Deeksha

ABHYAS KCET 2024

FREE TEST SERIES

MOCK TEST 6

PDF

SOLUTION

Deeksha - CET

Subject	Topic	
C + M + P	Complete Syllabus	

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:

$h = 6.626 \times 10^{-34}\,\mathrm{Js}$, $\mathrm{N_a} = 6.022 \times 10^{23}\,\mathrm{mol^{-1}}$, $\mathrm{c} = 2.998 \times 10^{8}\,\mathrm{m\,s^{-1}}$, $\mathrm{m_e} = 9.1 \times 10^{-31}\,\mathrm{kg}$, $R = 8.314\,\mathrm{J\,mol^{-1}\,K^{-1}}$

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 electon is $1.0\times10^{-5}kg\ ms^{-1}$. 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 $\left(1s^2 2s^2\right)$ has higher ionisation energy than $B\left(1s^2 2s^2 2p^1\right)$ 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 $=8+2\times7=22$

   $\frac{22}{8}=2(Q_1)+6(R_1),\ \frac{6}{2}=3(Q_2)+0(R_2);\quad X=Q_1+Q_2+R_2=2+3=5$

   Hence, hybridisation is sp^3d .

   Ans: (c)

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

Options:

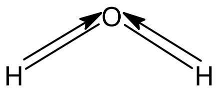
(a) H_2O is angular and BeF_2 is linear

(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:



$\mu \neq 0$

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

Partial pressure $\propto$ mole fraction

$\therefore \dfrac{8}{9}$ 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 $\Delta G = \Delta H - T\Delta S$

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

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

$\Delta G = -382.64 - 298\times(-0.1456) = -339.3\ kJ\ mol^{-1}$

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: $Na^+ + OH^- + H^+ + Cl^- \to Na^+ + Cl^- + H_2O$

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

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

Ans: (b)

9. $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$. 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 $2p$ p

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

$\therefore\ p = 1$ atm

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

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

$$3\overset{+1}{Cl}O^- \longrightarrow 2\overset{-1}{Cl^-} + \overset{+5}{Cl}O_3^-$$

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

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

Ans: (d)

12. Which one of the following sets of ions represents the collection of isoelectronic species?

Options:

(a) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$
(b) $Na^+, Ca^{2+}, Sc^{3+}, F^-$
(c) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$
(d) $Na^+, Mg^{2+}, Al^{3+}, Cl^-$

Sol: $K^+, Ca^{2+}, Sc^{3+}, Cl^-$ have 18 electrons each.

Ans: (c)

13. Which of the following ions has the highest value of ionic radius?

Options:

(a) O^{2-}
(b) B^{3+}
(c) Li^+
(d) F^-

Sol: O^{2-} has highest value of ionic radius because of least *p/e* ratio. The decreasing order of radii is

$O^{2-} > F^- > Li^+ > B^{3+}$

Ans: (a)

14. Acidified sodium fusion extract on addition of ferric chloride solution gives blood red colouration which confirms the presence of:

Options:

(a) N and S
(b) S and Cl
(c) S
(d) N

Sol: Formation of blood red colour in sodium extract test indicates the presence of both N and S.

Ans: (a)

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) $CH_3 - \overset{+}{C}(CH_3) - CH_3$
(d) $CH_3 - C(CH_3)_2 - \overset{+}{C} H - C_6H_5$

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

Ans: (a)

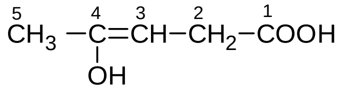
16. The IUPAC name of the compound,

$CH_3 - C(OH) = CH - CH_2 - COOH$ is

Options:

(a) Hydroxypentenoic acid
(b) 4-Hydroxypent-3-enoic acid
(c) 2-Hydroxypent-4-enoic acid
(d) 4-Hydroxy-4-methylpent-3-enoic acid

Sol:



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. A plot of $\frac{1}{\text{T}}$ Vs $\ln k$ for a reaction gives the slope -1×10^4 K. The energy of activation for the reaction is (Given $\text{R} = 8.314 \text{ J K}^{-1}\text{mol}^{-1}$)

Options:

(a) $1.202 \text{ kJ mol}^{-1}$ (b) $83.14 \text{ kJ mol}^{-1}$ (c) 8314 J mol^{-1} (d) 12.02 J mol^{-1}

Sol: Slope = $-\frac{\text{E}_\text{a}}{\text{R}}$

$E_a = -\text{Slope} \times \text{R}$

$= -\left(-1\times10^4 \text{ K}\right)\times 8.314 \text{ J K}^{-1}\text{mol}^{-1}$

$= 83140 \text{ J} = 83.14 \text{ kJ mol}^{-1}$

Ans: (b)

19. Which is a wrong statement?

Options:

(a) Rate constant k = Arrhenius constant A : if $\text{E}_a = 0$

(b) $\ln k$ vs $\frac{1}{\text{T}}$ plot is a straight line.

(c) $e^{-\text{E}_a/\text{RT}}$ gives the fraction of reactant molecules that are activated at the given temp.

(d) Presence of catalyst will not alter the value of E_a

Sol: Presence of catalyst will not alter the value of E_a is wrong statement because catalyst lowers the activation energy, E_a

Ans: (d)

20. In a *hydrogen-oxygen* fuel cell, combustion of hydrogen occurs to

Options:

(a) generate heat

(b) remove absorbed oxygen from electrode surface

(c) produce high purity water

(d) create potential difference between the two electrodes.

Sol: create potential difference between the two electrodes.

Ans: (d)

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 $353.3K$. 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: $M_2 = \frac{1000 \times w_2 \times K_b}{\Delta T_b \times w_1} = \frac{1000 \times 1.8 \times 2.52}{0.8 \times 90}$ $[\because \Delta T_b = 354.11\ K - 353.23K = 0.88K] = 63\ g\ mol^{-1}$

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

$$\log K_c = \frac{0.46V \times 2}{0.059V} = 15.6; \quad K_c = 3.98 \times 10^{15}$$

Ans: (c)

25. Λ°_m for $NaCl$, HCl and $NaAc$ are 126.4, 425.9 and 91.0 $S\ cm^2\ mol^{-1}$ respectively. Λ° 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) $2.3 \times 10^{-4} s^{-1}$ (b) $4.8 \times 10^{-4} s^{-1}$ (c) $3 \times 10^{-4} s^{-1}$ (d) $8 \times 10^{-4} s^{-1}$

Sol:

$$k = \frac{2.303}{100} \log \frac{0.5}{2 \times 0.5 - 0.512}$$

$$= \frac{2.303}{100} \log 1.024 = \frac{2.303}{100} \times 10^{-2} = 2.3 \times 10^{-4}$$

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) $1.92 \times 10^{-4} s^{-1}$ (b) $3 \times 10^{-2} s^{-1}$ (c) $5 \times 10^{-3} s^{-1}$ (d) $4.75 \times 10^{-4} s^{-1}$

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. When an electrolyte is dissociated in solution, the van't Hoff's factor(i) is,

Options:

(a) $=0$ (b) >1 (c) $=1$ (d) <1

Sol: Van't Hoff factor (i) depends on the number of particles of solute. On dissociation of an electrolyte, number of particles of solute increases, therefore $i > 1$.

Ans: (b)

31. A galvanic cell is constructed using a redox reaction

$1/2\ H_2(g)+AgCl(s)\rightleftharpoons H^+(aq)+Cl^-(aq)+Ag(s)$

It is represented as:

Options:

(a) $Pt/H_2(g)\,|\,KCl(aq)\,||\,AgCl(s)/Ag(s)$

(b) $Pt/H_2(g);HCl(aq)\,||\,AgCl(s)/Ag(s)$

(c) $Pt/H_2(g)\,|\,HCl(aq)\,||\,AgNO_3(s)/Ag(s)$

(d) $Ag/AgCl(s)\,|\,KCl(aq)\,||\,HCl(aq),\ H_2(g)/Pt$

Sol: $Pt/H_2(g);HCl(aq)\,||\,AgCl(s)/Ag(s)$

Ans: (b)

32. Colour of light absorbed by aqueous solution of $CuSO_4$ is

Options:

(a) Orange red (b) Bluish green (c) Yellow (d) Violet

Sol: Blue colour is the complementary colour of orange red.

Ans: (a)

33. The degenerate orbitals of $\left[Cr(H_2O)_6\right]^{3+}$ are

Options:

(a) d_{xz} and d_{yz} (b) $d_{x^2-y^2}$ and d_{xy} (c) d_{x^2} and d_{xz} (d) d_{yz} and d_{z^2}

Sol: Cr^{3+} has d^3 configuration and forms an octahedral inner orbital complex (d^2sp^3 hybridisation)

The set of degenerate orbitals are $\left(d_{xy}, d_{yz}\text{ and } d_{xz}\right)$ and $\left(d_{x^2-y^2}\text{ and } d_{z^2}\right)$

Ans: (a)

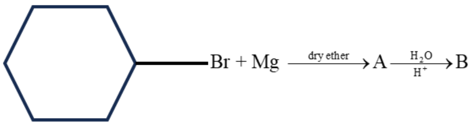
34. The number of unidentate ligands in the complex ion is called

Options:

(a) primary valency (b) oxidation number (c) EAN (d) Coordination number

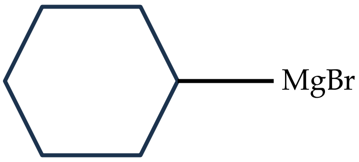
Sol: Coordination number

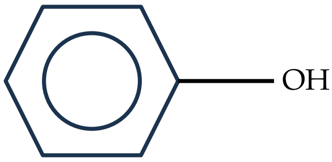
Ans: (d)

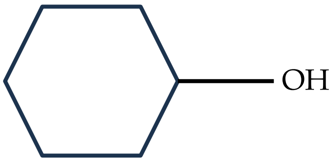
35. 

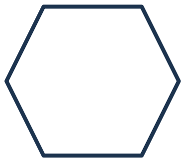
The product 'B' is

Options:

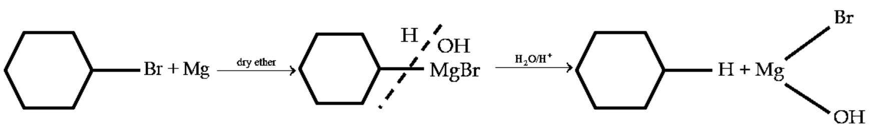
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (d)

36. A reaction in which a primary amine is formed from primary amide is called

Options:

(a) Hoffmann bromamide reaction

(b) Gabriel phthalimide reaction

(c) Carbylamine reaction

(d) Libermann's nitrosoamine reaction

Sol: Hoffmann bromamide reaction

Ans: (a)

37. $X \xleftarrow{LiAlH_4} C_6H_5-CH=CH-CH=O \xrightarrow{NaBH_4} Y$

X and Y respectively are

Options:

(a) $C_6H_5-CH_2CH_2CH_2OH,\ C_6H_5-CH=CH-CH_2OH$

(b) $C_6H_5-CH=CH-CH_2OH,\ C_6H_5-CH_2CH_2CH_2OH$

(c) $C_6H_5-CH_2CH_2CH_3,\ C_6H_5-CH=CH-CH_2OH$

(d) $C_6H_5-CH=CH-CH_2OH,\ C_6H_5-CH_2CH_2CH_3$

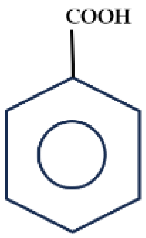
Sol: $C_6H_5-CH_2CH_2CH_2OH,\ C_6H_5-CH=CH-CH_2OH$

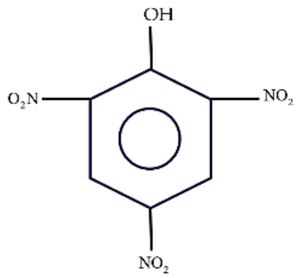
Ans: (a)

38. The strongest acid among the following is:

Options:

(a) CCl_3COOH (b) FCH_2COOH

(c) 

(d) 

Sol: The presence of three electrons withdrawing NO_2 groups makes picric acid the strongest acid.

Ans: (d)

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 $= \sqrt{5(5+2)}BM = \sqrt{35} = 5.91\ BM$

$Co^{2+} = 3d^7$, 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 $\left[Co(H_2O)(CN)(en)_2\right]^{2+}$ is

Options:

(a) +2 (b) +3 (c) −3 (d) −2

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

$x = +3$

Ans: (b)

43. Amongst the following the most stable complex is

Options:

(a) $\left[Fe(H_2O)_6\right]^{3+}$ (b) $\left[Fe(NH_3)_6\right]^{3+}$ (c) $\left[Fe(C_2O_4)_3\right]^{3-}$ (d) $[FeCl_6]^{3-}$

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

Ans: (c)

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

Options:

(a) Potassium tetracyanidonickelate (II)

(b) Potassium tetracyanidonickelate (III)

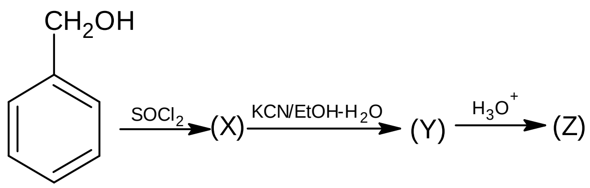
(c) Potassium tetracyanidonickle (II)

(d) Potassium tetracyanidonickle (III)

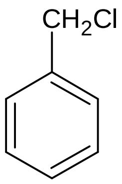
Sol: Potassium tetracyanidonickelate (II)

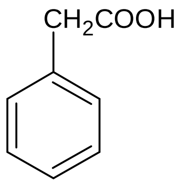
Ans: (a)

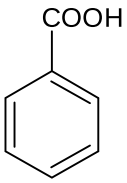
45. Identify Z in the following sequence of reactions

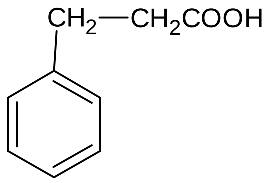


Options:

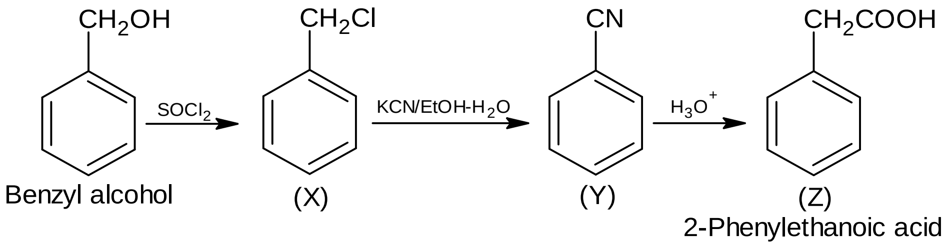
(a) 

(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

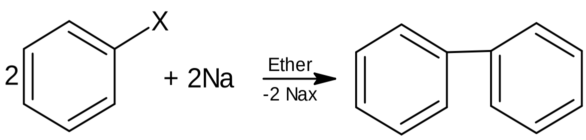
(d) 1-Chlorobutane< 2- Chloropropane<1-Chloroporpane

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.

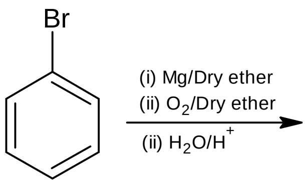
$$\underset{\text{II}}{n-\text{butane}} < \underset{\text{IV}}{\text{ethoxyethane}} < \underset{\text{III}}{\text{pentanal}} < \underset{\text{I}}{\text{pentan-1-ol}}$$

Ans: (c)

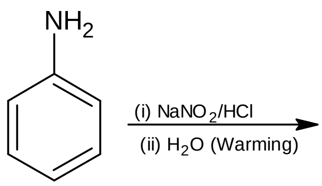
49. Which of the following reactions will not yield phenol?

Options:

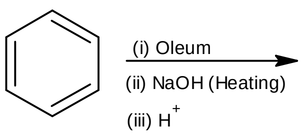
(a)



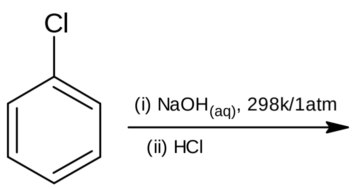
(b)



(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:

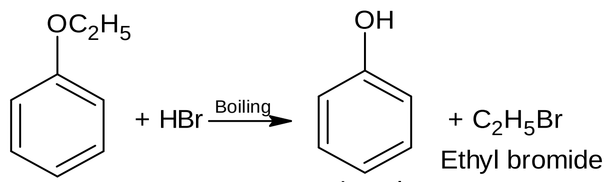
(a) Phenol and ethyl bromide

(b) Bromobenzene and ethanol

(c) Phenol and ethane

(d) Bromobenzene and ethane

Sol:



Ethyl phenyl ether Phenol

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: $\underset{\text{Allyl alcohol}}{CH_2 = CHCH_2OH} \xrightarrow[CH_2Cl_2]{C_5H_5\overset{+}{N}HCrO_3Cl^-(PCC)} \underset{\text{Prop-2-enal}}{CH_2 = CH - CHO}$

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. $CH_3CH_2CH_2COOH$

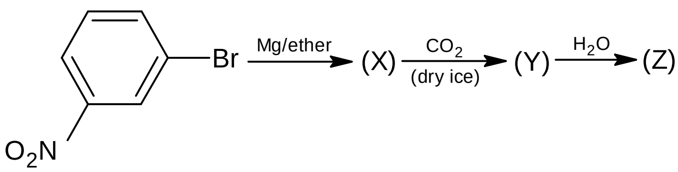
Options:

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

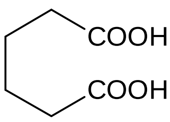
Sol: The overall increasing order of ease of hydrogen bond formation is III<I<II<IV

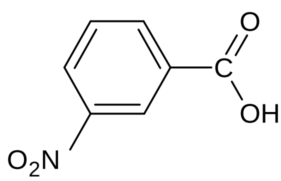
Ans: (b)

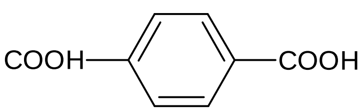
53. What is Z in the following sequence of reactions?

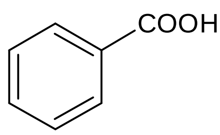


Options:

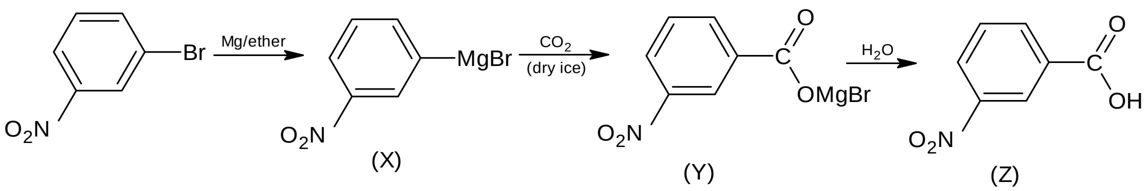
(a)


(b)


(c)


(d)


Sol:



Ans: (b)

54. In Clemmensen reduction carbonyl compound is treated with

Options:

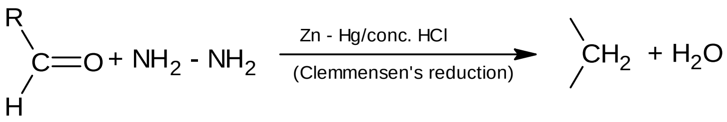
(a) Zinc amalgam + HCl

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

(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:

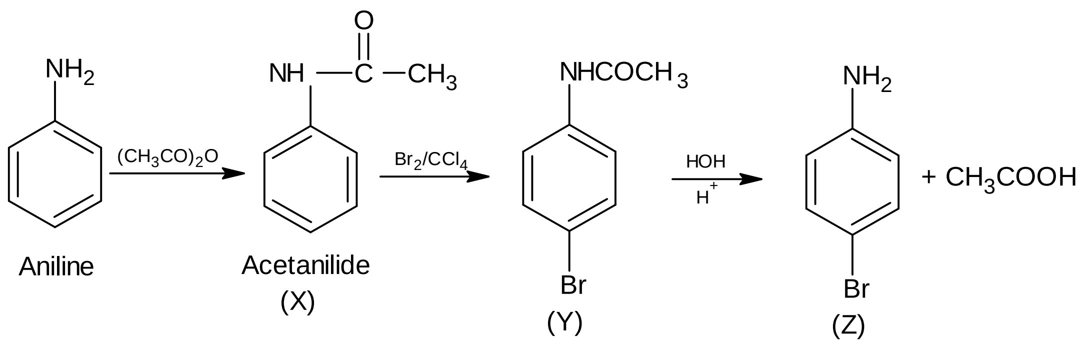
(a) $p-$Bromoaniline

(b) Bromoacetophenone

(c) $p-$Bromoacetanilide

(d) $o-$Bromoacetanilide

Sol:



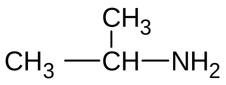
Ans: (a)

57. C_3H_9N represent

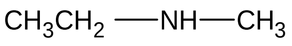
Options:

(a) Primary amine (b) Secondary amine (c) Tertiary amine (d) All of these

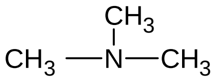
Sol: C_3H_9N : $CH_3CH_2CH_2NH_2$ or



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) Racemisation (b) Asymmetric induction

(c) Fluxional isomerism (d) Mutarotation

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 $\beta -$ 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. 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)

62. 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)

63. If $m = \sin x + \cos x$ and $n = \sec x + \operatorname{cosec} x$ 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: $m^2 = (\sin x + \cos x)^2 = 1 + 2\sin x \cos x \Rightarrow m^2 - 1 = 2\sin x \cos x$

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

Ans: (c)

64. 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)

65. 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)

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

Options:

(a) 1 (b) $\cos 1$ (c) $\sin 1$ (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)

67. 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)

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

Options:

(a) $\frac{\sqrt{3}}{2}$ (b) $\frac{1}{2}$ (c) $\frac{-1}{2}$ (d) 0

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

$\Rightarrow \cos x=\frac{\sqrt{3}}{2}$

Ans: (a)

69. 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)

70. 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: $z_1+z_2+z_3=0 \quad \therefore z_1^3+z_2^3+z_3^3=3z_1z_2z_3=3(-2)(1+i)(1-i)=-12$

Ans: (b)

71. 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)

72. 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)

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

Options:

(a) 200 (b) 400 (c) 600 (d) 800

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

Ans: (b)

74. 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)

75. 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)

76. 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)

77. 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)

78. 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: $A=x(x^2-1)-1(x-1)+1(1-x)=x^3-x-x+1+1-x=x^3-3x+2$; $B=x^2-1; \frac{dA}{dx}=3x^2-3=3B$

Ans: (b)

79. 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)

80. 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)

81. 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: $= |(7\vec{a}+5\vec{b})\times(8\vec{a}+11\vec{b})| \quad = |\vec{0}+(77-40)\vec{a}\times\vec{b}+\vec{0}| = 37|\vec{a}\times\vec{b}| = 37\times 20 = 740$

Ans: (b)

82. 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)

83. 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, $\cos\theta = \frac{3(2)+2(-12)-6(-3)}{\sqrt{9+4+36}\sqrt{4+144+9}} = \frac{6-24+18}{7\sqrt{157}} = 0 \quad \therefore \theta = 90°$

Ans: (a)

84. 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)

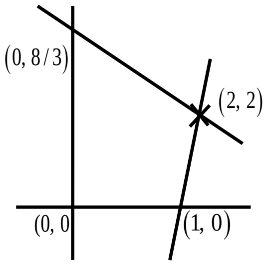
85. $x=0, y=0, 2x-y=2$ and $x+3y-8=0$ are the sides of a quadrilateral. Then the product of the slopes of the diagonal is

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 $=-\frac{8}{3}$



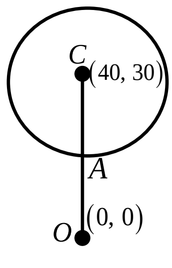
Ans: (c)

86. 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)

87. 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:

$\sigma^2=36; \sigma_y^2=4\times36=144$

Ans: (c)

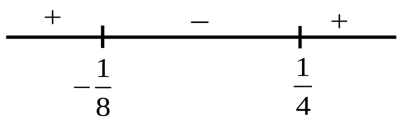
88. The solution of $\frac{6x}{4x-1}<\frac{1}{2}$ is

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)

89. 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)

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

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)

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

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)

92. 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 $g(x)=x^3-3x$

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

Ans: (c)

93. 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: $\cos^{-1}\sqrt{1-x^2}=\sin^{-1}x \quad \therefore \cos^{-1}\sqrt{1-x}=\sin^{-1}\sqrt{x}$

Ans: (a)

94. 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: $xy=\tan xy$

$\therefore \frac{d}{dx}(xy)=\frac{d}{dx}(\tan xy) \quad y+x\frac{dy}{dx}=\sec^2(xy)\left(y+x\frac{dy}{dx}\right) \Rightarrow y+x\frac{dy}{dx}=0 \Rightarrow \frac{dy}{dx}=-\frac{y}{x}$

Ans: (c)

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

Options:

(a) 0 (b) 4 (c) -2 (d) 2

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

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

Ans: (b)

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

Options:

(a) $\sec x-\tan x$ (b) $\sec x+\tan x$ (c) $\tan x-\sec x$ (d) $-(\sec x+\tan x)$

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

Ans: (b)

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

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)

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

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)

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

Options:

(a) $2(1-e)$ (b) 2 (c) -2 (d) $2(1+e)$

Sol:

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

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

Ans: (b)

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

Options:

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

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

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

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

Ans: (b)

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

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 $\cos^2 x$

$=\int\frac{\sec^2 x}{\sec^2 x-10\tan^2 x}dx=\int\frac{\sec^2 x}{1-9\tan^2 x}dx=\frac{1}{3}\int\frac{d(3\tan x)}{1-(3\tan x)^2}=\frac{1}{3}.\frac{1}{2\times1}\log\frac{1+3\tan x}{1-3\tan x}+C$

Ans: (c)

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

$\Rightarrow y+3=e^{x+c}=ke^x \quad \Rightarrow 2+3=k.e^0 \Rightarrow k=5 \quad \therefore y+3=5e^x$

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

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

Ans: (d)

103. 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) $x^2y+y=c$ (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)

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

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)

105.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)

106.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 $HTH,\ HHT,\ HTT,\ HHH$]

$P(E\cap F)=\frac{3}{8}$

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

Ans: (a)

107.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 $={}^9C_3=\frac{9.8.7}{6}=84$

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

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

Ans: (c)

108. 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)

109. 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)

110. 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)

111. If m and n are degree and order of $\left(1+y_1^2\right)^{2/3} = y_2$ then the value of $\frac{m+n}{m-n}$ is

Options:

(a) 3 (b) 4 (c) 5 (d) 12

Sol: We have, $\left(1+y_1^2\right)^{2/3} = y_2 \Rightarrow \left(1+y_1^2\right)^2 = y_2^3$

$\Rightarrow m = 3, n = 2$

$\therefore \frac{m+n}{m-n} = \frac{5}{1} = 5$

Ans: (c)

112.If $I=\int_{-\pi}^{\pi}\frac{e^{\sin x}}{e^{\sin x}-e^{-\sin x}}dx$ then $I=$

Options:

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

Sol: We have, $\int_{-a}^{a}f(x)dx=\int_0^a\{f(x)+f(-x)\}dx$

$$I=\int_0^{\pi}\left[\frac{e^{\sin x}}{e^{\sin x}+e^{-\sin x}}+\frac{e^{-\sin x}}{e^{-\sin x}+e^{\sin x}}\right]dx$$

$$=\int_0^{\pi}1\,dx=\pi$$

Ans: (c)

113. $\int\frac{\sin x\cos x}{\sqrt{1-\sin^4 x}}dx=$

Options:

(a) $\frac{1}{2}\cos^{-1}\left(\sin^2 x\right)$ (b) $\frac{1}{2}\sin^{-1}\left(\sin^2 x\right)$ (c) $\tan^{-1}(2\sin x)$ (d) $\tan^{-1}\left(\sin^2 x\right)$

Sol: $I=\frac{1}{2}\int\frac{\sin 2x}{\sqrt{1-\left(\sin^2 x\right)^2}}dx$

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

$$\left(\because\ \frac{d}{dx}\left(\sin^2 x\right)=\sin 2x\right)$$

Ans: (b)

114.If $y=x^{x^{x^{\cdot^{\cdot^{\cdot^{\infty}}}}}}$,then $x(1-y\log x)\frac{dy}{dx}=$

Options:

(a) x^2 (b) y^2 (c) xy^2 (d) xy

Sol: We have, $y=x^y$

$$\Rightarrow\quad \frac{dy}{dx}=y\left[\frac{y}{x}\cdot 1+\log x\cdot\frac{dy}{dx}\right]$$

$$\Rightarrow\quad \frac{dy}{dx}(1-y\log x)=\frac{y^2}{x}\quad\Rightarrow\quad x(1-y\log x)\frac{dy}{dx}=y^2$$

Ans: (b)

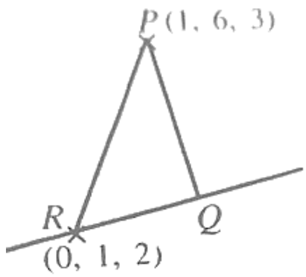
115.The length of the perpendicular from $(1,6,3)$ to the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$ is

Options:

(a) 3 (b) $\sqrt{11}$ (c) $\sqrt{13}$ (d) 5

Sol: Let Q be the foot of the perpendicular from $P(1,6,3)$ onto the line.

The line passes through $R(0,1,2)$



Now, $PR^2 = 1^2 + 5^2 + 1^2 = 27$

Direction cosines of the line are, $\frac{1}{\sqrt{14}}, \frac{2}{\sqrt{14}}, \frac{3}{\sqrt{14}}$

$RQ =$ Projection of PR along the line

$= (1-0)\frac{1}{\sqrt{14}} + (6-1)\frac{2}{\sqrt{14}} + (3-2)\frac{3}{\sqrt{14}}$

$= \frac{1}{\sqrt{14}} + \frac{10}{\sqrt{14}} + \frac{3}{\sqrt{14}} = \sqrt{14}$

Now, $PQ^2 = PR^2 - RQ^2 = 27 - 14 = 13$

$\therefore \quad PQ = \sqrt{13}$

Ans: (c)

116.If $f(x) = \begin{cases} x \cdot \sin\left(\frac{1}{x}\right) & x \neq 0 \\ 0 & x = 0 \end{cases}$ then at $x = 0$, the function is

Options:

(a) differentiable but not continuous

(b) continuous but not differentiable

(c) not continuous

(d) continuous and differentiable

Sol: Consider $\lim_{x \to 0} x \cdot \left(\sin\frac{1}{x}\right) = 0 \times (\text{a finite quantity})$

$\therefore$ The function is continuous at $x = 0$

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

$= \lim_{h \to 0} \frac{h\left(\sin\frac{1}{h}\right)}{h} = \lim_{h \to 0} \sin\left(\frac{1}{h}\right)$

This limit does not exist as it does not tend to a unique finite quantity.

Ans: (b)

117.If $f(x) = \begin{cases} \frac{\sin 5x}{x^2 + 2x} & x \neq 0 \\ k + \frac{1}{2} & x = 0 \end{cases}$ is continuous at $x = 0$, then the value of k is

Options:

(a) 2

(b) 1/2

(c) 1

(d) −4

Sol: For continuity of $f(x)$ at $x = 0$,

$\lim_{x \to 0} f(x) = f(0) \Rightarrow \lim_{x \to 0} \frac{\sin 5x}{x^2 + 2x} = k + \frac{1}{2}$

$\Rightarrow \lim_{x\to 0}\frac{\sin 5x}{5x}\cdot\left(\frac{5}{x+2}\right)=k+\frac{1}{2}$

$\Rightarrow 1.\frac{5}{2}=k+\frac{1}{2}\Rightarrow k=2$

Ans: (a)

118. In the interval $(-3,3)$ the function $f(x)=\frac{x}{3}+\frac{3}{x}, x\neq 0$ is

Options:

(a) increasing
(b) decreasing
(c) neither increasing nor decreasing
(d) partly increasing and partly decreasing

Sol: We have, $f(x)=\frac{x}{3}+\frac{3}{x}\Rightarrow f'(x)=\frac{1}{3}-\frac{3}{x^2}$

$\Rightarrow f'(x)=\frac{x^2-9}{3x^2}$

Now, $f'(x)<0\Rightarrow x^2-9<0$

$\Rightarrow x^2<9$

$\Rightarrow |x|<3\Rightarrow -3<x<3$

$\therefore f'(x)<0$ in $(-3,3)$

$\Rightarrow f(x)$ is decreasing in $(-3,3)$.

Ans: (b)

119. The function $f(x)=xe^{-x}(x\in R)$ attains a maximum value at $x=$

Options:

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

Sol: We have, $f(x)=xe^{-x}\Rightarrow f'(x)=-xe^{-x}+e^{-x}$

$f'(x)=0\Rightarrow e^{-x}(1-x)=0\Rightarrow x=1;\quad f''(x)=e^{-x}(-1)-e^{-x}(1-x)=e^{-x}(x-2)$

$\Rightarrow f''(1)=-\frac{1}{e^x}<0 \quad \therefore\ f(x)$ attains maximum at $x=1$.

Ans: (c)

120. Area of the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ is

Options:

(a) 36π
(b) 6π
(c) 6
(d) none of these

Sol: Area of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is πab.

Here $a=3, b=2$.

$\therefore$ Area $=\pi\cdot 3\cdot 2=6\pi$

Ans: (b)

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

(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

(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

(a) $45°$ (b) $60°$ (c) $75°$ (d) $30°$

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

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

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

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

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

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.

(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

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

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

(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.

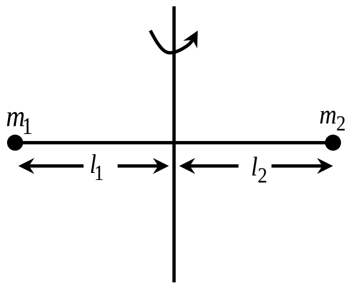
Ans: (b)

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

(a) $\dfrac{m_1 m_2}{m_1 + m_2} l^2$ (b) $\dfrac{m_1 + m_2}{m_1 m_2} l^2$ (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,



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

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

Required moment of inertia of the system,

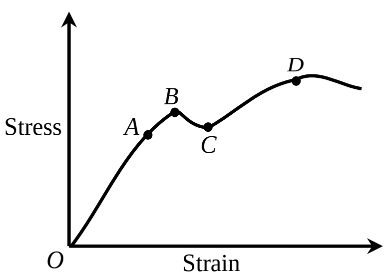
$I = m_1 l_1^2 + m_2 l_2^2$

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

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

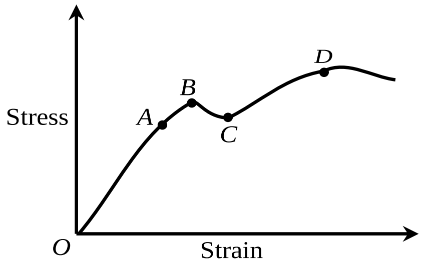
Ans: (a)

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



(a) OA (b) OB (c) OC (d) AC

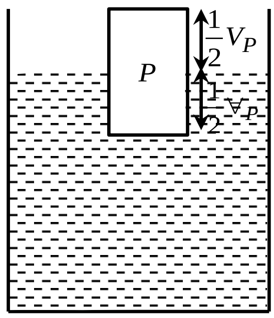
Sol: The material is elastic in the region OA because in this region, the stree-strain graph is linear and Hooke's law is obeyed.



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

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



Sol: For solid P,

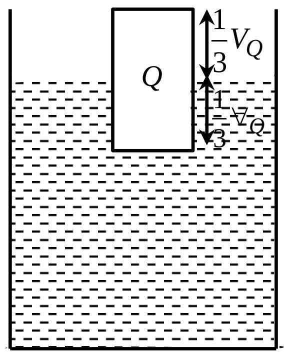
Let V_P and ρ_p volume and density of solid P respectively.

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 $(r_1 = 1.5 r_2)$ through 1K are in the ratio of

(a) $\frac{27}{8}$ (b) $\frac{9}{4}$ (c) $\frac{3}{2}$ (d) 1

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

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

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

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

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

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

$Q_2=m_2S_{copper}\Delta T=\frac{4}{3}\pi r_2^3\rho_{copper}\times S_{copper}\times 1$

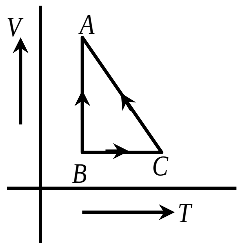
$=\frac{4}{3}\pi r_2^3\rho_{copper}S_{copper}$ … (ii)

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



(a) at A is more than at B

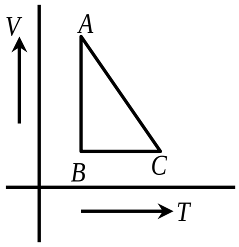
(b) at C is less than at B

(c) at B is more than at A

(d) at A and B are equal

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 of molecules of a gas, (radius r) is inversely proportional to

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

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

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

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

Ans: (b)

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

(a) $200\ \mathrm{m s^{-2}}$ (b) $10\ \mathrm{m s^{-2}}$ (c) $0.1\ \mathrm{m\ s^{-2}}$ (d) $100\ \mathrm{m\ s^{-2}}$

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

(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 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

(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

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

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

Ans: (d)

135.Water rises in plant fibres due to

(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 nC, then how many electrons are removed from the body?

(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

$$n = \frac{q}{e} = \frac{1 \times 10^{9} C}{1.6 \times 10^{-19} C} = 6.25 \times 10^{9}$$

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

(a) $+17 \text{ Vm}^{-1}$ (b) -17 Vm^{-1} (c) $+12 \text{ Vm}^{-1}$ (d) -12 Vm^{-1}

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

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

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

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

Ans: (c)

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

(a) $3 \times 10^{4} \text{ Vm}^{-1}$ (b) $3 \times 10^{6} \text{ Vm}^{-1}$ (c) $3 \times 10^{-4} \text{ Vm}^{-1}$ (d) 3 Vm^{-1}

Sol: Here, $Q = 3 \text{ nC} = 3 \times 10^{-9} \text{ C}$

$R = 2 \text{ cm} = 2 \times 10^{-2} \text{ m}$; At a point 3 cm from the Centre, i.e., $r = 3 \text{ cm} = 3 \times 10^{-2} \text{ m}$

$$\text{Electric field, } E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} = \frac{9 \times 10^{9} \times 3 \times 10^{-9}}{\left(3 \times 10^{-2}\right)^2} = 3 \times 10^{4} \text{ Vm}^{-1}$$

Ans: (a)

139.Pick out the statement which is incorrect.

(a) The electric field lines forms closed loop

(b) Electric field lines never intersect

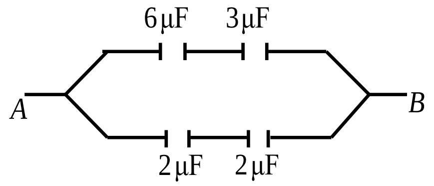
(c) The tangent drawn to a line of force represents the direction of electric field

(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.

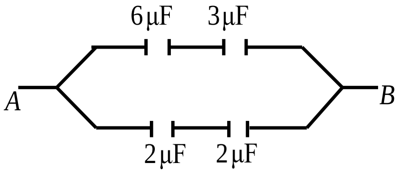
Ans: (a)

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



(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



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

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 $r >> a$

(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 $1.0\ \mu\text{C}$ separated by a distance of $2.0\,\text{cm}$. The dipole is placed in an external field of $10^5\ \text{N C}^{-1}$. The maximum torque on the dipole is

(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, $q = 1\mu\text{C} = 10^{-6}C,\ 2a = 2\ \text{cm} = 2\times 10^{-2}\ \text{m}$,

$E = 10^5\ \text{NC}^{-1}, \tau = ?\quad \therefore\ \tau = 10^{-6}\times 2\times 10^{-2}\times 10^5 = 2\times 10^{-3}\ \text{Nm}$

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

(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 cm long wire and 1 mm^2 cross-sectional area carries a current of 4 A when connected to a 2 V battery. The resistivity of the wire is

(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 mm^2 carries a current of 3.2 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

(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),

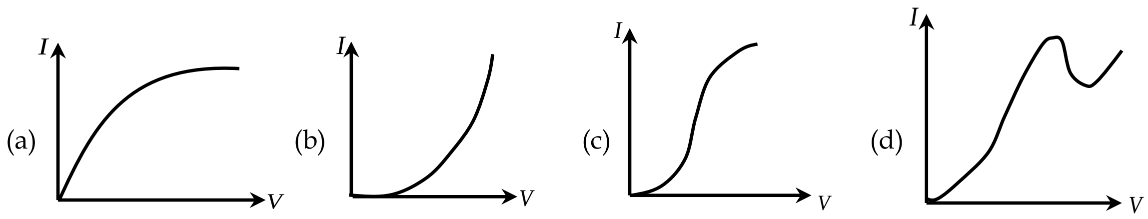
$n = 5\times10^{26}\text{ m}^{-3}$

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?



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

(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

(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, $H = I^2 R$

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

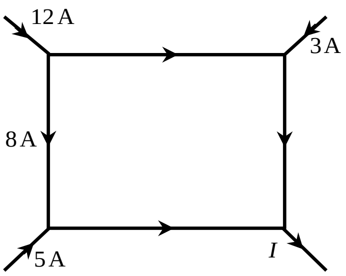
$\therefore \; H \propto R$

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



(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

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

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

(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 $r = \dfrac{mv}{eB} = \dfrac{v}{\frac{e}{m}B}$

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

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

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

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

(a) 1.5×10^{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, $v = 2\times10^{3}\text{ms}^{-1}$, $B = 1.5$ T

$\therefore\ E = \left(2\times10^{3}\ \text{m s}^{-1}\right)(1.5\text{T}) = 3\times10^{3}\ \text{N C}^{-1}$

Ans: (c)

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

(a) $\dfrac{1}{r^2}$ (b) $\dfrac{1}{r}$ (c) $\dfrac{1}{r^3}$ (d) $\dfrac{1}{\sqrt{r}}$

Sol: Magnetic field due to an infinitely long straight conductor carrying steady current at a distance r from it is given by

$B = \dfrac{\mu_0 2I}{4\pi r}$ or $B \propto \dfrac{1}{r}$

Ans: (b)

154. A magnetic needle is kept in a non-uniform magnetic field. It experiences

(a) neither a force nor a torque (b) a torque but not a force

(c) a force but not a torque (d) a force and a torque

Sol: a magnetic needle kept in non uniform magnetic field experience a force and torque due to unequal forces acting on poles.

Ans: (d)

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

(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

(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 $\quad I = 1\text{ A}, \mu_r = 500$

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

As $\mu_r = 1+\chi$

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

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

$= 499\times 500\text{ A m}^{-1} = 2.495\times10^{5}\text{ A m}^{-1}$

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

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 $t = 0.5\text{s}$ if resistance of coil is $10\,\Omega$?

(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, $R = 10\ \Omega$

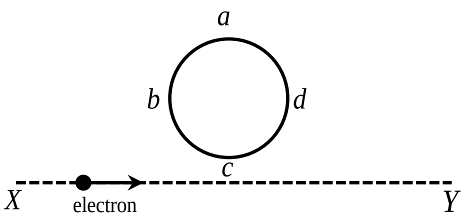
The induced emf is $\varepsilon = \frac{d\phi}{dt} = -\frac{d}{dt}\left(6t^2 - 5t + 1\right) = -(12t - 5)$

At $t = 0.5\text{s}$; $\varepsilon = -(6-5) = -1\text{ V}$

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

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?



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

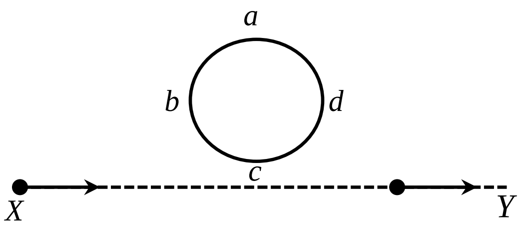
(b) No current will be induced

(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

(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

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

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

(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. $I_sV_s = (1/2)I_pV_p$.

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

(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

(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

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

Refractive index for medium M_2 is

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

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

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

$\therefore\ \sin\theta > \frac{\mu_2}{\mu_1} > \frac{3/2}{2}$ 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 6cm and refractive index is 1.5. Then its radii of curvature are ________ respectively

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

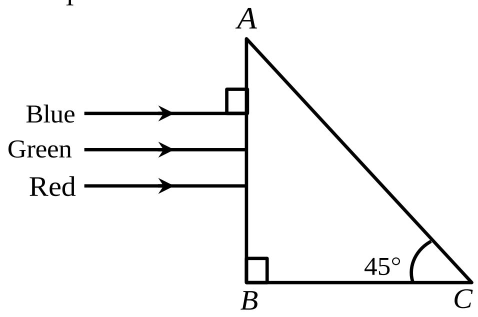
Here, $f = 6$ cm, $\mu = 1.5$; $R_1 = R, R_2 = -2R$ $\therefore \frac{1}{6} = (1.5-1)\left(\frac{1}{R} - \frac{1}{-2R}\right) = 0.5\left(\frac{1}{R} + \frac{1}{2R}\right)$

$\frac{1}{6} = 0.5\left(\frac{3}{2R}\right)$ or $\frac{1}{6} = \frac{1.5}{2R}$; $R = \frac{1.5 \times 6}{2} = 4.5$ cm

$\therefore R_1 = 4.5$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



(a) not separate the three colours at all

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

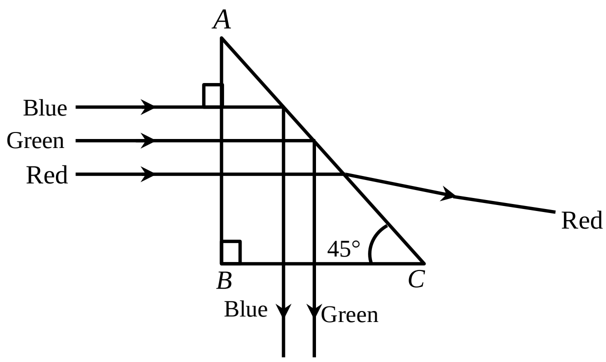
(c) separate the blue colour part from the red and green colours

(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.Resolving power of a telescope increases with

(a) Increase in focal length of eye-piece (b) Increase in focal length of objective

(c) Increase in aperture of eye piece (d) Increase in aperture of objective

Sol: Resolving power $= \frac{\lambda}{d\lambda}$ plane transmission grating

Resolving power for telescope $= \frac{1}{\text{limit of resolution}} = \frac{d}{1.22\lambda} = \frac{d_0}{d_1}$

By increasing the aperture of objective resolving power can be increased.

Ans: (d)

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

(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

(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 $1.8 \times 10^6\ \text{m s}^{-1}$. Take the value of specific charge of the electron is $1.8 \times 10^{11}\ \text{C kg}^{-1}$. Then the stopping potential (in volt) is

(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, $\frac{e}{m} = 1.8 \times 10^{11}$ C kg^{-1}, $v_{max} = 1.8 \times 10^{6}$ m s^{-1}

$$\therefore \quad V_S = \frac{1}{2} \times \frac{1}{1.8 \times 10^{11}} \times \left(1.8 \times 10^{6}\right)^2 = 9\,\text{V}$$

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

(a) $(4\lambda)/3$ (b) 6λ (c) 4λ (d) 8λ

Sol: $h\upsilon = W_0 + KE(\text{max})$

$$\frac{hc}{\lambda} = W_0 + 3eV_s \qquad \dots \text{(i)}$$

$$\frac{hc}{2\lambda} = W_0 + eV_s \qquad \dots \text{(ii)}$$

Eqns (i) –Eqns (ii)

$$\therefore \quad \frac{hc}{\lambda} - \frac{hc}{2\lambda} = \frac{hc}{2\lambda} = 2eV_s \quad \therefore \quad \frac{hc}{\lambda} = 4eV_s \qquad \dots \text{(iii)}$$

$$\therefore \; W_0 = eV_s \qquad \dots \text{(iv)}$$

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

(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

(a) 1.36 eV (b) 13.6 eV (c) 0.136 eV (d) 136 eV

Sol: $E_n = -\frac{Rhc}{n^2} = \frac{Rhc}{n^2 e}\text{eV}$

$$E_{n=1} = \frac{1.09 \times 10^{7} \times 6.63 \times 10^{-34} \times 3 \times 10^{8}}{(1)^2 \times 1.6 \times 10^{-19}}\text{eV} = 13.6\text{eV}$$

13.6 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)

(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

(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

(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?

(a) Germanium is doped with bismuth (b) Silicon is doped with antimony

(c) Germanium is doped with gallium (d) Silicon is doped with phosphorus

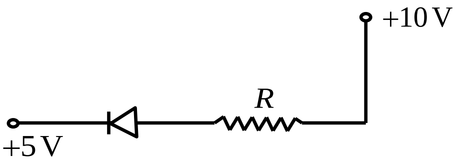
Sol: $p-$type semiconductor is obtained when silicon (Si) or germanium (Ge) is doped with a trivalent impurity like, boron (B), aluminium (Al), gallium (Ga) etc.

$n-$type semiconductor is obtained when silicon (Si) or germanium (Ge) is doped with a pentavalent impurity like arsenic (As), antimony (Sb), bismuth (Bi) etc.

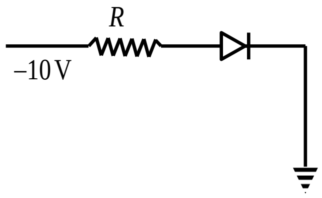
Ans: (c)

177.In the following figure, the diodes which are forward biased, are

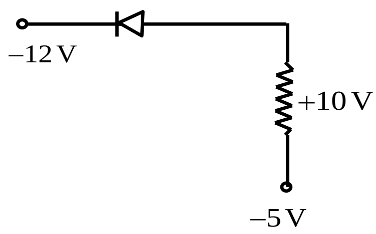
(A)



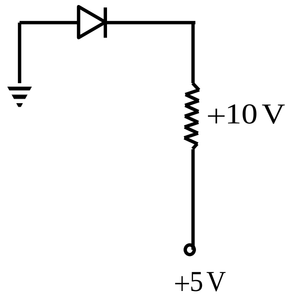
(B)



(C)



(D)



(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.In semiconductors, at room temperature

(a) The conduction band is completely empty

(b) The valence band is partially empty and the conduction band is partially filled

(c) The valence band is completely filled and the conduction band is partially filled

(d) The valence band is completely filled

Sol: The valence band is completely filled and the conduction band is partially filled.

Ans: (c)

179.The velocity of electromagnetic radiation in vacuum of permittivity ε_0 and permeability μ_0 is given by

(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?

(a) 0.1227 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

$\lambda = \frac{12.27}{\sqrt{V}}$ Å For $V = 100$ volt $\lambda = \frac{12.27}{\sqrt{100}}$ Å $= 1.227$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. c	13. a	14. a	15. a	16. b	17. c	18. b	19. d	20. d
21. b	22. b	23. d	24. c	25. c	26. d	27. d	28. a	29. a	30. b
31. b	32. a	33. a	34. d	35. d	36. a	37. a	38. d	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. d	63. c	64. d	65. b	66. b	67. d	68. a	69. c	70. b
71. a	72. b	73. b	74. d	75. d	76. d	77. c	78. b	79. a	80. c
81. b	82. d	83. a	84. b	85. c	86. a	87. c	88. b	89. b	90. d
91. d	92. c	93. a	94. c	95. b	96. b	97. d	98. d	99. b	100.b
101.c	102.d	103.c	104.d	105.c	106.a	107.c	108.b	109.c	110.d
111.c	112.c	113.b	114.b	115.c	116.b	117.a	118.b	119.c	120.b
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.d	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.c	179.a	180.d