Deeksha - CET

Subject	Topic	Mock Test – 01	Date
C + M + P	Complete Syllabus	CET – 12 – CT C1220240103	3rd Jan 2024

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:

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

Chemistry

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

1. Among the following pairs of compounds, the one that illustrates the law of multiple proportions is

   (a) NH_3 and NCl_3 (b) H_2S and SO_2 (c) MnO and Mn_2O_3 (d) CS_2 and $FeSO_4$

   Sol: For the same amount of oxygen weight ratio of Mn is $1:2$ therefore law of multiple proportion.

   Ans: (c)

2. In the reaction, $3Cl_2 + 6NaOH \longrightarrow NaClO_3 + 5NaCl + 3H_2O$

   The element which loses as well as gains electrons is

   (a) Na (b) Cl (c) O (d) H

   Sol: In the reaction

   $3Cl_2 + 6NaOH \longrightarrow NaClO_3 + 5NaCl + 3H_2O$

   O.N. of Cl increases from zero in Cl_2 to +5 in $NaClO_3$ and decreases from zero in Cl_2 to -1 to $NaCl$.

   Ans: (b)

3. Which of the following has the highest bond order?

   (a) N_2 (b) O_2 (c) He_2 (d) H_2

   Sol: N_2

   Ans: (a)

4. The uncertainty in the position of an electron moving with a velocity of $3.0\times10^2\,\text{m/s}$ accurate upto 0.011% will be $\left(m = 9.1\times10^{-31}\,\text{Kg}\right)$

   (a) $80\times10^{-4}\,\text{m}$ (b) $40\times10^{-3}\,\text{m}$ (c) $1.75\times10^{-3}\,\text{m}$ (d) $1.75\times10^{-5}\,\text{m}$

   Sol: $\Delta x = \dfrac{h}{4\pi\Delta p} = \dfrac{h}{4\pi m\Delta v} = \dfrac{6.6\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times3.0\times10^{2}\times\dfrac{0.011}{100}} = 1.75\times10^{-3}\,\text{m}$

   Ans: (c)

5. The pair of species having same percentage of carbon is

   (a) C_2H_5OH and CH_3OCH_3 (b) CH_3COOH and $HCOOH$

   (c) $HCOOCH_3$ and C_3H_7OH (d) $C_6H_{12}O_6$ and C_6H_5OH

   Sol: % of C in $C_2H_5OH = \dfrac{24\times100}{46} = 52\%$

   % of C in $CH_3OCH_3 = \dfrac{24\times100}{46} = 52\%$

   Ans: (a)

6. Which of the following properties show gradual decrease with increase in atomic number across a period in the Periodic Table?

   (a) Electron affinity (b) Ionisation potential (c) Electronegativity (d) Size of atom

   Sol: Size of atom decreases with increase in atomic number across the period in Periodic Table.

Ans: (d)

7. For the reaction $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$. Which of the following is correct?

(a) $\Delta H = \Delta U$ (b) $\Delta H > \Delta U$ (c) $\Delta H < \Delta U$ (d) $\Delta H = 2\Delta U$

Sol: $\Delta H = \Delta U + \Delta nRT$

$\Delta n = (2-4) = -2$

$\therefore \Delta H = \Delta U - 2RT$

Or $\Delta U = \Delta H + 2RT$

Ans: (c)

8. Which of the following is NOT a state function?

(a) Internal energy (b) Enthalpy (c) Work (d) Entropy

Sol: Work is not a state function.

Ans: (c)

9. Given the reaction between two gases represented by A_2 and B_2 to give the compound $AB_{(g)}$

$A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)}$

At equilibrium, the concentration of $A_2 = 3.0\times10^{-3}M$, of $B_2 = 4.2\times10^{-3}M$, of $AB = 2.8\times10^{-3}M$. If the reaction takes place in a sealed vessel at $527°C$, then the value of K_c will be

(a) 2.0 (b) 1.9 (c) 0.62 (d) 4.5

Sol: $A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_g$

$$K_c = \frac{[AB]^2}{[A_2][B_2]} = \frac{\left(2.8\times10^{-3}\right)^2}{\left(3.0\times10^{-3}\right)\left(4.2\times10^{-3}\right)} = \frac{2.8\times2.8}{3.0\times4.2} = 0.62$$

Ans: (c)

10. pH Value of which one of the following is not equal to one?

(a) 0.1 M CH_3COOH (b) 0.1 M HNO_3

(c) 0.05 M H_2SO_4 (d) 50 cm^3 0.4 M HCl + 50 cm^3 0.2 M $NaOH$

Sol: CH_3COOH is a weak acid, it does not dissociate completely.

$\therefore$ $pH \neq 1$

Ans: (a)

11. Which of the following aqueous solution will have a pH less than 7.0 ?

(a) KNO_3 (b) $NaOH$ (c) $FeCl_3$ (d) $NaCN$

Sol: Fe^{3+} ions are hydrolysis to develop acidic nature.

Ans: (c)

12. The oxide of an element whose electronic configuration is $1s^2 2s^2 2p^6 3s^1$ is

(a) amphoteric (b) basic (c) acidic (d) neutral

Sol: The given element is sodium, which is an alkali metal and alkali metal oxides are strongly basic.

Ans: (b)

13. The correct order of electronegativities of N, O, F and P is

(a) $F > O > N > P$ (b) $N > O > F > P$ (c) $F > N > P > O$ (d) $F > O > P > N$

Sol: Electronegativity decreases down the group and increases along the period, so the order (choice 1) is justified.

Ans: (a)

14. Number of molecules in one litre of water is close to

(a) $\frac{18}{22.4} \times 10^{23}$ (b) $55.5 \times 6.022 \times 10^{23}$ (c) $\frac{6.022}{23.4} \times 10^{23}$ (d) $18 \times 6.022 \times 10^{22}$

Sol: No. of moles in 1L of water $= \frac{1000\text{ g}}{18\text{ g mol}^{-1}} = 55.5\text{ mol}$

No. of molecules $= 55.5 \times 6.022 \times 10^{23}$

Ans: (b)

15. IUPAC name of $H_3C{-}CH_2{-}C(Br){=}CH{-}Cl$ is

(a) 2-Bromo-1-chlorobut-1-ene (b) 1-chloro-2-bromobut-1-ene

(c) 3-chloro-2-bromobut-1-ene (d) 3-Bromo-4-chlorobut-3-ene

Sol:

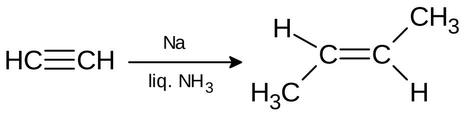
$\overset{4}{H_3C}{-}\overset{3}{CH_2}{-}\overset{2}{C}(Br){=}\overset{1}{CH}{-}Cl$

Ans: (a)

16. 2-butyne is reduced to trans-but-2-ene using

(a) $H_2|Ni$ (b) $H_2|Pd-C$ (c) Na in liq. NH_3 (d) Zn in dil. HCl

Sol: 2 butyne $\xrightarrow[\text{Birch reduction}]{Na/lqNH_3}$ trans-but-2-ene



Ans: (c)

17. In the reaction

$S + \frac{3}{2}O_2 \longrightarrow SO_3 + 2x\text{ kJ}$ and $SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3 + y\text{ kJ}$

Heat of formation of SO_2 is

(a) $x - y$ (b) $2x + y$ (c) $x + y$ (d) $2x - y$

Sol: $S(g) + O_2(g) \longrightarrow SO_2(g)$

ΔH_f for the above reaction can be obtained by subtracting equation (ii) from equation (i);

i.e., $(2x - y)$

Ans: (d)

18. Strongest reducing agent among the following is

(i) $Na^{+}+e^{-} \longrightarrow Na_{(s)} -2.71\, E^{\Theta}/V$

(ii) $Al^{3+}+3e^{-} \longrightarrow Al_{(s)} -1.66^{\Theta}/V$

(iii) $F_{2(g)}+2e^{-} \longrightarrow 2F^{-} +2.87\, E^{\Theta}/V$

(iv) $2H_2O+2e^{-} \longrightarrow F_{2(g)}+2OH^{-}{}_{(g)} -0.83\, E^{\Theta}/V$

(a) iv (b) iii (c) ii (d) i

Sol: Lower the standard reduction potential, stronger is the reducing agent.

Ans: (d)

19. The half life of the first order reaction having rate constant $k=1.7\times10^{-5}\text{s}^{-1}$ is

(a) 12.1 h (b) 9.7 h (c) 11.3 h (d) 1.8 h

Sol: $t_{1/2}=\dfrac{0.693}{k}=\dfrac{0.693}{1.7\times10^{-5}\text{s}^{-1}}=0.407\times10^{5}\text{ s}$

$=\dfrac{0.407\times10^{5}}{3600}\text{hour}=11.3\text{ h}$

Ans: (c)

20. The equation for the rate constant is $k=Ae^{-E_a/RT}$. A chemical reaction will proceed more rapidly if there is a decrease in

(a) k (b) A (c) E_a (d) T

Sol: Lesser the activation energy, faster is the reaction.

Ans: (c)

21. A solution containing $1.8g$ of a compound (empirical formula CH_2O) in $40\,g$ of water is observed to freeze at $-0.465°C$. The molecular formula of the compound is (K_f of water $=1.86\,kg$ K mol^{-1})

(a) $C_2H_4O_2$ (b) C_3H_6 (c) $C_4H_8O_4$ (d) $C_6H_{12}O_6$

Sol: $M_2=\dfrac{1000K_f w_2}{w_1\times\Delta T_f}=\dfrac{1000\times1.86\times1.8}{40\times0.465}=180$

E.F. mass $CH_2O=30$ $\quad\therefore\; n=\dfrac{180}{30}=6$

$\therefore$ Molecular formula $=6\times CH_2O=C_6H_{12}O_6$

Ans: (d)

22. What is the amount of urea dissolved per litre if its aqueous solution is isotonic with 20% cane sugar solution? (mol. wt. of urea $=60$)

(a) 200 g / L (b) 35.08 g / L (c) 17.54 g / L (d) 16.7 g / L

Sol: Isonic solution means

$\pi_1 = \pi_2 \Rightarrow \frac{w_1}{m_1 V_1} = \frac{w_2}{m_2 V_2}$

$V_1 = 1\text{Lit} \qquad V_2 = 100\,\text{ml} = 0.1\text{L}$

$\frac{w_1}{60 \times 1} = \frac{20}{342 \times 0.1} = 35.08 = w_1$

Ans: (b)

23. A salt dissolves in water if:

(a) Lattice energy $<$ hydration energy

(b) Ionic product $<$ solubility product

(c) Ions may form hydrogen bonds with water

(d) All of the above

Sol: All of the above

Ans: (d)

24. An electric current of $0.5F$ is passed through 1 litre of 1M $CuSO_4$ solution. After the completion of electrolysis the molarity of the resulting solution will be:

(a) 0.75 M

(b) 0.60 M

(c) 0.50 M

(d) 0.90 M

Sol: $0.5F$ deposits 0.5 equivalent of $Cu = 0.25$ mol of Cu.

$1 - 0.25 = 0.75$ mol in litre $= 0.75\,(\text{M})$

Ans: (a)

25. The Standard Reduction Potential values of Ag, Cu, Co and Zn electrodes are 0.799, 0.337, -0.277 and -0.762 V respectively. Which of the following cells will have maximum cell emf?

(a) $Zn_{(s)} / Zn^{+2}_{(aq)} // Co^{+2}_{(aq)} / Co_{(s)}$

(b) $Zn_{(s)} / Zn^{+2}_{(aq)} // Ag^{+}_{(aq)} / Ag_{(s)}$

(c) $Cu_{(s)} / Cu^{+2}_{(aq)} // Ag^{+}_{(aq)} / Ag_{(s)}$

(d) $Zn_{(s)} / Zn^{+2}_{(aq)} // Cu^{+2}_{(aq)} / Cu_{(s)}$

Sol: $0.799 - (-0.762) = 1.561$

Ans: (b)

26. The molar conductance of 0.1M solution of a weak acid HA is $1.4\,\text{S}\,\text{cm}^2\,\text{mol}^{-1}$. The molar conductance of HA at infinite dilution is $140\,\text{S}\,\text{cm}^2\text{mol}^{-1}$. Calculate the pH of $0.1\,\text{M}$ solution of HA.

(a) 4

(b) 2

(c) 3

(d) 8

Sol: The degree of dissociation of $HA = \alpha = \frac{\Lambda m}{\Lambda_m^0} = \frac{1.4}{140} = 0.01$

$[H^+] = C\alpha = 0.01 \times 0.1 = 0.001M$

$pH = -\log(0.001) = 3$

Ans: (c)

27. For the reaction $A + 2B \rightarrow 3C$, the rate of reaction at a given instant can be represented by

(a) $+\frac{d[A]}{dt}=+\frac{1}{2}\frac{d[B]}{dt}=+\frac{1}{3}\frac{d[C]}{dt}$

(b) $\frac{d[A]}{dt}=+\frac{1}{2}\frac{d[B]}{dt}=-\frac{1}{3}\frac{d[C]}{dt}$

(c) $-\frac{d[A]}{dt}=-\frac{1}{2}\frac{d[B]}{dt}=+\frac{1}{3}\frac{d[C]}{dt}$

(d) $-\frac{d[A]}{dt}=+\frac{2d[B]}{dt}+\frac{3d[C]}{dt}$

Sol: For reaction $A+2B\rightarrow C$,

Rate $=-\frac{d[A]}{dt}=-\frac{1}{2}\frac{d[B]}{dt}=+\frac{1}{3}\frac{d[C]}{dt}$.

Ans: (c)

28. The rate constant of a reaction is $2.1\times10^{-2}\,\text{mol}^{-2}L^2\,\text{min}^{-1}$. The order of reaction is

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

Sol: For 3rd order, $\frac{dx}{dt}=k[conc.]^3$, i.e., n = 3

Unit of rate constant = $\left(\text{mol}\,L^{-1}\right)^{1-n}s^{-1}=\left(\text{mol}\,L^{-1}\right)^{-2}s^{-1}=\text{mol}^{-2}L^2s^{-1}$

Ans: (d)

29. If the activation energy for the forward reaction is $150\,\text{kJ mol}^{-1}$ and that of the reverse reaction is $260\,\text{kJ mol}^{-1}$, what is the enthalpy change for the reaction?

(a) $410\,\text{kJ mol}^{-1}$ (b) $-110\,\text{kJ mol}^{-1}$ (c) $110\,\text{kJ mol}^{-1}$ (d) $-410\,\text{kJ mol}^{-1}$

Sol: $\Delta H=E_f-E_b=150-260\,\text{kJ}=-110\,\text{kJ}$

Ans: (b)

30. All form ideal solution except

(a) C_6H_6 and $C_6H_5CH_3$

(b) C_2H_5Br and C_2H_5I

(c) C_6H_5Cl and C_6H_5Br

(d) C_2H_5I and C_2H_5OH

Sol: $C_2H_5I+C_2H_5OH$ is a non-ideal solution.

Ans: (d)

31. Which of the following aqueous solution has highest freezing point?

(a) 0.1 molal $Al_2(SO_4)_3$

(b) 0.1 molal $BaCl_2$

(c) 0.1 molal $AlCl_3$

(d) 0.1 molal NH_4Cl

Sol: $\Delta T_f=i\times K_f\times m$

For $Al_2(SO_4)_3, i=5$

For $BaCl_2, i=3$

For $AlCl_3, i=4$

For $NH_4Cl, i=2$

Least $i\Rightarrow$ minimum $\Delta T_f\Rightarrow$ Highest freezing point.

Ans: (d)

32. The magnetic nature of elements depends on the presence of unpaired electrons. Identify the configuration of transition elements which shows highest magnetic moment?

(a) $3d^7$ (b) $3d^5$ (c) $3d^8$ (d) $3d^2$

Sol: $3d^5$ has higher number of unpaired electrons, so it will have highest magnetic moment.

Ans: (b)

33. Misch metal contains iron to the extent of

(a) 25% (b) 15% (c) 5% (d) 20%

Sol: Misch metal contains approx. 5% iron.

Ans: (c)

34. Which metal has the highest melting point?

(a) Tungsten (b) Platinum (c) Silver (d) Gold

Sol: Melting point of tungsten is $3410°C$. Melting points of Pt, Ag and Au are $1769°C, 960°C$ and $1063°C$ respectively.

Ans: (a)

35. Which is colourless in water?

(a) Ti^{4+} (b) V^{3+} (c) Cr^{3+} (d) Ti^{3+}

Sol: $Ti^{4+}\left(3d^0\right)$ has no d-electron. Hence there is no d-d transition of electron and Ti^{4+} ion is colourless.

Ans: (a)

36. Which of the following is not a consequence of the Lanthanide contraction?

(a) $5d$ Series elements have a higher IE_1 than $3d$ or $4d$ series

(b) Irregularity in the ionization enthalpy of $3d$ series

(c) Zr and Hf occurs together in the earth crust in their minerals

(d) Zr and Hf have a comparable size

Sol: Irregularity in the ionization enthalpy of $3d$ series is not due to lanthanide contraction.

Ans: (b)

37. Which of the following has the highest molar conductivity in solution?

(a) $\left[Pt(NH_3)_6\right]Cl_4$ (b) $\left[Pt(NH_3)_5Cl\right]Cl_3$ (c) $\left[Pt(NH_3)_4Cl_2\right]Cl_2$ (d) $\left[Pt(NH_3)_3Cl_3\right]Cl$

Sol: More number of ions is available in aqueous solution.

Ans: (a)

38. The IUPAC name of $\left[Cr(NH_3)_5Cl\right]SO_4$ is:

(a) pentaaminechloridochromium sulphate

(b) pentaamminechloridochromium(III) sulphate

(c) chloridopentaamminechromium(III) sulphate

(d) pentaaminochloridochromium(II) sulphate

Sol: IUPAC name of $\left[Cr(NH_3)_5Cl\right]SO_4$ is pentamminechloridochromium(III) sulphate

Ans: (b)

39. Which of the following ligand has lowest Δ_0 value?

(a) en (b) F^- (c) ox (d) CN^-

Sol: Crystal field splitting ability of ligands as per spectrochemical series is

$I^- < Br^- < SCN^- < S^{-2} < F^- < OH^- < ox < H_2O < NSC^- < EDTA^{-4} < NH_3 < en < CN^- < CO$

Ans: (b)

40. Which of the following is NOT True for S_N1 reaction?

(a) The rate of the reaction does not depend upon the molar concentration of the nucleophile

(b) $1°-$alkyl halides generally react through S_N1 reaction

(c) Favoured by polar solvents

(d) $3°-$ alkyl halides generally react through S_N1 reaction

Sol: 1° – alkyl halides generally react through S_N1 reaction

Ans: (b)

41. The arrangement of following compounds

(i) Bromomethane (ii) Bromoform

(iii) Chloromethane (iv) Dibromomethane

In the increasing order of their boiling point is

(a) $(i)<(ii)<(iii)<(iv)$ (b) $(ii)<(iii)<(i)<(iv)$ (c) $(iv)<(iii)<(i)<(ii)$ (d) $(iii)<(i)<(iv)<(ii)$

Sol: (i) CH_3Br (ii) $CHBr_3$ (iii) CH_3Cl (iv) CH_2Br_2

Ans: (d)

42. Propane nitrile may be prepared by heating:

(a) Ethyl chloride with KCN (b) Propyl alcohol with KCN

(c) Propyl chloride with KCN (d) Propane with KCN

Sol: $CH_3CH_2Cl + KCN \rightarrow \underset{\text{Propane nitrile}}{CH_3CH_2CN}$

Ans: (a)

43. Which one of the following alcohols undergoes acid catalysed dehydration to alkene readily?

(a) $(CH_3)_2CHCH_2OH$ (b) $(CH_3)_3COH$

(c) $CH_3CHOHCH_2CH_3$ (d) $CH_3CH_2CH_2CH_2OH$

Sol: Alcohol which forms the more stable carbocation undergoes dehydration most readily. Since *tert*-butyl alcohol forms more stable *tert*-butyl carbocation, therefore, it undergoes dehydration most readily and n-butyl alcohol undergoes dehydration slowly.

Ans: (b)

44. Phenol reacts with bromine in water to give

(a) $m-$Bromophenol (b) 2, 4, 6 – Tribromophenol

(c) $p-$Bromophenol (d) Mixture of ortho and para-bromophenol

Sol: Phenols reacts with bromine in water to give 2, 4, 6 – Tribromophenol

Ans: (b)

45. The compound which does not react with Lucas reagent is

(a) $n-$Butyl alcohol (b) $sec-$Butyl alcohol

(c) Isobutyl alcohol (d) $tert-$Butyl alcohol

Sol: Primary alcohols such as n-butyl alcohol do not react with Lucas reagent.

Ans: (a)

46. Anisole on treatment with CH_3Cl in presence of anhydrous $AlCl_3$ gives

(a) Toluene (b) o-Chloroanisole

(c) $p-$Chloroanisole (d) $o-$and $p-$methylanisoles

Sol: $-CH_3$ group in anisole is $o, p-$directing. Therefore, anisole on Friedel Craft reaction gives a mixture of $o-$and $p-$methylanisoles.

Ans: (d)

47. One mole of a symmetrical alkene on ozonolysis gives two moles of an acetaldehyde. The alkene is

(a) $2-$Butene (b) Ethene (c) Propene (d) $1-$Butene

Sol: $2-$butene on ozonolysis gives two moles of acetaldehyde with molecular mass 44u.

Ans: (a)

48. The final product (Y) in the following sequence of chemical reaction is

$$CH_3OH \xrightarrow[300°C]{Cu} X \xrightarrow{NaOH} Y + CH_3OH$$

(a) an alkene (b) a carboxylic acid

(c) an aldehyde (d) sodium salt of carboxylic acid

Sol:

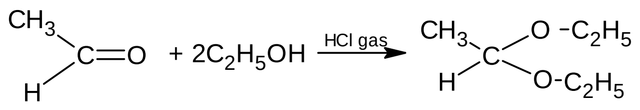
$$\underset{}{CH_3OH} \xrightarrow[300°C]{Cu} \underset{(X)}{HCHO} \xrightarrow{NaOH} \underset{(Y)}{HCOONa} + CH_3OH$$

Ans: (d)

49. In presence of dry HCl gas, CH_3CHO condenses with C_2H_5OH to give

(a) aldol (b) paraldehyde (c) ethyl acetate (d) acetal

Sol:



Ans: (d)

50. Ethanoyl chloride cannot be obtained by treating ethanoic acid with:

(a) $SOCl_2$ (b) $CHCl_3$ (c) PCl_3 (d) PCl_5

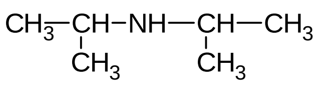
Sol: $R-COOH + PCl_5 \longrightarrow R-COCl + POCl_3 + HCl$

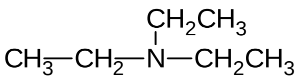
$3R-COOH + PCl_3 \longrightarrow 3R-COCl + H_3PO_3$

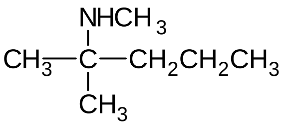
$R-COOH + SOCl_2 \longrightarrow R-COCl + SO_2 + HCl$

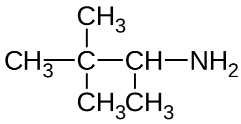
Ans: (b)

51. The amine that reacts with Hinsberg's reagent to give the product soluble in alkali

(a) 

(b) 

(c) 

(d) 

Sol: Primary amines with Hinsberg's reagent give N -alkylbenzene sulphonamide which is soluble in alkali. Secondary amines on reaction with Hinsberg's reagent gives N,N -dialkylbenzene sulphonamide which does not contain any hydrogen atom attached to N −atom, it is not acidic and hence insoluble in alkali. Tertiary amines do not react with Hinsberg's reagent.

Ans: (d)

52. The bad smelling substance formed by the action of alcoholic caustic potash on chloroform and aniline is

(a) Nitrobenzene (b) Phenyl isocyanide

(c) Phenyl cyanide (d) Phenyl isocyanate

Sol:

$$C_6H_5NH_2 + CHCl_3 + \underset{(alc)}{3KOH} \xrightarrow{\Delta} \underset{\text{Phenyl isocyanide}}{C_6H_5NC} + 3KCl + 3H_2O$$

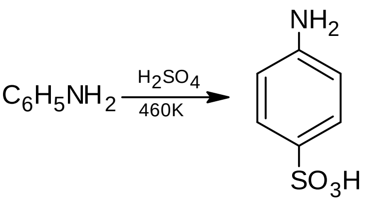
Ans: (b)

53. Aniline on heating with conc. H_2SO_4 at $460K$ gives:

(a) Aniline sulphate (b) Benzene sulphonic acid

(c) Sulphanilic acid (d) Sulphonic acid

Sol:



Ans: (c)

54. The presence of primary alcoholic group in glucose can be confirmed by

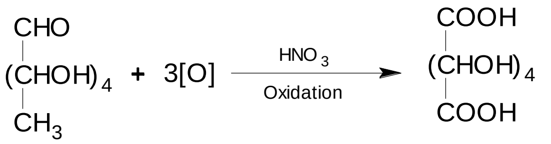
(a) Oxidation of glucose with mild oxidising agent

(b) Acetylation of glucose with acetic anhydride

(c) Oxidation of glucose with nitric acid

(d) Prolonged heating of glucose with HI

Sol: Strong oxidising agents like nitric acid oxidise both the terminal groups $(-CHO$ and $-CH_2OH)$ of glucose to give the dibasic acid, saccharic acid (also known as glucaric acid). This indicates the presence of a primary alcoholic $(-OH)$ group in glucose.



(Saccharic acid)

Ans: (c)

55. What type of sugar molecule is present in RNA?

(a) $D-3-$Deoxyribose (b) $D-$Ribose (c) $D-2-$Deoxyribose (d) $D-$Glucopyranose

Sol: RNA contains $D-$Ribose sugar moiety

Ans: (b)

56. Cheilosis and digestive disorders are due to the deficiency of

(a) Vitamin A (b) Riboflavin (c) Thiamine (d) Ascorbic acid

Sol: Due to the deficiency of vitamin B_2 or G (Riboflavin), Cheilosis (i.e., cracking of lips and corners of the mouth) and digestive disorders occur.

Ans: (b)

57. Clemmensen reduction is carried with:

(a) H_2 in the presence of Pd
(b) NH_2NH_2 / glycol and KOH
(c) $LiAlH_4$ in ether
(d) $Zn-Hg$ and HCl

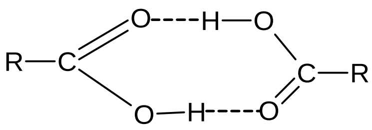
Sol: $Zn-Hg$ and HCl

Ans: (d)

58. Dimerisation in carboxylic acid is due to

(a) ionic bond
(b) covalent bond
(c) coordinate bond
(d) inter molecular hydrogen bond

Sol:



Intermolecular hydrogen bonding is formed, so it exists as a dimer.

Ans: (d)

59. How many peptide linkages are present in a tetrapeptide?

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

Sol: 3

Ans: (c)

60. Which of the following sets of monosaccharides form sucrose?

(a) $\alpha-D-$galactopyranose and $\alpha-D-$glucopytanose
(b) $\alpha-D-$glucopyranose and $\beta-D-$fructofuranose
(c) $\beta-D-$glucopyranose and $\alpha-D-$fructofuranose
(d) $\alpha-D-$glucopyanose and $\beta-D-$fructopyranose

Sol: In sucrose, $C_1-\alpha$ of D-glycopyranose is connected to $C_2-\beta$ of fructofuranose.

Ans: (b)

Mathematics

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

61. The set $A=\left\{x : x \in R, x^2=16 \text{ and } 2x=6\right\}$ is equal to

(a) ϕ (b) $\{14,3,4\}$ (c) $\{3\}$ (d) $\{4\}$

Sol: Since, $x^2=16 \Rightarrow x=\pm 4$ and $2x=6 \Rightarrow x=3$

Hence, no value of x is satisfied.

Ans: (a)

62. Which of the following is correct?

(a) $A\cap\phi=A$ (b) $A\cap\phi=\phi$ (c) $A\cap\phi=U$ (d) $A\cap\phi=A'$

Sol: $A\cap\phi=\phi$ is correct.

Ans: (b)

63. If $A=\{1,3,5,7\}$ and $B=\{1,2,3,4,5,6,7,8\}$ then, the number of one-one function from A into B is

(a) 1340 (b) 1860 (c) 1430 (d) 1680

Sol: Given, $A=\{1,3,5,7\}$ and $B=\{1,2,3,4,5,6,7,8\}$

Here, $n(A)=4$ and $n(B)=8$

$\therefore$ Number of one-one function from A into $B={}^8P_4=8\cdot7\cdot6\cdot5=1680$

Ans: (d)

64. The range of the function $f(x)=x^2+2x+2$ is

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

Sol: Given, $f(x)=x^2+2x+2=x^2+2x+1+1=(x+1)^2+1\geq 1$

So, the range of $f(x)$ is $[1,\infty)$

Ans: (d)

65. If $f(x)=4x^3+3x^2+3x+4$, then $x^3 f\left(\frac{1}{x}\right)$ is equal to

(a) $f(-x)$ (b) $\frac{1}{f(x)}$ (c) $\left[f\left(\frac{1}{x}\right)\right]^2$ (d) $f(x)$

Sol: Given, $f(x)=4x^3+3x^2+3x+4$

$\therefore x^3 f\left(\frac{1}{x}\right)=x^3\left(\frac{4}{x^3}+\frac{3}{x^2}+\frac{3}{x}+4\right)=4+3x+3x^2+4x^3=f(x)$

Ans: (d)

66. For any two real numbers θ and ϕ, we define $\theta R\phi$, if and only if $\sec^2\theta - \tan^2\phi = 1$. The relation R is

(a) reflexive but not transitive

(b) symmetric but not reflexive

(c) both reflexive and symmetric but not transitive

(d) an equivalence relation

Sol: Given relation is defined as $\theta R\phi$ such that $\sec^2\theta - \tan^2\phi = 1$

Reflexive When $\theta R\theta$, $\sec^2\theta - \tan^2\theta = 1$

$\Rightarrow \quad 1 = 1$, which is true.

Thus, it is reflexive

Symmetric

When $\theta R\phi$, $\sec^2\theta - \tan^2\phi = 1$

$\Rightarrow \quad \left(1+\tan^2\theta\right) - \left(\sec^2\phi - 1\right) = 1$

$\Rightarrow \quad 2 + \tan^2\theta - \sec^2\phi = 1$

$\Rightarrow \quad \sec^2\phi - \tan^2\theta = 1 \quad \Rightarrow \quad \phi R\theta$

Thus, it is symmetric.

Transitive

When $\theta R\phi$ and $\phi R\psi$, then

$\sec^2\theta - \tan^2\phi = 1$ and $\sec^2\phi - \tan^2\psi = 1$

Now, if $\theta R\psi$, then

$\sec^2\theta - \tan^2\psi = 1 \quad \Rightarrow \quad \sec^2\theta - \tan^2\psi + 1 = 1 + 1$

Here $\sec^2\theta - \tan^2\psi + 1 = \sec^2\theta - \tan^2\psi + \sec^2\phi - \tan^2\phi = 1 + 1$

$\therefore \quad \theta R\phi$ and $\phi R\psi \quad \Rightarrow \quad \theta R\psi$

Thus, it is transitive. Hence, it is an equivalence relation.

Ans: (d)

67. If $A = \{x, y, z\}$ and $B = \{a, b, c, d\}$. Then, which one of the following is not a relation from A to B?

(a) $\{(x, a), (x, c)\}$ (b) $\{(y, c), (y, d)\}$

(c) $\{(z, a), (z, d)\}$ (d) $\{(z, b), (y, b), (a, d)\}$

Sol: $\{(z, b), (y, b), (a, d)\}$ is not a relation from A to B because $a \notin A$.

Ans: (d)

68. If $\sin A + \sin B + \sin C = 3$, then $\cos A + \cos B + \cos C$ is equal to

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

Sol: Given, $\sin A + \sin B + \sin C = 3$

$\therefore \quad \sin A = \sin B = \sin C = 1 \qquad [\because \ -1 \le \sin x \le 1]$

$\Rightarrow \; A = B = C = \dfrac{\pi}{2}$

$\Rightarrow \; \cos A + \cos B + \cos C = 0$

Ans: (d)

69. If $\dfrac{\cos A}{3} = \dfrac{\cos B}{4} = \dfrac{1}{5}$, $\dfrac{\pi}{2} < A < 0$ and $-\dfrac{\pi}{2} < B < 0$, then the value of $2\sin A + 4\sin B$ is

(a) 4 (b) −2 (c) −4 (d) 0

Sol: Given, $\cos A = \dfrac{3}{5}$ and $\cos B = \dfrac{4}{5}$

$\because$ $\angle A$ and $\angle B$ lie on IV quadrant

$\therefore$ $\sin A = -\sqrt{1 - \dfrac{9}{25}}$ and $\sin B = -\sqrt{1 - \dfrac{16}{25}} \Rightarrow \sin A = -\dfrac{4}{5}$ and $\sin B = -\dfrac{3}{5}$

Now, $2\sin A + 4\sin B = 2\left(-\dfrac{4}{5}\right) + 4\left(-\dfrac{3}{5}\right) = -\dfrac{8}{5} - \dfrac{12}{5} = -\dfrac{20}{5} = -4$

Ans: (c)

70. The value of $\dfrac{\sin 55° - \cos 55°}{\sin 10°}$ is

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

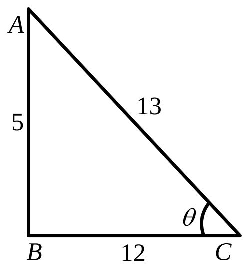
Sol: $\dfrac{\sin 55° - \cos 55°}{\sin 10°} = \dfrac{\sin 55° - \sin 35°}{\sin 10°} = \dfrac{2\cos 45° \sin 10°}{\sin 10°} = \sqrt{2}$

Ans: (d)

71. Find the value of $\cos(x/2)$, if $\tan x = 5/12$ and x lies in quadrant III

(a) $\dfrac{5}{\sqrt{13}}$ (b) $\dfrac{5}{\sqrt{26}}$ (c) $\dfrac{5}{13}$ (d) $-\sqrt{\dfrac{1}{26}}$

Sol: Given, $\tan x = \dfrac{5}{12}$ and x lies in III quadrant



$\therefore$ $\sin x = \dfrac{-5}{13}$ and $\cos x = \dfrac{-12}{13}$

Now, $\cos x = 2\cos^2 \dfrac{x}{2} - 1$

$\Rightarrow \; \cos^2 \dfrac{x}{2} = \dfrac{1}{2}(\cos x + 1) = \dfrac{1}{2}\left(\dfrac{-12}{13} + 1\right) = \dfrac{1}{2}\left(\dfrac{1}{13}\right) = \dfrac{1}{26}$

$\therefore$ $\cos \dfrac{x}{2} = -\sqrt{\dfrac{1}{26}}$

$\therefore \dfrac{x}{2}$ lies in II quadrant

Ans: (d)

72. The least value of $3\sin^2\theta + 4\cos^2\theta$ is

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

Sol: Consider, $3\sin^2\theta + 4\cos^2\theta$

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

We know that, least value of $\cos^2\theta$ is 0.

Hence, least value of $3\sin^2\theta + 4\cos^2\theta$ is 3

Ans: (b)

73. If $z_1 = \sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$ and $z_z = \sqrt{3}\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right)$, then $|z_1 z_2|$ is equal to

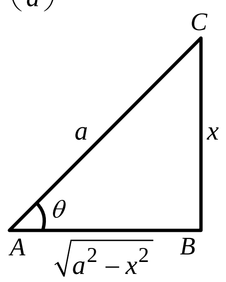
(a) 6 (b) $\sqrt{2}$ (c) $\sqrt{6}$ (d) $\sqrt{3}$

Sol: $|z_1| = \sqrt{2}$ and $|z_2| = \sqrt{3}$ $\therefore |z_1 z_2| = |z_1||z_2| = \sqrt{6}$

Ans: (c)

74. $\tan^{-1}\left(\frac{x}{\sqrt{a^2 - x^2}}\right)$ is equal to

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



Sol: Let $\tan^{-1}\left(\frac{x}{\sqrt{a^2 - x^2}}\right) = \theta \Rightarrow \tan\theta = \frac{x}{\sqrt{a^2 - x^2}}$

$\therefore \sin\theta = \frac{x}{a} \Rightarrow \theta = \sin^{-1}\left(\frac{x}{a}\right)$

Ans: (c)

75. The set $A = \{x : |2x+3| < 7\}$ is equal to the set

(a) $D = \{x : 0 < x+5 < 7\}$ (b) $B = \{x : -3 < x < 7\}$

(c) $E = \{x : -7 < x < 7\}$ (d) $C = \{x : -13 < 2x < 4\}$

Sol: Given, set $A = \{x : |2x+3| < 7\}$

Now, $|2x-3| < 7 \Rightarrow -7 < 2x+3 < 7$

$\Rightarrow -7-3 < 2x < 7-3 \Rightarrow -10 < 2x < 4$

$\Rightarrow -5 < x < 2 \Rightarrow 0 < (x+5) < 7$

Ans: (a)

76. The number of subsets of $\{1, 2, 3, \ldots, 9\}$ containing at least one odd number, is

(a) 324 (b) 396 (c) 496 (d) 512

Sol: The total number of subsets of given set is $2^9 = 512$

Case I: When selecting only one even number $\{2, 4, 6, 8\}$. Number of ways $= {}^4C_1 = 4$

Case II: when selecting only two even numbers $= {}^4C_2 = 6$

Case III: When selecting only three even numbers $= {}^4C_3 = 4$

Case IV: When selecting only four even numbers $= {}^4C_4 = 1$

$\therefore$ Required number of ways $= 512 - (4+6+4+1) - 1 = 496$

[here, we subtract 1 due to the null set]

Ans: (c)

77. If the foot of the perpendicular from the origin to a straight line is at the point $(3, -4)$. Then, the equation of the line is

(a) $3x - 4y = 25$ (b) $3x - 4y + 25 = 0$ (c) $4x + 3y - 25 = 0$ (d) $4x - 3y - 25 = 0$

Sol: Let $P(3, -4)$ be the foot of the perpendicular from the origin O on the required line. Then, the slope of $OP = \frac{-4-0}{3-0} = \frac{-4}{3}$

Therefore, the slope of the required line is $3/4$

Hence, its equation is : $y - (-4) = \frac{3}{4}(x-3) \Rightarrow 3x - 4y = 25$

Ans: (a)

78. The distance between the foci of the conic $7x^2 - 9y^2 = 63$ is equal to

(a) 8 (b) 4 (c) 3 (d) 7

Sol: Given equation of hyperbola is

$$\frac{x^2}{9} - \frac{y^2}{7} = 1$$

Distance between foci $= 2ae = 2\sqrt{a^2 + b^2}$

$= 2\sqrt{9+7} = 8$

Ans: (a)

79. $\lim_{x \to \infty} \left(\frac{1^3 + 2^3 + 3^3 + ... + k^3}{k^4} \right)$ is equal to

(a) 0 (b) 2 (c) $1/4$ (d) $1/3$

Sol:

$$\lim_{x \to \infty} \left(\frac{1^3 + 2^3 + 3^3 + ... + k^3}{k^4} \right) = \lim_{x \to \infty} \left(\frac{k^2 (k+1)^2}{4} \times \frac{1}{k^4} \right) = \lim_{x \to \infty} \left(\frac{k^4 (k+1/k)^2}{4} \times \frac{1}{k^4} \right) = \frac{1}{4}$$

Ans: (c)

80. If $f(5) = 7$ and $f'(5) = 7$, then $\lim_{x \to \infty} \frac{xf(5) - 5f(x)}{x-5}$ is equal to

(a) 35 (b) -35 (c) 28 (d) -28

Sol: $\lim_{x \to 5} \frac{xf(5) - 5f(x)}{x-5} = \lim_{x \to 5} \frac{f(5) - 5f'(x)}{1-0} = f(5) - 5f'(5)$

$= 7 - 5 \cdot 7 = 7 - 35 = -28$ [using L'Hospital's rule]

Ans: (d)

81. $\lim_{x\to 0}\frac{1-\cos^3 x}{x\sin x\cos x}$ is equal to

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

Sol: $\lim_{x\to 0}\frac{1-\cos^3 x}{x\sin x\cos x}=\lim_{x\to 0}\frac{(1-\cos x)\left(1+\cos^2 x+\cos x\right)}{x^2\cos x\cdot\frac{\sin x}{x}}=3\lim_{x\to 0}\frac{1-\cos x}{x^2}=3\times\frac{1}{2}=\frac{3}{2}$

Ans: (c)

82. If $f(x)=e^x\sin x$, then $f''(x)$ is equal to

(a) $e^{6x}\sin 6x$ (b) $2e^x\cos x$ (c) $8e^x\sin x$ (d) $8e^x\cos x$

Sol: Given, $f(x)=e^x\sin x \Rightarrow f'(x)=e^x\cos x+\sin xe^x$

$\Rightarrow f''(x)=e^x\cos x-e^x\sin+e^x\sin x+e^x\cos x=2e^x\cos x$

Ans: (b)

83. The value of $\frac{d}{dx}\left[\tan^{-1}\left\{\frac{\sqrt{x}(3-x)}{1-3x}\right\}\right]$ is

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

Sol: Let $y=\tan^{-1}\left\{\frac{3\sqrt{x}-x^{3/2}}{1-3x}\right\}$

Again, let $\sqrt{x}=\tan t$

$\therefore\ y=\tan^{-1}\left\{\frac{3\tan t-\tan^3 t}{1-3\tan^2 t}\right\}=\tan^{-1}(\tan 3t)$

$\Rightarrow y=3\tan^{-1}\sqrt{x} \quad \Rightarrow \frac{dy}{dx}=\frac{3}{1+x}\cdot\frac{1}{2\sqrt{x}}=\frac{3}{2(1+x)\sqrt{x}}$

Ans: (a)

84. Differential coefficient of $\sqrt{\sec\sqrt{x}}$ is

(a) $\frac{1}{4\sqrt{x}}\sec\sqrt{x}\sin\sqrt{x}$ (b) $\frac{1}{4\sqrt{x}}\left(\sec\sqrt{x}\right)^{3/2}\cdot\sin\sqrt{x}$

(c) $\frac{1}{2}\sqrt{x}\sec\sqrt{x}\sin\sqrt{x}$ (d) $\frac{1}{2}\sqrt{x}\left(\sec\sqrt{x}\right)^{3/2}\cdot\sin\sqrt{x}$

Sol: Let $y=\sqrt{\sec\sqrt{x}}$

$\Rightarrow \frac{dy}{dx}=\frac{1}{2\sqrt{\sec\sqrt{x}}}\cdot\sec\sqrt{x}\cdot\tan\sqrt{x}\cdot\frac{1}{2\sqrt{x}}$

$=\frac{1}{4\sqrt{x}}\left(\sec\sqrt{x}\right)^{3/2}\cdot\sin\sqrt{x}$

Ans: (b)

85. If $2x^2-3xy+y^2+x+2y-8=0$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{3y-4x-1}{2y-3x+2}$ (b) $\frac{3y+4x-1}{2y+3x+2}$ (c) $\frac{3y-4x+1}{2y-3x-2}$ (d) $\frac{3y-4x+1}{2y+3x+2}$

Sol: On differentiating given equation w.r.t. x, we get

$$4x-3x\frac{dy}{dx}-3y+2y\frac{dy}{dx}+1+2\frac{dy}{dx}-0=0 \Rightarrow \frac{dy}{dx}=\frac{3y-4x-1}{2y-3x+2}$$

Ans: (a)

86. If $f(x)=\begin{cases} cx+1, & x\le 3 \\ cx^2-1, & x>3 \end{cases}$ is continuous at $x=3$, then c is equal to

(a) $1/3$ (b) $2/3$ (c) $3/2$ (d) 3

Sol: At $x=3$

$$\text{LHL}=\lim_{x\to 3^-}(cx+1)=\lim_{h\to 0}\left[c(3-h)+1\right]=3c+1$$

$$\text{RHL}=\lim_{x\to 3^+}\left(cx^2-1\right)=\lim_{h\to 0}\left[c(3+h)^2-1\right]=9c-1$$

As $f(x)$ is continuous at $x=3$

$$\therefore\ 3c+1=9c-1 \Rightarrow 6c=1+1 \Rightarrow c=\frac{2}{6}=\frac{1}{3} \Rightarrow c=\frac{1}{3}$$

Ans: (a)

87. Mean deviation of 6, 8, 12, 15, 10, 9 from mean is

(a) 10 (b) 2.33 (c) 2.5 (d) None of these

Sol:

Here, mean $=\frac{6+8+12+15+10+9}{6}=10$

$$\therefore\ \text{Mean deviation}=\frac{\sum|x_i-\bar{x}|}{n}=\frac{\left[|6-10|+|8-10|+|12-10|+|15-10|+|10-10|+|9-10|\right]}{6}$$

$$=\frac{4+2+2+5+0+1}{6}=\frac{14}{6}=2.33$$

Ans: (b)

88. In a class, there are 10 boys and 8 girls. When 3 students are selected at random, the probability that 2 girls and 1 boy are selected, is

(a) $\frac{35}{102}$ (b) $\frac{15}{102}$ (c) $\frac{55}{102}$ (d) $\frac{25}{102}$

Sol: Total number of boys $=10$; Total number of girls $=8$

Number of students have to be selected at random $=3$

If 2 girls and 1 boy are selected, then the required probability

$$=\frac{{}^8C_2\times{}^{10}C_1}{{}^{18}C_3}=\frac{\frac{8\times 7}{2}\times 10}{\frac{18\times 17\times 16}{3\times 2}} \qquad \left[\because\ {}^nC_r=\frac{n!}{r!(n-r)!}\right]$$

$=\frac{4\times7\times10\times6}{18\times17\times16}=\frac{70}{3\times17\times4}=\frac{35}{6\times17}=\frac{35}{102}$

Ans: (a)

89. If A and B are two events such that $P\left(\overline{A\cup B}\right)=\frac{1}{6}$, $P(A\cap B)=\frac{1}{4}$ and $P\left(\bar{A}\right)=\frac{1}{4}$, where $\bar{A}$ stands for complement of the event A. Then, events A and B are

(a) mutually exclusive and independent
(b) independent but not equally likely
(c) equally likely but not independent
(d) equally likely and mutually exclusive

Sol: Given, $P\left(\overline{A\cup B}\right)=\frac{1}{6}$, $P(A\cap B)=\frac{1}{4}$, $P\left(\bar{A}\right)=\frac{1}{4}$

$P(A\cup B)=1-P\left(\overline{A\cup B}\right)=1-\frac{1}{6}=\frac{5}{6}$ and

$P(A)=1-P\left(\bar{A}\right)=1-\frac{1}{4}=\frac{3}{4}$

$P(A\cup B)=P(A)+P(B)-P(A\cap B)\quad\Rightarrow\ \frac{5}{6}=\frac{3}{4}+P(B)-\frac{1}{4}$

$P(B)=\frac{1}{3}\ \Rightarrow A$ and B are not equally likely.

$P(A\cap B)=P(A)\cdot P(B)=\frac{1}{4}$. So, events are independent.

Ans: (b)

90. If $P(A)=P(B)=x$ and $P(A\cap B)=P(A'\cap B')=\frac{1}{3}$, then x is equal to

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4}$ (d) $\frac{1}{6}$

Sol: $P(A'\cap B')=1-P(A\cup B)=\frac{1}{3}$ [given]

$\Rightarrow\ P(A\cup B)=\frac{2}{3}$

$\therefore\ P(A\cup B)=P(A)+P(B)-P(A\cap B)$

$\Rightarrow\ \frac{2}{3}=x+x-\frac{1}{3}\ \Rightarrow\ x=\frac{1}{2}$

Ans: (a)

91. If $A=\begin{bmatrix}2-k & 2\\ 1 & 3-k\end{bmatrix}$ is a singular matrix, then the value of $5k-k^2$ is

(a) 4 (b) 6 (c) −6 (d) −4

Sol: Given, $A=\begin{bmatrix}2-k & 2\\ 1 & 3-k\end{bmatrix}$

Since, the matrix A is singular.

$\therefore\ |A|=0$

$$\Rightarrow \begin{bmatrix} 2-k & 2 \\ 1 & 3-k \end{bmatrix} = 0 \Rightarrow (2-k)(3-k)-2=0$$

$$\Rightarrow 6-5k+k^2-2=0 \qquad \Rightarrow 4-5k+k^2=0 \qquad \Rightarrow 5k-k^2=4$$

Ans: (a)

92. If $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}$, then A^2 is equal to

(a) 0 (b) $-A$ (c) I (d) $2A$

Sol: Given, $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}$

$$\therefore \; A^2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}$$

$$= \begin{bmatrix} 1+0+0 & 0+0+0 & 0+0+0 \\ 0+0+0 & 0+1+0 & 0+0+0 \\ a+0-a & 0+b-b & 0+0+1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I$$

Ans: (c)

93. If X and Y are 2×2 matrices such that $2X+3Y=O$ and $X+2Y=I$, where O and I denote the 2×2 zero matrix and the 2×2 identity matrix, then X is equal to

(a) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$ (c) $\begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$ (d) $\begin{bmatrix} 3 & 0 \\ 0 & 3 \end{bmatrix}$

Sol: Given, $2X+3Y=O$ … (i)

and $X+2Y=I$ … (ii)

where, $O = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ and $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

On solving Eqs. (i) and (ii), we get

$$X = -3I = \begin{bmatrix} -3 & 0 \\ 0 & -3 \end{bmatrix}$$

Ans: (c)

94. If $\begin{vmatrix} 2a & x_1 & y_1 \\ 2b & x_2 & y_2 \\ 2c & x_3 & y_3 \end{vmatrix} = \frac{abc}{2} \neq 0$, then the area of the triangle whose vertices are $\left(\frac{x_1}{a}, \frac{y_1}{a}\right), \left(\frac{x_2}{b}, \frac{y_2}{b}\right)$ and $\left(\frac{x_3}{c}, \frac{y_3}{c}\right)$ is

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

Sol: Given, $\begin{vmatrix} 2a & x_1 & y_1 \\ 2b & x_2 & y_2 \\ 2c & x_3 & y_3 \end{vmatrix} = \frac{abc}{2}$

$$\Rightarrow 2\begin{vmatrix} a & x_1 & y_1 \\ b & x_2 & y_2 \\ c & x_3 & y_3 \end{vmatrix} = \frac{abc}{2} \Rightarrow \begin{vmatrix} a & x_1 & y_1 \\ b & x_2 & y_2 \\ c & x_3 & y_3 \end{vmatrix} = \frac{abc}{4} \quad \dots \text{(i)}$$

Given vertices of a triangle are $\left(\frac{x_1}{a}, \frac{y_1}{a}\right), \left(\frac{x_2}{b}, \frac{y_2}{b}\right)$ and $\left(\frac{x_3}{c}, \frac{y_3}{c}\right)$

$\therefore$ Area of triangle

$$= \frac{1}{2}\begin{vmatrix} \frac{x_1}{a} & \frac{y_1}{a} & 1 \\ \frac{x_2}{b} & \frac{y_2}{b} & 1 \\ \frac{x_3}{c} & \frac{y_3}{c} & 1 \end{vmatrix} = \frac{1}{2}\cdot\frac{1}{a}\cdot\frac{1}{b}\cdot\frac{1}{c}\begin{vmatrix} x_1 & y_1 & a \\ x_2 & y_2 & b \\ x_3 & y_3 & c \end{vmatrix}$$

$$= \frac{1}{2abc}\begin{vmatrix} a & x_1 & y_1 \\ b & x_2 & y_2 \\ c & x_3 & y_3 \end{vmatrix} = \frac{1}{2abc}\left(\frac{abc}{4}\right) \quad \text{[from eq. (i)]}$$

$$= \frac{1}{8}$$

Ans: (d)

95. If $\begin{vmatrix} x^2+x & 3x-1 & -x+3 \\ 2x+1 & 2+x^2 & x^3-3 \\ x-3 & x^2+4 & 3x \end{vmatrix} = a_0 + a_1x + a_2x^2 + \dots + a_7x^7$, then the value of a_0 is

(a) 21 (b) 24 (c) 23 (d) 22

Sol: On putting $x = 0$ in the given determinant equation, we get

$$a_0 = \begin{vmatrix} 0 & -1 & 3 \\ 1 & 2 & -3 \\ -3 & 4 & 0 \end{vmatrix} = 1(0-9) + 3(4+6)$$

$= 30 - 9 = 21$

Ans: (a)

96. Three non-zero non-collinear vectors, a, b and c are such that $a+3b$ is collinear with c, $3b+2c$ is collinear with a. Then, $a+3b+2c$ is equal to

(a) 0 (b) $2a$ (c) $3b$ (d) $4c$

Sol: Given, $a+3b$ is collinear with c.

$\therefore$ $a + 3b = \lambda c$

or $a + 3b - \lambda c = 0$ … (i)

and $3b + 2c$ is collinear.

$\Rightarrow$ $3b + 2c = \mu a$

$3b + 2c - \mu a = 0$ … (ii)

From eqs. (i) and (ii),

$a + 3b - \lambda c = 3b + 2c - \mu a$

On equating c, we get $\lambda = -2$

On putting $\lambda = -2$ in eq. (i), we get

$a + 3b + 2c = 0$

Ans: (a)

97. If a, b and c are pth, qth and rth terms of a GP, then the vectors $\log a\hat{i} + \log b\hat{j} + \log c\hat{k}$ and $(q-r)\hat{i} + (r-p)\hat{j} + (p-q)\hat{k}$ are

(a) equal (b) parallel (c) perpendicular (d) None of these

Sol: Let the first term and common ratio of a GP be α and β, then

$a = \alpha \cdot \beta^{p-1}$, $b = \alpha \cdot \beta^{q-1}$ and $c = \alpha \cdot \beta^{r-1}$

$\therefore \log a = \log \alpha + (p-1)\log \beta$

$\log b = \log \alpha + (q-1)\log \beta$

and $\log c = \log \alpha + (r-1)\log \beta$

The dot product of the given two vectors is

$(q-r)\log a + (r-p)\log b + (p-q)\log c$

$\Rightarrow (q-r)[\log \alpha + (p-1)\log \beta] + (r-p)$

$[\log \alpha + (q-1)\log \beta] + (p-q)[\log \alpha + (r-1)\log \beta]$

$\Rightarrow \log \alpha[q - r + r - p + p - q] + \log \beta[(p-q)(q-r) + (r-p)(q-1) + (r-1)(p-q)]$

$= 0 + 0 = 0$

So, the two vectors are perpendicular.

Ans: (c)

98. If $a = \hat{i} + 2\hat{j} + 2\hat{k}, |b| = 5$ and the angle between a and b is $\pi/6$, then the area of the triangle formed by these two vectors as two sides is

(a) $\frac{15}{4}$ (b) $\frac{15}{2}$ (c) 15 (d) $\frac{15\sqrt{3}}{2}$

Sol: Area of the triangle $= \frac{1}{2}|a \times b| = \frac{1}{2}|a||b|\sin\theta$

$= \frac{1}{2}\left[3 \times 5 \times \sin\frac{\pi}{6}\right]$ $\left[\because |a| = \sqrt{1 + 2^2 + 2^2} = 3\right]$

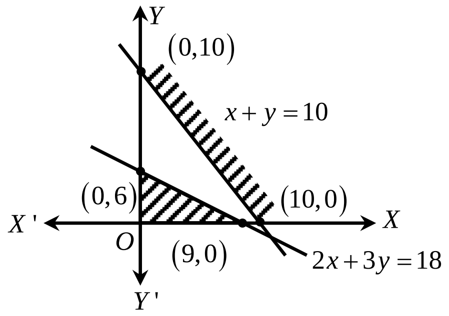
$= \frac{1}{2}\left[15 \times \frac{1}{2}\right] = \frac{15}{4}$ $\left[\because \sin\frac{\pi}{6} = \frac{1}{2}\right]$

Ans: (a)

99. The maximum value of $z = 4x + 2y$ subject to constraints $2x + 3y \le 18$, $x + y \ge 10$ and $x, y \ge 0$ is

(a) 20 (b) 36 (c) 40 (d) None of these

Sol: From the figure, it is clear that there is no common area.



So, we cannot find maximum value of z

Ans: (d)

100. $\int \frac{1}{\sqrt{7-x^2}}dx$ is equal to

(a) $\frac{1}{2\sqrt{7}}\log\left|\frac{\sqrt{7}+x}{\sqrt{7}-x}\right|+C$ (b) $\sin^{-1}\left(\frac{x}{\sqrt{7}}\right)+C$ (c) $\log\left|x+\sqrt{x^2-7}\right|+C$ (d) $\frac{1}{2\sqrt{7}}\log\left|\frac{x-\sqrt{7}}{x+\sqrt{7}}\right|+C$

Sol: $\int \frac{dx}{\sqrt{7-x^2}} = \int \frac{dx}{\sqrt{\left(\sqrt{7}\right)^2 - x^2}}$

$= \sin^{-1}\left(\frac{x}{\sqrt{7}}\right)+C$ $\left[\because \int \frac{1}{\sqrt{a^2-x^2}}dx = \sin^{-1}\left(\frac{x}{a}\right)\right]$

Ans: (b)

101. $\int \frac{x^4+x^2+1}{x^2-x+1}dx$ is equal to

(a) $\frac{x^3}{3}-\frac{x^2}{2}+x+C$ (b) $\frac{x^3}{3}+\frac{x^2}{2}+x+C$ (c) $\frac{x^3}{3}-\frac{x^2}{2}-x+C$ (d) $\frac{x^3}{3}+\frac{x^2}{2}-x+C$

Sol: $\int \frac{x^4+x^2+1}{x^2-x+1}dx = \int\left(x^2+x+1\right)dx = \frac{x^3}{3}+\frac{x^2}{2}+x+C$

$\because \frac{x^4+x^2+1}{x^2-x+1} = x^2+x+1$

Ans: (b)

102. $\int e^{-\log x}dx$ is equal to

(a) $e^{-\log x}+C$ (b) $-xe^{-\log x}+C$ (c) $e^{\log x}+C$ (d) $\log|x|+C$

Sol: $\int e^{-\log x}dx = \int \frac{1}{x}dx = \log|x|+C$

Ans: (d)

103. $\int \frac{(1+x)e^{x}}{\sin^2\left(xe^x\right)}dx$ is equal to

(a) $-\cot\left(xe^x\right)+C$ (b) $\tan\left(xe^x\right)+C$ (c) $\tan\left(e^x\right)+C$ (d) $\cot\left(xe^x\right)+C$

Sol: Let $I=\int \frac{(1+x)e^x}{\sin^2\left(xe^x\right)}dx$

Putting $xe^x=t \Rightarrow \left(1\cdot e^x+x\cdot e^x\right)dx=dt \Rightarrow (1+x)e^x dx=dt$

$\therefore \quad I=\int \frac{dt}{\sin^2 t}=\int \operatorname{cosec}^2 t dt=-\cot t+C \quad =-\cot\left(xe^x\right)+C$

Ans: (a)

104. Which of the following is correct?

(a) $\int_0^1 e^x dx=e$ (b) $\int_0^1 2^x dx=\log 2$ (c) $\int_0^1 \sqrt{x}dx=\frac{2}{3}$ (d) $\int_0^1 xdx=\frac{1}{3}$

Sol:

(a) $\int_0^1 e^x dx=\left[e^x\right]_0^1=e-1$

(b) $\int_0^1 2^x dx=\left[\frac{2^x}{\log_e 2}\right]_0^1=\frac{1}{\log 2}\cdot\left(2-2^{\circ}\right)=\frac{1}{\log 2}$

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

(d) $\int_0^1 xdx=\left[\frac{x^2}{2}\right]_0^1=\frac{1}{2}$

Ans: (c)

105. If $\int_a^b x^3 dx=0$ and $\int_a^b x^2 dx=\frac{2}{3}$, then the values of a and b are respectively

(a) 1,1 (b) $-1,-1$ (c) $1,-1$ (d) $-1,1$

Sol: $\int_a^b x^3 dx=\left.\frac{x^4}{4}\right|_a^b=\frac{1}{4}\left(b^4-a^4\right)=0 \Rightarrow b^4-a^4=0 \qquad \ldots (1)$

$\int_a^b x^2 dx=\left.\frac{x^3}{3}\right|_b^b=\frac{1}{3}\left(a^3-b^3\right)=\frac{2}{3} \Rightarrow b^3-a^3=2 \qquad \ldots (2)$

Solving (1) & (2)

$a=-1, b=1$

Ans: (d)

106. $\int_0^{2\pi}\left(\sin x+|\sin x|\right)dx$ is equal to

(a) 0 (b) 4 (c) 8 (d) 1

Sol: $\int_0^{2\pi}\left(\sin x+|\sin x|\right)dx$

$=\int_0^{\pi}(\sin x+\sin x)dx+\int_{\pi}^{2\pi}(\sin x-\sin x)dx$

$=2\int_0^{\pi}\sin xdx+0=-2[\cos x]_0^{\pi}$

$=-2(\cos\pi-\cos 0)=-2(-1-1)=4$

Ans: (b)

107.The degree of the differential equation $\frac{d^2y}{dx^2}+3\left(\frac{dy}{dx}\right)^2=x^2\log\left(\frac{d^2y}{dx^2}\right)$ is

(a) 1 (b) 2 (c) 3 (d) none of these

Sol: The degree of the differential equation can be determined only when the equation is a polynomial equation in the derivative

Here the given equation is not a polynomial equation in the derivatives

$\therefore$ the degree is not defined

Ans: (d)

108.Solution of the differential equation $\frac{dy}{dx}+\frac{y}{x}=\sin x$ is

(a) $x(y+\cos x)=\sin x+c$ (b) $x(y-\cos x)=\sin x+c$

(c) $x(y\cos x)=\sin x+c$ (d) $x(y+\cos x)=\cos x+c$

Sol: The equation $\frac{dy}{dx}+\frac{y}{x}=\sin x$ can be written as $xdy+ydx=x\cdot\sin xdx$

On integration

$\int(xdy+ydx)=\int x\cdot\sin x\ dx+k$

$\Rightarrow \int d(xy)=x(-\cos x)+\sin x+k$

$\Rightarrow xy+x\cos x=\sin x+k \qquad (\because\ d(xy)=xdy+ydx)$

$\Rightarrow x(y+\cos x)=\sin x+k$

Ans: (a)

109.The general solution of a differential equation of the type $\frac{dx}{dy}+P_1x=Q_1$ is

(a) $y\cdot e^{\int P_1\,dy}=\int\left(Q_1e^{\int P_1\,dy}\right)dy+c$ (b) $y\cdot e^{\int P_1\,dx}=\int\left(Q_1e^{\int P_1\,dy}\right)dx+c$

(c) $x\cdot e^{\int P_1\,dy}=\int\left(Q_1e^{\int P_1\,dy}\right)dy+c$ (d) $x\cdot e^{\int P_1\,dx}=\int\left(Q_1e^{\int P_1\,dx}\right)dx+c$

Sol: We have, $\frac{dy}{dx}+P_1x=Q$

Here, P_1 and Q_1 are functions of y. Thus

I.F. $=e^{\int P_1\,dy}$

Thus the solution is

$x\ e^{\int P_1\,dy}=\int\left(Q_1e^{\int P_1\,dy}\right)dy+c$

Ans: (c)

110. Solution of the differential equation $\tan y \sec^2 x\, dx + \tan x \sec^2 y\, dy = 0$ is

(a) $\tan x + \tan y = k$ (b) $\tan x - \tan y = k$ (c) $\frac{\tan x}{\tan y} = k$ (d) $\tan x \cdot \tan y = k$

Sol: We have, $\int \frac{\sec^2 x}{\tan x} dx + \int \frac{\sec^2 y}{\tan y} dy = \log c$

$\Rightarrow \log(\tan x) + \log(\tan y) = \log c$

$\Rightarrow \tan x \cdot \tan y = c$

Ans: (d)

111. The area bounded by $y = \sin x$ and $x-$axis from $x = 0$ to $x = \pi$ is

(a) 2 (b) π (c) π^2 (d) none of these

Sol: $A = \int_0^{\pi} y\, dx = \int_0^{\pi} \sin x\, dx$

$= -\cos x]_0^{\pi} = -(-1-1) = 2$

Ans: (a)

112. The area bounded by the curve $y = \sqrt{16 - x^2}$ is

(a) 8π sq. units (b) 20π sq. units (c) 16π sq. units (d) 256π sq. units

Sol: Now, $y = \sqrt{16 - x^2}$

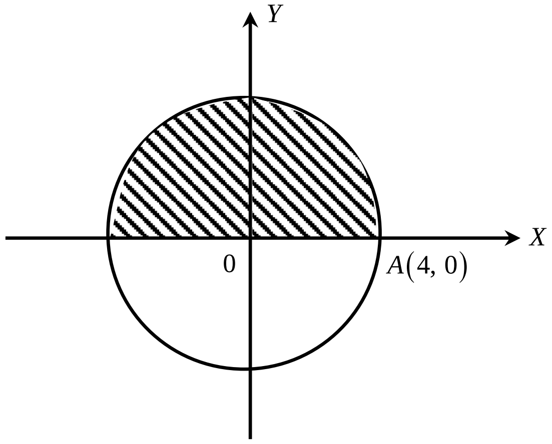
$\Rightarrow x^2 + y^2 = 16$

Required area

$= 2\int_0^4 \sqrt{16 - x^2}\, dx$

$= 2\left[\frac{x^2}{2}\sqrt{16 - x^2} + \frac{16}{2}\sin^{-1}\frac{x}{4}\right]_0^4$

$= 2\left(8 \times \frac{\pi}{2}\right) = 8\pi$ sq. units



Ans: (a)

113. The S.D. of scores 1, 2, 3, 4, 5 is

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

Sol: Variance of n natural number is given by $\frac{n^2 - 1}{12}$

$\therefore$ required S.D. $= \sqrt{\frac{5^2 - 1}{12}} = \sqrt{2}$

Ans: (a)

114. A bag contains 3 black and 4 white balls. Two balls are drawn one by one at random without replacement. The probability that second drawn ball is white is

(a) $\frac{4}{7}$ (b) $\frac{1}{7}$ (c) $\frac{4}{49}$ (d) $\frac{12}{49}$

Sol: Total number of balls $= 7$

White ball can be drawn in the second draw in two ways.

Case 1. First ball is black and second ball is white

Its probability $= \frac{3}{7} \cdot \frac{4}{6} = \frac{2}{7}$

Vase 2. First ball is white and second ball is white

Its probability $= \frac{4}{7} \cdot \frac{3}{6} = \frac{2}{7}$

$\therefore$ Required probability $= \frac{2}{7} + \frac{2}{7} = \frac{4}{7}$ ($\because$ events are independent)

Ans: (a)

115. The function $f(x) = \cot^{-1} x + x$ increases in the interval

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

Sol: $f(x) = \cot^{-1} x + x \Rightarrow f'(x) = \frac{1}{1+x^2} + 1$

$\Rightarrow f'(x) > 0$ for all x

$\therefore f(x)$ is increasing in $(-\infty, \infty)$

Ans: (c)

116. The minimum value of $(x-\alpha)(x-\beta)$ is

(a) 0 (b) $\alpha\beta$ (c) $\frac{1}{4}(\alpha-\beta)^2$ (d) $-\frac{1}{4}(\alpha-\beta)^2$

Sol: We have, $f(x) = (x-\alpha)(x-\beta)$

$\Rightarrow f(x) = x^2 - (\alpha+\beta)x + \alpha\beta$

Minimum value of $ax^2 + bx + c, (a > 0)$ is given by $\frac{4ac - b^2}{4a}$

$\therefore$ We have, $\frac{4\alpha\beta - (\alpha+\beta)^2}{4} = \frac{-(\alpha-\beta)^2}{4}$

Ans: (d)

117. The acute angle between the lines whose direction cosines are proportional to $3, -1, 2$ and $2, 1, -3$ is

(a) $\cos^{-1}\frac{2}{\sqrt{14}}$ (b) $\cos^{-1}\frac{1}{\sqrt{14}}$ (c) $\cos^{-1}\frac{\sqrt{3}}{\sqrt{14}}$ (d) $\cos^{-1}\frac{3}{\sqrt{14}}$

Sol: We have d.r's of the lines $3, -1, 2$ and $2, 1, -3$

The angle θ between the lines is given by

$$\cos\theta=\frac{3\cdot(2)+(-1)\cdot 1+2(-3)}{\sqrt{9+1+4}\sqrt{4+1+9}}=\frac{-1}{14}$$

Thus the acute angle $\theta=\cos^{-1}\left(\frac{1}{\sqrt{14}}\right)$

Ans: (b)

118.If the lines $\frac{x-1}{-3}=\frac{y-2}{2k}=\frac{z-3}{2}$ and $\frac{x-1}{3k}=\frac{y-5}{1}=\frac{z-6}{-5}$ are at right angles, then $k=$

(a) $-\frac{10}{7}$ (b) $\frac{10}{7}$ (c) $\frac{7}{10}$ (d) $-\frac{7}{10}$

Sol: The lines

$\frac{x-1}{-3}=\frac{y-2}{2k}=\frac{z-3}{2}$ and $\frac{x-1}{3k}=\frac{y-5}{1}=\frac{z-6}{-5}$ are at right angles if

$$-9k+2k-10=0\Rightarrow -7k=10\Rightarrow k=\frac{-10}{7}$$

Ans: (a)

119.The shortest distance between the lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}$ and $\frac{x-2}{3}=\frac{y-4}{4}=\frac{z-5}{5}$

(a) $\frac{1}{\sqrt{6}}$ (b) $\frac{1}{6}$ (c) $\frac{1}{3}$ (d) $\frac{1}{\sqrt{3}}$

Sol: Let, $\vec{b}_1=2i+3j+4k,\ \vec{b}_2=3i+4j+5k$

$\vec{a}_1=i+2j+3k,\ \vec{a}_2=2i+4j+5k$

$$\text{S.D.}=\frac{\left|\left(\vec{b}_1\times\vec{b}_2\right)\cdot\left(\vec{a}_2-\vec{a}_1\right)\right|}{\left|\vec{b}_1\times\vec{b}_2\right|}$$

$$\vec{b}_1\times\vec{b}_2=\begin{vmatrix} i & j & k\\ 2 & 3 & 4\\ 3 & 4 & 5\end{vmatrix}=-i+2j-k$$

$$\left|\vec{b}_1\times\vec{b}_2\right|=\sqrt{1+4+1}=\sqrt{6}$$

$$\vec{a}_2-\vec{a}_1=i+2j+2k$$

$$\text{S.D.}=\frac{|-1+4-4|}{\sqrt{6}}=\frac{1}{\sqrt{6}}$$

Ans: (a)

120.The number of terms in the expansion of $\left(x^2+y^2\right)^{25}-\left(x^2-y^2\right)^{25}$ after simplification is

(a) 0 (b) 13 (c) 26 (d) 50

Sol: The number of terms in the expansion of $(x+a)^n-(x-a)^n$ is $\frac{n}{2}$ if n is even, and is $\frac{n+1}{2}$ if n is odd. Here $n=25$. Thus the number of terms $=\frac{25+1}{2}=13$

Ans: (b)

Physics

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

121.A satellite has kinetic energy K, potential energy V and total energy E. Which of the following statements is true?

(a) $K=-\frac{V}{2}$ (b) $K=\frac{V}{2}$ (c) $E=\frac{K}{2}$ (d) $E=-\frac{K}{2}$

Sol: $K=\frac{GMm}{2r}$ and $V=-\frac{GMm}{r}$

$\therefore E=K+V=-\frac{GMm}{2r} \Rightarrow K=-\frac{V}{2}$

Ans: (a)

122.A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is

(a) $2Fl$ (b) Fl (c) $\frac{F}{2l}$ (d) $\frac{Fl}{2}$

Sol: Work done by constant force in displacing the object by a distance l = change in potential energy

$=\frac{1}{2}\times \text{stress}\times \text{strain}\times \text{volume}$

$=\frac{1}{2}\times\frac{F}{A}\times\frac{l}{L}\times A\times L=\frac{Fl}{2}$

Ans: (d)

123.A wheel has angular acceleration of $3.0\,\text{rad}\,\text{s}^{-2}$ and an initial angular speed of $2.00\,\text{rad}\,\text{s}^{-1}$. In a time of $2\,\text{s}$ it has rotated through an angle (in radian) of

(a) 10 (b) 12 (c) 4 (d) 6

Sol: Since, $\theta=\omega_0 t+\frac{1}{2}\alpha t^2$ where α is angular acceleration, ω_0 is the initial angular speed.

$t=2\,\text{s}$

$\theta=(2\times 2)+\frac{1}{2}\times 3(2)^2=4+6=10\,\text{rad}$

Ans: (a)

124.Spheres of iron and lead having same mass are completely immersed in water. Density of lead is more than that of iron. Apparent loss of weight is W_1 for iron sphere and W_2 for lead sphere. Then $\frac{W_1}{W_2}$ is

(a) 1 (b) Between 0 and 1 (c) 0 (d) >1

Sol: Density $(\rho)=\frac{\text{Mass}(M)}{\text{Volume}(V)}$

$\rho\propto\frac{1}{V}$ for the same mass

$\therefore \frac{\rho_{\text{lead}}}{\rho_{\text{iron}}} = \frac{V_{\text{iron}}}{V_{\text{lead}}}$ [Given]

As $\rho_{\text{lead}} > \rho_{\text{iron}}$ … (i)

$\therefore \frac{V_{\text{iron}}}{V_{\text{lead}}} > 1$

Using law of floatation,

For iron sphere, $W_1 = V_{\text{iron}}\, \rho_{\text{water}}\, g$ … (ii)

For lead sphere, $W_2 = V_{\text{lead}}\, \rho_{\text{water}}\, g$ … (iii)

Divide (ii) by (iii), we get

$\frac{W_1}{W_2} = \frac{V_{\text{iron}}}{V_{\text{lead}}} > 1$ [Using (i)]

Ans: (d)

125. The ratio of radiant energies radiated per unit surface area by two bodies is $16:1$, the temperature of hotter body is $1000\,\text{K}$, then the temperature of colder body will be

(a) $250\,\text{K}$ (b) $500\,\text{K}$ (c) $1000\,\text{K}$ (d) $62.5\,\text{K}$

Sol: By Stefan-Boltzmann law, the energy radiated by hot object at $T, E = \sigma T^4$

As, $\frac{16}{1} = \frac{\sigma(1000)^4}{\sigma T^4} \Rightarrow T^4 = \left(\frac{1000}{2}\right)^4 \Rightarrow T = 500\,\text{K}$

Ans: (b)

126. According to kinetic theory of gas, molecules of a gas behave like

(a) Inelastic rigid sphere (b) Perfectly elastic non-rigid sphere

(c) Perfectly elastic rigid sphere (d) Inelastic non-rigid sphere

Sol: Molecules of ideal gas behaves like perfectly elastic rigid sphere.

Ans: (c)

127. In an adiabatic process, the pressure is increased by $\left(\frac{2}{3}\right)\%$. If $\gamma = \frac{3}{2}$, then the volume decreases by nearly

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

Sol: $PV^{3/2} = \text{constant} = K$

$\log P + \frac{3}{2}\log V = \log K$

$\frac{\Delta P}{P} + \frac{3}{2}\frac{\Delta V}{V} = 0$

$\frac{\Delta V}{V} = -\frac{2}{3}\frac{\Delta P}{P}$ or $\frac{\Delta V}{V} = \left(-\frac{2}{3}\right)\left(\frac{2}{3}\right) = -\frac{4}{9}$

Ans: (a)

128. The displacement of particle from the mean position in SHM is given by $x = a\cos\omega t + b\sin\omega t$. If $a = 3,\ b = 4$ and $\omega = 4$, the amplitude and maximum velocity respectively will be

(a) $3, 4$ (b) $4, 16$ (c) $7, 14$ (d) $5, 20$

Sol: $A = \sqrt{a^2 + b^2} = 5$ and $V_{max} = A\omega = 20$

Ans: (d)

129. The number of beats produced per second by two vibrations, $x_1 = x_0 \sin 646\pi t$ and $x_2 = x_0 \sin 652\pi t$ is of

(a) 2 (b) 3 (c) 4 (d) 6

Sol: $\omega = 2\pi f \quad \therefore f = \dfrac{\omega}{2\pi}$

$f_1 = \dfrac{646\pi}{2\pi} = 323\,\text{s}^{-1}$

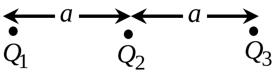
$f_2 = \dfrac{652\pi}{2\pi} = 326\,\text{s}^{-1}$

No. of beats/sec $= f_2 - f_1 = 326 - 323 = 3$

Ans: (b)

130. Three point charges Q_1, Q_2, Q_3 are placed equally spaced along a straight line. Q_2 and Q_3 are equal in magnitude but opposite in sign. If the net force on Q_3 is zero, the value of Q_1 is

(a) $Q_1 = 4(Q_3)$ (b) $Q_1 = 2(Q_3)$ (c) $Q_1 = \sqrt{2}(Q_3)$ (d) $Q_1 = (Q_3)$

Sol: 

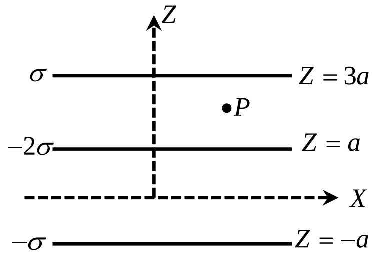
$Q_2 = -Q_3 = Q$

Force on Q_3 due to Q_2 + Force on Q_3 due to $Q_1 = 0$

$$\frac{1}{4\pi\varepsilon_0}\left(\frac{-Q^2}{a^2}\right) + \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q}{4a^2} = 0 \Rightarrow Q_1 = 4Q_3$$

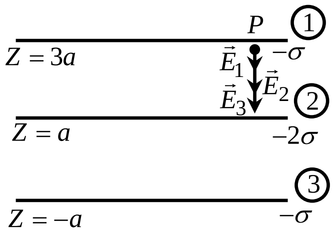
Ans: (a)

131. Three infinitely long charge sheets are placed as shown in figure. The electric field at point P is



(a) $\dfrac{2\sigma}{\varepsilon_0}\hat{k}$ (b) $\dfrac{4\sigma}{\varepsilon_0}\hat{k}$ (c) $-\dfrac{2\sigma}{\varepsilon_0}\hat{k}$ (d) $-\dfrac{4\sigma}{\varepsilon_0}\hat{k}$

Sol: Figure shows the electric fields due to the sheets $1, 2$ and 3 at point P. The direction of electric fields are according to the charge on the sheets (away from positively charge sheet and towards the negatively charged sheet and perpendicular).

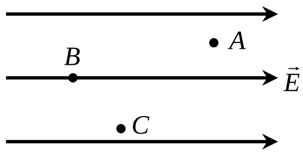


The total electric field, $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 = E_1(-\hat{k}) + E_2(-\hat{k}) + E_3(-\hat{k})$

$$= \left[\frac{\sigma}{2\varepsilon_0} + \frac{2\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}\right](-\hat{k}) = -\frac{2\sigma}{\varepsilon_0}\hat{k}$$

Ans: (c)

132. A, B and C are three points in a uniform electric field. The electric potential is



(a) maximum at B
(b) maximum at C
(c) same at all the three points A, B and C
(d) maximum at A

Sol: Potential at B, V_B is maximum

$V_B > V_C > V_A$

As in the direction of electric field potential decreases.

Ans: (a)

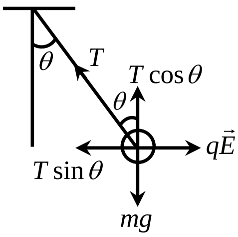
133. A pendulum bob of mass m carrying a charge q is at rest with its string making an angle θ with the vertical in a uniform horizontal electric field E. The tension in the string is

(a) $\frac{mg}{\sin\theta}$ and $\frac{qE}{\cos\theta}$
(b) $\frac{mg}{\cos\theta}$ and $\frac{qE}{\sin\theta}$
(c) $\frac{qE}{mg}$
(d) $\frac{mg}{qE}$

Sol: In equilibrium,

$T\cos\theta = mg$ ... (1)

$T\sin\theta = qE$ ... (2)



From (1), $T = \frac{mg}{\cos\theta}$

From (2), $T = \frac{qE}{\sin\theta}$

Ans: (b)

134. A dielectric slab is inserted between the plates of an isolated charged capacitor. Which of the following quantities remain unchanged?

(a) The charge on the capacitor
(b) The stored energy in the capacitor
(c) The potential difference between the plates
(d) The electric field in the capacitor

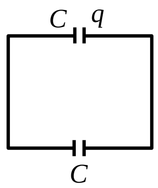
Sol: As the capacitor is isolated, so charge on capacitor will not change. Due to insertion of a dielectric slab capacitance increase by K times. The potential difference, the electric field and the stored energy decreases by $\frac{1}{K}$ times.

Ans: (a)

135. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system

(a) Decreases by a factor of 2
(b) Remains the same
(c) Increases by a factor of 2
(d) Increases by a factor of 4

Sol: When battery is replaced by another uncharged capacitor. As uncharged capacitor is connected parallel,



So, $C' = 2C$ and $V_c = \frac{q_1 + q_2}{C_1 + C_2}$

$V_c = \frac{q+0}{C+C} \qquad \Rightarrow V_c = \frac{V}{2}$

Initial energy of system, $U_i = \frac{1}{2}CV^2$ ... (i)

Final energy of system, $U_f = \frac{1}{2}(2C)\left(\frac{V}{2}\right)^2$

$= \frac{1}{2}CV^2\left(\frac{1}{2}\right)$ .. (ii)

From equation (i) and (ii), $U_f = \frac{1}{2}U_i$, i.e., total electrostatic energy of resulting system decreases by a factor of 2.

Ans: (a)

136. Two spheres A and B of radius $4\,\text{cm}$ and $6\,\text{cm}$ are given charges of $80\,\mu\text{C}$ and $40\,\mu\text{C}$ respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is

(a) $20\,\mu\text{C}$ from A to B
(b) $16\,\mu\text{C}$ from A to B
(c) $32\,\mu\text{C}$ from B to A
(d) $32\,\mu\text{C}$ from A to B

Sol: Total charge, $Q = 80 + 40 = 120\,\mu\text{C}$

By using the formula, $Q_1' = Q\left[\frac{r_1}{r_1 + r_2}\right]$

New charge on sphere A is $Q_A' = Q\left[\frac{r_A}{r_A + r_B}\right] = 120\left[\frac{4}{4+6}\right] = 48\,\mu\text{C}$

Initially it was $80\,\mu\text{C}$, i.e., $32\,\mu\text{C}$ charge flows from A to B.

Ans: (d)

137. There is an electric field E in $x-$direction. If the work done on moving a charge of $0.2\,\text{C}$ through a distance of $2\,\text{m}$ along a line making an angle $60°$ with $x-$axis is $4\,\text{J}$, then what is the value of E ?

(a) $3\,\text{NC}^{-1}$
(b) $4\,\text{NC}^{-1}$
(c) $5\,\text{NC}^{-1}$
(d) $20\,\text{NC}^{-1}$

Sol: Charge $(q) = 0.2\,\text{C}$; distance $(d) = 2\,\text{m}$; angle $\theta = 60°$ and work done $(W) = 4\,\text{J}$.

Work done in moving the charge $(W) = F \cdot d\cos\theta = qEd\cos\theta$

or, $E = \dfrac{W}{qd\cos\theta} = \dfrac{4}{0.2\times 2\times\cos 60°} = \dfrac{4}{0.4\times 0.5} = 20\,\text{N C}^{-1}$

Ans: (d)

138. A primary cell has an emf of 1.5 volt, when short-circuited it gives a current of 3 ampere. The internal resistance of the cell is

(a) 4.5 ohm (b) 2 ohm (c) 0.5 ohm (d) $\dfrac{1}{4.5}$ ohm

Sol: Short circuit current, $i_{SC} = \dfrac{E}{r} \Rightarrow 3 = \dfrac{1.5}{8} \Rightarrow r = 0.5\Omega$

Ans: (c)

139. An electric current passes through a circuit containing two wires of the same material connected in parallel. If the lengths of the wires are in the ratio of $\dfrac{4}{3}$ and radius of the wires are in the ratio of $\dfrac{2}{3}$, then the ratio of the currents passing through the wires will be

(a) 3 (b) $\dfrac{1}{3}$ (c) $\dfrac{3}{9}$ (d) None of these

Sol: Given: $\dfrac{l_1}{l_2} = \dfrac{4}{3}$ and $\dfrac{r_1}{r_2} = \dfrac{2}{3}$

Since the two wires are connected in parallel, potential remains same, i.e., $V = \text{constant}$, $IR = \text{constant}$

i.e., $I_1R_1 = I_2R_2 \Rightarrow \dfrac{I_1}{I_2} = \dfrac{R_2}{R_1}$ … (i)

But we know that, $R = \dfrac{\rho l}{A}$ $\therefore \dfrac{R_1}{R_2} = \left(\dfrac{l_1}{A_1}\right)\left(\dfrac{A_2}{l_2}\right) = \left(\dfrac{l_1}{l_2}\right)\left(\dfrac{A_2}{A_1}\right) = \left(\dfrac{l_1}{l_2}\right)\left(\dfrac{r_2}{r_1}\right)^2$ (since area, $A = \pi r^2$)

$= \left(\dfrac{4}{3}\right)\left(\dfrac{3}{2}\right)^2 = 3$

Substitute this value in equation (i), we get, $\dfrac{I_1}{I_2} = \dfrac{1}{3}$

Ans: (b)

140. The powers of two electric bulbs are 100 watt and 200 watt. Both of them are joined with 220 volt. The ratio of resistance of their filament will be

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

Sol: $P_1 = 100\,\text{W}$, $P_2 = 200\,\text{W}$

$R_1 = \dfrac{V^2}{P_1} = \dfrac{220\times 220}{100} = 22\times 22\Omega$

$R_2 = \dfrac{220\times 220}{200} = 22\times 11\,\Omega$ $\therefore R_1 : R_2 = 2:1$

Ans: (d)

141. A charged particle is moving in an electric field of $3\times10^{-10}\,\text{V m}^{-1}$ with mobility $2.5\times10^{6}\ \text{m}^2/\text{V}/\text{s}$, its drift velocity is

(a) $1.2\times10^{-4}\ \text{ms}^{-1}$ (b) $7.5\times10^{-4}\text{ms}^{-1}$ (c) $8.33\times10^{-4}\text{ms}^{-1}$ (d) $2.5\times10^{4}\text{ms}^{-1}$

Sol: $\mu=\dfrac{V_d}{E} \Rightarrow V_d=\mu E$

$=2.5\times10^{6}\times3\times10^{-10}=7.5\times10^{-4}\ \text{ms}^{-1}$

Ans: (b)

142. In an atom electrons revolve around the nucleus along a path of radius 0.72 Å making 9.4×10^{18} revolutions per second. The equivalent current is $-\left[\text{given } e=1.6\times10^{-19}C\right]$

(a) 1.8 A (b) 1.2 A (c) 1.5 A (d) 1.4 A

Sol: $I=\dfrac{ne}{t}=9.4\times10^{18}\times\left(1.6\times10^{-19}\right)$

$=1.504\times10^{-1}=1.5$ A

Ans: (c)

143. A steady current flows in a metallic conductor of non-uniform cross-section. The quantity/quantities remain constant along the length of the conductor is/are

(a) Current, electric field and drift speed (b) Drift speed only
(c) Current and drift speed (d) Current only

Sol: If E be electric field, then current density, $j=\sigma E$. Also we know that current density, $j=\dfrac{i}{A}$. Hence j is different for different area of cross-sections. When j is different, then E is also different. Thus, E is not constant. The drift velocity v_d is given by $v_d=\dfrac{j}{ne}=$ different for different j values. Hence only current i will be constant.

Ans: (d)

144. A conducting wire of length l is turned in the form of a circular coil and a current i is passed through it. For torque due to magnetic field produced at its centre, to be maximum, the minimum number of turns in the coil will be

(a) 1 (b) 2 (c) 5 (d) of any value

Sol: $\tau_{\max}=MB$ or $\tau_{\max}=ni\pi a^2B$

Let number of turns in length l is n

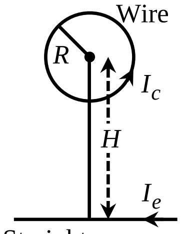
$l=n(2\pi a)$ or $a=\dfrac{l}{2\pi n}$

$$\tau_{\max}=\frac{ni\pi Bl^2}{4\pi^2n^2}=\frac{l^2iB}{4\pi^2n_{\min}}=\frac{l^2iB}{4\pi n_{\min}}$$

$\therefore \tau_{\max}\propto\dfrac{1}{n_{\min}},\ n_{\min}=1$

Ans: (a)

145. Circular loop of a wire and a long straight wire carry currents I_c and I_e, respectively as shown in figure. Assuming that these are placed in the same plane. The magnetic fields will be zero at the centre of the loop when the separation H is



(a) $\frac{I_e R}{I_c \pi}$ (b) $\frac{I_c R}{I_e \pi}$ (c) $\frac{\pi I_c}{I_e R}$ (d) $\frac{I_e \pi}{I_c R}$

Sol: $\frac{\mu_0 I_c}{2R} = \frac{\mu_0 I_e}{2\pi H} \Rightarrow H = \frac{I_e R}{\pi I_c}$

Ans: (a)

146. A wire of length l m carrying a current I A is bent into a circle. The magnitude of the magnetic moment is

(a) $\frac{lI^2}{2\pi}$ (b) $\frac{lI^2}{4\pi}$ (c) $\frac{l^2 I}{2\pi}$ (d) $\frac{l^2 I}{4\pi}$

Sol: If r is the radius of the circle, then $l = 2\pi r$ or $r = \frac{l}{2\pi}$

$\text{Area} = \pi r^2 = \frac{\pi l^2}{4\pi^2} = \frac{l^2}{4\pi}$ $\therefore$ Magnetic moment $= IA = \frac{Il^2}{4\pi}$

Ans: (d)

147. To convert a $800\,\text{mV}$ range milli voltmeter of resistance $40\,\Omega$ into a galvanometer of $100\,\text{mA}$ range, the resistance to be connected as shunt is

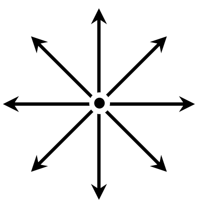
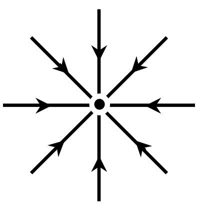
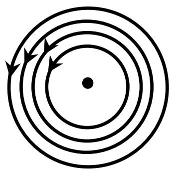
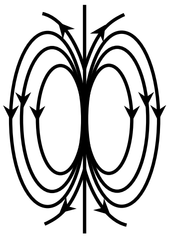
(a) $10\,\Omega$ (b) $20\,\Omega$ (c) $30\,\Omega$ (d) $40\,\Omega$

Sol: $\frac{i}{i_g} = 1 + \frac{G}{S} \Rightarrow \frac{iG}{V_g} = 1 + \frac{G}{S}$

$\Rightarrow \frac{100 \times 10^{-3} \times 40}{800 \times 10^{-3}} = 1 + \frac{40}{S} \quad \Rightarrow S = 10\,\Omega$

Ans: (a)

148. Which of the field pattern given below is valid for electric field as well as for magnetic field?

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

Sol: Induced electric field lines and magnetic field lines always form closed loop.

Ans: (c)

149.The distance between the wires of electric mains is $12\,\text{cm}$. These wires experience $4\,\text{mg wt}$ per unit length. The value of current flowing in each wire will be

(a) $4.85\,\text{A}$ (b) 0 (c) $4.85\times10^{-2}\,\text{A}$ (d) $4.85\times10^{-4}\,\text{A}$

Sol: $\frac{F}{l}=\frac{\mu_0 i^2}{2\pi d}=9.8\times4\times10^{-6}$

$\Rightarrow i=\sqrt{\frac{4\times10^{-6}\times9.8\times0.12}{2\times10^{-7}}}=4.85\,\text{A}$

Ans: (a)

150.Which of the following properties is 'False' for a bar magnet?

(a) It doesn't produce magnetic field

(b) It points in North-South direction when suspended

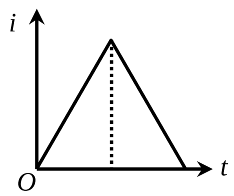
(c) Its poles cannot be separated

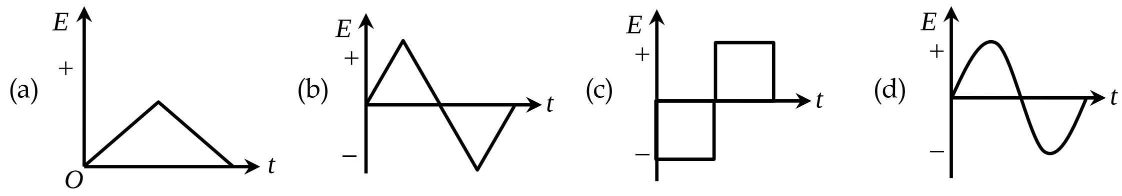
(d) Its like poles repel and unlike poles attract

Sol: Bar magnet produces magnetic field

Ans: (a)

151.The current i in an inductance coil varies with time t according to the graph shown in figure. Which one of the following plots shows the variation of voltage in the coil with time?





Sol: According to $i-t$ graph, in the first half current is increasing uniformly so a constant negative emf induces in the circuit. In the second half current is decreasing uniformly so a constant positive emf induces.

Ans: (c)

152.Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area $A=10\,\text{cm}^2$ and length $=20\,\text{cm}$. If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is $\left(\mu_0=4\pi\times10^{-7}\,\text{Tm A}^{-1}\right)$

(a) $2.4\pi\times10^{-5}\,\text{H}$ (b) $4.8\pi\times10^{-4}\,\text{H}$ (c) $4.8\pi\times10^{-5}\,\text{H}$ (d) $2.4\pi\times10^{-4}\,\text{H}$

Sol: $M=\frac{\mu_0 N_1 N_2 A}{l}=\frac{4\pi\times10^{-7}\times300\times400\times100\times10^{-4}}{0.2}=2.4\pi\times10^{-4}\,\text{H}$

$\left[\because \phi = MI \text{ and } \phi = N_1 B_2 A \text{ or } \phi = N_1\left(\frac{\mu_0 N_2 I}{l}\right)\cdot A\right]$

Ans: (d)

153.If instantaneous current is given by $i = 4\cos(\omega t + \phi)$ amperes, then the rms value of current is

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

Sol: $i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$ ampere

Ans: (b)

154.In a series LCR circuit $R = 300\Omega$, $L = 0.9\text{H}$, $C = 2.0\ \mu\text{F}$ and $\omega = 1000\ \text{rad s}^{-1}$, then impedance of the circuit is

(a) 400Ω (b) 1300Ω (c) 900Ω (d) 500Ω

Sol: $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$X_L = \omega L = 1000 \times 0.9 = 900\ \Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{1000 \times 2 \times 10^{-6}} = 500\ \Omega$

$Z = \sqrt{(300)^2 + (900-500)^2}$

$= \sqrt{(300)^2 + (400)^2}$

$Z = 500\ \Omega$

Ans: (d)

155.An inductance of $\left(\frac{200}{\pi}\right)$mH, a capacitance of $\left(\frac{10^{-3}}{\pi}\right)$F and a resistance of 10Ω are connected in series with an a.c. source 220 V 50 Hz. The phase angle of the circuit is

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{2}$ (d) $\frac{\pi}{3}$

Sol: Phase difference between E and $I = \theta$

$\therefore \tan\theta = \frac{X_L - X_C}{R}$ Now $X_L = 2\pi fL = 2\pi \times 50 \times \left(\frac{200}{\pi} \times 10^{-3}\right) = 20\Omega$

$X_C = \frac{1}{2\pi fC} = \frac{\pi}{2\pi \times 50 \times 10^{-3}} = 10\ \Omega$

$R = 10\Omega$

$\therefore \tan\theta = \frac{20-10}{10} = \frac{10}{10} = 1 = \tan\frac{\pi}{4}$

$\therefore \theta = \frac{\pi}{4}$.

The current will lag by $\frac{\pi}{4}$.

Ans: (b)

156. An electromagnetic wave travels along $z-$axis. Which of the following pairs of space and time varying fields would generate such a wave?

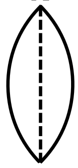
(a) E_x, B_y (b) E_y, B_x (c) E_z, B_x (d) E_y, B_z

Sol: E_x and B_y would generate a plane EM wave travelling in $z-$direction. $\vec{E}$, $\vec{B}$ and $\vec{k}$ from a right handed system $\vec{k}$ is along $z-$axis. As $\hat{i}\times\hat{j}=\hat{k}$

$\Rightarrow E_x\hat{i}\times B_y\hat{j}=C\hat{k}$, i.e., E is along $x-$axis and B is along $y-$axis.

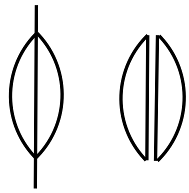
Ans: (a)

157. The equi-convex lens, shown in figure, has a focal length f. What will be the focal length of each half if the lens is cut along AB?



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

Sol: $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$



This is combination of two lenses of equal focal lengths.

$\therefore\frac{1}{f}=\frac{1}{f'}+\frac{1}{f'}=\frac{2}{f'}\Rightarrow f'=2f$

Ans: (d)

158. An astronomical telescope has a magnifying power 10, the focal length of the eyepiece is $20\,\text{cm}$. The focal length of the objective is

(a) $\frac{1}{200}\text{cm}$ (b) $\frac{1}{2}\text{cm}$ (c) $200\,\text{cm}$ (d) $2\,\text{cm}$

Sol: The magnifying power of telescope in normal adjustment is given by,

$M=\frac{f_0}{f_e}$

$\Rightarrow 10=\frac{f_0}{20}\Rightarrow f_0=200\,\text{cm}$

Ans: (c)

159. A convex mirror of focal length f forms an image which is $\frac{1}{n}$ times the object. The distance of the object from the mirror is

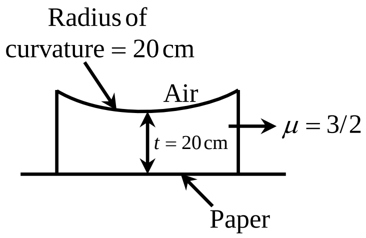
(a) $(n-1)f$ (b) $\left(\frac{n-1}{n}\right)f$ (c) $\left(\frac{n+1}{n}\right)f$ (d) $(n+1)f$

Sol: $m=+\frac{1}{n}=-\frac{v}{u}\Rightarrow v=-\frac{u}{n}$

By using mirror formula, $\frac{1}{f}=\frac{1}{\frac{-u}{n}}+\frac{1}{u}\Rightarrow u=-(n-1)f$

Ans: (a)

160. A plano-concave lens is placed on a paper on which a flower is drawn. How far above its actual position does this flower appear to be?



(a) 10 cm (b) 15 cm (c) 50 cm (d) None of these

Sol: Considering refraction at the curved surface, $u=-20,\ \mu_2=1,\ \mu_1=\frac{3}{2},\ R=+20$

Applying, $\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

$\Rightarrow \frac{1}{v}-\frac{3/2}{-20}=\frac{1-3/2}{20}\Rightarrow v=-10$

i.e., 10 cm below the curved surface or 10 cm above the actual position of flower.

Ans: (a)

161. A ray of light traveling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass-air surface at an angle of incident of $45°$. The refractive index of air is one. Under these conditions the ray will

(a) Emerge into the air without any deviation

(b) Be reflected back into the glass

(c) Be absorbed

(d) Emerge into the air with an angle of refraction equal to $90°$

Sol: $\sin C=\frac{1}{\mu}=\frac{1}{\sqrt{2}}$

$\therefore C=\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)=45°$

Now, $\frac{\sin C}{\sin r}=\frac{1}{\mu}$ or $\frac{\sin 45°}{\sin r}=\frac{1}{\sqrt{2}}$

$\sin r=1$ or $r=90°$

Ans: (d)

162. A polarized light of intensity I_0 is passed through another polarizer whose pass axis makes an angle of $60°$ with the pass axis of the former. What is the intensity of emergent polarized light from second polarizer?

(a) $\frac{I_0}{4}$ (b) $I=\frac{I_0}{5}$ (c) $I=\frac{I_0}{6}$ (d) $I=I_0$

Sol: $I = I_0 \cos^2 60 = \left(\frac{I_0}{4}\right)$

Ans: (a)

163.If in a photoelectric cell, the wavelength of incident light is changed from $4000\,\text{Å}$ to $3000\,\text{Å}$ then change in stopping potential will be

(a) $0.66\,\text{V}$ (b) $1.03\,\text{V}$ (c) $0.33\,\text{V}$ (d) $0.49\,\text{V}$

Sol: $eV_1 = h\nu_1 - h\nu_0$

$eV_2 = h\nu_2 - h\nu_0$

$$V_2 - V_1 = \frac{hc}{e}\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right) = 12400\left(\frac{1}{3000} - \frac{1}{4000}\right) = 1.03\,\text{eV}$$

Ans: (b)

164.If the momentum of electron is changed by P, then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be

(a) $200\,P$ (b) $400\,P$ (c) $\frac{P}{200}$ (d) $100\,P$

Sol: The de Broglie's wavelength associated with the moving electron, $\lambda = \frac{h}{P}$

Now, according to problem, $\frac{d\lambda}{\lambda} = -\frac{dP}{P}$; $\frac{0.5}{100} = \frac{P}{P'}$

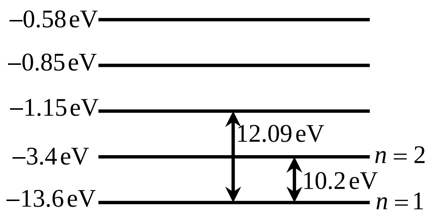
$P' = 200\,P$

Ans: (a)

165.Out of the following which one is not a possible energy for a photon to be emitted by hydrogen atom according to Bohr's atomic model?

(a) $1.9\,\text{eV}$ (b) 11.1eV (c) $13.6\,\text{eV}$ (d) $0.65\,\text{eV}$

Sol: Obviously, difference of 11.1eV is not possible.



Ans: (b)

166.An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to

(a) $\frac{1}{Ze}$ (b) v^2 (c) $\frac{1}{m}$ (d) $\frac{1}{v^4}$

Sol: Kinetic energy of α nucleus is equal to electrostatic potential energy of the system of the α particle and the heavy nucleus. That is,

$$\frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{q_\alpha Ze}{r_0}$$

where r_0 is the distance of closest approach

$$r_0 = \frac{2}{4\pi\varepsilon_0}\frac{q_\alpha Ze}{mv^2} \Rightarrow r_0 \propto Ze \propto q_\alpha \propto \frac{1}{m} \propto \frac{1}{v^2}$$

Ans: (c)

167. A nuclear reactor delivers a power of 10^9 W, the amount of fuel consumed by the reactor in one hour is

(a) $0.96\ g$ (b) $0.04\,g$ (c) $0.08\,g$ (d) $0.72\,g$

Sol: $P = 10^9$ W

$$\Rightarrow \frac{E}{t} = 10^9$$

$$\frac{mc^2}{t} = 10^9$$

$$m \times \frac{\left(3\times10^8\right)^2}{60\times60} = 10^9$$

$$m = \frac{10^9 \times 36\times10^2}{\left(3\times10^8\right)^2} = 4\times10^{-5}\text{ kg}$$

$\therefore\ m = 0.04$ g

Ans: (b)

168. The binding energy per nucleon for ${}_1^2H$ and ${}_2^4He$ respectively are 1.1 MeV and 7.1 MeV. The energy released in MeV when two ${}_1^2H$ nuclei fuse to form ${}_2^4He$ is

(a) 4.4 (b) 8.2 (c) 24 (d) 28.4

Sol: The chemical reaction of process is $2{}_1^2H \rightarrow {}_2^4He$

Energy released $= 4\times(7.1) - 4(1.1) = 24$ MeV

Ans: (c)

169. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio $2:1$. Ratio of their nuclear sizes will be

(a) $2^{1/3}:1$ (b) $1:3^{1/2}$ (c) $3^{1/2}:1$ (d) $1:2^{1/3}$

Sol: $p_1 = p_2$

$m_1v_1 = m_2v_2$

$2m_1 = m_2$

$$2\rho\cdot\frac{4}{3}\pi R_1^3 = \rho\cdot\frac{4}{3}\pi R_2^2;\ \frac{R_1^3}{R_2^3} = 1:2$$

$R_1 : R_2 = 1:2^{1/3}$

Ans: (d)

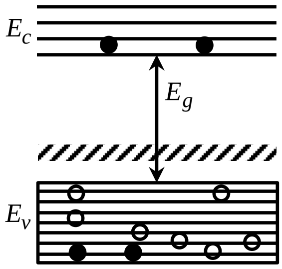
170.In Rutherford experiment, for head-on collision of $\alpha -$particles with a gold nucleus, the impact parameter is

(a) zero
(b) of the order of 10^{-14}m
(c) of the order of 10^{-10}m
(d) of the order of 10^{-6}m

Sol: Zero

Ans: (a)

171.In the energy band diagram of a material shown below, the open circles and filled circles denote holes and electrons respectively. The material is



(a) An insulator
(b) A metal
(c) An $n-$type semiconductor
(d) A $p-$type semiconductor

Sol: For a $p-$type semiconductor, the acceptor energy level, as shown in the diagram, is slightly above the top E_v of the volume band. With very small supply of energy an electron from the valence band can jump to the level E_A and ionise acceptor negatively.

Ans: (d)

172.The conductivity of semiconductor increases with increase in temperature because.

(a) number density of charge carriers increases
(b) relaxation time increases
(c) both number density of charge carriers and relaxation time increase
(d) number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density

Sol: Number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density

Ans: (d)

173.When a $p-n$ junction diode is reverse biased the flow of current across the junction is mainly due to

(a) Diffusion of charges
(b) Drift of charges
(c) Depends on the nature of material
(d) Both drift and diffusion of charges

Sol: When $p-n$ junction is reverse biased, the flow of current is due to drifting of minority charge carriers across the junction.

Ans: (b)

174. A $10\,\text{eV}$ electron is circulating in a plane at right angles to a uniform field of magnetic field $10^{-4}\,\text{Wb}\,\text{m}^{-2}$ $(=1.0$ gauss). The orbital radius of the electron is

(a) $12\,\text{cm}$ (b) $16\,\text{cm}$ (c) $11\,\text{cm}$ (d) $18\,\text{cm}$

Sol: K.E. of electron $=10\,\text{eV}$

$$\Rightarrow \frac{1}{2}mv^2 = 10\,\text{eV} \Rightarrow \frac{1}{2}\left(9.1\times10^{-31}\right)v^2 = 10\times1.6\times10^{-19} \Rightarrow v^2 = \frac{2\times10\times1.6\times10^{-19}}{9.1\times10^{-31}}$$

$$\Rightarrow v^2 = 3.52\times10^{12} \Rightarrow v = 1.88\times10^{6}\,\text{m}$$

Also we know that for circular motion, $\dfrac{mv^2}{r} = Bev \Rightarrow r = \dfrac{mv}{Be} = 11\,\text{cm}$

Ans: (c)

175. If the units of mass, length and time are doubled, unit of angular momentum will be

(a) Doubled (b) Tripled

(c) Quadrupled (d) 8 times the original value

Sol: $P_1 = \left[ML^2T^{-1}\right]$

$$P_2 = \left[(2M)(2L)^2(2T)^{-1}\right]$$

$$P_2 = 4\left[ML^2T^{-1}\right] = 4P_1$$

Ans: (c)

176. The displacement $'x'$ (in metre) of particle of mass $'m'$ (in kg) moving in one dimension under the action of a force, is related to time $'t'$ (in sec.) by, $t=\sqrt{x}+3$. The displacement of the particle when its velocity is zero, will be

(a) $2\,\text{m}$ (b) $4\,\text{m}$ (c) $0\,\text{m}$ (d) $6\,\text{m}$

Sol: $t=\sqrt{x}+3 \Rightarrow x=(t-3)^2$

$$v=\frac{dx}{dt}=\frac{d}{dt}\left((t-3)^2\right)=\frac{d}{dt}\left(t^2+9-6t\right)=2t+0-6$$

$v=2t-6$

When $v=0,\ t=3$

$x=(t-3)^2$

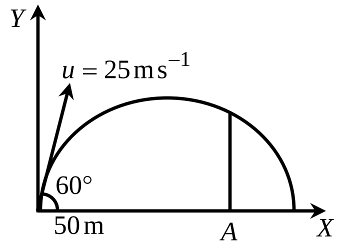
$x=(3-3)^2$

$x=0\text{ m}$

Ans: (c)

177. A cricketer hits a ball with a velocity $25\,\text{m}\,\text{s}^{-1}$ at $60°$ above the horizontal. How far above the ground it passes over a fielder $50\,\text{m}$ from the bat (assume the ball is truck very close to the ground)

(a) $8.2\,\text{m}$ (b) $9.0\,\text{m}$ (c) $11.6\,\text{m}$ (d) $12.7\,\text{m}$



Sol: Horizontal component of velocity, $v_x = 25\cos 60° = 12.5\,\text{m s}^{-1}$

Vertical component of velocity, $v_y = 25\sin 60° = 12.5\sqrt{3}\,\text{m s}^{-1}$

Time to cover $50\,\text{m}$ distance, $t = \dfrac{50}{12.5} = 4\,\text{s}$

The vertical height y is given by

$$y = u_y t - \frac{1}{2}gt^2 = 12.5\sqrt{3}\times 4 - \frac{1}{2}\times 9.8\times 16 = 8.2\,\text{m}$$

Ans: (a)

178. A person with his hands in his pockets is skating on ice at the velocity of $10\,\text{m s}^{-1}$ and describes a circle of radius $50\,\text{m}$. What is his inclination with vertical? $\left(g = 10\,\text{ms}^{-2}\right)$

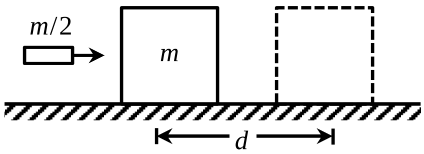
(a) $\tan^{-1}\left(\frac{1}{10}\right)$ (b) $\tan^{-1}\left(\frac{3}{5}\right)$ (c) $\tan^{-1}(1)$ (d) $\tan^{-1}\left(\frac{1}{5}\right)$

Sol: The inclination of person from vertical is given by

$$\tan\theta = \frac{v^2}{rg} = \frac{(10)^2}{50\times 10} = \frac{1}{5} \qquad \therefore \theta = \tan^{-1}(1/5)$$

Ans: (d)

179. A block of mass m rests on a rough horizontal surface (coefficient of friction is μ). When a bullet of mass $m/2$ strikes horizontally, and get embedded in it, the block moves a distance d before coming to rest. The initial velocity of the bullet is $k\sqrt{2\mu gd}$, then the value of k is



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

Sol: Let initial velocity of the bullet be v.

By linear momentum conservation, $\dfrac{m}{2}v = \left(\dfrac{m}{2} + m\right)v_1$ (v_1 = combined velocity)

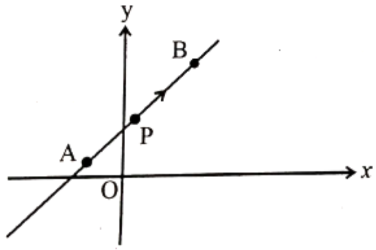
$v_1 = \dfrac{v}{3}$ … (i)

Retardation $= \mu g$

$$0 = \left(\frac{v}{2}\right)^2 - 2\mu gd \Rightarrow v = 3\sqrt{2\mu gd}$$

Ans: (b)

180. A particle is moving uniformly along a straight line as shown in the figure. During the motion of the particle from A to B, the angular momentum of the particle about 'O'



(a) increases
(b) decreases
(c) remains constant
(d) first increases then decreases

Sol: $\vec{L} = \vec{r} \times \vec{p}$

$= rp\sin\theta = (r\sin\theta)\,p$

$r\sin\theta$ remains constant during the motion of the particle from A to B.

Ans: (c)

Key Answers:

1. c	2. b	3. a	4. c	5. a	6. d	7. c	8. c	9. c	10. a
11. c	12. b	13. a	14. b	15. a	16. c	17. d	18. d	19. c	20. c
21. d	22. b	23. d	24. a	25. b	26. c	27. c	28. d	29. b	30. d
31. d	32. b	33. c	34. a	35. a	36. b	37. a	38. b	39. b	40. b
41. d	42. a	43. b	44. b	45. a	46. d	47. a	48. d	49. d	50. b
51. d	52. b	53. c	54. c	55. b	56. b	57. d	58. d	59. c	60. b
61. a	62. b	63. d	64. d	65. d	66. d	67. d	68. d	69. c	70. d
71. d	72. b	73. c	74. c	75. a	76. c	77. a	78. a	79. c	80. d
81. c	82. b	83. a	84. b	85. a	86. a	87. b	88. a	89. b	90. a
91. a	92. c	93. c	94. d	95. a	96. a	97. c	98. a	99. d	100.b
101.b	102.d	103.a	104.c	105.d	106.b	107.d	108.a	109.c	110.d
111.a	112.a	113.a	114.a	115.c	116.d	117.b	118.a	119.a	120.b
121.a	122.d	123.a	124.d	125.b	126.c	127.a	128.d	129.b	130.a
131.c	132.a	133.b	134.a	135.a	136.d	137.d	138.c	139.b	140.d
141.b	142.c	143.d	144.a	145.a	146.d	147.a	148.c	149.a	150.a
151.c	152.d	153.b	154.d	155.b	156.a	157.d	158.c	159.a	160.a
161.d	162.a	163.b	164.a	165.b	166.c	167.b	168.c	169.d	170.a
171.d	172.d	173.b	174.c	175.c	176.c	177.a	178.d	179.b	180.c