Deeksha

ABHYAS KCET 2024

FREE TEST SERIES

MOCK TEST 2

PDF

SOLUTION

Deeksha - CET

Subject	Topic	
C + M + P	Complete Syllabus	

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

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

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

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

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

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

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

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

   All the best!!

Useful Data

At. Wt.:

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

Physical Constants:

$h=6.626\times10^{-34}\,\text{Js}$, $\text{N}_\text{a}=6.022\times10^{23}\,\text{mol}^{-1}$, $\text{c}=2.998\times10^{8}\,\text{m s}^{-1}$, $\text{m}_\text{e}=9.1\times10^{-31}\,\text{kg}$, $R=8.314\ \text{J mol}^{-1}\ \text{K}^{-1}$

Chemistry

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

1. A phosphorus oxide has 43.6% phosphorus (at, mass = 31).

   The empirical formula is

   (a) P_2O_5 (b) P_2O_3 (c) P_4O_6 (d) PO_2

   Sol:

Element	Percentage	Atomic ratio	Simplest ratio	Whole no ratio
P	43.6%	$\frac{43.6}{31}=1.41$	$\frac{1.41}{1.41}=1$	2
O	56.4%	$\frac{56.4}{16}=3.52$	$\frac{3.52}{1.41}=2.5$	5

   Formula $= P_2O_5$

   Ans: (a)

2. Which of the following orbital designations is not correct corresponding to quantum number?

   (a) $n=5$ $\ell=2$ $\to 5d$ (b) $n=2$ $\ell=0$ $\to 2s$

   (c) $n=4$ $\ell=3$ $\to 4f$ (d) $n=7$ $\ell=2$ $\to 7d$

   Sol: When $n=7$, $\ell=2 \to 7d$

   Ans: (d)

3. Which of the following families have largest negative electron gain enthalpy values?

   (a) Alkali metals (b) Noble gases (c) Halogens (d) Alkaline earth metals

   Sol: Halogens (17^{th} group) have largest negative electron gain enthalpy values.

   Ans: (c)

4. The molecule/ion having pyramidal shape is

   (a) PCl_3 (b) SO_3 (c) CO_3^{2-} (d) NH_4^+

   Sol: PCl_3 is having pyramidal shape.

   Ans: (a)

5. Identify a molecule which doesn't exist.

   (a) C_2 (b) O_2 (c) He_2 (d) Li_2

   Sol: He_2 with bond order zero does not exist

   Ans: (c)

6. Density of 3M solution of $NaCl$ is 1.25 g/ml. The mass of the solvent in the solution is

   (a) 1075.4 g (b) 10.745 g (c) 10.754 g (d) 1074.5 g

   Sol: 1000 ml solution has 3 moles of $NaCl$

   Mass of $NaCl = 3\times 58.5 = 175.5$ g

   Mass of solution $= v\times d$

   $= 1000\,\text{ml}\times 1.25\text{ g ml}^{-1} = 1250\text{ g}$

Mass of solvent $=1250-175.5$

$=1074.5$ g

Ans: (d)

7. A certain reaction is at equilibrium at 355k and the enthalpy change for the reaction is 213kJ. The value of ΔS $\left(\text{in } Jk^{-1} mol^{-1}\right)$ for the reaction is

(a) 55.0 (b) 60.0 (c) 68.5 (d) 120.0

Sol: At equilibrium $\Delta G = 0$

$\therefore \Delta H = T\Delta S \quad (\because \Delta G = \Delta H - T\Delta S)$

$\therefore \Delta S = \frac{\Delta H}{T} = \frac{21.3\times1000}{355} = 60\,JK^{-1}\ mol^{-1}$

Ans: (b)

8. $H_2(g)+I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H=12.40\,kcal$

According to the reaction, heat of formation of HI will be

(a) 12.4 kcal (b) −12.4 kcal (c) −6.20 kcal (d) 6.20 kcal

Sol: Formation reaction for $HI, \frac{1}{2}H_2(g)+\frac{1}{2}I_2(g) \rightleftharpoons HI(g)\ \Delta H=6.20kcal$

Ans: (d)

9. The ratio of K_p/K_c for the reaction $CO(g)+\frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$ is

(a) 1 (b) RT (c) $(RT)^{\frac{1}{2}}$ (d) $(RT)^{-\frac{1}{2}}$

Sol: $K_p = K_c(RT)^{\Delta n}$

$\Delta n = 1-1\frac{1}{2} = -\frac{1}{2}$

$\therefore \frac{K_p}{K_c} = (RT)^{-\frac{1}{2}}$

Ans: (d)

10. Which of the following are Lewis acids?

(a) PH_3 and BCl_3 (b) $AlCl_3$ and $SiCl_4$ (c) PH_3 and $SiCl_4$ (d) BCl_3 and $AlCl_3$

Sol: BCl_3 and $AlCl_3$ are electron deficient compounds and behave like Lewis acids.

Ans: (d)

11. In the ionic equation for the reaction $IO_3^- + 6H^+ + ae^{-1} \rightarrow I^- + 3H_2O$ the value of a is

(a) 2 (b) 4 (c) 6 (d) 10

Sol: $IO_3^- + 6H^+ + 6e^{-1} \rightarrow I^- + 3H_2O$

Ans: (c)

12. Which of the following will given white precipitate on heating with $AgNO_3$?

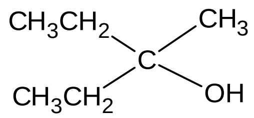
(a) $CHCl_3$ (b) CCl_4 (c) C_6H_5Cl (d) $NaCl$

Sol: $NaCl + AgNO_3 \longrightarrow AgCl \downarrow + NaNO_3$

$CHCl_3, CCl_4$ and C_6H_5Cl are covalent compounds, so these do not give ppt with $AgNO_3$.

Ans: (d)

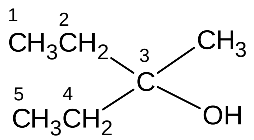
13. The correct nomenclature (IUPAC) for the following alcohol is



(a) 2-Ethylbutan-2-ol (b) 3-methyl pentan3-ol

(c) 3-Ehtyl-3-methyl ethanol (d) 1, 1 – diethylmethanol

Sol:



3 - methyl pentan - 3 - ol

Ans: (b)

14. In terms of relative stability, which of the following is in general wrong

(a) tertiary free radicals are more stable than secondary

(b) secondary free radicals are more staple than primary

(c) tertiary carbocation is less stable than secondary

(d) secondary carbocation is less stable than primary

Sol: Tertiary carbocation is more stable than secondary

Ans: (c)

15. Ethylene reacts with alkaline $KMnO_4$ to give

(a) Acetaldehyde (b) Ethylene glycol (c) Formaldehyde (d) Ethylene oxide

Sol: $CH_2 = CH_2 \xrightarrow{Al\,k.KMnO_4} \underset{OH}{CH_2} - \underset{OH}{CH_2}$

Ans: (b)

16. According to Huckel rate the aromatic compounds must have delocalised Π electrons equal to

(a) $(4n+1)$ (b) $(4n+2)$ (c) $4n$ (d) $(2n+2)$

Sol: $4n+2$

Ans: (b)

17. Ozonolysis of an organic compound $'A'$ produces acetone and propionaldehyde in equimolar mixture. Identify $'A'$ from thr following compunds.

(a) Pent $-1-$ ene (b) $2-$ Methylpent $-1-$ ene

(c) 2 Methylpent $-2-$ ene (d) $2-$ Methylpent $-1-$ ene

Sol: $CH_3 - \underset{CH_3}{C} = CH - CH_2 - CH_3 \xrightarrow{\text{Ozonolysis}} CH_3COCH_3 + CH_3CH_2CHO$

Ans: (c)

18. The complex $\left[Ag\left(NH_3\right)_2\right]\left[Ag\left(CN\right)_2\right]$ has the IUPAC name

(a) diamminesilver (I) dicyanosilver (I)

(b) diammine silver (I) dicyanoargentate (I)

(c) dicyanosilver (I) diammineargentate (I)

(d) diamminesilver (I) dicyanoargentate (II)

Sol: diammine silver (I) dicyanoargentate (I)

Ans: (b)

19. The half-life period of a 1st order reaction is 60 minutes. What percentage will be left over after 240 minutes?

(a) 5%

(b) 6.25%

(c) 6%

(d) 4.25%

Sol: No. of half lives, $n = \frac{\text{Total time}}{t_{1/2}} = \frac{240}{60} = 4$

Amount of substance left $= \left(\frac{1}{2}\right)^n \times \text{initial amount}$

$= \left(\frac{1}{2}\right)^4 \times 100 \ = 6.25\%$

Ans: (b)

20. 18 g of glucose $\left(C_6H_{12}O_6\right)$ is added to 178.2 g of water. The vapour pressure of water for this aqueous solution at $100°C$ is

(a) 76.00 torr

(b) 752.40 torr

(c) 759.00 torr

(d) 7.60 torr

Sol: $\frac{p^\circ - p_s}{p_s} = \frac{w_2}{m_2} \times \frac{M_1}{W_1}$

$\frac{760 - p_s}{p_s} = \frac{18}{180} \times \frac{18}{178.2} = \frac{18}{1782}$

$\frac{760 - 1}{p_s} = \frac{18}{1782}$

$\frac{760}{p_s} = \frac{18}{1782} + 1 = \frac{1800}{1782}$

$p_s = \frac{760}{1800} \times 1782$

$= 752.4$ torr

Ans: (b)

21. The ratio of the value of any colligative property for $CaCl_2$ solution to that of sugar solution under equal concentration is nearly

(a) 1.0

(b) 0.33

(c) 3.0

(d) 2.5

Sol: vant Hoff factor i for $CaCl_2 = 3$

vant Hoff facto i for sugar $= 1$

$\therefore$ Ratio = 3.0

Ans: (c)

22. The freezing point of a solution containing $36g$ of a compound having empirical formula CH_2O in $1200g$ of water is found to be $-0.93°$. Molecular formula of the compound is $\left(\text{Kf } = 1.86K \text{ kg mol}^{-1}\right)$

(a) CH_2O (b) $C_2H_4O_2$ (c) $C_3H_6O_3$ (d) $C_4H_8O_2$

Sol: $\Delta T_f = 0-(-0.93) = 0.93$

$$M_B = \frac{Kf \times 1000 \times W_2}{\Delta T_f \times W_1} = \frac{1.86 \times 1000 \times 36}{0.93 \times 1200} = 60$$

Empirical formula mass $= 12+2+16 = 30$

$$\therefore n = \frac{60}{30} = 2$$

$\therefore$ Molecular formula $= C_2H_4O_2$

Ans: (b)

23. All form ideal solution except

(a) C_6H_6 and $C_6H_5CH_3$ (b) C_2H_5Br and C_2H_5I

(c) C_6H_5Cl and C_6H_5Br (d) C_2H_5I and C_2H_5OH

Sol: C_2H_5I and C_2H_5OH form non-ideal solution

Ans: (d)

24. The electrode potential of a silver electrode dipped in a 0.01M solution of silver nitrate at 25°C $\left(E°_{Ag^+/Ag} = 0.80\text{V}\right)$

(a) 0.0741V (b) 0.059 V (c) 0.741V (d) 0.859 V

Sol: $E_{Ag^+/Ag} = E°_{Ag^+/Ag} + \frac{0.059}{n}\log\left[M^+\right]$

$$= 0.80 + \frac{0.059}{1}\log 10^{-1}$$

$$0.80 - 0.059 = 0.741$$

Ans: (c)

25. In $H_2 - O_2$ fuel cell, the reaction occurring at cathode is

(a) $H^+ + OH^{-1} \rightarrow H_2O(l)$ (b) $H^+ + e^{-1} \rightarrow \frac{1}{2}H_2$

(c) $O_2 + 2H_2O + 4e^{-1} \rightarrow 4OH^{-1}$ (d) $2H_2 + O_2 \rightarrow 2H_2O(l)$

Sol: $O_2 + 2H_2O + 4e^{-1} \rightarrow 4OH^-$

Ans: (c)

26. If $\wedge_C$ for NH_4OH is $11.5\Omega^{-1}\text{cm}^{-2}\text{mol}^{-1}$, its degree of dissociation would be (given that $\lambda^\circ_{NH_4+} = 73.4$ and $\lambda^\circ_{OH^-} = 197.6\Omega^{-1}\text{cm}^2\text{mol}^{-1}$)

(a) 0.0848 (b) 0.0424 (c) 0.0212 (d) 0.004

Sol: $\alpha = \frac{\wedge_c}{\overset{\circ}{\wedge}_c} = \frac{11.5}{73.4 + 197.6} = \frac{11.5}{271} = 0.0424$

Ans: (b)

27. How many hours does it take to reduce 1mol of Fe^{3+} to Fe^{2+} with $2A$ current?

(a) 35 (b) 20.0 (c) 26.8 (d) 13.4

Sol: $Fe^{3+} + e^- \rightarrow Fe^{2+}$

For $1\text{mole}, 96500C$ is required.

Change=current $\times$ time

$96500 = 2 \times \text{time}$ or $\text{time} = \frac{96500}{2} = 482505 = \frac{482505}{60 \times 60} = 13.4\text{hr}$

Ans: (d)

28. For the reaction: $3ClO^- \rightarrow 3Cl0_3^- + 2Cl^-$ various steps are

$Cl0^- + Cl0^- \rightarrow Cl0_2^- + Cl^-$ (slow)

$ClO_2^- + ClO^- \rightarrow ClO_3^- + Cl^-$ (fast)

The order of the reaction is

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

Sol: $\text{Rate} = \text{k}\left(ClO^-\right)^2$ order = 2

Ans: (b)

29. If the half-life period for a reaction in A is 100mins. How long will it take $[A]$ to reach 25% of its initial concentration?

(a) $50\,\text{min}$ (b) $250\,\text{min}$ (c) $200\,\text{min}$ (d) $500\,\text{min}$

Sol: Given $t_{\frac{1}{2}} = 100\text{mins}$

$100 \xrightarrow[1t_{\frac{1}{2}}]{} 50 \xrightarrow[2t_{\frac{1}{2}}]{} 25$

$\therefore t_{75\%} = 2 \times t_{\frac{1}{2}} = 2 \times 100 = 200\,\text{min}$

Ans: (c)

30. A reaction having equal energies of activation for forward and reverse reactions has

(a) $\Delta G = 0$ (b) $\Delta H = 0$ (c) $\Delta H = \Delta G = \Delta S = 0$ (d) $\Delta S = 0$

Sol: $\Delta H = E_f - E_b = 0$

Ans: (b)

31. A reaction has rate law expression as

$\text{Rate} = \text{k}[A]^{3/2}[B]^{-1/2}$

If concentration of both A and B are increased four times, the rate of the reaction

(a) increases 4 times (b) decreases 4 times (c) increases 16 times (d) remains same

Sol: Overall order $=\frac{3}{2}-\frac{1}{2}=1$

Rate of the reaction increases 4 times

Ans: (a)

32. The inversion of cane sugar into glucose and fructose is a reaction of

(a) first order (b) second order (c) third order (d) zero order

Sol: $r=k[\text{sugar}]^1[H_2O]^0$

It is a pseudo first order reaction.

Ans: (a)

33. The rate equation for the reaction $2NO+Cl_2 \longrightarrow 2NOCl$ is given by the rate equation $r=K[NO]^2[Cl_2]$.

The value of rate constant can be increased by

(a) increasing the temperature (b) increasing the concentration of NO

(c) increasing the concentration of Cl_2 (d) doing all these

Sol: The value of rate constant depends upon temperature and not upon the initial concentration of reactants & products.

Ans: (a)

34. Which of the following electrolytic solutions has the least specific conductance?

(a) $2\,N$ (b) $0.002\,N$ (c) $0.02N$ (d) $0.2\,\text{N}$

Sol: Specific conductance of an electrolyte decrease with decrease in concentration. So electrolytic solution of concentration 0.002 N has least specific conductance.

Ans: (b)

35. Cell constant of a cell is generally found using

(a) $NaCl$ (b) KCl (c) NH_4Cl (d) H_2SO_4

Sol: Standard KCl solution is used.

Ans: (b)

36.

Electrolyte	KCl	KNO_3	HCl	$NaOAc$	$NaCl$
$\wedge^\circ\left(\text{S cm}^2\text{mol}^{-1}\right)$	149.9	145.0	426.2	91.0	126.5

Calculate $\overset{\circ}{\wedge}_{HOAC}$ using appropriate molar conductance of the electrolytes listed above at infinite dilution in H_2O at $25°C$

(a) 517.2 (b) 552.7 (c) 390.7 (d) 217.5

Sol: $\lambda^{\infty}_{ACOH}=\lambda^{\infty}_{ACONa}+\lambda^{\infty}_{HCl}-\lambda^{\infty}_{NaCl}$

$=91.0+426.2-126.5$

$=390.75\ \text{cm}^2\text{mol}^{-1}$

Ans: (c)

37. Nickel carbonyl is having

(a) linear structure
(b) tetrahedral structure
(c) square planar structure
(d) octahedral structure

Sol: $NiCO_4$ has tetrahedral structure (sp^3 hybridisation)

Ans: (b)

38. According to crystal field theory, the $M-L$ bond in a complex is

(a) purely ionic (b) purely covalent (c) purely co-ordinate (d) partially covalent

Sol: According to CFT, the bonding in a complex is purely electrostatic or ionic.

Ans: (a)

39. Which of the following hybridisation has planar geometry?

(a) sp^3d (b) dsp^3 (c) dsp^2 (d) sp^3

Sol: dsp^2 - square planar geometry.

Ans: (c)

40. Which of the following forms a colourless solution in aqueous solution?

(a) v^{3+} (b) Cr^{3+} (c) Ti^{3+} (d) Sc^{3+}

Sol: $Sc^{3+}\left(d^0\right)$ has no unpaired electron so it is colourless in aqueous solution.

Ans: (d)

41. The electronic configuration of Cr^{3+} is

(a) $[Ar]3d^3 4s^\circ$ (b) $[Ar]3d^4 4s^2$ (c) $[Ar]3d^5 4s^1$ (d) $[Ar]3d^2 4s^1$

Sol: ${}_{24}Cr = [Ar]3d^5 4s^1$ & $Cr^{3+} = [Ar]3d^3 4s^0$

Ans: (a)

42. The correct order of the first ionisation enthalpies is

(a) $Mn < Ti < Zn < Ni$
(b) $Ti < Mn < Zn < Ni$
(c) $Ti < Mn < Ni < Zn$
(d) $Zn < Ni < Mn < Ti$

Sol: Order of I.E is $Ti < Mn < Ni < Zn$

Ans: (c)

43. Which of the following is most acidic?

(a) MnO_3 (b) MnO_2 (c) Mn_2O_7 (d) Mn_3O_4

Sol: Mn_2O_7

Ans: (c)

44. Which of the following is least basic?

(a) $La(OH)_3$ (b) $Lu(OH)_3$ (c) $Ce(OH)_3$ (d) $Nd(OH)_3$

Sol: $Lu(OH)_3$

Ans: (b)

45. Which of the following has maximum conductivity in aqueous solution?

(a) $Co(NH_3)_4 Cl_3$ (b) $Co(NH_3)_3 Cl_3$ (c) $Co(NH_3)_5 Cl_3$ (d) $Co(NH_3)_6 Cl_3$

Sol: $\left[Co(NH_3)_6\right]Cl_3$ maximum conductivity

Ans: (d)

46. Which of the following compounds show optical isomerism?

(a) $\left[Cu(NH_3)_4\right]^{2+}$ (b) $[ZnCl_4]^{2-}$ (c) $\left[Cr(C_2O_4)_3\right]^{3-}$ (d) $\left[Cr(CN)_6\right]^{3-}$

Sol: $\left[Cr(C_2O_4)_3\right]^{3-}$ show optical isomerism.

Ans: (c)

47. Ethyl bromide can be obtained by the action of HBr on

(a) Ethyne (b) Ethane (c) Propene (d) Ethanol

Sol: $C_2H_5OH + HBr \rightarrow C_2H_5Br + H_2O$

Ans: (d)

48. S_N1 mechanism of alkyl halide is favoured by

(a) Higher concentration of nucleophile (b) Polar solvents

(c) Presence of less bulky alkyl group (d) Strong nucleophiles

Sol: Polar solvents favour S_N1 reaction.

Ans: (b)

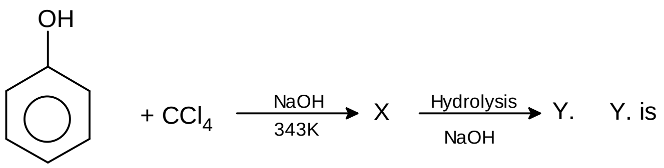
49. Which of the following is most acidic?

(a) CH_3CH_2OH (b) $(CH_3)_2 CHOH$ (c) $(CH_3)CHCH_2OH$ (d) CH_3OH

Sol: CH_3OH is most acidic.

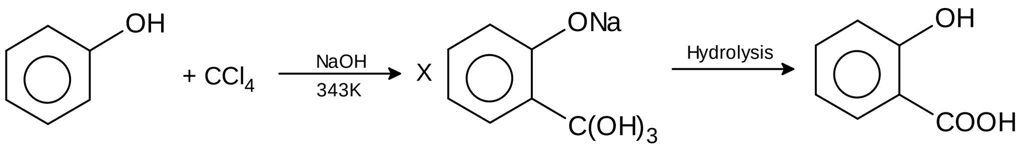
Ans: (d)

50. In the reaction



(a) Salicylaldehyde (b) Salicylic acid (c) $O-$Cresol (d) Benzoic acid

Sol:



Ans: (b)

51. The major product in the reaction

$CH_3-O-CH(CH_3)_2+HI \rightarrow$ Product

(a) $ICH-O-CH(CH_3)_2$ (b) $CH_3-O-\underset{\mid}{\overset{}{C}}(I)-(CH_3)_2$

(c) $CH_3I+(CH_3)_2CHOH$ (d) $CH_3OH+(CH_3)_2CHI$

Sol: $CH_3-O-CH(CH_3)_2+HI \rightarrow CH_3I+(CH_3)_2CH-OH$

Ans: (c)

52. Which of the following is most reactive towards HCN ?

(a) CH_3COCH_3 (b) CH_3CHO (c) $CH_3COC_2H_5$ (d) $HCHO$

Sol: Reactivity order: $HCHO > CH_3CHO > CH_3COCH_3 > CH_3COC_2H_5$

Ans: (d)

53. Which of the following will give cannizzaro reaction?

(a) CH_3CHO (b) CH_3COCH_3 (c) $(CH_3)_3C-CHO$ (d) $(CH_3)_2CHCHO$

Sol: $(CH_3)_3C-CHO$ does not have $\alpha-$hydrogen. Hence undergoes cannizzaro reaction.

Ans: (c)

54. In the reaction

$CH_3CH_2COOH \xrightarrow{P,Cl_2} X \xrightarrow{alc\,KOH} Y.$ Y is

(a) $CH_2=CH-COOH$ (b) $CH_3CH_2CH_2OH$ (c) CH_3-CH_2-CHO (d) $CH_3-\underset{\mid}{CH}(OH)-COOH$

Sol: $CH_3CH_2COOH \xrightarrow{P,Cl_2} CH_3-\underset{Cl}{CH}-COOH \xrightarrow{alc\,KOH} CH_2=CH-COOH$

Ans: (a)

55. Mononitration of aniline is achieved by

(a) direct treatment with nitration mixture under reflux

(b) using fuming HNO_3

(c) acetylation followed by nitration and subsequent hydrolysis

(d) $KNO_3+con.\ HNO_3$

Sol: $p-$Nitroaniline can be obtained by acetylation followed by nitration and hydrolysis

Ans: (c)

56. Structurally cellulose is a linear polymers of

(a) $\beta-$ glucose molecules (b) Sucrose molecules

(c) $\alpha-$ glucose molecules (d) Fructose molecules

Sol: Cellulose is a linear polymer of $\beta-$ glucose molecules

Ans: (a)

57. A peptide harmone is

(a) Estrone (b) Testosterone (c) Insulin (d) Corticoid

Sol: Insulin is a peptide

Ans: (c)

58. Which of the following statement is not correct about DNA molecule?

(a) It has double helix structure

(b) It serves as hereditary material

(c) The two DNA strands are exactly similar

(d) Its replication is called semi-conservative mode of replication

Sol: Two DNA strands are not similar

Ans: (c)

59. The order of reactivities of methyl halides in the formation of Grignard reagent is

(a) $CH_3Br > CH_3Cl > CH_3I$

(b) $CH_3Br > CH_3I > CH_3Cl$

(c) $CH_3I > CH_3Br > CH_3Cl$

(d) $CH_3Cl > CH_3Br > CH_3I$

Sol: This can be explained on the basis of decreasing bond dissociation energy from $CH_3 - I$ to $CH_3 - Br$ to $CH_3 - Cl$.

Ans: (c)

60. Tollen's reagent is

(a) Alkaline $KMnO_4$ solution

(b) Sodium potassium tartarate & $NaOH$

(c) Ammonical $AgNO_3$ solution

(d) Ammonical Cu_2Cl_2

Sol: Ammonical solution of $AgNO_3$ or $\left[Ag\left(NH_3\right)_2\right]OH$ is known as Tollen's reagent.

Ans: (c)

Mathematics

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

61. The value of $\cos^2 15° - \cos^2 30° + \cos^2 45° - \cos^2 60° + \cos^2 75°$ is

(a) 2 (b) 0 (c) $\frac{1}{4}$ (d) $\frac{1}{2}$

Sol: $\cos^2 15° - \cos^2 30° + \cos^2 45° - \cos^2 60° + \cos^2 75°$

$= \cos^2(90° - 75°) - \left(\frac{\sqrt{3}}{2}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2 - \left(\frac{1}{2}\right)^2 + \cos^2 75°$

$= \left(\sin^2 75° + \cos^2 75°\right) - \frac{3}{4} + \frac{1}{2} - \frac{1}{4} = \frac{1}{2}$.

Ans: (d)

62. $\sin 10° + \sin 20° + \sin 30° + ... + \sin 360°$ is equal to

(a) 0 (b) 1 (c) -1 (d) none of these

Sol: $\sin 10° + \sin 20° + \sin 30° + ... + \sin 180° + \sin(180° + 10°) + \sin(180° + 20°) + ... + \sin(180° + 180°) = 0$

$(\because \sin(180° + \theta) = -\sin\theta)$

Ans: (a)

63. If α is a root of $25\cos^2\theta + 5\cos\theta - 12 = 0$, $\frac{\pi}{2} < \alpha < \pi$, then $\sin 2\alpha$ is equal to

(a) $\frac{24}{25}$ (b) $\frac{-24}{25}$ (c) $\frac{25}{24}$ (d) none of these

Sol: $25\cos^2\alpha + 5\cos\alpha - 12 = 0$ $\Rightarrow \cos\alpha = -\frac{4}{5}, \frac{2}{5}$ but $\frac{\pi}{2} < \alpha < \pi$,

Therefore, $\cos\alpha = -\frac{4}{5}$ and hence $\sin\alpha = \sqrt{1 - \frac{16}{25}} = \frac{2}{5}$.

So, $\sin 2\alpha = 2\sin\alpha\cos\alpha = 2\left(\frac{3}{5}\right)\left(-\frac{4}{5}\right)$.

Ans: (b)

64. The solution set of the inequation $\left(x^2 + x + 1\right)(2x - 3) > 0$ is

(a) R (b) $\left(\frac{3}{2}, \infty\right)$ (c) $\left[\frac{3}{2}, \infty\right)$ (d) $\left(-\infty, \frac{3}{2}\right)$

Sol: $\left(x^2 + x + 1\right)(2x - 3) > 0 \Rightarrow 2x - 3 > 0$

$\Rightarrow 2x > 3$

$\left(\because\ x^2 + x + 1 = \left(x + \frac{1}{2}\right)^2 + \frac{3}{4} \geq \frac{3}{4} > 0\right)$

Ans: (b)

65. If $1 + 6 + 11 + ... + x = 148$, then x is equal to

(a) 36 (b) 8 (c) 30 (d) None of these

Sol: If n is the number of terms then

$$148 = S_n = \frac{n}{2}\left[2\times1+(n-1)5\right]$$

$$\Rightarrow 296 = n(5n-3)$$

$$\Rightarrow 5n^2 - 3n - 296 = 0$$

$\Rightarrow n = 8$ as n cannot be negative.

$\therefore \quad x = T_8 = 1+(8-1)5 = 36$.

Ans: (a)

66. The figures $4, 5, 6, 7, 8$ are written in every possible order. The number of numbers greater than 56000 is

(a) 72 (b) 90 (c) 96 (d) 98

Sol: ${}^5P_5 - \left({}^4P_4 + {}^3P_3\right)$; as ${}^4P_4$ numbers begin with 4 and ${}^3P_3$ with 54

Ans: (b)

67. The mean and S.D of $1, 2, 3, 4, 5, 6$ is

(a) $\frac{7}{2}, \sqrt{\frac{35}{12}}$ (b) $3, 3$ (c) $\frac{7}{2}, \sqrt{3}$ (d) $3, \frac{35}{12}$

Sol: Mean and S.D. of $1, 2, 3, ...n$ is $\frac{n+1}{2}$ and $\sqrt{\frac{n^2-1}{12}}$ respectively. Put $n = 6$ to get the result.

$$\text{Mean} = \frac{1+2+3+...+6}{6} = \frac{21}{6} = \frac{7}{2}$$

$$SD = \sqrt{\frac{6^2-1}{12}} = \sqrt{\frac{35}{12}}$$

Ans: (a)

68. A digit is selected at random from either of the two sets $\{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ and $\{1, 2, 3, 4, 5, 6, 7, 8, 9\}$. What is the chance that the sum of the digits selected is 10?

(a) $\frac{1}{9}$ (b) $\frac{10}{81}$ (c) $\frac{10}{18}$ (d) None of these

Sol: Two digits, one from each set can be selected in $9\times9 = 81$ ways. Favourable outcomes are $(1, 9)$, $(2, 8)$, $(3, 7)$, $(4, 6)$, $(5, 5)$, $(6, 4)$, $(7, 3)$, $(8, 2)$ and $(9, 1)$.

$\therefore$ required probability $= \frac{9}{81} = \frac{1}{9}$

Ans: (a)

69. A baised dice is tossed and the respective probabilities of various faces to show up are

Face	1	2	3	4	5	6
Probability	0.1	0.24	0.19	0.18	0.15	0.14

If an even face has turned up, then the probability that it is face 2 or face 4 is

(a) 0.42 (b) 0.75 (c) 0.25 (d) 0.33

Sol: Let E_1 : "an even number has turned up"

E_2 : "face 2 or face 4 has come up", then required probability

$$= P\left(\frac{E_2}{E_1}\right) = \frac{P(E_2 \cap E_1)}{P(E_1)} = \frac{P(E_2)}{P(E_1)} \qquad [E_2 C E_1]$$

$$= \frac{0.24+0.18}{0.24+0.18+0.14} = \frac{0.42}{0.56} = \frac{3}{4} = 0.75$$

Ans: (b)

70. Four cards are drawn simultaneously from a deck of 52 cards. The chance that they all are the same suit is

(a) $\frac{C(13, 4)}{C(52, 4)}$ (b) $\frac{4C(13, 4)}{C(52, 4)}$ (c) $\frac{4!C(13, 4)}{C(52, 4)}$ (d) None of these

Sol: Note that there are four suits and each contains 13 cards.

$\therefore$ Required probability $\frac{4\times {}^{13}C_4}{{}^{52}C_4} = \frac{4C(13, 4)}{C(52, 4)}$

Ans: (b)

71. The probability that an event E occurs in one trial of an experiment is 0.4. Three independent trials of experiment are performed. The probability that the event E occurs atleast once is

(a) 0.784 (b) 0.904 (c) 0.936 (d) none of these

Sol: Required probability $= 1 - P$ (E does not occur any time)

$= 1-(1-P(E))^3 = 1-(1-0\cdot 4)^3 = 1-0.216 = 0.784$.

Ans: (a)

72. A bag 'A' contains two white and two red balls and another bag 'B' contains 4 white and 5 red balls. A ball is drawn and is found to be red. The probability that is was drawn from bag B is

(a) $\frac{25}{52}$ (b) $\frac{1}{2}$ (c) $\frac{10}{19}$ (d) $\frac{13}{18}$

Sol: Let H_1 : "the ball is drawn from bag A"

and H_2 : "the ball is drawn from bag B"

then H_1 and H_2 are mutually exclusive and exhaustive.

Also $P(H_1) = P(H_2) = \frac{1}{2}$.

Let E : "a red ball is drawn"

Using Bayes theorem required probability $= P\left(\frac{H_2}{E}\right)$

$$= \frac{P\left(\frac{E}{H_2}\right)P(H_2)}{P\left(\frac{E}{H_1}\right)P(H_1) + P\left(\frac{E}{H_2}\right)P(H_2)} = \frac{\frac{5}{9}\times\frac{1}{2}}{\frac{2}{4}\times\frac{1}{2}+\frac{5}{9}\times\frac{1}{2}} = \frac{\frac{5}{9}}{\frac{1}{2}+\frac{5}{9}} = \frac{10}{19}.$$

Ans: (c)

73. If $P(A\cap B)=\frac{1}{2}$ and $P(A'\cap B')=\frac{1}{3}$, $P(A)=p$ and $P(B)=2p$ then value of p is

(a) $\frac{7}{18}$ (b) $\frac{1}{3}$ (c) $\frac{4}{9}$ (d) $\frac{1}{9}$

Sol: Given $P(A'\cap B')=\frac{1}{3}$

$\Rightarrow P((A\cup B)')=\frac{1}{3}$

$\Rightarrow 1-P(A\cup B)=\frac{1}{3}$

$\Rightarrow P(A\cup B)=1-\frac{1}{3}=\frac{2}{3}$

$\Rightarrow P(A)+P(B)-(A\cap B)=\frac{2}{3}$

$\Rightarrow p+2P-\frac{1}{2}=\frac{2}{3}\Rightarrow 3p=\frac{2}{3}+\frac{1}{2}=\frac{7}{6}\Rightarrow p=\frac{7}{18}$.

Ans: (a)

74. The range of the function $f(x)=a\sin x+b\cos x$ is

(a) $[a,b]$ (b) $[a-b,a+b]$ (c) $[-(a+b),(a+b)]$ (d) $\left[-\sqrt{a^2+b^2},\sqrt{a^2+b^2}\right]$

Sol: $f(x)=a\sin x+b\cos x$

$=(r\cos\alpha)\sin x+(r\sin\alpha)\cos x$

$=r\sin(x+\alpha)$,

Where $a=r\cos\alpha, b=r\sin\alpha$.

Since $-1\le\sin(x+\alpha)\le 1\forall x\in R$,

Therefore, $-r\le r\sin(x+\alpha)\le r$

$\Rightarrow -r\le f(x)\le r$.

So, range of $f(x)$ is

$[-r,r]=\left[-\sqrt{a^2+b^2},\sqrt{a^2+b^2}\right]$.

Ans: (d)

75. The function $f(x)=x^2+\sin x$ is

(a) an odd function (b) an even function

(c) neither even nor odd (d) a constant function

Sol: $f(x)=x^2+\sin x$ is neither even nor odd as $f(-x)$ is neither equal to $f(x)$ nor to $-f(x)$.

Ans: (c)

76. Let $f:[0,\infty)\to[0,2]$ be defined by $f(x)=\dfrac{2x}{1+x}$, then f is

(a) one-one, but not onto
(b) onto, but not one-one
(c) both one-one onto
(d) neither one-one nor onto

Sol: Here $f(x)=\dfrac{2x}{1+x}$, $D_f=[0,\infty)$.

Let $x_1, x_2\in D_f$ and $f(x_1)=f(x_2)$

$$\Rightarrow \frac{2x_1}{1+x_1}=\frac{2x_2}{1+x_2}$$

$$\Rightarrow 2x_1(1+x_2)=2x_2(1+x_1)$$

$$\Rightarrow 2x_1=2x_2\Rightarrow x_1=x_2$$

Hence f is one-one. Let $y\in[0,2]$ be arbitrary, then $y=f(x)$ iff

$$\Leftrightarrow y=\frac{2x}{1+x}\Leftrightarrow xy+y=2x\Leftrightarrow x(y-2)=-y\Leftrightarrow x=-\frac{y}{y-2}$$

This means that $y=2$ is not the image of any element from $[0,\infty)$. So f is not onto.

Ans: (a)

77. If $f(x)=\dfrac{x-1}{x+1}$, then $f\left(\dfrac{1}{f(x)}\right)$ equals

(a) 0
(b) 1
(c) x
(d) $\dfrac{1}{x}$

Sol: Given $f(x)=\dfrac{x-1}{x+1}$, therefore,

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

$$=\frac{\frac{x+1}{x-1}-1}{\frac{x+1}{x-1}+1}=\frac{x+1-x+1}{x+1+x-1}$$

$$=\frac{2}{2x}=\frac{1}{x}$$

Ans: (d)

78. The projection of the vector $\hat{i}-2\hat{j}+\hat{k}$ on the vector $4\hat{i}-4\hat{j}+7\hat{k}$ is

(a) $\dfrac{5}{19}\sqrt{5}$
(b) $\dfrac{19}{9}$
(c) $\dfrac{9}{19}$
(d) $\dfrac{1}{19}\sqrt{6}$

Sol: $$\frac{(\hat{i}-2\hat{j}+\hat{k})\cdot(4\hat{i}-4\hat{j}+7\hat{k})}{\sqrt{4^2+(-4)^2+7^2}}=\frac{4+8+7}{\sqrt{81}}=\frac{19}{9}$$

Ans: (b)

79. If $\vec{a}+\vec{b}$ is at right angles to $\vec{b}$ and $2\vec{b}+\vec{a}$ is at right angles to $\vec{a}$ then

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

Sol: Given $\left(\vec{a}+\vec{b}\right)\cdot\vec{b}=0$ and $\left(2\vec{b}+\vec{a}\right)\cdot\vec{a}=0 \Rightarrow \vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{b}=0$

$\Rightarrow 2\vec{b}\cdot\vec{a}+\vec{a}\cdot\vec{a}=0$

$\Rightarrow 2\left(-\vec{b}\cdot\vec{b}\right)+\vec{a}\cdot\vec{a}=0$ (eliminating $\vec{a}\cdot\vec{b}$

$\Rightarrow a^2=2b^2 \Rightarrow a=\sqrt{2}b$.

Ans: (a)

80. The lines $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}$ and $\frac{x-1}{3}=\frac{y-2}{4}=\frac{z-3}{5}$ are

(a) skew (b) parallel (c) intersecting (d) none of these

Sol: The given lines are not parallel and both the lines pass through the point $(1, 2, 3)$.

Ans: (c)

81. If $f(x)=(1-x)\tan\frac{\pi x}{2}$, then $\lim_{x\to 1} f(x)$ is equal to

(a) $\frac{\pi}{2}$ (b) $\frac{2}{\pi}$ (c) 0 (d) 1

Sol: $\lim_{x\to 1} f(x)=\lim_{x\to 1}(1-x)\tan\frac{\pi}{2}x$

$=\lim_{x\to 1}(h)\tan\left(\frac{\pi}{2}(1+h)\right)$

$=\lim_{x\to 1}\frac{h}{\tan\left(\frac{\pi}{2}h\right)}=\frac{2}{\pi}$

Ans: (b)

82. $\lim_{n\to\infty}\left(\frac{1}{1\cdot 2}+\frac{1}{2\cdot 3}+\frac{1}{3\cdot 4}+.......+\frac{1}{n(n+1)}\right)=$

(a) -1 (b) 1 (c) 0 (d) none of these

Sol: $=\lim_{x\to\infty}\left(\frac{1}{1.2}+\frac{1}{2.3}+\frac{1}{3.4}+...+\frac{1}{n(n+1)}\right)$

$=\lim_{x\to\infty}\left(\left(1-\frac{1}{2}\right)+\left(\frac{1}{2}-\frac{1}{3}\right)+\left(\frac{1}{3}-\frac{1}{4}\right)+...+\left(\frac{1}{n}-\frac{1}{n+1}\right)\right)$

$=\lim_{x\to\infty}\left(1-\frac{1}{n+1}=1-0=1\right)$

Ans: (b)

83. $\lim_{x\to 4}\frac{3-\sqrt{5+x}}{1-\sqrt{5-x}}=$

(a) 0 (b) $\frac{1}{3}$ (c) $-\frac{1}{3}$ (d) does not exist

Sol: $\lim_{x\to 4}\frac{3-\sqrt{5+x}}{1-\sqrt{5-x}}$

$$\lim_{x\to 4}\frac{-\frac{1}{2\sqrt{5+x}}}{-\frac{-1}{2\sqrt{5-x}}(1)}=\frac{\frac{-1}{2\times 3}}{+\frac{1}{2}}=-\frac{1}{3}$$

Ans: (c)

84. If $y=\frac{\log x}{x}$, then $\frac{d^2y}{dx^2}=$

(a) $\frac{3-2\log x}{x^3}$ (b) $\frac{2\log x-3}{x^3}$ (c) $\frac{2\log x-3}{x^4}$ (d) None of these

Sol: $y_1=\frac{1-\log x}{x^2}$

$$\Rightarrow y_2=\frac{x^2\left(-\frac{1}{x}\right)-(1-\log x)2x}{\left(x^2\right)^2}$$

$$=\frac{x(-1-2+2\log x)}{x^4}=\frac{2\log x-3}{x^3}$$

Ans: (b)

85. Let $f(x)=\frac{x^2}{1-x^2}$, $x\neq 0,\pm 1$. Then derivative of $f(x)$ w.r.t x^2 is

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

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

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

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

Therefore, $\frac{df(x)}{d\left(x^2\right)}=\frac{1}{\left(1-x^2\right)^2}$

Ans: (b)

86. If $y=\log\left(\sqrt{x}+\sqrt{x-a}\right)$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{1}{\sqrt{x}+\sqrt{x-a}}$ (b) $\frac{1}{2\sqrt{x}\sqrt{x-a}}$ (c) $\frac{1}{\sqrt{x}\sqrt{x-a}}$ (d) none of these

Sol: $\frac{dy}{dx}=\frac{d}{dx}\left\{\log\left(\sqrt{x}+\sqrt{x-a}\right)\right\}=\frac{1}{\sqrt{x}+\sqrt{x-a}}\left(\frac{1}{2\sqrt{x}}+\frac{1}{2\sqrt{x-a}}\right)$

$= \frac{1}{2\sqrt{x}\sqrt{x-a}}$.

Ans: (b)

87. Differential co-efficient of $\sec\left(\tan^{-1} x\right)$ is

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

Sol: Now $\sec\left(\tan^{-1} x\right) = \sec\theta, \theta = \tan^{-1} x \in \left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$

$\Rightarrow \sec\left(\tan^{-1} x\right) = \sec\left[\sec^{-1}\sqrt{1+x^2}\right] = \sqrt{1+x^2}$

Hence $\frac{d}{dx}\left(\sec\left(\tan^{-1} x\right)\right)$

$\frac{d}{dx}\sqrt{1+x^2} = \frac{x}{\sqrt{x^2+1}}$

Ans: (a)

88. Let $f(x) = \frac{1-\sin x}{(\pi-2x)^2}$ when $x \neq \frac{\pi}{2}$ and $f\left(\frac{\pi}{2}\right) = k$. The value of k which makes f continuous at $\frac{\pi}{2}$ is

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{8}$ (d) none of these

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

$= \lim_{h\to 0} \frac{1-\sin\left(\frac{\pi}{2}+h\right)}{4h^2} = \lim_{h\to 0} \frac{1-\cos h}{4h^2} = \frac{1}{4}\cdot\frac{1}{2} = \frac{1}{8}$

So, we must have $k = \frac{1}{8}$.

Ans: (c)

89. Let $f(x) = \begin{cases} a+x, & x \geq 0 \\ a-x, & x < 0 \end{cases}$, then $f(x)$ is

(a) continuous but not derivable at 0 (b) derivable at 0

(c) not continuous at 0 (d) none of these

Sol: $f(0) = a$, $\lim_{x\to 0^+} f(x) = \lim_{x\to 0^+}(a+x) = a$ and also $\lim_{x\to 0^-} f(x) = \lim_{x\to 0^-}(a-x) = a$

Hence f is continuous at 0. However, $L.f'(0) = \lim_{h\to 0^+} \frac{f(0+h)-f(0)}{h}$

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

Ans: (a)

90. Let $f(x)=x^{25}(1-x)^{75}$ for all $x\in[0,1]$, then $f(x)$ assumes its maximum value at

(a) 0 (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$

Sol: $f'(x)=x^{25}\times 75(1-x)^{74}(-1)+(1-x)^{75}\times 25x^{24}$

$=25x^{24}(1-x)^{74}\{-3x+(1-x)\}\forall x\in R$

$\Rightarrow f'(x)=0\Rightarrow x=\frac{1}{4}\in(0,1)$.

Now that $f(0)=f(1)=0$ and $f\left(\frac{1}{4}\right)=\frac{3^{75}}{4^{100}}$.

So $f(x)$ is maximum at $x=\frac{1}{4}$.

Ans: (b)

91. Let $f(x)=\tan x-4x$, then in the interval $\left(-\frac{\pi}{3},\frac{\pi}{3}\right)$, $f(x)$ is

(a) a decreasing function (b) an increasing function

(c) a constant function (d) none of these

Sol: $f'(x)=\sec^2 x-4<0 in\left(-\frac{\pi}{3},\frac{\pi}{3}\right)$.

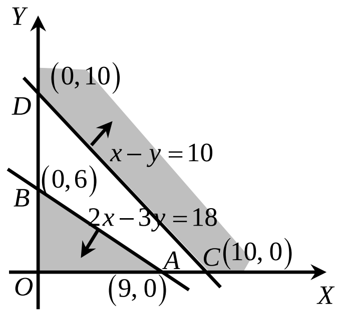
$\left(\because x\in\left(-\frac{\pi}{3},\frac{\pi}{3}\right)\Rightarrow 1\le\sec x<2\right)\Rightarrow 1\le\sec^2 x<4$

Ans: (a)

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

(a) 35 (b) 36 (c) 34 (d) none of these

Sol: Observe the adjoining figure. Graph of the inequality $2x+3y\le 18$ together with $x\ge 0, y\ge 0$ is the region bounded by the Triangle OAB (including the boundary points).



Graph of the inequality $x+y\ge 10$ together with $x\ge 0, y\ge 0$ is the region of whole XOY -plane except the points which lie within the triangle OCD. So feasible region is the empty set in this case. No optimum value of the objective function exists.

Ans: (d)

93. If A and B are any two sets, then $(A\cup B)-(A\cap B)$ is equal to

(a) $A-B$ (b) $B-A$ (c) $(A-B)\cup(B-A)$ (d) None of these

Sol: $A-B$, $B-A$ and $A\cap B$ are pairwise disjoint and their union is $A\cup B$.

Ans: (c)

94. $\int \frac{\cos 2x}{\cos x} dx =$

(a) $2\sin x + \log(\sec x + \tan x) + C$ (b) $2\sin x + \log(\sec x - \tan x) + C$

(c) $2\sin x - \log|\sec x + \tan x| + C$ (d) $2\sin x - \log|\sec x - \tan x| + C$

Sol: $\int \frac{\cos 2x}{\cos x} dx = \int \frac{2\cos^2 x - 1}{\cos x} dx$

$= 2\int \cos x dx - \int \sec x dx$

$= 2\sin x - \log|\sec x + \tan x| + C$

Ans: (c)

95. An anti-derivative of $\frac{x}{\cos^2 x}$ is

(a) $x\tan x + C$ (b) $\log|\cos x| + C$ (c) $x\tan x + \log|\cos x| + C$ (d) $\cot x + C$

Sol: $\int \frac{x}{\cos^2 x} dx = \int x\sec^2 x dx = x\tan x - \int \tan x dx = x\tan x + \log|\cos x| + C$

(Integrating by parts taking x as the first function)

Ans: (c)

96. $\int \frac{1}{\sqrt{1-x}} dx$ is equal to

(a) $\sqrt{1-x} + C$ (b) $-2\sqrt{1-x} + C$ (c) $2\sqrt{1-x} + C$ (d) none of these

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

Ans: (b)

97. $\int \frac{\log x - 1}{(\log x)^2} dx$ is equal to

(a) $\frac{\log x}{x} + c$ (b) $\frac{x}{\log x} + c$ (c) $\frac{(\log x)^2 - x}{\log x}$ (d) none of these

Sol: $\int \frac{\log x - 1}{(\log x)^2} dx = \int \frac{1}{\log x} \cdot 1 dx - \int \frac{1}{(\log x)^2} dx$

$= \left(\frac{1}{\log x}\right)x - \int \frac{-1}{(\log x)^2} \frac{1}{x} \cdot x dx - \int \frac{1}{(\log x)^2} dx = \frac{x}{\log x} + C$

(Applying rule of integration by parts to the first integral taking $\frac{1}{\log x}$ as the first function)

Ans: (b)

98. $\int \frac{1}{x^3 (x^3 + 1)^{1/3}} dx$ is equal to

(a) $-\frac{1}{2}(1 + x^{-3})^{2/3} + C$ (b) $-(1 + x^3)^{2/3} + C$ (c) $-(1 + x^{-3})^{-2/3} + C$ (d) none of these

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

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

Ans: (a)

99. The value of $\int_1^2 \frac{1}{x^2}e^{-1/x}dx$ is

(a) $\frac{1}{\sqrt{e}}+\frac{1}{e}$ (b) $\frac{1}{e}-\frac{1}{\sqrt{e}}$ (c) $\frac{1}{\sqrt{e}}-\frac{1}{e}$ (d) 0

Sol: Put $-\frac{1}{x}=t$, then $\int_1^2 \frac{1}{x^2}e^{-1/x^2}dx = \int_{-1}^{-1/2} e^t dt$

$= e^t\Big|_{-1}^{-1/2} = e^{-1/2}-e^{-1} = \frac{1}{\sqrt{e}}-\frac{1}{e}$

Ans: (c)

100. $\int_{-8}^{8}\left(\sin^{93}x + x^{295}\right)dx$ is equal to

(a) 0 (b) a number different from 0

(c) $2\left(8^{295}+1\right)$ (d) $2+8^{295}$

Sol: $f(x)=\sin^{93}x+x^{295}$ is an odd function and $\int_{-a}^{a} f(x)dx = 0$ whenever $f(x)$ is an odd function.

Ans: (a)

101. $\int_0^2 \frac{dx}{\{ax+b(2-x)\}^2}$ is equal to

(a) $\frac{-1}{2ab}$ (b) $\frac{1}{2ab}$ (c) $\frac{\alpha-b}{2ab}$ (d) none of these

Sol: $\int_0^2 \frac{dx}{\{ax+b(2-x)\}^2} = \int_0^2 \{2b+(a-b)x\}^{-2}dx$

$= \left[\frac{\left(2b+(a-b)x\right)^{-1}}{(-1)(a-b)}\right]_0^2 = \frac{1}{b-a}\left[\frac{1}{2a}-\frac{1}{2b}\right]$.

Ans: (b)

102. If $\int_0^{\pi/2} \frac{\cos x}{4-\sin^2 x}dx = \lambda \log 3$, then λ is equal to

(a) $\frac{1}{4}$ (b) $-\frac{1}{4}$ (c) $\frac{1}{2}$ (d) none of these

Sol: Substituting $\sin x = t \Rightarrow \cos x dx = dt$, we obtain

$$\int_0^{\pi/2} \frac{\cos x dx}{4-\sin^2 x} = \int_0^1 \frac{dt}{4-t^2}$$

$$= \frac{1}{4}\left[\log\left|\frac{2+t}{2-t}\right|\right]_0^1 = \frac{1}{4}\log 3$$

Ans: (a)

103. The solution of the differential equation $\cos x \sin y dx + \sin x \cos y dy = 0$ is

(a) $\frac{\sin x}{\sin y} = C$ (b) $\cos x + \cos y = C$ (c) $\sin x + \sin y = C$ (d) $\sin x \sin y = C$

Sol: Given equation is

$\cos x \sin y dx + \sin x \cos y dy = 0$

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

$\Rightarrow \cot x dx + \cot y dy = 0$

$\int \cot x dx + \int \cot y dy = \log c$

i.e., $\log \sin x + \log \sin y = \log c$

i.e., $\log(\sin x \sin y) = \log c$

$\Rightarrow \sin x \sin y = c$

Ans: (d)

104. If $\cos\left(2\sin^{-1} x\right) = \frac{1}{9}$ then $x =$

(a) $\frac{2}{3}$ (b) $\frac{-2}{3}$ (c) $\pm\frac{2}{3}$ (d) none of these

Sol: $\cos\left(2\sin^{-1} x\right) = \frac{1}{9}$

$\Rightarrow 1 - 2\sin^2\left(\sin^{-1} x\right) = \frac{1}{9} \Rightarrow 1 - 2x^2 = \frac{1}{9}$

$\Rightarrow x = \pm\frac{2}{3}$.

Ans: (c)

105. If A and B are symmetric matrices of the same order, then

(a) AB is a symmetric matrix (b) AB is skew-symmetric matrix

(c) $AB + BA$ is symmetric matrix (d) $AB - BA$ is a symmetric matrix

Sol: $(AB + BA)^t = (AB)^t + (BA)^t$

$= B^t A^t + A^t B^t - BA + AB = AB + BA$

$\left(\because A^t = A \text{ and } B^t = B\right)$

Ans: (c)

106.If the system of equations $x+ky-z=0$, $3x-ky-z=0$ and $x-3y+z=0$, has non-zero solution, then k is equal to

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

Sol: The system has non-zero solution, if

$$\therefore \begin{vmatrix} 1 & k & -1 \\ 3 & -k & -1 \\ 1 & -3 & 1 \end{vmatrix} = 0$$

$$\Rightarrow 1(-k-3)-k(3+1)-1(-9+k)=0 \Rightarrow -6k+6=0$$

$$\therefore \quad k=1$$

Ans: (c)

107.Let P and Q be 3×3 matrices, $P \neq Q$. If $P^3=Q^3$ and $P^2Q=Q^2P$, then determinant of $\left(P^2+Q^2\right)$ is equal to

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

Sol: Given

(i) Two matrices P and Q of order 3×3 such that $P \neq Q$.

(ii) $P^3=Q^3$ and $P^2Q=Q^2P$

To find the value of determinant of P^2+Q^2.

On substracting the given equations, we get

$$P^3-P^2Q=Q^3-Q^2P \Rightarrow P^2(P-Q)=Q^2(Q-P)$$

$$\Rightarrow (P-Q)\left(P^2+Q^2\right)=0 \Rightarrow \left|P^2+Q^2\right|=0$$

Ans: (c)

108.If $A=\begin{bmatrix} a & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & a \end{bmatrix}$, then $|A||adj\ A|$ is equal to

(a) a^9 (b) a^{-3} (c) $-a^7$ (d) $2a^6$

Sol: Given $A=\begin{bmatrix} a & 0 & 0 \\ 0 & a & 0 \\ 0 & 0 & a \end{bmatrix}$

Now, $|A|=a^3$

$$\Rightarrow |A||adjA|=|A|\cdot|A|^{3-1}=|A|^3=\left(a^3\right)^3=a^9$$

Ans: (a)

109.A straight line passes through the points $(5,0)$ and $(0,3)$. The length of perpendicular from the point $(4,4)$ on the line is

(a) $\frac{15}{\sqrt{34}}$ (b) $\frac{\sqrt{17}}{2}$ (c) $\frac{17}{2}$ (d) $\sqrt{\frac{17}{2}}$

Sol: The equation of time passing through points $(5,0)$ and $(0,3)$ is

$$(y-0)=\frac{(3-0)}{(0-5)}(x-5) \Rightarrow y=\frac{3}{-5}(x-5)$$

$$\Rightarrow -5y=3x-15 \Rightarrow 3x+5y-15=0$$

So, the length of perpendicular from the point $(4,4)$ to the above line

$$d=\frac{(3\times4+5\times4-15)}{\sqrt{3^2+5^2}}=\frac{12+20-15}{\sqrt{9+25}}$$

$$=\frac{17}{\sqrt{34}}=\sqrt{\frac{17}{2}}$$

Ans: (d)

110.The principal value of $\sin^{-1}\left[\sin\left(\frac{2\pi}{3}\right)\right]$ is

(a) $\frac{-2\pi}{3}$ (b) $\frac{2\pi}{3}$ (c) $\frac{4\pi}{3}$ (d) None of these

Sol: $\sin^{-1}\left(\sin\frac{2\pi}{3}\right)=\sin^{-1}\left[\sin\left(\pi-\frac{\pi}{3}\right)\right]=\sin^{-1}\left(\sin\frac{\pi}{3}\right)=\frac{\pi}{3}$

Ans: (d)

111.If $\sin^{-1}x+\sin^{-1}y+\sin^{-1}z=\frac{3\pi}{2}$, then the value of $x^9+y^9+z^9-\frac{1}{x^9y^9z^9}$ is

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

Sol: We know that, $\left|\sin^{-1}x\right|\le\pi/2$. From the given relation, we observe that each of $\sin^{-1}x,\sin^{-1}y$ and $\sin^{-1}z$ will be $\frac{\pi}{2}$.

$$\Rightarrow x=y=z=\sin\frac{\pi}{2}=1$$

$$\therefore x^9+y^9+z^9-\frac{1}{x^9y^9z^9}=1+1+1-\frac{1}{1}=3-1=2$$

Ans: (c)

112.Equation of the line passing through $(2,-1,1)$ and parallel to the line $\frac{x-5}{4}=\frac{y+2}{-3}=\frac{z}{5}$ is

(a) $\frac{x-2}{4}=\frac{y+1}{-3}=\frac{z-1}{5}$ (b) $\frac{x-2}{4}=\frac{y+1}{3}=\frac{z-1}{5}$

(c) $\frac{x-2}{-4}=\frac{y+1}{-3}=\frac{z-1}{5}$ (d) None of these

Sol: Equation of line passing through (x_1,y_1,z_1) and parallel to the line $\frac{x-x_2}{a}=\frac{y-y_2}{b}=\frac{z-z_2}{c}$ is

$$\frac{x-x_1}{a}=\frac{y-y_1}{b}=\frac{z-z_1}{c}$$

$\therefore$ Equation of line is $\frac{x-2}{4}=\frac{y+1}{-3}=\frac{z-1}{5}$

Ans: (a)

113.The angle between the lines $\frac{x+4}{1}=\frac{y-3}{2}=\frac{z+2}{3}$ and $\frac{x}{3}=\frac{y-1}{-2}=\frac{z}{1}$ is

(a) $\sin^{-1}\left(\frac{1}{7}\right)$ (b) $\cos^{-1}\left(\frac{2}{7}\right)$ (c) $\cos^{-1}\left(\frac{1}{7}\right)$ (d) None of these

Sol: Angle between two lines is given by

$$\cos\theta=\frac{a_1a_2+b_1b_2+c_1c_2}{\sqrt{a_1^2+b_1^2+c_1^2}\sqrt{a_2^2+b_2^2+c_2^2}}$$

$$=\frac{1\times3+2\times(-2)+3\times1}{\sqrt{1^2+2^2+3^2}\sqrt{3^2+(-2)^2+1^2}}=\frac{2}{\sqrt{14}\sqrt{14}}$$

$$\therefore \theta=\cos^{-1}\left(\frac{1}{7}\right)$$

Ans: (c)

114.A sphere increases its volume at the rate of $\pi\, cm^3/s$. The rate at which its surface area increases, when the radius is $1cm$ is

(a) 2π sq cm/s (b) π sq cm/s (c) $\frac{3\pi}{2}$ sq cm/s (d) $\frac{\pi}{2}$ sq cm/s

Sol: Let volume of sphere, $V=\frac{4}{3}\pi r^3$

$$\Rightarrow \frac{dV}{dt}=4\pi r^2\frac{dr}{dt}\Rightarrow \pi=4\pi r^2\frac{dr}{dt}\left[\because \frac{dV}{dt}=\pi\right]$$

$$\Rightarrow \frac{dr}{dt}=\frac{1}{4r^2} \qquad \text{.... (i)}$$

Now, $\frac{dS}{dt}=\frac{d}{dt}\left(4\pi r^2\right)=4\pi\left(2r\frac{dr}{dt}\right)$

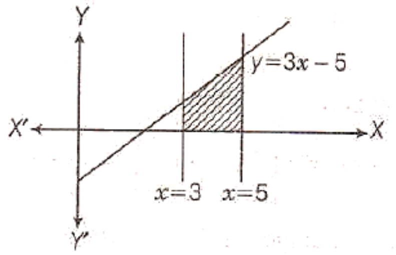
$\therefore \left(\frac{dS}{dt}\right)=4\pi\left(2\cdot1\cdot\frac{1}{4}\right)=2\pi\, cm^2/s$ [from Eq. (i)]

Ans: (a)

115.The area enclosed by $y=3x-5, y=0,\ x=3$ and $x=5$ is

(a) 12 sq units (b) 13 sq units (c) $13\frac{1}{2}$ sq units (d) 14 sq units

Sol: The region is bounded by the curves $y=3x-5, y=0, x=3$ and $x=5$.



$\therefore$ Required area $=\int_3^5 (3x-5)\,dx$

$=\left[\frac{3x^2}{2}-5x\right]_3^5=\left(\frac{75}{2}-25\right)-\left(\frac{27}{2}-15\right)$

$=\frac{75}{2}-25-\frac{27}{2}+15=\frac{48}{2}-10=14$ sq units

Ans: (d)

116.The solution of the differential equation $\frac{dy}{dx}=y\tan x-2\sin x$, is

(a) $y\sin x=C+\sin 2x$ (b) $y\cos x=C+\frac{1}{2}\sin 2x$ (c) $y\cos x=C-\sin 2x$ (d) $y\cos x=C+\frac{1}{2}\cos 2x$

Sol: Given, $\frac{dy}{dx}-y\tan x=-2\sin x$

Here, $P=-\tan x$ and $Q=-2\sin x$

$\therefore$ IF $=e^{-\int \tan x dx}=\cos x$

Hence, required solution is $y(\cos x)=\int -2\sin x\cos x\,dx+C$

$=-\int \sin 2x\,dx+C \Rightarrow y\cos x=\frac{\cos 2x}{2}+C$

Ans: (d)

117.The value of $\left|\frac{1+i\sqrt{3}}{\left(1+\frac{1}{i+1}\right)^2}\right|$ is

(a) 20 (b) 9 (c) $\frac{5}{4}$ (d) $\frac{4}{5}$

Sol: Let $z=\frac{1+i\sqrt{3}}{\left(\frac{i+2}{i+1}\right)^2}=\frac{\left(1+i\sqrt{3}\right)(2i)}{3+4i}=\frac{\left(1+i\sqrt{3}\right)(2i)(3-4i)}{25}$

Now, $|z|=\frac{\left|1+i\sqrt{3}\right||2i||3-4i|}{|25|}=\frac{2\times2\times5}{25}=\frac{4}{5}$

Ans: (d)

118.The sum of the coefficients in the expansion of $\left(1+x-3x^2\right)^{3148}$ is

(a) 8 (b) 7 (c) 1 (d) -1

Sol: On substituting $x=1$ in $\left(1+x-3x^2\right)^{3148}$, we get

$=(1+1-3)^{3148}=(-1)^{3148}=1$

Ans: (c)

119.If sum of the series $\sum_{n=0}^{\infty} r^n = S$ for $|r|<1$, then sum of the series $\sum_{n=0}^{\infty} r^{2n}$, is

(a) S^2 (b) $\frac{S^2}{2S+1}$ (c) $\frac{2S}{S^2-1}$ (d) $\frac{S^2}{2S-1}$

Sol: Since, $1+r+r^2+....\infty = S$

$\therefore \frac{1}{1-r} = S \Rightarrow r = \frac{S-1}{S}$ .... (i)

Now, $1+r^2+r^4+...\infty = \frac{1}{1-r^2} = \frac{1}{1-\left(\frac{S-1}{S}\right)^2}$ [From Eq. (i)]

$= \frac{S^2}{S^2-(S-1)^2} = \frac{S^2}{(2S-1)}$

Ans: (d)

120.The equation of the ellipse whose foci are $(\pm 2, 0)$ and eccentricity $1/2$, is

(a) $\frac{x^2}{12}+\frac{y^2}{16}=1$ (b) $\frac{x^2}{16}+\frac{y^2}{12}=1$ (c) $\frac{x^2}{16}+\frac{y^2}{8}=1$ (d) None of these

Sol: It is given that $e=\frac{1}{2}$ and $ae=2$

$\therefore a = 4$

$\therefore b^2 = a^2\left(1-e^2\right) \Rightarrow b^2 = 12$

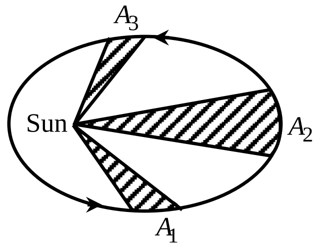
Thus, the required ellipse is $\frac{x^2}{16}+\frac{y^2}{12}=1$

Ans: (b)

Physics

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

121. A planet moving around sun sweeps area A_1 in 2 days, A_2 in 3 days and A_3 in 6 days. Then the relation between A_1, A_2 and A_3 is



(a) $3A_1 = 2A_2 = A_3$ (b) $2A_1 = 3A_2 = 6A_3$ (c) $3A_1 = 2A_2 = 6A_3$ (d) $6A_1 = 3A_2 = 2A_3$

Sol: When a planet revolves around the sun, its real velocity is constant.

$$\therefore \frac{A_1}{t_1} = \frac{A_2}{t_2} = \frac{A_3}{t_3}$$

$$\frac{A_1}{2} = \frac{A_2}{3} = \frac{A_3}{6} \Rightarrow 3A_1 = 2A_2 = A_3$$

Ans: (a)

122. Identical springs of steel and copper $\left(Y_{\text{steel}} > Y_{\text{copper}}\right)$ are equally stretched. Then

(a) Less work is done on copper spring (b) Less work is done on steel spring

(c) Equal work is done on both the springs (d) Data is incomplete

Sol: Work done, $W = \frac{1}{2} \times F \times \Delta L$

For given F, $W \propto \Delta L$ … (i)

and $\Delta L = \frac{FL}{AY}$

As F, A and L are constants

$\therefore \Delta L \propto \frac{1}{Y}$ … (ii)

From (i) and (ii), we get $W \propto \frac{1}{Y}$

Ans: (b)

123. A solid sphere is rotating in free space. If the radius of sphere is increased keeping mass same which one of the following will not be affected?

(a) Angular velocity (b) Angular momentum

(c) Moment of inertia (d) Rotational kinetic energy

Sol: When a solid sphere is rotated in free space, there will be no external torque, i.e., $\tau = 0$

But $\tau = \frac{dL}{dt}$ where L is the angular momentum. Hence $\tau = \frac{dL}{dt} = 0 \Rightarrow L = \text{constant}$

Ans: (b)

124.Streamline flow is more likely for liquids with

(a) High density and low viscosity (b) Low density and high viscosity

(c) High density and high viscosity (d) Low density and low viscosity

Sol: Streamline flow is more likely for liquids having low density. We know that greater the coefficient of viscosity of a liquid more will be the velocity gradient, hence each of flow can be differentiated streamline flow is related with critical velocity. The critical velocity is that velocity of liquid flow up to which its flow is streamlined and above which its flow becomes turbulent. Critical velocity (V_c) varies with coefficient of viscosity (η) and density of liquid (ρ) as $(V_c) \propto \frac{\eta}{\rho}$. Hence if the density will be low and viscosity will be high, the value of critical velocity will be more.

Ans: (b)

125. $0.1\ \text{m}^3$ of water at $80°\text{C}$ is mixed with 0.3m^3 of water at $60°\text{C}$. The final temperature of the mixture is

(a) $65°\text{C}$ (b) $70°\text{C}$ (c) $60°\text{C}$ (d) $75°\text{C}$

Sol: Density of water $= 10^3\ \text{kg m}^{-3}$

Let the final temperature of the mixture be t. Assuming no heat transfer to or from container

Heat lost by water at $= 0.1\times10^3 \times s_{\text{water}} \times (80-t)$. Heat gained by water at $= 0.3\times10^3 \times s_{\text{water}} \times (t-60)$

According to principle of calorimetry, heat lost = heat gain

$0.1\times10^3 \times s_{\text{water}} \times (80-t) = 0.3\times10^3 \times s_{\text{water}} \times (t-60)$ $\Rightarrow 1\times(80-t) = 3\times(t-60) \Rightarrow t = 65°\text{C}$

Ans: (a)

126.The velocity of the molecules of a gas at temperature $120\,\text{K}$ is v. At what temperature will the velocity be $2v$?

(a) $120\,\text{K}$ (b) $240\,\text{K}$ (c) $480\,\text{K}$ (d) $1120\,\text{K}$

Sol: $v \propto \sqrt{T}$ $\therefore \frac{v'}{v} = \sqrt{\frac{T'}{T}}$

Given $v' = 2v$ or $\frac{2}{1} = \sqrt{\frac{T'}{T}}$

$\therefore T' = 4T = 4\times120\text{K} = 480\,\text{K}$

Ans: (c)

127.One mole of an ideal monoatomic gas is heated at a constant pressure of one atmosphere from $0°\text{C}$ to $100°\text{C}$. Then the change in the internal energy is

(a) 6.56 joules (b) 8.32×10^2 joules (c) 12.48×10^2 joules (d) 20.80 joules

Sol: Change in internal energy is always equal to the heat supplied at constant volume.

i.e., $\Delta U = (\Delta Q)_V = \mu C_V \Delta T$

For monoatomic gas, $C_V = \frac{3}{2}R$

$\Rightarrow \Delta U = \mu\left(\frac{3}{2}R\right)\Delta T = 1\times\frac{3}{2}\times8.31\times(100-0) = 12.48\times10^2\ \text{J}$

Ans: (c)

128. A particle is executing a simple harmonic motion of amplitude a. Its potential energy is maximum when the displacement from the position of the maximum kinetic energy is

(a) 0 (b) $\pm a$ (c) $+\frac{a}{2}$ (d) $-\frac{a}{2}$

Sol: P.E. of particle executing SHM $= \frac{1}{2}m\omega^2 x^2$

At $x = \pm a$, PE is maximum $= \frac{1}{2}m\omega^2 a^2$

Ans: (b)

129. Three sound waves of equal amplitudes have frequencies $(n-1), n, (n+1)$. They superimpose to give beats. The number of beats produced per second will be

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

Sol: $(n-1)$ and $(n+1)$ suppose to form frequency n and n will be at resonance.

$(n-1)$ and $n \rightarrow$ produce 1 beat. $(n+1)$ and $n \rightarrow$ produce 1 beat. Number of beats formed are '2'

Ans: (d)

130. Two charges are at a distance d apart. If a copper plate of thickness $\frac{d}{2}$ is kept between them, then effective force will be

(a) $\frac{F}{2}$ (b) $\sqrt{2}\,F$ (c) $2F$ (d) Zero

Sol: The dielectric constant for metal is infinity, the force between the two charges would be reduced to zero.

Ans: (d)

131. The electric field due to an extremely short dipole at distance r from it is proportional to

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

Sol: Electric field due to a short dipole, $E \propto \frac{1}{r^3}$

Ans: (c)

132. A hollow conducting sphere of radius R has a charge $(+Q)$ on its surface. What is the electric potential within the sphere at a distance $r = \frac{R}{3}$ from its centre

(a) Zero (b) $\frac{3}{4\pi\varepsilon_0}\frac{Q}{R}$ (c) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2}$

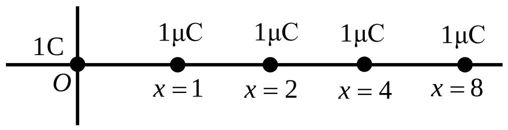
Sol: Inside a conducting body, potential is same everywhere and equals to the potential at its surface.

Ans: (c)

133. An infinite number of charges, each of charge $1\mu C$, are placed on the $x-$axis with coordinates $x = 1, 2, 4, 8, ...\infty$ (in m). If a charge of $1C$ is kept at the origin, then what is the net force acting on $1C$ charge?

(a) $9000\,N$ (b) $12000\,N$ (c) $24000\,N$ (d) $36000\,N$

Sol: The schematic diagram of distribution of charges on $x-$axis is shown in figure below:



Total force acting on $1C$ charge is given by

$$F = \frac{1}{4\pi\varepsilon_0}\left[\frac{1\times1\times10^{-6}}{(1)^2} + \frac{1\times1\times10^{-6}}{(2)^2} + \frac{1\times1\times10^{-6}}{(4)^2} + \frac{1\times1\times10^{-6}}{(8)^2} + ...\infty\right]$$

$$= \frac{10^{-6}}{4\pi\varepsilon_0}\left(\frac{1}{1} + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + ...\infty\right)$$

$$= 9\times10^9\times10^6\left(\frac{1}{1-\frac{1}{4}}\right)$$

$$= 9\times10^9\times10^{-6}\times\frac{4}{3} = 9\times\frac{4}{3}\times10^3 = 12000\,N$$

Ans: (b)

134. A particle A has a charge q and particle B has charge $+4q$ with each of them having the mass m, when allowed to fall from rest through same potential difference. The ratio of their speeds $v_A : v_B$ will be

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

Sol: The energy gained by a particle of charge $'q'$ as it falls through a potential difference of V volts,

P.E. = change in K.E.

$$qV = \frac{1}{2}mv^2$$

For A: $qV = \frac{1}{2}mv_A^2$

For B: $4qV = \frac{1}{2}mv_B^2$

Ratio of speed, i.e., $v_A : v_B = 1:2$

Ans: (c)

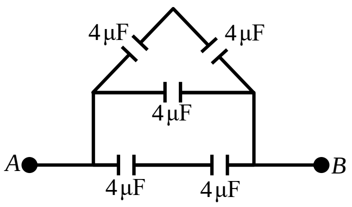
135. Equivalent capacitance between A and B is

(a) $8\,\mu F$

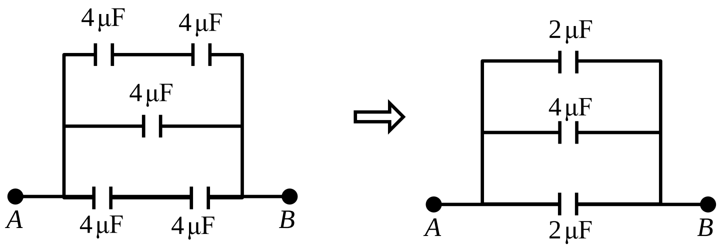
(b) $6\,\mu F$

(c) $26\,\mu F$

(d) $\frac{10}{3}\,\mu F$



Sol:



$\Rightarrow C_{AB} = 8\,\mu F$

Ans: (a)

136. A cube of side 'b' has a charge q at each of its vertices. The electric field at the centre of the cube is

(a) $\frac{4q}{3\pi\varepsilon_0 b^2}$ (b) $\frac{3q}{4\pi\varepsilon_0 b^2}$ (c) $\frac{2q}{\pi\varepsilon_0 b^2}$ (d) Zero

Sol: Due to symmetric charge distribution. The electric field at the centre of the cube is zero.

Ans: (d)

137. Two small similar metal spheres A and B having charges $4q$ and $-4q$, when placed at a certain distance apart, exert an electric force F on each other. When another identical uncharged sphere C, first touched with A then with B and then removed to infinity, the force of interaction between A and B for the same separation will be

(a) $\frac{F}{2}$ (b) $\frac{F}{8}$ (c) $\frac{F}{16}$ (d) $\frac{F}{32}$

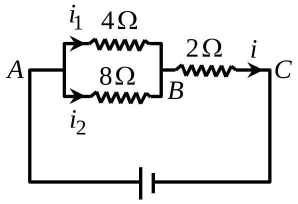
Sol: $F = \frac{1}{4\pi\varepsilon_0}\frac{(4q)(-4q)}{r^2}$

When C is touched with A, then charge on A and C each $= 2q$ after that C is touched with B, charge on $B = \frac{2q + (-4q)}{2} = -q$

Now, force $F' = \frac{1}{4\pi\varepsilon_0}\frac{(2q)(-q)}{r^2} \Rightarrow F' = \frac{F}{8}$

Ans: (b)

138. In the circuit shows in figure, the current in 4Ω resistance is $1.2\,A$. What is the potential difference between B and C?



(a) 3.6 volt (b) 6.3 volt (c) 1.8 volt (d) 2.4 volt

Sol: The potential difference across 4Ω resistance is given by $V = 4 \times i_1 = 4 \times 1.2 = 4.8$ volt

So, the potential across 8Ω resistance is also 4.8 volt. Current $i_2 = \frac{V}{8} = \frac{4.8}{8} = 0.6\,A$

Current in 2Ω resistance $i = i_1 + i_2$

$\therefore i = 1.2 + 0.6 = 1.8\,A$

Potential difference across 2Ω resistance, $V_{BC} = 1.8 \times 2 = 3.6$ volts

Ans: (a)

139. When no current is passed through a conductor,

(a) The free electrons do not move

(b) The average speed of a free electron over a large period of time is not zero

(c) The average velocity of a free electron over a large period of time is zero

(d) The average of the velocities of all the free electrons at an instant is non-zero

Sol: The average of the velocities of all the free electrons at an instant is non-zero

Ans: (d)

140. A piece of copper and another of germanium are cooled from room temperature to $50\,K$. The resistance of

(a) Each of them decreases
(b) Copper decreases and germanium increases
(c) Each of them increases
(d) Copper increases and germanium decreases

Sol: The resistance of metal decreases with decrease of temperature while for semiconductors, resistance increases when temperature decreases.

Ans: (b)

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

(a) Increases, thermal velocity of the electron increases

(b) decreases, thermal velocity of the electron increases

(c) Increases, thermal velocity of the electron decreases

(d) Decreases, thermal velocity of the electron decreases

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

Ans: (b)

142. The unit of specific resistance is

(a) $\Omega\,m$
(b) $\Omega^{-1}m^{-1}$
(c) Ω^{-1}
(d) $\Omega\,m^{-1}$

Sol: $\Omega\,m$

Ans: (a)

143. A cell of internal resistance r is connected across an external resistance nr. Then the ration of the terminal voltage to the emf of the cell is

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

Sol: Internal resistance $= r$, External resistance $= nr$.

Let terminal voltage $= V$

Then $V = E - Ir \Rightarrow V = E - \frac{Er}{(n+1)r}$

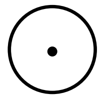
$V = \frac{nE}{n+1} \Rightarrow \frac{V}{E} = \frac{n}{n+1}$

Ans: (c)

144.Two identical wires A and B, each of length $'l'$, carry the same current I. Wire A is bent into a circle of radius R and wire B is bent to form a square of side $'a'$. If B_A and B_B are the values of magnetic field at the centres of the circle and square respectively, then the ratio $\frac{B_A}{B_B}$ is

(a) $\frac{\pi^2}{16}$ (b) $\frac{\pi^2}{8\sqrt{2}}$ (c) $\frac{\pi^2}{8}$ (d) $\frac{\pi^2}{16\sqrt{2}}$

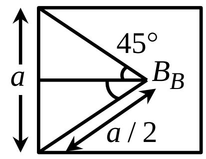
Sol: **Case (a)**:



$B_A = \frac{\mu_0}{4\pi}\frac{I}{R} \times 2\pi = \frac{\mu_0}{4\pi}\frac{I}{l/2\pi} \times 2\pi \qquad (2\pi R = l)$

$= \frac{\mu_0}{4\pi}\frac{I}{l} \times (2\pi)^2$

Case (b):



$B_B = 4 \times \frac{\mu_0}{4\pi}\frac{l}{a/2}[\sin 45° + \sin 45°]$

$= 4 \times \frac{\mu_0}{4\pi} \times \frac{I}{l/8} \times \frac{2}{\sqrt{2}} = \frac{\mu_0}{4\pi}\frac{I}{l} \times 32 \times \sqrt{2} \qquad [4a = l]$

$\therefore \frac{B_B}{B_A} = \frac{\pi^2}{8\sqrt{2}}$

Ans: (b)

145.A moving coil galvanometer has N number of turns in a coil of effective area A, it carries a current I. The magnetic field B is radial. The torque acting on the coil is

(a) NA^2B^2I (b) $NABI^2$ (c) N^2ABI (d) $NABI$

Sol: $\tau = MB\sin\theta$

$\Rightarrow \tau_{max} = NIAB, \ (\theta = 90°)$

Ans: (d)

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

(a) $4.85\,\text{A}$ (b) 0 (c) $4.85 \times 10^{-2}\,\text{A}$ (d) $4.85 \times 10^{-4}\,\text{A}$

Sol: $\frac{F}{l} = \frac{\mu_0 i^2}{2\pi d} = 9.8 \times 4 \times 10^{-6}$

$\Rightarrow i = \sqrt{\frac{4 \times 10^{-6} \times 9.8 \times 0.12}{2 \times 10^{-7}}} = 4.85\,\text{A}$

Ans: (a)

147. A ring of radius R, made of an insulating material carries a charge Q uniformly distributed on it. If the ring rotates about the axis passing through its centre and normal to plane of the ring with constant angular speed ω, then the magnitude of the magnetic moment of the ring is

(a) $Q\omega R^2$ (b) $\frac{1}{2}Q\omega R^2$ (c) $Q\omega^2 R$ (d) $\frac{1}{2}Q\omega^2 R$

Sol: $M = iA = i \times \pi R^2$

Also, $i = \frac{Q\omega}{2\pi} \Rightarrow M = \frac{1}{2}Q\omega R^2 \quad \left[\because i = \frac{Q}{t}\right]$

Ans: (b)

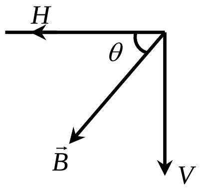
148. The horizontal component of the Earth's magnetic field is 3.6×10^{-5} tesla where the dip angle is $60°$. The magnitude of the Earth's magnetic field is

(a) 2.8×10^{-4} tesla (b) 2.1×10^{-4} tesla (c) 7.2×10^{-5} tesla (d) 3.6×10^{-5} tesla

Sol: Horizontal component of earth's field, $H = B\cos\theta$

Since, $\theta = 60°$

$3.6\times10^{-5} = B\times\frac{1}{2} \Rightarrow B = 7.2\times10^{-5}$ Tesla



Ans: (c)

149. A deuteron of kinetic energy $50\,\text{keV}$ is describing a circular orbit of radius 0.5 metre in a plane perpendicular to the magnetic field B. The kinetic energy of the proton that describes a circular orbit of radius 0.5 metre in the same plane with the same B is

(a) $25\,\text{keV}$ (b) $50\,\text{keV}$ (c) $200\,\text{keV}$ (d) $100\,\text{keV}$

Sol: For a charged particle orbiting in a circular path in a magnetic field

$\frac{mv^2}{r} = Bqv \Rightarrow v = \frac{Bqr}{m}$ or $mv^2 = Bqvr$

Also, $E_K = \frac{1}{2}mv^2 = \frac{1}{2}Bqvr = Bq\frac{r}{2}\cdot\frac{Bqr}{m} = \frac{B^2q^2r^2}{2m}$

For deuteron, $E_1 = \frac{B^2q^2r^2}{2\times2\text{m}}$

For proton, $E_2 = \frac{B^2q^2r^2}{2\text{m}}$

$\frac{E_1}{E_2} = \frac{1}{2} \Rightarrow \frac{50\,\text{keV}}{E_2} = \frac{1}{2} \Rightarrow E_2 = 100\,\text{keV}$

Ans: (d)

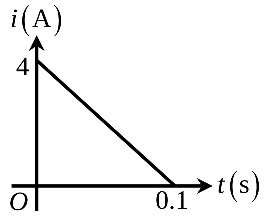
150. Susceptibility is positive and large for a

(a) paramagnetic substance (b) ferromagnetic substance
(c) diamagnetic substance (d) non magnetic substance

Sol: ferromagnetic substance

Ans: (b)

151. In a coil of resistance $10\,\Omega$, the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in weber is



(a) 8 (b) 2 (c) 6 (d) 4

Sol: The charge through the coil = area of current-time $(i-t)$ graph, $q = \frac{1}{2} \times 0.1 \times 4 = 0.2\,\text{C}$

$q = \frac{\Delta\phi}{R}$

$\because$ Change in flux $(\Delta\phi) = q \times R$

$q = 0.2 = \frac{\Delta\phi}{10}$

$\Delta\phi = 2$ Weber

Ans: (b)

152. Two coils have a mutual inductance $0.005\,\text{H}$. The current changes in the first coil according to equation $I = I_0 \sin\omega t$, where $I_0 = 10\,\text{A}$ and $\omega = 100\pi\,\text{rad}\,\text{s}^{-1}$. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π (c) π (d) 4π

Sol: $e = M\frac{di}{dt} = 0.005 \times \frac{d}{dt}(i_0 \sin\omega t)$

$= 0.0005 \times i\omega \cos\omega t$

$\therefore\ e_{max} = 0.005 \times 10 \times 100\pi = 5\pi \qquad [\because \cos\omega t = 1]$

Ans: (b)

153. A coil has resistance 30 ohm and inductive reactance 20 ohm at $50\,\text{Hz}$ frequency. If an ac source, of 200 volt, $100\,\text{Hz}$, is connected across the coil, the current in the coil will be

(a) $4.0\,\text{A}$ (b) $8.0\,\text{A}$ (c) $\frac{20}{\sqrt{13}}\,\text{A}$ (d) $2.0\,\text{A}$

Sol: If $\omega = 50 \times 2\pi$, then $\omega L = 20\,\Omega$

If $\omega' = 100 \times 2\pi$, then $\omega' L = 40\,\Omega$

Current flowing in the coil is $I = \frac{200}{Z} = \frac{200}{\sqrt{R^2 + (\omega' L)^2}} = \frac{200}{\sqrt{(30)^2 + (40)^2}}$

$I = 4\,\text{A}$

Ans: (a)

154. In an AC circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by

(a) $P = \sqrt{2}E_0 I_0$ (b) $P = \frac{E_0 I_0}{\sqrt{2}}$ (c) $P = \text{zero}$ (d) $P = \frac{E_0 I_0}{2}$

Sol: We know that power consumed in AC circuit is given by, $P = E_{\text{rms}} \cdot I_{\text{rms}} \cos\phi$

Here, $E = E_0 \sin \omega t$

$I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ which implies that the phase difference, $\phi = \frac{\pi}{2}$

$\therefore P = E_{\text{rms}} \cdot I_{\text{rms}} \cdot \cos\frac{\pi}{2} = 0$ $\left[\because \cos\frac{\pi}{2} = 0\right]$

Ans: (c)

155. An AC voltage is applied to a resistance R and an inductor L in series. If R and the inductive reactance are both equal to 3Ω, the phase difference between the applied voltage and the current in the circuit is

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

Sol: The phase difference ϕ is given by $\tan\phi = \frac{X_L}{R} = \frac{3}{3} = 1$ $\Rightarrow \phi = \frac{\pi}{4}$

Ans: (b)

156. The electromagnetic waves

(a) Travel with the speed of sound (b) Travel with the same speed in all media

(c) Travel in free space with the speed of light (d) Do not travel through a medium

Sol: The electromagnetic waves of all wavelengths travel with the same speed in space which is equal to velocity of light.

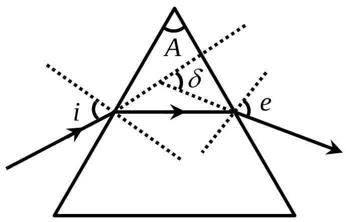
Ans: (c)

157. A ray of light passes through an equilateral prism such that the angle of incidence is equal to the angle of emergence and the latter is equal to $\frac{3}{4}$th of angle of prism. The angle of deviation is

(a) $25°$ (b) $30°$ (c) $45°$ (d) $35°$

Sol: From the figure, angle of deviation

$\delta = i + e - A$



Here, $e = i$ and $e = \frac{3}{4}A$

$\therefore \delta = \frac{3}{4}A + \frac{3}{4}A - A = \frac{A}{2}$

For equilateral prism, $A = 60°$

$\therefore \delta = \frac{60°}{2} = 30°$

Ans: (b)

158.The magnifying power of a telescope is 9. When it is adjusted for parallel rays the distance between the objective and eyepiece is $20\,\text{cm}$. The focal length of lenses are

(a) $10\,\text{cm}$, $10\,\text{cm}$ (b) $15\,\text{cm}$, $5\,\text{cm}$ (c) $18\,\text{cm}$, $2\,\text{cm}$ (d) $11\,\text{cm}$, $9\,\text{cm}$

Sol: $\text{M.P.} = 9 = \dfrac{f_0}{f_e}$

$\Rightarrow f_0 = 9 f_e$ … (1)

$f_0 + f_e = 20$ … (2)

From (1) and (2),

$f_0 = 18\,\text{cm}$ = focal length of the objective

$f_e = 2\,\text{cm}$ = focal length of the eyepiece

Ans: (c)

159.Identify the wrong sign convention.

(a) The magnification for virtual image formed by a convex lens is positive

(b) The magnification for real image formed by a convex lens is negative

(c) The height measured normal to the principal axis upwards is positive

(d) The magnification for virtual image formed by a concave lens is negative

Sol: The magnification for virtual image formed by concave lens is positive.

Ans: (d)

160.When plane face of plano-convex lens is silvered, it behaves as a concave mirror of focal length $30\,\text{cm}$. But when its curved surface is silvered, it behaves as a concave mirror of focal length $10\,\text{cm}$. The refractive index of lens material is

(a) 1.25 (b) 1.33 (c) 1.732 (d) 1.5

Sol: $f_1 = \dfrac{R}{2(\mu - 1)} = 30\,\text{cm}$; $f_2 = \dfrac{R}{2\mu} = 10\,\text{cm}$

Solving, $\mu = 1.5$ $\left[\because \dfrac{1}{f_{\text{eq}}} = \dfrac{1}{f_1} + \dfrac{1}{f_2}\right]$

Ans: (d)

161.Huygens's concept of secondary wave

(a) Allows us to find the focal length of a thick lens

(b) Is a geometrical method to find a wave front

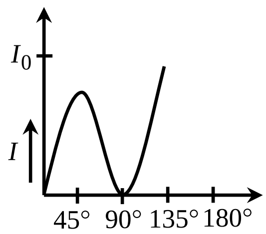
(c) Is used to determine the velocity of light

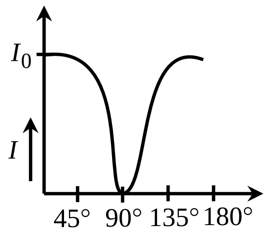
(d) Is used to explain polarisation

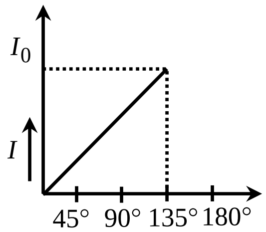
Sol: Huygen's principle gives us a geometrical method of tracing a wavefront.

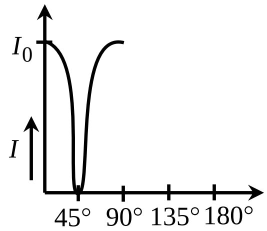
Ans: (b)

162.The graph showing the dependence of intensity of transmitted light on the angle between polariser and analyser, is

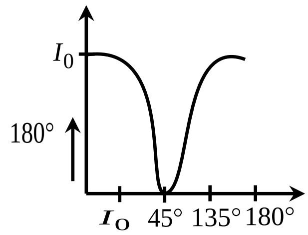
(a) 

(b) 

(c) 

(d) 

Sol: According to law of Malus, when a beam of completely plane polarised light is incident on analyser, the resultant intensity of light (I) transmitted from the analyser varies directly as the square of the cosine of the angle (θ) between planes of transmission of analyser and polariser.



i.e., $I \propto \cos^2\theta$ and $I = I_0 \cos^2\theta$ ... (i)

where $I_0 =$ intensity of the light from polariser. From eq. (i), we note that if the transmission axes of polariser and analyser are parallel (i.e., $\theta = 0°$ or $180°$) then $I = I_0$. It means that intensity of transmitted light is maximum. When the transmission axes of polariser and analyser are perpendicular (i.e., $\theta = 90°$), then $I = I_0 \cos^2 90° = 0$. It means the intensity of transmitted light is minimum. On plotting a graph between I and θ as given by relation (i), we get the curve as shown in figure.

Ans: (b)

163.Cathode ray consists of

(a) Photons (b) Electrons (c) Protons (d) $\alpha -$particles

Sol: Cathode ray consists of electrons

Ans: (b)

164.Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays $(v_1 > v_2)$. If the maximum values of kinetic energy of the photoelectrons emitted in two cases are in the ratio of $1:k$, then the threshold frequency of the metallic surface is

(a) $\frac{v_1 - v_2}{k-1}$ (b) $\frac{kv_1 - v_2}{k-1}$ (c) $\frac{kv_2 - v_1}{k-1}$ (d) $\frac{v_2 - v_1}{k}$

Sol: By using $hv - hv_0 = K_{max}$

$\Rightarrow h(v_1 - v_0) = k_1$ ... (i) and $h(v_2 - v_0) = k_2$ … (ii)

$$\Rightarrow \frac{v_1 - v_0}{v_2 - v_0} = \frac{k_1}{k_2} = \frac{1}{k}$$

Hence $v_0 = \dfrac{kv_1 - v_2}{k - 1}$

Ans: (b)

165. Rutherford's atomic model was unstable because

(a) Nuclei will break down

(b) Electrons do not remain in orbit

(c) Orbiting electrons radiate energy

(d) Electrons are repelled by the nucleus

Sol: Electrons do not remain in orbit

Ans: (b)

166. According to Bohr's model of hydrogen atom

(a) The linear velocity of the electron is quantised.

(b) The angular velocity of the electron is quantised.

(c) The linear momentum of the electrons is quantised.

(d) The angular momentum of the electron is quantised.

Sol: The angular momentum of the electron is quantised.

Ans: (d)

167. As per Bohr model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom $(Z = 3)$ is

(a) 1.51 (b) 13.6 (c) 40.8 (d) 122.4

Sol: $E = -Z^2 \times 13.6\,\text{eV} = -9 \times 13.6\,\text{eV} = -122.4\,\text{eV}$

So ionisation energy $= +122.4\,\text{eV}$

Ans: (d)

168. The radius of a nucleus is

(a) Directly proportional to its mass number

(b) Inversely proportional to its atomic weight

(c) Directly proportional to the cube root of its mass number

(d) None of these

Sol: Radius of nucleus $R = R_0 A^{1/3}$ where A is the mass number of nucleus.

$\therefore$ Volume of nucleus $= \dfrac{4}{3}\pi R^3 = \left(\dfrac{4}{3}\pi R_0^3\right)A$

$\therefore$ Volume is proportional to A.

Ans: (c)

169. Nuclear force exists between

(a) Neutron-neutron (b) Proton-proton (c) Neutron-proton (d) all of these

Sol: all of these

Ans: (d)

170. The mass of a ${}_3^7Li$ nucleus is $0.042\,u$ less than the sum of masses of all its nucleons. The binding energy per nucleon of ${}_3^7Li$ nucleus is nearly

(a) $46\,\text{MeV}$ (b) $5.6\,\text{MeV}$ (c) $3.9\,\text{MeV}$ (d) $23\,\text{MeV}$

Sol: $\text{B.E.} = 0.042 \times 931 \simeq 42\,\text{MeV}$

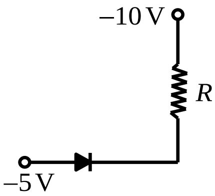
Number of nucleons in ${}_3^7Li$ is 7.

$\therefore$ $\text{B.E./Nucleon} = \frac{42}{7} = 6\,\text{MeV} \simeq 5.6\,\text{MeV}$

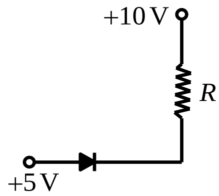
Ans: (b)

171. Which of the junction diodes shown below are forward biased?

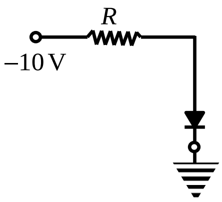
(a)



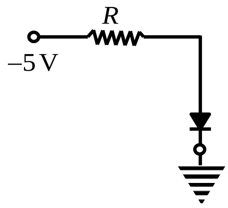
(b)



(c)



(d)



Sol: Positive terminal is at higher potential $(-5\,\text{V})$ and negative terminal is at lower potential $-10\,\text{V}$.

Ans: (a)

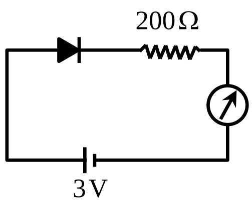
172. If the ratio of the concentration of electrons to that of holes in a semiconductor is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$, then what is the ratio of their drift velocities?

(a) $\frac{5}{8}$ (b) $\frac{4}{5}$ (c) $\frac{5}{4}$ (d) $\frac{4}{7}$

Sol: $\frac{I_e}{I_h} = \frac{n_e e A v_e}{n_h e A v_h} \Rightarrow \frac{7}{4} = \frac{7}{5} \times \frac{v_e}{v_h} \Rightarrow \frac{v_e}{v_h} = \frac{5}{4}$

Ans: (c)

173. The reading of the ammeter for a silicon diode in the given circuit is



(a) 0 (b) $15\,\text{mA}$ (c) $11.5\,\text{mA}$ (d) $13.5\,\text{mA}$

Sol: Clearly from figure given in question, silicon diode is in forward bias.

$\therefore$ Potential barrier across diode, $\Delta V = 0.7$ volts

Current, $I = \frac{V - \Delta V}{R} = \frac{3 - 0.7}{200} = \frac{2.3}{200} = 11.5\,\text{mA}$

Ans: (c)

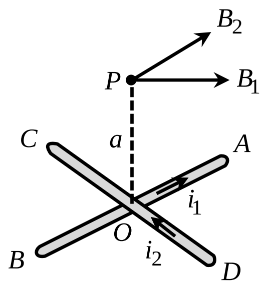
174.Two straight long conductors AOB and COD are perpendicular to each other and carry currents i_1 and i_2. The magnitude of the magnetic field at a point P at a distance a from the point O in a direction perpendicular to the plane $ABCD$ is

(a) $\frac{\mu_0}{2\pi a}(i_1 + i_2)$ (b) $\frac{\mu_0}{2\pi a}(i_1 - i_2)$ (c) $\frac{\mu_0}{2\pi a}\left(i_1^2 + i_2^2\right)^{1/2}$ (d) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1 + i_2)}$

Sol: At $P : B_{\text{net}} = \sqrt{B_1^2 + B_2^2}$

$= \sqrt{\left(\frac{\mu_0}{4\pi}\frac{2i_1}{a}\right)^2 + \left(\frac{\mu_0}{4\pi}\frac{2i_2}{a}\right)^2}$

$= \frac{\mu_0}{2\pi a}\left(i_1^2 + i_2^2\right)^{1/2}$



Ans: (c)

175.The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constant. The dimensions of a, b and c are respectively

(a) $\left[L^2\right], [T]$ and $\left[LT^2\right]$ (b) $\left[LT^2\right], [LT]$ and $[L]$

(c) $[L], [LT]$ and $\left[T^2\right]$ (d) $\left[LT^{-2}\right], [L]$ and $[T]$

Sol: Dimension of at = dimension of velocity

$a \cdot T = LT^{-1} \qquad \Rightarrow a = LT^{-2}$

Dimension of C = dimension of t (two physical quantity of same dimension can only be added)

So, dimension of $C = T$

Dimension of $\frac{b}{t+c}$ = dimension of V

$\frac{b}{T+T} = LT^{-1} \qquad \Rightarrow b \cdot T^{-1} = LT^{-1} \qquad \Rightarrow b = L$

So answer is $\left[LT^{-2}\right], [L]$ and $[T]$

Ans: (d)

176.A ball is dropped from a bridge at a height of $176.4\,\text{m}$ over a river. After $2\,\text{s}$, a second ball is thrown straight downwards. What should be the initial velocity of the second ball so that both hit the water simultaneously?

(a) $2.45\,\text{m s}^{-1}$ (b) $49\,\text{m s}^{-1}$ (c) $14.5\,\text{m s}^{-1}$ (d) $24.5\,\text{m s}^{-1}$

Sol: If t seconds be the time taken by the first ball to reach the river then time taken by the second ball to reach the river will be $(t-2)$ second. Distance covered by first ball in t second

$= \frac{1}{2}gt^2 \Rightarrow 179.4 = \frac{1}{2} \times 9.8 \times t^2$

$\Rightarrow t = \sqrt{\frac{2 \times 176.4}{9.8}} = 6\,\text{s}$

Thus, second ball will take $4\,\text{s}$ to reach the river. If u be its initial speed, then

$176.4 = (u \times 4) + \frac{1}{2} \times 9.8 \times (4)^2$ (using $h = ut + \frac{1}{2}gt^2$)

$\Rightarrow 4u = 176.4 - (9.8 \times 8) = 98$

$\Rightarrow u = 24.5\,\text{m s}^{-1}$

Ans: (d)

177. If the relation between the range R and time of flight T of a projectile is given as $R = 5T^2$, the value of angle of projection is

(a) $45°$ (b) $15°$ (c) $60°$ (d) $90°$

Sol: Given $R = 5T^2$

$\Rightarrow \frac{u^2 \sin 2\theta}{g} = 5 \times \left(\frac{2u \sin\theta}{g}\right)^2$ $\Rightarrow \frac{\sin 2\theta}{1} = \frac{5 \times 4 \times \sin^2\theta}{g}$ $\Rightarrow 2\sin\theta\cos\theta \times g = 20 \times \sin^2\theta$

$\Rightarrow \tan\theta = 1$ $\left(\because g = 10\,\text{m s}^{-2}\right)$

$\Rightarrow \theta = \tan^{-1}(1) = 45°$

Ans: (a)

178. A body of mass $10\,\text{kg}$ is acted upon by two perpendicular forces, $6\,\text{N}$ and $8\,\text{N}$. The resultant acceleration of the body is

(a) $1\,\text{m s}^{-2}$ at an angle of $\tan^{-1}\left(\frac{3}{4}\right)$ w.r.t. $8\,\text{N}$ force

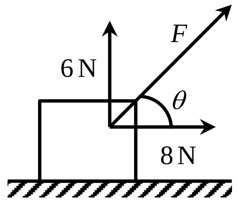
(b) $0.2\,\text{m s}^{-2}$ at an angle of $\tan^{-1}\left(\frac{3}{4}\right)$ w.r.t. $8\,\text{N}$ force

(c) $1\,\text{m s}^{-2}$ at an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t. $8\,\text{N}$ force

(d) $0.2\,\text{m s}^{-2}$ at an angle of $\tan^{-1}\left(\frac{4}{3}\right)$ w.r.t. $8\,\text{N}$ force

Sol: Here, $m = 10\,\text{kg}$

The resultant force acting on the body is $F = \sqrt{(8\,\text{N})^2 + (6\,\text{N})^2} = 10\,\text{N}$



Let the resultant force F makes an angle θ w.r.t. $8\,\text{N}$ force.

From figure, $\tan\theta = \frac{6\,\text{N}}{8\,\text{N}} = \frac{3}{4}$

The resultant acceleration of the body is $a = \frac{F}{m} = \frac{10\,\text{N}}{10\,\text{kg}} = 1\,\text{m s}^{-2}$

The resultant acceleration is along the direction of the resultant force. Hence, the resultant acceleration of the body is $1\,\text{m}\,\text{s}^{-2}$ at an angle of $\tan^{-1}\left(\frac{3}{4}\right)$ w.r.t. $8\,\text{N}$ force.

Ans: (a)

179. Which one of the following statement is true?

(a) Momentum is conserved in elastic collisions but not in inelastic collisions

(b) Total kinetic energy is conserved in elastic collisions but momentum is not conserved in elastic collisions

(c) Total kinetic energy is not conserved but momentum is conserved in inelastic collisions

(d) Kinetic energy and momentum both are conserved in all types of collisions

Sol: The law of conservation of momentum is true in all type of collisions, but kinetic energy is conserved only in elastic collision. The kinetic energy is not conserved in inelastic collision but the total energy is conserved in all type of collisions.

Ans: (c)

180. According to the principle of conservation of angular momentum, if moment of inertia of a rotating body decreases, then its angular velocity

(a) Decreases (b) Increases (c) Remains constant (d) Becomes zero

Sol: As $L = I\omega$ = constant, therefore, when I decreases, ω will increase.

Ans: (b)

Key Answers:

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