Deeksha

ABHYAS KCET 2024

FREE TEST SERIES

MOCK TEST 4

PDF

SOLUTION

Subject	Topic	
C + M + P	Complete Syllabus	

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

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

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

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

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

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

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

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

All the best!!

Useful Data

At. Wt.:

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

Physical Constants:

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

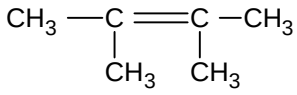
Chemistry

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

1. Hyper – conjugation is not possible in

   Options:

   (a) $CH_3 - CH = CH_2$ (b) $CH_2 = CH_2$

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

   Sol: In $CH_2 = CH_2$, there are no $-\alpha$ hydrogens

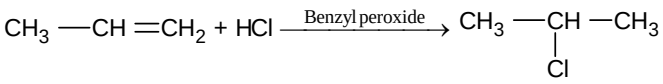
   Ans: (b)

2. When hydrogen chloride gas is treated with propene in presence of benzoyl peroxide, it gives

   Options:

   (a) 2 – Chloropropane (b) Allyl chloride (c) no reaction (d) 1 – Chloropropane

   Sol:

   Peroxide effect is seen only with HBr

   Ans: (a)

3. Which of the following compounds has highest boiling point?

   Options:

   (a) $CH_3CH_2CH_2Cl$ (b) $CH_3CH_2CH_2CH_2Cl$

   (c) $CH_3CH(CH_3)CH_2Cl$ (d) $(CH_3)_3CCl$

   Sol: $CH_3CH_2CH_2CH_2Cl$ has higher boiling point.

   Ans: (b)

4. Which one of the following forms propane nitrile as the major product?

   Options:

   (a) ethyl bromide + alcoholic KCN (b) propyl bromide + alcoholic KCN

   (c) propyl bromide + alcoholic $AgCN$ (d) ethyl bromide + alcoholic $AgCN$

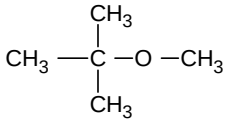
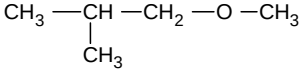
   Sol:

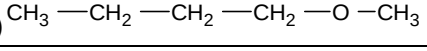
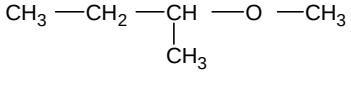
   $$CH_3 - CH_2 - Br + KCN(alc) \rightarrow \underset{\text{Propane nitrile}}{CH_3CH_2CN} + KBr$$

   Ans: (a)

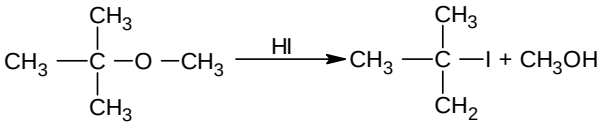
5. Among following ethers, which one will produce methyl alcohol on treatment hot concentrated HI?

   Options:

   (a)  (b) 

   (c)  (d) 

Sol:



Ans: (a)

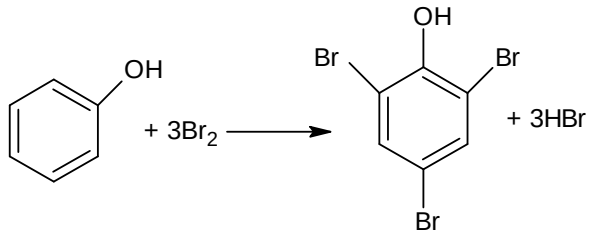
6. Phenol when treated with excess of bromine water gives a white precipitate of

Options:

(a) 2, 4, 6 – tribromophenol (b) o – bromophenol

(c) p – bromophenol (d) bromobenzene

Sol:



Ans: (a)

7. Vapours of an alcohol X when passed over hot reduced copper, produce an aldehyde, the alcohol is

Options:

(a) primary alcohol (b) secondary alcohol (c) tertiary alcohol (d) dihydric alcohol

Sol: Primary alcohol gives aldehyde.

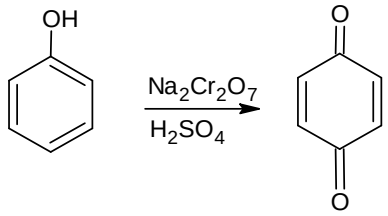
Ans: (a)

8. Benzoquinone is produced by reaction of phenol with

Options:

(a) $Na_2Cr_2O_7, H_2SO_4$ (b) $KMnO_4, H_2SO_4$ (c) Na_2CrO_4, HCl (d) K_2MnO_4, H_2SO_4

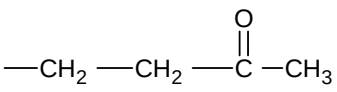
Sol:

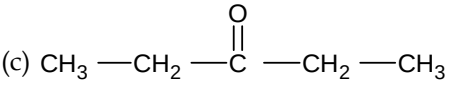
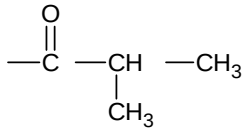


Ans: (a)

9. Which of the following is the most reactive isomer?

Options:

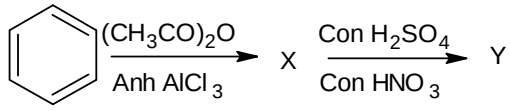
(a) $CH_3-CH_2-CH_2-CH_2-CHO$ (b) 

(c)  (d) 

Sol: Aldehydes are more reactive than ketones.

Ans: (a)

10. Identify the products (X) and (Y) in the given reaction:



Options:

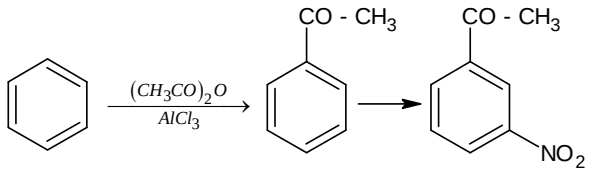
(a) X : Acetophenone Y : $m-$Nitroacetophenone

(b) X : Toluene Y : $p-$Nitrotoluene

(c) X : Acetophenone Y : o and p Nitroacetophenone

(d) X : Benzaldehyde Y : $m-$ Nitrobenzaldehyde

Sol:



Ans: (a)

11. Which of the following compounds undergo Cannizzaro reaction?

Options:

(a) CH_3CHO (b) CH_3COCH_3 (c) C_6H_5CHO (d) $C_6H_5CH_2CHO$

Sol: Benzaldehyde does not contain $\alpha-$ hydrogen. Hence undergoes Cannizzaro reaction

Ans: (c)

12. Which of the following compounds would have the smallest value for pKa ?

Options:

(a) $CHF_2CH_2CH_2COOH$ (b) $CH_3CH_2CF_2COOH$

(c) $CH_2FCHFCH_2COOH$ (d) $CH_3CF_2CH_2COOH$

Sol: $CH_3CH_2CF_2COOH$ is more acidic and hence it will have smallest pKa value

Ans: (b)

13. Which of the following amines does not react with Hinsberg reagent?

Options:

(a) $CH_3CH_2-NH_2$ (b) $CH_3-NH-CH_3$ (c) $(CH_3)_3N$ (d) $CH_3CH_2CH_2-NH_2$

Sol: Tertiary amines do not react with Hinsberg reagent

Ans: (c)

14. The action of nitrous acid on an aliphatic primary amine gives

Options:

(a) secondary amine (b) nitroalkanes (c) alcohol (d) alkyl nitrite

Sol: The action of nitrous acid on aliphatic primary amines gives alcohol

Ans: (c)

15. Which of the following orders is true regarding the basic nature of $-NH_2$ group?

Options:

(a) $O-$Toluidine $>$aniline $>O-$nitroaniline (b) $O-$Toluidine $<$aniline $>O-$nitroaniline

(c) $O-$Toluidine $>$aniline $<O-$nitroaniline (d) $O-$Toluidine $>$aniline $<O-$nitroaniline

Sol: $O-$Toluidine is weaker base than aniline because of orthoeffect

Ans: (b)

16. The anomeric carbon in $D(+)$ glucose is

Options:

(a) $C-1$ carbon (b) $C-2$ carbon (c) $C-5$ carbon (d) $C-6$ carbon

Sol: $C-1$ carbon

Ans: (a)

17. 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: Hydrogen bonds

Ans: (c)

18. A unit in nucleic acid which contains base sugar – phosphate unit is called

Options:

(a) nucleotide (b) nucleoside (c) phosphotide (d) polypeptide

Sol: It is nucleotide

Ans: (a)

19. Which of the following complex has minimum magnitude of Δ_0 ?

Options:

(a) $\left[Cr(CN)_6\right]^{3-}$ (b) $\left[Co(NH_3)_6\right]^{3+}$ (c) $[CoCl_6]^{3-}$ (d) $\left[Cr(H_2O)_6\right]^{3+}$

Sol: magnitude of Δ_0 depends upon spectrochemical series

$CN^- > NH_3 > H_2O > Cl^-$

Ans: (c)

20. The two isomers X and Y with the formula $Cr(H_2O)_5 ClBr_2$ were taken for experiment on depression in freezing point. It was found that one mole of X gave depression corresponding to 2 moles of particles and one mole of Y gave depression due to 3 moles of particles. The structural formula of X and Y respectively are

Options:

(a) $\left[Cr(H_2O)_5 Cl\right]Br_2$ $\left[Cr(H_2O)_4 Br_2\right]Cl.H_2O$

(b) $\left[Cr(H_2O)_5 Cl\right]Br_2$ $\left[Cr(H_2O)_3 Cl\ Br_2\right]2H_2O$

(c) $\left[Cr(H_2O)_5 Br\right]BrCl$ $\left[Cr(H_2O)_4 Cl\,Br\right]Br.H_2O$

(d) $\left[Cr(H_2O)_4 Br_2\right]Cl.H_2O$ $\left[Cr(H_2O)_5 Cl\right]Br_2$

Sol: $\underset{X}{\left[Cr\left(H_2O\right)_4 Br_2\right]}Cl \rightarrow \left[Cr\left(H_2O\right)_4 Br_2\right]+Cl^-$ Two particles

$\underset{Y}{\left[Cr\left(H_2O\right)_5 Cl\right]}Br_2 \rightarrow \left[Cr\left(H_2O\right)_5 Cl\right]^{2+}+2Br^-$ Three particles

Ans: (d)

21. Platinum dissolves in aqua regia to form

Options:

(a) $PtCl_4$ (b) H_2PtCl_6 (c) $Pt\left(NO_3\right)_4$ (d) $\left[PtCl_2\left(NO_3\right)_2\right]$

Sol: H_2PtCl_6

Ans: (b)

22. In $Fe\left(CO\right)_5$ the $Fe \leftarrow CO$ σ bond results by the overlap between filled sp hybrid orbital of $C-$atom of CO molecule and vacant

Options:

(a) d^2sp^3 hybrid orbitals of Fe (b) sp^3 hybrid orbitals of Fe

(c) dsp^3 hybrid orbitals of Fe (d) dsp^2 hybrid orbitals of Fe

Sol: In $Fe\left(CO\right)_5 \rightarrow Fe$ undergoes dsp^3 hybridization

Ans: (c)

23. The acidic, basic and amphoteric nature of Mn_2O_7, V_2O_5 and CrO are respectively

Options:

(a) Acidic, acidic and basic (b) Basic, amphoteric and basic

(c) Acidic, amphoteric, basic (d) Acidic, basic, amphoteric

Sol: $Mn_2O_7 \rightarrow$ acidic

$V_2O_5 \rightarrow$ Amphoteric

$CrO \rightarrow$ Basic

Ans: (c)

24. The catalytic activity of transition metals and their compounds is mainly due to

Options:

(a) their ability to adopt variable oxidation state (b) their chemical reactivity

(c) their magnetic behavior (d) their unfilled $d-$orbitals

Sol: Variable oxidation states

Ans: (a)

25. The titanium (atomic number 22) compound that does not exist as

Options:

(a) TiO (b) TiO_2 (c) K_2TiF_6 (d) K_2TiO_4

Sol: In K_2TiO_4 oxidation state of Ti is

$2\left(+1\right)+x+4\left(-2\right)=0 \quad x=+6$

Ti electronic configuration is $[Ar]3d^2 4S^2$

It can show a maximum oxidation state of $+4$ only

Ans: (d)

26. For which one of the following metals, the standard potential $\left(E^{\circ}_{M^{2+}/M}\right)$ value has a positive sign?

Options:

(a) $Cu(Z=29)$ (b) $Fe(Z=26)$ (c) $Co(Z=27)$ (d) $Ni(Z=28)$

Sol: $E^{\circ}_{Cu^{2+}/Cu} = +0.34\,V$

Ans: (a)

27. Which of the following statement is wrong?

Options:

(a) In highest oxidation states, the transition metals show acidic character.

(b) Metals in highest oxidation states are more stable in oxides than in fluorides.

(c) Mn^{3+} and Co^{3+} are oxidation agents in aqueous solution

(d) All elements of 3d series exhibit variable oxidation states.

Sol: All elements of 3d series exhibit variable oxidation states.

Ans: (d)

28. The incorrect statement in respect to Chromyl chloride test is

Options:

(a) Formation of red vapours (b) Formation of lead chromate

(c) Formation of Chromyl chloride (d) Liberation of Chlorine

Sol: $K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \xrightarrow{\Delta} 2KHSO_4 + 4NaHSO_4 + \underset{\substack{\text{Red Vapours}\\(\text{Chromyl chloride})}}{2CrO_2Cl_2} + 3H_2O$

$CrO_2Cl_2 + 4NaOH \rightarrow \underset{\text{Yellow}}{Na_2CrO_4}\downarrow + 2NaCl + 2H_2O$

$Na_2CrO_4 + Pb(CH_3COO)_2 \rightarrow \underset{\text{Yellow ppt.}}{PbCrO_4(s)} + 2CH_3COONa$

Thus, choice (d) is the answer.

Ans: (d)

29. The species having tetrahedral shape is:

Options:

(a) $[PdCl_4]^{2-}$ (b) $[Ni(CN)_4]^{2-}$ (c) $[Pd(CN)_4]^{2-}$ (d) $[NiCl_4]^{2-}$

Sol: $[NiCl_4]^{2-}$ is tetrahedral with sp^3 hybridized Ni^{2+}. Others are square planar.

Ans: (d)

30. According to crystal field theory, the M–L bond in a complex is

Options:

(a) Purely ionic (b) purely covalent

(c) purely co-ordinate (d) partially covalent

Sol: According to crystal field theory, the bonding in a complex is purely electrostatic or ionic

Ans: (a)

31. Activation energy (E_a) and rate constant $(k_1$ and $k_2)$ for a chemical reaction at two different temperatures T_1 and T_2 are related by:

Options:

(a) $\ln\frac{k_2}{k_1}=\frac{E_a}{2.303R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$ (b) $\ln\frac{k_2}{k_1}=+\frac{E_a}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)$

(c) $\ln\frac{k_2}{k_1}=-\frac{E_a}{R}\left(\frac{1}{T_2}+\frac{1}{T_1}\right)$ (d) $\ln\frac{k_2}{k_1}=\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

Sol: $\ln\frac{k_2}{k_1}=\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$

Ans: (d)

32. The cathode reaction in the dry cell will be

Options:

(a) $Zn(s)\rightarrow Zn^{+2}+2e^-$ (b) $MnO_2+NH_4^++e^-\rightarrow MnO(OH)+NH_3$

(c) $Zn(Hg)+2OH^-\rightarrow ZnO(s)+H_2O+2e^-$ (d) $MnO(OH)+NH_3\rightarrow MnO_2+NH_4^++2e^-$

Sol: $MnO_2+NH_4^++e^-\rightarrow MnO(OH)+NH_3$

Ans: (b)

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

Options:

(a) 0.01 M NaCl (b) 0.01 M Na_2SO_4 (c) 0.1 M Sucrose (d) 0.1 M NaCl

Sol: Highest freezing point is for the salt which produces lowest ΔT_f.0.01 M NaCl will give least number of ions and produces lowest ΔT_f , so it has the highest freezing point.

Ans: (a)

34. The rate of the reaction

$CH_3COOC_2H_5+NaOH\rightarrow CH_3COONa+C_2H_5OH$ is given by the equation.

$\text{rate}=k[CH_3COOC_2H_5][NaOH]$

The unit of rate constant is

Options:

(a) $\text{mol}^{-2}L^2S^{-1}$ (b) $\text{mol}\,L^{-1}S^1$ (c) $L\,\text{mol}^{-1}S^{-1}$ (d) S^{-1}

Sol: It's a second order reaction. Unit of rate constant $=L\,\text{mol}^{-1}S^{-1}$ Ans: (c)

35. The half-life of the first order reaction $X\rightarrow Y$ with the initial concentration of X to be $0.01\,\text{mol}\,L^{-1}$ and initial rate to be $0.00352\,\text{mol}\,L^{-1}\,\text{min}^{-1}$ will be

Options:

(a) 19.68 min (b) 1.968 min (c) 77.5 min (d) 7.7 min

Sol: Rate $= k[A]$

$$k = \frac{\text{Rate}}{[\text{A}]} = \frac{0.00352}{0.01} = 0.352\,\text{min}^{-1}$$

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.352} = 1.968\,\text{min}$$

Ans: (b)

36. For a reaction $P + Q \rightarrow 2R + S$, which of the following statements are incorrect?

Options:

(a) rate of disappearance of P = rate of appearance of S

(b) rate of disappearance of $Q = 2\times$ rate of appearance of R

(c) rate of disappearance of P = rate of appearance of R

(d) rate of disappearance of $Q = \frac{1}{2}\times$ rate of appearance of R

Sol: $\text{Rate} = -\frac{dP}{dt} = -\frac{dQ}{dt} = 1/2\frac{dR}{dt} = \frac{dS}{dt}$

Rate of disappearance of $Q = -\frac{dQ}{dt} = 1/2\frac{dR}{dt}$

$= 1/2 \times$ Rate of appearance of R

Ans: (b)

37. What will be the rate equation for the reaction $2X + Y \rightarrow Z$, if the order of the reaction is zero?

Options:

(a) rate $= k[X][Y]$

(b) rate $= k$

(c) rate $= k[X]^{\circ}[Y]$

(d) rate $= k[X][Y]^{\circ}$

Sol: Rate $= k$

Ans: (b)

38. Which of the following is not an application of electrochemical series?

Options:

(a) to compare the relative oxidising and reducing power of substances

(b) to predict evolution of hydrogen gas on reaction of metal with acid

(c) to predict spontaneity of a redox reaction

(d) to calculate the amount of metal deposited on cathode

Sol: The amount of metal deposited on cathode can be calculated using Faraday's law

Ans: (d)

39. The reduction potential for the following half-cell reaction at $298\,K$?

$\left(\text{given}: \left[Ag^{+}\right] = 0.1\text{M and } E^{\circ}_{\text{cell}} = +0.80\,\text{V}\right)$

Options:

(a) $0.741\,\text{V}$ (b) $0.80\,\text{V}$ (c) $-0.80\,\text{V}$ (d) $-0.741\,\text{V}$

Sol: $E = E° - \frac{0.591}{n}\log\frac{1}{[M]}$

$= 0.80 - \frac{0.0591}{1}\log\frac{1}{0.1} = 0.80 - 0.0591 = 0.7409 = 0.741\,\text{V}$

Ans: (a)

40. Henry's law constant for molality of methane in benzene at $298\,K$ is 4.27×10^5 mm Hg. The mole fraction of methane in benzene at $298\,K$ under 760 mm Hg is

Options:

(a) 1.78×10^{-3} (b) 17.43 (c) 0.114 (d) 2.814

Sol: $P = K_h x$ or $x = \frac{P}{K_h} = \frac{760}{4.27\times10^5} = 1.78\times10^{-3}$

Ans: (a)

41. What is the mole fraction of ethanol in the vapour phase, if the solution contains equimolar mixture of ethanol and methanol? Given($P^{\circ}_{ethanol} = 90$ mm of Hg , $P^{\circ}_{methanol} = 46$ mm of Hg)

Options:

(a) 0.34 (b) 0.5 (c) 0.66 (d) 0.8

Sol: $P_{\text{total}} = P_E + P_M = x_E P^{\circ}_E + x_M P^{\circ}_M$

$= 0.5\times46 + 0.5\times90 = 23 + 45 = 68$ mm

$\therefore\ X_E = \frac{P_E}{P_{\text{total}}} = \frac{23}{68} = 0.34$

Ans: (a)

42. Which of the following solution exhibits highest boiling point?

Options:

(a) 0.1m urea solution (b) 1m urea solution

(c) 0.01m urea solution (d) 0.001m urea solution

Sol: Higher the concentration, higher will be the boiling point

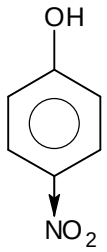
Ans: (b)

43. Which of the following is more stronger acid than phenol?

Options:

(a) Ethanol (b) Phenylethanol (c) $p-$Nitrophenol (d) $p-$Cresol

Sol:



$p-$Nitrophenol

is more stronger acid than phenol due to the presence of an electron withdrawing nitro group.

Ans: (c)

44. The arrangement of following compounds:

(i) bromomethane (ii) bromoform (iii) chloromethane (iv) dibromomethane

Options:

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

Sol: Higher the molecular mass, greater are the intermolecular forces and greater is the *b.p.* Thus, increasing order of boiling point is: $CH_3Cl\ (III) < CH_3Br(I) < CH_2Br_2\ (IV) < CHI_3\ (II)$.

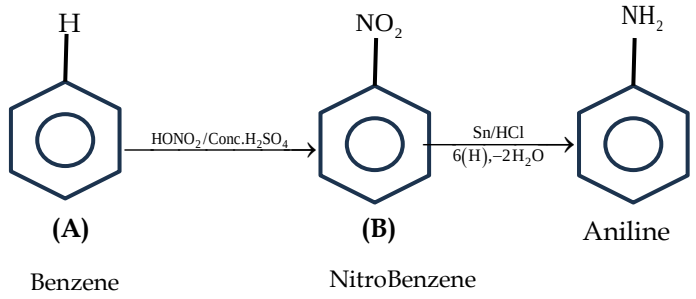
Ans: (c)

45. A compound 'A' when treated with HNO_3 (in presence of H_2SO_4) gives compound B, which is then reduced with Sn and HCl to aniline. The compound 'A' is

Options:

(a) Toluene (b) Benzene (c) Ethane (d) Acetamide

Sol:



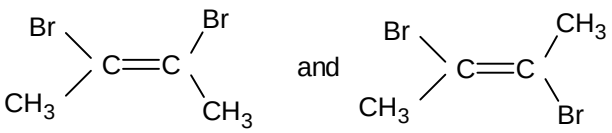
Ans: (b)

46. Which is a pair of geometrical isomers?

Options:

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

Sol:



Are geometrical isomers.

Ans: (c)

47. For the reaction, $CO_{(g)} + Cl_{2(g)} \leftrightarrows COCl_{2(g)}$ the value of Kp / Kc is equal to

Options:

(a) 1.0 (b) RT (c) $\sqrt{RT}$ (d) $\frac{1}{RT}$

Sol: $\Delta n_g = 1-2 = -1 \quad Kp = Kc(RT)^{\Delta ng}$; $Kp / Kc = (RT)^{-1} = \frac{1}{RT}$

Ans: (d)

48. The solubility product of MgF_2 is 7.4×10^{-11} calculate the solubility of MgF_2 in 0.1M NaF solution

Options:

(a) 7.4×10^{-9} (b) 3.7×10^{-9} (c) 3.7×10^{-11} (d) 7.4×10^{-11}

Sol: $K_{sp} = \left[Mg^{2+}\right]\left[F^{-}\right]^2$; K_{sp} S x^2; $S = \frac{K_{sp}}{x^2} = \frac{7.4\times10^{-11}}{(0.1)^2} = 7.4\times10^{-9}$

Ans: (a)

49. A sample of pure compound contains 1.15g of sodium, 3.1×10^{22} atoms of carbon and 0.1mole of oxygen atom. Its empirical formula is

Options:

(a) Na_2CO_3 (b) $NaCO_2$ (c) Na_2CO (d) Na_2CO_2

Sol: mole ratio

Number of moles of $Na = \frac{1.15}{23} = 0.05$ 1

Number of moles of $C = \frac{3.01\times10^{22}}{6.02\times10^{23}} = 0.05$ 1

Number of moles of $O = 0.1$mole 2

$EF = NaCO_2$

Ans: (b)

50. Which of the following sets of quantum numbers is not possible?

Options:

(a) $n=4,\ l=1,\ m=0,\ s=+\frac{1}{2}$ (b) $n=4,\ l=3,\ m=3,\ s=-\frac{1}{2}$

(c) $n=4,\ l=1,\ m=+2,\ s=-\frac{1}{2}$ (d) $n=4,\ l=0,\ m=0,\ s=-\frac{1}{2}$

Sol: When $l=1$, m cannot have a value $+2$

$m = 0, +1$ or -1

Ans: (c)

51. Which of the following element is expected to have highest electron affinity?

Options:

(a) $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^5$ (b) $1S^2\ 2S^2\ 2P^3$

(c) $1S^2\ 2S^2\ 2P^4$ (d) $1S^2\ 2S^2\ 2P^5$

Sol: $1S^2\ 2S^2\ 2P^6\ 3S^2\ 3P^5$ -------- Cl

$1S^2\ 2S^2\ 2P^3$ --------- N

$1S^2 2S^2 2P^4$ -------- O

$1S^2\ 2S^2\ 2P^5$ -------- F

Cl has highest electron affinity.

Ans: (a)

52. Which of the following compound has $\mu = 0$?

Options:

(a) CCl_4 (b) $CHCl_3$ (c) HF (d) NH_3

Sol: CCl_4 has $M = 0$ because of symmetric structure

Ans: (a)

53. Which of the following relationships is true?

Options:

(a) Bond dissociation energy of O_2 and O_2^- are same

(b) Bond dissociation energy of O_2^+ is higher that O_2

(c) Bond dissociation energy of O_2^- and O_2^{2-} are same

(d) Bond dissociation energy of O_2^{2-} is higher than O_2^-

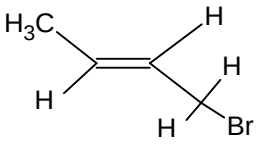
Sol: Higher the bond order, higher is the dissociation energy

O_2^+, $BO = 2.5$; O_2, $BO = 2$, ; O_2^-, $BO = 1.5$, O_2^{2-}, $BO = 1$

O_2^+ is having higher dissociation energy

Ans: (b)

54. IUPAC name of the compound



Options:

(a) Bromo butene (b) 1-Bromobut-2-ene (c) 1-Bromobut-3-ene (d) 2-Bromo-2-butene

Sol: 1-Bromobut-2-ene

Ans: (b)

55. What will be the heat of reaction for the following reaction? Will the reaction be exothermic or endothermic?

$Fe_2O_3 + 3H_2 \rightarrow 2Fe + 3H_2O$; $\Delta H_f^\circ\left(H_2O\right) = -285.83\,kJ\,mol^{-1}$

$\Delta H_f^\circ\left(Fe_2O_3\right) = -824.2\,kJ\,mol$

Options:

(a) $-824.2\,\text{kJ}$, exothermic (b) $+33.3$, kJ endothermic

(c) -33.3, kJ exothermic (d) $+824.2$ kJ, endothermic

Sol: $\Delta H_{\text{reaction}} = \sum \Delta H_f^{\circ}(\text{reactant}) - \sum \Delta H_f^{\circ}(\text{products})$

$= -824.2 - 3(-285.83) = -824.2 + 857.49 = +33.29\,\text{kJ/mol}$

Ans: (b)

56. Which of the following statements is not correct

Options:

(a) For a spontaneous process, ΔG° must be negative

(b) Enthalpy, entropy, free energy etc are state variables

(c) A spontaneous process is reversible in nature

(d) Total of all possible kinds of energy of a system is called internal energy

Sol: A spontaneous process is an irreversible process

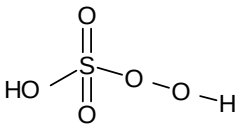
Ans: (c)

57. Oxidation number of Sulphur in peroxomonosulphuric acid (H_2SO_5) is

Options:

(a) $+4$ (b) $+2$ (c) $+6$ (d) -2

Sol:



$H_2SO_5 \rightarrow 2(+1) + x + 3(-2) + 2(-1) = 0;\ \ x = +6$

Ans: (c)

58. What is the reaction given below called?

$H_2O(l) + H_2O(l) \leftrightarrows H_3O^+(aq) + OH^-(aq)$

Options:

(a) hydrolysis of water (b) hydration of water

(c) disproportionation of water (d) auto – protolysis of water

Sol: Auto – protolysis of water

Ans: (d)

59. The No. of electrons present in 18 mL of water is

Options:

(a) 6.02×10^{25} (b) 6.02×10^{23} (c) 6.02×10^{24} (d) None of these

Sol: Number of electron in one molecule of H_2O is 2+8=10.

Density = 1g/mL

$\therefore$ 18 mL means 18g

$\text{Moles} = \frac{18}{18} = 1$

Molecules $= 6.023\times10^{23}$

Electrons $= 6.023\times10^{23}\times10 = 6.023\times10^{24}$

The total number of electrons present in 18 mL of water is 6.023×10^{24}

Ans: (c)

60. The scientific notation of 0.0000000540 is

Options:

(a) 5.40×10^{-7} (b) 5.40×10^{-8} (c) 54.0×10^{-7} (d) 54.0×10^{-8}

Sol: 5.40×10^{-8}

Ans: (b)

Mathematics

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

61. The value of $\left(z^2+5z\right)^2+z\left(z+5\right)$ when $z=\frac{-5+\sqrt{3}i}{2}$ is

Options:

(a) 42 (b) 49 (c) 53 (d) 60

Sol: Given $z=\frac{-5+\sqrt{3}i}{2}$

$\Rightarrow z+5=5+\frac{-5+\sqrt{3}i}{2}=\frac{5+\sqrt{3}i}{2}$

$\Rightarrow z\left(z+5\right)=\left(\frac{-5+\sqrt{3}i}{2}\right)\left(\frac{5+\sqrt{3}i}{2}\right)$

$=\frac{\left(\sqrt{3}i\right)^2-5^2}{4}=\frac{-3-25}{4}=\frac{-28}{4}=-7.$

Hence $\left(z^2+5z\right)^2+z\left(z+5\right)=\left(-7\right)^2-7=42.$

Ans: (a)

62. If $5\le x\le8$, then

Options:

(a) $\left(x-5\right)\left(x-8\right)\ge0$ (b) $\left(x-5\right)\left(x-8\right)>0$ (c) $\left(x-5\right)\left(x-8\right)\le0$ (d) $\left(x-5\right)\left(x-8\right)<0$

Sol: $5\le x\le8\Rightarrow5-x\le0$ and $x-8\le0$

$\Rightarrow x-5\ge0$ and $x-8\le0$

$\Rightarrow\left(x-5\right)\left(x-8\right)\le0.$

Ans: (c)

63. If $\cos\left(\alpha+\beta\right)=\frac{4}{5}$ and $\sin\left(\alpha-\beta\right)=\frac{5}{13}$, where $0\le\alpha,\beta\le\frac{\pi}{4}$, then $\tan2\alpha$ is equal to

(a) $\frac{25}{16}$ (b) $\frac{56}{33}$ (c) $\frac{19}{12}$ (d) $\frac{20}{7}$

Sol:

Given, $\cos(\alpha+\beta)=\frac{4}{5}\Rightarrow(\alpha+\beta)\in$ *Ist quadrant* and

$\sin(\alpha-\beta)=\frac{5}{13}\Rightarrow\alpha-\beta\in$ *Ist quadrant*

$\because \quad 2\alpha=(\alpha+\beta)+(\alpha-\beta)$

$\therefore \quad \tan 2\alpha=\frac{\tan(\alpha+\beta)+\tan(\alpha-\beta)}{1-\tan(\alpha+\beta)\tan(\alpha-\beta)}=\frac{\frac{3}{4}+\frac{5}{12}}{1-\frac{3}{4}\cdot\frac{5}{12}}=\frac{56}{33}$

Ans: (b)

64. If $\sin\theta=\frac{21}{29}$ and θ lies in the second quadrant, then the value of $\sec\theta+\tan\theta$ is

Options:

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

Sol: $\sec\theta+\tan\theta=\frac{1+\sin\theta}{\cos\theta}$

$=\frac{1+\sin\theta}{1\sqrt{1-\sin^2\theta}}=\frac{-\left(1+\frac{21}{29}\right)}{\sqrt{1-\left(\frac{21}{29}\right)^2}}=\frac{-5}{2}$ ($\because$ θ lies in the second quadrant, $\because$ $\cos\theta<0$)

Ans: (d)

65. $\tan\left(\frac{\pi}{4}+\theta\right)\tan\left(\frac{3\pi}{4}+\theta\right)$ is equal to

Options:

(a) -2 (b) -1 (c) 1 (d) None of these

Sol: $\tan\left(\frac{\pi}{4}+\theta\right)\tan\left(\frac{3\pi}{4}+\theta\right)=\tan\left(\frac{\pi}{4}+\theta\right)\tan\left(\frac{\pi}{2}+\left(\frac{\pi}{4}+\theta\right)\right)$

$=\tan\left(\frac{\pi}{4}+\theta\right)\tan\left(\frac{\pi}{2}+\left(\frac{\pi}{4}+\theta\right)\right)=\tan\left(\frac{\pi}{4}+\theta\right)\left\{-\cot\left(\frac{\pi}{4}+\theta\right)\right\}=-1$

$\left(\because \tan\left(\frac{\pi}{2}+\alpha\right)=-\cot\alpha\right)$

Ans: (b)

66. The value of $\left(1+\cos\frac{\pi}{6}\right)\left(1+\cos\frac{\pi}{3}\right)\left(1+\cos\frac{2\pi}{3}\right)\left(1+\cos\frac{7\pi}{6}\right)$ is

(a) $\frac{3}{16}$ (b) $\frac{3}{8}$ (c) $\frac{3}{4}$ (d) $\frac{1}{2}$

Sol: $\left(1+\cos\frac{\pi}{6}\right)\left(1+\cos\frac{\pi}{3}\right)\left(1+\cos\frac{2\pi}{3}\right)\left(1+\cos\frac{7\pi}{6}\right)$

$$=\left(1+\frac{\sqrt{3}}{2}\right)\left(1+\frac{1}{2}\right)\left(1-\frac{1}{2}\right)\left(1-\frac{\sqrt{3}}{2}\right) \quad =\left(1-\frac{3}{4}\right)\left(1-\frac{1}{4}\right)=\frac{1}{4}\times\frac{3}{4}=\frac{3}{16}$$

Ans: (a)

67. If $\tan\theta=\operatorname{cosec}2\theta-\sin2\theta$, then the value of $\tan^2\theta$ is equal to

Options:

(a) $2-\sqrt{5}$ (b) $-2+\sqrt{5}$ (c) $\frac{9+4\sqrt{5}}{2-\sqrt{5}}$ (d) None of these

Sol: $\tan\theta=\operatorname{cosec}2\theta-\sin2\theta$

$\Rightarrow t=\frac{1+t^2}{2t}-\frac{2t}{1+t^2}$, where $t=\tan\theta$

$\Rightarrow 2t^2\left(1+t^2\right)=\left(1+t^2\right)^2-4t^2$

$\Rightarrow 2t^2+2t^4=1+t^4-2t^2$

$\Rightarrow t^4+4t^2-1=0$

$\Rightarrow t^2=\frac{-4\pm\sqrt{16+4}}{2}=\frac{-4\pm2\sqrt{5}}{2}$

$\Rightarrow t^2=-2-\sqrt{5}$ or $-2+\sqrt{5}$, but $t^2\not<0$, therefore, $t^2=-2+\sqrt{5}$.

Ans: (b)

68. If the sum of an infinite geometric series is $\frac{4}{3}$ and its 1st term is $\frac{3}{4}$, then its common ratio is

Options:

(a) $\frac{7}{16}$ (b) $\frac{9}{16}$ (c) $\frac{1}{9}$ (d) $\frac{7}{9}$

Sol: Given, and $a=\frac{3}{4}$ $S_\infty=\frac{4}{3}$

Let r be the common ratio.

$\therefore \quad \frac{a}{1-r}=\frac{4}{3}\Rightarrow\frac{4}{3}-\frac{4}{3}r=\frac{3}{4}$

$\Rightarrow \quad \frac{16-9}{12}=\frac{4}{3}r\Rightarrow\frac{7}{12}=\frac{4}{3}r\Rightarrow r=\frac{7}{16}$

Ans: (a)

69. If $C(12,4)+C(12,5)=C(n,5)$, then n is equal to

Options:

(a) 11 (b) 13 (c) 12 (d) None of these

Sol:

${}^nC_r+{}^nC_{r-1}={}^{n+1}C_r\Rightarrow{}^{12}C_4+{}^{12}C_5={}^{13}C_5={}^nC_5$.

$\therefore \quad n=13$

Ans: (b)

70. The straight lines $x+y=0$, $3x+y-4=0$, $x+3y-4=0$ form a triangle which is

Options:

(a) isosceles (b) equilateral (c) right angled (d) None of these

Sol: The vertices of the triangle are $A(1,1)$, $B(-2,2)$ and $C(2,-2)$. (Find the vertices by solving the given equations taken two at a time)

Here $|AB|=\sqrt{(-3)^2+1^2}=\sqrt{10}$ and $|AC|=\sqrt{1^2+(-3)^2}=\sqrt{10} \Rightarrow |AB|=|AC|\neq|BC|=4\sqrt{2}$

Triangle is an isosceles triangle.

Ans: (a)

71. The parabolas $x^2=4y$ and $y^2=4x$ intersect

Options:

(a) in a unique point (b) on the line $y=x$ (c) on the line $x+y=0$ (d) none of these

Sol: The given parabolas are $x^2=4y$ and $y^2=4x$ i.e. $x^2-4y=0$ and $y^2-4x=0$.

The two meet where $\left(\frac{x^2}{4}\right)^2-4x=0$ (eliminating y between the two equations)

$\Rightarrow \left(x^3-64\right)x=0 \Rightarrow x=0,4$. When $x=0$, then $y=\frac{x^2}{4}=\frac{0^2}{4}=0$ and when $x=4$, $y=\frac{4^2}{4}=4$

So, the two parabolas meet in $(0,0)$ and $(4,4)$ i.e., on the line $y=x$

Ans: (b)

72. Which of the following is not a measure of dispersion?

Options:

(a) Mean (b) Variance (c) Mean deviation (d) Range

Sol: Mean is not a measure of dispersion Ans: (a)

73. A man speaks truth in 75% cases. He throws a dice and reports that it is a six. The probability that it is actually a six is

Options:

(a) $\frac{3}{8}$ (b) $\frac{1}{5}$ (c) $\frac{3}{24}$ (d) None of these

Sol: Let E_1 : 'dice shows up a six' and E_2 : 'dice does not show up a six', then E_1 and E_2 are mutually exclusive and exhaustive. Also, $P(E_1)=\frac{1}{6}$ and $P(E_2)=\frac{5}{6}$.

Let E : 'the man reports that, a six has come up then $P\left(\frac{E}{E_1}\right)=\frac{3}{4}$ and $P\left(\frac{E}{E_2}\right)=\frac{1}{4}$. By Baye's theorem

$$P\left(\frac{E_1}{E}\right)=\frac{P\left(\frac{E}{E_1}\right)P(E_1)}{P\left(\frac{E}{E_1}\right)P(E_1)+P\left(\frac{E}{E_2}\right)P(E_2)}=\frac{\frac{3}{4}\times\frac{1}{6}}{\frac{3}{4}\times\frac{1}{6}+\frac{1}{4}\times\frac{5}{6}}=\frac{3}{3+5}=\frac{3}{8}.$$

Ans: (a)

74. A team of 8 married couples attend a party at which four persons are chosen for a prize. The chance that the selected persons are of the same sex is

Options:

(a) $\frac{{}^{8}C_4}{{}^{16}C_4}$ (b) $\frac{2\times{}^{8}C_4}{{}^{16}C_4}$

(c) $\frac{{}^{16}C_1\times{}^{14}C_1\times{}^{12}C_1\times{}^{10}C_1}{{}^{16}C_4}$ (d) None of these

Sol: Four persons can be selected out of 16 in ${}^{16}C_4$ ways. The selected persons are the same sex when either they are all males or they are all females. Four males out of 8 can be selected in ${}^{8}C_4$ ways and again four females out of 8 can be selected in ${}^{8}C_4$ ways.

$\therefore$ Required probability $\frac{{}^{8}C_4+{}^{8}C_4}{{}^{16}C_4}=\frac{2\times{}^{8}C_4}{{}^{16}C_4}$

Ans: (b)

75. For two events A and B, if $P(A)=P\left(\frac{A}{B}\right)=\frac{1}{4}$ and $P\left(\frac{B}{A}\right)=\frac{1}{2}$, then

Options:

(a) A and B are independent events (b) $P\left(\frac{A'}{B}\right)=\frac{3}{4}$

(c) $P\left(\frac{B'}{A}\right)=\frac{1}{2}$ (d) All of these

Sol: Given, $P\left(\frac{B}{A}\right)=\frac{1}{2}\Rightarrow P(B\cap A)=\frac{1}{8}$

And $P\left(\frac{A}{B}\right)=\frac{1}{4}\Rightarrow P(B)=\frac{1}{2}$

$\therefore \quad P(A\cap B)=\frac{1}{8}=P(A)\cdot P(B)$

So, events are independent.

Now, $P\left(\frac{A'}{B}\right)=\frac{P(A'\cap B)}{P(B)}=\frac{P(B)-P(A\cap B)}{P(B)}=\frac{3}{4}$

And $P\left(\frac{B'}{A}\right)=\frac{P(A\cap B')}{P(A)}=\frac{P(A)-P(A\cap B)}{P(A)}=\frac{1}{2}$

Ans: (d)

76. If A and B are two independent events such that $P(A)=\frac{1}{2}$ and $P(B)=\frac{1}{3}$, then P (neither A nor B)is equal to

(a) $\frac{2}{3}$ (b) $\frac{1}{6}$ (c) $\frac{5}{6}$ (d) $\frac{1}{3}$

Sol: Since, A and B are independent events.

$\therefore \quad P(A\cap B)=P(A)\cdot P(B)=\frac{1}{2}\times\frac{1}{3}=\frac{1}{6}$

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

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

$\therefore \quad P(\vec{A}\cap\vec{B})=1-P(A\cup B)=1-\frac{2}{3}=\frac{1}{3}$

Ans: (d)

77. Three numbers are chosen at random from 1 to 20. The probability that they are consecutive is

Options:

(a) $\frac{3}{190}$ (b) $\frac{1}{60}$ (c) $\frac{1}{57}$ (d) None of these

Sol: Three numbers can be selected out of 20 in $C(20,3)=1140$ ways. They can be three consecutive numbers is 18 ways:

$(1,2,3),(2,3,4),(3,4,5),.....,(18,19,20)$. So, the required probability $=\frac{18}{1140}=\frac{3}{190}$.

Ans: (a)

78. The domain of the function $f(x)=\frac{x^2-x+1}{x^2+x+1}$ is

Options:

(a) $\mathbf{R}-\{-1\}$ (b) $\mathbf{R}-\{0,-1\}$ (c) $\mathbf{R}$ (d) None of these

Sol: $D_f=\left\{x\in\mathbf{R}:x^2+x+1\neq 0\right\}=\left\{x\in\mathbf{R}:x\neq\frac{-1+\sqrt{3}i}{2}\right\}=\mathbf{R}$

Ans: (c)

79. The range of the function $f(x)=x+\frac{1}{x},\ x\neq 0$ is

Options:

(a) $[2,\infty)$ (b) $(-\infty,-2]$ (c) $(-\infty,-2]\cup[2,\infty)$ (d) None of these

Sol: Let $y=f(x)=x+\frac{1}{x},\ x\neq 0$; then $yx=x^2+1$ or $x^2-xy+1=0$.

Since $x\in\mathbf{R}$, therefore, we must have $(-y)^2-4.1.1\geq 0\Rightarrow y^2\geq 4\Rightarrow |y|\geq 2$.

Ans: (c)

80. If $f(x)=1-\frac{1}{x}$, then $f\left(f\left(\frac{1}{x}\right)\right)$ is

Options:

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

Sol: $f\left(f\left(\frac{1}{x}\right)\right)=f\left(1-\frac{1}{1/x}\right)=f(1-x)$

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

Ans: (c)

81. If $f(x) = x^2 + 3x$ and $A = \{x \in R : f(x) = f(2x)\}$ then A is

Options:

(a) $\{0, -1\}$ (b) $\{1, -4\}$ (c) $\{0, 1, -1\}$ (d) None of these

Sol: Now, $f(x) = f(2x)$

$\Rightarrow x^2 + 3x = (2x)^2 + 3(2x)$

$\Rightarrow 3x^2 + 3x = 0 \Rightarrow x = 0, -1$.

Ans: (a)

82. If $f(x) = \begin{cases} 2x - 3, & x \geq 2 \\ x, & x < 2 \end{cases}$ then $f(2)$ is equal to

Options:

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

Sol: $f(2) = 2 \times 2 - 3 = 1 = f(1)$.

Ans: (b)

83. The vector $2\hat{i} + \hat{j} - \hat{k}$ is perpendicular to $\hat{i} - 4\hat{j} - \lambda\hat{k}$, if λ is equal to

Options:

(a) 0 (b) –1 (c) 2 (d) –3

Sol: $\left(2\hat{i} + \hat{j} - \hat{k}\right)$ perpendicular to $\left(\hat{i} - 4\hat{j} - \lambda\hat{k}\right)$

$\Rightarrow 2 \times 1 + 1 \times (-4) + (-1)(-\lambda) = 0$.

Ans: (c)

84. If $\hat{a}$ and $\hat{b}$ are two unit vectors inclined at an angle 60° to each other, then which one of the following is correct?

(a) $|a + b| < 1$ (b) $|a + b| > 1$ (c) $|a - b| < 1$ (d) $|a - b| > 1$

Sol: $|a + b| = \sqrt{|a + b|^2}$

$= \sqrt{|a|^2 + |b|^2 + 2|a||b|\cos 60°}$ $= \sqrt{1^2 + 1^2 + 2 \cdot 1 \cdot 1 \cdot \frac{1}{2}} = \sqrt{1+1+1} = \sqrt{3}$

$\therefore$ $|a + b| > 1$

Ans: (b)

85. The area of the parallelogram, whose diagonals are given by the vectors $3\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{i} - 3\hat{j} + 4\hat{k}$, is

Options:

(a) $10\sqrt{3}$ (b) $5\sqrt{3}$ (c) 8 (d) 4

Sol: $\frac{1}{2}\left|3\hat{i}+\hat{j}-2\hat{k}\times\left(\hat{i}-3\hat{j}+4\hat{k}\right)\right| = \frac{1}{2}\left|-2i-14j-10k\right| = \frac{1}{2}\sqrt{300} = 5\sqrt{3}$

Ans: (b)

86. A line makes the same angle θ with each of the X and $Z-axes$. If it makes the angle β and $Y-axies$ such that $\sin^2\beta = 3\sin^2\theta$, then $\cos^2\theta$ equals

(a) $3/5$ (b) $1/5$ (c) $2/5$ (d) $2/3$

Sol:Given line makes the same angle θ with each of the X and Z axes and angle β with $Y-axis.$

$\therefore \quad l=\cos\theta, m=\cos\beta \ \ and \ \ n=\cos\theta$

Now, $l^2+m^2+n^2=1$

$\Rightarrow \cos^2\theta+\cos^2\beta+\cos^2\theta=1$

$\Rightarrow 2\cos^2\theta+\cos^2\beta=1$

$\Rightarrow 2\cos^2\theta=1-\cos^2\beta=\sin^2\beta \qquad \left[\because \quad \cos^2\theta+\sin^2\theta=1\right]$

$\Rightarrow 2\cos^2\theta=3\sin^2\theta=3\left(1-\cos^2\theta\right)$

$\Rightarrow 5\cos^2\theta=3\Rightarrow\cos^2\theta=3/5$

Ans: (a)

87. The lines $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z-3}{0}$ and $\frac{x-2}{0}=\frac{y-3}{0}=\frac{z-4}{1}$ are

Options:

(a) parallel (b) coincident (c) skew (d) perpendicular

Sol: $d.n$ of the two lines are $<1,2,0>$ and $<0,0,1>$. Hence the two lines are at right angles.

$\left(\because 1\times0+2\times0+0\times1=0\right)$

Ans: (d)

88. The angle between the lines $x=1, y=2$ and $y=-1, z=0$ is

(a) $30°$ (b) $60°$ (c) $90°$ (d) $0°$

Sol: Given lines are $\frac{x-1}{0}=\frac{y-2}{0}=\frac{z}{1}$ and $\frac{x}{1}=\frac{y+1}{0}=\frac{z}{0}$

$\therefore \ \cos\theta=0.1+0.0+1.0=0\Rightarrow\theta=90°$

Ans: (c)

89. $\underset{x\to0}{Lt}\frac{(1+x)^8-1}{(1+x)^2-1}$ is equal to

Options:

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

Sol: $\underset{x\to0}{Lt}\frac{(1+x)^8-1}{(1+x)^2-1}$

$= \underset{x\to 0}{Lt} \dfrac{\left((1+x)^4-1\right)\left((1+x)^4-1\right)}{(1+x)^2-1}$

$= \underset{x\to 0}{Lt} \dfrac{\left((1+x)^4-1\right)\left((1+x)^2-1\right)\left((1+x)^2+1\right)}{(1+x)^2-1}$

$= \underset{x\to 0}{Lt} \left((1+x)^4+1\right)\left((1+x)^2+1\right)$

$2\left((1+0)^4+1\right)\left((1+0)^2+1\right)$

$= 2\times 2 = 4$

Ans: (c)

90. $\underset{x\to \frac{\pi}{4}}{Lt} \dfrac{\cot 2x}{\tan\left(\frac{\pi}{4}-x\right)}$ is equal to

Options:

(a) 0 (b) -2 (c) 2 (d) None of these

Sol: $\underset{x\to \frac{\pi}{4}}{Lt} \dfrac{\cot 2x}{\tan\left(\frac{\pi}{4}-x\right)}$

$= \underset{x\to \frac{\pi}{4}}{Lt} \left(\dfrac{1-\tan^2 x}{2\tan x}\right)\left(\dfrac{1+\tan x}{1-\tan x}\right) = \underset{x\to \frac{\pi}{4}}{Lt} \dfrac{(1+\tan x)^2}{2\tan x} = \dfrac{(1+1)^2}{2.1} = \dfrac{4}{2} = 2$

Ans: (c)

91. $\underset{x\to 0}{Lt}\, x[x]$ is equal to

Options:

(a) 0 or 1 (b) 0 or -1 (c) 0 (d) does not exist

Sol: $\underset{x\to 0}{Lt}\,(x) = 0$ and $[x]$ is finite (equal to -1 or 0) in a small deleted *nhd* of 0, therefore,

$\underset{x\to 0}{Lt}\, x[x] = 0$.

Ans: (c)

92. $\dfrac{d}{dx}\left(x\sqrt{a^2-x^2} + a^2 \sin^{-1}\left(\dfrac{x}{a}\right)\right)$ is equal to

Options:

(a) $\sqrt{a^2-x^2}$ (b) $2\sqrt{a^2-x^2}$ (c) $\dfrac{1}{\sqrt{a^2-x^2}}$ (d) None of these

Sol: Since $\int \sqrt{a^2-x^2}\,dx$

$\dfrac{x}{2}\sqrt{a^2-x^2} + \dfrac{a^2}{2}\sin^{-1}\left(\dfrac{x}{a}\right)$, therefore,

$2\int\sqrt{a^2-x^2}\,dx = x\sqrt{a^2-x^2}+a^2\sin^{-1}\left(\frac{x}{a}\right)$

$\Rightarrow \frac{d}{dx}x\sqrt{a^2-x^2}+a^2\sin^{-1}\left(\frac{x}{a}\right)=2\sqrt{a^2-x^2}$

Ans: (b)

93. $\frac{d}{dx}\left[\log\left\{e^x\left(\frac{x-2}{x+2}\right)^{3/4}\right\}\right]$ equals

Options:

(a) $\frac{x^2-1}{x^2-4}$ (b) 1 (c) $\frac{x^2+1}{x^2-4}$ (d) $e^x\left(\frac{x^2-1}{x^2-4}\right)$

Sol: Let $y=\log\left\{e^x\left(\frac{x-2}{x+2}\right)^{3/4}\right\}=x\log e+\frac{3}{4}\log\left(\frac{x-2}{x+2}\right)$

$=x+\frac{3}{4}\{\log(x-2)-\log(x+2)\}$ $\Rightarrow \frac{dy}{dx}=1+\frac{3}{4}\left\{\frac{1}{x-2}-\frac{1}{x+2}\right\}$.

Ans: (a)

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

Options:

(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)

95. If $x=a(\cos\theta+\theta\sin\theta)$, $y=a(\sin\theta-\theta\cos\theta)$, then $\frac{d^2y}{dx^2}=$

Options:

(a) $\frac{\sec^3\theta}{a\theta}$ (b) $\frac{\sec^2\theta}{\theta}$ (c) $a\theta\cos^2\theta$ (d) $\frac{\sec^2\theta}{a}$

Sol: Here, $\frac{dx}{d\theta}=a(-\sin\theta+\theta\cos\theta+\sin\theta)$ and $\frac{dy}{d\theta}=a(\cos\theta+\theta\sin\theta-\cos\theta)$

$\Rightarrow \frac{dy}{dx}=\frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}}=\frac{\theta\sin\theta}{\theta\cos\theta}=\tan\theta$

$\Rightarrow \frac{d^2y}{dx^2}=\frac{d}{dx}(\tan\theta)=\sec^2\theta\frac{d\theta}{dx}$

$=\sec^2\theta\left(\frac{1}{a\theta\cos\theta}\right)=\frac{\sec^3\theta}{a\theta}$

Ans: (a)

96. Let $F(x)=\begin{cases}3x-4 \text{ for } 0\le x\le 2\\ 2x+\lambda \text{ for } 2<x\le 3\end{cases}$. If $F(x)$ is continuous at $x=2$, then $\lambda=$

Options:

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

Sol: $F(x)$ is continuous at $x=2$ only if $=\underset{x\to 2^-}{Lt}F(x)=\underset{x\to 2^+}{Lt}F(x)$

i.e. if $\underset{x\to 2^-}{Lt}(3x-4)$

$=3\times 2-4=\underset{x\to 2^+}{Lt}(2x+\lambda)$

i.e. if $3\times 2-4=2=4+\lambda$ i.e. if $\lambda=-2$

Ans: (a)

97. The function $f(x)=[x]$ is

Options:

(a) derivable for all x (b) continuous for all x

(c) a constant function (d) discontinuous only for integral x

Sol: $f(x)=[x]$ is discontinuous at all $x=k\in I$ as $\Rightarrow \lim_{x\to k^+}k[x]=k$

$\Rightarrow \lim_{x\to k^-}[x]=k-1$

$\lim_{x\to k^-}[x]\neq \lim_{x\to k^+}[x]$

Ans: (d)

98. The function $f(x)=x^2-2x$ is increasing in the interval

Options:

(a) $x\neq -1$ (b) $x\ge -1$ (c) $x\neq 1$ (d) $x\ge 1$

Sol: $f(x)=x^2-2x$

$\Rightarrow f'(x)=2x-2=2(x-1)$.

So $f(x)$ is increasing if $2(x-1)\ge 0$ i.e. if $x\ge 1$.

Ans: (d)

99. The smallest value of the polynomial x^3-18x^2+96x in the interval $[0,9]$ is

Options:

(a) 126 (b) 0 (c) 135 (d) 160

Sol:

$x^3-18x^2+96x=x\left(x^2-18x+96\right)$

$=x\left[(x-9)^2+15\right]=x(x-9)^2+15x\ge 15x\ge 0.$

$(\because x\ge 0)$

Ans: (b)

100.If $f(x)=kx-\cos x$ is monotonically increasing for all $x\in R$,then

(a) $k>1$ (b) $k<1$ (c) $k>-1$ (d) None of these

Sol: $f'(x)=k+\sin x>0$

[since, $f(x)$ is monotonically increasing]

Or $k>-\sin x$ *or* $k>1$

Ans: (a)

101.Let x, y be two variables and $x>0,\ xy=1$, then minimum value of $x+y$ is

Options:

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

Sol: Now $x+y=x+\frac{1}{x}(\because xy=1)$

$=\left(\sqrt{x}-\frac{1}{\sqrt{x}}\right)^2+2 \quad (\because x>0)$

≥ 2 for all $x>0$

Ans: (b)

102.The graph of the inequality $2x+3y>6$ is

Options:

(a) half plane that contains the origin

(b) half plane not containing the origin excluding the points on the line $2x+3y=6$

(c) whole XOY -plane excluding the points on the line $2x+3y=6$

(d) none of these

Sol: Note that the origin i.e. $(0,0)$ does not satisfy the inequality $2x+3y>6 \quad (\because 2.0+3.0<6)$

So, the graph of $2c+3y>6$ is the half plane not containing the origin. Also, the points on the line $2x+3y=6$ do not satisfy $2x+3y>6$, therefore, graph does not contain the points of the line $2x+3y=6$.

Ans: (b)

103.If $P=\left\{\theta:\sin\theta-\cos\theta=\sqrt{2\cos\theta}\right\}$ and $Q=\left\{\theta:\sin\theta+\cos\theta=\sqrt{2\sin\theta}\right\}$ are two sets. Then,

(a) $P\subset Q$ *and* $Q-P\neq\phi$ (b) $Q\not\subset P$ (c) $P\not\subset Q$ (d) $P=Q$

Sol: Since, $\cos\theta\left(\sqrt{2}+1\right)=\sin\theta$

$\Rightarrow \quad \tan\theta=\sqrt{2}+1$

And $\sin\theta\left(\sqrt{2}-1\right)=\cos\theta$

$\therefore \quad \tan\theta=\frac{1}{\sqrt{2}-1}\times\frac{\sqrt{2}+1}{\sqrt{2}+1}=\left(\sqrt{2}+1\right)$

$\therefore \quad P=Q$

Ans: (d)

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

Options:

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

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

$= \frac{(1-x)^{1/2}}{\left(\frac{1}{2}\right)(-1)} = -2\sqrt{1-x}$

Ans: (b)

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

Options:

(a) $\sin 2x$ (b) $\frac{\sin 2x}{2}$ (c) $-\frac{\sin 2x}{2}$ (d) None of these

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

Ans: (b)

106. $\int \frac{1}{e^x + e^{-x}}dx$ is equal to

Options:

(a) $\log\left(e^x + e^{-x}\right) + C$ (b) $\log\left(e^{2x}+1\right) + C$

(c) $\tan^{-1}\left(e^x\right) + C$ (d) None of these

Sol: $\int \frac{1}{e^x + e^{-x}}dx = \int \frac{e^x}{e^{2x}+1}dx = \int \frac{dt}{t^2+1} = \tan^{-1} t = \tan^{-1}\left(e^x\right) + C$.

Ans: (c)

107. $\int (x-1)e^{-x}dx$ is equal to

Options:

(a) $xe^{-x} + C$ (b) $-xe^{-x} + C$ (c) $(x-1)e^{-x} + C$ (d) None of these

Sol: $\int (x-1)e^{-x}dx$, apply rule of integration by parts

$= (x-1)\frac{e^{-x}}{-1} - \int 1\frac{e^{-x}}{-1}dx \quad = -(x-1)e^{-x} + \frac{e^{-x}}{-1} + C$

Ans: (b)

108. $\int_0^{\pi/2} \frac{dx}{1+\tan^n x}$ is equal to

Options:

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

Sol: Let $I = \int_0^{\pi/2} \frac{1}{1+\tan^n x} dx$

$= \int_0^{\pi/2} \frac{\cos^n x}{\cos^n x + \sin^n x} dx$ … (1)

then $I = \int_0^{\pi/2} \frac{\cos^n\left(\frac{\pi}{2}-x\right)}{\cos^n\left(\frac{\pi}{2}-x\right)+\sin^n\left(\frac{\pi}{2}-x\right)} dx$

$= \int_0^{\pi/2} \frac{\sin^n x}{\sin^n + \cos^n x} dx$ … (2)

Adding (1) and (2), we get $2I = \int_0^{\pi/2} dx = \frac{\pi}{2} \Rightarrow I = \frac{\pi}{4}$

Ans: (d)

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

Options:

(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)

110. $\int_0^1 \frac{1}{\sqrt{x^2+1}} dx$ is equal to

Options:

(a) $\sqrt{2}$ (b) $\sqrt{2}+1$ (c) $\frac{1}{2}\log\left(\sqrt{2}+1\right)$ (d) $\log\left(\sqrt{2}+1\right)$

Sol: $\int_0^1 \frac{1}{\sqrt{x^2+1}} dx = \left[\log\left(x+\sqrt{x^2+1}\right)\right]_0^1 = \log\left(\sqrt{2}+1\right)$

Ans: (d)

111.The integral $\int_{-1}^1 \frac{|x+2|}{x+2} dx$ is equal to

Options:

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

Sol: For $-1 \le x \le 1,\ 1 \le x+2 \le 3$

$\Rightarrow |x+2| = x+2$

Hence, $\int_{-1}^{1} \frac{|x+2|}{x+2} dx = \int_{-1}^{1} 1 dx = 2$

Ans: (b)

112. Which of the following functions is a solution of the differential equation $\left(\frac{dy}{dx}\right)^2 - x\left(\frac{dy}{dx}\right) + y = 0$?

Options:

(a) $y = 2x^2 - 4$ (b) $y = 2x - 4$ (c) $y = 2x$ (d) $y = 2$

Sol: We notice that $y = 2x - 4$ gives $\frac{dy}{dx} = 2$ and these two equations together satisfy the given differential equation. ($\because 2^2 - x(2) + 2x - 4 = 0$ is true for all x)

Ans: (b)

113. Integrating factor of the differential equation $\frac{dy}{dx} + y = \frac{1+y}{x}$ is

Options:

(a) $\frac{x}{e^x}$ (b) $\frac{e^x}{x}$ (c) xe^x (d) e^x

Sol: Given differential equation can be written as $\frac{dy}{dx} + y = \frac{1}{x} + \frac{1}{x}y$ or $\frac{dy}{dx} + \left(1 - \frac{1}{x}\right)y = \frac{1}{x}$

$\therefore$ I.F. $= e^{\int \left(1-\frac{1}{x}\right)dx} = e^{x - \log x} = \frac{e^x}{e^{\log x}} = \frac{e^x}{x}$; assuming $x > 0$.

Ans: (b)

114. If $\theta = \tan^{-1} x$ then $\sin 2\theta$ is equal to

Options:

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

Sol: Given $\theta = \tan^{-1} x$,

therefore, $\sin 2\theta = \frac{2\tan\theta}{1+\tan^2\theta} = \frac{2x}{1+x^2}$

Ans: (a)

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

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

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

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

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

Ans: (c)

116. The value of $\det A$ where $A = \begin{bmatrix} 1 & \sin\theta & \theta \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{bmatrix}$ lies in the interval

Options:

(a) $[1, 2]$ (b) $[0, 2]$ (c) $(1, 2)$ (d) None of these

Sol: Operating, $R_1 \to R_1 + R_3$, we get

$$A = \begin{vmatrix} 0 & 0 & 1 \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{vmatrix} = 1 + \sin^2\theta$$

Since, $0 \le \sin^2\theta \le 1$, therefore, $1 \le 1 + \sin^2\theta \le 2$

Ans: (a)

117. If A is a square matrix such that $A^3 = I$ then A^{-1} is equal to

Options:

(a) I (b) A (c) A^2 (d) None of these

Sol: $A^3 = I \Rightarrow AA^2 = A^2A = I \Rightarrow A^{-1} = A^2$.

Ans: (c)

118. If $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, then for all natural numbers n, A^n is equal to

Options:

(a) $\begin{bmatrix} n & 0 \\ 1 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 0 \\ n & 1 \end{bmatrix}$ (c) $\begin{bmatrix} 1 & 0 \\ 1 & n \end{bmatrix}$ (d) None of these

Sol: $A^2 = AA = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}$ and $A^3 = A^2A$

$= \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 3 & 1 \end{bmatrix}$.... so on.

Hence $A^n = \begin{bmatrix} 1 & 0 \\ n & 1 \end{bmatrix} \forall n \in N$.

Ans: (b)

119. If $A = [x\ y\ z]$, $B = \begin{bmatrix} a & h & g \\ h & b & f \\ g & f & c \end{bmatrix}$ and $C = [x\ y\ z]^t$, then ABC is

Options:

(a) not defined (b) a 3×3 matrix (c) a 1×1 matrix (d) none of these

Sol: A is of order 1×3, B is of order 3×3, therefore, AB is of order 1×3 and since C is of order 3×1, therefore, $ABC=(AB)C$ is of order 1×1.

Ans: (c)

120. The number of terms in the expansion of $(a+b+c)^{10}$ is

(a) 11 (b) 21 (c) 55 (d) 66

Sol: The number of terms in the expansion of

$$(a+b+c)^{10} = {}^{12}C_2 = \frac{11\cdot12}{2} = 66$$

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 mean radius of earth is R, its angular speed on its own axis is ω and the acceleration due to gravity at earth's surface is g. What will be the radius of the orbit of a satellite?

(a) $\left(R^2g/\omega^2\right)^{1/3}$ (b) $\left(Rg/\omega^2\right)^{1/3}$ (c) $\left(R^2\omega^2/g\right)^{1/3}$ (d) $\left(R^2g/\omega\right)^{1/3}$

Sol: $T=\dfrac{2\pi r}{v_0}=\dfrac{2\pi r}{\left(gR^2/r\right)^{1/2}}=\dfrac{2\pi r^{3/2}}{\sqrt{gR^2}}=\dfrac{2\pi}{\omega}$

Hence, $r^{3/2}=\dfrac{\sqrt{gR^2}}{\omega}$ or $r^3=\dfrac{gR^2}{\omega^2}$

or, $r=\left(gR^2/\omega^2\right)^{1/3}$

Ans: (a)

122. If two equal and opposite deforming forces are applied parallel to the cross-sectional area of the cylinder as shown in the figure, there is a relative displacement between the opposite faces of the cylinder.

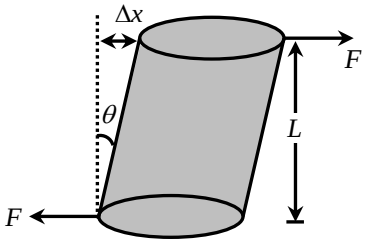
The ratio of Δx to L is known as

(a) Longitudinal strain

(b) Volumetric strain

(c) Shearing strain

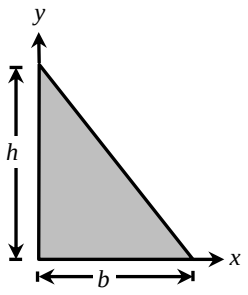
(d) Poisson's ratio



Sol: Shearing strain $=\dfrac{\Delta x}{L}$

Ans: (c)

123. The centre of mass of triangle system shown in figure has coordinates, if three equal masses placed at three vertices of the triangle

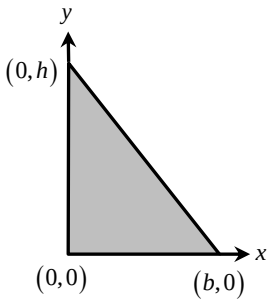


(a) $x=\frac{h}{2}, y=\frac{b}{2}$ (b) $x=\frac{b}{2}, y=\frac{h}{2}$

(c) $x=\frac{b}{3}, y=\frac{h}{3}$ (d) $x=\frac{h}{3}, y=\frac{b}{3}$

Sol:

As three particles of equal mass m are placed at the corners of triangle.



$\vec{r}_1=0\hat{i}+0\hat{j}, \vec{r}_2=b\hat{i}+0\hat{j}$ and $\vec{r}_3=0\hat{i}+h\hat{j}$

$\therefore \overrightarrow{r_{cm}}=\frac{m_1\vec{r}_1+m_2\vec{r}_2+m_3\vec{r}_3}{m_1+m_2+m_3}=\frac{b}{3}\hat{i}+\frac{h}{3}\hat{j}$

i.e., coordinates of centre of mass is $\left(\frac{b}{3},\frac{h}{3}\right)$

Ans: (c)

124. If the terminal speed of a sphere of gold(density $=19.5\,\text{kg/m}^3$) is $0.2\,\text{m/s}$ in a viscous liquid (density $=1.5\,\text{kg/m}^3$), find the terminal speed of a sphere of silver (density $=10.5\,\text{kg/m}^3$) of the same size in the same viscous liquid

(a) $0.4\,\text{m/s}$ (b) $0.133\,\text{m/s}$ (c) $0.1\,\text{m/s}$ (d) $0.2\,\text{m/s}$

Sol: Terminal velocity, $v_T=\frac{2r^2(d_1-d_2)g}{9\eta}$

$\frac{v_{T_2}}{0.2}=\frac{(10.5-1.5)}{(19.5-1.5)}\Rightarrow v_{T_2}=0.2\times\frac{9}{18}$

$\therefore v_{T_2}=0.1\,\text{m/s}$

Ans: (c)

125. A body initial at $80°C$ cools to $64°C$ in 5 minutes and to $52°C$ in 10 minutes. The tempearture of the body after 15 minutes will be

(a) $42.7°C$ (b) $35°C$ (c) $47°C$ (d) $40°C$

Sol: From Newton's law of cooling

$\frac{\theta_1-\theta_2}{t}=k\left(\frac{\theta_1+\theta_2}{2}-\theta_0\right)$ where θ_1 is higher temperature, θ_2 is lower temperature.

$\frac{80-64}{5}=k(72-\theta_0)$ … (i)

Where θ_0 is temperature of surroundings

$\frac{64-52}{10}=k(58-\theta_0)$ … (ii)

Dividing (i) and (ii) we get θ_0

$\frac{52-\theta}{15}=k\left(\frac{52+\theta}{2}-\theta_0\right)$ … (iii)

This $\theta = 42.7°C$ is found.

Ans: (a)

126. Four mole of hydrogen, two mole of helium and one mole of water vapour form an ideal gas mixture. What is the molar specific heat at constant pressure of mixture? (C_v for water vapour $= 3R$)

(a) $\frac{16}{7}R$ (b) $\frac{7}{16}R$ (c) R (d) $\frac{23}{7}R$

Sol: C_v for hydrogen $= \frac{5}{2}R$

C_v for helium $= \frac{3R}{2}$

C_v for water vapour $= \frac{6R}{2} = 3R$

$$\therefore (C_v)_{mix} = \frac{\left[4\times\frac{5}{2}R + 2\times\frac{3}{2}R + 1\times 3R\right]}{(4+2+1)} = \frac{16}{7}R$$

$\therefore C_p = C_v + R$

$C_p = \frac{16}{7}R + R$ or $C_p = \frac{23}{7}R$

Ans: (d)

127. In Carnot engine efficiency is 40% at hot reservoir temperature T. For efficiency 50% what will be temperature of hot reservoir?

(a) $\frac{T}{5}$ (b) $\frac{2T}{5}$ (c) $6T$ (d) $\frac{6T}{5}$

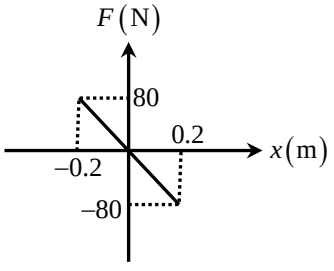
Sol: $\eta = 1 - \frac{T_2}{T_1}$ and $T_1 = T$ (Temperature of hot reservoir)

For $\eta = 40\%$, $\frac{40}{100} = 1 - \frac{T_2}{T} \Rightarrow \frac{T_2}{T} = \frac{3}{5} \Rightarrow T_2 = \frac{3}{5}T$

For $\eta = 50\%$, $\frac{50}{100} = 1 - \frac{\frac{3}{5}T}{T_1} \Rightarrow T_1 = \frac{6T}{5}$

Ans: (d)

128. A body of mass 0.01kg executes simple harmonic motion about $x = 0$ under the influence of a force as shown in figure. The time period of SHM is



(a) 1.05s (b) 0.52s (c) 0.25s (d) 0.03s

Sol: Slope of $F-x$ curve $=-k=-\frac{80}{0.2}\Rightarrow k=400\,\text{N m}^{-1}$,

Time period, $T=2\pi\sqrt{\frac{m}{k}}=0.0314\,\text{s}$

Ans: (d)

129. Speed of sound in mercury at a certain temperature is $1450\,\text{m s}^{-1}$. If the density of mercury is $13.6\times10^{3}\,\text{kg m}^{-3}$, then the bulk modulus for mercury is

(a) $2.86\times10^{10}\,\text{N m}^{-3}$ (b) $3.86\times10^{10}\,\text{N m}^{-3}$ (c) $4.86\times10^{10}\,\text{N m}^{-3}$ (d) $5.86\times10^{10}\,\text{N m}^{-3}$

Sol: $v=\sqrt{\frac{K}{\rho}}$ $\therefore K=v^2\rho=2.86\times10^{10}\,\text{N m}^{-3}$

Ans: (a)

130. Two identical conducting spheres carrying different charges attract each other with a force F when placed in air medium at a distance $'d'$ apart. The sphere are brought into contact and then taken to their original positions. Now the two spheres repel each other with a force whose magnitude is equal to that of the initial attractive force. The ratio between initial charges on the spheres is

(a) $-\left(3+\sqrt{8}\right)$ only (b) $\left(-3+\sqrt{8}\right)$ only

(c) $-\left(3+\sqrt{8}\right)\text{or}\left(-3+\sqrt{8}\right)$ (d) $+\sqrt{3}$

Sol: $F_1=\frac{kQ_1Q_2}{d^2}$ and $F_2=\frac{k\left(\frac{Q_1-Q_2}{2}\right)^2}{d^2}$

According to question, $F_1=F_2$

$$Q_1Q_2=\frac{(Q_1-Q_2)^2}{4}\Rightarrow 4Q_1Q_2=Q_1^2+Q_2^2-2Q_1Q_2$$

$$0=Q_1^2+Q_2^2-6Q_1Q_2\Rightarrow\frac{Q_1}{Q_2}=\left(-3\pm\sqrt{8}\right)$$

Ans: (c)

131. The S.I. unit of electric flux is

(a) Weber (b) Newton per coulomb

(c) Volt $\times$ metre (d) Joule per coulomb

Sol: S.I. unit of electric flux is

$$\frac{N\times m^2}{C}=\frac{J\times m}{C}$$

$=\text{Volt}\times\text{m}.$

Ans: (c)

132. A parallel plate air capacitor has a capacitance C. When it is half filled with a dielectric of dielectric constant 5, the percentage increase in the capacitance will be

(a) 400% (b) 66.6% (c) 33.3% (d) 200%

Sol: $C=\frac{\varepsilon_0 A}{d}$ and $C'=\frac{\varepsilon_0 A}{2d}+\frac{\varepsilon_0(5A)}{2d}$

$=\frac{\varepsilon_0 A}{2d}(1+5)=\frac{6\varepsilon_0 A}{2d}=\frac{3\varepsilon_0 A}{d}$

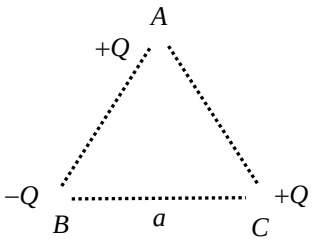
$\Rightarrow \Delta C=C'-C=\frac{3\varepsilon_0 A}{d}-\frac{\varepsilon_0 A}{d}=\frac{2\varepsilon_0 A}{d}$

Percentage change in capacitance

$\frac{\Delta C}{C}=\frac{\frac{2\varepsilon_0 A}{d}}{\frac{\varepsilon_0 A}{d}}\times 100\%=200\%$

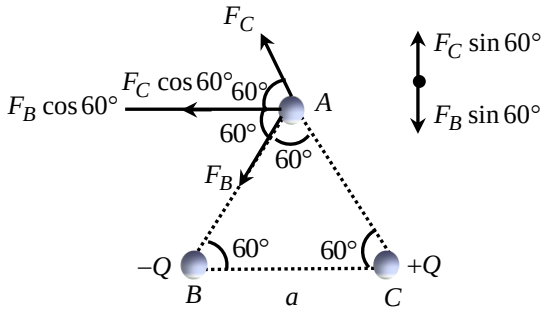
Ans: (d)

133. Three charges are placed at the vertices of an equilateral triangle of side $'a'$ as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is



(a) $Q^2/\left(4\pi\varepsilon_0 a^2\right)$ (b) $-Q^2/\left(4\pi\varepsilon_0 a^2\right)$ (c) Zero (d) $Q^2/\left(2\pi\varepsilon_0 a^2\right)$

Sol: $\left|\overrightarrow{F_B}\right|=\left|\overrightarrow{F_C}\right|=k.\frac{Q^2}{a^2}$



Hence force experienced by the charge as A in the direction normal to BC is zero.

Ans: (c)

134. Each corner of a cube of side l has a negative charge, $-q$. The electrostatic potential energy of a charge q at the centre of the cube is

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

Sol: Length of body diagonal $=\sqrt{3}l$

$\therefore$ Distance of centre of cube from each corner

$r=\frac{\sqrt{3}}{2}l$

P.E. at centre $=8\times$ Potential Energy due to A

$$=8\times\frac{Kq\times(-q)}{r}=8\times\frac{1}{4\pi\varepsilon_0\sqrt{3}l}\times2\times q\times(-q)=\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 l}$$

Ans: (d)

135. The electric potential at a point (x,y) in the $x-y$ plane is given by $V=-kxy$. The magnitude of field intensity at a distance r from the origin varies as (directly proportional)

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

Sol: Given $V=-kxy$

$$\vec{E}=\frac{\partial V}{\partial x}\hat{i}+\frac{\partial V}{\partial y}\hat{j}$$

$$\therefore\vec{E}=ky\hat{i}+kx\hat{j}$$

$$\therefore\left|\vec{E}\right|=k\left(\sqrt{x^2+y^2}\right)=kr \qquad \Rightarrow E\propto r$$

Ans: (b)

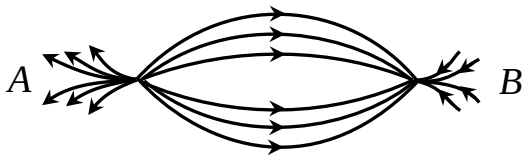
136. An electric dipole is kept in a non-uniform electric field. It experiences

(a) A force and a torque
(b) A force but not a torque
(c) A torque but no force
(d) Neither a force nor a torque

Sol: A force and a torque

Ans: (a)

137. The spatial distribution of electric field due to charges (A,B) is shown in figure. Which one of the following statement is correct?



(a) A is $+ve$ and $B-ve, |A|>|B|$
(b) A is $-ve$ and $B+ve, |A|=|B|$
(c) Both are $+ve$ but $A>B$
(d) Both are $-ve$ but $A>B$

Sol: Since lines of force starts from A and ends at B, so A is $+ve$ and B is $-ve$.

Lines of forces are more crowded near A, so $A>B$.

Ans: (a)

138. Constantan wire is used for making standard resistance, because it has

(a) High melting point
(b) Low specific resistance
(c) High specific resistance
(d) Negligible temperature coefficient of resistance

Sol:

Negligible temperature coefficient of resistance

Ans: (d)

139. Two resistors of 6Ω and 9Ω are connected in series to a $120V$ source. The power consumed by 6Ω resistor is

(a) $384\,W$ (b) $616\,W$ (c) $1500\,W$ (d) $1800\,W$

Sol:

In series circuit it is always preferable to use formula I^2R, because I throughout is same.

$I = \dfrac{120}{6+9} = 8$

$\therefore P = I^2R = 64 \times 6 = 384$

Ans: (a)

140. A 100 watt bulb working on 200 volt has resistance R and a bulb 200 watt bulb working on 100 volt has resistance S then R/S is

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

Sol: $P = V^2/R$

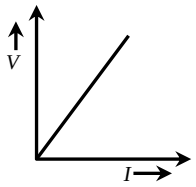
$\Rightarrow R = V^2/P = 4\times10^4/100 = 400\Omega$

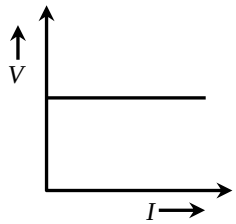
$S = 10^4/200 = 0.5\times10^2 = 50\Omega$

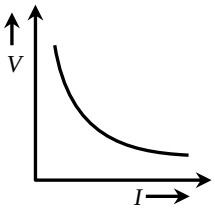
$R/S = 8$

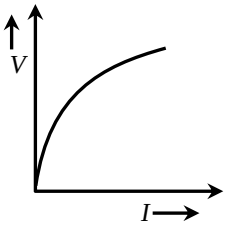
Ans: (c)

141. Which of the adjoining graphs represents ohmic resistance

(a) 

(b) 

(c) 

(d) 

Sol: For ohmic resistance $V \propto i \Rightarrow V = Ri$ (here R is constant)

Ans: (a)

142. Two wires A and B of the same material, having radii in the ratio $1:2$ and curry current in the ratio $4:1$. The ratio of drift speed of electrons in A and B is

(a) $16:1$ (b) $1:16$ (c) $1:4$ (d) $4:1$

Sol: Current flowing through the conductor,

$I = n$ e v A. Hence

$\frac{4}{1}=\frac{nev_{d_1}\pi(1)^2}{nev_{d_2}\pi(2)^2}$ or $\frac{v_{d_1}}{v_{d_2}}=\frac{4\times1}{1}=\frac{16}{1}$.

Ans: (a)

143. When a piece of aluminium wire of finite length is drawn through a series of dies to reduce its diameter to half its original value, its resistance will become

(a) Two times (b) Four times (c) Eight times (d) Sixteen times

Sol: $R\propto\frac{1}{d^4}\Rightarrow R'=16R$

Ans: (d)

144. A charged particle of mass m and charge q travels in a circular path of radius r that is perpendicular to a magnetic field B. The time taken by the particle to complete one revolution is

(a) $\frac{2\pi qB}{m}$ (b) $\frac{2\pi m}{qB}$ (c) $\frac{2\pi mq}{B}$ (d) $\frac{2\pi q^2B}{m}$

Sol: Equating magnetic force to centripetal force, $\frac{mv^2}{r}=qvB\sin90°$

Time to complete one revolution, $T=\frac{2\pi r}{v}=\frac{2\pi m}{qB}$

Ans: (b)

145. A charge moving with velocity v in $X-$direction is subjected to a magnetic field in negative $X-$direction. As a result, the charge will

(a) remain unaffected (b) start moving in a circular path $Y-Z$ plane

(c) retard along $X-$axis (d) move along a helical path around $X-$axis

Sol: The force acting on a charged particle in magnetic field is given by

$F=q\left(\vec{v}\times\vec{B}\right)$ or $F=qvB\sin\theta$. when angle between v and B is $180°$,

$F=0$

Ans: (a)

146. A galvanometer having a coil resistance of 100Ω gives a full scale deflection, when a current of 1mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10A, is

(a) $0.1\ \Omega$ (b) $3\ \Omega$ (c) $0.01\ \Omega$ (d) $2\ \Omega$

Sol: $I_gG=\left(I-I_g\right)s\quad\therefore10^{-3}\times100=\left(10-10^{-3}\right)\times s$

$s=0.01\Omega$

Ans: (c)

147. At what distance from a long straight wire carrying a current of 12A will the magnetic field be equal to $3\times10^{-5}\ \text{Wb m}^{-2}$?

(a) 8×10^{-2} m (b) 12×10^{-2} m (c) 18×10^{-2} m (d) 24×10^{-2} m

Sol: Current $(I) = 12\text{A}$ and magnetic field $(B) = 3\times10^{-5}\,\text{Wb}\,\text{m}^{-2}$

Consider magnetic field $\vec{B}$ at distance r

Magnetic field, $B = \dfrac{\mu_0 I}{2\pi r}$

$$\Rightarrow r = \frac{\mu_0 I}{2\pi B} = \frac{\left(4\pi\times10^{-7}\right)\times12}{2\times\pi\times\left(3\times10^{-5}\right)} = 8\times10^{-2}\,\text{m}$$

Ans: (a)

148. Current I is flowing in a coil of area A and number of turns is N, then magnetic moment of the coil in M equal to

(a) NIA (b) NI/A (c) $NI/\sqrt{A}$ (d) N^2AI

Sol: $M = NIA$

Ans: (a)

149. A coil in the shape of equilateral triangle of side $0.2\,\text{m}$ is suspended from the vertex such that it is hanging in a vertical plane between the pole-pieces of a permanent magnet producing a horizontal magnetic field of 5×10^{-2} tesla. The couple acting on the coil when a current of 0.1A is passed through it and the magnetic field is parallel to its plane will be

(a) $3.28\times10^{-7}\,\text{Nm}$ (b) $5.28\times10^{-7}\,\text{Nm}$ (c) $8.66\times10^{-7}\,\text{Nm}$ (d) $1.23\times10^{-7}\,\text{Nm}$

Sol: The torque on a closed flat current loop of any shape, placed in magnetic field of flux density B is given by $\tau = Bi\ NA\sin\theta$,

According to the question the area of this coil is

$A = (1/2)\,\text{base}\times\text{height}$

$$A = (1/2)(0.2\times0.1732) = 1.732\times10^{-4}\,\text{m}^2$$

$$\tau = 1\times01\times1.732\times10^{-4}\times\left(5\times10^{-2}\right)\times1$$

$$\tau = 8.66\times10^{-7}\,\text{N-m}$$

Ans: (c)

150. Magnetic field intensity is defined as

(a) Magnetic moment per unit volume

(b) Magnetic force acting on a unit magnetic pole

(c) Number of lines of force crossing per unit area

(d) Number of lines of force crossing per unit volume

Sol: Number of lines of force passing through per unit area normally is intensity of magnetic field.

Ans: (c)

151. A short-circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the wire radius halved, the electrical power dissipated would be

(a) halved (b) the same (c) doubled (d) quadrupled

Sol: Power $P=\frac{e^2}{R}$; Here $e=-\left(\frac{d\phi}{dt}\right)$ where $\phi=NBA$

$\therefore e=-NA\left(\frac{dB}{dt}\right)$ Also $R\propto\frac{l}{r^2}$

where $R=$ resistance, $r=$ radius, $l=$ Length

$\therefore P\propto\frac{N^2r^2}{l}\Rightarrow\frac{P_1}{P_2}=1$

Ans: (b)

152. A copper wire of length $40\,\text{cm}$, diameter $2\,\text{mm}$ and resistivity $1.7\times10^{-8}\Omega\text{m}$ forms a square frame. If a uniform magnetic field B exists in a direction perpendicular to the plane of square frame and it changes at a steady rate $\frac{dB}{dt}=0.02\,\text{T s}^{-1}$, then find the current induced in the frame.

(a) $9.3\times10^{-2}\,\text{A}$ (b) $9.3\times10^{-1}\,\text{A}$ (c) $3.3\times10^{-2}\,\text{A}$ (d) $19.3\times10^{-2}\,\text{A}$

Sol: Area of the loop $=0.1\times0.1=0.01\text{m}^2$

$\varepsilon=-\frac{d\phi}{dt}=-\frac{d}{dt}(BA)$

Magnitude of emf

$\varepsilon=A\frac{dB}{dt}=\left(0.01\text{m}^2\right)\left(0.02\,\text{T s}^{-1}\right)=2\times10^{-4}\,\text{V}$

Resistance of the loop is

$R=\rho\frac{l}{A}=\frac{1.7\times10^{-8}\times40\times10^{-2}}{3.14\times10^{-6}}=2.16\times10^{-3}\Omega$

Current induced in the loop

$I=\frac{\varepsilon}{R}=\frac{2\times10^{-4}\,\text{V}}{2.16\times10^{-3}\Omega}=9.3\times10^{-2}\,\text{A}$

Ans: (a)

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

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

Sol:

Phase difference between E and $I=\theta$

$\therefore\tan\theta=\frac{X_L-X_C}{R}$ Now, $X_L=2\pi fL=2\pi\times50\times\left(\frac{200}{\pi}\times10^{-3}\right)=20\Omega$

$X_C=\frac{1}{2\pi fC}=\frac{\pi}{2\pi\times50\times10^{-3}}=10\Omega$

$R=10\Omega$

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

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

Ans: (b)

154. A resistor 30Ω, inductor of reactance 10Ω and capacitor of reactance 10Ω are connected in series to an a.c. voltage source $e = 300\sqrt{2}\sin(\omega t)$. The current in the circuit is

(a) $10\sqrt{2}$ A (b) 10 A (c) $30\sqrt{11}$ A (d) $\frac{30}{\sqrt{11}}$ A

Sol: The current in the circuit

$I_{\text{rms}} = \frac{V_{\text{rms}}}{Z}$

$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{300\sqrt{2}}{\sqrt{2}} = 300\,\text{V}$

$z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{30^2 + (10-10)^2} = 30\Omega$

$\therefore I_{\text{rms}} = \frac{300}{30} = 10\text{A}$

Ans: (b)

155. A 220 volts input is supplied to a transformer. The output circuit draws a current of 2.0 A at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is

(a) 3.6 A (b) 2.8 A (c) 2.5 A (d) 5.0 A

Sol: $\frac{V_2}{V_1} = 0.8\frac{I_1}{I_2}$

$\Rightarrow \frac{V_2 I_2}{V_1 I_1} = 0.8$

$V_1 = 220\,\text{V}, I_2 = 2.0\,\text{A}, V_2 = 440\,\text{V}$

$I_1 = \frac{V_2 I_2}{V_1} \times \frac{10}{8} = \frac{440 \times 2 \times 10}{220 \times 8} = 5\,\text{A}$

Ans: (a)

156. The electric field part of an electromagnetic wave in a medium is represented by $E_x = 0$;

$E_y = 2.5\,\text{N C}^{-1}\cos\left[\left(2\pi \times 10^6\,\text{rad m}^{-1}\right)t - \left(\pi \times 10^{-2}\,\text{rad s}^{-1}\right)x\right]$;

$E_z = 0$. The wave is

(a) moving along x direction with frequency 10^6 Hz and wave length 100m

(b) moving along x direction with frequency 10^6 Hz and wave length 200m

(c) moving along $-x$ direction with frequency 10^6 Hz and wave length 200m

(d) moving along y direction with frequency $2\pi \times 10^6$ Hz and wave length 200m

Sol: Comparing with the equation of wave,

$E_y = E_0 \cos(\omega t - kx)$

$\omega = 2\pi f = 2\pi \times 10^6 \qquad \therefore f = 10^6$ Hz

$\frac{2\pi}{\lambda} = k = \pi \times 10^{-2}\,\text{m}^{-1},\ \lambda = 200\text{m}$

Ans: (b)

157. A thin glass (refractive index 1.5) lens has optical power of $-5D$ in air. Its optical power in a liquid medium with refractive index 1.6 will be

(a) $-1D$ (b) $1D$ (c) $-25D$ (d) $25D$

Sol: $\frac{1}{f_a} = \left(\frac{1.5}{1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ … (i)

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

$\frac{1}{f_m} = \left(\frac{1.5}{1.6} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ … (ii)

Dividing (i) by (ii), $\frac{f_m}{f_a} = \left(\frac{1.5-1}{\frac{1.5}{1.6} - 1}\right) = -8$

$P_a = -5 = \frac{1}{f_a} \Rightarrow f_a = -\frac{1}{5}$

$\Rightarrow f_m = -8 \times f_a = -8 \times -\frac{1}{5} = \frac{8}{5}$

$P_m = \frac{\mu}{f_m} = \frac{1.6}{8} \times 5 = 1D$

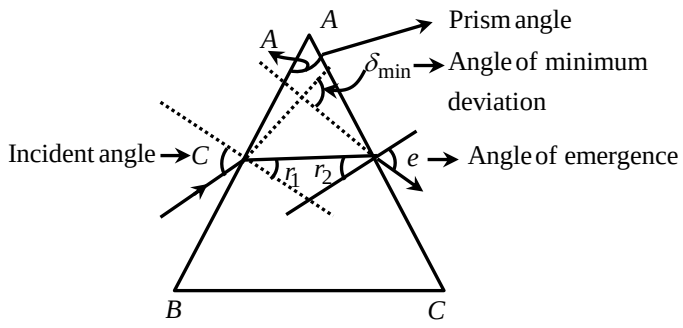
Ans: (b)

158. For the angle of minimum deviation of a prism to be equal to its refractive angle, the prism must be made of a material whose refractive index

(a) lies between $\sqrt{2}$ and 1 (b) lies between 2 and $\sqrt{2}$

(c) is less than 1 (d) is greater than 2

Sol:



The angle of minimum deviation is given as

$\delta_{\min} = i + e - A$

For minimum deviation

$\delta_{\min} = A$ then

$2A = i + e$

In case of $\delta_{\min} i = e$

$2A = 2i \; r_1 = r_2 = \frac{A}{2}$

$i = A = 90°$ from snell's law

$1\sin \; i = n \sin \; r_1$

$\sin A = n \sin \frac{A}{2}$

$2\sin \frac{A}{2} \cos \frac{A}{2} = n \sin \frac{A}{2}$

$2\cos \frac{A}{2} = n$

When, $A = 90° = i_{\min}$

Then, $n_{\min} = \sqrt{2}$

$i = A = 0 n_{\max} = 2$

Ans: (b)

159. When light travels from one medium to the other of which the refractive index is different, then which of the following will change?

(a) Frequency, wavelength and velocity (b) Frequency and wavelength

(c) Frequency and velocity (d) Wavelength and velocity

Sol: Velocity and wavelength change but frequency remains same.

Ans: (d)

160. Total internal reflection can take place only if

(a) Light goes from optically rarer medium (smaller refractive index) to optically denser medium

(b) Light goes from optically denser medium to rarer medium

(c) The refractive indices of the two media are close to different

(d) The refractive indices of the two media are widely different

Sol: According to Snell's Law, $\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$

Where $r = 90°$ for particular incidence angle called critical angle. When the incidence angle is equal to or greater than i_c, then total internal reflection occurs. It takes place when ray of light travels from optically denser medium $(\mu_1 > \mu_2)$ to optically rarer medium.

Ans: (b)

161. By Huygen's wave theory of light, we cannot explain the phenomenon of

(a) Interference (b) Diffraction (c) Photoelectric effect (d) Polarisation

Sol: Huygen's wave theory fails to explain the particle nature of light (i.e., photoelectric effect)

Ans: (c)

162. If two coherent sources are vibrating in phase then we have constructive interference at any point P whenever the path difference is

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

Sol: When path difference $=n\lambda\left(n=0,1,2,...\right)$ the resultant intensity is $4I_0$.

Ans: (d)

163. Monochromatic light of wavelength $667\,\text{nm}$ is produced by a helium neon laser. The power emitted is 9mW. The number of photons arriving per second on the average at a target irradiated by this beam is

(a) 3×10^{16} (b) 9×10^{15} (c) 3×10^{19} (d) 9×10^{17}

Sol: $\lambda=667\times10^{-9}\,\text{m}, P=9\times10^{-3}\,\text{W}$

$P=\frac{Nhc}{\lambda}, N=\text{No. of photons emitted/s}$

$N=\frac{9\times10^{-3}\times667\times10^{-9}}{6.6\times10^{-34}\times3\times10^{8}}$

$=\frac{9\times6.67\times10^{-10}}{3\times6.6\times10^{-26}}\simeq3\times10^{16}\,/\,\text{s}$

Ans: (a)

164. A proton accelerated through a potential difference of $100\,\text{V}$, has de-Broglie wavelength λ_0. The de-Broglie wavelength of an $\alpha-$particle, accelerated through $800\,\text{V}$ is

(a) $\frac{\lambda_0}{\sqrt{2}}$ (b) $\frac{\lambda_0}{2}$ (c) $\frac{\lambda_0}{4}$ (d) $\frac{\lambda_0}{8}$

Sol: $\frac{\lambda_p}{\lambda_\alpha}=\sqrt{\frac{m_\alpha q_a V_\alpha}{m_p q_p V_p}}=\sqrt{\frac{\left(4m_p\right)\times\left(2e\right)\times\left(800\right)}{\left(m_p\right)\times\left(e\right)\times\left(100\right)}}=8$

$\Rightarrow\lambda_\alpha=\frac{\lambda_p}{8}=\frac{\lambda_0}{8}$

Ans: (d)

165. The Rutherford $\alpha-$particle experiment shows that most of the $\alpha-$particles pass through almost unscattered while some are scattered through large angles. What information does it give about the structure of the atom?

(a) Atom is hollow

(b) The whole mass of the atom is concentrated a small centre called nucleus

(c) Nucleus is positively charged

(d) All the above

Sol: Rutherford concluded from the α-particle scattering experiment that

(i) Most of the space inside the atom is empty because most of the $\alpha-$particles passed through the gold foil without getting deflected.

(ii) Very few particles were deflected from their path, indicating that the positive charge of the atom occupies very little space.

(iii) A very small fraction of α -particles were deflected by 1800, indicating that all the positive charge and mass of the gold atom were concentrated in a very small volume within the atom.

From the data, he also calculated that the radius of the nucleus is about 105 times less than the radius of the atom.

On the basis of his experiment, Rutherford put forward the nuclear model of an atom, which had the following features:

(i) There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.

(ii) The electrons revolve around the nucleus in circular paths.

(iii) The size of the nucleus is very small as compared to the size of the atom

Ans: (d)

166. An electron in the hydrogen atom jumps from excited state n to the ground state. The wavelength so emitted illuminates a photosensitive material having work function $2.75\,\text{eV}$. If the stopping potential of the photoelectron is $10\,\text{V}$, the value of n is

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

Sol: $KE_{\max} = 10\,\text{eV}$

$\phi = 2.75\ \text{eV}$

Total incident energy

$E = \phi + KE_{\max} = 12.75\,\text{eV}$

$\therefore$ Energy is released when electron jumps from the excited state n to the ground state.

$\because E_4 - E_1 = \{-0.85 - (-13.6)\,\text{eV}\}$

$= 12.75\,\text{eV}$

$\therefore$ value of $n = 4$

Ans: (b)

167. 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 electron is quantised

(d) the angular momentum of the electron is quantised

Sol: As per Bohr's model of hydrogen atom, the angular momentum of an electron around the nucleus, is an integral multiple of $\frac{h}{2\pi}$

Thus angular momentum $= mvr = \frac{nh}{2\pi}$ where n is an integer.

Therefore the angular momentum can have only discrete values, i.e. it is quantised.

Ans: (d)

168. Nuclear force exists between

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

Sol: All of these

Ans: (d)

169. A nucleus splits into two nuclear parts which have their velocity ratio equal to $2:1$. What will be the ratio of their nuclear radius?

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

Sol: As momentum is conserved, therefore,

$$\frac{m_1}{m_2}=\frac{A_1}{A_2}=\frac{v_2}{v_1}=\frac{1}{2}$$

$$\therefore \frac{R_1}{R_2}=\left(\frac{A_1}{A_2}\right)^{1/3}=\left(\frac{1}{2}\right)^{1/3}=1:2^{1/3}$$

Ans: (b)

170. The mass of a $^{7}_{3}Li$ nucleus is $0.042\ u$ less than the sum of the masses of all its nucleons. The binding energy per nucleon of $^{7}_{3}Li$ nucleus is nearly

(a) 46 MeV (b) 5.6 MeV (c) 3.9 MeV (d) 23 MeV

Sol: $B.E=0.042\times 931\simeq 42$ MeV

Number of nucleons in $^{7}_{3}Li$ is 7.

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

Ans: (b)

171. In order to prepare a $p-$ type semiconductor, pure silicon can be doped with

(a) Phosphorus (b) Aluminium (c) Antimony (d) Germanium

Sol: When we add a trivalent impurity in intrinsic semiconductor (such as B, Al, In), we obtain $P-$ type semiconductors. In $P-$ type semiconductor, the holes are majority carries and electrons are minority carries.

Ans: (b)

172. The resistivity of a semiconductor at room temperature is in between

(a) 10^{-2} to $10^{-5}\Omega$ cm (b) 10^{-3} to $10^{6}\Omega$ cm (c) 10^{6} to $10^{8}\Omega$ cm (d) 10^{10} to $10^{12}\Omega$ cm

Sol: Resistivity of a semiconductor at room temp. is in between $10^{-5}\Omega$m to $10^{4}\Omega$m i.e. 10^{-3} to $10^{6}\Omega$cm

Ans: (b)

173. When an impurity is doped into an intrinsic semiconductor, the conductivity of the semiconductor

(a) Increases (b) Decreases (c) Remain the same (d) Become zero

Sol: When an impurity is doped into an intrinsic semiconductor, the conductivity of the semiconductor increases.

Ans: (a)

174. The magnetic field $d\vec{B}$ due to a small current element $d\vec{\ell}$ at a distance $\vec{r}$ and element carrying current i is,

(a) $d\vec{B}=\frac{\mu_0}{4\pi}i\left(\frac{d\vec{\ell}\times\vec{r}}{r}\right)$ (b) $d\vec{B}=\frac{\mu_0}{4\pi}i^2\left(\frac{d\vec{\ell}\times\vec{r}}{r}\right)$ (c) $d\vec{B}=\frac{\mu_0}{4\pi}i^2\left(\frac{d\vec{\ell}\times\vec{r}}{r^2}\right)$ (d) $d\vec{B}=\frac{\mu_0}{4\pi}i\left(\frac{d\vec{\ell}\times\vec{r}}{r^3}\right)$

Sol: $dB=\frac{\mu_0}{4\pi}.\frac{id\ell\sin\theta}{r^2}\Rightarrow d\vec{B}=\frac{\mu_0}{4\pi}.\frac{i\left(d\vec{\ell}\times\vec{r}\right)}{r^3}$

Ans: (d)

175. If E, m, J and G represent energy, mass, angular momentum and gravitational constant respectively, then the dimensional formula of EJ^2/m^5G^2 is same as that os

(a) angle (b) length (c) mass (d) time

Sol: $\frac{\left[ML^2T^{-2}\right]\left[ML^2T^{-1}\right]^2}{\left[M^5\right]\left[M^{-1}L^3T^{-2}\right]^2}=\left[M^0L^0T^0\right]=\text{angle}$

Ans: (a)

176. A man throws a ball downwards from the roof of a tower of height $400\,\text{m}$. At the same time another ball is thrown upwards with velocity of $50\,\text{m s}^{-1}$ from the surface of the tower, then at which height form the surface of the tower they will meet?

(a) $100\,\text{m}$ (b) $320\,\text{m}$ (c) $80\,\text{m}$ (d) $240\,\text{m}$

Sol: Let us consider that the two balls meet at height h after time t.

For the ball thrown upwards

$u=50\,\text{m/s}, g=9.8\text{m/s}\,(\text{given})$;

$h=ut-\frac{1}{2}gt^2=50t-\frac{1}{2}gt^2$ … (i)

For the ball thrown downward, $400-h=\frac{1}{2}gt^2$

From equation(i), $400-\left(50t-\frac{1}{2}gt^2\right)=\frac{1}{2}gt^2$

$\Rightarrow 400-50t+\frac{1}{2}gt^2=\frac{1}{2}gt^2\Rightarrow 50t=400\Rightarrow t=8\text{s}$

Again from equation (i), $h=50\times8-\frac{1}{2}\times10\times64=80\text{m}$

Ans: (c)

177. An object is projected with a velocity of $20\,\text{m/s}$ making an angle of $45°$ with horizontal. The equation for the trajectory is $h=Ax-Bx^2$ where h is height, x is horizontal distance, A and B are constants. The ratio $A:B$ is $\left(g=10\text{ms}^{-2}\right)$

(a) 1:5 (b) 5:1 (c) 1:40 (d) 40:1

Sol: Standard equation of projectile motion $y=x\tan\theta-\frac{gx^2}{2u^2\cos^2\theta}$

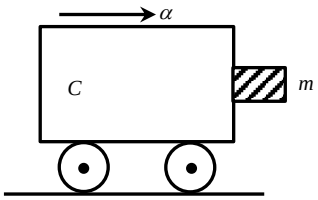
Comparing with given equation $A = \tan\theta$ and $B = \dfrac{g}{2u^2\cos^2\theta}$

So $\dfrac{A}{B} = \dfrac{\tan\theta \times 2u^2\cos^2\theta}{g} = 40$

$\left(\text{As } \theta = 45°, u = 20\,\text{m/s}, g = 10\,\text{m/s}^2\right)$

Ans: (d)

178. A block of mass m is in contact with the cart C as shown in the figure. The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies



(a) $\alpha > \dfrac{mg}{\mu}$ (b) $\alpha > \dfrac{g}{\mu m}$ (c) $\alpha \geq \dfrac{g}{\mu}$ (d) $\alpha < \dfrac{g}{\mu}$

Sol: Forces acting on the block are as shown in the figure.

Normal reaction N is provided by the force $m\alpha$ due to acceleration α

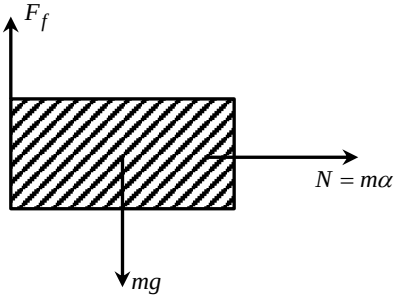
$\therefore N = m\alpha$

For the block not to fall, frictional force, $F_f \geq mg$

$\Rightarrow \mu N \geq mg$

$\Rightarrow \mu\, m\alpha \geq mg$

$\Rightarrow \alpha \geq g/\mu$



Ans: (c)

179. A bullet of mass m moving horizontally with a velocity v strikes a block of wood of mass M and gets embedded in the block. The block is suspended from the ceiling by a massless string. The height to which block rises is

(a) $\dfrac{v^2}{2g}\left(\dfrac{m}{M+m}\right)^2$ (b) $\dfrac{v^2}{2g}\left(\dfrac{M+m}{m}\right)^2$ (c) $\dfrac{v^2}{2g}\left(\dfrac{m}{M}\right)^2$ (d) $\dfrac{v^2}{2g}\left(\dfrac{M}{m}\right)^2$

Sol:

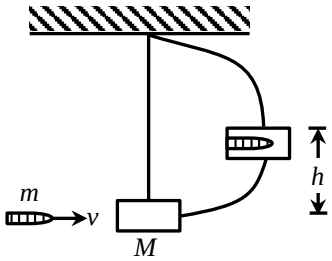
The situation is as shown in the figure.

Let V be velocity of the block – bullet system just after collision.

Then by the law of conservation of linear momentum, we get

$mv = (m+M)V$

$V = \dfrac{mv}{m+M}$



Let the block rises to a height h.

According to law of conservation of mechanical energy, we get

$$\frac{1}{2}(m+M)V^2 = (m+M)gh$$

$$h = \frac{V^2}{2g} = \frac{v^2}{2g}\left(\frac{m}{m+M}\right)^2$$

Ans: (a)

180. The angular momentum of a system of particle is conserved

(a) When no external force acts upon the system

(b) When no external torque acts upon the system

(c) When no external impulse acts upon the system

(d) When axis of rotation remains same

Sol: We know that $\tau_{ext} = \frac{dL}{dt}$

If angular momentum is conserved, it means change in angular momentum = 0

Or, $dL = 0$

$$\frac{dL}{dt} = 0 \Rightarrow \tau_{ext} = 0$$

Thus total external torque =0.

Ans: (b)

Key Answers:

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