans: (c)

177. In the following figure, the diodes which are forward biased, are

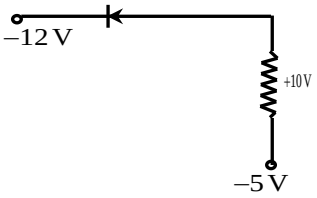
(A)



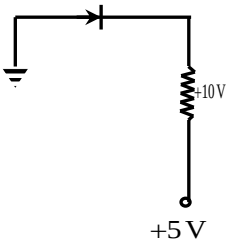
(B)



(C)



(D)



Options:

(a) (A), (B) and (D)

(b) (C) only

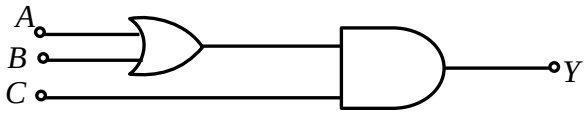
(c) (A) and (C)

(d) (B) and (D)

Sol: A $p-n$ junction diode is said to be forward biased when $p-$side is at a higher potential than that of n side. It is for circuits (A) and (C).

Ans: (c)

178. To get output 1 for the following circuit, the correct choice for the input is



Options:

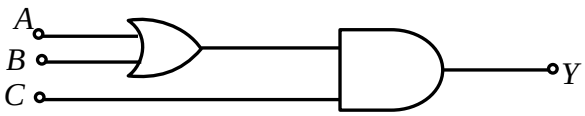
(a) $A=1,\ B=1,\ C=0$

(b) $A=1,\ B=0,\ C=1$

(c) $A=0,\ B=1,\ C=0$

(d) $A=1,\ B=0,\ C=0$

Sol: Output of the circuit, $Y=(A+B).C$



$Y=1$ if $C=1$ and $A=0,\ B=1$ or $A=1$

$B=0$ or $A=B=1$

Ans: (b)

179. The velocity of electromagnetic radiation in vacuum of permittivity ε_0 and permeability μ_0 is given by

Options:

(a) $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$

(b) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$

(c) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$

(d) $\sqrt{\mu_0\varepsilon_0}$

Sol: The velocity of electromagnetic radiation in vacuum is $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$, where μ_0 *and* ε_0 are the permeability and permittivity of vacuum.

Ans: (a)

180. What is the de Brogile wavelength of the electron accelerated through a potential difference of 100 volt?

Options:

(a) $0.1227\ \text{Å}$

(b) 12.27Å

(c) 0.001227Å

(d) 1.227Å

Sol: de Brogile wavelength of the electron accelerated through a potential difference of V volt is

$\lambda=\frac{12.27}{\sqrt{V}}\ \text{Å}$ For $V=100$ volt $\lambda=\frac{12.27}{\sqrt{100}}\ \text{Å}=1.227\text{Å}$

Ans: (d)

Key Answers:

1. a	2. c	3. b	4. c	5. a	6. b	7. c	8. b	9. a	10. a
11. d	12. a	13. b	14. b	15. a	16. b	17. c	18. a	19. c	20. a
21. b	22. b	23. d	24. c	25. c	26. d	27. d	28. a	29. a	30. c
31. c	32. c	33. a	34. c	35. a	36. a	37. c	38. b	39. d	40. a
41. b	42. b	43. c	44. a	45. b	46. b	47. b	48. c	49. d	50. a
51. c	52. b	53. b	54. a	55. d	56. a	57. d	58. d	59. d	60. a
61. b	62. b	63. d	64. b	65. c	66. d	67. b	68. b	69. d	70. a
71. c	72. b	73. a	74. b	75. b	76. d	77. d	78. d	79. d	80. c
81. b	82. a	83. c	84. b	85. d	86. a	87. b	88. a	89. c	90. a
91. c	92. b	93. b	94. d	95. d	96. c	97. a	98. c	99. b	100.b
101.d	102.d	103.b	104.b	105.c	106.c	107.b	108.d	109.c	110.a
111.d	112.c	113.a	114.c	115.b	116.c	117.b	118.b	119.d	120.d
121.a	122.c	123.d	124.b	125.b	126.a	127.a	128.b	129.a	130.d
131.b	132.b	133.d	134.d	135.a	136.d	137.c	138.a	139.a	140.c
141.c	142.c	143.b	144.d	145.c	146.a	147.b	148.a	149.d	150.d
151.d	152.c	153.b	154.c	155.a	156.b	157.d	158.a	159.c	160.c
161.a	162.b	163.a	164.d	165.b	166.d	167.a	168.b	169.c	170.c
171.c	172.b	173.a	174.a	175.d	176.c	177.c	178.b	179.a	180.d