Deeksha - CET

| Subject | Topic | Mock Test – 06 | Date |
|---|---|---|---|
| C + M + P | Complete Syllabus | CET – 12 – CT<br>C1220230507 | $7^{th}$ May 2023 |

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

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

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

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

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

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

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

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

   **All the best!!**

## Useful Data

**At. Wt.:**

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

**Physical Constants:**

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

## Chemistry

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

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

Options:

(a) $C_6H_{12}O_6$ and $C_{12}H_{22}O_{11}$

(b) $CH_3COOH$ and $C_2H_5OH$

(c) $CH_3COOH$ and $C_6H_{12}O_6$

(d) $HCOOH$ and $CH_3COOH$

Sol: $CH_3COOH$ and $C_6H_{12}O_6$ have same empirical formula.

Hence have same percentage of carbon.

Ans: (c)

2. Which of the following sets of quantum numbers represents an impossible arrangement?

Options:

$n \quad \ell \quad m \quad s$

(a) $2 \quad 2 \quad -2 \quad +\frac{1}{2}$

(b) $4 \quad 0 \quad 0 \quad -\frac{1}{2}$

(c) $5 \quad 2 \quad 0 \quad +\frac{1}{2}$

(d) $3 \quad 3 \quad +2 \quad +\frac{1}{2}$

Sol: When $n = 3$ $\quad \ell$ cannot be $3$

Ans: (d)

3. Which of the following statements is correct

Options:

(a) Ionization enthalpy of $Mg$ is less than that of $Na$ and $Al$

(b) The atomic radius of $F$ is more than that of $O$

(c) Negative electron gain enthalpy of $F$ is less than that of $O$

(d) Among $Be, B$ and $C$, $B$ has lowest ionization enthalpy

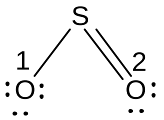
Sol: $IF_c$ of $Be \rightarrow 900\,\text{kJ/mol}$ $\qquad EA$ of $F = 328\,\text{kJ/mol}$

$IF_c$, of $B \rightarrow 800\,\text{kJ/mol}$ $\qquad EA$ of $o = -141\,\text{kJ/mol}$

$IF_c$, of $C \rightarrow 1090\,\text{kJ/mol}$

Ans: (d)

4. Formal charge on two $O$ atoms in



Options:

(a) $-1,+1$

(b) $-1,0$

(c) $0,+1$

(d) $-1,-1$

Sol: $FC = V - L - \frac{1}{2}S$

$$FC_{01} = 6-6-\frac{1}{2}(2)$$

$$= -1$$

$$FC_{O2} = 6-4-\frac{1}{2}(4)$$

$$= 0$$

Ans: (b)

5. A gaseous mixture was prepared by taking equal mole of $CO$ and $N_2$ of the total pressure of the mixture was found to be $1\,\text{atm}$, the partial pressure of nitrogen $(N_2)$ in the mixture is

Options:

(a) $0.5\,\text{atm}$

(b) $0.8\,\text{atm}$

(c) $0.9\,\text{atm}$

(d) $1\,\text{atm}$

Sol: Let number of moles of $CO$ and $N_2 = x$

$$X_{co} = \frac{x}{2x} = \frac{1}{2} \quad \text{and} \quad X_{N_2} = \frac{1}{2}$$

$$\therefore P_{N_2} = X_{N_2} \times P_{\text{total}} = \frac{1}{2} \times 1 = 0.5$$

Ans: (a)

6. For which of the following reaction, $\Delta S$ is not positive?

Options:

(a) $I_2(s) \to I_2(g)$

(b) $CuO(s) + H_2(g) \to Cu(g) + H_2O(l)$

(c) $2O_3(g) \to 3O_2(g)$

(d) $2Ag_2O(s) \to 4Ag + O_2(g)$

Sol: $CuO(s)+H_2(g)\rightarrow Cu(s)+H_2O(l)$

$\Delta n=0-1=-1$

$\therefore \Delta S$ is negative.

Ans: (d)

7. The heat of combustion of carbon to $CO_2$ is $-393.5\,\text{kJ/mol}$

The heat released for the formation of $22g$ of $CO_2$ from carbon and oxygen is

Options:

(a) $-393.5\,\text{kJ/mol}$

(b) $-39.3\,\text{kJ/mol}$

(c) $-19.6\,\text{kJ/mol}$

(d) $-196.75\,\text{kJ/mol}$

Sol: Heat released for forming

$44g$ of $CO_2=-393.5\,\text{kJ}$

$\therefore$ Heat released for forming

$22g$ of $CO_2=\dfrac{-393.5\times 22}{44}=-196.75\,\text{kJ/mol}$

Ans: (d)

8. The precipitate of Calcium fluoride $(CaF_2)$ with $K_{sp}=1.7\times10^{-10}$ is obtained when equal volumes of the following are mixed. The mixture which gives precipitate is

Options:

(a) $10^{-4}\,MCa^{2+}$ and $10^{-4}\,MF^{-}$

(b) $10^{-2}\,MCa^{2+}$ and $10^{-3}\,MF^{-}$

(c) $10^{-5}\,MCa^{2+}$ and $10^{-3}\,MF^{-}$

(d) $10^{-5}\,MCa^{2+}$ and $10^{-5}\,MF^{-}$

Sol: $Ksp$ of $CaF_2=\left[Ca^{2+}\right]\left[F^{-}\right]^2=1.7\times10^{-10}$

$IP$ of $CaF_2=10^{-2}\times\left(10^{-3}\right)^2=10^{-8}$ for

option (b)

Precipitation happens when

$IP>K_{SP}$

Ans: (b)

9. $Ka$, $Ka_2$ and $Ka_3$ are respective constants for the following reactions.

$H_2S \rightleftharpoons H^+ + HS^-$ $\quad Ka_1$

$HS^- \rightleftharpoons H_+ + S^{2-}$ $\quad Ka_2$

$H_2S \rightleftharpoons 2H^+ + S^{2-}$ $\quad Ka_3$

The correct relationship between $Ka_1, Ka_2$ and $Ka_3$ is

Options:

(a) $Ka_3 = Ka_1 \times Ka_2$

(b) $Ka_3 = Ka_1 + Ka_2$

(c) $Ka_3 = Ka_1 - Ka_1$

(d) $Ka_3 = \dfrac{Ka_1}{Ka_2}$

Sol: $Ka_3 = Ka_1 \times Ka_2$

Ans: (a)

10. $3C10^-(aq) \rightarrow C10_3^- + 2C1^-$ is an example of

Options:

(a) Oxidation reaction

(b) Reduction reaction

(c) Disproportionation reaction

(d) Displacement reaction

Sol: $3\overset{+1}{C}10^-(aq) \rightarrow \overset{+5}{C}10_3^- + 2\overset{-1}{C}1^-$

Chlorine is undergoing oxidation as well as reduction.

Ans: (c)

11. Which of the following is not an example for molecular solid?

Options:

(a) $PH_3$

(b) $H_2S$

(c) $SrH_2$

(d) $NH_3$

Sol: $SrH_2$ is ionic hydride

Ans: (c)

12. Slaking is the process of adding water to

Options:

(a) $Ca(OH)_2$

(b) $CaCl_2$

(c) $CaO$ (d) $CaCO_3$

Sol: $\underset{(\text{solid})}{CaO} + H_2O \rightarrow Ca(OH)_2$ is called slaking

Ans: (c)

13. Diamond has each of the following properties except.

Options:

(a) High melting point

(b) Ability to conduct electricity

(c) Inertness to chemical

(d) Extreme hardness

Sol: Diamond does not conduct electricity

Ans: (b)

14. In Duma's method $0.03g$ of an organic compound gave $41.9\,\text{ml}$ of nitrogen at STP. The percentage of $N$ is

Options:

(a) 29.46%

(b) 25.2%

(c) 17.37%

(d) 39.2%

Sol: $\%$ of $N = \frac{28}{22,400} \times \frac{V_{STP}}{W_{o,c}} \times 100$

$= \frac{28}{22,400} \times \frac{41.9}{0.3} \times 100 = 17.37$

Ans: (c)

15. Which of the following is most reactive towards sodium?

Options:

(a) $CH_3 - C = CH$

(b) $CH_3 - C = C - CH_3$

(c) $CH_3 - CH_2 - C \equiv CH$

(d) $CH \equiv CH$

Sol: $CH \equiv CH$ is most acidic and hence most reactive towards sodium.

Ans: (d)

16. In the following sequence of reaction, the end product is

$$CaC_2 \xrightarrow{H_2O} A \xrightarrow{Hg^{2+}/H_2SO_4} B \xrightarrow{[O]} C \xrightarrow{Ca(OH)_2} \xrightarrow{Heat} E$$

Options:

(a) Acetaldehyde

(b) Formaldehyde

(c) Acetic acid

(d) Acetone

Sol: $CaC_2 \xrightarrow{H_2O} CH = CH \xrightarrow{Hg^{2+}/H_2SO} CH_3CHO \xrightarrow{[O]} CH_3COOH \xrightarrow{Ca(OH)_2}$

$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 \xleftarrow{\text{heat}} (CH_3COO)_2\,Ca$

Ans: (d)

17. Metallic gold crystallizes in body centred cubic lattice. The co-ordination number of gold is:

Options:

(a) Zero

(b) 6

(c) 8

(d) 4

Sol: Co-ordination number of bcc lattice $=8$

Ans: (c)

18. A solid is made up of two elements $A$ and $B$. Atoms of $B$ are in $CCP$ arrangements, while atoms of $A$ occupy all the tetrahedral sites. The formal of the compound is

Options:

(a) $AB_2$

(b) $AB$

(c) $AB_3$

(d) $A_2B$

Sol: As $B$ atoms are in $CCP$ arrangements, the number of atoms per unit cell $=4$.

Number of tetrahedral voids $=2\times4=8$

$\therefore$ Number of $A$ atoms in tetrahedral voids $=8$

$\therefore$ Ratio of $A$ and $B=8:4$ or $2:1$

Formula $=A_2B$

Ans: (d)

19. The metal elevation constant is the ratio of elevation in boiling point to

Options:

(a) Molarity

(b) Boiling point of pure liquid

(c) Mole fraction of solute

(d) Molality

Sol: $\Delta T_b = K_p m$

$K_b = \dfrac{\Delta T_b}{m}$ where $'m'$ is the molality of the solution.

Ans: (d)

20. A plant cell shrinks when placed in

Options:

(a) Water

(b) Hypotonic solution

(c) Isotonic solution

(d) Hypertonic solution

Sol: A plant cell shrinks when placed in hypertonic solution

Ans: (d)

21. Two moles of a non-volatile solute are dissolved in $5$ moles of water. The vapour pressure of the solute relative to that of water is

Options:

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

(b) $\frac{2}{7}$

(c) $\frac{4}{7}$

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

Sol: $\frac{P_o - P_S}{P_o} = X_2 = \frac{n_2}{n_1 + n_2} = \frac{2}{2+5} = \frac{2}{7}$

$1 - \frac{P_s}{P_o} = \frac{2}{7}$ or $\frac{P_s}{P_o} = 1 - \frac{2}{7} = \frac{5}{7}$

Ans: (d)

22. In the Laclanche dry cell, anode is

Options:

(a) Graphite rod

(b) Carbon

(c) Zinc container

(d) $MnO_2 + C$

Sol: Anode – Zinc container

Ans: (c)

23. The emf of the cell at $25°C$

$Cu / Cu^{2+}(0.01M) \| Ag^{+}(0.1M) / Ag$ is

$$\left( given\, E^{\circ}_{cell \frac{2t}{Cu}} = 0.34V \text{ and } E^{\circ}_{\frac{Ag^{+}}{Ag}} = 0.80V \right)$$

Options:

(a) $0.46V$

(b) $1.14V$

(c) $0.43V$

(d) $1.29V$

Sol: $E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n} \log \frac{Cu^{2+}}{\left(Ag^{+}\right)^{2}}$

$= (0.80 - 0.34) - \frac{0.0591}{2} \log 1 = 0.46V$

Ans: (a)

24. The quantity of electricity needed to separately electrotype $1\text{M}$ solution of $ZnSO_4, AlCl_3$ and $AgNO_3$ completely is in the ratio of

Options:

(a) $2:3:1$

(b) $2:1:1$

(c) $2:1:3$

(d) $2:2:1$

Sol: $Zn^{2+}(1\text{M}) + 2e^{-} \rightarrow Zn$ charge required $2F$

$Al^{3+}(1\text{M}) + 3e^{-} \rightarrow Al$ charge required $3F$

$Ag^{+}(1\text{M}) + e^{-} \rightarrow Ag$ charge required $F$

Ans: (a)

25. What is the activation energy for a reaction if its rate doubles when the temperature is raised from $300\,\text{k}$ to $310\,\text{k}$?

Options:

(a) $535\,\text{kJ mol}^{-1}$

(b) $5350\,\text{kJ mol}^{-1}$

(c) $53.5\,\text{kJ mol}^{-1}$

(d) $5.35\,\text{kJ mol}^{-1}$

Sol: $\log\frac{K_2}{K_1}=\frac{E_a}{2.303R}\left[\frac{T_2-T_1}{T_2T_1}\right]$

$\log 2=\frac{E_a}{2.303\times 8.314}\left[\frac{10}{300\times 310}\right]$

$E_a=0.301\times 19.14\times 30\times 310=53,578\text{J}=53.5\text{kJ/mol}$

Ans: (c)

26. Which of the following form micelles in aqueous solution above certain concentration?

Options:

(a) Dodecyl trimethylammonium chloride

(b) Glucose

(c) Urea

(d) Pyridinium chloride

Sol: Surfactants like soaps and detergents form micelle

Ans: (a)

27. Adsorption is an exothermic process. The amount of substance adsorbed should

Options:

(a) increase with decrease in temperature

(b) increase with decrease in temperature

(c) decrease with increase in temperature

(d) no change with increase in temperature

Sol: Since adsorption is an exothermic process, it increases with decrease in temperature.

Ans: (a)

28. Zone refining has been employed for preparing ultra-pure samples of

Options:

(a) $Cu$

(b) $Na$

(c) $Ge$

(d) $Zn$

Sol: It can be used for metalloids like $Ge$ also.

Ans: (c)

29. Which of the following represents smelting process?

Options:

(a) $ZnCO_3\rightarrow ZnO+CO_2$

(b) $Fe_2O_3+3C\rightarrow 2Fe+3CO$

(c) $2PbS+3O_2\rightarrow 2PbO+2SO_2$

(d) $Al_2O_3,2H_2O\rightarrow Al_2O_3+2H_2O$

Sol: Smelting involves reducing of the ore to crude metal

Ans: (b)

30. Which of the following forms two series of salts?

Options:

(a) $H_3PO_4$

(b) $H_3PO_3$

(c) $H_4P_2O_7$

(d) $H_3PO_2$

Sol: $H_3PO_3$ is dibasic, forms two series of salts

Ans: (b)

31. The least thermally stable hydride is

Options:

(a) $NH_3$

(b) $SbH_3$

(c) $PH_3$

(d) $AsH_3$

Sol: Thermal stability decreases down the group.

Ans: (b)

32. Dinitrogen pentoxide dissolves in water to give

Options:

(a) $HNO_2$

(b) $H_2N_2O_2$

(c) $NO_2$

(d) $HNO_3$

Sol: $N_2O_5 + H_2O \rightarrow 2HNO_3$

Ans: (d)

33. Reaction of chlorine with hot $KOH$ gives

Options:

(a) $KCl$ and $KClO$

(b) $KClO$ and $KClO_3$

(c) $KCl$ and $KClO_3$

(d) Only $KClO_3$

Sol: $Cl_2 + KOH \rightarrow KCl + KClO_3 + H_2O$

Ans: (c)

34. Among the following the square planar geometry is for

Options:

(a) $XeF_4$

(b) $XeF_4$

(c) $XeF_2$

(d) $XeO_3$

Sol: $XeF_4$ has square pyramidal geometry

Ans: (b)

35. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphite ion in acidic solution is

Options:

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

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

(c) $\frac{4}{5}$

(d) 1

Sol: $2MnO_4^- + 5SO_3^{2-} + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

Ans: (a)

36. Which of the following pairs has the same size?

Options:

(a) $Zr^{4+}, Hf^{4+}$

(b) $Zn^{2+}, Hf^{4+}$

(c) $Fe^{2+}, Ni^{2+}$

(d) $Zr^{4+}, Ti^{4+}$

Sol: $Zr^{4+}, Hf^{4+}$ show similar size because of lanthanide contraction.

Ans: (a)

37. The ion sowing a magnetic moment of 2.83BM among the following is

Options:

(a) $Ti^{3+}$

(b) $Ni^{2+}$

(c) $Cr^{3+}$ (d) $Mn^{2+}$

Sol: $2.83\,\text{BM}$ magnetic moment is shown by ion with $2$ unpaired electrons i.e. $Ni^{2+}$, $\mu = \sqrt{n(n+2)}$

Ans: (b)

38. The crystal field splitting energy for octahedral $(\Delta_o)$ and tetrahedral $(\Delta t)$ complexes is related as

Options:

(a) $\Delta_t = \frac{1}{2}\Delta_o$

(b) $\Delta_t = \frac{4}{9}\Delta_o$

(c) $\Delta_t = \frac{3}{5}\Delta_o$

(d) $\Delta_t = \frac{2}{5}\Delta_o$

Sol: $\Delta_t = \frac{4}{9}\Delta_o$

Ans: (b)

39. Which of the following statements is not correct?

Options:

(a) $[FeF_6]^{3-}$ has five unpaired electrons

(b) $\left[Co(NH_3)_3 Cl_3\right]$ is an non-conductor

(c) Tetrahedral complexes do not show geometrical isomerism

(d) In $CN$ group, bonding occurs through $N$

Sol: In $CN$ group, bonding occurs through $C$.

Ans: (d)

40. Which of the following is a order orbital complex?

Options:

(a) $\left[Fe(CN)_6\right]^{4-}$

(b) $[CoF_6]^{3-}$

(c) $\left[Co(NH_3)_6\right]^{3+}$

(d) $\left[Fe(cn)_3\right]^{2+}$

Sol: $[CoF_6]^{3-}$ is an outer orbital complex

Ans: (b)

41. The addition of a catalyst during a chemical reaction alters which of the following quantities?

Options:

(a) Entropy

(b) Internal energy

(c) Enthalpy

(d) Activation energy

Sol: Catalyst changes the path of the reaction and reduces the activation energy.

Ans: (d)

42. The rate for the first order reaction is $0.0069\,\text{mol}\,L^{-1}\,\text{min}^{-1}$ and the initial concentration is $0.2\,\text{mol}\,L^{-1}$. The half-life period is

Options:

(a) 10mins

(b) 20mins

(c) 15 min

(d) 7 min

Sol: Rate $= K[R]$

$$\therefore K = \frac{0.0069}{0.2} = 0.0345$$

$$t_{\frac{1}{2}} = \frac{0.693}{\text{k}} = \frac{0.693}{0.0345} = 20.08\text{mins}$$

Ans: (b)

43. Ethyl isocyanide is prepare by the reaction between

Options:

(a) $C_2H_5Br$ and $KCN(alc)$

(b) $C_2H_5Br$ and $AgCN(alc)$

(c) $C_2H_5Br$ and $HCN$

(d) $C_2H_5Br$ and ammonia

Sol: $C_2H_5Br + AgCN(acl) \rightarrow C_2H_5NC + AgBr$

Ans: (b)

44. $1,3-$ Dibromopropane reacts with metallic zinc to form

Options:

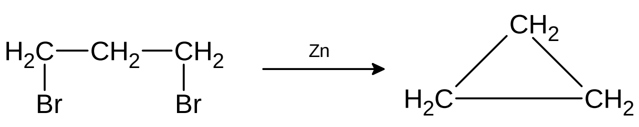
(a) Propene

(b) Propane

(c) Hexane

(d) Cyclopropane

Sol:




Ans: (d)

45. Which of the following is most reactive towards $S_N1$ reaction?

Options:

(a) Methyl bromide

(b) Tertiary butyl bromide

(c) Secondary butyl bromide

(d) Ethyl bromide

Sol: Methyl bromide

Ans: (a)

46. An alkene $CH_3CH=CH_2$ is treated with $B_2H_6$ in presence of $H_2O_2$. The final product formed is

Options:

(a) $CH_3CH_2CHO$

(b) $CH_3CH(OH)CH_3$

(c) $CH_3CH_2CH_2OH$

(d) $(CH_3CH_2CH_2)_3B$

Sol: $CH_3CH=CH_2+(BH_3)_2 \rightarrow CH_3CH_2CH_2BH_2 \xrightarrow{CH_3CH=CH_2} (CH_3CH_2CH_2)BH$

$\xrightarrow{CH_3CH=CH_2} (CH_3CH_2CH_2)_2B \xrightarrow[3H_2O_2/OH]{H_2O} 3CH_3CH_2CH_2OH + B(OH)_3$

Ans: (c)

47. Acid catalysed dehydration of $t-$butanol is faster than that of $n-$butanol because

Options:

(a) tertiary carbocation is more stable than primary carbocation

(b) primary carbocation is more stabl than teritiary carbocation

(c) $t-$butanol has higher boiling point

(d) rearrangement takes place during dehydration of $t-$butanol

Sol: Teritiary carbocation is more stable than $1°$, hence the dehydration in $3°$ alcohol proceeds faster than $1°$ alcohol.

Ans: (a)

48. Cumene on reaction with oxygen followed by hydrolysis gives

Options:

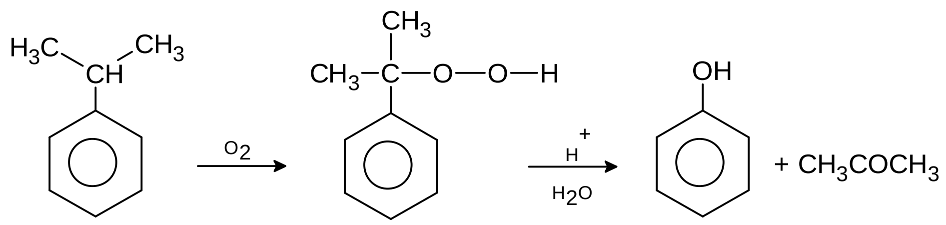
(a) $CH_4OH$ and $C_6H_5COCH_3$

(b) $C_6H_5OH$ and $(CH_3)_2O$

(c) $C_6H_5OCH_3$ and $CH_3OH$

(d) $C_6H_5OH$ and $CH_3COCH_3$

Sol:




Ans: (d)

49. Anisole on reaction with chloromethane in presence of anhydrous $AlCl_3$ gives

Options:

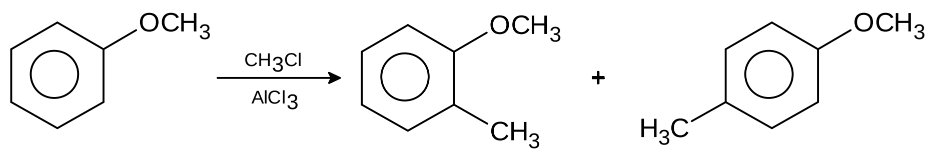
(a) $o-$ methylanisole and $p-$ methoxyanisole

(b) $p-$ methylanisole and $p-$ methoxyanisole

(c) $o-$ methylanisole and $p-$ methoxyanisole

(d) $o-$ methoxyacetophenone and $p-$ methoxyacetophenone

Sol:




Ans: (c)

50. The most acidic among the following

Options:

(a) Phenol

(b) $p-$Cresol

(c) $p-$Nitrophenol

(d) $2,4-$Dinitrophenol

Sol: $2,4-$ Dinitrophenol

Ans: (d)

51. Which of the following compound does not react with $NaHSO_3$ ?

Options:

(a) $HCHO$

(b) $C_6H_5COCH_3$

(c) $CH_3COCH_3$

(d) $CH_3CHO$

Sol: $C_6H_5COCH_3$ does not react with $NaHSO_3$ because of steric hindrance

Ans: (b)

52. A compound $(X)$ with a molecular formula $C_5H_{10}O$ gives a positive $2,4-DNP$ test but a negative Tollen's test. On oxidation it gives carboxylic acid $(Y)$ with a molecular formula $C_3H_6O_2$. Potassium salt of $(Y)$ undergoes Kolbe's reaction to give a hydrocarbon $(2)$. $X$. $Y$ and $Z$ respectively are

Options:

(a) Pentan $-3-$ one, propanoicacid, butane

(b) Pentanol, pentanoic acid, octane

(c) $2-$ Methylbutanone, butanoic acid, hexane

(d) $2,2-$ dimethylpropanone, propanoic acid, hexane

Sol: $CH_3-CH_4-\overset{\overset{O}{\|}}{C}-CH_2-CH_3 \xrightarrow{[O]} CH_3CH_2COOH + CH_3COOH \xrightarrow{KOH} CH_3CH_2-COOK$

$\xrightarrow{\text{Kolbe's electrolysis}} C_4H_{10} + 2CO_2$

Ans: (a)

53. Complete the missing links $(X),(Y)$ and $(Z)$ by making an appropriate choice

$CH_3COOH \xrightarrow{PBr_3/Br_3} X \xrightarrow{KCN} Y \xrightarrow{H_3O} Z$

Options:

| | $X$ | $Y$ | $Z$ |
|---|---|---|---|
| (a) | $CH_3COBr$ | $CH_3COCN$ | $CH_3COOH$ |
| (b) | $BrCH_2COOH$ | $\underset{\underset{CN}{\vert}}{CH_2}-COOH$ | $HOOC-CH_2-COOH$ |
| (c) | $BrCH_2COOH$ | $CH_2(CN)COOH$ | $COOH-COOH$ |
| (d) | $Br_2CH-COOH$ | $Br_2C(CN)COOH$ | $CH_3CH_2COOH$ |

Sol: $CH_3COOH \xrightarrow{PBr/Br_2} \underset{\underset{Br}{\vert}}{CH_2}-COOH \xrightarrow{KCN} \underset{\underset{CN}{\vert}}{CH_2}-COOH \xrightarrow{H_3O^+} \underset{\underset{COOH}{\vert}}{CH_2}-COOH$

Ans: (b)

54. Which of the following will form isocyanide on reaction with $CHCl_3$ and $KOH$ ?

Options:

(a) $C_6H_5NHCH_3$

(b) $CH_3C_6H_4NH_2$

(c) $C_6H_5NHC_4H_9$

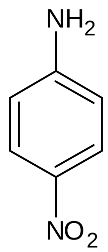
(d) $C_6H_5N(C_2H_5)_2$

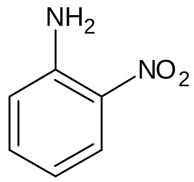
Sol: Only primary amines undergo carbylamine reaction

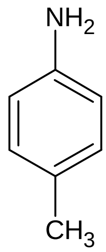
Ans: (b)

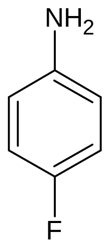
55. The most basic amine among the following is

Options:

(a) 

(b) 

(c) 

(d) 

Sol: Electron releasing groups increases basicity of amines

Ans: (c)

56. On oxidation with a mild oxidising agent like $Br_2 / H_2O$ the glucose is oxidised to

Options:

(a) Saccharic acid

(b) Glucaric acid

(c) Gluconic acid

(d) Valeric acid

Sol: Glucose $\xrightarrow[\text{Oxidation}]{Br_2/H_2O}$ gluconic acid

Ans: (c)

57. Which of the following vitamins is water soluble?

Options:

(a) Vitamin E

(b) Vitamin D

(c) Riboflavin

(d) Retinol

Sol: Riboflavin

Ans: (c)

58. In fibrous proteins polypeptide chains are held together by

Options:

(a) Vander Waal's forces

(b) Electrostatic forces of attraction

(c) Hydrogen bonds

(d) Covalent bonds

Sol: Polypeptide chain in fibrous proteins are held together by hydrogen bonds

Ans: (c)

59. Which of the following is not true for the thermoplastic polymers?

Options:

(a) Thermoplastics are linear polymers

(b) They soften and melt on heating

(c) Molten polymer can be remoulded into any shape

(d) They have cross-linkages which break on heating

Sol: They do not have any cross-linkages.

Ans: (d)

60. Which of the following is not an anti-depressant?

Options:

(a) Iproniazid

(b) Phenelzine

(c) Equanil

(d) Salvarsan

Sol: Salvarsan is an antibiotic

Ans: (d)

## Mathematics

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

61. Out of $50$ staff members in an office 20 members prefer to drink tea only, 10 prefer to drink coffee only and 5 prefer to drink neither tea nor coffee. Then the number of members who prefer to take atleast one of the two drinks is

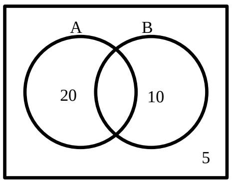
Options:

(a) 40

(b) 45

(c) 30

(d) 35




Sol: Let $A$ and $B$ be the set of staff members who drink tea and coffee respectively

"At least one of $A$ and $B$ means $A \cup B$"

Ans: (b)

62. If $n(A)=10, n(B)=6$ and $x, y$ are respectively the minimum number of elements in $A \cup B$ and maximum number of elements in $A \cap B$, then

Options:

(a) $x=y$

(b) $x>y$

(c) $x<y$

(d) $y=x+4$

Sol: $x=n(A)=10$ and happens when $B \subset A$

$y=n(B)=6 \quad \therefore x>y$

Ans: (b)

63. The relation $R$, defined on real numbers by a $R$ b iff $a-b$ is rational, is

Options:

(a) Reflexive but not symmetric

(b) Symmetric but not transitive

(c) Transitive but not reflexive

(d) Reflexive, symmetric and transitive

Sol: For every real number $x, xRx$ since $x-x=0 \in Q \therefore R$ is transitive

$xRy \Rightarrow yRx \Rightarrow x-y \in Q$ and $y-x \in Q \quad \therefore R$ is symmetric

Let $xRy$ and $yRz \Rightarrow (x-y)$ and $(y-z) \in Q$

$\Rightarrow (x-y)+(y-z) \in Q \Rightarrow (x-z) \in Q$

$\Rightarrow R$ is transitive

Ans: (d)

64. The number of constant function defined from the set $A = \{a_1, a_2, ....., a_p\}$ to the set $B = \{a_1, a_2, .....a_{2p}\}$ is

Options:

(a) $p$

(b) $2p$

(c) $p!$

(d) $(2p)!$

Sol: $f(a) = a_1, \quad \forall a \in A \text{ and } i = 1, 2, 3, ....., 2\text{p}$

Ans: (b)

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

Options:

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

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

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

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

Sol: $2^{-1} * 3^{-1} = (2*3)^{-1} = (2+3+6)^{-1} = 11^{-1} = \frac{-11}{11+1} = \frac{-11}{12}$ [identity $e = 0$]

Ans: (b)

66. The domain of the function $f(x)\frac{1}{\sqrt{[x]^2 - [x] - 6}}$ is

Options:

(a) $(-\infty, -2] \cup (4, \infty)$

(b) $(-\infty, -2) \cup (4, \infty)$

(c) $(-\infty, -2] \cup [4, \infty)$

(d) $(-\infty, -2) \cup [4, \infty)$

Sol: $[x]^2 - [x] - 6 > 0 \Rightarrow > 0$

$\Rightarrow [x] > 3 \text{ or } [x] < -2 \Rightarrow x \geq 4 \text{ and } x < -2 \Rightarrow x \in (-\infty, -2) \cup [4, \infty)$

Ans: (d)

67. If the moduli of $z$ and $1+z$ are equal, then

Options:

(a) $z$ is a real number

(b) real part of $z$ is $-\frac{1}{2}$

(c) real part of $z$ is zero

(d) real part of $z$ is $\frac{1}{2}$

Sol: $|x+iy| = |1+x+iy| \Rightarrow x^2+y^2 = (1+x)^2 + y^2$

$\Rightarrow x^2 = (1+x)^2 \Rightarrow 2x+1=0 \Rightarrow x = -\frac{1}{2}$

Ans: (b)

68. If $8\sin\theta = 4+\cos\theta$, then one of the values of $\sin\theta$ is equal to

Options:

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

(b) $\frac{5}{13}$

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

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

Sol: $(8\sin\theta-4)^2 = \cos^2\theta \Rightarrow 64\sin^2\theta - 64\sin\theta + 16 = 1-\sin^2\theta$

$\therefore 65\sin^2\theta - 64\sin\theta + 15 = 0; 65\times15 = 13\times75 = 39\times25; 39+25 = 64$

$65\sin^2\theta - 39\sin^2\theta - 25\sin\theta + 15 = 0 \Rightarrow 13\sin\theta(5\sin\theta-3) - 5(5\sin\theta-3) = 0 \Rightarrow \sin\theta = \frac{5}{13} \text{ or } \frac{3}{5}.$

As $\frac{3}{5}$ is not present in the alternatives, we can conclude that $\sin\theta = \frac{5}{13}$

Ans: (b)

69. $\tan 10^\circ \tan 20^\circ \tan 30^\circ \tan 40^\circ \tan 50^\circ \tan 60^\circ \tan 70^\circ \tan 80^\circ =$

Options:

(a) 0

(b) $-1$

(c) $\frac{1}{\sqrt{3}}$

(d) 1

Sol: Use $\tan\theta.\tan(90^\circ-\theta) = 1$

Ans: (d)

70. If $1+\tan\theta+\tan^2\theta+......\text{upto}+\infty = \frac{\sqrt{3}}{\sqrt{3}-1}$, then the least +ve value of $\theta$ is

Options:

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

(b) $\frac{\pi}{6}$

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

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

Sol: It is G.P. and the sum $=\dfrac{1}{1-\tan\theta}=\dfrac{\sqrt{3}}{\sqrt{3}-1}=\dfrac{1}{1-\dfrac{1}{\sqrt{3}}}$

$\therefore \tan\theta=\dfrac{1}{\sqrt{3}}\Rightarrow\theta=\dfrac{\pi}{6}$

Ans: (b)

71. If $\sin(45^\circ+A)\sin(45^\circ-A)=k\cos 2A$, then $k=$

Options:

(a) 2

(b) $\dfrac{1}{2}$

(c) 1

(d) 4

Sol: $\sin(45^\circ-A)\sin(45^\circ-A)=\sin^2 45-\sin^2 A=\dfrac{1}{2}-\sin^2 A$

$=\dfrac{1}{2}\left(1-2\sin^2 A\right)=\dfrac{1}{2}\cos 2\text{A}\therefore k=\dfrac{1}{2}$

Ans: (b)

72. If $\sin x\cos y=\dfrac{1}{2}$ and $2\tan x=5\tan y$, then $\sin(x+y)=$

Options:

(a) $\dfrac{7}{10}$

(b) $\dfrac{3}{10}$

(c) $\dfrac{1}{10}$

(d) $\dfrac{9}{10}$

Sol: $2\tan x=5\tan y\Rightarrow 2\sin x\cos y=5\sin y\cos x$

$\Rightarrow\cos x\sin y=\dfrac{1}{5}$

$\therefore\sin x\cos y=\dfrac{1}{2}$ and $\cos x\sin y=\dfrac{1}{5}$

$\therefore\sin(x+y)=\dfrac{1}{2}+\dfrac{1}{5}=\dfrac{7}{10}$

Ans: (a)

73. The value of $\sin\left(2\tan^{-1}\frac{1}{3}\right)+\cos\left(\tan^{-1}\left(2\sqrt{2}\right)\right)=$

Options:

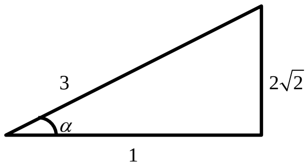
(a) $\frac{4}{5}$

(b) $\frac{13}{15}$

(c) $\frac{14}{15}$

(d) 1

Sol: $\sin 2\theta=\frac{2\tan\theta}{1+\tan^2\theta}=\frac{2.\frac{1}{3}}{1+\frac{1}{9}}=\frac{2.3}{9+1}=\frac{3}{5}$




Also, $\cos\alpha=\frac{1}{3}\therefore G.E=\frac{3}{5}+\frac{1}{3}=\frac{9+5}{15}=\frac{14}{15}$

Ans: (c)

74. If $3\operatorname{cosec}^{-1}\frac{1+x^2}{2x}-4\sec^{-1}\frac{1+x^2}{1+x^2}+2\cot^{-1}\frac{1-x^2}{2x}=\cot^{-1}\frac{\sqrt{3}}{3},\cdot$ then $x=$

Options:

(a) $\sqrt{3}$

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

(c) $2-\sqrt{3}$

(d) $\sqrt{2}-1$

Sol: $3\left(2\tan^{-1}x\right)-4\left(2\tan^{-1}x\right)+2\left(2\tan^{-1}x\right)=\cot^{-1}\frac{1}{\sqrt{3}}=\frac{\pi}{3}\Rightarrow 2\tan^{-1}x=\frac{\pi}{3}\Rightarrow x=\tan\frac{\pi}{6}=\frac{1}{\sqrt{3}}$

Ans: (b)

75. If $|3-2x|<1,$ then $x$ lies on the interval

Options:

(a) $(3,4)$

(b) $(1,2)$

(c) $(-1,2)$

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

Sol: $|3-2x|<1\Rightarrow -1<3-2x<1$

$\Rightarrow -4<-2x<-2$

$\Rightarrow 4>2x>2$

$\Rightarrow 2>x>1\Rightarrow x\in(1,2)$

Ans: (b)

76. The total number of $3$ digit even numbers than can be composed from the digits $1, 2, 3, ........9,$ when the repetition of digits is not allowed is

Options:

(a) 224

(b) 280

(c) 324

(d) 405

Sol: The last place of on even number can be filled by any one of the digits $2, 4, 6, 8$ in $4$ ways. After filing last place by any one of these $4$ digits we have $8$ digits. The remaining two places can be filled by $8$ digits in ${}^5P_2$ ways.

$\therefore$ Required number of numbers $= 4 \times {}^8P_2 = 4 \times 8 \times 7 = 224$

Ans: (a)

77. The term independent of $x$ in the expansion of $\left(x^2 - \frac{1}{3x}\right)^9$ is equal to

Options:

(a) $\frac{28}{81}$

(b) $\frac{28}{243}$

(c) $\frac{-28}{243}$

(d) $\frac{-28}{81}$

Sol: $r = \frac{np-k}{p+q} = \frac{9(2)-0}{2+1} = \frac{18}{3} = 6 \ \therefore T_{6+1} = {}^9C_6 \cdot \left(-\frac{1}{3}\right) = \frac{9.8.7}{6} . \frac{1}{9.81} = \frac{28}{243}$

**OR**

$$T_{r+1} = {}^9C_r \left(x^2\right)^{9-r} \left(-\frac{1}{3x}\right)^r = {}^9C_r \, x^{18-3r} \left(-\frac{1}{3}\right)^r$$

Condition $18 - 3r = 0 \Rightarrow r = 6$

$\therefore$ Required coefficient $= {}^9C_6 \left(-\frac{1}{3}\right)^6 = \frac{28}{243}$

Ans: (b)

78. The $50^{\text{th}}$ term of the series $5 + 11 + 19 + 29 + 41 + .........$ is

Options:

(a) 2651

(b) 2652

(c) 2653

(d) 2654

Sol: The differences are in A.P. Let $t_n = an^2 + bn + c$ (Second Method)

$$\left.\begin{array}{r} t_1 = a+b+c=5 \\ t_2 = 4a+2b+c=11 \\ t_3 = 9a+3b+c=19 \end{array}\right\} \Rightarrow \left.\begin{array}{r} 3a+b=6 \\ 5a+b=8 \end{array}\right\} \Rightarrow a=1, b-3, c=1$$

$\therefore t_n = n^2 + 3n + 1 \Rightarrow t_{50} = 2500 + 150 + 1 = 2651$

Ans: (a)

79. $ABC$ is an equilateral triangle. If $A$ is $(1,2)$ and the equation of the side $BC$ is $3x+4y+14=0,$ then the mid-point of the side $BC$ is

Options:

(a) $(-2,-1)$

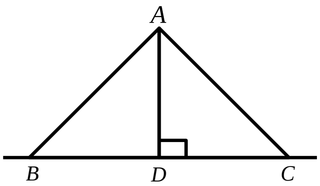
(b) $(2,-5)$

(c) $(-2,-2)$

(d) $(-3,-1)$

Sol: $AD$ is a medium as well as an altitude.

$\therefore D$ is the foot of the $\perp$ drawn from $(1,2)$ to the line $3x+4y-1=0$




$\therefore \frac{h-1}{3} = \frac{k-2}{4} = \frac{(3+8+14)}{9+16} = -1$

$\therefore h = -3+1, k = -4+2 \therefore D = (-2,-2)$

Ans: (c)

80. If $C$ is the centre and $L$ and $L'$ are the ends of the latus rectum of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1,$ then the area of the triangle $CLL'$ *is*

Options:

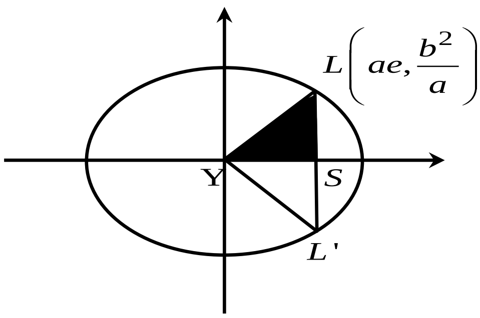
(a) 4.8 sq. units

(b) 9.6 sq. units

(c) 19.6 sq. units

(d) None of these

Sol: Area of $\Delta CLL'$




$= \frac{1}{2}(\text{Base})(\text{Altitude})$

$= \frac{1}{2}(LL')(CS) = \frac{1}{2}\left(2.\frac{b^2}{a}\right).\ ae$

$= \frac{b^2}{a}.\sqrt{a^2-b^2} = \frac{16}{5}\sqrt{25-16} = \frac{16}{5}\cdot 3 = \frac{48}{5} = 9.6$ sq. units

Ans: (b)

81. If the eccentricity of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ is $\frac{5}{4}$ and $2x+3y-6=0$ is a focal chord of the hyperbola, then the length of transverse axis equal to……

Options:

(a) $\frac{12}{5}$

(b) $\frac{24}{5}$

(c) $\frac{6}{4}$

(d) $\frac{5}{24}$

Sol: $(ae,o)$ lies on $2x+3y-6=0 \Rightarrow 2ae=6 \quad \therefore ae=3$

As $e=\frac{5}{4}, a.\frac{5}{4}=3 \Rightarrow a=\frac{12}{5} \quad \therefore \quad 2a=\frac{24}{5}$

Ans: (b)

82. Equation of a plane through the line of intersecting of the planes $x+2y+3z=2$ and $x-y+z=3$ and a distance $\frac{2}{\sqrt{3}}$ from the point $(3.1.-1)$ is

Options:

(a) $5x-11y+z=17$

(b) $\sqrt{2}x+y=3\sqrt{2}$

(c) $x+y+z=\sqrt{3}$

(d) $x-\sqrt{2}y=1-\sqrt{2}$

Sol: Equation of the plane in question is $x+2y+3z-2+\lambda(x+y+z-3)=0$

i.e. $(1+\lambda)x+(2-\lambda)y+(3+\lambda)z+(-2-3\lambda)=0$

$$\left|\frac{(1+\lambda)3+(2-\lambda).1+(3+\lambda)(-1)-2-3\lambda}{\sqrt{(1+\lambda)^2+(2-\lambda)^2+(3+\lambda)^2}}\right|=\frac{2}{\sqrt{3}}$$

Simplify to get $\sqrt{3}\lambda=\sqrt{3\lambda^2+4\lambda+14} \Rightarrow \lambda=-\frac{7}{2}$

$\therefore$ Required equation is $5x-11y+z=17$

Ans: (a)

83. Find the value of $k$ for which the lines $\frac{x-1}{2}=\frac{2y-1}{3}=\frac{1-3z}{k}$ and $\frac{x+1}{2}=\frac{3y-5}{2}=\frac{z-4}{3}$ are $\perp$ to each other

Options:

(a) 5

(b) −5

(c) 6

(d) 4

Sol: The given lines in symmetric form are:

$$\frac{x-1}{2}=\frac{y-\frac{1}{2}}{\frac{3}{2}}=\frac{z-\frac{1}{3}}{-\frac{k}{3}} \text{ and } \frac{x+1}{2}=\frac{y-\frac{5}{3}}{\frac{2}{3}}=\frac{z-4}{3}$$

$$\perp \Rightarrow (2)(2)+\left(\frac{3}{2}\right)\left(\frac{2}{3}\right)+\left(-\frac{k}{3}\right)(3)=0 \Rightarrow 4+1-k=0 \Rightarrow k=5$$

Ans: (a)

84. The distance of the point $(-1,-5,-10)$ from the point of intersection of the line $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}$ and the plane $x-y+z=5$ is

Options:

(a) 10

(b) 8

(c) 21 (d) 13

Sol: Any point $Q$ on the line $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}=r$ is $(3r+2,4r-1,2r+2)$

If it lies on the plane $x-y+z=5$, then $3r+2-(4r-1)+12r+2=5$

$\Rightarrow 3r+2-4r+1+12r+2=5 \Rightarrow 11r=0 \Rightarrow r=0$

$\therefore$ The coordinates of $Q$ are $(2,-1,2)$

$$\therefore PQ=\sqrt{(2+1)^2+(-1+5)^2+(2+10)^2}=\sqrt{9+16+144}=13$$

Ans: (d)

85. The equation of the plane through $(1,4,-2)$ and $\perp$ to the line $\frac{x-1}{2}=\frac{y+1}{-1}=\frac{z+0}{3}$ is

Options:

(a) $2x+y-3z+8=0$

(b) $2x-y-3z=8$

(c) $2x-y+3z+8=0$

(d) $2x+y-3z+8=0$

Sol: $2(x-1)-(y-4)+3(z+2)=0$ i.e. $2x-y+3z+8=0$

Ans: (c)

86. If the points with position vectors $10\,\hat{i}+3\hat{j}, 12\hat{i}-5\hat{j}$ and $x\hat{i}+11\hat{j}$ are collinear, then $x=$

Options:

(a) $-8$

(b) 4

(c) 8

(d) $-4$

Sol: Collinear $\Rightarrow \begin{vmatrix} 1 & x_1 & y_1 \\ 1 & x_2 & y_2 \\ 1 & x_3 & y_3 \end{vmatrix} = 0 \Rightarrow \begin{vmatrix} 1 & 10 & 3 \\ 1 & 12 & -5 \\ 1 & x & 11 \end{vmatrix} \Rightarrow 0 \Rightarrow x = 8$ (check)

Aliter: $\overrightarrow{AB} = (2,-8); \overrightarrow{BC} = (x-12, 16) \Rightarrow \frac{x-12}{2} = \frac{16}{-8} = \Rightarrow x-12 = -4 \therefore x = 8$

Ans: (c)

87. The diagonal of a parallelogram are along the vectors $3i+6j-2k$ and $-1-2j+8k$. Then the length of shorter side of the parallelogram is

Options:

(a) $2\sqrt{3}$

(b) $\sqrt{14}$

(c) $3\sqrt{5}$

(d) $4\sqrt{3}$

Sol: Let $\vec{a}+\vec{b} = 3i+6j-2k$ and $\vec{a}-\vec{b} = -i-2j+8k$

Then $\vec{a} = i+2j+3k$ and $\vec{b} = 2i+4j-5k$

Now $|\vec{a}| = \sqrt{1+4+9} = \sqrt{14}$ and $|\vec{b}| > |\vec{a}|$ $\qquad \because |\vec{b}| = \sqrt{4+16+25}$

Ans: (b)

88. If $\vec{a}$ and $\vec{b}$ are the two vectors such that $|\vec{a}| = 3\sqrt{3}, |\vec{b}| = 4$ and $|\vec{a}+\vec{b}| = \sqrt{7}$, then the angle between $\vec{a}$ and $\vec{b}$ is

Options:

(a) 150°

(b) 30°

(c) 60°

(d) 120°

Sol: $7 = 27+16+2 \,.\, 3\sqrt{3} \,.\, 4 \,.\, \cos\theta \Rightarrow \cos\theta = -\frac{\sqrt{3}}{2} \Rightarrow \theta = 150°$

Ans: (a)

89. If the four points with position vectors $-j+k,\ 2i-j-k,\ i+\lambda j+k,\ 3j+3k$ are coplanar, then $\lambda =$

Options:

(a) 0

(b) 1

(c) $-1$

(d) 2

Sol: $\overrightarrow{AB}=2i-2k;\overrightarrow{AC}=i+\lambda+1j;\overrightarrow{AD}=4j+2k$

$$\left[\overrightarrow{AB}\ \overrightarrow{AC}\ \overrightarrow{AD}\right]=0\Rightarrow\begin{vmatrix}2 & 0 & -2\\ 1 & \lambda+1 & 0\\ 0 & 4 & 2\end{vmatrix}=0\Rightarrow 2[2\lambda+2]-2[4]=4\lambda-4=0\Rightarrow\lambda=1$$

Ans: (b)

90. If $\begin{pmatrix}-1 & 2\\ 3 & -2\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}0\\ 4\end{pmatrix}$, then $(x,y)=$

Options:

(a) $(4,0)$

(b) $(0,4)$

(c) $(4,4)$

(d) None of these

Sol: $-x+2y=0$ and $3x-2y=4$ ; $x=2$ and $y=1$

Ans: (d)

91. If $A=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & 2\cos\theta\end{bmatrix}$ and $A^T+A=I_2$, then

Options:

(a) $\theta=n\pi, n\in Z$

(b) $\theta=(2n+1)\dfrac{\pi}{2}, n\in Z$

(c) $\theta=2n\pi\pm\dfrac{\pi}{3}, n\in Z$

(d) None of these

Sol: $\begin{pmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{pmatrix}+\begin{pmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{pmatrix}=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$

$$\Rightarrow\begin{pmatrix}2\cos\theta & 0\\ 0 & 2\cos\theta\end{pmatrix}=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}\Rightarrow\cos\theta=\frac{1}{2}=\cos\frac{\pi}{3}$$

$$\theta=2n\pi\pm\frac{\pi}{3}, n\in Z$$

Ans: (c)

92. If $\omega$ is an imaginary cube root of unity, then the value of $\begin{vmatrix} 1 & \omega^2 & 1-\omega^2 \\ \omega & 1 & 1+\omega^2 \\ 1 & \omega & \omega^2 \end{vmatrix}$ is

Options:

(a) 4

(b) $\omega^2$

(c) $\omega^2 - 4$

(d) $-4$

Sol: $\Delta = \begin{vmatrix} 1 & \omega^2 & 1-\omega \\ \omega & 1 & 1+\omega^2 \\ 1 & \omega & \omega^2 \end{vmatrix} = \begin{vmatrix} 1 & \omega^2 & 1-\omega \\ \omega & 1 & \omega \\ 1 & \omega & \omega^2 \end{vmatrix}$

$= 1\left(\omega^2 + \omega^2\right) - \omega^2\left(\omega^2 + \omega\right) + (1-\omega)\left(\omega^2 - 1\right)$

$= 2\omega^2 - \omega^2 - 1 + \omega^2 - 1 - 1 + \omega = \omega^2 + \left(\omega^2 + \omega\right) - 3 = \omega^2 - 4$

Ans: (c)

93. If $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, then $A^{-1} =$

Options:

(a) $\frac{1}{2}\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

(b) $\frac{-1}{2}\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & 4 \\ 1 & 3 \end{bmatrix}$

(d) $\begin{bmatrix} -2 & 4 \\ 1 & 3 \end{bmatrix}$

Sol: $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \Rightarrow \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix} = 4 - 6 = -2$

$AdjA = \begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix} \Rightarrow A^{-1} = \frac{AdjA}{|A|} = -\frac{1}{2}\begin{bmatrix} 4 & -2 \\ -3 & 1 \end{bmatrix}$

Ans: (b)

94. $\lim_{n\to\infty}\left(2^2 + 3^n + 5^n\right)^{1/n} =$ ___________

Options:

(a) 2

(b) 3

(c) 5

(d) $e^{2+3+5}$

Sol: Limit $= \lim\limits_{a\to\infty}\left\{5^n\left[\left(\frac{2}{5}\right)^n+\left(\frac{3}{5}\right)^n+1\right]\right\}^{1/n}$

$= 5 \quad \lim\limits_{n\to\infty}\left[1+\left(\frac{2}{5}\right)^n+\left(\frac{3}{5}\right)^n\right]^{1/n} \quad = 5\times 1 = 5$

Ans: (c)

95. $\lim\limits_{x\to 0}\frac{(1-\cos 2x)\ (3+\cos x)}{x\tan 4x}$ is equal to

Options:

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

(b) 1

(c) 2

(d) $-\frac{1}{4}$

Sol: L $= \lim\limits_{x\to 0}\frac{1-\cos 2x}{x^2}\cdot\frac{4x}{\tan 4x}\cdot(3+\cos x)\cdot\frac{1}{4}$

$= \lim\limits_{x\to 0}\frac{2\sin^2 x}{x^2}.\frac{4x}{\tan 4x}.\ 4\ .\frac{1}{4} = 2\ .\ 1^2\ .\ 1 = 2$

Ans: (c)

96. $\lim\limits_{x\to 0}\frac{\sec 5x-\sec 3x}{\sec 3x-\sec x} =$

Options:

(a) 2

(b) 1

(c) 4

(d) 8

Sol: $L = \lim\limits_{x\to 0}\frac{\cos 3x-\cos 5x}{\cos 3x\cos 5x}\times\frac{\cos 3x\cos 5x}{\cos x-\cos 3x}$

$= \lim\limits_{x\to 0}\frac{\sin 4x\cos x}{\cos 5x\sin 2x} = \lim\limits_{x\to 0}\frac{\frac{\sin 4x}{4x}\times\cos x\times 4x}{\cos 5x\frac{\sin 2x}{2x}\times 2x} = 2$

Ans: (a)

97. Let $f(x)=\begin{cases} x^2+1 & x\le 0 \\ 2-x & x>0 \end{cases}$, then which of the following is true?

Options:

(a) $f(x)$ is continuous for all $x$

(b) $\lim\limits_{x\to 0} f(x)$ doesn't exist

(c) $\lim\limits_{x\to 0} f(x)=1$

(d) $f(x)$ is not defined for all $x$

Sol: $\lim\limits_{x\to 0^-} f(x)=1,\ \lim\limits_{x\to 0^+} f(x)=2$ $\therefore$ limit does not exist

Ans: (b)

98. The function $f(x)=\begin{cases} x^2 & \text{for } x<1 \\ 2-x & \text{for } x\ge 1 \end{cases}$ is

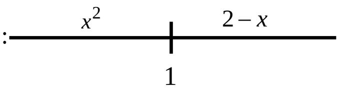
Options:

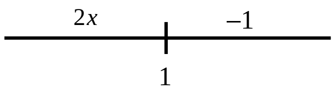
(a) not differentiable at $x=1$

(b) differentiable at $x=1$

(c) not continuous at $x=1$

(d) none of these

Sol: $f(x)$: 

$f'(x)$: 


$f(x)$ is continuous, $\forall x$; note that $f(1+0)=f(1)=f(1-0)=1$

But $f'(1+0)=-1$ and $f'(1-0)=2(1)=2\ne f'(1+0)$

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

Ans: (a)

99. If $f(x)=1+\sin x+\frac{\sin^2 x}{2!}+\frac{\sin^3 x}{3!}+$...................... then $f'(x)=$

Options:

(a) $f(x)$

(b) $f(x)\cos x$

(c) $f(x)\operatorname{cosec} x$

(d) $f(x)\sin x$

Sol: $f(x)$ is in exponential form; $f(x)=e^{\sin x}$

$f'(x)=e^{\sin x}\cos x=f(x)\ .\ \cos x$

Ans: (b)

100.Is $f(\sin x) = \tan^2 x$, then $f'(x) =$

Options:

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

(b) $\frac{2x}{\left(1-x^2\right)^2}$

(c) $\frac{2x-4x^2}{\left(1-x^2\right)^2}$

(d) $\frac{2x}{\left(1+x^2\right)^2}$

Sol: $f(\sin x) = \frac{\sin^2 x}{\cos^2 x} = \frac{\sin^2 x}{1-\sin^2 x}$

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

$\therefore f'(x) = -\frac{1}{\left(1-x^2\right)^2} \ .(-2x) = \frac{2x}{\left(1-x^2\right)^2}$

Ans: (b)

101.If $y = \tan^{-1}\left(\frac{2x^3}{1-x^6}\right) + \tan^{-1}\left[\frac{x^3+1}{1-x^3}\right]$, then $\frac{dy}{dx} =$

Options:

(a) $\frac{9x^2}{1-x^6}$

(b) $\frac{3x^2}{1+x^6}$

(c) $\frac{6x^2}{1+x^6}$

(d) $\frac{9x^2}{1+x^6}$

Sol: $y = \tan^{-1}\left[\frac{2x^3}{1-\left(x^3\right)^2}\right] + \tan^{-1}\left[\frac{1+x^3}{1-x^3}\right] = 2\tan^{-1} x^3 + \tan^{-1} 1 + \tan^{-1} x^3 = 3\tan^{-1} x^3 + \frac{\pi}{4}$

$\therefore \frac{dy}{dx} = 3.\frac{1}{1+x^6} \ . \ 3x^2 = \frac{9x^2}{1+x^6}$

Ans: (d)

102.If $x = a\ \cos^2 t,\ \ y = a\ \sin^2 t,\ \ \frac{dy}{dx} = ?$

Options:

(a) 1

(b) $-1$

(c) 0

(d) none of these

Sol: $\frac{dx}{dt} = a.2\ \cos t(-\sin t),\ \frac{dy}{dt} = a.2\sin t.\ \cos t.\ \therefore \frac{dy}{dx} = -1$

**OR**

$x + y = a\left(\cos^2 + \sin^2 t\right) \Rightarrow x + y = a \quad \therefore 1 + y' = 0\ \therefore y' = -1$

Ans: (b)

103.If $A$ and $B$ are two events such that $P(A) = \frac{1}{2}, P(B) = \frac{1}{3}$ and $P(A|B) = \frac{1}{4}$, then $P(A' \cap B')$ equal

Options:

(a) $\frac{1}{12}$

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

(c) $\frac{1}{4}$

(d) $\frac{3}{16}$

Sol: $P(A|B) = \frac{P(A \cap B)}{P(B)} = P(A \cap B) \Rightarrow \frac{1}{4}.\frac{1}{3} = \frac{1}{12}\ \ \therefore P(A' \cap B') = P\left[(A \cup B)'\right]$

$= 1 - \{P(A) + P(B) - P(A \cap B)\}\ = 1 - \left\{\frac{1}{2} + \frac{1}{3} - \frac{1}{12}\right\} = \frac{1}{4}$

Ans: (c)

104.The interval in which the function $y = x^3 + 6x^2 + 6$ is increasing, is

Options:

(a) $(-\infty, -4) \cup (0, \infty)$

(b) $(-\infty, 4)$

(c) $(-4, 0)$

(d) $(-\infty, 0) \cup (4, \infty)$

Sol: $y' = 3x^2 + 12x = 3x[x + 4]$

$y' > 0 \Rightarrow x[x + 4] > 0 \Rightarrow x < -4$ or $x > 0$

$\therefore y$ is increasing in $(-\infty, -4) \cup (0, \infty)$

Ans: (a)

105. A rectangle has three of it vertices on the coordinate axes and fourth on the curve $y=4-x^2$. Then the maximum area of the rectangle is (in sq. units)

Options:

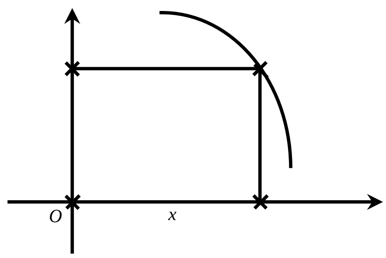
(a) $\frac{1}{3\sqrt{3}}$

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

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

(d) $\frac{16}{3\sqrt{3}}$

Sol: Let $\left(x, 4-x^2\right)$ be the fourth vertex.




Then area $A=x\left(4-x^2\right)$

If the area is maximum then $\frac{dA}{dx}=4-3x^2=0 \Rightarrow x=\frac{2}{\sqrt{3}}$

$\therefore x>0$

Also $\frac{d^2A}{dx^2}=-6x<0$ as $x>0$

Max. $A=\frac{2}{\sqrt{3}}\left(4-\frac{4}{3}\right)=\frac{16}{3\sqrt{3}}$

Ans: (d)

106. The slope of the tangent to the curve $x=t^2+3t-8, y=2t^2-2t-5$ at the point $(2,-1)$ is

Options:

(a) $\frac{6}{7}$

(b) $\frac{-6}{7}$

(c) $\frac{22}{7}$

(d) $\frac{7}{6}$

Sol: $x=2$ and $y=-1 \Rightarrow t^2+3t-10=0$ and $2t^2-2t-4=0$

Now, $t^2+3t-10=0 \Rightarrow t=2$ or $-5$ and $t^2-t-2=0 \Rightarrow t=-1$ or $t=2$

Thus common value is $t=2$

Slope $=\frac{dy}{dx}=\frac{4t-2}{2t+3}=\frac{8-2}{4+3}=\frac{6}{7}$

Ans: (a)

107.The area of an equilateral triangle is increasing at the rate of $10\sqrt{3}$ sq.cm/sec. Then the rate of increase of the inradius of the triangle when the area is $3\sqrt{3},$ is

Options:

(a) $4\,\text{cm/ sec}$

(b) $\frac{5}{3}\text{cm/ sec}$

(c) $\frac{10}{3}\text{cm/ sec}$

(d) $2\,\text{cm/ sec}$

Sol: $A=\frac{\sqrt{3}}{4}a^2=\frac{p^2}{\sqrt{3}}$ where $p=$ altitude

But in an equilateral triangle, altitude $=$ median $=R+r$ and $R=2r$

$\therefore p=3r \quad A=\frac{1}{\sqrt{3}}.9r^2$ and when $A=3\sqrt{3},\ 3\sqrt{3}=3\sqrt{3}r^2 \Rightarrow r=1$

$\frac{dA}{dt}=\frac{9}{\sqrt{3}}.2r\frac{dr}{dt}\Rightarrow 10\sqrt{3}=3\sqrt{3}.2.1\frac{dr}{dt}=\frac{5}{3}\text{cm/ sec}$

Ans: (b)

108. $\int(1-\cos x)\operatorname{cosec}^2 x\,dx=$

Options:

(a) $\tan\frac{x}{2}+c$

(b) $\cot\frac{x}{2}+c$

(c) $\frac{1}{2}\tan\frac{x}{2}+c$

(d) $2\tan\frac{x}{2}+c$

Sol: $I=\int\frac{1-\cos x}{\sin^2 x}dx=\int\frac{1-\cos x}{1-\cos^2 x}dx=\int\frac{1}{1+\cos x}dx=\int\frac{1}{2\cos^2\frac{x}{2}}dx=\int\frac{1}{2}\sec^2\frac{x}{2}dx=\tan\frac{x}{2}+c$

Ans: (a)

109. $\int\frac{e^{2x}+1}{e^{2x}-1}dx=$

Options:

(a) $\log\left(e^x+e^{-x}\right)+c$

(b) $\tan^{-1}\left(2^x\right)+c$

(c) $\frac{1}{2}\log\frac{e^x-1}{e^x+1}$

(d) $\log\left(e^x-e^{-x}\right)+c$

Sol: $I=\int \frac{e^{x}+e^{-x}}{e^{x}-e^{-x}}dx=\int \frac{f'(x)}{f(x)}dx=\log\left(e^{x}-e^{-x}\right)+c$

Ans: (d)

110. $\int\left(\frac{\cos x}{x}-\log x^{\sin x}\right)dx=$

Options:

(a) $\log x^{\cos x}+C$

(b) $\log x^{\sin x}+C$

(c) $\log(x\cos x)+C$

(d) $\log\left(\frac{\cos x}{x}\right)+C$

Sol: $\int\left(\frac{\cos x}{x}-\log x^{\sin x}\right)dx=\int \cos x.d(\log x)-\int \sin x\log x\,dx=\cos x\log x+\int \log x\sin x\,dx-\int \sin x\log x\,dx$

$=\cos x\log x+c$

Ans: (a)

111. $\int e^{x}\left\{\frac{1+\sin x\cos x}{\cos^{2}x}\right\}dx=$

Options:

(a) $e^{2}\cos x+c$

(b) $e^{x}\sec x\tan x+c$

(c) $e^{x}\tan x+c$

(d) $e^{x}\cos^{2}x-1+c$

Sol: $I=\int e^{x}\left[\frac{1}{\cos^{2}x}+\frac{\sin x\cos x}{\cos^{2}x}\right]dx=\int e^{x}\left[\sec^{2}x+\tan x\right]dx=e^{x}\tan x+c$

Ans: (c)

112. $\int_{1}^{2}\frac{dx}{x+x^{9}}=$

Options:

(a) $\frac{1}{8}\log\frac{128}{257}$

(b) $\frac{1}{8}\log\frac{512}{257}$

(c) $\frac{1}{8}\log\frac{1024}{257}$

(d) None of these

Sol: $\int_1^2 \frac{dx}{x\left(1+x^8\right)}=\frac{1}{n}\log\frac{x^n}{x^n+1}=\frac{1}{8}\log\frac{x^8}{1+x^8}\Big|_1^2$

$\frac{1}{8}\left[\log\frac{256}{257}-\log\frac{1}{2}\right]=\frac{1}{8}\log\frac{512}{257}$

Ans: (b)

113. The probability that an event $A$ happens in one trial of an experiment is $0.4.$ three independent trials of these experiments are performed. The probability that the event $A$ happens atleast once is

Options:

(a) 0.936

(b) 0.784

(c) 0.904

(d) 0.216

Sol: Given $P(A)=0.4$ $\quad\therefore P(\overline{A})=1-P(A)=0.6$

$P(\text{atleast once})=1-P(\text{none})$

$=1-$ probability that $A$ does not happen in any of the three events

$=1-P(\overline{A})\,.\,P(\overline{A})\,.\,P(\overline{A})=1-(0.6)^3=1-0.216=0.784$

Ans: (b)

114. The differential equation of the family of parabola $y^2=4ax,$ where $a$ is parameter, is

Options:

(a) $\frac{dy}{dx}=\frac{y}{2x}$

(b) $\frac{dy}{dx}=-\frac{y}{2x}$

(c) $\frac{dy}{dx}=\frac{2y}{x}$

(d) $\frac{dy}{dx}=\frac{2y}{x}$

Sol: $\frac{y^2}{x}=4a\Rightarrow x.2yy'-y^2.1=0\Rightarrow\frac{dy}{dx}=\frac{y}{2x}$

Ans: (a)

115. The general solution of the differential equation $2x\frac{dy}{dx}-y=3$ is a family of

Options:

(a) Straight lines

(b) Circles

(c) Parabolas

(d) Hyperbolas

Sol: The DE is $2x\ dy-(y+3)\ dx=0$

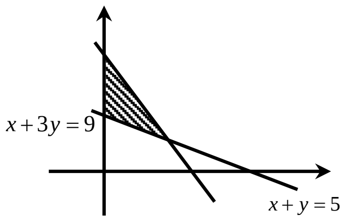
$$\Rightarrow \frac{2d}{y+3}-\frac{dx}{x}=0 \Rightarrow 2\log(y+3)-\log\ x=\log c$$

$\Rightarrow (y+3)^2=cx.$ This represents a family of parabolas.

Ans: (c)

116. The feasible region for an $LPP$ is shown in the figure:

If $Z=11x+7y,$ then $Z_{\max}=$




Options:

(a) 57

(b) 35

(c) 46

(d) 47

Sol: Corner points are $(0,5),(0,3)$ and $(3,2)$

$$Z_{\max}=Max\{0+35,\ 0+21,\ 33+14\}=47$$

Ans: (d)

117. The area of the region bonded by the parabola $y^2=4x$ and the line $x+y=3$ is

Options:

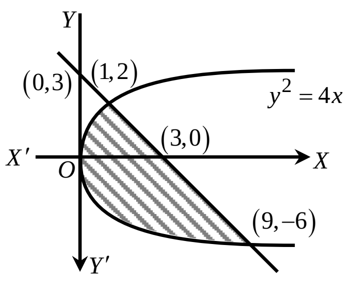
(a) $\frac{16}{3}$

(b) $\frac{8}{5}$

(c) $\frac{32}{3}$

(d) $\frac{64}{3}$

Sol: The points of intersection are $(1,2)$ and $(9,-6)$ which lie on the same side of $y-$axis




$$\therefore A=\int_a^b[f(y)-g(y)]dy=\int_{-6}^{2}\left(3-y-\frac{y^2}{4}\right)dy=\frac{64}{3}$$

Ans: (d)

118. Bag $A$ contains $2$ white and $3$ red balls and bag $B$ contains $4$ white and $5$ red balls. One ball is drawn at random from one of the bags and is found to be red. Then the probability that it was drawn from Bag $B$ is

Options:

(a) $\frac{25}{52}$

(b) $\frac{25}{51}$

(c) $\frac{15}{52}$

(d) $\frac{5}{52}$

Sol: Let the event of drawing a red ball be denoted by $R$ and the event of choosing bag $A$ be denoted by $A$ and $B$ respectively and the event of choosing bag $B$ be denoted by $B$

Then, $P(A)=P(B)=\frac{1}{2}; P(R|A)=\frac{3}{5}$ and $P(R|B)=\frac{5}{9}$.

Required probability $=P(B/R)$

$$\frac{P(B).P(R|B)}{P(B).P(R|B)+P(A)-P(R|A)}$$

$$=\frac{\frac{1}{2}.\frac{5}{9}}{\frac{1}{2}.\frac{5}{9}+\frac{1}{2}.\frac{3}{5}}=\frac{5.5}{5.5+3.9}=\frac{25}{52}$$

Ans: (a)

119. A die is thrown, Let $A$ be the event that the number obtained is greater than $3.$ Let $B$ be the event that the number obtained is less than $5.$ Then $(A\cup B)$ is

Options:

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

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

(c) $0$

(d) $1$

Sol: $A=\{4,5,6\}$ and $B=\{1,2,3,4\} \Rightarrow A\cup B=\{1,2,3,4,5,6\}=S$

$P(S)=1,$ since it is a sure event.

Hence $P(A\cup B)=1$

Ans: (d)

120. A die is thrown $5$ times. If getting an even number is considered as success, then variance of distribution is

Options:

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

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

(c) $\frac{4}{5}$

(d) $\frac{5}{4}$

Sol: It is case of binomial distribution where $n=5,\ p=\frac{3}{6}=\frac{1}{2}$ and $q=1-p=\frac{1}{2}$

Variance $=\sigma^2=npq=5\times\frac{1}{2}\times\frac{1}{2}=\frac{5}{4}$

Ans: (d)

## Physics

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

121. The maximum and minimum distances of a comet from the sun are $8\times10^{12}\text{ m}$ and $1.6\times10^{12}\text{ m}$ respectively. If its velocity when nearest to the sun is $60\,\text{ms}^{-1}$, what will be its velocity in $\text{ms}^{-1}$ when it is farthest?

Options:

(a) 12

(b) 60

(c) 112

(d) 6

Sol: By law of conservation of angular momentum, $mvr = \text{constant}$

$v_{min}\times r_{max} = v_{max}\times r_{min}$

$$\therefore\ v_{min} = \frac{60\times1.6\times10^{12}}{8\times10^{12}} = 12\,\text{ms}^{-1}$$

Ans: (a)

122. A steel cable with a radius $2\text{ cm}$ supports a chairlift at a ski area. If the maximum stress is not to exceed $10^8\text{ Nm}^{-2}$, the maximum load the cable can support is

Options:

(a) $4\pi\times10^5\text{ N}$

(b) $4\pi\times10^4\text{ N}$

(c) $2\pi\times10^5\text{ N}$

(d) $2\pi\times10^4\text{ N}$

Sol: Here, $r = 2\,\text{cm} = 2\times10^{-2}\text{ m}$

Maximum load = maximum stress $\times$ Area of cross-section

$$= 10^8\text{ Nm}^{-2}\times\pi\times\left(2\times10^{-2}\text{m}\right)^2 = 4\pi\times10^4\text{ N}$$

Ans: (b)

123. A ring of radius $0.5\text{ m}$ and mass $10\text{ kg}$ is rotating about its diameter with angular velocity of $20\text{ rad s}^{-1}$. Its rotational kinetic energy is

Options:

(a) 10 J

(b) 100 J

(c) 500 J

(d) 250 J

Sol: Rotational kinetic energy $=\frac{1}{2}I\omega^2=\frac{1}{2}\left(\frac{1}{2}MR^2\right)\times\omega^2$

$=\frac{1}{2}\left(\frac{1}{2}\times10\times(0.5)^2\right)\times(20)^2=250\text{ J}$

Ans: (d)

124. A $20\,\text{cm}$ long capillary tube is dipped in water. The water rises up to $8\,\text{cm}$. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be

Options:

(a) $10\,\text{cm}$

(b) $8\,\text{cm}$

(c) $20\,\text{cm}$

(d) $4\,\text{cm}$

Sol: Water fills the tube entirely in gravity less condition i.e., $20\,\text{cm}$

Ans: (c)

125. When the temperature of a rod increases from $t$ to $(t+\Delta t)$, its moment of inertia increases from $I$ to $(I+\Delta I)$. If $\alpha$ be the coefficient of llinear expansion of the rod, then the value of $\frac{\Delta I}{I}$ is

Options:

(a) $2\alpha\Delta t$

(b) $\alpha\Delta t$

(c) $\frac{\alpha\Delta t}{2}$

(d) $\frac{\Delta t}{2}$

Sol: Moment of inertia of a rod,

$I=\frac{1}{12}ML^2$ … (i)

where $M$ is the mass of the rod and $L$ is the length of the rod

$\therefore\ \Delta I=\frac{1}{2}2ML\Delta L$ [$\because$ $M$ is a constant] … (ii)

Divide (ii) by (i), we get

$\frac{\Delta I}{I}=2\frac{\Delta L}{L}$ … (iii)

$\because\ \Delta L=L\alpha\Delta t$

or $\frac{\Delta L}{L}=a\Delta t$

Substituting the value of $\frac{\Delta L}{L}$ in (iii), we get $\frac{\Delta I}{I}=2a\Delta t$

Ans: (a)

126.The pressure is $P$, volume $V$ and temperature $T$ of a gas in jar $A$ and the other gas in jar $B$ is at pressure $P$, volume $V/4$ and temperature $2T$, then the ratio of the number of molecules in jar $A$ and $B$ will be

Options:

(a) $1:1$

(b) $1:2$

(c) $2:1$

(d) $8:1$

Sol: $PV = NkT \Rightarrow \dfrac{N_A}{N_B} = \dfrac{P_A V_A}{V_B V_B} \times \dfrac{T_B}{T_A}$

$$\Rightarrow \frac{N_A}{N_B} = \frac{P \times V \times (2T)}{P \times \frac{V}{4} \times T} = \frac{8}{1}$$

Ans: (d)

127.Two moles of helium gas $(\gamma = 5/3)$ are initially at temperature $27\,°\text{C}$ and occupy a volume of $20$ litres. The gas is first expanded at constant pressure until the volume is doubled. Then, it undergoes an adiabatic change until the temperature returns to the initial value. What is the final volume of the gas?

Options:

(a) $112.4$ lit

(b) $115.2$ lit

(c) $120$ lit

(d) $125$ lit

Sol: For a perfect gas, $PV = \mu RT$

$$P_1 = \frac{\mu RT}{V} = \frac{2 \times 8.31 \times (273 + 27)}{20 \times 10^{-3}}$$

$$P_1 = 2.5 \times 10^5 \text{ Nm}^{-2}$$

At constant pressure, $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$

$$\therefore\ T_2 = \left(\frac{V_2}{V_1}\right) T_1 = 2 \times 300 = 600\,\text{K}$$

The gas now undergoes an adiabatic change.

$T_1 = 600\,\text{K},\ T_2 = 300\,\text{K},\ V_1 = 40\,\text{lit.},\ V_2 = ?$

$\gamma - 1 = 5/3 - 1 = 2/3$

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$600(40)^{2/3} = 300(V_2)^{2/3}$$

$(2)^{3/2} \times 40 = V_2$ or $V_2 = 112.4$ lit.

Ans: (a)

128.Two equations of two S.H.M. are $x = a\sin(\omega t - \alpha)$ and $y = b\cos(\omega t - \alpha)$. The phase difference between the two is

Options:

(a) $0°$

(b) $\alpha°$

(c) $90°$

(d) $180°$

Sol: $y = a\sin(\omega t - \alpha) = a\cos\left(\omega t - \alpha - \frac{\pi}{2}\right)$

Another equation is given $y = \cos(\omega t - \alpha)$

So, there exists a phase difference of $\frac{\pi}{2} = 90°$

Ans: (c)

129.The ratio of fundamental frequency of an organ pipe opened at both ends to that of the organ pipe closed at one end is

Options:

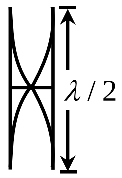
(a) $1:1$

(b) $1.5:1$

(c) $2:1$

(d) $3:1$

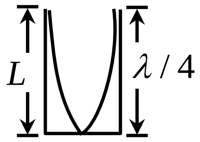
Sol: The fundamental frequency of an organ pipe open at both ends is




$n_0 = \frac{v}{2L}$ … (i)

The fundamental frequency of an organ pipe closed at one end is

$n_c = \frac{v}{4L}$ … (ii)




Dividing equation (i) by (ii)

$\frac{n_0}{n_c} = \frac{v}{2L} \times \frac{4L}{v} = \frac{2}{1}$

Ans: (c)

130.The charges on two spheres are $+7\mu C$ and $5\mu C$ respectively. They experience a force $F$. If each of them is given and additional charge of $-2\mu C$, the new forces of attraction will be

Options:

(a) $F$

(b) $F/2$

(c) $F/\sqrt{3}$

(d) $2F$

Sol: $F=\frac{1}{4\pi\varepsilon_0}\frac{(+7\times10^{-6})(-5\times10^{-6})}{r^2}=-\frac{1}{4\pi\varepsilon_0}\frac{35\times10^{12}}{r^2}\text{N}$

$$F'=\frac{1}{4\pi\varepsilon_0}\frac{(+5\times10^{-6})(-7\times10^{-6})}{r^2}$$

$$=-\frac{1}{4\pi\varepsilon_0}\frac{35\times10^{12}}{r^2}\text{N}$$

Ans: (a)

131. A charge $Q$ is enclosed by a Gaussian spherical surface of radius $R$. If the radius is doubled, then the outward electric flux will

Options:

(a) increase four times

(b) be reduced to half

(c) remain the same

(d) be doubled

Sol: By Gauss's theorem, $\phi=\frac{Q_{\text{in}}}{\varepsilon_0}$

Thus, the net flux depends only on the charge enclosed by the surface. Hence, there will be no effect on the net flux if the radius of the surface is doubled.

Ans: (c)

132. Four charges $q_1=2\times10^{-8}\text{C}$, $q_2=-2\times10^{-8}\text{C}$, $q_3=-3\times10^{-8}\text{C}$, and $q_4=6\times10^{-8}\text{C}$ are placed at four corners of a square of side $\sqrt{2}\text{ m}$. What is the potential at the centre of the square?

Options:

(a) 270 V

(b) 300 V

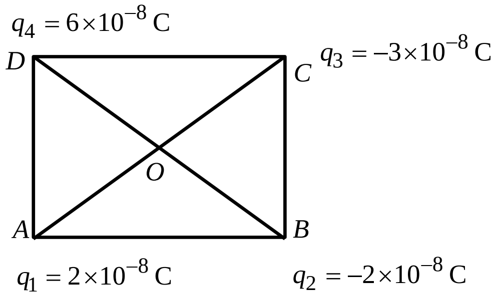
(c) zero

(d) 100 V

Sol: $AC=BD=\sqrt{(\sqrt{2})^2+(\sqrt{2})^2}=2\text{m}$

$\therefore\ DO=OB=AO=OC=\frac{2}{2}=1\text{m}$

$\therefore$ Potential at the centre $O$, $V=k\frac{q}{r}$




$$V=k\left[\frac{2\times10^{-8}}{1}+\frac{-2\times10^{8}}{1}+\frac{-3\times10^{-8}}{1}+\frac{6\times10^{-8}}{1}\right]$$

$V=k\times3\times10^{-8}=9\times10^9\times3\times10^{-8}$ volt

$V=27\times10=270$ volt

Ans: (a)

133.A pendulum bob of mass $30.7\times10^{-6}$ kg carrying a charge $2\times10^{-8}$ C is at rest in a horizontal uniform electric field of $20000\ \text{Vm}^{-1}$. The tension in the thread of the pendulum is $\left(g=9.8\,\text{ms}^{-2}\right)$

Options:

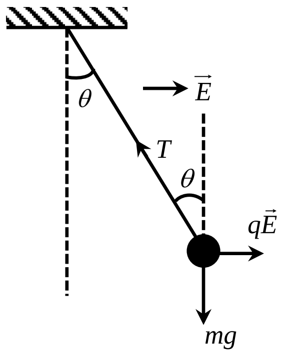
(a) $3\times10^{-4}$ N

(b) $4\times10^{-4}$ N

(c) $5\times10^{-4}$ N

(d) $6\times10^{-4}$ N

Sol: At equilibrium




$T\cos\theta = mg$ and $T\sin\theta = qE$

$mg = 30.7\times10^{-6}\times9.8 = 3\times10^{-4}$ N

$qE = 2\times10^{-8}\times20000 = 4\times10^{-4}$ N

$\therefore\ T=\sqrt{\left(3\times10^{-4}\right)^2+\left(4\times10^{-4}\right)^2}$

$=5\times10^{-4}$ N

Ans: (c)

134.The electric potential at a point $(x,y,z)$ is given by $V=-x^2y-xz^3+4$. The electric field $\vec{E}$ at that point is

Options:

(a) $\vec{E}=\hat{i}\,2xy+\hat{j}\left(x^2+y^2\right)+\hat{k}\left(3xz-y^2\right)$

(b) $\vec{E}=\hat{i}z^3+\hat{j}xyz+\hat{k}z^2$

(c) $\vec{E}=\hat{i}\left(2xy-z^3\right)+\hat{j}xy^2+\hat{k}3z^2x$

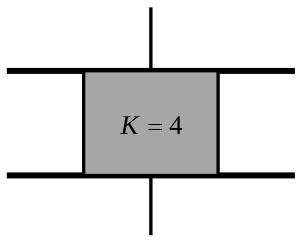
(d) $\vec{E}=\hat{i}\left(2xy+z^3\right)+\hat{j}x^2+\hat{k}3xz^2$

Sol: The electric field at a point is equal to negative potential gradient at that point.

$$\vec{E}=-\frac{\partial V}{\partial r}=\left[-\frac{\partial V}{\partial x}\hat{i}-\frac{\partial V}{\partial y}\hat{j}-\frac{\partial V}{\partial z}\hat{k}\right]=\left[\left(2xy+z^3\right)\hat{i}+\hat{j}x^2+\hat{k}\,3x\,z^2\right]$$

Ans: (d)

135.Consider a parallel plate capacitor of $10\,\mu\text{F}$ (micro-farad) with air filled in the gap between the plates. Now one half of the space between the plates is filled with a dielectric of dielectric constant $4$, as shown in the figure. The capacity of the capacitor changes to




Options:

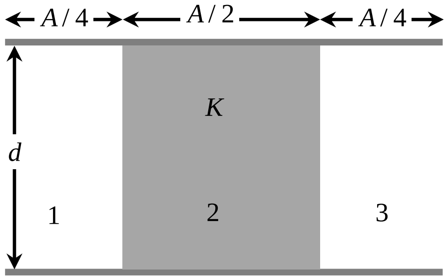
(a) 25 μF

(b) 20 μF

(c) 40 μF

(d) 5 μF

Sol: $C_1 = \dfrac{\varepsilon_0\left(\dfrac{A}{4}\right)}{d}$, $C_2 = \dfrac{K\varepsilon_0\left(\dfrac{A}{2}\right)}{d}$, $C_3 = \dfrac{\varepsilon_0\left(\dfrac{A}{4}\right)}{d}$

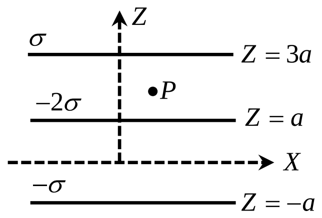



$C_{eq} = C_1 + C_2 + C_3 = \left(\dfrac{K+1}{2}\right)\dfrac{\varepsilon_0 A}{d} = \left(\dfrac{4+1}{2}\right)\times 10$

$= 25\ \mu\text{F}$

Ans: (a)

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




Options:

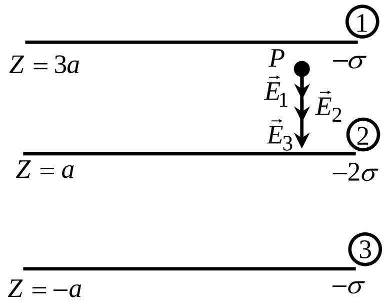
(a) $\dfrac{2\sigma}{\varepsilon_0}\hat{k}$

(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, $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3$

$= E_1\left(-\hat{k}\right) + E_2\left(-\hat{k}\right) + E_3\left(-\hat{k}\right) = \left[\dfrac{\sigma}{2\varepsilon_0} + \dfrac{2\sigma}{2\varepsilon_0} + \dfrac{\sigma}{2\varepsilon_0}\right]\left(-\hat{k}\right) = -\dfrac{2\sigma}{\varepsilon_0}\hat{k}$

Ans: (c)

137. The electric field intensity just sufficient to balance the earth's gravitational attraction on an electron will be: (given mass and charge of an electron respectively are $9.1\times10^{-31}$ kg, $1.6\times10^{-19}$ C and $g = 10\,\text{m s}^{-2}$)

Options:

(a) $-5.6\times10^{-11}\ \text{NC}^{-1}$

(b) $-4.8\times10^{-15}\ \text{NC}^{-1}$

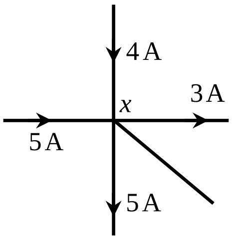
(c) $-1.6\times10^{-19}\ \text{NC}^{-1}$ (d) $-3.2\times10^{-19}\ \text{NC}^{-1}$

Sol: $-eE = mg$

$$\vec{E} = -\frac{9.1\times10^{-31}\times10}{1.6\times10^{-19}} = -5.6\times10^{11}\ \text{NC}^{-1}$$

Ans: (a)

138. Five conductors are meeting at a point $x$ as shown in the figure. What is the value of current in fifth conductor




Options:

(a) $3\,\text{A}$ away from $x$

(b) $1\text{A}$ away from $x$

(c) $4\ \text{A}$ away from $x$

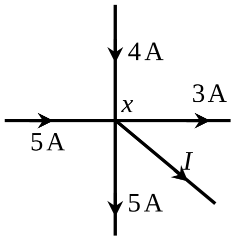
(d) $1\ \text{A}$ away from $x$

Sol: According to Kirchhoff's first law,

$(+5\,\text{A})+(+4\,\text{A})+(-3\,\text{A})+(-5\,\text{A})+I$

$\Rightarrow\ I = -1\text{A}$

$-$ve sign shows that current is flowing away from $x$




Ans: (b)

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 $4/3$ and radius of the wires are in the ratio of $2/3$, then the ratio of the currents passing through the wires will be

Options:

(a) 3

(b) $1/3$

(c) $3/9$

(d) none of these

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

Since the two wires are connected in parallel, potential remains same. i.e.,

$V =$ constant

$IR =$ Constant

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

But we know that, $R = \frac{\rho l}{A}$

$$\therefore\ \frac{R_1}{R_2} = \left(\frac{l_1}{A_1}\right)\left(\frac{A_2}{l_2}\right) = \left(\frac{l_1}{l_2}\right)\left(\frac{A_1}{A_2}\right)$$

$$= \left(\frac{l_1}{l_2}\right)\left(\frac{r_1}{r_2}\right)^2 \quad \text{(since area, } A = \pi r^2\text{)}$$

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

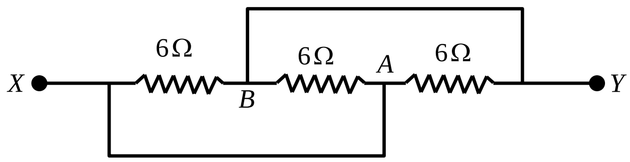
Substitute this value in equation (i)

we get, $\frac{I_1}{I_2}=\frac{1}{3}$

Ans: (b)

140.In a given network, each resistance has value of $6\,\Omega$. The point $X$ is connected to point $A$ by a copper wire of negligible resistance and point $Y$ is connected to point $B$ by the same wire. The effective resistance between $X$ and $Y$ will be

Options:



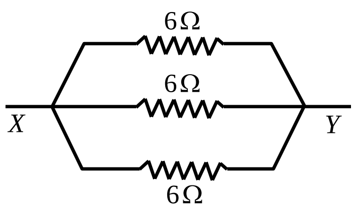

(a) $18\,\Omega$

(b) $6\,\Omega$

(c) $3\,\Omega$

(d) $2\,\Omega$

Sol: The equivalent circuit is given below




The equivalent resistance is given by

$\frac{1}{R}=\frac{1}{6}+\frac{1}{6}+\frac{1}{6}=\frac{3}{6}=\frac{1}{2}$

$\Rightarrow\ R_{eq}=2\,\Omega$

Ans: (d)

141.A small power station supplies electricity to $5000$ lamps connected in parallel. Each lamp has a resistance of $220\,\text{ohm}$ and is operated at $220\,\text{V}$. The total current supplied by the station is

Options:

(a) 2500 A

(b) 3500 A

(c) 5000 A

(d) 10000 A

Sol: All the lamps have been connected in parallel. Therefore, each operates at the same voltage of 220 V.

$\therefore$ Current drawn by each lamp

$=\frac{220}{220}=1\text{A}$

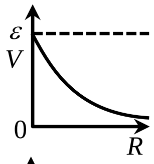
$\therefore$ Total current drawn by lamps

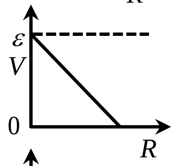
$=5000\,\text{A}$

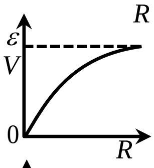
Ans: (c)

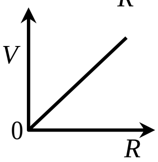
142. Cell having an emf $\varepsilon$ and internal resistance $r$ is connected across a variable external resistance $R$. As the resistance $R$ is increased, the plot of potential difference $V$ across $R$ is given by

Options:

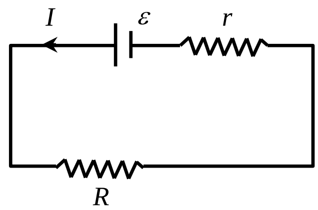
(a) 


(b) 


(c) 


(d) 


Sol: The current through the resistance $R$

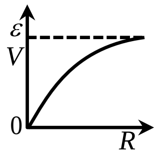



$I = \left(\dfrac{\varepsilon}{R+r}\right)$

The potential difference across $R$

$V = IR = \left(\dfrac{\varepsilon}{R+r}\right)R$

$V = \dfrac{\varepsilon}{\left(1+\dfrac{r}{R}\right)}$




when $R = 0,\ V = 0,$

$R = \infty,\ V = \varepsilon$

Thus $V$ increases as $R$ increases upto certain limit, but it does not increase further.

Ans: (c)

143. The resistance of a bulb filmnet is $100\,\Omega$ at a temperature of $100\,^\circ\mathrm{C}$. If its temperature of coefficient be $0.005$ per $^\circ\mathrm{C}$, its resistance will become $200\,\Omega$ at a temperature of

Options:

(a) 300°C

(b) 400°C

(c) 500°C

(d) 200°C

Sol: $R_1 = R_0\left[1+\alpha\times 100\right] = 100$ … (i)

$R_2 = R_0\left[1+\alpha\times T\right] = 200$ … (ii)

On dividing we get

$$\frac{200}{100}=\frac{1+\alpha T}{1+100\alpha} \Rightarrow 2=\frac{1+0.005T}{1+100\times 0.005}$$

$\Rightarrow \quad T=400\,°\text{C}$

Ans: (b)

144. An electron enters a region where magnetic field $(B)$ and electric field $(E)$ are mutually perpendicular, then

Options:

(a) it will always move in the direction of $B$

(b) it will always move in the direction of $E$

(c) it always possesses circular motion

(d) it can go undeflected also

Sol: When electrons enter in a region where there is only magnetic field, then force exerted by the magnetic field will deflect the electron in a direction perpendicular to its motion and also perpendicular to the magnetic field.

Whereas in the presence of electric field, force exerted by the electric field is in a direction opposite to the direction of electric field. As a result, electron deflected by magnetic field is nullified by the deflection by electric field. As a result, electron moves un-deflected.

Ans: (d)

145. Magnetic field intensity at the centre of a coil of $50$ turns, radius $0.5\,\text{m}$ and carrying a current of $2\,\text{A}$ is

Options:

(a) $0.5\times 10^{-5}\,\text{T}$

(b) $1.25\times 10^{-4}\,\text{T}$

(c) $3\times 10^{-5}\,\text{T}$

(d) $4\times 10^{-5}\,\text{T}$

Sol: We know that magnetic field at the centre of circular coil,

$$B=\frac{\mu_0 In}{2r}=\frac{4\pi\times 10^{-7}\times 2\times 50}{2\times 0.5}$$

$=1.25\times 10^{-4}\,\text{T}$

Ans: (b)

146. A straight wire of length $0.5$ metre and carrying a current of $1.2$ ampere is placed in uniform magnetic field of induction $2$ tesla. The magnetic field is perpendicular to the length of the wire. The force on the wire is

Options:

(a) $2.4\,\text{N}$

(b) $1.2\,\text{N}$

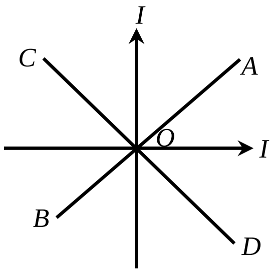
(c) $3.0\,\text{N}$

(d) $2.0\,\text{N}$

Sol: $F = Bi\ell = 2\times1.2\times0.5 = 1.2\,\text{N}$

Ans: (b)

147.Two equal electric currents are flowing perpendicular to each other as shown in the figure. $AB$ and $CD$ are perpendicular to each other and symmetrically placed with respect to the current flow. Where do we expect the resultant magnetic field to be zero?




Options:

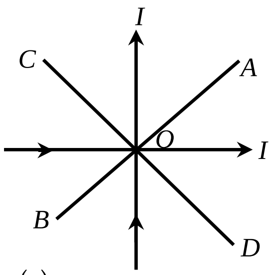
(a) on $AB$

(b) on $CD$

(c) on both $AB$ and $CD$

(d) on both $OD$ and $BO$

Sol: Net magnetic field on $AB$ is zero because magnetic field due to both current carrying wires is equal in magnitude but opposite in direction.




Ans: (a)

148.At a certain place, the horizontal component of earth's magnetic field is $\sqrt{3}$ times the vertical component. The angle of dip at that place is

Options:

(a) $60°$

(b) $45°$

(c) $90°$

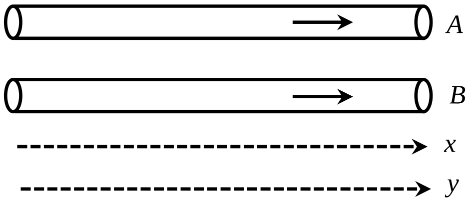
(d) $30°$

Sol: $B_H = \sqrt{3}B_V$,

Also $\tan\phi = \dfrac{B_V}{B_H} = \dfrac{1}{\sqrt{3}} \Rightarrow \phi = 30°$

Ans: (d)

149. $A$ and $B$ are two conductors carrying a current $i$ in the same direction. $x$ and $y$ are two electron beams moving in the same direction. Then




Options:

(a) there will be repulsion between $A$ and B, attraction between $x$ and $y$

(b) there will be attraction between $A$ and B, repulsion between $x$ and $y$

(c) there will be repulsion between $A$ and B and also $x$ and $y$

(d) there will be attraction between $A$ and B and also $x$ and $y$

Sol: Current carrying conductors will attract each other, while electron beams will repel each other.

Ans: (b)

150. If a diamagnetic substance is brought near north or south pole of a bar magnet, it is

Options:

(a) attracted by the poles

(b) repelled by the poles

(c) repelled by north pole and attracted by the south pole

(d) attracted by the north pole and repelled by the south pole

Sol: Diamagnetic substances do not have any unpaired electron. And they magnetised in direction opposite to that of magnetic field. Hence, when they are brought to north or south pole of a bar magnet, they are repelled by poles.

Ans: (b)

151. A square coil of side $25\text{ cm}$ having 1000 turns is rotated with a uniform speed in a magnetic field about an axis perpendicular to the direction of the field. At an instant $t$, the emf induced in the coil is $e = 200\sin 100\pi t$. The magnetic induction is

Options:

(a) $0.50\,\text{T}$

(b) $0.02\,\text{T}$

(c) $0.01\,\text{T}$

(d) $0.1\,\text{T}$

Sol: $e = 200\sin 100\pi t$

$\therefore\ e_0 = 200, \omega = 100\pi$

Now, $NAB\omega = e_0$

$$\therefore\ B = \frac{e_0}{NA\omega} \text{ or } B = \frac{200}{1000\left(25\times10^{-2}\right)^2 \times 100\pi} \text{ or } B = 0.01\,\text{T}$$

Ans: (c)

152. The magnetic potential energy stored in a certain inductor is $25\,\text{mJ}$, when the current in the inductor is $60\,\text{mA}$. This inductor is of inductance

Options:

(a) $0.138\,\text{H}$

(b) $138.88\,\text{H}$

(c) $13.89\,\text{H}$

(d) $1.389\,\text{H}$

Sol: From question energy stored in inductor,

$U = 25\times10^{-3}\ \text{J}$

Current, $I = 60\ \text{mA}$

Energy stored in inductor

$$U = \frac{1}{2}LI^2$$

$$25\times10^{-3} = \frac{1}{2}\times L\times\left(60\times10^{-3}\right)^2$$

$$L = \frac{25\times2\times10^{6}\times10^{-3}}{3600} = 13.89\ \text{H}$$

Ans: (c)

153. A resistance of $20\,\text{ohm}$ is connected to a source of an alternating potential $V = 200\cos(100\pi t)$. The time taken by the current to change from its peak value to rms value, is

Options:

(a) $2.5\times10^{-3}\,\text{s}$

(b) $25\times10^{-3}\,\text{s}$

(c) $0.25\,\text{s}$

(d) $0.20\,\text{s}$

Sol: The current and potential difference are in phase with the resistance. So, the time taken would be same as time for voltage to change from $(t = 0)$ that is peak value to rms value.

Time taken by voltage to achieve its rms value of $\frac{200}{\sqrt{2}}$

$$\frac{200}{\sqrt{2}} = 200\cos(100\pi t)$$

$$\Rightarrow\ \cos(100\pi t) = \frac{1}{\sqrt{2}} = \cos\left(\frac{\pi}{4}\right)$$

$$t = \frac{1}{400}\text{second} = 2.5\times10^{-3}\ \text{s}$$

Ans: (a)

154. In a circuit, $L, C$ and $R$ are connected in series with an alternating voltage source of frequency $f$. The current leads the voltage by $45°$. The value of $C$ is

Options:

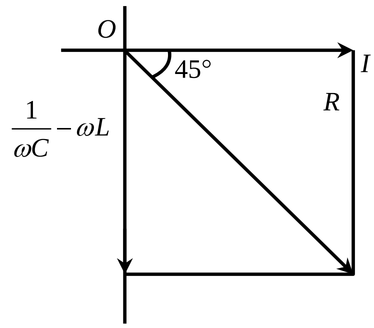
(a) $\frac{1}{\pi f(2\pi fL - R)}$

(b) $\frac{1}{2\pi f(2\pi fL - R)}$

(c) $\frac{1}{\pi f(2\pi fL + R)}$

(d) $\frac{1}{2\pi f(2\pi fL + R)}$

Sol: From figure,




$$\tan 45° = \frac{\frac{1}{\omega C} - \omega L}{R}$$

$$\Rightarrow \frac{1}{\omega C} - \omega L = R$$

$$\Rightarrow \frac{1}{\omega C} = R + \omega L$$

$$C = \frac{1}{\omega(R + \omega L)}$$

$$= \frac{1}{2\pi f(R + 2\pi fL)}$$

Ans: (d)

155. A transformer is used to light a $100\,\text{W}$ and $110\,\text{V}$ lamp from a $220\,\text{V}$ mains. If the main current is $0.5\,\text{A}$, the efficiency of the transformer is approximately

Options:

(a) 50%

(b) 90%

(c) 10%

(d) 30%

Sol: Efficiency of the transformer

$$\eta = \frac{P_{\text{output}}}{P_{\text{input}}} \times 100$$

$$= \frac{100}{220 \times 0.5} \times 100 = 90.9\%$$

Ans: (b)

156.The electric and the magnetic field associated with an E.M. wave, propagating along the $+z-$axis, can be represented by

Options:

(a) $\left[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}\right]$

(b) $\left[\vec{E} = E_0\vec{k}, \vec{B} = B_0\hat{i}\right]$

(c) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$

(d) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$

Sol: E.M. wave always propagates in a direction perpendicular to both electric and magnetic fields. So, electric and magnetic fields should be along $+X-$and $+Y-$directions respectively. Therefore, option (a) is the correct option.

Ans: (a)

157.A concave mirror of focal length '$f_1$' is placed at a distance of '$d$' from a convex lens of focal length '$f_2$'. A beam of light coming from infinity and falling on this convex-lens concave mirror combination returns to infinity. The distance '$d$' must be equal to

Options:

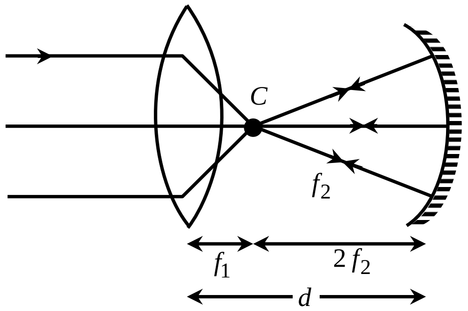
(a) $f_1 + f_2$

(b) $-f_1 + f_2$

(c) $2f_2 + f_1$

(d) $-2f_1 + f_2$

Sol: $d = 2f_2 + f_1$




Ans: (c)

158. A ray of light is incident at an angle of incidence, $i$, on one face of prism of angle $A$ (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is $\mu$, the angle of incidence $i$, is nearly equal to

Options:

(a) $\mu A$

(b) $\frac{\mu A}{2}$

(c) $\frac{A}{\mu}$

(d) $\frac{A}{2\mu}$

Sol: For normally emerge $e=0$

Therefore $r_2=0$ and $r_1=A$

Snell's law for incident ray's

$1\sin i=\mu\sin r_1=\mu\sin A$

For small angle

$i=\mu A$

Ans: (a)

159. When a biconvex lens of glass having refractive index $1.47$ is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index

Options:

(a) equal to that of glass

(b) less than one

(c) greater than that of glass

(d) less than that of glass

Sol: $\frac{1}{f}=\left(\frac{\mu_g}{\mu_m}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

If $\mu_g=\mu_m$,

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

$\Rightarrow \frac{1}{f}=0$

$f=\frac{1}{0}=\infty$

This implies that the liquid must have refractive index equal to glass.

Ans: (a)

160. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$ and the fish is $12\text{ cm}$ below the surface, the radius of this circle in cm is

Options:

(a) $\frac{36}{\sqrt{7}}$

(b) $36\sqrt{7}$

(c) $4\sqrt{5}$

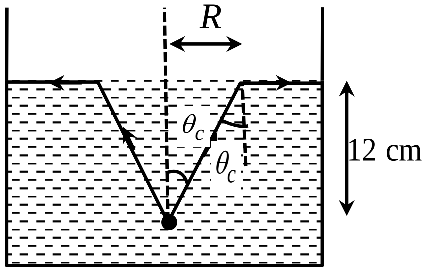
(d) $36\sqrt{5}$

Sol: $\sin\theta_c = \frac{1}{\mu} = \frac{3}{4}$

or $\tan\theta_c = \frac{3}{\sqrt{16-9}}$

$= \frac{3}{\sqrt{7}} = \frac{R}{12}$

$\Rightarrow \ R = \frac{36}{\sqrt{7}}\text{cm}$




Ans: (a)

161. Two identical light waves, propagating in the same direction, have a phase difference $\delta$. After they superimpose, the intensity of the resulting wave will be proportional to

Options:

(a) $\cos\delta$

(b) $\cos(\delta/2)$

(c) $\cos^2(\delta/2)$

(d) $\cos^2\delta$

Sol: Here $A^2 = a_1^2 + a_2^2 + 2a_1a_2\cos\delta$

$\because \ a_1 = a_2 = a$

$\because \ A^2 = 2a^2(1+\cos\delta) = 2a^2\left(1+2\cos^2\frac{\delta}{1}-1\right)$

$\Rightarrow \ A^2 \propto \cos^2\frac{\delta}{2}$

Now, $I \propto A^2$ $\qquad \therefore \ I \propto A^2 \propto \cos^2\frac{\delta}{2}$

$\therefore \ I \propto \cos^2\frac{\delta}{2}$

Ans: (c)

162. A thin mica sheet of thickness $2\times10^{-6}$ m and refractive index $(\mu=1.5)$ is introduced in the path of the first wave. The wavelength of the wave used is $5000\,\text{Å}$. The central bright maximum will shift

Options:

(a) 2 fringes upward

(b) 2 fringes downward

(c) 10 fringes upward

(d) 10 fringes downward

Sol: Shift $=\frac{\beta}{\lambda}(\mu-1)t=\frac{\beta}{\left(5000\times10^{-10}\right)}\times(1.5-1)\times2\times10^{-6}$

$=2\beta$ i.e., fringes upwards.

Ans: (a)

163. A steel ball of mass $m$ is moving with a kinetic energy $K$. The de-Broglie wavelength associated with the ball is

Options:

(a) $\frac{h}{2mK}$

(b) $\sqrt{\frac{h}{2mK}}$

(c) $\frac{h}{\sqrt{2mK}}$

(d) none of these

Sol: de-Broglie's relation, $\lambda=\frac{h}{p}$

momentum $p=\sqrt{2mE}$

$$\Rightarrow\ \lambda=\frac{h}{\sqrt{2mE}}=\frac{h}{\sqrt{2mK}}\qquad(\because\ E=K)$$

Ans: (c)

164. All electrons ejected from a surface by incident light of wavelength $200\,\text{nm}$ can be stopped before travelling $1\,\text{m}$ in the direction of uniform electric field of $4\ \text{NC}^{-1}$. The work function of the surface is

Options:

(a) 4 eV

(b) 6.2 eV

(c) 2 eV

(d) 2.2 eV

Sol: The electron ejected with maximum speed $v_{\max}$ are stopped by electric field $E=4\ \text{NC}^{-1}$

After travelling a distance $d=1\text{m}$

$\frac{1}{2}mv_{max}^2 = eED = 4\,eV$

The energy of incident photon $= \frac{1240}{200} = 6.2\,eV$

From equation of photo electric effect

$\frac{1}{2}mv_{max}^2 = hv - \phi$

$\therefore\ \phi_0 = 6.2 - 4 = 2.2$ eV

Ans: (d)

165.The third line of Balmer series of an ion equivalent to hydrogen atom has wavelength of $108.5\,nm$. The ground state energy of an electron of this ion will be

Options:

(a) 3.4 eV

(b) 13.6 eV

(c) 54.4 eV

(d) 122.4 eV

Sol: From third line of Balmer series, $n_1 = 2,\ n_2 = 5$

$\therefore\ \frac{1}{\lambda} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ gives $Z^2 = \frac{n_1^2 n_2^2}{\left(n_2^2 - n_1^2\right)\lambda R}$

On putting values $Z = 2$

From $E = -\frac{13.6Z^2}{n^2} = \frac{-13.6(2)^2}{(1)^2} = -54.4$ eV

Ans: (c)

166.According to the Bohr theory of $H-$atom, the speed of the electron, its energy and the radius of its orbit varies with the principal quantum number $n$, respectively, as

Options:

(a) $\frac{1}{n}, n^2, \frac{1}{n^2}$

(b) $n, \frac{1}{n^2}, n^2$

(c) $n, \frac{1}{n^2}, \frac{1}{n^2}$

(d) $\frac{1}{n}, \frac{1}{n^2}, n^2$

Sol: According to Bohr's theory of hydrogen atom,

(i) The speed of the electron in the $n^{th}$ orbit is $v_n = \frac{1}{n}\frac{e^2}{4\pi\varepsilon_0 (h/2\pi)}$ or $v_n \propto \frac{1}{n}$

(ii) The energy of the electron in the $n^{\text{th}}$ orbit is $E_n = -\frac{me^4}{8n^2\varepsilon_0^2 h^2} = -\frac{13.6}{n^2}\text{eV}$ or $E_n \propto \frac{1}{n^2}$

(iii) The radius of the electron in the $n^{\text{th}}$ orbit is $r_n = \frac{n^2 h^2 \varepsilon_0}{\pi mc^2} = n^2 a_0$ where $a_0 = \frac{h^2\varepsilon_0}{\pi me} = 5.29\times 10^{11}$ m is called Bohr's radius, or $r_n \propto n^2$.

Ans: (d)

167. Energy of an electron in an excited hydrogen atom is $-3.4\,\text{eV}$. Its angular momentum will be

Options:

(a) $3.72\times 10^{-34}$ Js

(b) $2.10\times 10^{-34}$ Js

(c) $1.51\times 10^{-34}$ Js

(d) $4.20\times 10^{-34}$ Js

Sol: $E = -3.4\,\text{eV}$ and $r = \frac{kze^2}{2E}$

angular momentum $= mvr$

$\Rightarrow \frac{1}{2}mv^2 = E = 3.4\times\left(10^{-19}\times 1.6\right)$

$\Rightarrow m^2v^2 = \left(9.1\times 10^{-31}\right)2\times 3.4\times 1.6\times 10^{-19}$

$= 99.008\times 10^{-50}$

$mv = 9.95028\times 10^{-25}$

$\therefore L = \left(9.95028\times 10^{-25}\right)\left(\frac{9\times 10^9\times 1\times\left(1.6\times 10^{-19}\right)^2}{2\times(3.4)}\right)$

$= 2.10\times 10^{-34}$ Js

Ans: (b)

168. $M_n$ and $M_p$ represent mass of neutron and proton respectively. If an element having atomic mass $M$ and $N-$neutrons and $Z-$protons, then the correct relation will be

Options:

(a) $M < \left[NM_n + ZM_p\right]$

(b) $M > \left[NM_n + ZM_p\right]$

(c) $M = \left[NM_n + ZM_p\right]$

(d) $M = N\left[M_n + M_p\right]$

Sol: Actual mass of the nucleus is always less than total mass of nucleons, so $M < \left(NM_n + Zm_p\right)$

Ans: (a)

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

Options:

(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 $= 4\times(7.1) - 4(1.1) = 24\text{ eV}$

Ans: (c)

170.The fossil bone has a ${}^{14}C:{}^{12}C$ ratio, which is $\left[\frac{1}{16}\right]$ of that in a living animal bone. If the half-life of ${}^{14}C$ is 5730 years then the age of the fossil bone is

Options:

(a) 11460 years

(b) 17190 years

(c) 22920 years

(d) 45840 years

Sol: $\frac{{}^{14}C}{{}^{12}C} = \frac{1}{16} = \frac{N}{N_0}$ $\qquad \because \frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$\Rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^n \Rightarrow \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$

or, $n = 4$ or $\frac{t}{T} = 4$

or $t = 4\times T = 4\times 5730 = 22920$ years

Ans: (c)

171.When germanium is doped 1 part in a million with indium, its conductivity increases by a factor of about

Options:

(a) 10

(b) $10^3$

(c) $10^5$

(d) $10^6$

Sol: The introduction of indium in the proportion of 1 in $10^6$ (million) increases the conductivity by a factor of $10^6$.

Ans: (d)

172.Pure $Si$ at $500\,\text{K}$ has equal number of electron $(n_e)$ and hole $(n_h)$ concentrations of $1.5\times10^{16}\,\text{m}^{-3}$. Doping by indium increases $n_h$ to $4.5\times10^{22}\,\text{m}^{-3}$. The doped semiconductor is of

Options:

(a) $n-$type with electron concentration $n_e = 5\times10^{22}\,\text{m}^{-3}$

(b) $p-$type with electron concentration $n_e = 2.5\times10^{10}\,\text{m}^{-3}$

(c) $n-$type with electron concentration $n_e = 2.5\times10^{23}\,\text{m}^{-3}$

(d) $p-$type having electron concentration $n_e = 5\times10^{9}\,\text{m}^{-3}$

Sol: $n_i^2 = n_e n_h$

$\left(1.5\times10^{16}\right)^2 = n_e\left(4.5\times10^{22}\right)$

$\Rightarrow\ n_e = 0.5\times10^{10}$ or $\Rightarrow\ n_e = 5\times10^{9}$

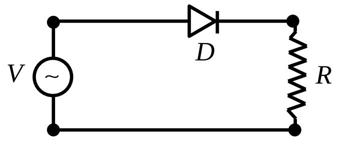
Given, $n_h = 4.5\times10^{22}$ $\Rightarrow\ n_h >> n_e$

$\therefore$ Semiconductor is $p-$type and

$n_e = 5\times10^{9}\,\text{m}^{-3}$

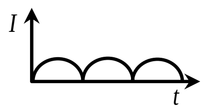
Ans: (d)

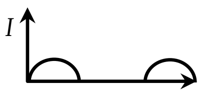
173.A $p-n$ junction $(D)$ shown in the figure can act as a rectifier. An alternative current source $(V)$ is connected in the circuit.

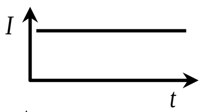


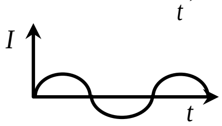

The current $(I)$ in the resistor $(R)$ can be shown by

Options:

(a) 


(b) 


(c) 


(d) 

Sol: We know that a single $p-n$ junction diode connected to an $a-c$ source acts as a half wave rectifier. [Forward biased in one half cycle and reverse biased in the other half cycle].

Ans: (b)

174. A charged particle with charge $q$ enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then

Options:

(a) $\vec{v} = \vec{B} \times \vec{E} / E^2$

(b) $\vec{v} = \vec{E} \times \vec{B} / B^2$

(c) $\vec{v} = \vec{B} \times \vec{E} / B^2$

(d) $\vec{v} = \vec{E} \times \vec{B} / E^2$

Sol: Here, $\vec{E}$ and $\vec{B}$ are perpendicular to each other and the velocity $\vec{v}$ does not change; therefore

$$qE = qvB \Rightarrow v = \frac{E}{B}$$

Also, $\left|\frac{\vec{E} \times \vec{B}}{B^2}\right| = \frac{EB\sin\theta}{B^2} = \frac{EB\sin 90^\circ}{B^2} = \frac{E}{B} = |\vec{v}| = v$

Ans: (b)

175. If momentum $(P)$, area $(A)$ and time $(T)$ are taken to be fundamental quantities, then the energy has the dimensional formula

Options:

(a) $\left[P^1 A^{-1} T^1\right]$

(b) $\left[P^2 A^1 T^1\right]$

(c) $\left[P^1 A^{-1/2} T^1\right]$

(d) $\left[P^1 A^{1/2} T^{-1}\right]$

Sol: Let energy $E = kp^a A^b t^c$ ... (i)

Where $k$ is a dimensionless constant of proportionality.

Equating dimensions on both sides of (i), we get

$$\left[ML^2T^{-2}\right] = \left[MLT^{-1}\right]^a \left[M^0L^2T^0\right]^b \left[M^0L^0T\right]^c = \left[M^aL^{a+2b}T^{-a+c}\right]$$

Applying the principle of homogeneity of dimensions, we get

$a = 1$ ... (ii)

$a + 2b = 2$ ... (iii)

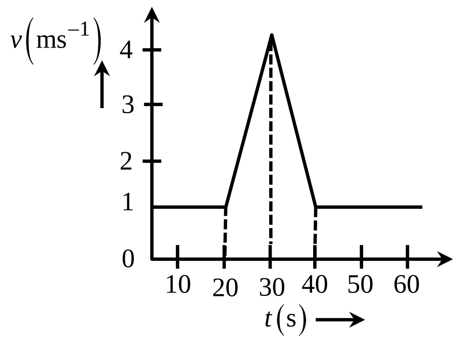
$-a + c = -2$ ... (iv)

On solving eqs. (ii), (iii) and (iv), we get $a=1, b=\frac{1}{2}, c=-1$

$\therefore[E]=\left[p^1 A^{1/2} t^{-1}\right]$

Ans: (d)

176. Velocity time $(v-t)$ graph for a moving object is shown in the figure. Total displacement of the object during the time interval when there is non-zero acceleration and retardation is




Options:

(a) $60\,\mathrm{m}$

(b) $50\,\mathrm{m}$

(c) $30\,\mathrm{m}$

(d) $40\,\mathrm{m}$

Sol: Between time interval $20\,\mathrm{s}$ to $40\,\mathrm{s}$, there is non-zero acceleration and retardation. Hence distance travelled during this interval = Area between time interval $20\,\mathrm{s}$ to $40\,\mathrm{s}$

$=\frac{1}{2}\times 20\times 3+20\times 1=30+20=50\,\mathrm{m}$

Ans: (b)

177. A person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of $0.5\,\mathrm{ms}^{-1}$ at an angle of $120°$ with the direction of flow of water. The speed of water in the stream is

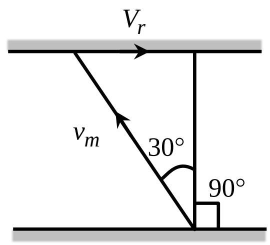
Options:

(a) $1\ \mathrm{ms}^{-1}$

(b) $0.5\,\mathrm{ms}^{-1}$

(c) $0.25\,\mathrm{ms}^{-1}$

(d) $0.433\,\mathrm{ms}^{-1}$




Sol: $\sin 30° = \frac{v_r}{v_m} = \frac{1}{2}$

$\Rightarrow\ v_r = \frac{v_m}{2} = \frac{0.5}{2} = 0.25\ \mathrm{ms}^{-1}$

Ans: (c)

178. A conveyor belt is moving at a constant speed of $2\ \text{ms}^{-1}$. A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it taking $g = 10\,\text{ms}^{-2}$, is

Options:

(a) $1.2\ \text{m}$

(b) $0.6\ \text{m}$

(c) zero

(d) $0.4\ \text{m}$

Sol: Frictional force on the box $f = \mu mg$

$\therefore$ Acceleration in the box

$a = \mu g = 5\,\text{ms}^{-2}$

$v^2 = u^2 + 2as$

$\Rightarrow\ 0 = 2^2 + 2\times(5)\text{s}$

$\Rightarrow\ \text{s} = -\frac{2}{5}$ w.r.t. belt

$\Rightarrow$ distance $= 0.4\,\text{m}$

Ans: (d)

179. A body of mass $5\,\text{kg}$ is moving with a momentum of $10\,\text{kg ms}^{-1}$. A force of $0.2\,\text{N}$ acts on it in the direction of motion of the body for $10$ second. The increase in its kinetic energy is

Options:

(a) $4.4\,\text{J}$

(b) $3.8\,\text{J}$

(c) $3.2\,\text{J}$

(d) $2.8\,\text{J}$

Sol: Initial momentum, $p_1 = 10\ \text{kg ms}^{-1}$

Change in momentum for force $0.2\,\text{N}$ for $10$ second,

$\Delta p = ft = (0.2\times 10)\,\text{kg ms}^{-1} = 2\,\text{kg ms}^{-1}$

Change in momentum,

$p_2 = (10+2) = 12\,\text{kg ms}^{-1}$

Initial velocity, $v_1 = \frac{p_1}{m} = \frac{10}{5} = 2\ \text{ms}^{-1}$

$v_2 = \frac{p_2}{m} = \frac{12}{5}\text{ms}^{-1}$

Change in kinetic energy

$$\Delta k = \frac{1}{2}m\left(v_2^2 - v_1^2\right) = \frac{1}{2}\times 5\times\left[\left(\frac{12}{5}\right) - (2)^2\right]$$

$$= \frac{1}{2}\times 5\left(\frac{144}{25} - 4\right) = 4.4 \text{ J}$$

Ans: (a)

180. A thin uniform rod of length $l$ and mass $m$ is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is $\omega$. Its centre of mass rises to a maximum height of

Options:

(a) $\frac{1}{3}\frac{l^2\omega^2}{g}$

(b) $\frac{1}{6}\frac{l\omega}{g}$

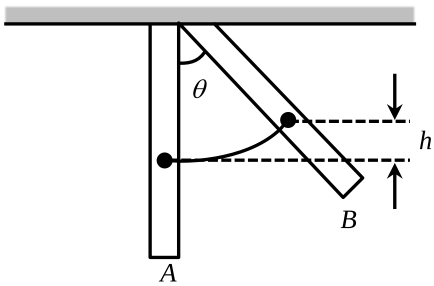
(c) $\frac{1}{2}\frac{l^2\omega^2}{g}$

(d) $\frac{1}{6}\frac{l^2\omega^2}{g}$

Sol: Rotational KE at $A$ position $= \frac{1}{2}I\omega^2$

Potential energy at $B$ position $= mgh$

By the law of conservation of energy




$$mgh = \frac{1}{2}I\omega^2 \Rightarrow mgh = \frac{1}{2}\left(\frac{ml^2}{3}\right)\omega^2$$

$$h = \frac{l^2\omega^2}{6g}$$

Ans: (d)

**Key Answers**:

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