Deeksha

ABHYAS KCET 2024

FREE TEST SERIES

MOCK TEST 7

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:

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

Chemistry

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

1. Most common oxidation states of Ce (Cerium) are______.

   Options:

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

   Sol: +3 and +4 $\left(f^0\right)$ oxidation states are the most common oxidation states of cerium.

   Ans: (a)

2. Which one of these is not known?

   Options:

   (a) CuI_2 (b) $CuBr_2$ (c) $CuCl_2$ (d) CuF_2

   Sol: CuI_2 is unstable and changes to Cu_2I_2 and I_2 .

   $2CuI_2 \rightarrow Cu_2I_2 + I_2$

   Ans: (a)

3. In which of the following coordination compounds, the central metal atom obeys the EAN rule?

   Options:

   (a) $K_3\left[Fe(CN)_6\right]$ (b) $K_4\left[Fe(CN)_6\right]$ (c) $\left[Cu(NH_3)_4\right]SO_4$ (d) All

   Sol: $K_4\left[Fe(CN)_6\right]$

   Ans: (b)

4. Which of the following can participate in linkage isomerism?

   Options:

   (a) NO_2^- (b) $H_2\ddot{N}CH_2CH_2\ddot{N}H_2$ (c) H_2O (d) $:NH_3$

   Sol: NO_2^- may be bonded to metal through nitrogen (nitro) or through oxygen (nitrito). Hence, NO_2^- can participate in linkage isomerism.

   Ans: (a)

5. The structure of $Fe(CO)_5$ is $(Z = 26 \text{ for } Fe)$

   Options:

   (a) octahedral (b) tetrahedral (c) square pyramidal (d) trigonal bipyramidal

   Sol: Fe in $Fe(CO)_5$ has sp^3d hybridization

   Hence has trigonal bi pyramidal geometry

   Ans: (d)

6. Which of the following descriptions about $[FeF_6]^{4-}$ is correct about complex ion?

   Options:

   (a) sp^3d, inner orbital complex, diamagnetic (b) sp^3d^2, outer orbital complex, paramagnetic

   (c) d^2sp^3, inner orbital complex, paramagnetic (d) d^2sp^3, outer orbital complex, diamagnetic

Sol: $[FeF_6]^{4-} \rightarrow Fe$ has sp^3d^2 hybridization

It is an outer orbital complex and paramagnetic

Ans: (b)

7. Which of the following ligands will not show chelation?

Options:

(a) $EDTA$ (b) DMG

(c) Ethane $-1, 2-$diamine (d) SCN^-

Sol: SCN^- is a monodentate ligand

Ans: (d)

8. The magnetic moment of a divalent ion in aqueous solution with atomic number 25 is

Options:

(a) 5.9 BM (b) 2.9 BM (c) 6.9 BM (d) 9.9 BM

Sol: Atomic no $\rightarrow (Mn) = 25$

Electronic configuration: $[Ar]3d^5 4s^2$

Its divalent will have configuration $[Ar]3d^5$

Number of unpaired electrons $= 5$

$\therefore \quad u = \sqrt{n(n+2)} = \sqrt{5(7)} = \sqrt{35} = 5.9\,BM$

Ans: (a)

9. Which of the following element has lowest melting point?

Options:

(a) Cr (b) Fe (c) Ni (d) Cu

Sol: Cu has a lowest melting point as it has only one unpaired electron

Ans: (d)

10. Which of the following Lanthanoids is commonly used?

Options:

(a) Lanthanum (b) Nobelium (c) Thorium (d) Cerium

Sol: Cerium used extensively

Ans: (d)

11. The trend of basicity of lanthanoid hydroxides

Options:

(a) increases across the lanthanoid series

(b) decrease across the lanthanoid series

(c) first increases and then decreases

(d) first decreases and then increases

Sol: It decreases across the lanthanoid series

Ans: (b)

12. In a mixture of A and B, components show negative deviation when

Options:

(a) A – B interaction is stronger that A – A and B – B interaction

(b) A – B interaction is weaker that A – A and B – B interaction

(c) $\Delta V_{mix} > 0, \Delta S_{mix} > 0$

(d) $\Delta V_{mix} = 0, \Delta S_{mix} > 0$

Sol: A – B interaction is stronger that A – A and B – B interaction

Ans: (a)

13. For which of the following electrolyte, $\alpha \Lambda_m^c / \Lambda_m^\infty$ doesn't hold good:

Options:

(a) CH_3OH (b) $HClO_4$ (c) HCOOH (d) CH_3COOH

Sol: This relation holds good for weak electrolytes only.

Ans: (b)

14. The rate of reaction increases with rise in temperature because of

Options:

(a) Increase in number of activated molecules

(b) Increase in energy of activation

(c) Decrease in energy of activation

(d) Increase in the number of effective collisions.

Sol: This is due to increase in the number of effective collisions.

Ans: (d)

15. The rate constant for a first order reaction is $2\times10^{-2}\,\text{min}^{-1}$. The $t_{75\%}$ of reaction is

Options:

(a) 69.3 (b) 34.65 (c) 17.37 (d) 3.46

Sol: $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{2\times10^{-2}} = 34.65\,\text{min}$;

$t_{75\%} = 2\times t_{1/2} = 2\times34.65 = 69.3\text{mins}$

Ans: (a)

16. The unit of rate constant for the reaction $2H_2 + 2NO \rightarrow 2H_2O + N_2$ which has rate $= k[H_2][NO]^2$ is

Options:

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

Sol: Order $= 3$ $\therefore$ unit of rate constant is $\text{mol}^{-2}L^2S^{-1}$

Ans: (c)

17. Half-life of a first order reaction is 10 mins. What percentage of the reaction will be completed in 100 min?

Options:

(a) 25% (b) 50% (c) 99.9% (d) 75%

Sol: $k = \frac{2.303}{t}\log\frac{9}{a-x}$

$\frac{0.693}{10} = \frac{2.303}{100}\log\frac{100}{100-x}$

$\log\frac{100}{100-x} = \frac{100\times 2.303\times 0.3}{2.303\times 10} = 3$

$\frac{100}{100-x} = 10^3 = 1000$; $\frac{100}{1000} = 100 - x$ or $100 - x = 0.1$

Or $x = 100 - 0.1 = 99.9$

Ans: (c)

18. Limiting molar conductivity of NH_4OH is

Options:

(a) $\Lambda_m^\circ(NH_4OH) = \Lambda_m^\circ(NH_4Cl) + \Lambda_m^\circ(NaCl)$

(b) $\Lambda_m^\circ(NH_4OH) = \Lambda_m^\circ(NH_4Cl) + \Lambda_m^\circ(NaOH) - \Lambda_m^\circ(NaCl)$

(c) $\Lambda_m^\circ(NH_4OH) = \Lambda_m^\circ(NaOH) - \Lambda_m^\circ(NaCl)$

(d) $\Lambda_m^\circ(NH_4OH) = \Lambda_m^\circ(NaOH) + \Lambda_m^\circ(NaCl) - \Lambda_m^\circ(NH_4Cl)$

Sol: $\Lambda_m^\circ(NH_4OH) = \Lambda_m^\circ(NH_4Cl) + \Lambda_m^\circ(NaOH) - \Lambda_m^\circ(NaCl)$

Ans: (b)

19. The equivalent conductivity of $N/10$ solution of acetic acid at $25°C$ is $14.3\,\mathrm{Scm^2}\,eq^{-1}$. What will be the degree of dissociation of acetic acid?

$\left(\Lambda_m^\circ(CH_3COOH) = 390.71\,\mathrm{Scm^2eq^{-1}}\right)$

Options:

(a) 3.66% (b) 4.9% (c) 2.12% (d) 0.008%

Sol: % of dissociation $= \frac{\Lambda_m^c}{\Lambda_m^\circ}\times 100 = \frac{14.3}{390.71}\times 100 = 3.66\%$

Ans: (a)

20. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does not depend on _________

Options:

(a) temperature (b) nature of solute (c) pressure (d) nature of solvent

Sol: Since solute is a solid, solubility is independent of pressure

Ans: (c)

21. Value of Henry's law constant K_H

Options:

(a) increases with increase in temperature

(b) decreases with increase in temperature

(c) remains constant

(d) first increases then decreases

Sol: Solubility decreases with increases in temperature for gaseous solute. $\therefore K_H$ Value increases

Ans: (a)

22. Osmotic pressure of a solution containing 2g dissolved protein per $300\,cm^3$ of solution is 20 mm of Hg at $27°C$. The molecular mass of protein is

Options:

(a) $5630\,g\,mol^{-1}$ (b) $6239.6\,g\,mol^{-1}$ (c) $7130\,g\,mol^{-1}$ (d) $5120\,g\,mol^{-1}$

Sol: $M_B = \frac{WB}{V} \times \frac{RT}{\Pi}$

$$= \frac{2}{300/1000} \times \frac{0.0821 \times 300}{20/760} = 6239.69\,g\,mol^{-1}$$

Ans: (b)

23. A plant cell shrinks when it is kept in a

Options:

(a) hypotonic solution (b) hypertonic solution (c) isotonic solution (d) pure water

Sol: Solution must be of higher concentration. Hence hypertonic solution

Ans: (b)

24. In the given set of reactions $2-\text{Bromopropane} \xrightarrow[\text{alc/heat}]{\text{AgCN}} X \xrightarrow{\text{LiA/H}_4} Y$ the IUPAC name of product 'Y' is

Options:

(a) N-Isopropylmethanamine (b) N-Methylpropan-2-amine

(c) N-Methylpropanamine (d) Butan-2-amine

Sol: $\underset{\text{3-Bromopropane}}{CH_3-\underset{Br}{\underset{|}{C}}H-CH_3} \xrightarrow[\substack{Heat \\ -AgBr}]{\text{AgCN(alc.)}} CH_3-\underset{NC}{\underset{|}{C}}H-CH_3 \xrightarrow[\text{(Reduction)}]{\text{LiAlH}_4} \underset{\text{N-Methylpropan-2-amine}}{CH_3-\underset{NH-CH_3}{\underset{|}{CH}}-CH_3}$

Ans: (b)

25. Lucas test is associated with

Options:

(a) Aldehydes (b) Phenols (c) Carboxylic acid (d) Alcohols

Sol: Lucas test is to distinguish between $1^\circ, 2^\circ$ and 3° alcohols

Ans: (d)

26. Which represents the correct order of relative acidic strengths?

Options:

(a) $HCOOH > CH_3COOH > ClCH_2COOH > C_2H_5COOH$

(b) $ClCH_2COOH > HCOOH > CH_3COOH > C_2H_5COOH$

(c) $CH_3COOH > HCOOH > ClCH_2COOH > C_2H_5COOH$

(d) $C_2H_5COOH > CH_3COOH > HCOOH > ClCH_2COOH$

Sol:

Correct order is $ClCH_2COOH > HCOOH > CH_3COOH > C_2H_5COOH$

Ans: (b)

27. Which of the following ions have maximum stability?

Options:

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

(b) $CH_3 - \overset{+}{C}H - OCH_3$

(c) $CH_3 - CH_2 - \overset{+}{C}H_2$

(d) $CH_3 - \overset{+}{C}H - CH_2 - OCH_3$

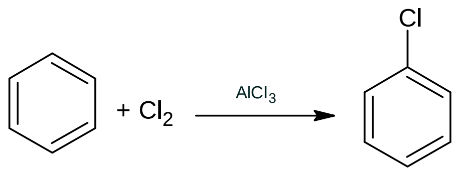
Sol: $CH_3 - \overset{+}{C}H - OCH_3$ is stabilized by $+R$ effect.

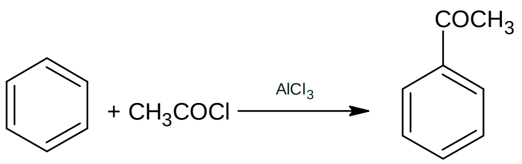
Hence more stable

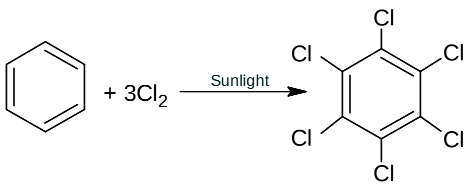
Ans: (b)

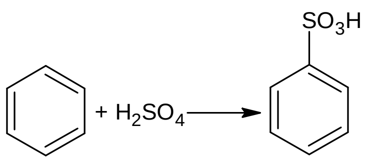
28. Which of the following reactions is not an example of electrophilic substitution in benzene ring?

Options:

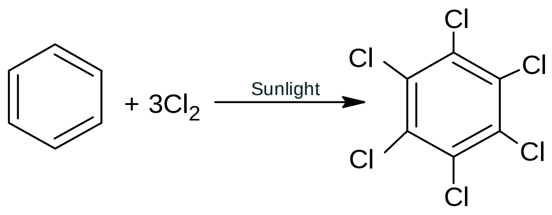
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (c)

29. The equilibrium constant at $717\,K$ for the reaction $H_2(g)+I_2(g)\rightleftharpoons 2HI(g)$ is 60. The equilibrium constant for the reaction: $2HI(g)\rightleftharpoons H_2(g)+I_2(g)$ is

Options:

(a) 1.6×10^{-2} (b) 2×10^{-2} (c) 2.56×10^{-2} (d) 3×10^{-2}

Sol: $K'=\frac{1}{K}=\frac{1}{60}=1.6\times10^{-2}$

Ans: (a)

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

Options:

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

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

Ans: (a)

31. Which of the following statements is not correct?

Options:

(a) the shape of an atomic orbital depends on the magnetic quantum number

(b) the orientation of an atomic orbital depends on the magnetic quantum number

(c) the energy of an electron in an atomic orbital of multi electron atom depends on principal quantum number

(d) the number of degenerate atomic orbitals of one type depends on the values of azimuthal and magnetic quantum numbers

Sol: The energy of an electron in an atomic orbital of multi electron atom depends on principal and azimuthal quantum numbers

Ans: (c)

32. Which of the following is incorrect for SF_4 ?

Options:

(a) it has sp^3d hybridization (b) it has two lone pairs of electrons

(c) it has four bonding electrons (d) it has see-saw shape

Sol: It has one lone pair of electron

Ans: (b)

33. For the reaction at $25°C$, $X_2O_4 \rightarrow 2XO_2$; $\Delta H = 211 k\text{cal}$ and $\Delta S = 20\,\text{cal}\,K^{-1}$. The reaction would be

Options:

(a) Spontaneous (b) Non-spontaneous (c) At equilibrium (d) unpredictable

Sol: $\Delta G=\Delta H-T\Delta S = 2.1\times10^3-298\times20 \quad = 2100-5960=-3860=-3.8\,k\,\text{cal}$

The reaction is spontaneous.

Ans: (a)

34. The reaction in which $\Delta H > \Delta U$ is

Options:

(a) $N_2(g)+O_2(g) \rightarrow 2NO(g)$

(b) $N_2(g)+3H_3(g) \rightarrow 2NH_3(g)$

(c) $CaCO_3 \rightarrow CaO(s)+CO_2(g)$

(d) $CH_4(g)+2O_2(g) \rightarrow CO_2(g)+2H_2O(l)$

Sol: As $\Delta H = \Delta U + \Delta n_g RT$.

For the reaction, $CaCO_3 \rightarrow CaO(s)+CO_2(g)$

$\Delta n_g = 1$, so $\Delta H > \Delta U$

Ans: (c)

35. The *trans*-alkenes are formed by the reduction of alkynes with

Options:

(a) H_2-Pd/C,$BaSO_4$ (b) $NaBH_4$ (c) Na/liq. NH_3 (d) Sn-HCl

Sol: Birch reduction of alkynes with Na/liq. NH_3 gives *trans* alkenes. The reduction is selectively anti since the vinyl radical formed during reduction is more stable in *trans* configuration.

Ans: (c)

36. Which has maximum number of molecules?

Options:

(a) $7g N_2$ (b) $2g H_2$ (c) $16g\ NO_2$ (d) $16g\ O_2$

Sol: Mole of $N_2 = 7/28 = 0.25$

Mole of $H_2 = 2/2 = 1$

Mole of $NO_2 = 16/46 = 0.347$

Mole of $O_2 = 16/32 = 0.5$

Ans: (b)

37. The shape of ClF_3 according to *VSEPR* theory is

Options:

(a) planar triangle (b) $T-$shape (c) tetrahedral (d) square planar

Sol: ClF_3 has sp^3d hybridization with $T-$shape

Ans: (b)

38. The pH of $0.05M\ Ba(OH)_2$ solution is

Options:

(a) 12 (b) 13 (c) 1 (d) 10

Sol: $\left[OH^-\right] = 0.05 \times 2 = 0.1 = 10^{-1}$

$\therefore POH = 1$

$\therefore PH = 13$

Ans: (b)

39. Which of the following elements will have highest second ionization enthalpy?

Options:

(a) $1s^2, 2s^2, 2p^6, 3s^2$ (b) $1s^2, 2s^2, 2p^6, 3s^1$

(c) $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$ (d) $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$

Sol: $1s^2, 2s^2, 2p^6, 3s^1 (Na)$ has highest second ionization enthalpy

Ans: (b)

40. Functional group of acid anhydride is

Options:

(a) $-\overset{\overset{O}{\|}}{C}-O$ (b) $-\overset{\overset{O}{\|}}{C}-O-\overset{\overset{O}{\|}}{C}-$ (c) $-\overset{\overset{O}{\|}}{C}-Cl$ (d) $-\overset{\overset{O}{\|}}{C}-NH_2$

Sol:

$-\overset{\overset{O}{\|}}{C}-O-\overset{\overset{O}{\|}}{C}-$ is anhydride functional group

Ans: (b)

41. For which of the process, ΔS is negative?

Options:

(a) $H_2(g) \rightarrow 2H(g)$ (b) $N_2(g, 1\text{atm}) \rightarrow N_2(g, 8\text{atm})$

(c) $2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$ (d) $C(\text{diamond}) \rightarrow C(\text{graphite})$

Sol: $N_2(g, 1\text{ atm}) \rightarrow N_2(g, 8\text{ atm})$ $\Delta S = -ve$

Ans: (b)

42. Oxidation state of P in $Ba(H_2PO_2)_2$?

Options:

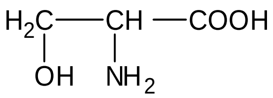
(a) +3 (b) +2 (c) +1 (d) −1

Sol: $Ba(H_2PO_2)_2 : +2 + (+2)2 + 2x + 4(-2) = 0$

$2x = 2$ or $x = +1$

Ans: (c)

43. The IUPAC name of the compound



Options:

(a) $2-$amino $-3-$hydroxypropanoic acid (b) $1-$hydroxyl $-2-$aminoprop $-3-$oic acid

(c) $1-$amino $-2-$hydroxypropanoic acid (d) $3-$hydroxyl $-2-$aminopropanoic acid

Sol: 2 – amino – 3 – hydroxypropanoic acid

Ans: (a)

44. The incorrect statement regarding glucose

Options:

(a) Glucose on reduction with HI/ red P forms n – hexane

(b) Glucose does not react with hydroxylamine (NH_2OH)

(c) Glucose on oxidation with Br_2 / H_2O given Gluconic acid

(d) Glucose on acetylation forms pentaacetyl derivative

Sol: Glucose reacts with hydroxylamine (NH_2OH) to form oxime

Ans: (b)

45. Each polypeptide in a protein has amino acids linked with each other in a specific sequence. This sequence of amino acids is said to be

Options:

(a) primary structure of proteins
(b) secondary structure of protein
(c) tertiary structure of protein
(d) quaternary structure of protein

Sol: It is referring to primary structure

Ans: (a)

46. In DNA, the complimentary bases are

Options:

(a) adenine and guanine : thymine and cytosine

(b) uracil and adenine : cytosine and guanine

(c) adenine and thymine : guanine and cytosine

(d) adenine and thymine : guanine and uracil

Sol: Adenine – thymine

Guanine - cytosine

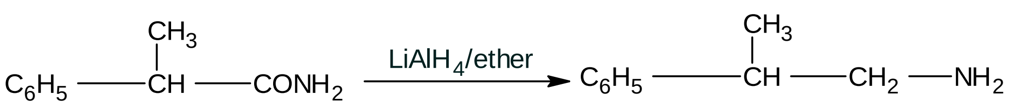
Ans: (c)

47. The best reagent for converting 2 – phenylpropanamide into 2 – phenylpropanamine is

Options:

(a) excess of H_2
(b) Br_2 in aqueous $NaOH$
(c) iodine in presence of red P
(d) $LiAlH_4$ in ether

Sol:



Ans: (d)

48. The source of nitrogen in Gabriel synthesis of amine is

Options:

(a) sodium azide NaN_3

(b) sodium nitride $NaNO_2$

(c) potassium cyanide KCN

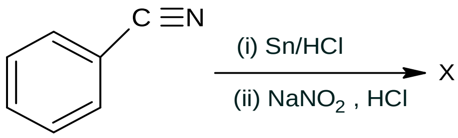
(d) potassium pthalimide $C_6H_4(CO)_2 N^-K^+$

Sol:

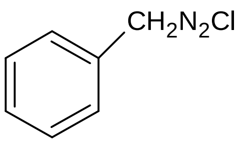
Potassium pthalimide - $C_6H_4(CO)_2 N^-K^+$

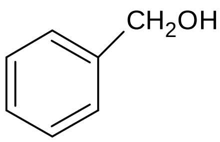
Ans: (d)

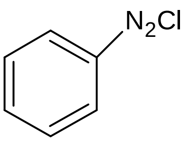
49. In the following reaction X is

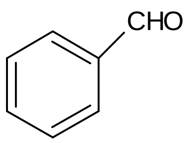


Options:

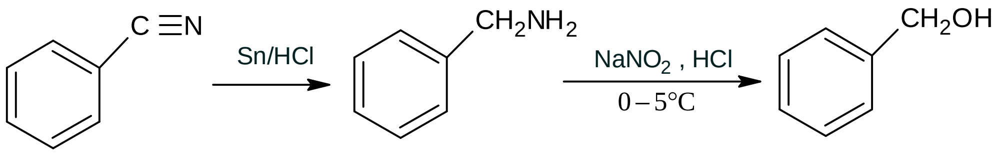
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (b)

50. Which of the following reagents are used for detecting the presence of carbonyl group?

Options:

(a) NH_2NH_2 (b) NH_2OH (c) NH_4Cl (d) Both (a) and (b)

Sol: Both NH_2-NH_2 and NH_2-OH react with carbonyl group.

Ans: (d)

51. Under Wolf Kishner reduction, the conversions which may be brought about are

Options:

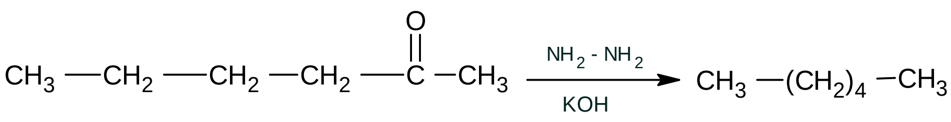
(a) Benzophenone to diphenyl methanol

(b) Benzaldehyde into benzyl alcohol

(c) $2-$Hexanone into $n-$Hexane

(d) $2-$Hexanone into $2-$Hexanol

Sol:



Ans: (c)

52. Which of the following acids has the smallest dissociation constant?

Options:

(a) $CH_3CHFCOOH$ (b) FCH_2CH_2COOH (c) $BrCH_2CH_2COOH$ (d) $CH_3CHBrCOOH$

Sol: Among the given acids $Br-CH_2CH_2COOH$ is the weakest. Hence it has smallest dissociation constant.

Ans: (c)

53. Which among the following reactants and products not correctly matched

Options:

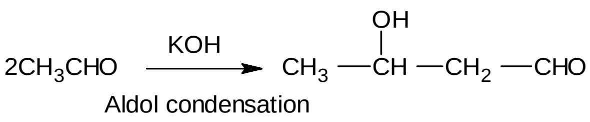
(a) $2CH_3CHO+NaOH$ $CH_3-CH(OH)-CH_2-CHO$

(b) $CH_3CHO+H_2N-NH_2$ $CH_3-CH=N-NH_2$

(c) $CH_3CHO+HCN$ $CH_3-CH(OH)CN$

(d) $2CH_3CHO+KOH$ $CH_3COOK+CH_3CH_2OH$

Sol:



CH_3CHO does not undergo Cannizzaro reaction.

Ans: (d)

54. Iodoform can be prepared from all except

Options:

(a) isopropyl alcohol (b) $3-$methyl $-2-$butanone

(c) isobutyl alcohol (d) ethyl methyl Ketone

Sol: Tertiary alcohol does not undergo iodoform reaction

Ans: (c)

55. From among the following alcohols the one that would react fastest with conc. HCl and anhydrous $ZnCl_2$ is____.

Options:

(a) $2-$Methyl Propanol (b) $1-$Butanol

(c) $2-$Butanol (d) $2-$Methyl propan $-2-$ol

Sol:

3° alcohols($2-$Methylpropan $-2-$ol) reacts faster.

Ans: (d)

56. Phenol on treatment with alcoholic KOH and chloroform gives

Options:

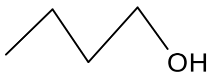
(a) Salicylaldehyde (b) Salicylic acid (c) Phthalic acid (d) benzoic acid

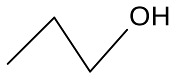
Sol: $\text{Phenol} \xrightarrow{\text{CHCl}_3/\text{KOH}} \text{Salicylaldehyde}$

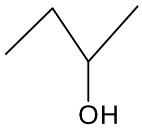
Ans: (a)

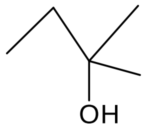
57. Which of the following has maximum pK_a value?

Options:

(a) 

(b) 

(c) 

(d) 

Sol: The acidic nature of alcohols decreases in the order $1° > 2° > 3°$. Higher the pK_a, lower is the acidic strength.

Ans: (d)

58. Which of the following is an example of $S_N 2$ reaction?

Options:

(a) $\text{CH}_3\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{OH} + \text{Br}$

(b) $(\text{CH})_2\,\text{CHBr} + \text{OH}^- \rightarrow (\text{CH}_3)_2\,\text{CHOH} + \text{Br}^-$

(c) $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{-\text{H}_2\text{O}} \text{CH}_2 = \text{CH}_2$

(d) $(\text{CH}_3)_3\,\text{C} - \text{Br} + \text{OH}^- \rightarrow (\text{CH}_3)_3\,\text{C} - \text{OH} + \text{Br}^-$

Sol: Primary halides undergo $S_N 2$ reaction.

$1° > 2° > 3°$

Ans: (a)

59. In the following reaction

$C_6H_5CH_2Br \xrightarrow[(ii)H_3O^+]{(i)\text{Mg.ether}} X$

The product X is

Options:

(a) $C_6H_5CH_2OCH_2C_6H_5$ (b) $C_6H_5CH_2C_6H_5$ (c) $C_6H_5CH_3$ (d) $C_6H_5CH_2CH_2C_6H_5$

Sol: $C_6H_5CH_2Br \xrightarrow[(ii)H_3O^+]{(i)\text{Mg.ether}} C_6H_5CH_3$

Ans: (c)

60. Which of the following is the correct method of preparation of methyl fluoride?

Options:

(a) $CH_4 + HF \rightarrow$ (b) $CH_3OH + HF \rightarrow$ (c) $CH_4 + F_2 \rightarrow$ (d) $CH_3Br + AgF \rightarrow$

Sol: $CH_3Br + AgF \rightarrow CH_3F + AgBr$ (Swart's reaction)

Ans: (d)

Mathematics

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

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

Options:

(a) Reflexive but not symmetric (b) Symmetric but not transitive

(c) Transitive but not reflexive (d) Reflexive, symmetric and transitive

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

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

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

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

Ans: (d)

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

Options:

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

Sol: $[x]^2-[x]-6>0 \Rightarrow >0$ $\Rightarrow [x]>3$ or $[x]<-2 \Rightarrow x \geq 4$ and $x<-2 \Rightarrow x \in (-\infty,-2)\cup[4,\infty)$

Ans: (d)

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

Options:

(a) z is a real number (b) real part of z is $-\dfrac{1}{2}$

(c) real part of z is zero (d) real part of z is $\dfrac{1}{2}$

Sol: $|x+iy|=|1+x+iy| \Rightarrow x^2+y^2=(1+x)^2+y^2$ $\Rightarrow x^2=(1+x)^2 \Rightarrow 2x+1=0 \Rightarrow x=-\dfrac{1}{2}$

Ans: (b)

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

Options:

(a) $\dfrac{5}{11}$ (b) $\dfrac{5}{13}$ (c) $\dfrac{5}{7}$ (d) $\dfrac{5}{9}$

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

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

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

As $\dfrac{3}{5}$ is not present in the alternatives, we can conclude that $\sin\theta=\dfrac{5}{13}$ Ans: (b)

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

Options:

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

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

Ans: (d)

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

Options:

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{6}$ (c) $\frac{\pi}{8}$ (d) $\frac{\pi}{12}$

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

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

Ans: (b)

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

Options:

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

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

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

Ans: (b)

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

Options:

(a) $\frac{7}{10}$ (b) $\frac{3}{10}$ (c) $\frac{1}{10}$ (d) $\frac{9}{10}$

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

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

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

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

Ans: (a)

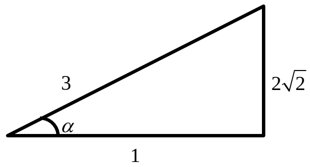
69. The value of $\sin\left(2\tan^{-1}\frac{1}{3}\right)+\cos\left(\tan^{-1}\left(2\sqrt{2}\right)\right)=$

Options:

(a) $\frac{4}{5}$ (b) $\frac{13}{15}$ (c) $\frac{14}{15}$ (d) 1

Sol:

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



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

Ans: (c)

70. Two finite sets have m and n elements. The number of subsets of the first set 112 more than that of the second set. The value of m and n are respectively

Options:

(a) 4, 7 (b) 7, 4 (c) 4, 4 (d) 7, 7

Sol: By data $2^m=112+2^n$

$\Rightarrow \quad 2^m-2^n=112$

$\Rightarrow \quad 2^n\left(2^{m-n}-1\right)=2^4\cdot 7$

$\Rightarrow \quad n=4,\quad 2^{m-4}-1=7$

$\Rightarrow \quad n=4,\quad 2^{m-4}=2^3$

$\Rightarrow \quad n=4,\quad m=7$

Ans: (b)

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

Options:

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

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

Ans: (b)

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

Options:

(a) $(3,4)$ (b) $(1,2)$ (c) $(-1,2)$ (d) $(-2,-1)$

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

$\Rightarrow -4<-2x<-2 \quad \Rightarrow 4>2x>2 \quad \Rightarrow 2>x>1\Rightarrow x\in(1,2)$

Ans: (b)

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

Options:

(a) 224 (b) 280 (c) 324 (d) 405

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

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

Ans: (a)

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

Options:

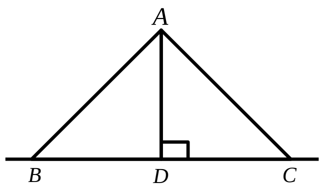
(a) $(-2,-1)$ (b) $(2,-5)$ (c) $(-2,-2)$ (d) $(-3,-1)$

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

$\therefore D$ is the foot of the $\perp$ drawn from $(1, 2)$ to the line $3x+4y+14=0$

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

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



Ans: (c)

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

Options:

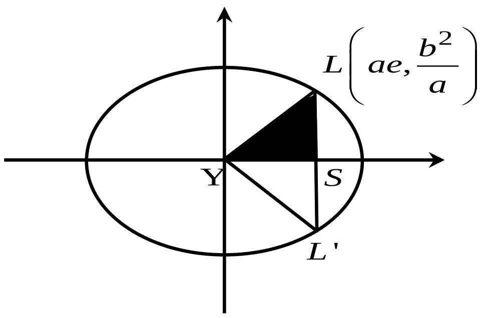
(a) 4.8 sq. units (b) 9.6 sq. units (c) 19.6 sq. units (d) None of these

Sol: Area of $\Delta CLL'$

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

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

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



Ans: (b)

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

Options:

(a) $\frac{12}{5}$ (b) $\frac{24}{5}$ (c) $\frac{6}{4}$ (d) $\frac{5}{24}$

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

As $e=\frac{5}{4}, a.\frac{5}{4}=3 \Rightarrow a=\frac{12}{5} \quad \therefore \; 2a=\frac{24}{5}$ Ans: (b)

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

Options:

(a) 5 (b) −5 (c) 6 (d) 4

Sol: The given lines in symmetric form are:

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

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

Ans: (a)

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

Options:

(a) −8 (b) 4 (c) 8 (d) −4

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

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

Ans: (c)

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

Options:

(a) $2\sqrt{3}$ (b) $\sqrt{14}$ (c) $3\sqrt{5}$ (d) $4\sqrt{3}$

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

Then $\vec{a}=i+2j+3k$ and $\vec{b}=2i+4j-5k$ Now $|\vec{a}|=\sqrt{1+4+9}=\sqrt{14}$ and $|\vec{b}|>|\vec{a}|$ $\because |\vec{b}|=\sqrt{4+16+25}$

Ans: (b)

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

Options:

(a) $150°$ (b) $30°$ (c) $60°$ (d) $120°$

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

Ans: (a)

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

Options:

(a) $(4,0)$ (b) $(0,4)$ (c) $(4,4)$ (d) None of these

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

Ans: (d)

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

Options:

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) None of these

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

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

$\theta = \frac{\pi}{3}$

Ans: (c)

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

Options:

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

Sol:

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

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

Ans: (b)

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

Options:

(a) 2 (b) 3 (c) 5 (d) e^{2+3+5}

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

$= 5 \lim_{n\to\infty}\left[1+\left(\frac{2}{5}\right)^n+\left(\frac{3}{5}\right)^n\right]^{1/n} = 5\times1=5$

Ans: (c)

85. $\lim_{x\to0}\frac{(1-\cos2x)\ (3+\cos x)}{x\tan4x}$ is equal to

Options:

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

Sol: L $= \lim_{x\to0}\frac{1-\cos2x}{x^2}\cdot\frac{4x}{\tan4x}\cdot(3+\cos x)\cdot\frac{1}{4}$

$= \lim_{x\to0}\frac{2\sin^2x}{x^2}\cdot\frac{4x}{\tan4x}.\ \ 4\ \ .\frac{1}{4}=2\ .\ 1^2\ \ .\ \ 1=2$

Ans: (c)

86. $\lim_{x\to0}\frac{\sec5x-\sec3x}{\sec3x-\sec x} =$

Options:

(a) 2 (b) 1 (c) 4 (d) 8

Sol: $L = \lim_{x\to0}\frac{\cos3x-\cos5x}{\cos3x\cos5x}\times\frac{\cos3x\cos5x}{\cos x-\cos3x}$

$= \lim_{x\to0}\frac{2\sin4x\cdot\sin x}{2\sin2x\cdot\sin x} = \lim_{x\to0}\frac{\sin4x}{2x}=\frac{4}{2}=2$

Ans: (a)

87. Let $f(x)=\begin{cases}x^2+1 & x\le0\\ 2-x & x>0\end{cases}$, then which of the following is true?

Options:

(a) $f(x)$ is continuous for all x (b) $\lim_{x\to0}f(x)$ doesn't exist

(c) $\lim_{x\to0}f(x)=1$ (d) $f(x)$ is not defined for all x

Sol:

$\lim_{x\to0^-}f(x)=1,\ \ \lim_{x\to0^+}f(x)=2$ $\therefore$ limit does not exist

Ans: (b)

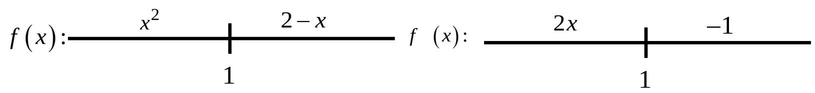
88. The function $f(x)=\begin{cases} x^2 & \text{for } x<1 \\ 2-x & \text{for } x\geq 1 \end{cases}$ is

Options:

(a) not differentiable at $x=1$ (b) differentiable at $x=1$

(c) not continuous at $x=1$ (d) none of these

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



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

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

Ans: (a)

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

Options:

(a) $f(x)$ (b) $f(x)\cos x$ (c) $f(x)\operatorname{cosec} x$ (d) $f(x)\sin x$

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

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

Ans: (b)

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

Options:

(a) $\dfrac{x^2}{1-x^2}$ (b) $\dfrac{2x}{(1-x^2)^2}$ (c) $\dfrac{2x-4x^2}{(1-x^2)^2}$ (d) $\dfrac{2x}{(1+x^2)^2}$

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

$\Rightarrow f(x)=\dfrac{x^2}{1-x^2}=\dfrac{(x^2-1)+1}{1-x^2}=-1+\dfrac{1}{1-x^2}$

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

Ans: (b)

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

Options:

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

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

OR

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

Ans: (b)

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

Options:

(a) $\frac{1}{12}$ (b) $\frac{3}{4}$ (c) $\frac{1}{4}$ (d) $\frac{3}{16}$

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

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

Ans: (c)

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

Options:

(a) $(-\infty,-4)\cup(0,\infty)$ (b) $(-\infty,4)$ (c) $(-4,0)$ (d) $(-\infty,0)\cup(4,\infty)$

Sol:

$y'=3x^2+12x=3x[x+4];\quad y'>0\Rightarrow x[x+4]>0\Rightarrow x<-4$ or $x>0$

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

Ans: (a)

94. The area of an equilateral triangle is increasing at the rate of $10\sqrt{3}$ sq.cm/sec. Then the rate of increase of the sides of the triangle when the area is $4\sqrt{3}$, is

Options:

(a) 4 cm/sec (b) 5 cm/sec (c) $\frac{10}{3}$ cm/sec (d) 2 cm/sec

Sol:

$A=\frac{\sqrt{3}}{4}a^2\ ;\ 4\sqrt{3}=\frac{\sqrt{3}}{4}a^2\Rightarrow a=4\ cm\quad \therefore A=\frac{\sqrt{3}}{4}a^2$

$\frac{dA}{dt}=\frac{\sqrt{3}}{4}\times 2a\cdot\frac{da}{dt}$

$10\sqrt{3}=\frac{\sqrt{3}}{4}\times 2\times 4\frac{da}{dt}$

$\frac{da}{dt}=5cm/s$

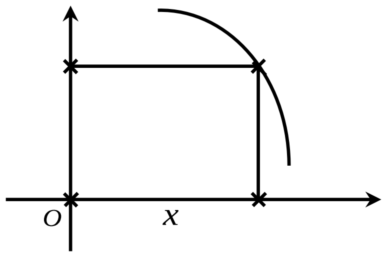
Ans: (b)

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

Options:

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

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



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

If the area is maximum then

$\frac{dA}{dx} = 4 - 3x^2 = 0 \Rightarrow x = \frac{2}{\sqrt{3}} \quad \therefore x > 0$

Also $\frac{d^2A}{dx^2} = -6x < 0$ as $x > 0$ Max. $A = \frac{2}{\sqrt{3}}\left(4 - \frac{4}{3}\right) = \frac{16}{3\sqrt{3}}$

Ans: (d)

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

Options:

(a) $\tan\frac{x}{2} + c$ (b) $\cot\frac{x}{2} + c$ (c) $\frac{1}{2}\tan\frac{x}{2} + c$ (d) $2\tan\frac{x}{2} + c$

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

Ans: (a)

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

Options:

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

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

Ans: (d)

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

Options:

(a) $\log x^{\cos x} + C$ (b) $\log x^{\sin x} + C$ (c) $\log(x \cos x) + C$ (d) $\log\left(\frac{\cos x}{x}\right) + C$

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

$= \cos x \log x + c$

Ans: (a)

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

Options:

(a) $e^2 \cos x + c$ (b) $e^x \sec x \tan x + c$ (c) $e^x \tan x + c$ (d) $e^x \cos^2 x - 1 + c$

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

Ans: (c)

100. $\int_1^2 \frac{dx}{x+x^9} =$

Options:

(a) $\frac{1}{8}\log\frac{128}{257}$ (b) $\frac{1}{8}\log\frac{512}{257}$ (c) $\frac{1}{8}\log\frac{1024}{257}$ (d) None of these

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

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

Ans: (b)

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

Options:

(a) 0.936 (b) 0.784 (c) 0.904 (d) 0.216

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

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

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

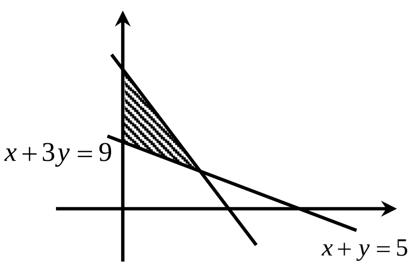
$= 1 - P(\overline{A}) \,.\, P(\overline{A}) \,.\, P(\overline{A}) = 1 - (0.6)^3 = 1 - 0.216 = 0.784$

Ans: (b)

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

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

Options:



(a) 57 (b) 35 (c) 46 (d) 47

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

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

Ans: (d)

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

Options:

(a) $\frac{25}{52}$ (b) $\frac{25}{51}$ (c) $\frac{15}{52}$ (d) $\frac{5}{52}$

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

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

Required probability $=P(B/R)$

$$\frac{P(B)\cdot P(R\,|\,B)}{P(B)\cdot P(R\,|\,B)+P(A)\cdot P(R\,|\,A)}$$

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

Ans: (a)

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

Options:

(a) $\frac{2}{5}$ (b) $\frac{3}{5}$ (c) 0 (d) 1

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

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

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

Ans: (d)

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

Options:

(a) $y-3=cx$ (b) $(y-3)^2+2cx=0$ (c) $(y+3)^2=cx$ (d) $(y-3)^2=cx$

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

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

Ans: (c)

106.If $|x+5|\ge 10$ then

Options:

(a) $x\in(-15,5]$ (b) $x\in(-5,5]$

(c) $x\in(-\infty,-15]\cup[5,\infty)$ (d) $x\in(-\infty,-15)\cap(5,\infty)$

Sol: $|x+5|\ge 10 \Rightarrow \quad x+5\le -10$ or $x+5\ge 10$

$\Rightarrow \quad x\le -15$ or $x\ge 5 \quad \Rightarrow x\in(-\infty,-15]\cup[5,\infty)$

Ans: (c)

107.The equation of the line parallel to the line $3x-4y+2=0$ and passing through $(-2,3)$ is

Options:

(a) $3x-4y+18=-0$ (b) $3x-4y-18=0$ (c) $3x+4y+18=0$ (d) $3x+4y-18=0$

Sol: Equation of line parallel to $3x-4y+2=0$ and through $(-2,3)$ is given by,

$3(x+2)-4(y-3)=0$ $\quad (\because\ a(x-x_1)+b(y-y_1)=0)$

$\Rightarrow \quad 3x-4y+18=0$

Ans: (a)

108.If $\left(\frac{1-i}{1+i}\right)^{96}=a+ib$ then (a,b) is

Options:

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

Sol: We have, $\left(\frac{1-i}{1+i}\right)^{96}=a+b \Rightarrow (-i)^{96}=a+ib \Rightarrow 1=a+ib \Rightarrow a=1, b=0$

Thus, $(a,b)=(1,0)$

Ans: (b)

109.The number of ways in which 5 girls and 3 boys can be seated in a row so that no two boys are together is

Options:

(a) 14040 (b) 14440 (c) 14000 (d) 14400

Sol:

5 girls can be arranged in a row in $5!$ ways. We have, 6 places where we can accommodate 3 boys.

This can be done in $6C_3\times 3!$ ways.

Thus, required number $=5!\times 6C_3\times 3!=120\times\frac{6\times5\times4}{1\times2\times3}\times 6=14400$

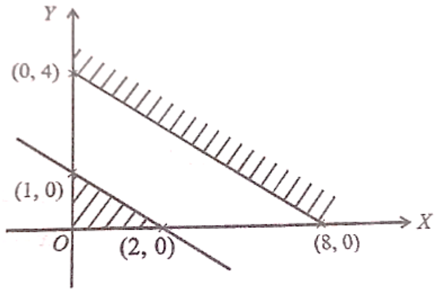
Ans: (d)

110.For the LPP, maximise $z=x+4y$ subject to the constraints $x+2y\le 2,\ \ x+2y\ge 8,\ x,y\ge 0$

Options:

(a) $z_{max}=4$ (b) $z_{max}=8$ (c) $z_{max}=18$ (d) Has no feasible solution

Sol: We have, $z = x + 4y$, $x + 2y \le 2$, $x + 2y \ge 8$, $x, y \ge 0$



From figure, it follows, no feasible solution.

Ans: (d)

111. $\int_0^{\pi/2} \frac{\sin^{1000} x dx}{\sin^{1000} x + \cos^{1000} x}$ is equal to

Options:

(a) $\frac{\pi}{2}$ (b) 1000 (c) $\frac{\pi}{4}$ (d) 1

Sol: $\int_0^{\pi/2} \frac{\sin^n x}{\sin^n x + \cos^n x} dx = \frac{\pi}{4}$

Ans: (c)

112. The value of $\sin^{-1}\left(\cos\frac{53\pi}{5}\right)$ is

Options:

(a) $\frac{\pi}{10}$ (b) $\frac{3\pi}{5}$ (c) $\frac{-\pi}{10}$ (d) $\frac{-3\pi}{5}$

Sol:

$$\cos\frac{53\pi}{5} = \cos\left(10\pi + \frac{3\pi}{5}\right) = \cos\frac{3\pi}{5} = \sin\left(\frac{\pi}{2} - \frac{3\pi}{5}\right) = \sin\left(-\frac{\pi}{10}\right)$$

Now, $\sin^{-1}\left(\cos\frac{53\pi}{5}\right) = \sin^{-1}\left(\sin\left(-\frac{\pi}{10}\right)\right) = -\frac{\pi}{10}$

Ans: (c)

113. The value of $\int \frac{e^x\left(x^2 \tan^{-1} + \tan^{-1} x + 1\right)}{x^2 + 1} dx$ is equal to

Options:

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

Sol:

$$I = \int \frac{e^x\left[\left(1 + x^2\right)\tan^{-1} x + 1\right]}{1 + x^2} dx = \int e^x\left[\tan^{-1} x + \frac{1}{1 + x^2}\right] dx = e^x \tan^{-1} x$$

Ans: (b)

114.If A is a matrix of order $m\times n$ and B is a matrix such that AB' *and* $B'A$ are both defined order of the matrix B is

Options:

(a) $n\times m$ (b) $m\times m$ (c) $m\times n$ (d) $n\times n$

Sol: A is of $m\times n$

$$\left.\begin{array}{l} AB' \text{ is possible if } B' \text{ is of } n\times p \text{ order} \\ B'A \text{ ispossible if } A \text{ is of } p\times n \text{ order} \end{array}\right] \Rightarrow p=m$$

Thus, B is of order $m\times n$.

Ans: (c)

115.The total number of terms in the expansion of $(x+a)^{47}-(x-a)^{47}$ after simplification is

Options:

(a) 24 (b) 47 (c) 48 (d) 96

Sol: Number of terms in $(x+a)^{47}-(x-a)^{47}=\dfrac{47+1}{2}=24$

[Number of terms in $(a+b)^n-(a-b)^n=\dfrac{n+1}{2}$]

Ans: (a)

116.The range of the function $f(x)=\sqrt{9-x^2}$ is

Options:

(a) $(0,3)$ (b) $[0,3]$ (c) $(0,3]$ (d) $[0,3)$

Sol: Let, $y=\sqrt{9-x^2}\Rightarrow y^2=9-x^2\Rightarrow x=\sqrt{9-y^2}$

Now, $9-y^2\geq 0\Rightarrow 9\geq y^2\Rightarrow -3\leq y\leq 3$

But, $y\geq 0$. Thus the range is $0\leq y\leq 3$,i.e., $y\in[0,3]$.

Ans: (b)

117.The area of triangle with vertices $(K,0),(4,0),(0,2)$ is 4 square units, then the value of K is

Options:

(a) 0 *or* 8 (b) 0 *or* -8 (c) 0 (d) 8

Sol: By data, $\frac{1}{2}\left[k(0-2)+4(2-0)+0(0)\right]=\pm 4\Rightarrow -2k+8=\pm 8\Rightarrow 2k=8\pm 8\Rightarrow k=0 \text{ or } 8$.

Ans: (a)

118.Let $f:R\to R$ be defined by $f(x)=x^4$, then

Options:

(a) f is one-one and onto

(b) f may be one-one and onto

(c) f is one-one but not onto

(d) f is neither one-one nor onto

Sol: Now, $f(-1)=1$ and $f(1)=1$, but $-1\neq 1$. Thus, f is not one-one.

Now, $-1\in R$ (codomain). But $-1\neq a^4$ for any $a\in R$ (domain). That is -1 is not the image of any element of the domain. Thus f is not onto.

Ans: (d)

119.If A is a square matrix of order 3×3, then $|KA|$ is equal to

Options:

(a) $K|A|$ (b) $K^2|A|$ (c) $K^3|A|$ (d) $3K|A|$

Sol: If A is 3×3 matrix then, $|kA|=k^3|A|$.

Ans: (c)

120.The integrating factor of the differential equation $x\cdot\frac{dy}{dx}+2y=x^2$ is $(x\neq 0)$

Options:

(a) x^2 (b) $\log|x|$ (c) $e^{\log x}$ (d) x

Sol: We have, $\frac{dy}{dx}+\frac{2}{x}y=x.\ I.F.=e^{\int\frac{2}{x}dx}=e^{2\log x}=e^{\log x^2}=x^2$ Ans: (a)

Physics

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

121.With what velocity should a particle be projected so that its height becomes equal to radius of Earth? (G is gravitational constant, M and R are mass and radius of the Earth)

(a) $\left(\frac{GM}{R}\right)^{1/2}$ (b) $\left(\frac{8GM}{R}\right)^{1/2}$ (c) $\left(\frac{2GM}{R}\right)^{1/2}$ (d) $\left(\frac{4GM}{R}\right)^{1/2}$

Sol: From law of conservation of energy, $\frac{1}{2}mu^2-\frac{GMm}{R}=\frac{1}{2}m\times(0)^2-\frac{GMm}{R+R}$

$\Rightarrow u^2=\frac{2GM}{R}-\frac{2GM}{2R}=\frac{GM}{R}\Rightarrow u=\sqrt{\frac{GM}{R}}$

Ans: (a)

122.A ball is falling in a lake of depth $200\,\text{m}$ creates a decrease 0.1% in its volume at the bottom. The bulk modulus of the material of the ball will be $\left(g=9.8\,\text{m}\,\text{s}^{-2}\right)$

(a) $19.6\times10^{-8}\,\text{N}\,\text{m}^{-2}$ (b) $19.6\times10^{10}\,\text{N}\,\text{m}^{-2}$ (c) $19.6\times10^{-10}\,\text{N}\,\text{m}^{-2}$ (d) $19.6\times10^{8}\,\text{N}\,\text{m}^{-2}$

Sol: Bulk modulus $=\frac{dP}{\frac{dV}{V}}$; $dp=h\rho g=200\times10^3\times9.8$

$\frac{dV}{V}=\frac{0.1}{100}$; Bulk modulus $=\frac{200\times10^3\times9.8}{0.1/100}=19.6\times10^8\,\text{N}\,\text{m}^{-2}$

Ans: (d)

123. A ring of mass $10\,\text{kg}$ and diameter $0.4\,\text{m}$ is rotated about its axis. If it makes 2100 revolutions per minute, then its angular momentum will be about

(a) $44\,\text{kg}\,\text{m}^2\,\text{s}^{-1}$ (b) $88\,\text{kg}\,\text{m}^2\,\text{s}^{-1}$ (c) $4.4\,\text{kg}\,\text{m}^2\,\text{s}^{-1}$ (d) $0.4\,\text{kg}\,\text{m}^2\,\text{s}^{-1}$

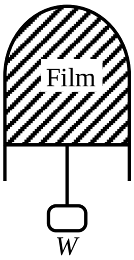
Sol: $I = mr^2 = 10\times(0.2)^2 = 0.4\,\text{kg}-\text{m}^2$

$\omega = 2\pi n = 2\pi\times\frac{2100}{60}\,\text{rad}\,\text{s}^{-1}$

$\therefore L = I\omega = \frac{0.4\times 2\pi\times 210}{6} = 88\,\text{kg}\,\text{m}^2\text{s}^{-1}$

Ans: (b)

124. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of $1.5\times10^{-2}\,\text{N}$ (see figure). The length of the slider is $30\,\text{cm}$ and its weight negligible. The surface tension of the liquid film is



(a) $0.0125\,\text{N}\,\text{m}^{-1}$ (b) $0.1\,\text{N}\,\text{m}^{-1}$ (c) $0.05\,\text{N}\,\text{m}^{-1}$ (d) $0.025\,\text{N}\,\text{m}^{-1}$

Sol: At equilibrium, weight of the given block is balanced by force due to surface tension, i.e.,

$2L\cdot S = W$

or $S = \frac{W}{2L} = \frac{1.5\times10^{-2}\,\text{N}}{2\times0.3\,\text{m}} = 0.025\,\text{Nm}^{-1}$

Ans: (d)

125. The ratio of the coefficient of thermal conductivity of two different materials is $5:3$. If the thermal resistance of the two rods of these materials of same thickness is same, then the ratio of the length of these rods will be

(a) $5:3$ (b) $3:5$ (c) $9:25$ (d) $25:9$

Sol: $R = \frac{l}{kA}$

$R = \text{same},\ l = \text{same}$

$\therefore\ \frac{l_1}{l_2} = \frac{k_1}{k_2} = \frac{5}{3}$

Ans: (a)

126. A gas at the temperature $250\,\text{K}$ is contained in a closed vessel. If the gas is heated through $25\,\text{K}$, then the percentage increase in its pressure will be

(a) 10% (b) 20% (c) 30% (d) 40%

Sol: $P \propto T \quad \Rightarrow \frac{P_1}{P_2} = \frac{T_1}{T_2} \qquad \Rightarrow \frac{P_2 - P_1}{P_1} = \frac{T_2 - T_1}{T_1}$

$\Rightarrow \left(\frac{\Delta P}{P}\right)\% = \left(\frac{275-250}{250}\right) \times 100 = 10\%$

Ans: (a)

127.If Q, E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then

(a) $E = 0$ (b) $Q = 0$ (c) $W = 0$ (d) $Q = W = 0$

Sol: In a closed cyclic process change in internal energy is always zero.

$\therefore E = 0$

Ans: (a)

128.A hollow sphere is filled with water. It is hung by a long thread. As the water flows out of a hole at the bottom, the period of oscillation will

(a) First increase and then decrease (b) First decrease and then increase

(c) Go on increasing (d) Go on decreasing

Sol: Time period of simple pendulum, $T = 2\pi\sqrt{\left(\frac{l}{g}\right)} \propto \sqrt{l}$ where l is effective length [i.e., distance between centre of suspension and centre of gravity of bob].

Initially, centre of gravity is at the centre of sphere. When water leaks the centre of gravity goes down until it is half filled, then it begins to go up and finally it again goes at the centre. That is effective length first increases and then decreases. As $T \propto \sqrt{l}$, so time period first increases and then decreases.

Ans: (a)

129.What type of vibrations are produced in a sitar wire?

(a) Progressive transverse (b) Progressive longitudinal

(c) Stationary transverse (d) Stationary longitudinal

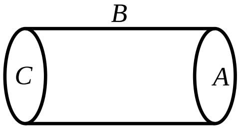
Sol: When vibrations are produced in a sitar wire the superposition takes place between incident and reflected wave from the rigid ends and a new wave is produced which appears stationary in the medium. This wave is called stationary in the medium. This wave is called stationary wave and its nature is transverse.

Ans: (c)

130.A hollow cylinder has a charge qC within it. If ϕ is the electric flux in units of V-m associated with the curved surface B, the flux linked with the plane surface A in units of V-m will be

(a) $\frac{q}{2\varepsilon_0}$ (b) $\frac{\phi}{3}$

(c) $\left(\frac{q}{\varepsilon_0} - \phi\right)$ (d) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$



Sol: Since $\phi_{total} = \phi_A + \phi_B + \phi_C = \frac{q}{\varepsilon_0}$ where q is the total charge. As shown in the figure, flux associated with the curved surface B is $\phi = \phi_B$. Let us assume flux linked with the plane surfaces A and C be $\phi_A = \phi_C = \phi'$

Therefore, $\frac{q}{\varepsilon_0} = 2\phi' + \phi_B = 2\phi' + \phi$

$\Rightarrow \phi' = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$

Ans: (d)

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

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

Sol: Charge $(q) = 0.2\,\text{C}$; Distance $(d) = 2\,\text{m}$; Angle $\theta = 60°$ and Work done $(W) = 4\,\text{J}$

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

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

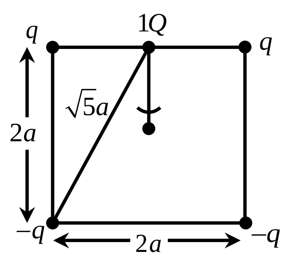
Ans: (d)

132.Two positive charges of magnitude q are placed at the ends of a side l of a square of side $2a$. Two negative charges of the same magnitude are kept at the other corners. Starting from rest, if a charge Q moves from the middle of side l to the centre of square, its kinetic energy at the centre of square is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{1}{\sqrt{5}}\right)$ (b) zero

(c) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1+\frac{1}{\sqrt{5}}\right)$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{2}{\sqrt{5}}\right)$

Sol: $U_i = \frac{2kqQ}{a} + \frac{2k(-q)Q}{\sqrt{5}\,a} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{2qQ}{a}\left[1-\frac{1}{\sqrt{5}}\right]$



$U_f = 0$

By conservation of energy, Gain in KE = loss in PE

$K = \frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left[1-\frac{1}{\sqrt{5}}\right]$

Ans: (a)

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

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

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

Sol: Total charge, $Q = 80 + 40 = 120\,\mu\text{C}$. By using the formula, $Q_1' = Q\left[\frac{r_1}{r_1+r_2}\right]$

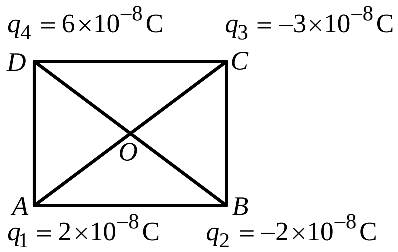
New charge on sphere A is $Q_A' = Q\left[\frac{r_A}{r_A+r_B}\right] = 120\left[\frac{4}{4+6}\right] = 48\,\mu\text{C}$

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

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

(a) $270\,\text{V}$ (b) $300\,\text{V}$ (c) Zero (d) $100\,\text{V}$

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



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

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

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

$V = k\times3\times10^{-8} = 9\times10^{9}\times3\times10^{-8}$ volt; $V = 27\times10 = 270$ volt

Ans: (a)

135. A parallel plate capacitor has a plate area of $50\,\text{cm}^2$ and plate separation of $1.0\,\text{cm}$. A potential difference of 200 volt is applied across the plates with air as the dielectric between plates. The battery is then disconnected and a piece of Bakelite of dielectric constant 4.8 inserted which fills the complete volume between the plates. The capacitance before and after inserting Bakelite are respectively.

(a) $44\,\text{pF}$, $211.2\,\text{pF}$ (b) $4.4\,\text{pF}$, $211.2\,\text{pF}$ (c) $4.4\,\text{pF}$, 21.1pF (d) $21.12\,\text{pF}$, $44\,\text{pF}$

Sol: $C = \frac{k\varepsilon_0 A}{d} = \frac{1\times8.85\times10^{-12}\times50\times10^{-4}}{1.0\times10^{-2}}$

$= 8.85\times5\times10^{-13}$ ($\because$ for air, $k = 1$)

$= 44.25\times10^{-13} = 4.4\times10^{-12} = 4.4$ pF

The capacitance after inserting Bakelite (K = dielectric constant)

$C'' = KC = 4.8\times4.4\,\text{pF} = 21.12\,\text{pF}$

Ans: (c)

136. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)

(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$ (c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$

Sol: Let n be the number of electrons missing.

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{d^2} \Rightarrow q = \sqrt{4\pi\varepsilon_0 d^2 F} = ne\,; \quad \therefore n = \sqrt{\frac{4\pi\varepsilon_0 F d^2}{e^2}}$$

Ans: (c)

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

(a) $-5.6 \times 10^{-11}\,\text{N C}^{-1}$ (b) $-4.8 \times 10^{-15}\,\text{N C}^{-1}$ (c) $-1.6 \times 10^{-19}\,\text{N C}^{-1}$ (d) $-3.2 \times 10^{-19}\,\text{N C}^{-1}$

Sol: $-eE = mg$

$$\vec{E} = \frac{9.1 \times 10^{-31} \times 10}{1.6 \times 10^{-19}} = -5.6 \times 10^{-11}\,\text{N C}^{-1}$$

Ans: (a)

138. At room temperature, copper has free electron density of 8.4×10^{28} per m^3. The copper conductor has a cross-section of $10^{-6}\,\text{m}^2$ and carries a current of $5.4\,\text{A}$. The electron drift velocity in copper is

(a) $400\,\text{m s}^{-1}$ (b) $0.4\,\text{m s}^{-1}$ (c) $0.4\,\text{mm s}^{-1}$ (d) $72\,\text{m s}^{-1}$

Sol: $v_d = \frac{I}{neA}$ Here, $I = 5.4\,\text{A}$, $n = 8.4 \times 10^{28}$ per m^3

$A = 10^{-6}\,\text{m}^2$, $e = 1.6 \times 10^{-19}\,\text{C}$ $\quad \therefore v_d = \frac{5.4}{8.4 \times 10^{28} \times 1.6 \times 10^{-19} \times 10^{-6}} = 0.4\,\text{mm s}^{-1}$

Ans: (c)

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

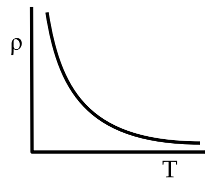
(a) $4:1$ (b) $1:4$ (c) $1:2$ (d) $2:1$

Sol: $P_1 = 100\,\text{W}$, $P_2 = 200\,\text{W}$; $R_1 = \frac{V^2}{P_1} = \frac{220 \times 220}{100} = 22 \times 22\,\Omega$

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

Ans: (d)

140. The graph shows the variation of resistivity with temperature T. The graph can be of



(a) Copper
(b) Nichrome
(c) Germanium
(d) Silver

Sol: The resistivity of semiconductor decreases with increase in temperature.

Ans: (c)

141. The resistance of a wire at room temperature $30°\text{C}$ is found to be $10\,\Omega$. Now to increase the resistance by 10%, the temperature of the wire must be [The temperature coefficient of resistance of the material of the wire is 0.002 per °C]

(a) 36°C (b) 83°C (c) 63°C (d) 33°C

Sol: $R_t = R_0(1+\alpha t)$

Initially, $R_0(1+30\alpha) = 10\Omega$

Finally, $R_0(1+\alpha t) = 11\Omega \quad \therefore \frac{11}{10} = \frac{1+\alpha t}{1+30\alpha}$

Or, $10 + (10 \times 0.002 \times t) = 11 + 330 \times 0.002$ Or, $0.02t = 1 + 0.66 = 1.066$ or $t = \frac{1.66}{0.02} = 83°C$

Ans: (b)

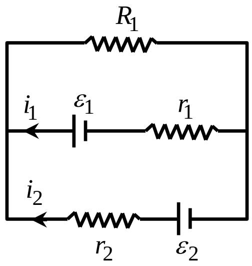
142.See the electric circuit shown in the figure. Which of the following equations is a correct equation for it?

(a) $\varepsilon_2 - i_2 r_2 - \varepsilon_1 - i_1 r_1 = 0$

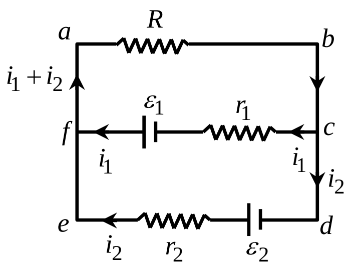
(b) $-\varepsilon_2 - (i_1 + i_2)R + i_2 r_2 = 0$

(c) $\varepsilon_1 - (i_1 + i_2)R + i_1 r_1 = 0$

(d) $\varepsilon_1 - (i_1 + i_2)R - i_1 r_1 = 0$



Sol:



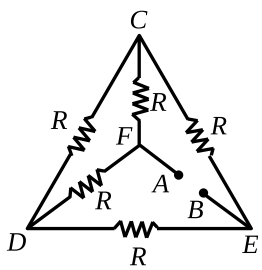
Applying Kirchhoff's rule in loop $abcfa$, $\varepsilon_1 - (i_1 + i_2)R - i_1 r_1 = 0$

Ans: (d)

143.Five equal resistances each of resistance R are connected as shown in the figure. A battery of V volts is connected between A and B. The current flowing in $AFCEB$ will be

(a) $\frac{2V}{R}$ (b) $\frac{3V}{R}$

(c) $\frac{V}{R}$ (d) $\frac{V}{2R}$



Sol:

A balanced Wheatstone' bridge exists between A and B; $R_{eq} = R$

Current through circuit is V/R

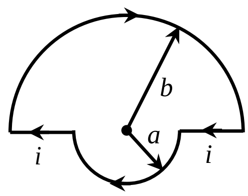
Current through $AFCEB = V/2R$

Ans: (d)

144.You are given a closed circuit with radii a and b as shown in figure carrying current i. The magnetic dipole moment of the circuit is

(a) $\pi(a^2 + b^2)i$ (b) $\frac{1}{2}\pi(a^2 + b^2)i$

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



Sol:

$$m = \text{current} \times \text{area} = i\left(\frac{1}{2}\pi a^2 + \frac{1}{2}\pi b^2\right) = \frac{1}{2}i\pi\left(a^2 + b^2\right)$$

Ans: (b)

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

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

Sol: KE of electron $= 10\,\text{eV}$

$$\Rightarrow \frac{1}{2}mv^2 = 10\,\text{eV}$$

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

$$\Rightarrow v^2 = \frac{2\times10\times1.6\times10^{-19}}{9.1\times10^{-31}}$$

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

Also we know that for circular motion,

$$\frac{mv^2}{r} = Bev \Rightarrow r = \frac{mv}{Be} = 11\,\text{cm}$$

Ans: (c)

146. The length of a solenoid is $0.4\,\text{m}$ and the number of turns in it is 500. A current of $3\,\text{A}$ is flowing in it. In a small coil of radius 0.01m and number of turns 10, a current of $0.4\,\text{A}$ is flowing. The torque necessary to keep the axis of this coil perpendicular to the axis of solenoid will be

(a) $3.6\times10^{-6}\,\text{N m}$ (b) $3.6\times10^{-4}\,\text{N m}$ (c) 3.6×10^{-6} dyne-cm (d) 3.6×10^{-4} dyne-cm

Sol:

$$\tau_{\max} = MB = niAB = ni\left(l\times b\right)B$$

$$\tau_{\max} = 600\times10^{-5}\times5\times10^{-2}\times12\times10^{-2}\times0.10 = 3.6\times10^{-6}\,\text{N m}$$

Ans: (a)

147. An electric current of 30 ampere is flowing in each of two parallel conducting wires placed $5\,\text{cm}$ apart. The force acting per unit length on either of the wires will be

(a) $3.6\times10^{-3}\,\text{N m}^{-1}$ (b) $3.6\times10^{-3}\,\text{dyne cm}^{-1}$ (c) $3.6\times10^{-5}\,\text{N m}^{-1}$ (d) $3.6\times10^{-2}\,\text{N m}^{-1}$

Sol:

$$F' = \frac{\mu_0 i_1 i_2}{2\pi r} \quad \text{or}$$

$$F' = \frac{4\pi\times10^{-7}\times30\times30}{2\times\pi\times5\times10^{-2}} = 3.6\times10^{-3}\,\text{Nm}^{-1}$$

Ans: (a)

148. A vibration magnetometer placed in magnetic meridian has a small bar magnet. The magnet executes oscillations with a time period of $2\,s$ in Earth's horizontal magnetic field of 24 microtesla. When a horizontal field of 18 microtesla is produced opposite to the Earth's field by placing a current carrying wire, the new time period of magnet will be

(a) $1s$ (b) $2\,s$ (c) $3\,s$ (d) $4\,s$

Sol: Time period of a vibration magnetometer, $T \propto \frac{1}{\sqrt{B}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2}{B_1}}$

$$\Rightarrow T_2 = T_1\sqrt{\frac{B_1}{B_2}} = 2\sqrt{\frac{24\times10^{-6}}{6\times10^{-6}}} = 4\,s$$

Ans: (d)

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

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

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

$$\Rightarrow \frac{100\times10^{-3}\times40}{800\times10^{-3}} = 1+\frac{40}{S} \quad \Rightarrow S = 10\,\Omega$$

Ans: (a)

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

(a) neither a force nor a torque (b) a torque but not a force
(c) a force but not a torque (d) a force and a torque

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

Ans: (d)

151. A six pole generator with fixed field excitation develops an e.m.f. of 100 V when operating at 1500 r.p.m. At what speed must it rotate to develop $120\,V$?

(a) 1200 r.p.m (b) 1800 r.p.m (c) 1500 r.p.m (d) 400 r.p.m

Sol: The e.m.f. induced is directly proportional to rate at which flux is intercepted which in turn varies directly as the speed of rotation of the generator.

$$\varepsilon \propto v \qquad \varepsilon_2 = \frac{v_2}{v_1}\times\varepsilon_1 \Rightarrow 120 = \frac{v_2}{1500}\times100$$

$\therefore v_2 = 1800$ rpm

Ans: (b)

152. A coil of $N = 100$ turns carries a current $I = 5\,A$ and creates a magnetic flux $\phi = 10^{-5}\,Tm^2$ per turn. The value of its inductance L will be

(a) $0.05\,mH$ (b) $0.10\,mH$ (c) $0.15\,mH$ (d) $0.20\,mH$

Sol: $N\phi = Li \Rightarrow L = \frac{N\phi}{i} = \frac{100\times10^{-5}}{5} = 0.20\,\text{mH}$

Ans: (d)

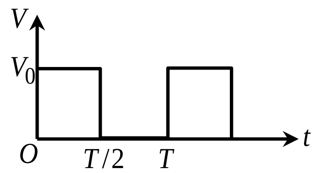
153.A transformer reduces $220\,\text{V}$ to $11\,\text{V}$. The primary draws $5\,\text{A}$ of current and secondary $90\,\text{A}$. The efficiency of the transformer is

(a) 20% (b) 40% (c) 70% (d) 90%

Sol: $\eta = \frac{E_S I_S}{E_p I_p}$ $\therefore \eta = \frac{11\times90}{220\times5} = 0.9\times100\% = 90\%$

Ans: (d)

154.The r.m.s. value of potential difference V shown in the figure is



(a) V_0 (b) $V_0/\sqrt{2}$

(c) $V_0/2$ (d) $V_0/\sqrt{3}$

Sol: $V_{\text{rms}} = \sqrt{\frac{(T/2)V_0^2 + 0}{T}} = \frac{V_0}{\sqrt{2}}$

Ans: (b)

155.In series combination of R, L and C with an $A.C$ source at resonance, if $R = 20$ ohm, then impedence Z of the combination is

(a) 20 ohm (b) Zero (c) 10 ohm (d) 400 ohm

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

Now, $X_L = X_C \quad \Rightarrow Z = R = 20\Omega$

Ans: (a)

156.The range of wavelength of visible light is

(a) 10Å to 100 Å (b) 4000 Å to 8000Å

(c) 8000Å to 10,000Å (d) 10,000Å to 15,000Å

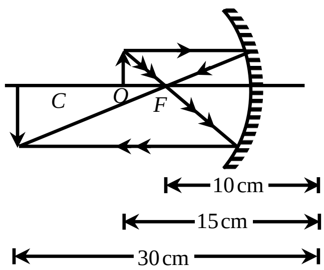
Sol: The range of visible radiations is 4000Å to 8000Å

Ans: (b)

157.A $2.0\,\text{cm}$ tall object is placed $15\,\text{cm}$ in front of a concave mirror of focal length $10\,\text{cm}$. What is the size and nature of the image?

(a) $4\,\text{cm}$, real (b) $4\,\text{cm}$, virtual (c) $1.0\,\text{cm}$, real (d) None of these

Sol: According to New Cartesian sign convention,



Object distance, $u = -15\,\text{cm}$

Focal length of a concave lens, $f = -10\,\text{cm}$

Height of the object, $h_0 = 2.0\,\text{cm}$

According to mirror formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{-10}-\frac{1}{-15}\Rightarrow v=-30\,\text{cm}$$

This image is formed $30\,\text{cm}$ from the mirror on the same side of the object. It is real image.

Magnification of the mirror, $m=\frac{-v}{u}=\frac{h_1}{h_0}\quad\Rightarrow\frac{-(-30)}{-15}=\frac{h_1}{2}\Rightarrow h_1=-4\,\text{cm}$

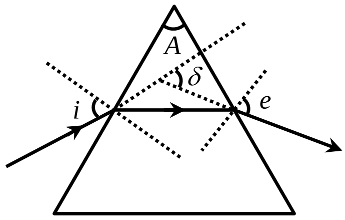
Negative sign shows that image is inverted. The image is real, inverted, of size $4\,\text{cm}$ at a distance $30\,\text{cm}$ in front of the mirror.

Ans: (a)

158. 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 $e=\frac{3}{4}A\quad\therefore\delta=\frac{3}{4}A+\frac{3}{4}A-A=\frac{A}{2}$

For equilateral prism, $A=60°$

$\therefore\delta=\frac{60°}{2}=30°$

Ans: (b)

159. Light travels in two media A and B with speeds $1.8\times10^8\,\text{m s}^{-1}$ and $2.4\times10^8\,\text{m s}^{-1}$ respectively. Then the critical angle between them is

(a) $\sin^{-1}\left(\frac{2}{3}\right)$ (b) $\tan^{-1}\left(\frac{3}{4}\right)$ (c) $\tan^{-1}\left(\frac{2}{3}\right)$ (d) $\sin^{-1}\left(\frac{3}{4}\right)$

Sol: Here, $v_A=1.8\times10^8\,\text{m s}^{-1}$ and $v_B=2.4\times10^8\,\text{m s}^{-1}$

Light travels slower in denser medium. Hence medium A is a denser medium and medium B is a rarer medium. Here, light travels from medium A to medium B. Let C be the critical angle between them.

$\therefore\sin C={}_A\mu_B=\frac{1}{{}_B\mu_A}$

Refractive index of medium B w.r.t. medium A is ${}_A\mu_B=\frac{\text{Velocity of light in medium }A}{\text{Velocity of light in medium }B}=\frac{v_A}{v_B}$

$\therefore\sin C=\frac{v_A}{v_B}=\frac{1.8\times10^8}{2.4\times10^8}=\frac{3}{4}\quad\Rightarrow C=\sin^{-1}\left(\frac{3}{4}\right)$

Ans: (d)

160. A thin prism of angle $15°$ made of glass of refractive index $\mu_1=1.5$ is combined with another prism of glass of refractive index $\mu_2=1.75$. The combination of the prism produces dispersion without deviation. The angle of the second prism should be

(a) $7°$ (b) $10°$ (c) $12°$ (d) $5°$

Sol: Deviation = zero

So, $\delta = \delta_1 + \delta_2 = 0$

$\Rightarrow (\mu_1 - 1)A_1 + (\mu_2 - 1)A_2 = 0$

$\Rightarrow A_2(1.75 - 1) = -(1.5 - 1)15°$

$\Rightarrow A_2 = -\dfrac{0.5}{0.75} \times 15°$ or $A_2 = -10°$

Negative sign shows that the second prism is inverted with respect to the first.

Ans: (b)

161.If two waves represented by $y_1 = 4\sin\omega t$ and $y_2 = 3\sin\left(\omega t + \dfrac{\pi}{3}\right)$ interfere at a point, the amplitude of the resulting wave will be about

(a) 7 (b) 6 (c) 5 (d) 3.5

Sol:

$\phi = \dfrac{\pi}{3},\ a_1 = 4,\ a_2 = 3$

So, $A = \sqrt{a_1^2 + a_2^2 + 2a_1 \cdot a_2 \cos\phi} \Rightarrow A \approx 6$

Ans: (b)

162.Green light of wavelength 5460 Å is incident on an air-glass interface. If the refractive index of glass is 1.5, the wavelength of light in glass would be ($c = 3\times10^8\ \text{m s}^{-1}$)

(a) 3640 Å (b) 5460 Å

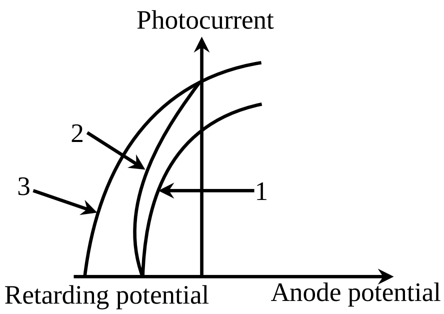
(c) 4861 Å (d) None of these

Sol:

$\lambda_g = \dfrac{\lambda_a}{\mu} = \dfrac{5460}{1.5} = 3640\ \text{Å}$

Ans: (a)

163.The figure shows a plot of photocurrent versus anode potential for a photosensitive surface for three different radiations. Which one of the following is a correct statement?



(a) Curves (1) and (2) represent incident radiations of same frequency but of different intensities

(b) Curves (2) and (3) represent incident radiations of different frequencies and different intensities

(c) Curves (2) and (3) represent incident radiations of same frequency having same intensity

(d) Curves (1) and (2) represent incident radiations of different frequencies and different intensities

Sol: Retarding potential depends on the frequency of incident radiation but is independent of intensity.

Ans: (a)

164. Which metal will be suitable for a photoelectric cell using light of wavelength $4000\,\text{Å}$. The work functions of sodium and copper are respectively $2.0\,\text{eV}$ and $4.0\,\text{eV}$.

(a) Sodium (b) Copper (c) Both (d) None of these

Sol:

$$\because \lambda_0 = \frac{hc}{\phi}$$

$$\therefore (\lambda_0)_{\text{sodium}} = \frac{6.6\times10^{-34}\times3\times10^{8}}{2\times1.6\times10^{-19}} = 6188\,\text{Å}$$

$$\because \lambda_0 \propto \frac{1}{\phi} \Rightarrow \frac{(\lambda_0)_{\text{sodium}}}{(\lambda_0)_{\text{copper}}} = \frac{(\phi)_{\text{copper}}}{(\phi)_{\text{sodium}}}$$

$$\Rightarrow (\lambda_0)_{\text{copper}} = \frac{2}{4}\times6188 = 3094\,\text{Å}$$

To eject photoelectrons from sodium the longest wavelength is $6188\,\text{Å}$ and that for copper is $3094\,\text{Å}$. Hence for light of wavelength $4000\,\text{Å}$, sodium is suitable.

Ans: (a)

165. In Bohr model of hydrogen atom, let $P.E.$ represents potential energy and $T.E.$ represents the total energy. In going to a higher level.

(a) $P.E.$ decreases, $T.E.$ increases (b) $P.E.$ increases, $T.E.$ decreases

(c) $P.E.$ decreases, $T.E.$ decreases (d) $P.E.$ increases, $T.E.$ increases

Sol: $P.E.$ increases, $T.E.$ increases

Ans: (d)

166. An $\alpha-$particle of energy $5\,\text{MeV}$ is scattered through 180° by a fixed uranium nucleus. The distance of closest approach is of the order of

(a) 10^{-12} cm (b) 10^{-10} cm (c) 1Å (d) 10^{-15} cm

Sol: Distance of closest approach, $r_0 = \dfrac{Ze(2e)}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)}$

Energy, $E = 5\times10^{6}\times1.6\times10^{-19}$ J

$$\therefore r_0 = \frac{9\times10^{9}\times\left(92\times1.6\times10^{-19}\right)\left(2\times1.6\times10^{-19}\right)}{5\times10^{6}\times1.6\times10^{-19}}$$

$$\Rightarrow r = 5.2\times10^{-14}\,\text{m} = 5.3\times10^{-12}\,\text{cm}$$

Ans: (a)

167. 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)

168. The mass defect in a particular nuclear reaction is 0.3 grams. The amount of energy liberated in kilowatt hour is (Velocity of light $= 3\times10^8\ \text{m s}^{-1}$)

(a) 1.5×10^6
(b) 2.5×10^6
(c) 3×10^6
(d) 7.5×10^6

Sol: $E = \Delta mc^2 \Rightarrow E = \frac{0.3}{1000}\times\left(3\times10^8\right)^2 = 2.7\times10^{13}\ \text{J}$

$= \frac{2.7\times10^{13}}{3.6\times10^6} = 7.5\times10^6\ \text{kWh}$

Ans: (d)

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

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

Sol: $p_1 = p_2\ ;\ m_1v_1 = m_2v_2$

$2m_1 = m_2\ 2\rho\cdot\frac{4}{3}\pi R_1^3 = \rho\cdot\frac{4}{3}\pi R_2^3;\ \frac{R_1^3}{R_2^3} = 1:2;\ R_1 : R_2 = 1:2^{1/3}$

Ans: (d)

170. If the total binding energies of $_1^2H$, $_2^4He$, $_{26}^{56}Fe$ & $_{92}^{235}U$ nuclei are 2.22, 28.3, 492 and 1786 MeV respectively, identify the most stable nucleus of the following.

(a) $_{26}^{56}Fe$
(b) $_1^2H$
(c) $_{92}^{235}U$
(d) $_2^4He$

Sol: $B.E_H = \frac{2.22}{2} = 1.11$

$B.E_{He} = \frac{28.3}{4} = 7.08$

$B.E._{Fe} = \frac{492}{56} = 8.78 = \text{maximum}$

$B.E_U = \frac{1786}{235} = 7.6$

$_{26}^{56}Fe$ is most stable as it has maximum binding energy per nucleon.

Ans: (a)

171. At absolute zero, Si acts as

(a) non-metal
(b) metal
(c) insulator
(d) none of these

Sol:

Semiconductors are insulators at room temperature.

Ans: (c)

172. In semiconductors, at room temperature

(a) The conduction band is completely empty

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

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

(d) The valence band is completely filled

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

Ans: (c)

173. Reverse bias applied to a junction diode

(a) Increases the minority carrier current

(b) Lowers the potential barrier

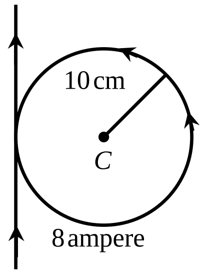
(c) Raises the potential barrier

(d) Increases the majority carrier current

Sol: In reverse biasing, the conduction across the $p-n$ junction does not take place due to majority carriers, but takes place due to minority carriers if the voltage of external battery is large. The size of the depletion region increases thereby increasing the potential barrier.

Ans: (c)

174. A long straight wire is turned into a loop of radius $10\,\text{cm}$ (see figure). If a current of 8 amperes is passed through the loop, then the value of the magnetic field and its direction at the centre C of the loop shall be close to



(a) 5.0×10^{-5} Newton/(ampere-meter), upward

(b) 3.4×10^{-5} Newton/(ampere-meter), upward

(c) 1.6×10^{-5} Newton/(ampere-meter), downward

(d) 1.6×10^{-5} Newton/(ampere-meter), upward

Sol: B at the centre of a coil carrying a current, i is $B_{\text{coil}} = \dfrac{m_0 i}{2t}$ [upward]

B due to wire $B_{\text{wire}} = \dfrac{\mu_0 i}{2\pi r}$ [downward]

Given, $i = 8\,\text{A}$; $r = 10\times10^{-2}\,\text{m}$ $\dfrac{\mu_0}{4\pi} = 10^{-7}$

Magnetic field at centre C, $B_C = B_{\text{coil}} + B_{\text{wire}} = \dfrac{\mu_0 i}{2r}(\text{upward}) + \dfrac{\mu_0 i}{2\pi r}(\text{downward})$

$$= \frac{\mu_0 i}{2r} - \frac{\mu_0 i}{2\pi r} = \frac{\mu_0 i}{2r}\left(1-\frac{1}{\pi}\right) \text{ upward}$$

$$= \frac{4\pi\times10^{-7}\times8}{2\times10\times10^{-2}}\left(1-\frac{1}{3.14}\right) \text{ upward}$$

$$= \frac{4\times3.14\times10^{-7}\times8\times2.14}{2\times10\times10^{-2}\times3.14} = 3.424\times10^{-5} \text{ upward}$$

Ans: (b)

175.Turpentine oil is flowing through a tube of length l and radius r. The pressure difference between the two ends of the tube is p. The viscosity of oil is given by $\eta = \frac{p\left(r^2 - x^2\right)}{4vl}$ where v is the velocity of oil at a distance x from the axis of the tube. The dimensions of η are

(a) $\left[M^0L^0T^0\right]$ (b) $\left[MLT^{-1}\right]$ (c) $\left[ML^2T^{-2}\right]$ (d) $\left[ML^{-1}T^{-1}\right]$

Sol:

$$\eta = \frac{p\left(r^2 - x^2\right)}{4vl} = \frac{\left(ML^{-1}T^{-2}\right)\left(L^2\right)}{\left(LT^{-1}\right)(L)} = \left[ML^{-1}T^{-1}\right]$$

Ans: (d)

176.If a car covers $(2/5)^{\text{th}}$ of the total distance with v_1 speed and $(3/5)^{\text{th}}$ distance with v_2 then average speed is

(a) $\frac{1}{2}\sqrt{v_1v_2}$ (b) $\frac{v_1+v_2}{2}$ (c) $\frac{2v_1v_2}{v_1+v_2}$ (d) $\frac{5v_1v_2}{3v_1+2v_2}$

Sol:

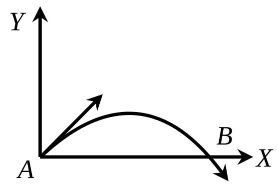
$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

$$= \frac{x}{\frac{2x/5}{v_1} + \frac{3x/5}{v_2}}$$

$$= \frac{5v_1v_2}{3v_1 + 2v_2}$$

Ans: (d)

177.The velocity of a projectile at the initial point A is $\left(2\hat{i} + 3\hat{j}\right)\text{m s}^{-1}$. Its velocity (in m s^{-1}) at point B is



(a) $-2\hat{i} + 3\hat{j}$ (b) $2\hat{i} - 3\hat{j}$

(c) $2\hat{i} + 3\hat{j}$ (d) $-2\hat{i} - 3\hat{j}$

Sol: At point B the direction of velocity component of the projectile along $Y-$axis reverses.

Hence, $\vec{V}_B = 2\hat{i} - 3\hat{j}$

Ans: (b)

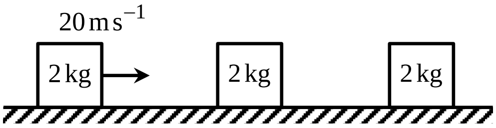
178.The maximum speed of a car on a road having turn of radius $30\,\text{m}$ if the coefficient of friction between the tyres and the road is 0.4 will be ($g = 9.8\,\text{m s}^{-2}$)

(a) $9.84\,\text{m s}^{-1}$ (b) $10.84\,\text{m s}^{-1}$ (c) $7.84\,\text{m s}^{-1}$ (d) $5.84\,\text{m s}^{-1}$

Sol: $v = \sqrt{\mu g r} = \sqrt{0.4 \times 30 \times 9.8} = 10.84\,\text{m s}^{-1}$

Ans: (b)

179. A block of mass $2\,kg$ collide with identical stationary block head on elastically with velocity of $20\,m\,s^{-1}$. After collision second block collide with the third block of mass $2\,kg$ initially at rest. If they collide head on perfectly inelastically then the velocity of their combination will be



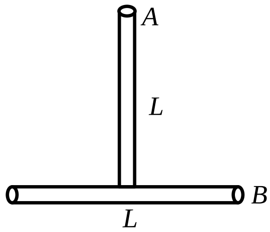
(a) $5\,m\,s^{-1}$ (b) $4\,m\,s^{-1}$ (c) $10\,m\,s^{-1}$ (d) $20\,m\,s^{-1}$

Sol: From momentum conservation in first collision velocity interchanges.

For second collision, $2 \times 20 = 4 \times v;\ v = 10\,m\,s^{-1}$

Ans: (c)

180. A T joint is formed by two identical rods A and B each of mass m and length L in the XY plane as shown. Its moment of inertia about axis coinciding with rod A is



(a) $\frac{2mL^2}{3}$ (b) $\frac{mL^2}{12}$

(c) $\frac{mL^2}{6}$ (d) None of these

Sol:

$$I = I_1 + I_2 \Rightarrow I = 0 + \frac{mL^2}{12} \Rightarrow I = \frac{mL^2}{12}$$

Ans: (b)

Key Answers:

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