Subject	Topic	Mock Test – 04	Date
C + M + P	Complete Syllabus	CET – 12 – CT C1220230505	5th May 2023

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

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

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

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

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

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

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

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

   All the best!!

Useful Data

At. Wt.:

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

Physical Constants:

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

Chemistry

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

1. If one atom of an element A weighs $6.644\times10^{-23}g$, then the molar mass in $g\,mol^{-1}$ of the element is

   Options:

   (a) 50

   (b) 40

   (c) 100

   (d) 20

   Sol: Atomic weight of A = weight of one atom $\times$ Avogadro's constant

   $= 6.644\times10^{-23}\times6.023\times10^{23} = 40g$

   Ans: (b)

2. The uncertainity in the momentum of an electonis 1.0×10^{-5} kg ms^{-1}. The uncertainty in its position will be (given $\frac{h}{4\pi}\approx5.25\times10^{-35}$)

   Options:

   (a) $1.05\times10^{-28}m$

   (b) $1.0510^{-26}m$

   (c) $5.27\times10^{-30}m$

   (d) $5.25\times10^{-28}m$

   Sol: We know, $\Delta x\cdot\Delta p = \frac{h}{4\pi}\approx5.25\times10^{-35}$

   $$\Delta x = \frac{5.25\times10^{-35}}{1.0\times10^{-5}} = 5.25\times10^{-30}m$$

   Ans: (c)

3. The order of first ionisation energies of the elements $Li,\ Be,\ B,\ Na$ is

   Options:

   (a) $Li > Be > B > Na$

   (b) $Be > B > Li > Na$

   (c) $Na > Li > B > Be$

   (d) $Be > Li > B > Na$

   Sol: Ionisation energy increases from left to right $(Li\rightarrow B)$ and decreases from top to bottom in periodic table. But Be $\left(1s^2 2s^2\right)$ has higher ionisation energy than $B\left(1s^2 2s^2 2p^1\right)$ due to fully filled $s-$ orbital electronic configuration.

   Ans: (b)

4. The hybridisation of xenon in XeF_2 is

Options:

(a) sp^3

(b) sp^2

(c) sp^3d (d) sp^3d^2

Sol: Total number of valence electrons $=8+2\times7=22$

$\frac{22}{8}=2(Q_1)+6(R_1),\ \frac{6}{2}=3(Q_2)+0(R_2)$

$X=Q_1+Q_2+R_2=2+3=5$

Hence, hybridisation is sp^3d

Ans: (c)

5. H_2O is dipolar, whereas BeF_2 is not. It is because

Options:

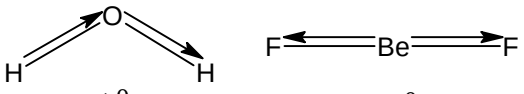
(a) H_2O is angular and BeF_2 is linear

(b) The electronegativity of F is greater than that of O

(c) H_2O involves hydrogen bonding whereas BeF_2 is a discrete molecule

(d) H_2O is linear and BeF_2 is angular

Sol:



$\mu\neq0$ (Angular) $\mu=0$ (Angular)

Ans: (a)

6. Equal masses of methane and hydrogen are mixed in an empty container at $25°C$. The fraction of the total pressure exerted by hydrogen is

Options:

(a) 1/2

(b) 8/9

(c) 1/9 (d) 16/17

Sol: Let wg of each methane (CH_4, molecular weight 16) and hydrogen (H_2, mol. Weight 2) are mixed

Mole fraction of $H_2\left(x_{H_2}\right)=\frac{n_{H_2}}{n_{CH_4}+n_{H_2}}=\frac{\frac{w}{2}}{\frac{w}{16}+\frac{w}{2}}=\frac{w}{2}\times\frac{16}{9w}=\frac{8}{9}$

Partial pressure $\propto$ mole fraction

$\therefore\frac{8}{9}$ fraction of total pressure is exerted by hydrogen

Ans: (b)

7. Standard enthalpy and standard entropy changes for the oxidation of ammonia at $298K$ are $-382.0\,\text{kJ mol}^{-1}$ and $-145.0\,\text{JK}^{-1}\,\text{mol}^{-1}$ respectively. Standard Gibb's energy change for the same reaction at $300\,K$ is

Options:

(a) -523.2 kJ mol

(b) -221.1 kJ mol

(c) -338.5 kJ mol

(d) -439.3 kJ mol

Sol: Applying $\Delta G = \Delta H - T\Delta S$

$\Delta H = -382.0\text{ kJ mol}^{-1},\ T = 300\ K,$

$\Delta S = -145.0\text{ JK}^{-1}\text{mol}^{-1} = -0.145\text{ kJ K}^{-1}\text{mol}^{-1}$

$\Delta G = -382.0 - 300\times(-0.145) = -338.5\text{ kJ mol}^{-1}$

Ans: (c)

8. Heat of neutralization of a strong acid by a strong base is a constant value because

Options:

(a) Salt formed does not hydrolyse

(b) Only H^+ and OH^- ions react in every case

(c) The strong base and strong acid react completely

(d) The strong base and strong acid react in aqueous solution

Sol: For example: $Na^+ + OH^- + H^+ + Cl^- \rightarrow Na^+ + Cl^- + H_2O$

i.e., $H^+ + OH^- \rightarrow H_2O$

Thus heat of neutralization of a strong acid with strong base is constant.

Ans: (b)

9. $NH_4COONH_{2(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)} + CO_{2(g)}$. If equilibrium pressure is 3 atm for the above reaction, K_p for the reaction is

Options:

(a) 4

(b) $\frac{4}{27}$

(c) $\frac{1}{27}$

(d) 27

Sol:

$$NH_4COONH_{2(s)} \rightleftharpoons 2NH_{2(g)} + CO_{2(g)}$$

Pressure at equilibrium $\quad 2p \quad p$

It is given that $2p + p = 3\,\text{atm} \qquad \therefore\ p = 1\,\text{atm}$

$K_p = P_{NH_3}^2 \times P_{CO_2} = (2)^2 \times 1 = 4$

Ans: (a)

10. Why only As^{3+} gets precipitated as As_2S_3 and not Zn^{2+} as ZnS when H_2S is passed through an acidic solution containing As^{3+} and Zn^{2+} ?

Options:

(a) Solubility product of As_2S_3 is less than that of ZnS

(b) Enough As^{3+} are present in acidic medium

(c) Zinc salt does not ionise in acidic medium

(d) Solubility product changes in presence of an acid

Sol: K_{sp} of $As_2S_3 < ZnS$ in acidic solution.

Ans: (a)

11. Which of the following species do not show disproportionation reaction?

Options:

(a) ClO^-

(b) ClO_2^-

(c) ClO_3^-

(d) ClO_4^-

Sol: ClO_4^- does not disproportionate because in this oxoanion chlorine is present in its highest oxidation state that is, $+7$. The disproportionation reactions for the other three oxoanions of chlorine are as follows

$$\overset{+1}{3ClO^-} \longrightarrow \overset{-1}{2Cl^-} + \overset{+5}{ClO_3^-}$$

$$\overset{+3}{3ClO_2^-} \xrightarrow{h\nu} \overset{+5}{2ClO_3^-} + \overset{-1}{Cl^-}$$

$$\overset{+5}{4ClO_3^-} \longrightarrow \overset{-1}{Cl^-} + \overset{+7}{3ClO_4^-}$$

Ans: (d)

12. Which of the following metal hydride is more ionic in nature?

Options:

(a) Li

(b) Be

(c) K (d) Mg

Sol: Active metals like alkali and alkaline earth metals form saline ionic hydrides except Li, Be and Mg.

Ans: (c)

13. Which of the following statements is false for alkali metals?

Options:

(a) Lithium is the strongest reducing agent

(b) Oxides of sodium are amphoteric in nature

(c) Li^+ is exceptionally small

(d) All alkali metals give blue solution in liquid ammonia

Sol: Oxides of sodium are basic in nature.

Ans: (b)

14. Which of the following statements is correct with respect to the property of elements with increase in atomic number in the carbon family (group 14)?

Options:

(a) Their metallic character decrease

(b) The stability of $+2$ oxidation state increases

(c) Their ionization energy increases

(d) Their atomic size decreases

Sol: Stability of $+2$ oxidation state in carbon family increases with increases in atomic number due to inert pair effect.

Ans: (b)

15. Which of the following is least stable?

Options:

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

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

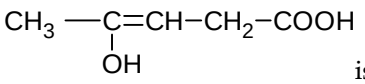
(c) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle +}{\underset{|}{\overset{|}{C}}}}-CH_3$

(d) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-\overset{+}{C}H-C_6H_5$

Sol: 1° carbocation is least stable because of less $+I$ effect

Ans: (a)

16. The IUPAC name of the compound,



is

Options:

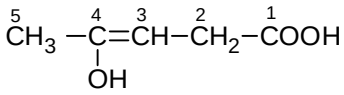
(a) Hydroxypentenoic acid

(b) 4-Hydroxypent-3-enoic acid

(c) 2-Hydroxypent-4-enoic acid

(d) 4-Hydroxy-4-methylpent-3-eonic acid

Sol:



4-Hydroxypent-3-enoic acid

Ans: (b)

17. The order of reactivity of halogens in the substitution reaction of aliphatic hydrocarbons is

Options:

(a) $Br_2 > Cl_2 > F_2$

(b) $Cl_2 > Br_2 > F_2$

(c) $F_2 > Cl_2 > Br_2$

(d) $F_2 > Br_2 > Cl_2$

Sol: Order of reactivity of halogenation of aliphatic hydrocarbons is $F_2 > Cl_2 > Br_2$.

Ans: (c)

18. Silver forms ccp lattice and X-ray studies of its crystals show that the edge length of its unit cell is $408\ pm$. The density of silver (Atomic mass $= 108\ u$) is

Options:

(a) $10.6\ \text{g cm}^{-3}$

(b) $12.5\ \text{g cm}^{3}$

(c) $5\ \text{g cm}^{-2}$

(d) $15.7\ \text{g cm}^{-3}$

Sol: Since the lattice is ccp the number of silver atoms per unit cell $= Z = 4$

Molar mass of silver $= 108\ \text{g mol}^{-1}$

Edge length of unit cell $= a = 408$ pm

Density, $d = \frac{Z}{a^3} \cdot \frac{M}{N_A} = \frac{4 \times 108}{(408)^3 \times 6.022 \times 10^{23} \times 10^{-30}}$

$= 10.56\ \text{g/cm}^3 \approx 10.6\ \text{g/cm}^3$

Ans: (a)

19. Which of the following is an amorphous solid?

Options:

(a) Naphthalene

(b) Copper

(c) Bakelite

(d) Benzoic acid

Sol: Bakelite being polymer is an amorphous solid and other solids are crystalline.

Ans: (c)

20. An electron trapped in an anion site in a crystal is called

Options:

(a) F-centre

(b) Frenkel defect

(c) Schottky defect

(d) Interstitial defect

Sol: F – centres are electrons trapped anion sites which are responsible for colour.

Ans: (a)

21. A mixture of two completely miscible non-ideal liquids which distils as such without change in its composition at a constant temperature like a pure liquid. This mixture is known as

Options:

(a) Binary liquid mixture

(b) Azeotropic mixture

(c) Eutectic mixture

(d) Ideal mixture

Sol: Azeotropes have a definite composition and boil like a pure liquid.

Ans: (b)

22. The osmotic pressure of 6.84% (mass/volume) solution of cane sugar at $300\,K$ (molecular weight of sugar $=342$) is

Options:

(a) 4 atm

(b) 4.926 atm

(c) 3.55 atm

(d) 2.45 atm

Sol: 5% (mass-volume) solution means $5g$ of sugar dissolved in $100\,\text{mL}$ water.

$$\pi = \frac{n}{V}RT = \frac{6.84}{342} \times \frac{1000}{100} \times 0.0821 \times 300 = 4.926 \text{ atm}$$

Ans: (b)

23. The boiling point of benzene is $353.3\,K$. When $1.80\,g$ of a non-volume solute was dissolved in $90\,g$ of benzene, the boiling point is raised to $354.1\,K$ given that K_b for benzene is $2.52\ \text{K kg mol}^{-1}$, the molar mass of the solute is

Options:

(a) $15\ \text{g mol}^{-1}$

(b) $20\ \text{g mol}^{-1}$

(c) $25\ \text{g mol}^{-1}$

(d) $63\ \text{g mol}^{-1}$

Sol: $M_2 = \dfrac{1000 \times w_2 \times K_b}{\Delta T_b \times w_1} = \dfrac{1000 \times 1.8 \times 2.52}{0.8 \times 90}$

$\left[\because \Delta T_b = 354.11\,K - 353.23K = 0.88K\right] = 63\ \text{g mol}^{-1}$

Ans: (d)

24. $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$ $E^{\circ}_{\text{cell}} = 0.46\ \text{V}$. The equilibrium constant of above reaction is

Options:

(a) $K_c = 4.92 \times 10^{25}$

(b) $K_c = 2.5 \times 10^{18}$

(c) $K_c = 3.98 \times 10^{15}$

(d) $K_c = 7.5 \times 10^{12}$

Sol: $E^{\circ}_{(\text{cell})} = \dfrac{0.059V}{2} \log K_c = 0.46V$ or

$\log K_c = \dfrac{0.46V \times 2}{0.059V} = 15.6$

$K_c = 3.98 \times 10^{15}$

Ans: (c)

25. Λ°_m for $NaCl$, HCl and sodium acetate are 126.4, 425.9 and 91.0 $S\ \text{cm}^2\ \text{mol}^{-1}$ respectively. Λ°_m for acetic acid is

Options:

(a) $285\ S\ \text{cm}^{-2}\ \text{mol}^{-1}$

(b) $400\ S\ \text{cm}^{-2}\ \text{mol}^{-1}$

(c) $390.5\ S\ \text{cm}^{-2}\ \text{mol}^{-1}$

(d) $125\ S\ \text{cm}^{-2}\ \text{mol}^{-1}$

Sol: $\Lambda^{\circ}_{m(HAc)} = \lambda^{\circ}_{H^+} + \lambda^{\circ}_{Ac^-} = \lambda^{\circ}_{H^+} + \lambda^{\circ}_{Cl^-} + \lambda^{\circ}_{AC^-} + \lambda^{\circ}_{Na^+} - \lambda^{\circ}_{Cl^-} - \lambda^{\circ}_{Na^+}$

$= \Lambda^{\circ}_{m(HCl)} + \Lambda^{\circ}_{m(NaAC)} - \Lambda^{\circ}_{m(NaCl)} = (425.9 + 91.0 - 126.4)\,S \text{ cm mol}^{-1}$

$= 390.5\,S \text{ cm}^2 \text{ mol}^{-1}$

Ans: (c)

26. Which of the following will not displace hydrogen?

Options:

(a) *Pb*

(b) *Sn*

(c) *Ba*

(d) *Hg*

Sol: Mercury lies below hydrogen in the electrochemical series so it will not displace hydrogen from acids.

Ans: (d)

27. What is the order of a reaction which has a rate expression, rate $= K[A]^{3/2}[B]^{-1}$?

Options:

(a) 1

(b) 2

(c) 3/2

(d) 1/2

Sol: Order: $\frac{3}{2} + (-1) = \frac{1}{2}$

Ans: (d)

28. The following data were obtained during the first order thermal decomposition of $A_{(g)}$ at constant volume:

$A_{(g)} \rightarrow B_{(g)} + C_{(g)}$

S. No.	Time/s	Total pressure/(atm)
1.	0	0.5
2.	100	0.512

The rate constant is

Options:

(a) $2.3\times10^{-4}\,s^{-1}$

(b) $4.8\times10^{-4}\,s^{-1}$

(c) $3\times10^{-4}\,s^{-1}$

(d) $8\times10^{-4}\,s^{-1}$

Sol: $k=\frac{2.303}{100}\log\frac{P_i}{2P_i-P_t}=\frac{2.303}{100}\log\frac{0.5}{2\times0.5-0.512}$

$=\frac{2.303}{100}\log1.024=\frac{2.303}{100}\times10^{-2}=2.3\times10^{-4}$

Ans: (a)

29. Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes. If the decomposition is a first order reaction, the rate constant of the reaction is

Options:

(a) $1.92\times10^{-4}s^{-1}$

(b) $3\times10^{-2}s^{-1}$

(c) $5\times10^{-3}s^{-1}$

(d) $4.75\times10^{-4}s^{-1}$

Sol: For a first order reaction, $k=\frac{0.693}{t_{1/2}}=\frac{0.693}{60}=1.155\times10^{-2}\ \text{min}^{-1}$

Or $k=\frac{0.693}{60\times60}=1.925\times10^{-4}s^{-1}$

Ans: (a)

30. Which of the following statement regarding adsorption of gases on a solid surface is incorrect?

Options:

(a) Enthalpy of adsorption in negative

(b) Entropy of adsorption is negative

(c) On adsorption, the residual forces on the surface are increased

(d) On adsorption decrease in surface energy appears as heat

Sol: After adsorption there is decrease in the residual forces due to bond formation. ΔG, ΔH and ΔS, all are negative in the case of adsorption.

Ans: (c)

31. The coagulation power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphide sol increases in the order

Options:

(a) $Al^{3+}<Na^+<Ba^{2+}$

(b) $Al^{3+}<Ba^{2+}<Na^+$

(c) $Na^+<Ba^{2+}<Al^{3+}$

(d) $Ba^{2+}<Na^+<Al^{3+}$

Sol: For a negatively charged sol, like As_2S_3, greater the positive charge on cations, greater is the coagulation isotherm.

Ans: (c)

32. NH_3 has a much higher boiling point than PH_3 because

Options:

(a) NH_3 has a larger molecular weight

(b) NH_3 undergoes pyramidal inversion

(c) NH_3 forms hydrogen bonds

(d) NH_3 contains ionic bonds whereas PH_3 contains covalent bonds

Sol: NH_3 possesses intermolecular $H-$bonding and thus shows higher boiling point than PH_3

Ans: (c)

33. A metal X on heating in nitrogen gas gives Y. Y on treatment with H_2O gives a colourless gas, which when passed through $CuSO_4$ solution gives a deep blue colour. Y is

Options:

(a) $Mg(NO_3)_2$

(b) Mg_3N_2

(c) NH_3

(d) MgO

Sol: $\underset{X}{3Mg} + N_2 \longrightarrow \underset{Y}{Mg_3N_2}$

$$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$$

$$4NH_3 + CuSO_4 \longrightarrow [Cu(NH_3)_4]SO_4$$

Ans: (b)

34. Which of the following bonds has highest energy?

Options:

(a) $Se-Se$

(b) $Te-Te$

(c) $S-S$

(d) $O-O$

Sol: $S-S$ bond is the strongest bond; $O-O$ bond is weaker than $S-S$ because of strong interelectronic repulsions due to small size.

Ans: (c)

35. Which of the following hydrides is most acidic?

Options:

(a) H_2Te

(b) H_2Se

(c) H_2O

(d) H_2S

Sol: Acidic character of hydrides of group 16 elements increases down the group because of the weakening of $M-H$ bond strength.

Ans: (a)

36. What is the oxidation number of sulphur in $Na_2S_4O_6$?

Options:

(a) 2/3

(b) 3/2

(c) 3/5

(d) 5/2

Sol: $2(+1)+4x+6(-2)=0 \quad 4x=10 \quad x=\frac{5}{2}$

Ans: (d)

37. The halogen that is most easily reduced is

Options:

(a) F_2

(b) Cl_2

(c) Br_2

(d) I_2

Sol: Since bond energy for Cl_2 is maximum, it must have the strongest bond. $F-F$ bond is weaker than $Cl-Cl$ bond because of inter electronic repulsions taking place in small sized fluorine

Ans: (a)

38. The ease of liquefaction of noble gases decreases in the order

Options:

(a) $He > Ne > Ar > Kr > Xe$

(b) $Xe > Kr > Ar > Ne > He$

(c) $Kr > Xe > He > Ar > Ne$

(d) $Ar > Kr > Xe > He > Ne$

Sol: Easy of liquefaction of noble gases increases down the group since van der Waals forces of attraction increases down the group with increasing atomic size. Thus, $Xe > Kr > Ar > Ne > He$.

Ans: (b)

39. Which of the following will be colourless in aqueous solution?

I. Ti^{3+} II. V^{3+} III. Cu^{+}

IV. Mn^{2+} V. Co^{2+} VI. Sc^{3+}

Options:

(a) (I), (II), (IV)

(b) (III) and (V)

(c) (II), (IV) and (VI)

(d) (III) and (VI)

Sol: $Ti^{3+} - 3d^1 4s^0$ 1 unpaired electrons

$V^{3+} - 3d^2 4s^0$ 2 unpaired electrons

$Cu^{+} - 3d^{10} 4s^0$ No unpaired electrons

$Mn^{2+} - 3d^5 4s^0$ 5 unpaired electrons

$Co^{3+} - 3d^7 4s^0$ 3 unpaired electrons

$Sc^{3+} - 3d^0 4s^0$ No unpaired electrons

Ans: (d)

40. Magnetic moment of Cr^{2+} is nearest to

Options:

(a) Fe^{2+}

(b) Mn^{2+}

(c) Co^{2+}

(d) Ni^{2+}

Sol:

$Cr^{2+} = 3d^4$, No of unpaired electrons $(n) = 4$

Magnetic moment $= \sqrt{n(n+2)}BM = \sqrt{4(4+2)} = \sqrt{24} = 4.89\ BM$

$Fe^{2+} = 3d^6$, No of unpaired electrons $(n) = 4$

Magnetic moment $= \sqrt{4(4+2)}BM = \sqrt{24} = 4.89\ BM$

$Mn^{2+} = 3d$, No of unpaired electrons $(n) = 5$

Magnetic moment $= \sqrt{5(5+2)}BM$

$Co^{2+} = 3d^7$, No of unpaired electrons $(n) = 3$

Magnetic moment $= \sqrt{3(3+2)}BM = \sqrt{15} = 3.87\ BM$

$Ni^{2+} = 3d^8$, No of unpaired electrons $(n) = 2$

Magnetic moment $= \sqrt{2(2+2)}BM = \sqrt{8} = 2.82\ BM$

Ans: (a)

41. The lanthanide contraction is responsible for the fact that

Options:

(a) Zr and Y have about the same radius

(b) Zr and Hf have about the same radius

(c) Zr and Nb have similar oxidation state

(d) cannot be predicted

Sol: Due to lanthanide contraction, the elements of second and third i.e. Zr and Hf transition series resemble more with each other than the elements of first and second transition series

Ans: (b)

42. The oxidation state of Co in $\left[Co\left(H_2O\right)\left(CN\right)\left(en\right)_2\right]^{2+}$ is

Options:

(a) $+2$

(b) $+3$

(c) -3

(d) -2

Sol:

$x+\left(-1\right)=+2$

$x=+3$

Ans: (b)

43. Amongst the following the most stable complex is

Options:

(a) $\left[Fe\left(H_2O\right)_6\right]^{3+}$

(b) $\left[Fe\left(NH_3\right)_6\right]^{3+}$

(c) $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$

(d) $\left[FeCl_6\right]^{3-}$

Sol:

Since $C_2O_4^{2-}$ is a bidentate ligand, it forms the most stable complex.

Ans: (c)

44. The IUPAC name of $K_2\left[Ni\left(CN\right)_4\right]$ is

Options:

(a) Potassium tetracyanidonickelate(II)

(b) Potassium tetracyanidonickelate(III)

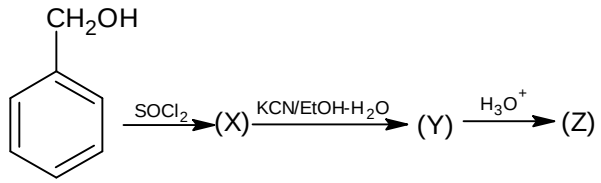
(c) Potassium tetracyanidonickle(II)

(d) Potassium tetracyanidonickle(III)

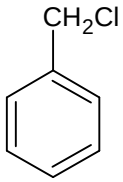
Sol: Potassium tetracyanidonickelate(II)

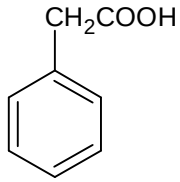
Ans: (a)

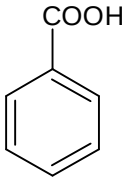
45. Identify Z in the following sequence of reactions

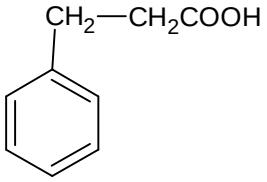


Options:

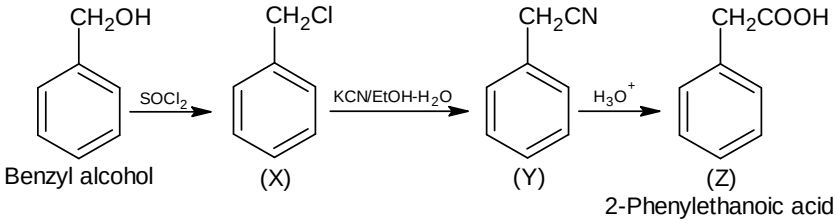
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (b)

46. Which of the following represents the correct order of increasing boiling points?

Options:

(a) 1-Chloropropane<1-Chlorobutane< 2-Chloropropane

(b) 2- Chloropropane <1-Chloropropane<1-Chlorobutane

(c) 2-Chloropropane <1-Chlorobutane<1-Chloropropane

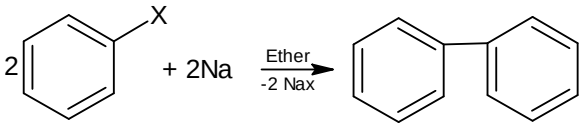
(d) 1-Chlorobutane< 2- Chloropropane<1-Chloroporpane

Sol: Amongst molecules with same mass, it is the size of the molecule that determines the boiling point. Branched compounds are more compact and therefore have less surface area as compared to their straight chain counterparts and thus have lower boiling point. The correct order of increasing boiling point is

2- Chloropropane <1-Chloropropane<1-Chlorobutane

Ans: (b)

47. The following reaction is called



Options:

(a) Wurtz Fitting reaction

(b) Fittig reaction

(c) Wurtz reaction

(d) Friedel-Crafts reaction

Sol: Fittig reaction

Ans: (b)

48. Arrange the following compounds in increasing order of solubility in water

(I). Pentan-1-ol (II) $n-$Butane (III) Pentanal (IV) Ethoxyethane

Options:

(a) (III)<(IV)<(I)<(II)

(b) (IV)<(II)<(III)<(I)

(c) (II)<(IV)<(III)<(I)

(d) (II)<(III)<(IV)<(I)

Sol:

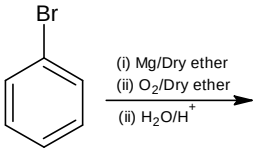
Carboxylic acids are more soluble in H_2O than corresponding alcohols, aldehydes and hydrocarbons.

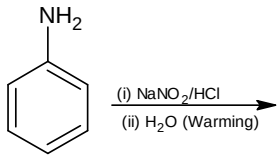
$$\underset{\text{II}}{n-\text{butane}} < \underset{\text{IV}}{\text{ethoxyethane}} < \underset{\text{III}}{\text{pentanal}} < \underset{\text{I}}{\text{pentan-1-ol}}$$

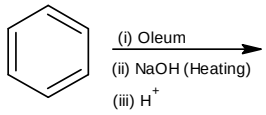
Ans: (c)

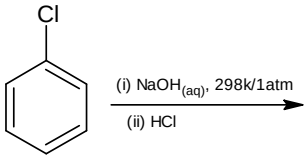
49. Which of the following reactions will not yield phenol?

Options:

(a) 

(b) 

(c) 

(d) 

Sol: Chlorobenzene does not undergo hydrolysis on treatment with aq. $NaOH$ at $298\ K$.

Ans: (d)

50. On boiling with concentrated HBr, ethyl phenyl ether will give

Options:

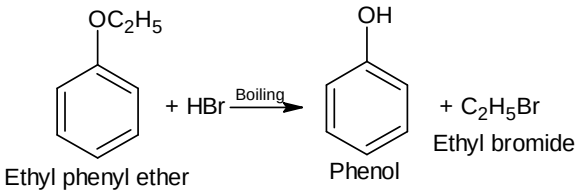
(a) Phenol and ethyl bromide

(b) Bromobenzene and ethanol

(c) Phenol and ethane

(d) Bromobenzene and ethane

Sol:



Ans: (a)

51. Which is the most suitable reagent for the following conversion?

$CH_2 = CHCH_2 - OH \longrightarrow CH_2 = CH - CHO$

Options:

(a) $K_2Cr_2O_7$ in acidic medium

(b) DIBAL-H

(c) PCC

(d) $O_3/H_2O - Zn$ dust

Sol: $\underset{\text{Allyl alcohol}}{CH_2=CHCH_2-OH} \xrightarrow[CH_2Cl_2]{C_5H_5\overset{+}{N}HCrO_3Cl^-(PCC)} \underset{\text{Prop-2-enal}}{CH_2=CH-CHO}$

Ans: (c)

52. Arrange the following compounds in the increasing order of ease of hydrogen bond formation

I. $CH_2CH_2CH_2CHO$ II. $CH_3CH_2CH_2CH_2OH$

III. $C_2H_5-O-C_2H_5$ IV. $CH_3CH_2CH_2COOH$

Options:

(a) I<III<II<IV

(b) III<I<II<IV

(c) III<II<IV<I

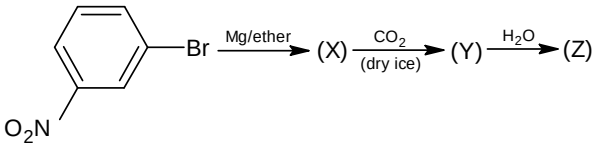
(d) IV<III<II<I

Sol: The overall increasing order of ease of hydrogen bond formation is

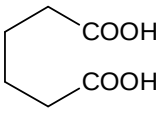
III<I<II<IV

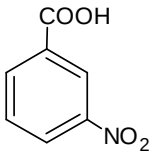
Ans: (b)

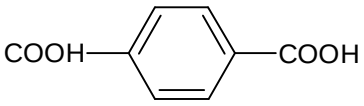
53. What is Z in the following sequence of reactions?

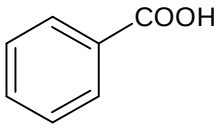


Options:

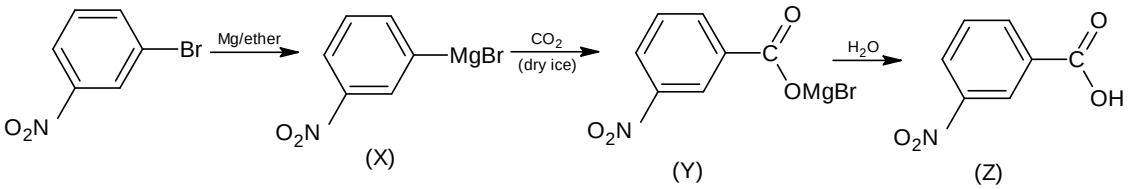
(a) 

(b) 

(c) 

(d) 

Sol:



Ans: (b)

54. In Clemmensen's reduction carbonyl compound is treated with

Options:

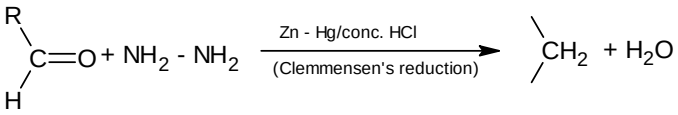
(a) Zinc amalgam + HCl

(b) Sodium amalgam + HCl

(c) Zinc amalgam + nitric acid

(d) Sodium amalgam + HNO_3

Sol:



Ans: (a)

55. What is the decreasing order of basicity of primary, secondary and tertiary ethyl amines and NH_3 ?

Options:

(a) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2 NH > (C_2H_5)_3 N$

(b) $(C_2H_5)_3 N > (C_2H_5)_2 NH > C_2H_5NH_2 > NH_3$

(c) $(C_2H_5)_2 NH > C_2H_5NH_2 > (C_2H_5N) > NH_3$

(d) $(C_2H_5)_2 NH > (C_2H_5)_3 N > C_2H_5NH_2 > NH_3$

Sol: In case of ethyl amines, the combined effect of inductive effect, steric effect and solvation effect gives the order of basic strength as:

$\underset{(2°)}{(C_2H_5)_2 NH} > \underset{(3°)}{(C_2H_5)_3 N} > \underset{(1°)}{C_2H_5NH_2} > NH_3$

Ans: (d)

56. What is Z in the following sequence of reactions?

$$C_6H_5NH_2 \xrightarrow{(CH_3CO)_2O} X \xrightarrow{Br_2/CCl_4} Y \xrightarrow[H^+]{HOH} Z$$

Options:

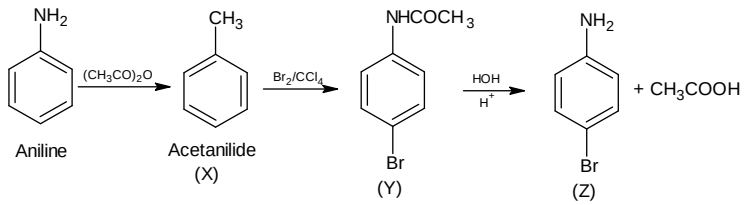
(a) $p-$ Bromoaniline

(b) Bromoacetophenone

(c) $p-$ Bromoacetanilide

(d) $o-$ Bromoacetanilide

Sol:



Ans: (a)

57. C_3H_9N represent

Options:

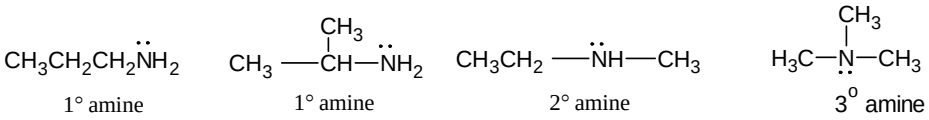
(a) Primary amine

(b) Secondary amine

(c) Tertiary amine

(d) All of these

Sol:



Ans: (d)

58. The rapid inter conversion of $\alpha-D-$ glucose and $\beta-D-$ glucose in solution is known as

Options:

(a) Racemization

(b) Specific rotation

(c) Inversion

(d) Mutarotation

Sol: Spontaneous rapid inter conversion of $\alpha-D-$ glucose in solution is known as mutarotation.

Ans: (d)

59. The pH value of the solution at which a particular amino acid does not migrate under the influence of an electric field is called the

Options:

(a) Eutectic point

(b) Yielding point

(c) Neutralisation point

(d) Isoelectric point

Sol: Isoelectric point is the pH of a solution at which a particular amino acid does not migrate under the influence of electric field.

Ans: (d)

60. Which of the following statements is not correct regarding the DNA?

Options:

(a) It has single stranded $\beta-$ helix structure

(b) It controls the synthesis of proteins

(c) It has the unique property of replication

(d) It chiefly occurs in the nucleus of cell

Sol: DNA has double stranded α -helix structure.

Ans: (a)

Mathematics

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

61. $2^{3n}-7n-1$ is divisible by

Options:

(a) 36

(b) 64

(c) 49

(d) 25

Sol: For $n=1, n=2$

$2^{3n}-7n-1$ is divisible by 49 (but not by 36, 64)

$\therefore$ (c) is true.

Ans: (c)

62. $1\cdot2\cdot3+2\cdot3\cdot4+3\cdot4\cdot5+\ldots$ to n terms $=$

Options:

(a) $\frac{n(n+1)(n+2)(n+3)}{12}$

(b) $\frac{n(n+1)(n+2)(2n+1)}{12}$

(c) $\frac{n(n+1)(n+2)(3n+5)}{12}$

(d) none of these

Sol: $T_n=n(n+1)(n+2)=n\left(n^2+3n+2\right)=n^3+3n^2+2n$

$\therefore S_n=\sum\left(n^3+3n^2+2n\right)=\sum n^3+3\sum n^2+2\sum n$

$=\left(\frac{n(n+1)}{2}\right)^2+3\frac{n(n+1)(2n+1)}{6}+2\frac{n(n+1)}{2}=\frac{n(n+1)}{2}\left[\frac{n(n+1)}{2}+(2n+1)+2\right]$

$=\frac{n(n+1)}{2}\left[\frac{n^2+5n+6}{2}\right]=\frac{n(n+1)(n+2)(n+3)}{4}$

Ans: (a)

63. If the product of the roots of the equation $mx^2+6x+(2m-1)=0$ is -1, then the value of m is

Options:

(a) 1

(b) -1

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

(d) $-\frac{1}{3}$

Sol: Product of the roots $\frac{2m-1}{m}=-1$

$\Rightarrow 2m-1=-m \Rightarrow 3m=1 \Rightarrow m=\frac{1}{3}$

Ans: (c)

64. The co-efficient of $\frac{1}{x}$ in the expansion of $\left(\frac{1}{x}+1\right)^n(1+x)^n$ is

Options:

(a) ${}^{2n}C_n$

(b) ${}^{2n}C_{n-1}$

(c) ${}^{2n}C_1$

(d) ${}^{n}C_{n-1}$

Sol: $\left(\frac{1}{x}+1\right)^n(1+x)^n=\frac{1}{x^n}(1+x)^{2n}$

$=\frac{1}{x^n}\left(1+{}^{2n}C_1x+{}^{2n}C_2x^2+\ldots+{}^{2n}C_{n-1}x^{n-1}+{}^{2n}C_nx^n+{}^{2n}C_{n+1}x^{n+1}+\ldots+{}^{2n}C_{2n}\right)$

Co-eff. of $\frac{1}{x}={}^{2n}C_{n-1}$.

Ans: (b)

65. Negation of "$2+3=5$ and $8<10$" is

Options:

(a) $2+3\neq 5$ and <10

(b) $2+3=5$ and $8\not<10$

(c) $2+3\neq 5$ or $8\not<10$

(d) None of these

Sol: Let $p: 2+3=5$

$q: 8<10$

Given proposition is: $p\wedge q$

Its negation is $\sim(p\wedge q)=\sim p\vee\sim q$ $\therefore$ we have $2+3\neq 5$ or $8\not<10$

Ans: (c)

66. The smallest set A such that $A\cup\{1,2\}=\{1,2,3,5,9\}$ is

Options:

(a) $\{2,3,5\}$

(b) $\{3,5,9\}$

(c) $\{1,2,5,9\}$

(d) None of these

Sol: Since $A \cup \{1, 2\} = \{1, 2, 3, 5, 9\}$ $\therefore$ Smallest value of A

$= \{1, 2, 3, 5, 9\} - \{1, 2\} = \{3, 5, 9\}$

Ans: (b)

67. Domain of $\sqrt{4x - x^2}$ is

Options:

(a) $[0, 4]$

(b) $(0, 4)$

(c) $(0, 1) \cup (1, \infty)$

(d) $R - [0, 4]$

Sol: For domain $4x - x^2 \geq 0$

$\Rightarrow x^2 - 4x \leq 0 \Rightarrow (x-2)^2 \leq 4 \Rightarrow |x-2| \leq 2 \Rightarrow 2-2 \leq x \leq 2+2$

$\Rightarrow 0 \leq x \leq 4.$

Ans: (a)

68. The range of the function $f(x) = |x-1|$ is

Options:

(a) $(-\infty, \infty)$

(b) $(0, \infty)$

(c) $[0, \infty)$

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

Sol: Range $= [0, \infty) [\because |x-1| \geq 0 \ \forall \ x \in R]$

Ans: (c)

69. If $1+2x$ is a function having $(-\infty, \infty)$ as domain and $(-\infty, \infty)$ as codomain, then it is

Options:

(a) onto but not one-one

(b) one-one but not onto

(c) one-one and onto

(d) neither one-one nor onto

Sol: f is one-one onto

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

And to each $y \in R_f$, $\exists \frac{y-1}{2}$ such that $f\left(\frac{y-1}{2}\right)$

$= 1+2\left(\frac{y-1}{2}\right) = y$ $\therefore f$ is onto.

Ans: (c)

70. Let $f\left(x+\frac{1}{x}\right)=x^2+\frac{1}{x^2}, x\neq 0,$ then $f(x)=$

Options:

(a) x^2

(b) x^2-1

(c) x^2-2

(d) x^2+1

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

$\therefore f(z)=z^2-2$ where $z=x+\frac{1}{x}.$

$\Rightarrow f(x)=x^2-2$

Ans: (c)

71. The value of $\sin 28°\cos 17°+\cos 28°\sin 17°$ is

Options:

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

(b) 1

(c) $-\frac{1}{\sqrt{2}}$

(d) 0

Sol: The given value $=\sin(28°+17°)$

$=\sin 45°=\frac{1}{\sqrt{2}}.$

Ans: (a)

72. If $\cos 20°=k$ and $\cos x=2k^2-1,$ then the possible values of x between $0°$ and $360°$ are

Options:

(a) $140°$

(b) $40°$ and $140°$

(c) $50°$ and $130°$

(d) $40°$ and $320°$

Sol: $\cos x=2k^2-1=2\cos^2 20°-1=\cos 40°$

$\left[\because \cos 2\theta=2\cos^2\theta-1\right]$

$=\cos(360°-40°)=\cos 320°$

$\therefore x=40°$ and $320°$

Ans: (d)

73. $\sin 200° + \cos 200°$ is

Options:

(a) Negative

(b) Positive

(c) Zero

(d) Zero or positive

Sol: Since $200°$ lies in III^{rd} quadrant

$\therefore \sin 200°, \cos 200°$ are both $-ve$

$\therefore$ Their sum is $-ve$.

Ans: (a)

74. Two points $(a, 0)$ and $(0, b)$ are joined by a straight line. Another point on this line is

Options:

(a) $(3a, -2b)$

(b) $\left(a^2, ab\right)$

(c) $(-3a, 2b)$

(d) (a, b)

Sol: Equation of the line is $\frac{x}{a} + \frac{y}{b} = 1$

$(3a, -2b)$ lies on it.

Ans: (a)

75. The line passing through $(0, 1)$ and perpendicular to the line $x - 2y + 11 = 0$ is

Options:

(a) $2x - y + 1 = 0$

(b) $2x - y + 3 = 0$

(c) $2x + y - 1 = 0$

(d) $2x + y - 2 = 0$

Sol: The line $\perp$ to $x - 2y + 1 = 0$ is

$2x + y + K = 0$

It passes through $(0, 1) \therefore 0 + 1 + K = 0$

$\Rightarrow K = -1$

$\therefore$ Line is $2x + y - 1 = 0$

Ans: (c)

76. $\lim_{x\to 0}\frac{1-\cos 2x}{\cos 2x-\cos 8x}=$

Options:

(a) $\frac{1}{5}$

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

(c) $\frac{1}{15}$

(d) 1

Sol: $\lim_{x\to 0}\frac{1-\cos 2x}{\cos 2x-\cos 8x}=\lim_{x\to 0}\frac{2\sin^2 x}{2\sin 5x.\sin 3x}$

$=\lim_{x\to 0}\frac{\left(\frac{\sin x}{x}\right)^2}{\frac{\sin 5x}{x}.\frac{\sin 3x}{x}}$

$=\lim_{x\to 0}\frac{\left(\frac{\sin x}{x}\right)^2}{5.\frac{\sin 5x}{5x}.\frac{\sin 3x}{3x}.3}$

$=\frac{(1)^2}{5.1.1.3}=\frac{1}{15}$

$\therefore$ (c) is the correct answer.

Ans: (c)

77. $\lim_{x\to 3^+}\frac{|x-3|}{x-3}$

Options:

(a) 1

(b) -1

(c) 0

(d) does not exist

Sol: $\lim_{x\to 3^+}\frac{|x-3|}{x-3}=\lim_{x\to 3}\frac{x-3}{x-3}=1$

Ans: (a)

78. If $f(x)=x+2$ when $x\le 1$ and $f(x)=4x-1$ when $x>1$, then

Options:

(a) $f(x)$ is continuous at $x=1$

(b) $\lim_{x\to 1} f(x)=4$

(c) $f(x)$ is discontinuous at $x=0$

(d) none of these

Sol: $\lim_{x\to 1^-} f(x) = \lim_{x\to 1}(x+2) = 1+2 = 3$

$\lim_{x\to 1^+} f(x) = \lim_{x\to 1}(4x-1) = 4-1 = 3$

$\therefore \lim_{x\to 1} f(x) = 3 = f(1)$

$\therefore f(x)$ is continuous at $x = 1$.

Ans: (a)

79. If $A = \begin{bmatrix} 4 & 2 \\ -1 & 1 \end{bmatrix}$, then $(A-2I)(A-3I) =$

Options:

(a) A

(b) I

(c) O, where O is null matrix

(d) $5I$

Sol: $(A-2I)(A-3I)$

$= \begin{bmatrix} 2 & 2 \\ -1 & -1 \end{bmatrix}\begin{bmatrix} 1 & 2 \\ -1 & -2 \end{bmatrix}$

$= \begin{bmatrix} 2-2 & 4-4 \\ -1+1 & -2+2 \end{bmatrix} = \begin{bmatrix} O & O \\ O & O \end{bmatrix} = 0$

Hence (c) is the correct answer.

Ans: (c)

80. If $\begin{vmatrix} p & q-y & r-z \\ p-x & q & r-z \\ p-x & q-y & r \end{vmatrix} = 0$, then the value of $\frac{p}{x}+\frac{q}{y}+\frac{r}{z}$ is

Options:

(a) 2

(b) 1

(c) 0

(d) $4\,pqr$

Sol: Operate $R_1 - R_2$; $R_2 - R_3$, we get

$\Delta = \begin{vmatrix} x & -y & 0 \\ 0 & y & -z \\ p-x & q-y & r \end{vmatrix} = 0$

$\Rightarrow x(yr+qz-yz)+y(0+pz-zx) = 0$

$\Rightarrow xyr + xqz - xyz + pyz - xyz = 0$

$\Rightarrow \frac{p}{x}+\frac{q}{y}+\frac{r}{z} = 2$

Ans: (a)

81. The repeated factor of the determinant $\begin{vmatrix} x+z & x & y \\ z+x & z & x \\ x+y & y & z \end{vmatrix}$ is

Options:

(a) $(x-y)$

(b) $(y-z)$

(c) $(z-x)$

(d) None of these

Sol: Operate $R_1+R_2+R_3$, we get given value

$$=\begin{vmatrix} 2(x+y+z) & x+y+z & x+y+z \\ z+x & z & x \\ x+y & y & z \end{vmatrix}$$

$$(x+y+z)\begin{vmatrix} 2 & 1 & 1 \\ z+x & z & x \\ x+y & y & z \end{vmatrix}$$

Operate $C_1-C_2-C_3$

$$=(x+y+z)\begin{vmatrix} 0 & 1 & 1 \\ 0 & z & x \\ x-z & y & z \end{vmatrix}=(x+y+z)(x-z)^2 \quad \therefore \text{ Required factor } = z-x.$$

Ans: (c)

82. If $A=\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$, then determinant of A^2-2A is

Options:

(a) 5

(b) 25

(c) –5

(d) –25

Sol: $A=\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$

$$\therefore A^2=\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}=\begin{bmatrix} 1+6 & 1+6 \\ 2+2 & 6+1 \end{bmatrix}=\begin{bmatrix} 7 & 7 \\ 4 & 7 \end{bmatrix}$$

$$A^2-2A=\begin{bmatrix} 7 & 7 \\ 4 & 7 \end{bmatrix}-2\begin{bmatrix} 1 & 3 \\ 2 & 1 \end{bmatrix}$$

$$=\begin{bmatrix} 7 & 7 \\ 4 & 7 \end{bmatrix}-\begin{bmatrix} 2 & 6 \\ 4 & 2 \end{bmatrix}=\begin{bmatrix} 5 & 1 \\ 0 & 5 \end{bmatrix}$$

$$\det.\left(A^2-2A\right)=\begin{vmatrix} 5 & 1 \\ 0 & 5 \end{vmatrix}=25$$

Ans: (b)

83. If a, b, c, d, e and f are in G.P., then the value of $\begin{vmatrix} a^2 & d^2 & x \\ b^2 & e^2 & y \\ c^2 & f^2 & z \end{vmatrix}$ depends on

Options:

(a) x and y

(b) x and z

(c) y and z

(d) independent of x, y and z

Sol: Since a, b, c, d, e, f are in G.P. and if r is the common ratio of the G.P. then

$b = ar$

$c = ar^2$

$d = ar^3$

$e = ar^4$

$f = ar^5$

$\therefore$ Given determinant

$$= \begin{vmatrix} a^2 & a^2r^6 & x \\ a^2r^2 & a^2r^8 & y \\ a^2r^4 & a^2r^{10} & z \end{vmatrix} = a^2.a^2.r^6 = \begin{vmatrix} 1 & 1 & x \\ r^2 & r^2 & y \\ r^4 & r^4 & z \end{vmatrix}$$

$= a^4r^6(0) = 0$ $[\because C_1, C_2$ are identical$]$

$\therefore$ (d) is correct.

Ans: (d)

84. Let $\begin{vmatrix} 6i & -3i & 1 \\ 4 & 3i & -1 \\ 20 & 3 & i \end{vmatrix} = x + iy$, then (x, y) is equal to

Options:

(a) $(0, 1)$

(b) $(0, 0)$

(c) $(1, 0)$

(d) $(1, 1)$

Sol: By the given condition, $6i(-3+3) + 3i(4i+20) + 1(12-60i) = x + iy$

$\Rightarrow 12i^2 + 60i + 12 - 60i = x + iy$

$\Rightarrow -12 + 12 = x + iy$

$\Rightarrow 0 = x + iy \quad \therefore x = 0, y = 0$

Ans: (b)

85. $ABCD$ is a parallelogram with AC, BD as diagonals. Then $\overrightarrow{AC} - \overrightarrow{BD} =$

Options:

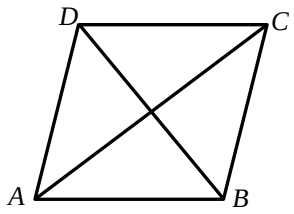
(a) $4\overrightarrow{AB}$

(b) $3\overrightarrow{AB}$

(c) $2\overrightarrow{AB}$

(d) $\overrightarrow{AB}$

Sol: In the parallelogram $ABCD$,



$\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}; \overrightarrow{BD} = \overrightarrow{BA} + \overrightarrow{AD}$

$\overrightarrow{AC} - \overrightarrow{BD} = \left(\overrightarrow{AB} + \overrightarrow{BC}\right) - \left(\overrightarrow{BA} + \overrightarrow{AD}\right)$

$= \overrightarrow{AB} + \overrightarrow{BC} - \overrightarrow{BA} - \overrightarrow{AD}$

$= \overrightarrow{AB} - \overrightarrow{BA} \quad \left[\because \overrightarrow{BC} = \overrightarrow{AD}\right]$

$= \overrightarrow{AB} + \overrightarrow{AB} = 2\overrightarrow{AB}$

Hence (c) is the correct answer.

Ans: (c)

86. $ABCDEF$ is a regular hexagon. If $\overrightarrow{AB} = \vec{a}$ and $\overrightarrow{BC} = \vec{b}$, the $\overrightarrow{CD} =$

Options:

(a) $\vec{a} + \vec{b}$

(b) $\vec{b} - \vec{a}$

(c) $\vec{a} - \vec{b}$

(d) none of these

Sol: $\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$

$= \vec{a} + \vec{b}$

$\overrightarrow{AD} = 2\overrightarrow{BC} = 2\vec{b}$

$\left(\because AD \parallel BC \text{ and } AD = 2BC\right)$

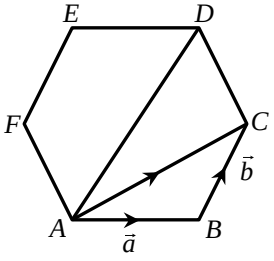
Also $\overrightarrow{AD} = \overrightarrow{AC} + \overrightarrow{CD}$

$\therefore \overrightarrow{CD} = \overrightarrow{AD} - \overrightarrow{AC}$

$= 2\vec{b} - \left(\vec{a} + \vec{b}\right) = \vec{b} - \vec{a}$

$\therefore$ (b) is the correct answer.

Ans: (b)



87. The position vectors of A, B, C are $\vec{i}+\vec{j}+\vec{k}, 4\vec{i}+5\vec{j}+\vec{k}, 5\vec{i}-2\vec{j}+\vec{k}$. Then the area of ΔABC is

Options:

(a) 5 square units

(b) $\frac{25}{2}$ square units

(c) 25 square units

(d) 50 square units

Sol: $\overrightarrow{AB}=\left(4\vec{i}+5\vec{j}+\vec{k}\right)-\left(\vec{i}+\vec{j}+\vec{k}\right)=3\vec{i}+4\vec{j}$

$\overrightarrow{AC}=5\vec{i}-2\vec{j}+\vec{k}-\vec{i}-\vec{j}-\vec{k}$

$=4\vec{i}-3\vec{j}$

Required area $=\frac{1}{2}\left|\overrightarrow{AB}\times\overrightarrow{AC}\right|$

$=\frac{1}{2}\left|\left(3\vec{i}+4\vec{j}\right)\times\left(4\vec{i}-3\vec{j}\right)\right|$

$=\frac{1}{2}\left|-9\vec{k}-16\vec{k}\right|=\frac{1}{2}\left|-25\vec{k}\right|$

$=\frac{25}{2}$ square units $\therefore$ (b) is the correct answer.

Ans: (b)

88. Let $\vec{a}=pi+qj$ and $\vec{b}=5i+j$, then $\vec{a}$ & $\vec{b}$ are parallel if

Options:

(a) $p+q=5$

(b) $pq=5$

(c) $p=5q$

(d) $q=5p$

Sol: $\vec{a}=\lambda\vec{b}\rightarrow pi+qj=\lambda\left(5i+j\right)\Rightarrow\frac{p}{5}=\frac{q}{1}\Rightarrow p=5q$

Ans: (c)

89. Solutions of the equation $\sin^2\theta-\cos\theta=\frac{1}{4}, 0\le\theta\le 2\pi$ are

Options:

(a) $\frac{2\pi}{3}, \frac{\pi}{3}$

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

(c) $-\frac{\pi}{3}, \frac{2\pi}{3}$

(d) $\frac{2\pi}{3}, \frac{5\pi}{3}$

Sol: $\sin^2\theta-\cos\theta=\frac{1}{4}$

$\Rightarrow 4\left(1-\cos^2\theta\right)-4\cos\theta=1$

$\Rightarrow 4\cos^2\theta+4\cos\theta-3=0 \Rightarrow (2\cos\theta+3)(2\cos\theta-1)=0$

$\Rightarrow \cos\theta=-\frac{3}{2}$ or $\cos\theta=\frac{1}{2}$ But $\cos\theta=-\frac{3}{2}$ is not possible.

$\therefore \cos\theta=\frac{1}{2}=\cos\frac{\pi}{3}$ or $\cos\left(2\pi-\frac{\pi}{3}\right)$

$=\cos\frac{\pi}{3}$ or $\cos\frac{5\pi}{3}[0\le\theta\le 2\pi]$

$\therefore \theta=\frac{\pi}{3},\frac{5\pi}{3}$

Ans: (b)

90. If n is any integer, then i^n is

Options:

(a) $1,-1,i,-i$

(b) $i,-i$

(c) $1,-1$

(d) i

Sol: Since $i^1=i$

$i^2=-1$

$i^3=-i$

$i^4=1$

$i^5=i$ and so on.

$\therefore i^n=1,-1,i,-i$

Hence (a) is the correct answer.

Ans: (a)

91. The value of $\tan\left(\frac{1}{2}\cos^{-1}\frac{\sqrt{5}}{3}\right)$ is

Options:

(a) $\frac{3-\sqrt{5}}{2}$

(b) $\frac{3+\sqrt{5}}{2}$

(c) $\frac{\sqrt{5}-3}{2}$

(d) none of these

Sol: Put $\frac{1}{2}\cos^{-1}\frac{\sqrt{5}}{3}=\theta \Rightarrow \cos 2\theta=\frac{\sqrt{5}}{3}$ and $0\le 2\theta\le\pi$

$\Rightarrow \frac{1-\tan^2\theta}{1+\tan^2\theta}=\frac{\sqrt{5}}{3}$

$\Rightarrow \frac{1+\tan^2\theta}{1-\tan^2\theta}=\frac{3}{\sqrt{5}}$

$\Rightarrow \frac{2\tan^2\theta}{2}=\frac{3-\sqrt{5}}{3+\sqrt{5}}=\frac{3-\sqrt{5}}{3+\sqrt{5}}\cdot\frac{3-\sqrt{5}}{3-\sqrt{5}}$

$\Rightarrow \tan^2\theta=\frac{\left(3-\sqrt{5}\right)^2}{9-5}=\frac{\left(3-\sqrt{5}\right)^2}{4}$

$\Rightarrow \tan\theta=\pm\left(\frac{3-\sqrt{5}}{2}\right)$

But $0\le 2\theta\le\pi \ \therefore 0\le\theta\le\frac{\pi}{2} \Rightarrow \theta$ lies in the first quadrant.

Hence (a) is the correct answer.

Ans: (a)

92. If $\tan^{-1}(x+1)+\tan^{-1}(x-1)=\tan^{-1}\left(\frac{8}{31}\right)$, then $x=$

Options:

(a) 1

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

(c) $-\frac{1}{2}$

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

Sol: $\tan^{-1}\left[\frac{x+1+x-1}{1-(x+1)(x-1)}\right]=\tan^{-1}\frac{8}{31}$

$\Rightarrow \frac{2x}{1-\left(x^2-1\right)}=\frac{8}{31}$

$\Rightarrow 62x=16-8x^2$

$\Rightarrow 8x^2+62x-16=0$ or $4x^2+31x-8=0$

$\Rightarrow 4x^2+32x-x-8=0$

$\Rightarrow 4x(x+8)-1(x+8)=0$

$\Rightarrow (x+8)(4x-1)=0$

$\Rightarrow x=-8,\frac{1}{4} \therefore x=\frac{1}{4}$

Ans: (d)

93. In a ΔABC, if $\frac{\tan A-\tan B}{\tan A+\tan B}=\frac{c-b}{c}$, then A is equal to

Options:

(a) $30°$

(b) $45°$

(c) $60°$

(d) $90°$

Sol: $\frac{\tan A-\tan B}{\tan A+\tan B}=\frac{c-b}{c}$

$\Rightarrow \frac{\sin A\cos B-\cos A\sin B}{\sin A\cos B+\cos A\sin C}=\frac{c-b}{c}$

$\Rightarrow \frac{\sin(A-B)}{\sin(A+B)}=\frac{K(\sin C-\sin B)}{K\sin C} \Rightarrow \frac{\sin(A-B)}{\sin C}=\frac{\sin C-\sin B}{\sin C}$

$\Rightarrow \sin(A-B)=\sin(A+B)-\sin B$

$\Rightarrow \sin B=\sin(A+B)-\sin(A-B) \ =2\cos A\sin B$

$\therefore 2\cos A=1 \ [\because B\neq C]$

i.e., $\cos A=\frac{1}{2} \ \because A=60°$

Ans: (c)

94. If $a=4, b=3, \angle A=60°$, then c is the root of the equation

Options:

(a) $c^2-3c-7=0$

(b) $c^2+3c+7=0$

(c) $c^2-3c+7=0$

(d) $c^2+3c-7=0$

Sol: $\cos A=\frac{b^2+c^2-a^2}{2bc}=\frac{9+c^2-16}{2(3)c} \Rightarrow \cos 60°=\frac{c^2-7}{6c}$

$\Rightarrow c^2-7=3c \Rightarrow c^2-3c-7=0$

Ans: (a)

95. If $y=x\sin^{-1}x+\sqrt{1-x^2}$, then $\frac{dy}{dx}=$

Options:

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

(b) $-\sqrt{1-x^2}$

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

(d) $\sin^{-1}x$

Sol: $\frac{dy}{dx}=1.\sin^{-1}x+\frac{x}{\sqrt{1-x^2}}+\frac{1}{2}\frac{(-2x)}{\sqrt{1-x^2}}$

$=\sin^{-1}x+\frac{x}{\sqrt{1-x^2}}-\frac{x}{\sqrt{1-x^2}}$

$=\sin^{-1}x$

$\therefore$ (d) is the correct answer.

Ans: (d)

96. If $y=\sqrt{x\log_e x}$, then $\frac{dy}{dx}$ at $x=e$ is

Options:

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

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

(c) $\sqrt{e}$

(d) none of these

Sol: $y=(x\log_e x)^{1/2}$

$\therefore \log y=\frac{1}{2}\left[\log x+\log(\log x)\right]$

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

$\frac{1}{\sqrt{x\log x}}\frac{dy}{dx}=\frac{1}{2x}\left(1+\frac{1}{\log x}\right)$

At $x=e$, we have $\frac{1}{\sqrt{e\log e}}\frac{dy}{dx}=\frac{1}{2x}\left(1+\frac{1}{\log e}\right)$

$\Rightarrow \frac{dy}{dx}=\frac{\sqrt{e}}{2e}(1+1)=\frac{1}{\sqrt{e}}$

Hence (b) is the correct answer.

Ans: (b)

97. Let $f(x)=e^x g(x), g(0)=4, g'(0)=2,$ then $f'(0)$ is

Options:

(a) 1

(b) 3

(c) 2

(d) 6

Sol: $f'(x)=e^x g'(x)+e^x g(x)$

$\Rightarrow f'(0)=g'(0)+g(0)=4+2=6$

Ans: (d)

98. If $y=(\sin x)^{(\sin x)^{(\sin x)\ldots\infty}}$, then $\frac{dy}{dx}=$

Options:

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

(b) $\frac{y^2\sin x}{1-\log y}$

(c) $\frac{y^2\cot x}{1-\log y}$

(d) $\frac{y^2\tan x}{1-\log y}$

Sol: $y=(\sin x)^y \Rightarrow \log y = y\log\sin x$

$\Rightarrow \frac{1}{y}\frac{dy}{dx}=\frac{dy}{dx}\log(\sin x)+y\frac{1}{\sin x}.\cos x$

$\Rightarrow \frac{dy}{dx}\left(\frac{1}{y}-\log\sin x\right)=y\cot x$

$\Rightarrow \frac{dy}{dx}=\frac{y^2\cot x}{1-y\log\sin x}=\frac{y^2\cot x}{1-\log y}\ [\because \log y = y\log\sin x]$

Ans: (c)

99. Derivative of $\tan^{-1}\left(\frac{t}{1+z}\right)$ w.r.t. $\tan^{-1}\left(\frac{z}{1+t}\right)$, where $t=\sin x, z=\cos x$ is

Options:

(a) -1

(b) 0

(c) 1

(d) 2

Sol: Put $u=\tan^{-1}\frac{t}{1+z}=\tan^{-1}\frac{\sin x}{1+\cos x}=\tan^{-1}\tan\frac{x}{2}=\frac{x}{2}$

$\therefore \frac{du}{dx}=\frac{1}{2}$

Let $v=\tan^{-1}\frac{z}{1+t}=\tan^{-1}\frac{\cos x}{1+\sin x}$

$=\tan^{-1}\frac{\cos^2\frac{x}{2}-\sin^2\frac{x}{2}}{\left(\cos\frac{x}{2}+\sin\frac{x}{2}\right)^2}$

$=\tan^{-1}\frac{\cos\frac{x}{2}-\sin\frac{x}{2}}{\cos\frac{x}{2}+\sin\frac{x}{2}}$

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

$$\therefore \frac{dv}{dx} = -\frac{1}{2}$$

$$\therefore \frac{du}{dv} = \frac{du/dx}{dv/dx} = \frac{\frac{1}{2}}{-\frac{1}{2}} = -1$$

Ans: (a)

100. Equation of the normal line to the curve $y = x\log x$ parallel to $2x-2y+3=0$ is

Options:

(a) $x-y=3e^{-2}$

(b) $x-y=6e^{-2}$

(c) $x-y=3e^{2}$

(d) none of these

Sol: $\frac{dy}{dx} = x.\frac{1}{x}+\log x = 1+\log x$

$\therefore$ Slope of the normal $= -\frac{1}{1+\log x} = 1$ $\quad\left[\because \text{slope of } 2x-2y+3=0 \text{ is } \frac{-2}{-2}=1\right]$

$\therefore 1+\log x = -1 \Rightarrow \log x = -2 \Rightarrow x = e^{-2}$

$\therefore y = e^{-2}\log e^{-2} = -2e^{-2}$

$\therefore$ Normal is $y-\left(-2e^{-2}\right) = 1\left(x-e^{-2}\right)$

$\Rightarrow y+2e^{-2} = x-e^{-2} \Rightarrow x-y = 3e^{-2}$

$\therefore$ (a) is correct answer.

Ans: (a)

101. $\sin x+\sqrt{3}\cos x$ is maximum when

Options:

(a) $x = 60°$

(b) $x = 45°$

(c) $x = 30°$

(d) $x = 0°$

Sol: Let $y = \sin x+\sqrt{3}\cos x$

$$\therefore \frac{dy}{dx} = \cos x-\sqrt{3}\sin x$$

$$\frac{d^2y}{dx^2} = -\sin x-\sqrt{3}\cos x$$

For max or min. $\frac{dy}{dx}=0.$

$\therefore \cos x=\sqrt{3}\sin x$

$\Rightarrow \tan x=\frac{1}{\sqrt{3}}\Rightarrow x=30°$

Since $\frac{d^2y}{dx^2}<0$ for $x=30°.$

$\therefore$ (c) is the correct answer.

Ans: (c)

102. A man is walking at the rate of 8 kmph towards the foot of a tower 60 metres high. The rate at which he is approaching the top when he is 80 metres from the foot of the tower is

Options:

(a) $6\cdot4$ kmph

(b) $\frac{32}{3}$ kmph

(c) 6 kmph

(d) none of these

Sol: Let $x=$ distance between foot of the lower and the man and $y=$ distance between top of the tower and the man. Then $x^2+60^2=y^2$

$\Rightarrow 2x\frac{dx}{dt}+0=2y\frac{dy}{dt}$

$\Rightarrow \frac{dx}{dt}=\frac{x}{y}\frac{dx}{dt}$

$=\frac{80}{\sqrt{80^2+60^2}}\times 8=6\cdot4$

Ans: (a)

103. $\int\frac{x^3}{1+x^8}dx$

Options:

(a) $\tan^{-1}\left(x^4\right)+C$

(b) $\frac{1}{4}\tan^{-1}\left(x^4\right)+C$

(c) $\tan^{-1}\left(x^8\right)+C$

(d) None of these

Sol: $\int\frac{x^3}{1+x^8}dx=\frac{1}{4}\int\frac{4x^3}{1+\left(x^4\right)^2}dx$

Put $x^4=t$

$= \frac{1}{4}\int \frac{dt}{1+t^2} = \frac{1}{4}\tan^{-1}(t) + c$

$= \frac{1}{4}\tan^{-1}\left(x^4\right) + c$

Ans: (b)

104. $\int e^{3x}\left(x^2 + \frac{2x}{3}\right)dx$

Options:

(a) $\frac{1}{3}x^2e^{3x} + C$

(b) $x^2e^{3x} + C$

(c) $\frac{1}{9}x^2e^{3x} + C$

(d) None of these

Sol: Let $I = \int e^{3x}\left(x^2 + \frac{2x}{3}\right)dx$

Put $3x = y, dx = \frac{dy}{3}\ x = \frac{y}{3}$

$\therefore I = \frac{1}{3}\int e^y\left[\frac{y^2}{9} + \frac{2}{9}y\right]dy = \frac{1}{27}\int e^y\left(y^2 + 2y\right)dy$

$= \frac{1}{27}e^y y^2 + C = \frac{1}{27}e^{3x}\left(9x^2\right) + C$

$= \frac{1}{3}x^2e^{3x} + C$

Ans: (a)

105. If $\int \frac{2^{\frac{1}{x}}}{x^2}dx = K.2^{\frac{1}{x}}$, then K is

Options:

(a) -1

(b) $-\log 2$

(c) $-\frac{1}{\log 2}$

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

Sol: By the given condition $\frac{d}{dx}\left(K2^{\frac{1}{x}}\right) = \frac{2^{\frac{1}{x}}}{x^2}$

$\Rightarrow K.2^{\frac{1}{x}}\left(-\frac{1}{x^2}\right)\log 2 = \frac{2^{\frac{1}{x}}}{x^2} \Rightarrow K = -\frac{1}{\log 2}$ $\therefore$ (c) is the correct answer.

Ans: (c)

106. $\int \frac{x}{x-\sqrt{x^2-1}}dx =$

Options:

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

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

(c) $\frac{x^3}{3}+\frac{1}{3}\left(x^2-1\right)^{3/2}+c$

(d) $\frac{x^3}{3}+\left(x^2-1\right)^{3/2}+c$

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

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

$=\int x^2dx+\frac{1}{2}\int \sqrt{x^2-1}.2x\,dx$

$=\frac{x^3}{3}+\frac{1}{2}.\frac{\left(x^2-1\right)^{3/2}}{3/2}+c \;=\frac{x^3}{3}+\frac{1}{3}\left(x^2-1\right)^{3/2}+c$

$\therefore$ (c) is the correct answer.

Ans: (c)

107. $\int \frac{dx}{\sqrt{e^{2x}-1}} =$

Options:

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

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

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

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

Sol: $I=\int \frac{dx}{\sqrt{e^{2x}-1}}$

Put $e^x=z \;\; \therefore e^xdx=dz$

$\Rightarrow dx=\frac{dz}{e^x}=\frac{dz}{z}=\int \frac{dz}{z\sqrt{z^2-1}}$

$=\sec^{-1}(z)+c=\sec^{-1}\left(e^x\right)+c \;\; \therefore$ (d) is the correct answer.

Ans: (d)

108. $\int_0^1 x\, e^{x^2}\, dx =$

Options:

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

(b) $\frac{e-1}{2}$

(c) $\frac{e}{2}$

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

Sol: $\int_0^1 x\, e^{x^2}\, dx = \frac{1}{2}\int_0^1 2x.e^{x^2}\, dx$

$= \frac{1}{2}.\left|e^{x^2}\right|_0^1$

$= \frac{1}{2}\left(e^1 - e^0\right) = \frac{e-1}{2}$

$\therefore$ (b) is the correct answer.

Ans: (b)

109. $\int_0^{\pi/2} \frac{\sin x \cos x}{1+\sin^4 x}\, dx =$

Options:

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

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

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

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

Sol: Put $\sin^2 x = z \quad \therefore 2\sin x \cos x\, dx = dz$

When $x = 0,\ z = 0;\ x = \frac{\pi}{2},\ z = 1$

$\therefore$ Given integral $= \int_0^1 \frac{dz}{2\left(1+z^2\right)} = \frac{1}{2}\left|\tan^{-1} z\right|_0^1$

$= \frac{1}{2}\left[\tan^{-1} 1 - \tan^{-1} 0\right]$

$= \frac{1}{2}.\frac{\pi}{4} = \frac{\pi}{8}$ $\therefore$ (c) is the correct answer.

Ans: (c)

110. $\int_{-5}^{5} |x+2|dx =$

Options:

(a) 15

(b) 40

(c) 29

(d) 10

Sol: $\int_{-5}^{5} |x+2|$

$= \int_{-5}^{-2} |x+2|dx + \int_{-2}^{5} |x+2|dx = \int_{-5}^{-2} -(x+2)dx + \int_{-2}^{5} (x+2)dx$

$= -\left|\frac{x^2}{2}+2x\right|_{-5}^{-2} + \left|\frac{x^2}{2}+2x\right|_{-2}^{5}$

$= -\left((2-4)-\left(\frac{25}{2}-10\right)\right)+\left(\frac{25}{2}+10\right)-\left(\frac{4}{2}-4\right)$

$= -\left(-2-\frac{5}{2}\right)+\frac{45}{2}+2 = 29 \therefore$ (c) is the correct answer.

Ans: (c)

111. The area enclosed by the curve $y = \sin 2x$, $x-$axis and the lines $x = \frac{\pi}{4}$ and $x = \frac{3\pi}{4}$ is

Options:

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

(b) 1 square unit

(c) 2 square unit

(d) none of these

Sol: We have $y = \sin 2x$

$\frac{\pi}{4} \le x < \frac{3\pi}{4} \Rightarrow \frac{\pi}{2} \le 2x < \frac{3\pi}{2}.$

Table of values

x	$\pi/4$	$\pi/3$	$5\pi/12$	$\pi/2$	$7\pi/12$	$2\pi/3$	$3\pi/4$
$2x$	$\pi/2$	$2\pi/3$	$5\pi/6$	π	$7\pi/6$	$4\pi/3$	$3\pi/2$
$y = \sin 2x$	1	0·87	0.50	0	–0·50	–0·87	–1

$\therefore$ Required area (shown shaded)

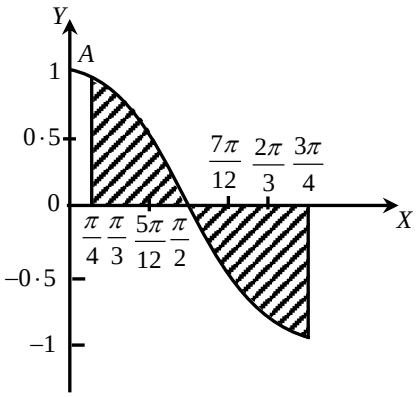
$$= \int_{\pi/4}^{\pi/2} y\,dx + \int_{\pi/2}^{3\pi/2} (-y)\,dx$$

$$= \int_{\pi/4}^{\pi/2} \sin 2x\,dx - \int_{\pi/2}^{3\pi/4} \sin 2x\,dx$$

$$= \frac{-\cos 2x}{2}\Big|_{\pi/4}^{\pi/2} - \left(-\cos\frac{2x}{2}\right)\Big|_{\pi/2}^{3\pi/4}$$

$$= -\frac{1}{2}\left[\cos\pi - \cos\frac{\pi}{2}\right] + \frac{1}{2}\left[\cos\frac{3\pi}{2} - \cos\pi\right]$$

$$= -\frac{1}{2}[-1-0] + \frac{1}{2}[0-(-1)] = \frac{1}{2} + \frac{1}{2} = 1 \text{ square unit.}$$



$\therefore$ (b) is the correct answer.

Ans: (b)

112. The complete solution of differential equation $\frac{dy}{dx} = 2x + 5$ is

Options:

(a) $y = x^2 + 5x$

(b) $y = x^2 + 5x + 1$

(c) $y = x^2 + 5x + 2$

(d) $y = x^2 + 5x + c$ where c is an arbitrary constant

Sol: G.S. is $y = x^2 + 5x + c$. $\left[\because \text{G.S. is } y = \int (2x+5)\,dx + c\right]$

Ans: (d)

113. The equation of the curve, whose slope at any point different from origin is $y + \frac{y}{x}$, is

Options:

(a) $y = c\,xe^x, c \neq 0$

(b) $y = xe^x$

(c) $xy = e^x$

(d) $y + xe^x = c$

Sol: By the given condition $\frac{dy}{dx} = y + \frac{y}{x} \Rightarrow \frac{dy}{dx} = y\left(1 + \frac{1}{x}\right)$

$$\Rightarrow \frac{dy}{y} = \left(1 + \frac{1}{x}\right)dx \Rightarrow \log y = x + \log x + \log c \Rightarrow \log y - \log cx = x$$

$$\Rightarrow \log\left(\frac{y}{cx}\right) = x$$

$$\Rightarrow y = cx\,e^x.$$

Ans: (a)

114. ABC is a triangle with $A=(2,3,5), B=(-1,3,2)$ and $C=(a,5,b)$. If the medean through A is equally inclined to the axes, then:

Options:

(a) $a=7\ \ b=10$

(b) $a=4\ \ b=3$

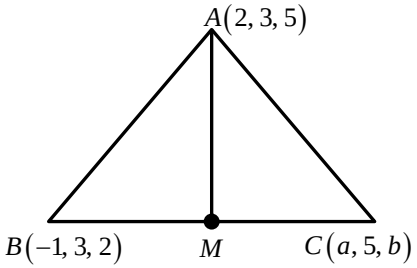
(c) $a=8\ \ b=5$

(d) $a=1\ \ b=5$

Sol: Midpoint of $BC=\left(\frac{a-1}{2}, 4, \frac{b+2}{2}\right)$

$\therefore AM=\left(\frac{a-1}{2}-2, 4-3, \frac{b+2}{2}-5\right)$

$=\left(\frac{1-5}{2}, 1, \frac{b-8}{2}\right)$



Since AM is equally inclined to axes

$\frac{a-5}{2}=1=\frac{b-8}{2}\Rightarrow a=7, b=10$

Ans: (a)

115. Equation of line passing through $(1,0,2)$ d intersecting the line $\frac{x+1}{3}=\frac{y-2}{-2}=\frac{z+1}{-1}$ at right angles is:

Options:

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

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

(c) $\frac{x-1}{1}=\frac{y}{-2}=\frac{z-2}{7}$

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

Sol: Let the required line meet $\frac{x+1}{3}=\frac{y-2}{-2}=\frac{z+1}{-1}$ at

$=(3r-1, -2r+2, -r-1)\ P(1,0,2)$

Since $PQ\perp$ the given line

$\therefore 3(3r-2)-2(-2r+2)-1(-r-3)=0$

$\Rightarrow r=\frac{1}{2}\ \therefore$ Direction ratio y required line: $-\frac{1}{2}, 1, -\frac{7}{2}$ or $1, -2, 7$

$\therefore$ Required equation $\frac{x-1}{1}=\frac{y}{-2}=\frac{z-2}{7}$

Ans: (c)

116. The equation of the plane containing the line $\frac{x+1}{-3}=\frac{y-3}{2}=\frac{z-2}{1}$ and the point $(0, 7, -7)$ is

Options:

(a) $x+y+z=0$

(b) $x-y+z=10$

(c) $x-y-z=3$

(d) None of these

Sol: Let the direction ratio of normal to the plane be a, b, c

Since the line is on plane, $(-1, 3, -2)$ lies on plane

$\therefore$ Equation of plane $a(x+1)+b(y-3)+c(z+2)=0$

This plane through $(0, 7, -7)$

$\Rightarrow a+4b-5c=0$ … (i)

Also $-3a+2b+c=0$ … (ii)

From (i) and (ii) $\frac{a}{-14}=\frac{b}{-14}=\frac{c}{-14}$

$\Rightarrow a, b, c=1, 1, 1$ $\therefore$ Required equation: $x+y+z=0$

Ans: (a)

117. The distance between the plane $x+2y-2z+1=0$ and $2x+4y-4z+5=0$

Options:

(a) 2

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

(c) $\frac{2}{3}$

(d) None of these

Sol: The planes are parallel.

Plane: $x+2y-22+1=0 \Rightarrow 2x+4y-4z+2=0$

$2x+4y-4z+5=0$

$\therefore d=\left|\frac{2-5}{\sqrt{2^2+4^2+4^2}}\right|=\left|\frac{-3}{6}\right|=\frac{1}{2}$

Ans: (b)

118. The maximum value of $z=10x+9y$ subject to the conditions $x+y\le 50; 2x+y\le 80; x\ge 0, y\ge 0$ is

Options:

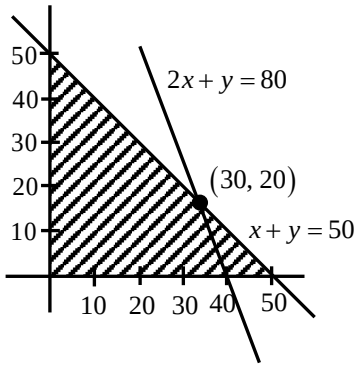
(a) 500

(b) 450

(c) 480

(d) None of these

Sol:



$z = 10x + 9y$

$\therefore$ Corner points are $(0, 0), (0, 50), (40, 0), (30, 20)$

$\therefore z(0, 0) = 0 \quad z(40, 0) = 400$

$z(0, 50) = 450 \quad z(30, 20) = 300 + 180 = 480$

Ans: (c)

119. A card from a pack of 52 cards is lost. From the remaining cards a card is drawn and found to be spade.

The probability that the card lost in spade:

Options:

(a) $\frac{12}{52}$

(b) $\frac{13}{51}$

(c) $\frac{12}{51}$

(d) None of these

Sol: Let S be the event that card drawn is spade.

Let E_1 : the card lost is spade

E_2 : the card lost is not spade

$\therefore P(E_1) = \frac{1}{4} \quad P(E_2) = \frac{3}{4}$

$P(S/E_1) = \frac{12}{51} \quad P(S/E_2) = \frac{13}{51}$

$$P(E_1/S) = \frac{P(E_1)P(S/E_1)}{P(E_1)P(S/E_1) + P(E_2)P(S/E_2)}$$

$$= \frac{\frac{1}{4} \times \frac{12}{51}}{\frac{1}{4} \times \frac{12}{51} + \frac{3}{4} \times \frac{13}{51}} = \frac{12}{12 + 39} = \frac{12}{51}$$

Ans: (c)

120. A die is thrown 3 times. The probability of getting different number is:

Options:

(a) $\frac{5}{36}$

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

(c) $\frac{13}{36}$

(d) None of these

Sol: Total no of outcomes $= n(5) = 6\times6\times6 = 6^3$

The ways of getting different nos $= 6\times5\times4$

$\therefore$ Required probability $= \frac{6\times5\times4}{6\times6\times} = \frac{5}{9}$

Ans: (b)

Physics

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

121. The potential energy of a satellite, having mass m and rotating at a height of 6.4×10^6 m from the earth surface, is

Options:

(a) $-mgR_e$

(b) $-0.67\,mgR_e$

(c) $-0.5\,mgR_e$

(d) $-0.33\,mgR_e$

Sol: Mass of the satellite $=m$ and height of satellite from earth $(h)=6.4\times10^6$ m .

We know that gravitational potential energy of the satellite at height

$$h=-\frac{GM_em}{(R_e+h)}=-\frac{gR_e^2m}{2R_e}=-\frac{gR_em}{2}=-0.5\,mgR_e \text{ (where, } GM_e=gR_e^2 \text{ and } h=R_e)$$

Ans: (c)

122. Which of the following statements is correct regarding Poisson's ratio?

Options:

(a) It is the ratio of the longitudinal strain to the lateral strain

(b) Its value is independent of the nature of the material

(c) It is unitless and dimensionless quantity

(d) The practical value of Poisson's ratio lies between 0 and 1

Sol: The ratio of the lateral strain to longitudinal strain is called Poisson's ratio.

Ans: (c)

123. The wheel of a car is rotating at the rate of 1200 revolutions per minute. On pressing the accelerator for 10 seconds. It starts rotating at 4500 revolutions per minute. The angular acceleration of the wheel is

Options:

(a) 30 radians/second^2

(b) 1880 degree/second^2

(c) 40 radians/second^2

(d) 1980 degree/second^2

Sol: $\alpha=\dfrac{2\pi(n_2-n_1)}{t}=\dfrac{2\pi\left(\dfrac{4500-1200}{60}\right)}{10}\text{ rad s}^{-2}$

$$=\frac{2\pi\dfrac{3300}{60}}{10}\times\frac{360}{2\pi}\frac{\text{degree}}{s^2}=1980\text{ degree/s}^2$$

Ans: (d)

124. The cylindrical tube of a spray pump has a cross-section of $8\,\text{cm}^2$, one end of which has 40 fine holes each of area $10^{-8}\,\text{m}^2$. If the liquid flows inside the tube with a speed of $0.15\,\text{m min}^{-1}$, the speed with which the liquid is ejected through the hole is

Options:

(a) $50\ \text{ms}^{-1}$

(b) $5\ \text{ms}^{-1}$

(c) $0.05\ \text{ms}^{-1}$

(d) $0.5\ \text{ms}^{-1}$

Sol: According to equation n to continuity, $(\text{area } a)\times(\text{velocity } v) = \text{constant}$

$\therefore$ For tube, $\left(8\times10^{-4}\right)\times\left(\dfrac{0.15}{60}\right) = a_1v_1$

For holes, $\left(40\times10^{-8}\right)\times v = a_2v_2$

$\because\ a_2v_2 = a_1v_1$

$\therefore\ 40\times10^{8}\times v$

$= \dfrac{8\times10^{-4}\times0.15}{60}$

$\Rightarrow\ v = \dfrac{8\times10^{-4}\times0.15}{40\times10^{-8}\times60} = \dfrac{8\times15}{4\times6} = 5\ \text{ms}^{-1}$

Ans: (b)

125. A beaker is completely filled with water at $4°\text{C}$. It will overflow, if

Options:

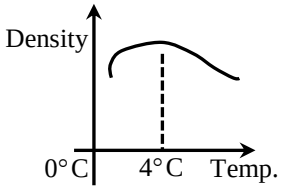
(a) heated above $4°\text{C}$

(b) cooled below $4°\text{C}$

(c) both heated and cooled above and below $4°\text{C}$ respectively

(d) none of these

Sol: Water has maximum density at $4°\text{C}$, so if the water is heated above $4°\text{C}$ or cooled below $4°\text{C}$ density decreases, i.e., volume increases.



In other words, it expands so it overflows in both the cases.

Ans: (c)

126. A graph is plotted with PV/T on $y-$axis and mass of the gas along $x-$axis for different gases. The graph is

Options:

(a) a straight line parallel to $x-$axis for all the gases

(b) a straight line passing through origin with a slope having a constant value for all the gases

(c) a straight line passing through origin with a slope having different values for different gases

(d) a straight line parallel to $y-$axis for all the gases

Sol: $\frac{PV}{T}=nR=\left(\frac{m}{M}\right)R$

or $\frac{PV}{T}=\left(\frac{R}{M}\right)m$

i.e. $\frac{PV}{T}$ versus m graph is straight line passing through origin with slope R/M, i.e. the slope depends on molecular mass of the gas M and is different for different gases.

Ans: (c)

127. A perfect gas contained in a cylinder is kept in vacuum. If the cylinder suddenly bursts, then the temperature of the gas

Options:

(a) remains constant

(b) becomes zero

(c) increases

(d) decreases

Sol: During free expansion of a perfect gas no work is done and also no heat is supplied from outside. Therefore, no change in internal energy. Hence, temperature remains constant.

Ans: (a)

128. If the length of a simple pendulum is increased by 2%, then the time period

Options:

(a) increases by 2%

(b) decreases by 2%

(c) increases by 1%

(d) decreases by 1%

Sol: We know that

$T=2\pi\sqrt{\frac{l}{g}}$

$\frac{\Delta T}{T}\times 100=\frac{1}{2}\frac{\Delta l}{l}\times 100$

If length is increased by 2%,

time period increases by 1%.

Ans: (c)

129. A 5.5 metre long string has a mass of $0.035\,\text{kg}$. If the tension in the string is $77\ \text{N}$, the speed of a wave on the string is

Options:

(a) $110\ \text{ms}^{-1}$

(b) $165\ \text{ms}^{-1}$

(c) $77\ \text{ms}^{-1}$

(d) $102\ \text{ms}^{-1}$

Sol: $m=\frac{0.035}{5.5}\,\text{kg m}^{-1}$, $T=77\ \text{N}$

$$v=\sqrt{\frac{T}{m}}=\sqrt{\frac{77\times5.5}{0.035}}=100\,\text{ms}^{-1}$$

Ans: (a)

130. One metallic sphere A is given positive charge whereas another identical metallic sphere B of exactly same mass as of A is given equal amount of negative charge. Then

Options:

(a) mass of A and mass of B still remain equal

(b) mass of A increases

(c) mass of B decreases

(d) mass of B increases

Sol: Negative charge means excess of electron which increases the mass of sphere B.

Ans: (d)

131. If the electric field is given by $\left(5\hat{i}+4\hat{j}+9\hat{k}\right)$. The electric flux through a surface of area 20 units lying in the $Y-Z$ plane will be

Options:

(a) 100 units

(b) 80 units

(c) 180 units

(d) 20 units

Sol: Here, E must be perpendicular to $Y-Z$ plane, i.e., area must be parallel to $X-$ plane,

so $d\vec{s}=20\hat{i}$ units

$\therefore$ electric flux

$$=\vec{E}\cdot d\vec{s}=\left(5\hat{i}+4\hat{j}+9\hat{k}\right)\cdot\left(20\hat{i}\right)=100\text{ units}$$

Ans: (a)

132. Three concentric metal shells A, B and C of respective radii a, b and $c(a<b<c)$ have surface charge densities $+\sigma, -\sigma$ and $+\sigma$ respectively. The potential of shell B is

Options:

(a) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{a}+c\right]$

(b) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{b}+c\right]$

(c) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2-c^2}{b}+a\right]$

(d) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2-c^2}{c}+a\right]$

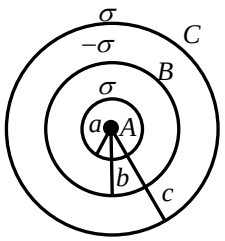
Sol: Potential outside the shell,

$V_{\text{outside}}=\frac{KQ}{r}$

where r is distance of point from the centre of shell Potential inside the shell,

$V_{\text{inside}}=\frac{KQ}{R}$

where $'R"$ is radius of the shell



$V_B=\frac{Kq_A}{r_b}+\frac{Kq_B}{r_b}+\frac{Kq_C}{r_c}$

$V_B=\frac{1}{4\pi\varepsilon_0}\left[\frac{\sigma 4\pi a^2}{b}-\frac{\sigma 4\pi b^2}{b}+\frac{\sigma 4\pi c^2}{c}\right]$

$V_B=\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{b}+c\right]$

Ans: (b)

133. Equal charges q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be

Options:

(a) $\frac{3q^2}{4\pi\varepsilon_0 a^2}$

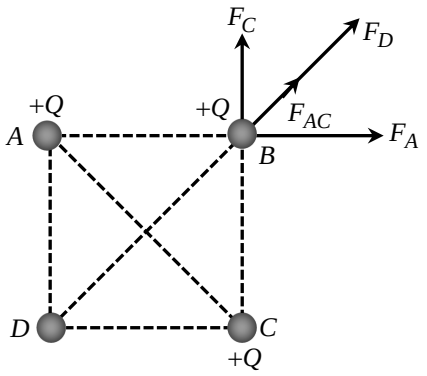
(b) $\frac{4q^2}{4\pi\varepsilon_0 a^2}$

(c) $\left(\frac{1+2\sqrt{2}}{2}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$

(d) $\left(2+\frac{1}{\sqrt{2}}\right)\frac{q^2}{4\pi\varepsilon_0 a^2}$

Sol: $F_{\text{net}} = F_{AC} + F_D = \sqrt{F_A^2 + F_C^2} + F_D$

Since, $F_A = F_C = \dfrac{kq^2}{a^2}$ and $F_D = \dfrac{kq^2}{\left(a\sqrt{2}\right)^2}$



$$F_{\text{net}} = \frac{\sqrt{2}kq^2}{a^2} + \frac{kq^2}{2a^2}$$

$$= \frac{kq^2}{a^2}\left(\sqrt{2} + \frac{1}{2}\right)$$

$$= \frac{q^2}{4\pi\varepsilon_0 a^2}\left(\frac{1+2\sqrt{2}}{2}\right)$$

Ans: (c)

134. Two points P and Q are maintained at the potentials of $10\,\text{V}$ and $-4\,\text{V}$, respectively. The work done in moving 100 electrons from P and Q is

Options:

(a) 9.60×10^{-7} J

(b) -2.24×10^{-16} J

(c) 2.24×10^{-16} J

(d) -9.60×10^{-17} J

Sol: $\dfrac{W_{PQ}}{q} = -\left(V_Q - V_P\right)$

$W_{PQ} = q\left(V_Q - V_P\right) = \left(-100\times1.6\times10^{-19}\right)\left(-4-10\right) = 2.24\times10^{-16}$ J

Ans: (c)

135. A parallel plate capacitor with air between the plates has a capacitance of $9\,\text{pF}$. The separation between its plates is 'd'. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $k_1 = 3$ and thickness $d/3$ while the other one has dielectric constant $k_2 = 6$ and thickness $2d/3$. Capacitance of the capacitor is now

Options:

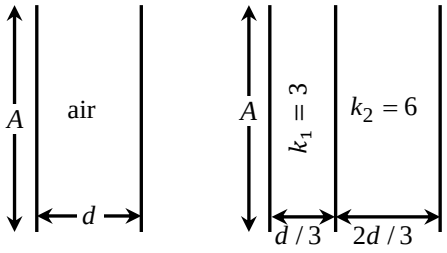
(a) 45 pF

(b) 40.5 pF

(c) 20.25 pF

(d) 1.8 pF

Sol: $C_{air} = \frac{\varepsilon_0}{d} = 9$



$$\frac{1}{C_{med}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d_1}{k_1\varepsilon_0 A} + \frac{d_2}{k_2\varepsilon_0 A}$$

$$\Rightarrow \frac{1}{C_{med}} = \frac{k_1 k_2 \varepsilon_0 A}{k_1 d_2 + k_1 d_1}$$

$$= \frac{3\times 6\times \varepsilon_0 A}{3\times 2d/3 + 6\times d/3} = \frac{18}{4}\times 9 = 40.5 \text{ pF}$$

Ans: (b)

136. An oil drop of radius r and density ρ is held stationary in a uniform vertically upwards electric field 'E'. If $\rho_0 (< \rho)$ is the density of air and e is quanta of charge, then the drop has -

Options:

(a) $\frac{4\pi r^3 (\rho - \rho_0) g}{3eE}$ excess electrons

(b) $\frac{4\pi r^2 (\rho - \rho_0) g}{3eE}$ excess electrons

(c) deficiency of $\frac{4\pi r^3 (\rho - \rho_0) g}{3eE}$ electrons

(d) deficiency of $\frac{4\pi r^2 (\rho - \rho_0) g}{eE}$ electrons

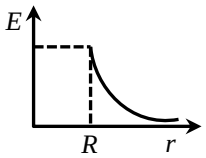
Sol: Net downward force on the drop $= \frac{4}{3}\pi r^3 (\rho - \rho_0) g$. For equilibrium, electric force must be upwards

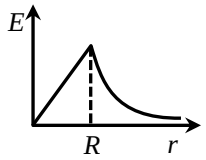
i.e. charge on the drop is positive: $neE = \frac{4}{3}\pi r^3 (\rho - \rho_0) g$ i.e., $n = \frac{4\pi r^3 (\rho - \rho_0) g}{3eE}$

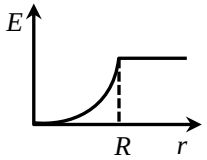
Ans: (c)

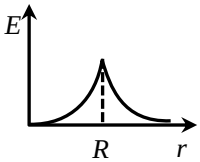
137. Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the spherical conductor?

Options:

(a) 

(b) 

(c) 

(d) 

Sol: Electric field due to a hollow spherical conductor is governed by following equation,

$E = 0,$ for $r < R$ … (i)

and $E = \dfrac{Q}{4\pi\varepsilon_0 r^2}$ for $r \geq R$

i.e. inside the conductor field will be zero and outside the conductor will vary according to $E \propto \dfrac{1}{r^2}$

Ans: (a)

138. The sensitivity of a potentiometer can be increased

Options:

(a) by increasing the length of potentiometer wire

(b) by decreasing the current of potentiometer wire circuit

(c) by joining high resistance to potentiometer wire circuit

(d) all the above

Sol: $\phi(\text{Potential gradient}) \downarrow \Rightarrow \text{Sensitivity} \uparrow$

$\phi = \dfrac{IR}{\ell}$

Ans: (d)

139. If negligibly small current is passed through a wire of length $15\,\text{m}$ and of resistance 5Ω having uniform cross-section of $6\times10^{-7}\ \text{m}^2$, then coefficient of resistivity of material, is

Options:

(a) $1\times10^{-7}\ \Omega-\text{m}$

(b) $2\times10^{-7}\ \Omega-\text{m}$

(c) $3\times10^{-7}\ \Omega-\text{m}$

(d) $4\times10^{-7}\ \Omega-\text{m}$

Sol: Given: Length of wire $(l) = 15\ \text{m}$

Area $(A) = 6\times10^{-7}\ \text{m}^2$

Resistance $(R) = 5\Omega$

We know that resistance of the wire material

$R = \rho\dfrac{l}{A} \Rightarrow$

$5 = \rho\times\dfrac{15}{6\times10^{-7}} = 2.5\times10^{7}\ \rho$

$\Rightarrow \rho = \dfrac{5}{2.5\times10^{-7}} = 2\times10^{-7}\ \Omega-\text{m}$

[where $\rho =$ coefficient of resistivity]

Ans: (b)

140. A current of 1mA flows through a copper wire. How many electrons will pass through a given point of wire in each second?

Options:

(a) 6.25×10^{8}

(b) 6.25×10^{31}

(c) 6.25×10^{15}

(d) 6.25×10^{19}

Sol: Current, $I=\dfrac{\text{Charge}}{\text{Time}}$

as a charge $q=n\times1.6\times10^{-19}$

$10^{-3}\text{ A}=\dfrac{n\times1.6\times10^{-19}}{1\text{s}}$

$n=6.25\times10^{15}$

Ans: (c)

141. The number of free electrons per $100\,\text{mm}$ of ordinary copper wire is 2×10^{21}. Average drift speed of electrons is 0.25 mm s^{-1}. The current flowing is

Options:

(a) $5\,\text{A}$

(b) $80\,\text{A}$

(c) $8\,\text{A}$

(d) $0.8\,\text{A}$

Sol: $I=neAv_d=2\times10^{21}\times1.6\times10^{-19}\times10\times0.25\times10^{-3}$

$=2\times1.6\times0.25=\dfrac{8}{10}=0.8\text{ A}$

Ans: (d)

142. For the resistance network shown in the figure, choose the incorrect option(s)

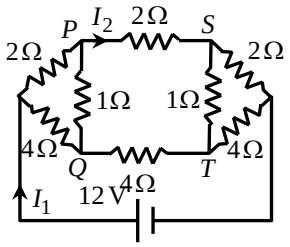
Options:

(a) the current through PQ is zero

(b) $I_1=3\,\text{A}$

(c) the potential at S is less than that at Q

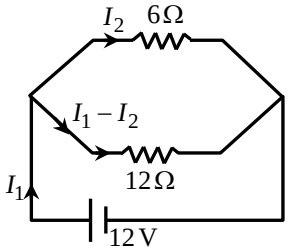
(d) $I_2=5\,\text{A}$



Sol: The given circuit is an extension of Wheatstone bridge, therefore points P and Q are at the same potential and point S and T are also at the same potential. Therefore no current passes through PQ and ST and the circuit reduces to as shown

$I_1=\dfrac{12}{4}$ $\qquad\left[\because\ R_{eq}=\dfrac{6\times12}{6+12}\right]$

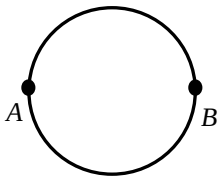
$= 3\,\text{A}$ $\quad\quad$ $\therefore\ I_2 = 3\left[\dfrac{12}{6+12}\right] = 2\,\text{A}$



As P and Q are equipotential and potential at S is less than the potential at P (potential drops across a resistance as current passes through it), therefore $V_S < V_Q$.

Ans: (d)

143. A wire of resistance 12 ohms per meter is bent to form a complete circle of radius 10 cm. The resistance between its two diametrically opposite points, A and B as shown in the figure, is



Options:

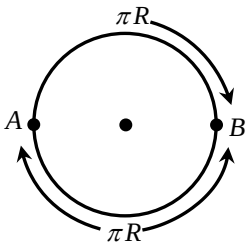
(a) 3Ω

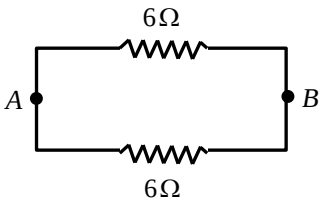
(b) $6\pi\,\Omega$

(c) 6Ω

(d) $0.66\pi\,\Omega$

Sol: The resistance of length $2\pi R$ is $12\,\Omega$. Hence the resistance of length πR is $6\,\Omega$. Thus two resistances of $6\,\Omega$ can be represented as shown in figure 2.

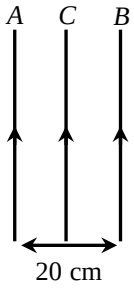




$\therefore$ Equivalent resistance $R = \dfrac{6\times 6}{12} = 3\Omega$

Ans: (a)

144. In the adjoining figure, two very long parallel wires A and B carry currents of 10 ampere and 20 ampere respectively, and are at a distance $20\,\text{cm}$ apart. If a third wire C (length $15\,\text{cm}$) having a current of 10 ampere is placed midway between them, then how much force will act on C. The direction of current in all the three wires is same.



Options:

(a) $3\times 10^{-5}\ \text{N}\ (\text{left})$

(b) $3\times 10^{-5}\ \text{N}\ (\text{right})$

(c) $6\times 10^{-5}\ \text{N}\ (\text{left})$

(d) $6\times 10^{-5}\ \text{N}\ (\text{right})$

Sol: The wires A and C carry current in same direction, therefore they attract each other. The force on C due to A is towards the wire A and is given by.

$$F_{CA} = \frac{\mu_0}{4\pi}\cdot\frac{2i_A i_C}{r_{AC}}l = \frac{10^{-7}\times 2\times 10\times 10}{0.10}0.15$$

or $F_{CA} = 3\times 10^{-5}\ \text{N}$ (towards left)

Similarly, the wires B and C attract each other as they also the current sin the same direction, the force on C due to current in B is towards right hand side. Therefore, the force on C due to B is given by

$F_{BC} = \frac{\mu_0}{4\pi} \cdot \frac{2i_B i_C}{r_{BC}} l = \frac{10^{-7} \times 2 \times 20 \times 10 \times 0.15}{0.10}$ or $F_{BC} = 6 \times 10^{-5}$ N (towards right)

Therefore, the net force on C is $F = \left(6 \times 10^{-5} - 3 \times 10^{-5}\right) = 3 \times 10^{-5}$ N (towards right)

Ans: (b)

145. In a moving coil galvanometer, the deflection of the coil θ is related to the electrical current i by the relation

Options:

(a) $i \propto \tan\theta$

(b) $i \propto \theta$

(c) $i \propto \theta^2$

(d) $i \propto \sqrt{\theta}$

Sol: $i = \frac{C\theta}{NAB} \Rightarrow i \propto \theta$

Ans: (b)

146. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength $20\,\text{Vm}^{-1}$ and $0.5\,\text{T}$ respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be

Options:

(a) $8\ \text{ms}^{-1}$

(b) $20\ \text{ms}^{-1}$

(c) $40\ \text{ms}^{-1}$

(d) $\frac{1}{40}\ \text{ms}^{-1}$

Sol: As electron move with constant velocity without deflection. Hence, force due to magnetic field is equal and opposite to force due to electric field.

$qvB = qE \Rightarrow v = \frac{E}{B} = \frac{20}{0.5} = 40\ \text{ms}^{-1}$

Ans: (c)

147. At what distance from a long straight wire carrying a current of $12\,\text{A}$ will the magnetic field be equal to $3 \times 10^{-5}\ \text{Wb m}^{-2}$?

Options:

(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 $(B) = 3\times10^{-5}$ Wb m^{-2}

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

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

Ans: (a)

148. A coil in the shape of an equilateral triangle of side $0.02\,\text{m}$ is suspended from its vertex such that it is hanging in a vertical plane between the pole pieces of permanent magnet producing a uniform field of 5×10^{-2} T. If a current of 0.1A is passed through the coil, what is the couple acting?

Options:

(a) $5\sqrt{3}\times10^{-7}\ \text{N}-\text{m}$

(b) $5\sqrt{3}\times10^{-10}\ \text{N}-\text{m}$

(c) $\dfrac{\sqrt{3}}{5}\times10^{-7}\ \text{N}-\text{m}$

(d) none of these

Sol: Torque $\tau = iAB\sin\theta,\ i = 0.1\text{A}, \theta = 90°$

$A = \dfrac{1}{2}\times\text{base}\times\text{height}$

or $A = \dfrac{1}{2}a\times\dfrac{a\sqrt{3}}{2} = \dfrac{\sqrt{3}a^2}{4} = \dfrac{\sqrt{3}\times(0.02)^2}{4} = \sqrt{3}\times10^{-4}\ \text{m}^2,\ \theta = 90°$

$\tau = 0.1\times\sqrt{3}\times10^{-4}\times5\times10^{-2}\sin90° = 5\sqrt{3}\times10^{-7}\ \text{N}-\text{m}$

Ans: (a)

149. The distance at which the magnetic field on axis as compared to the magnetic field at the center of the coil carrying current I and radius R is $\dfrac{1}{8}$, would be

Options:

(a) R

(b) $\sqrt{2}R$

(c) $2R$ (d) $\sqrt{3}R$

Sol: $\dfrac{B_A}{B_C} = \left(\dfrac{R^2}{x^2+R^2}\right)^{3/2}$

$\dfrac{1}{8} = \left(\dfrac{R^2}{x^2+R^2}\right)^{3/2} \Rightarrow \dfrac{1}{4} = \dfrac{R^2}{x^2+R^2}$

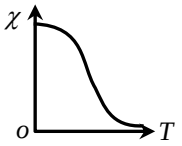
$\Rightarrow\ x^2+R^2 = 4R^2$

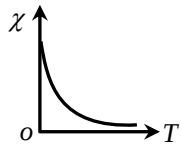
$\Rightarrow\ x = \sqrt{3}R$

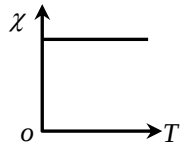
Ans: (d)

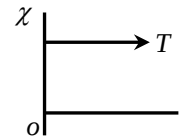
150. The variation of magnetic susceptibility (χ) with absolute temperature T for a ferromagnetic material is

Options:

(a) 

(b) 

(c) 

(d) 

Sol: Susceptibility of a ferromagnetic substance falls with rise of temperature $\left(\chi = \frac{C}{T - T_C}\right)$ and the substance becomes paramagnetic above curie temperature, so magnetic susceptibility becomes very small above curie temperature.

Ans: (a)

151. A magnetic field of $2\times10^{-2}\,\text{T}$ acts at right angles to a coil of area $100\,\text{cm}^2$, with 50 turns. The average e.m.f. induced in the coil is $0.1\,\text{V}$, when it is removed from the field in $t\,\text{s}$. The value of t is

Options:

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

(b) 0.1s

(c) 0.01s

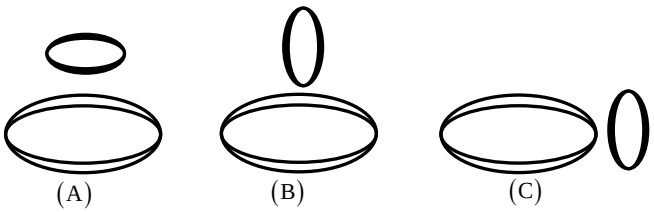
(d) 1s

Sol: $e = \frac{-(\phi_2 - \phi_1)}{t} = \frac{-(0 - NBA)}{t} = \frac{NBA}{t}$

$t = \frac{NBA}{e} = \frac{50\times2\times10^{-2}\times10^{-2}}{0.1} = 0.1\text{s}$

Ans: (b)

152. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be



Options:

(a) maximum in situation (A)

(b) maximum in situation (B)

(c) maximum in situation (C)

(d) the same in all situation

Sol: The mutual inductance between two coils depends on their degree of flux linkage, i.e., the fraction of flux linked with one coil which is also linked to the other coil. Here, the two coils in arrangement (a) are placed with their planes parallel. This will allow maximum flux linkage.

Ans: (a)

153. In an A.C. circuit with voltage V and current I the power dissipated is

Options:

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

(b) $\frac{1}{2}VI$

(c) VI

(d) dependent on the phase between V and I

Sol: Power dissipated $E_{\text{rms}} \cdot I_{\text{rms}} = (E_{\text{rms}})(I_{\text{rms}})\cos\theta$

Hence, power dissipated depends upon phase difference.

Ans: (d)

154. A $100\,\mu\text{F}$ capacitor in series with a $40\,\Omega$ resistance is connected to a $100\,\text{V}, 60\,\text{Hz}$ supply. What is the maximum current in the circuit?

Options:

(a) $3.24\,\text{A}$

(b) $4.25\,\text{A}$

(c) $2.25\,\text{A}$

(d) $5.20\,\text{A}$

Sol: Here, $C = 100\,\mu\text{F} = 100\times10^{-6}\,\text{F}$, $R = 40\,\Omega$, $V_{\text{rms}} = 100\,\text{V}$, $f = 60\,\text{Hz}$

Peak voltage, $V_0 = \sqrt{2}\cdot V_{\text{rms}} = 100\sqrt{2} = 155.54\,\text{V}$

Circuit impedance,

$$Z = \sqrt{R^2 + \frac{1}{\omega^2 C^2}} = \sqrt{40^2 + \frac{1}{\left(2\times\pi\times60\times100\times10^{-6}\right)^2}} = \sqrt{1600 + 703.60} = \sqrt{2303.60} = 48\,\Omega$$

Hence, maximum current in coil, $I_0 = \frac{V_0}{Z} = \frac{155.54}{48} = 3.24\,\text{A}$

Ans: (a)

155. An alternating current in a circuit is given by $I = 20\sin(100\pi t + 0.05\pi)\,\text{A}$. The r.m.s. value and the frequency of current respectively are

Options:

(a) $10\,\text{A}$ and $100\,\text{Hz}$

(b) $10\,\text{A}$ and $50\,\text{Hz}$

(c) $10\sqrt{2}\,\text{A}$ and $50\,\text{Hz}$

(d) $10\sqrt{2}\,\text{A}$ and $100\,\text{Hz}$

Sol: $I = 20\sin(100\pi t + 0.05\pi)$

$\therefore\ I_{\text{rms}} = \dfrac{20}{\sqrt{2}} = 10\sqrt{2}$

$\omega = 100\pi \ \Rightarrow\ f = 50\,\text{Hz}$

Ans: (c)

156. A point source of electromagnetic radiation has an average power output of $800\,\text{W}$. The maximum value of electric field at a distance $4.0\,\text{m}$ from the source is

Options:

(a) $64.7\ \text{V m}^{-1}$

(b) $57.8\ \text{V m}^{-1}$

(c) $56.72\ \text{V m}^{-1}$

(d) $54.77\ \text{V m}^{-1}$

Sol: Intensity of EM wave is given by,

$$I = \frac{P}{4\pi R^2} = v_{av}\cdot c = \frac{1}{2}\varepsilon_0 E_0^2 \times c$$

$$\Rightarrow\ E_0 = \sqrt{\frac{P}{2\pi R^2 \varepsilon_0 c}} = \sqrt{\frac{800}{2\times 3.14\times (4)^2 \times 8.85\times 10^{-12}\times 3\times 10^8}} = 54.77\,\text{V m}^{-1}$$

Ans: (d)

157. Two lenses of power $+12$ and -2 diopters are placed in contact. The combined focal length of the combination will be

Options:

(a) 8.33 cm

(b) 16.6 cm

(c) 12.5 cm (d) 10 cm

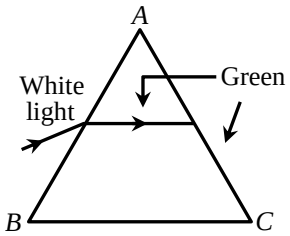
Sol: The combined power of lenses placed in contact,

$P = P_1 + P_2,\ P = 12 - 2 = 10$ dioptres

$$F = \frac{1}{10}\,\text{m} = 10\,\text{cm}$$

Ans: (d)

158. White light is incident on face AB of a glass prism. The path of the green component is shown in the figure. If the green light is just totally internally reflected at face AC as shown, the light emerging from face AC will contain



Options:

(a) yellow, orange and red colours

(b) violet, indigo and blue colours

(c) all colours

(d) all colours except green

Sol: Wavelength (λ) increases in the sequence of VIBGYOR. According to Cauchy's formula, (μ) decreases as wavelength increases. Therefore, μ decreases in the sequence VIBGYOR.

As $C = \sin^{-1}\left(\frac{1}{\mu}\right)$, therefore, critical angle C increases in the sequence VIBGYOR. For green colour, $\angle i = C$. For yellow, orange and red, critical angle is greater. Therefore, $\angle i$ is less than critical angle for YOR. These colours will not suffer total internal reflection. They will emerge from glass-air interface.

Ans: (a)

159. A 2.0 cm tall object is placed 15 cm in front of a concave mirror of focal length 10 cm. What is the size and nature of the image?

Options:

(a) 4 cm, real

(b) 4 cm, virtual

(c) 1.0 cm, real

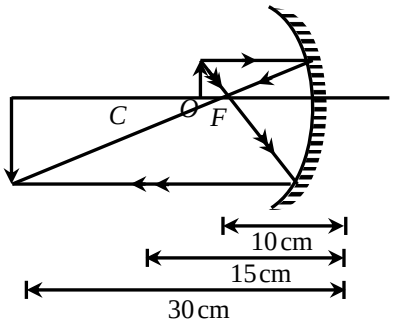
(d) none of these

Sol: According to New Cartesian sign convention,

Object distance $u = -15$ 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,

$$m=\frac{-v}{u}=\frac{h_1}{h_0} \qquad \Rightarrow \frac{-(-30)}{-15}=\frac{h_1}{2} \Rightarrow h_1=-4\,\text{cm}$$

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)

160. A vessel of depth $2d$ cm is half filled with a liquid of refractive index μ_1 and the upper half with a liquid of refractive index μ_2. The apparent depth of the vessel seen perpendicularly is

Options:

(a) $d\left(\frac{\mu_1\mu_2}{\mu_1+\mu_2}\right)$

(b) $d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

(c) $2d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

(d) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

Sol: $h'=\frac{d_1}{\mu_1}+\frac{d_2}{\mu_2}=d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

Ans: (b)

161. If yellow light emitted by sodium lamp in Young's double slit experiment is replaced by a monochromatic blue light of the same intensity

Options:

(a) fringe width will decrease

(b) fringe width will increase

(c) fringe width will remain unchanged

(d) fringes will become less intense

Sol: As $\beta=\frac{\lambda D}{d}$ and $\lambda_b<\lambda_y$

$\therefore$ Fringe width β will decrease

Ans: (a)

162. Raito of intensities of two waves are given by $4:1$. Then the ratio of the amplitudes of the two waves is

Options:

(a) $2:1$

(b) $1:2$

(c) $4:1$ (d) $1:4$

Sol: $\frac{I_1}{I_2}=\frac{a_1^2}{a_2^2}=\frac{4}{1}$

$\therefore \frac{a_1}{a_2}=\frac{2}{1}$

Ans: (a)

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

Options:

(a) $200P$

(b) $400P$

(c) $\frac{P}{200}$

(d) $100P$

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

Now, according to problem

$$\frac{d\lambda}{\lambda} = -\frac{dp}{P}$$

$$\frac{0.5}{100} = \frac{P}{P'}$$

$$P' = 200P$$

Ans: (a)

164. When a metal surface is illuminated by light of wavelengths $400\,\text{nm}$ and $250\,\text{nm}$, the maximum velocities of the photoelectrons ejected are υ and 2υ respectively. The work function of the metal is (h = Planck's constant, c = velocity of light in air)

Options:

(a) $2hc\times10^{6}$ J

(b) $1.5hc\times10^{6}$ J

(c) $hc\times10^{6}$ J

(d) $0.5hc\times10^{6}$ J

Sol: By using, $\frac{hc}{\lambda} = W_0 + \frac{1}{2}m\upsilon^2$

$$\Rightarrow \frac{hc}{400\times10^{-9}} = W_0 + \frac{1}{2}m\upsilon^2 \quad \ldots \text{(i)}$$

and, $$\frac{hc}{250\times10^{-9}} = W_0 + \frac{1}{2}m(2\upsilon)^2 \quad \ldots \text{(ii)}$$

on solving (i) and (ii)

$$\frac{1}{2}m\upsilon^2 = \frac{hc}{3}\left[\frac{1}{250\times10^{-9}} - \frac{1}{400\times10^{-9}}\right] \quad \ldots \text{(iii)}$$

From equation (i), (ii) and (iii),

$$W_0 = 2hc\times10^{6}\ \text{J}$$

Ans: (a)

165. As the quantum number increases, the difference of energy between consecutive energy levels

Options:

(a) remain the same

(b) increases

(c) decreases

(d) sometimes increases and sometimes decreases

Sol: The energy of an electron revolving in an orbit is: $E=-\frac{me^4}{8n^2h^2\varepsilon_0^2}$ where variables have their usual meanings.

$\Rightarrow E_n \propto \frac{1}{n^2}$

$\Delta E_{n,n-1}=E_n-E_{n-1}=-\frac{1}{(n-1)^2}+\frac{1}{n^2}=\frac{2n-1}{n^2-n}$

This can be approximated to $\frac{2}{n}$ when n is very large. Thus, energy difference consecutive levels as n increases.

Ans: (c)

166. A photon of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be

Options:

(a) $\frac{24hR}{25m}$

(b) $\frac{25hR}{24m}$

(c) $\frac{25m}{24hR}$

(d) $\frac{24m}{25hR}$

Sol: For emission, the wave number of the radiation is given as

$\frac{1}{\lambda}=Rz^2\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$

$R=$ Rydberg constant, $Z=$ atomic number

$=R\left(\frac{1}{1^2}-\frac{1}{5^2}\right)=R\left(1-\frac{1}{25}\right) \quad \Rightarrow \frac{1}{\lambda}=R\frac{24}{25}$

Linear momentum, $P=\frac{h}{\lambda}=h\times R\times\frac{24}{25}$ (de-Broglie hypothesis)

$\Rightarrow mv=\frac{24hR}{25} \Rightarrow V=\frac{24hR}{25m}$

Ans: (a)

167. The electron in a hydrogen atom makes a transition $n_1 \to n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

Options:

(a) $n_1 = 4,\ n_2 = 2$

(b) $n_1 = 8,\ n_2 = 2$

(c) $n_1 = 8,\ n_2 = 1$

(d) $n_1 = 6,\ n_2 = 3$

Sol: $T \propto n^3$. Given $T_{n_1} = 8T_{n_2}$, hence $n_1 = 2n_2$

Ans: (a)

168. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N_0 / e counts per minute at $t = 5$ minutes. The time (in minutes) at which the activity reduces to half its value is

Options:

(a) $\log_e 2/5$

(b) $\dfrac{5}{\log_e 2}$

(c) $5\log_{10} 2$

(d) $5\log_e 2$

Sol: $N = N_0 e^{-\lambda t}$

Here, $t = 5$ minutes

$$\frac{N_0}{e} = N_0 \cdot e^{-5\lambda} \qquad \Rightarrow\ 5\lambda = 1,\ \lambda = \frac{1}{5}$$

Now, $T_{1/2} = \dfrac{\ln 2}{\lambda} = 5\ln 2$

Ans: (d)

169. A radioactive nucleus undergoes a series of decay according to the scheme $A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$. If the number and atomic number of 'A' are 180 and 72 respectively, then what are these numbers for A_4

Options:

(a) 172 and 69

(b) 174 and 70

(c) 176 and 69

(d) 176 and 70

Sol: ${}_{72}A^{180} \xrightarrow{\alpha} {}_{70}A_1^{166} \xrightarrow{\beta} {}_{71}A_2^{176} \xrightarrow{\alpha} {}_{69}A_3^{172} \xrightarrow{\gamma} {}_{69}A_4^{172}$

Ans: (a)

170.If $220\,\text{MeV}$ energy is released in the fission of a single U^{235} nucleus, the number of fissions required per second to produce $1\,\text{kilowatt}$ power shall be (Given $1\text{eV} = 1.6\times10^{-19}\,\text{J}$)

Options:

(a) 3.125×10^{13}

(b) 3.125×10^{14}

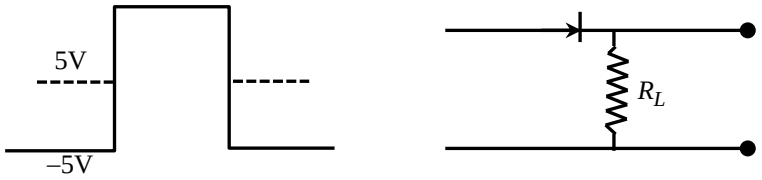
(c) 3.125×10^{15}

(d) 3.125×10^{16}

Sol: $P = n\left(\frac{E}{t}\right) \quad \Rightarrow 1000 = \frac{n\times200\times10^{6}\times1.6\times10^{-19}}{t} \quad \Rightarrow \frac{n}{t} = 3.125\times10^{3}$

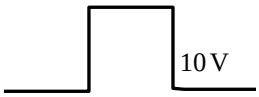
Ans: (a)

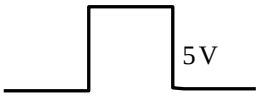
171.In a $p-n$ junction diode, a square input signal of $10\,\text{V}$ is applied as shown in fig.

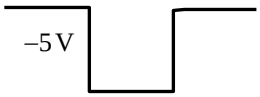


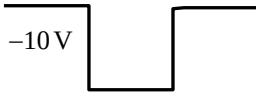
The output signal across R_L will be

Options:

(a) 

(b) 

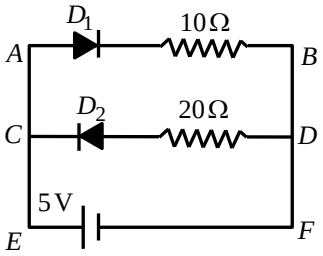
(c) 

(d) 

Sol: The $p-n$ junction diode is a half wave rectifier which produces output in forward biased mode only. Thus, there will be no output corresponding to $-5\,\text{V}$ input. Hence, output will be obtained corresponding to $+5\,\text{V}$ only.

Ans: (b)

172. Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is



Options:

(a) 0.75 A

(b) zero

(c) 0.25 A

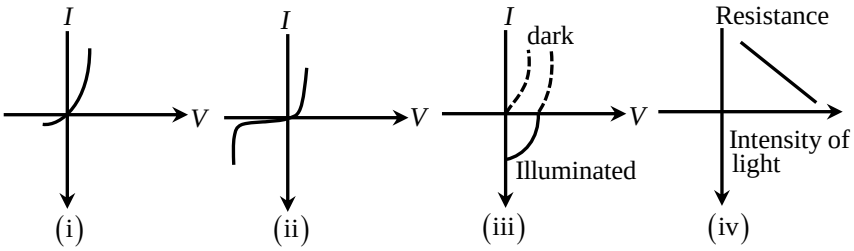
(d) 0.5 A

Sol: Here D_1 is in forward bias and D_2 is in reverse bias so, D_1 will conduct and D_2 will not conduct. Thus, no current with flow through DC.

$$I = \frac{V}{R} = \frac{5}{10} = \frac{1}{2} \text{ A}$$

Ans: (d)

173. Identify the semiconductor devices whose characteristics are given below, in order (i), (ii), (iii), (iv)



Options:

(a) Solar cell, Light dependent resistance, Zener diode, simple diode

(b) Zener diode, Solar cell, simple diode, Light dependent resistance

(c) simple diode, Zener diode, Solar cell, Light dependent resistance

(d) Zener diode, simple diode, Light dependent resistance, Solar cell

Sol: Graph (a) is for a simple diode. Graph (b) is showing the V Break down used for Zener diode. Graph (c) is for solar cell which shows cut-off voltage and open circuit. Graph (d) shows the variation of resistance h and hence current with intensity of light.

Ans: (c)

174. A charged particle of charge q and mass m enters perpendicularly in a magnetic field $\vec{B}$. Kinetic energy of the particle is E; then frequency of rotation is

Options:

(a) $\frac{qB}{m\pi}$

(b) $\frac{qB}{2\pi m}$

(c) $\frac{qBE}{2\pi m}$

(d) $\frac{qB}{2\pi E}$

Sol: For circular path in magnetic field,

$mr\omega^2 = qvB$

$\Rightarrow \ \omega^2 = \frac{qvB}{mr}$

As $v = r\omega$

$\therefore \ \omega^2 = \frac{q(r\omega)B}{mr}$

$\Rightarrow \ \omega = \frac{qB}{m}$

$\therefore$ If v is frequency of rotation, then

$v = \frac{\omega}{2\pi} \ \Rightarrow \ v = \frac{qB}{2\pi m}$

Ans: (b)

175. Which of the following is the most precise instrument for measuring length?

Options:

(a) Metre rod of least count 0.1 cm

(b) Vernier callipers of least count 0.01 cm

(c) Screw gauge of least count 0.001 cm

(d) None of these

Sol: Screw gauge has minimum least count of 0.001 cm . Hence, is most precise instrument.

Ans: (c)

176. The water drops fall at regular intervals from a tap 5m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far above the ground is the second drop at that instant? (Take $g = 10 \text{ ms}^{-2}$)

Options:

(a) 1.25 m

(b) 2.50 m

(c) 3.75 m

(d) 5.00 m

Sol: Height of tap $= 5\text{m}$ and $(g) = 10\text{m s}^{-2}$

For the first drop,

$5 = ut + \frac{1}{2}gt^2 = (0 \times t) + \frac{1}{2} \times 10t^2 = 5t^2$ or $t^2 = 1$ or $t = 1$

It means that the third drop leaves after one second of the first drop. Or, each drop leaves after every 0.5s . distance covered by the second drop in 0.5s .

$= ut + \frac{1}{2}gt^2 = (0 \times 0.5) + \frac{1}{2} \times 10 = (0.5)^2 = 1.25$ m

Therefore, distance of the second drop above the ground $= 5 - 1.25 = 3.75$ m .

Ans: (c)

177. A particle starts from origin at $t = 0$ with velocity $5\hat{i}$ ms^{-1} and moves in $x - y$ plane under the action of a force which produces a constant acceleration of $3\hat{i} + 2\hat{j}$ ms^{-2}. The $y-$coordinate of the particle at the instant when its $x-$coordinate is 84 m , is

Options:

(a) 12 m

(b) 24 m

(c) 36 m

(d) 48 m

Sol: The position of the particle is given by

$\vec{r} = \vec{r}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$

where, $\vec{r}_0$ is the position vector at $t = 0$ and $\vec{v}_0$ is the velocity at $t = 0$

Here, $\vec{r}_0 = 0$, $\vec{v}_0 = 5\hat{i}$ ms^{-1}, $\vec{a} = (3\hat{i} + 2\hat{j})$ ms^{-2}

$\therefore \ \vec{r} = 5t\hat{i} + \frac{1}{2}(3\hat{i} + 2\hat{j})t^2 = (5t + 1.5t^2)\hat{i} + 1t^2\hat{j}$ … (i)

Compare it with $\vec{r} = x\hat{i} + y\hat{j}$, we get $x = 5t + 1.5t^2$, $y = 1t^2$

$\therefore \ x = 84$ m

$\because \ 84 = 5t + 1.5t^2$

On solving, we get $t = 6$ s

At $t = 6$ s, $y = (1)(6)^2 = 36$ m

Ans: (c)

178. A block weighs W is held against a vertical wall by applying a horizontal force F . The minimum value of F needed to hold the block is

Options:

(a) Less than W

(b) Equal to W

(c) Greater than W

(d) Data is insufficient

Sol: Here applied horizontal force F acts as normal reaction.

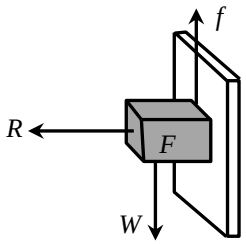
For holding the block

Force of friction = Weight of block

$F = W \Rightarrow \mu R = W \Rightarrow \mu F = W$

$\Rightarrow F = \frac{W}{\mu}$

As $\mu < 1 \quad \therefore F > W$



Ans: (c)

179. A running man has half the kinetic energy of that of a boy of half of his mass. The man speeds up by $1 ms^{-1}$ so as to have same K.E. as that of the boy. The original speed of the man will be

Options:

(a) $\sqrt{2}\ ms^{-1}$

(b) $\left(\sqrt{2}-1\right) ms^{-1}$

(c) $\frac{1}{\left(\sqrt{2}-1\right)} ms^{-1}$

(d) $\frac{1}{\sqrt{2}} ms^{-1}$

Sol: Let $m =$ mass of boy, $M =$ mass of man $v =$ velocity of boy, $V =$ velocity of man

$\frac{1}{2}MV^2 = \frac{1}{2}\left[\frac{1}{2}mv^2\right]$ …(i)

$\frac{1}{2}M\left(V+1\right)^2 = 1\left[\frac{1}{2}mv^2\right]$ … (ii)

Putting $m = \frac{M}{2}$ and solving $V = \frac{1}{\sqrt{2}-1}$

Ans: (c)

180. Three bricks each of length L and mass M arranged as shown from the wall. The distance of the centre of mass of the system from the wall is

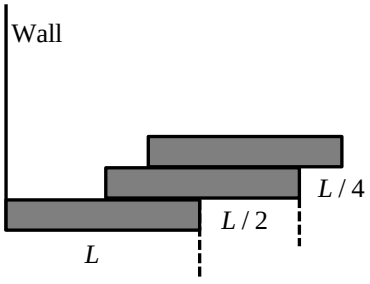
Options:

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

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

(c) $\left(\frac{3}{2}\right)L$

(d) $\left(\frac{11}{12}\right)L$



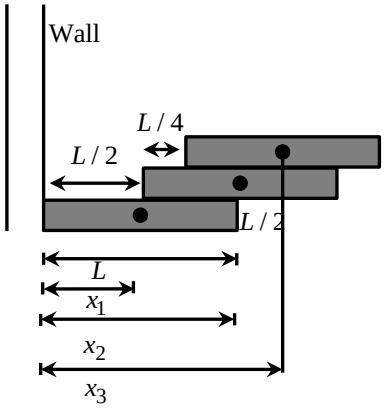
Sol: From figure, $x_1 = \frac{L}{2}$, $x_2 = \frac{L}{2} + \frac{L}{2} = L$

$$x_3 = \frac{L}{2} + \frac{L}{4} + \frac{L}{2} = \frac{5L}{4}$$

$$\therefore \quad X_{CM} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$

$$= \frac{M \times \frac{L}{2} + M \times L + 6M \times \frac{5L}{4}}{M + M + M} = \frac{\frac{11}{4} ML}{3M} = \frac{11L}{12}$$

Ans: (d)



Key Answers:

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