| Subject | Topic | Mock Test – 02 | Date |
|---|---|---|---|
| C + M + P | Complete Syllabus | CET – 12 – CT | |

**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. Calculate the mass of one molecule of bromine (Atomic mass of bromine=80u).

   Options:

   (a) $5.313\times10^{-22}$ g

   (b) $2.6569\times10^{-23}$ g

   (c) $1.328\times10^{-22}$ g

   (d) $1.602\times10^{-23}$ g

   Sol: Mass of one molecule of bromine $=\frac{80}{6.022\times10^{23}}=13.28\times10^{-23}\,\text{g}=1.328\times10^{-22}\,\text{g}$

   Ans: (c)

2. How many electrons are needed for balancing the reaction $H_2O_2 \longrightarrow O_2+2H^+ + xe^-$ ?

   Options:

   (a) 1

   (b) 2

   (c) 3

   (d) 4

   Sol: $x=2$ electrons

   Ans: (b)

3. The value of Vander Waal's constant $'a'$ for gases $O_2, N_2, NH_3, CH_4$ are $1.360, 1.390, 4.170, 2.253\,\text{litre}^2$ atm $\text{mol}^{-2}$ respectively. The gas which can be most easily liquefied is:

   Options:

   (a) $O_2$

   (b) $N_2$

   (c) $NH_3$

   (d) $CH_4$

   Sol: The gas having highest a value, will be liquefied more easily.

   Ans: (c)

4. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?

   Options:

   (a) Pauli's exclusion principle

   (b) Heisenberg's uncertainly principle

   (c) Hund's rule of maximum multiplicity

   (d) Aufbau principle

Sol: Heisenberg's uncertainly principle states the path of the electrons cannot be measured with certainly.

Ans: (b)

5. A compound was found to contain, nitrogen and oxygen in the ratio, nitrogen $28\,\text{g}$ and $80\,\text{g}$ of oxygen. The formula of the compound is:

Options:

(a) $NO$

(b) $N_2O_3$

(c) $N_2O_5$

(d) $N_2O_4$

Sol: g atom of $N = \frac{28}{14} = 2$

g atom of oxygen $= \frac{80}{16} = 5$

Ans: (c)

6. For one of the element various successive ionization enthalpies (in $\text{kJ mol}^{-1}$) are given below

| | | | | | |
|---|---|---|---|---|---|
| I.E. | 1st | 2nd | 3rd | 4th | 5th |
| | 577.5 | 1810 | 2750 | 11,580 | 14,820 |

The element is

Options:

(a) $Mg$

(b) $Al$

(c) $P$

(d) $Si$

Sol: The element should be $Al$ as 4th ionization enthalpy is very high.

Ans: (b)

7. The enthalpy and entropy change for the reaction $Br_2(l) + Cl_2(g) \rightarrow 2BrCl(g)$ are $30\text{KJ mol}^{-1}$ and $105\,\text{J mol}^{-1}$ respectively. The temperature at which the reaction will be in equilibrium is:

Options:

(a) 300 K

(b) 285.7 K

(c) 273 K

(d) 450 K

Sol: $\Delta G = \Delta H - T\Delta S = 0$

$$\Delta H = T\Delta S \Rightarrow T = \frac{\Delta H}{\Delta S} = \frac{30}{105 \times 10^{-3}} = 285.7\,\text{K}$$

Ans: (b)

8. The heat of combustion of sucrose $(C_{12}H_{22}O_{11})$ is $1350\,\text{kcal}$. How much of heat will be liberated when $17.1\text{g}$ of sucrose is burnt?

Options:

(a) 67.5 kcal

(b) 13.5 kcal

(c) 40.5 kcal

(d) 25.5 kcal

Sol: Heat evolved from 1 mole of sucrose $(342\text{ g}) = 1350\,\text{kcal}$

Heat evolved from 17.1 g of sucrose $= \frac{1350}{342} \times 17.1 = 67.5\,\text{kcal}$

Ans: (a)

9. Reaction in which yield of product will increase with increase in pressure is

Options:

(a) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

(b) $H_2O(g) + CO(g) \rightleftharpoons CO_2(g) + H_2(g)$

(c) $H_2O(g) + C(g) \rightleftharpoons CO(g) + H_2(g)$

(d) $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

Sol: In reaction $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ Volume is decreasing in forward direction. Hence on increasing pressure the yield of product will increase.

Ans: (d)

10. Which of the following is a Lewis acid?

Options:

(a) $BF_4^-$

(b) $OH^-$

(c) $AlCl_3$

(d) $RNH_2$

Sol: Lewis acid is a substance which can accept a pair of electrons. Molecules is which the central atom has incomplete octet are Lewis acids, e.g., $AlCl_3$

Ans: (c)

11. The solubility product of a sparingly soluble salt $AgBr$ at room temperature is $6.4 \times 10^{-13}$. Its solubility in $0.1\text{M}$ $NaBr$ solution is

Options:

(a) $6.4 \times 10^{-9}$

(b) $6.4 \times 10^{-10}$

(c) $6.4 \times 10^{-11}$

(d) $6.4 \times 10^{-12}$

Sol: $AB$ is a binary electrolyte.

$K_{sp} = s(0.1)$

$s = \frac{K_{sp}}{0.1} = \frac{6.4\times10^{-13}}{10^{-1}} = 6.4\times10^{-12}$

Ans: (d)

12. When temporary hard water containing $Mg(HCO_3)_2$ is boiled the ppt. formed is of

Options:

(a) $MgCO_3$

(b) $MgO$

(c) $Mg(OH)_2$

(d) $MgS$

Sol: $Mg(OH)_2$ is less soluble than $MgCO_3$. On boiling temporary hard water containing $Mg^{+2}$ ions, the ppt. obtained is of $Mg(OH)_2$ are not that of $MgCO_3$.

Ans: (c)

13. Aqueous solution of a group 2 element is precipitated by adding $Na_2CO_3$, then this precipitate is tested on flame, no light in visible region is observed, this element can be

Options:

(a) $Ba$

(b) $Mg$

(c) $Ca$

(d) $Sr$

Sol: Electrons in $Mg$ due to its small size are tightly bound so they cannot be excited by the flame.

Ans: (b)

14. Silicones are

Options:

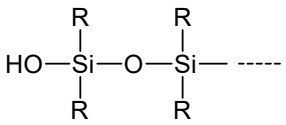
(a) Organosilicon polymers containing $Si-O-Si$ linkages

(b) Organosilicon polymers containing $-Si-O-O-Si-$ linkages

(c) Inorganic polymers of low molecular mass

(d) Inorganic polymers containing $SiO_4^{4-}$ tetrahedral

Sol: Silicones are organosilicon polymers containing $Si-O-Si$ linkages.




Ans: (a)

15. Which of the following pairs is an example of position isomerism?

Options:

(a) $CH_3-CH_2-CH_2-CH_3$ and $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$

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

(c) $CH_3-CH_2OH$ and $CH_3-O-CH_3$

(d) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$ and $CH_3-CH_2-CH_2-CH_2-CH_3$

Sol: $\underset{\text{1–butene}}{CH_3-CH_2-CH=CH_2}$ & $\underset{\text{2–butene}}{CH_3-CH=CH-CH_3}$

Ans: (b)

16. A hydrocarbon '$X$' on reduction gives $2-$methylbutane. On ozonolysis it gives acetone as one of the products. The hydrocarbon is

Options:

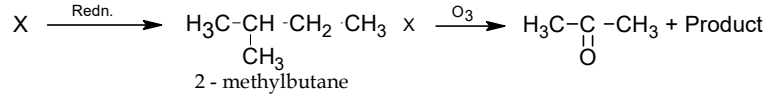
(a) $CH_3-CH_2-CH=CH_2$

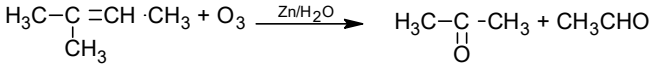
(b) $H_3C-\underset{\underset{CH_3}{|}}{C}=CH-CH_3$

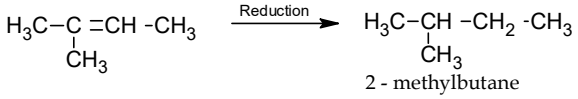
(c) $CH_3-CH_2-C\equiv CH$

(d) $CH_3-CH=CH-CH_2-CH_3$

Sol:




Ans: (b)

17. Formation of photochemical smog takes place generally in

Options:

(a) Winter during day time

(b) Summer during morning time

(c) Summer during day time

(d) Winter during morning time

Sol: Formation of photochemical smog takes place in summer during morning time.

Ans: (b)

18. A metallic element crystallises into lattice containing a sequence of layers of ABCABCABC…. any packing of spheres lives out voids in the lattice. Percentage of empty space (by volume) is:

Options:

(a) 52%

(b) 26%

(c) 50%

(d) 74%

Sol: ABC, ABC, ABC….. Arrangement represents ccp packing

Ans: (b)

19. Among the following, the molecular solid is

Options:

(a) Silicon

(b) Iodine

(c) Graphite

(d) Brass

Sol: Iodine

Ans: (b)

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: $F$ – centre

Ans: (a)

21. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water $\left(\Delta T_f\right)$, when $0.02$ mole of sodium sulphate is dissolved in $1$ kg of water, is $\left(k_f = 1.86\, K\,\text{kg}\,\text{mol}^{-1}\right)$

Options:

(a) 0.0372 K

(b) 0.1116 K

(c) 0.0744 L

(d) 0.0186 K

Sol: $Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

van't Hoff factor for $NaSO_4 = 3$ ; $\Delta T_f = i\, k_f m = 3 \times 1.86 \times 0.02 = 0.1116$

Ans: (b)

22. A solution of two liquids boils at a temperature more than the boiling point of either them. Hence, the binary solution shows

Options:

(a) Negative deviation from Raoult's law

(b) Positive deviation from Raoult's law

(c) No deviation or negative deviation from Raoult's law

(d) Positive or negative deviation from Raoult's law depending upon the composition

Sol: A solution of two liquids whose boiling point is more either of two pure components is formed by non-ideal solution showing negative deviation.

Ans: (a)

23. The value of Henry's constant $K_H$ is

Options:

(a) Greater for gases with higher solubility

(b) Greater for gases with lower solubility

(c) Constant for all gases

(d) Not related to the solubility of gases

Sol: $p = K_H x$

Higher the value of $K_H$ at a given pressure, lower is the solubility of the gas in the liquid.

Ans: (b)

24. The molar conductance at infinite dilution of $AgNO_3$, $NaCl$ and $NaNO_3$ are 116.5, 110.3 and $105.2\ \text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$. The molar conductance of $AgCl$ at infinite dilution is (in $\text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$)

Options:

(a) 114.1

(b) 130.6

(c) 121.6

(d) 150.2

Sol: $116.5+110.3-105.2 = 121.6$

Ans: (c)

25. If the standard electrode potential of $Cu^{+2}$ / $Cu$ electrode is $+\ 0.34$ V, what is the electrode potential at 0.01 M concentration of $Cu^{+2}$

Options:

(a) 0.399 V

(b) 0.281 V

(c) 0.222 V

(d) 0.176 V

Sol: $E = 0.34 + \frac{0.059}{2}\log(0.01) = 0.34 - 0.059 = 0.281$ V

Ans: (b)

26. The anode reaction in dry cell can be represented as

Options:

(a) $Zn^{+2} + 2e^- \rightarrow Zn$

(b) $Zn \rightarrow Zn^{+2} + 2e^-$

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

(d) $2MnO_2 + 2H_2O + 2e^- \rightarrow 2MnO(OH) + 2OH^-$

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

Ans: (b)

27. For the first order gas phase decomposition reaction, $X_{(g)} \rightarrow Y_{(g)} + Z_{(g)}$. If $P_0$ is the initial pressure of $A$ and $P_t$ is total pressure after time $t$, then

Options:

(a) $k = \frac{2.303}{t} \log \frac{P_o}{P_t}$

(b) $k = \frac{2.303}{t} \log \frac{P_o}{P_t - P_o}$

(c) $k = \frac{2.303}{t} \log \frac{P_o}{P_t - 2P_o}$

(d) $k = \frac{2.303}{t} \log \frac{P_o}{2P_o - P_t}$

Sol: $k = \frac{2.303}{t} \log \frac{P_o}{2P_o - P_t}$

Ans: (d)

28. The half-life period of the first order reaction $PCl_5 \rightarrow PCl_3 + Cl_2$ is $20$ minutes. The time in which the concentration of $PCl_5$ would be reduced to $10\ \%$ of the original concentration approximately will be

Options:

(a) 66 Minutes

(b) 90 Minutes

(c) 71 Minutes

(d) 33 Minutes

Sol: $k = \frac{0.693}{20} \min^{-1}$

$t_{90\%} = \frac{2.303}{k} \log \frac{a}{0.10a} = \frac{2.303 \times 20}{0.693}$

=66min approx

Ans: (a)

29. The initial rate of a second order reaction is $4\times10^{-4}$ mol $L^{-1}$ $s^{-1}$. If the initial concentration of the reaction substance is 0.20 mol $L^{-1}$, the value of rate constant is

Options:

(a) 0.02 L $mol^{-1}s^{-1}$

(b) 0.03 L $mol^{-1}s^{-1}$

(c) 0.01 L $mol^{-1}s^{-1}$

(d) 0.4 L $mol^{-1}s^{-1}$

Sol: $k = \frac{\text{rate}}{[A]^2} = \frac{4\times10^{-4}}{(0.2)^2} = 0.01\ s^{-1}\ L\ mol^{-1}$

Ans: (c)

30. An aerosol is a

Options:

(a) Dispersion of a solid or liquid in a gas

(b) Dispersion of a solid in a liquid

(c) Dispersion of a liquid in a liquid

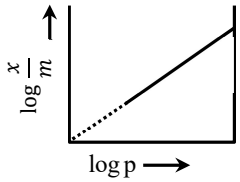
(d) Solid solution

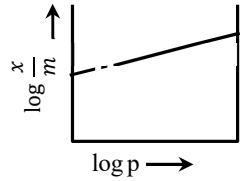
Sol: An aerosol is dispersion of solid or liquid in a gas. Smoke and dust are examples of aerosol. Aerosol is a type of colloidal system.

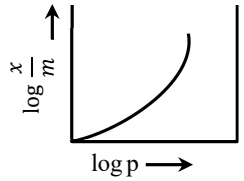
Ans: (a)

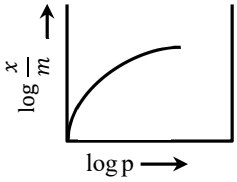
31. Which of the following curve is in accordance with Freundlich adsorption isotherm?

Options:

(a) 


(b) 


(c) 


(d) 

Sol: $\log\frac{x}{m}=\log k+\frac{1}{n}P$

Intercept $=\log k$

Ans: (b)

32. Sulphur sol contains

Options:

(a) Discreet S-atoms

(b) Discrete S-molecules

(c) Large aggregates of S-molecules

(d) Water dispersed in Solid Sulphur

Sol: A sol of sulphur consists of colloidal particles which are aggregates of $S_8$ molecules

Ans: (c)

33. Among the following, the main reactions occurring in blast furnace during extraction of iron from haematite are

(i) $Fe_2O_3+3CO\longrightarrow 2Fe+3CO_2$

(ii) $FeO+SiO_2\longrightarrow FeSiO_3$

(iii) $Fe_2O_3+3C\longrightarrow 2Fe+3CO$

(iv) $CaO+SiO_2\longrightarrow CaSiO_3$

Options:

(a) (i) and (ii)

(b) (ii) and (iii)

(c) (iii) and (iv)

(d) (i) and (iv)

Sol: Reaction at reduction zone $Fe_2O_3+3CO\rightarrow 2Fe+3CO_2$

Slag zone $CaO+SiO_2\rightarrow CaSiO_3$

Ans: (d)

34. Which of the following does not belong to $3d$ series of transition elements?

Options:

(a) Titanium

(b) Iron

(c) Palladium

(d) Vanadium

Sol: As last electron enters in the $4d$ sub-shell, it belongs to $4d$ series not $3d$ series.

Ans: (c)

35. Which of the following transition metal ions has least magnetic moment?

Options:

(a) $Co^{3+}$

(b) $Fe^{3+}$

(c) $Cr^{2+}$

(d) $V^{3+}$

Sol: (a) Valence shell electron configuration of $Co^{3+}$ is $3d^6 4s^0$. So has $4$ unpaired electrons

(b) Valence shell electron configuration of $Fe^{3+}$ is $3d^5 4s^0$. So has $5$ unpaired electrons

(c) Valence shell electron configuration of $Cr^{2+}$ is $3d^4 4s^0$. So has $4$ unpaired electrons

(d) Valence shell electron configuration of $V^{3+}$ is $3d^2 4s^0$. So has $2$ unpaired electrons

It has least number of unpaired electrons, so it has least magnetic moment.

Ans: (d)

36. Which of the following hydroxide has the least basic characteristics?

Options:

(a) $La(OH)_3$

(b) $Eu(OH)_3$

(c) $Ho(OH)_3$

(d) $Lu(OH)_3$

Sol: As the size of the ion is decreased, its tendency to donate electron is decreased, causing decrease in basic nature. Hence basic nature decreases from lanthanum hydroxide to lutetium hydroxide.

Ans: (d)

37. In which of the complex oxidation state of the metal is zero?

Options:

(a) $K_2\left[Ni(CN)_4\right]$

(b) $\left[Fe(CO)_5\right]$

(c) $\left[Co(NH_3)_6\right]Cl_3$

(d) $\left[Cu(NH_3)_4\right]SO_4$

Sol: In iron carbonyl, metal iron does not lose electrons to form a positive ion. Hence the oxidation number is zero.

Ans: (b)

38. The complex $CoCl_3 \cdot 5NH_3$ is treated with silver nitrate solution. Maximum number of chloride ions that can be precipitated is

Options:

(a) 9

(b) 4

(c) 3

(d) 2

Sol: The formula of the complex is $\left[Cu\left(NH_3\right)_5 Cl\right]Cl_2$. Hence, 2 $Cl^-$ ions precipitated by $AgNO_3$ solution.

Ans: (d)

39. Primary and secondary valency of platinum in the complex $\left[Pt\left(en\right)_2 Cl_2\right]$

Options:

(a) 4, 6

(b) 2, 6

(c) 4, 4

(d) 6, 4

Sol: Primary valency corresponds to oxidation number while secondary valency corresponds to coordination number.

Ans: (b)

40. The compound '$X$' of molecular formula $C_3H_6Cl_2$ gives propanal when treated with aq. alkali, $X$ is:

Options:

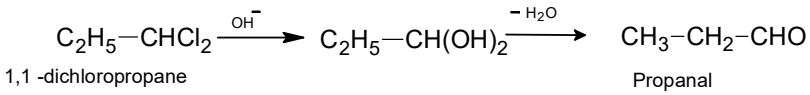
(a) 1, 1 – dichloropropane

(b) 2, 2 – dichloropropane

(c) 1, 2 – dichloropropane

(d) 1, 3 – dichloropropane

Sol:




Ans: (a)

41. Replacement of $Cl$ of Chlorobenzene to give phenol requires drastic conditions but chlorine of 2,4,6 – Trinitrochlorobenzene is readily replaced. This is because

Options:

(a) $-NO_2$ makes the ring electron rich at *ortho* and *para* positions

(b) $-NO_2$ withdraws $e^-$ from *meta*-position

(c) $-NO_2$ donates $e^-$ at $m$ – position

(d) $-NO_2$ withdraws $e^-$ from *ortho/para*-positions

Sol: $NO_2$ group withdraws electrons from o-and p-positions and hence activates the $Cl$ towards nucleophilic substitution reactions.

Ans: (d)

42. Elimination of $HCl$ from $2-$Chlorobutane results in the formation of:

Options:

(a) Equimolar mixture of $1-$ and $2-$butene

(b) $2-$butene only

(c) $1-$butene only

(d) $2-$butyne only

Sol: In the elimination reaction major product follows Satytzeff rule.

Ans: (b)

43. Propene $CH_3CH=CH_2$ can be converted into 1-propanol by oxidation. Indicate which set of reagents amongst the following is ideal to effect the above conversion?

Options:

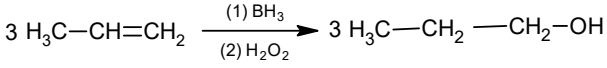
(a) $B_6H_6$ and alk. $H_2O_2$

(b) Osmium tetroxide $(OsO_4 / CH_2Cl_2)$

(c) $KMnO_4$ (Alkaline)

(d) $O_3 / Zn$

Sol: $KMnO_4$ (alkaline) and $OsO_4 / CH_2Cl_2$ are used for hydroxylation of double bond while $O_3 / Zn$ is used for ozonolysis.




Ans: (a)

44. The decreasing order of acidic nature of alcohol

Options:

(a) Primary > Secondary > Tertiary

(b) Primary < Secondary < Tertiary

(c) Primary < Secondary > Tertiary

(d) Primary > Secondary < Tertiary

Sol: Acidic character of alcohols decreases, i.e., the acidic character of alcohols decreases in the order: $1° > 2° > 3°$

Ans: (a)

45. On boiling with concentrated hydrobromic acid, ethyl phenyl ether will yield:

Options:

(a) Phenol and ethyl bromide

(b) Bromobenzene and ethanol

(c) Phenol and ethane

(d) Bromobenzene and ethane

Sol: $C_6H_5OCH_2CH_3 \xrightarrow[\Delta]{HBr} C_6H_5OH + CH_3CH_2Br$

Ans: (a)

46. Salicylic acid is produced when phenol in KOH is treated with

Options:

(a) $CHCl_3$

(b) $CH_3Cl$

(c) $CCl_4$

(d) $CH_2Cl_2$

Sol: Salicylic acid is produced when phenol reacts with KOH (alc) and $CCl_4$

Ans: (c)

47. Propanone is less reactive than ethanal because

Options:

(a) The $+I-$ effect of the alkyl groups increases the electron deficiency of the carbonyl carbon

(b) The $+I-$ effect of the alkyl groups decreases the electron deficiency of the carbonyl carbon

(c) Of steric hindrance to the attacking nucleophile

(d) Both (b) and (c)

Sol: Acetone are less reactive because the $+I-$ effect of the alkyl groups and steric hindrance.

Ans: (d)

48. A Propanal on treatment with dilute sodium hydroxide gives

Options:

(a) $CH_3CH_2CH_2CH_2CH_2CHO$

(b) $CH_3CH_2CH(OH)CH_2CH_2CHO$

(c) $CH_3CH_2CH(OH)CH(CH_3)CHO$

(d) $CH_3CH_2COOH$

Sol:

$$CH_3CH_2CHO + \underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH_2}}CHO \xrightarrow{\text{dil. NaOH}} CH_3 - CH_2 - \underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\overset{|}{CH}}} - \underset{|}{CHCHO}$$

Ans: (c)

49. The best oxidising agent for oxidation of $CH_3 - CH = CH - CHO$ to $CH_3 - CH = CH - COOH$ is

Options:

(a) Baeyer's reagent

(b) Tollens' reagent

(c) Schiff's reagent

(d) acidified dichromate

Sol: Tollen's reagent oxidises only $-CHO$ to $-COOH$ group

$$CH_3CH=CHCHO \xrightarrow{Ag(NH_3)_2^+} CH_3CH=CHCOOH$$

Ans: (b)

50. A liquid was mixed with methanol and a drop of concentrated $H_2SO_4$ was added. A compound with a fruity smell was formed. The liquid was

Options:

(a) $CH_3CHO$

(b) $CH_3COCH_3$

(c) $CH_3COOH$

(d) $CH_3CH_2OH$

Sol: Acid $(CH_3COOH)$ reacts with methanol to form ester $(CH_3COOCH_3)$ having fruity smell.

Ans: (c)

51. Mendius method of preparation of amines consists of:

Options:

(a) Catalytic reduction of alkyl cyanides

(b) Reduction of amide with $LiAiH_4$

(c) Reduction of nitroalkanes with $Sn+HCI$

(d) Reduction of oximes with $Na+C_2H_5OH$

Sol: $R-CN \xrightarrow{\text{Reduction}} RCH_2NH_2$

Ans: (a)

52. Acetanilide is prepared by the reaction of acetyl chloride on:

Options:

(a) Acetamide

(b) Aniline

(c) Acetaldehyde

(d) Benzene

Sol: $C_6H_5NH_2+CH_3COCl \rightarrow C_6H_5NHCOCH_3$

Ans: (b)

53. Propanamine reacts with nitrous acid to give

Options:

(a) Nitropropane

(b) Propyl nitrate

(c) Propanol

(d) Propanal

Sol: $CH_3CH_2CH_2NH_2+HNO_2 \rightarrow CH_3CH_2CH_2OH+N_2+H_2O$

Ans: (c)

54. Which of the following gives positive Fehling's solution test?

Options:

(a) Sucrose

(b) Galactose

(c) Fats

(d) Protein

Sol: Fehling's test is for aldehydes. In sucrose, there is no free aldehyde group but galactose in its open chain structure has free aldehyde group.

Ans: (b)

55. Which statement is not true for describing enzymes?

Options:

(a) They are polypeptides

(b) There are peptide linkages between the molecules

(c) They are not specific for a reaction

(d) They catalyse biological reactions

Sol: They are specific for a particular reaction

Ans: (c)

56. Adenosine is an example of

Options:

(a) Purine base

(b) Pyrimidine base

(c) Nucleoside

(d) Nucleotide

Sol: Nucleoside

Ans: (c)

57. Which of the following polymers are thermoplastic?

Options:

(a) Teflon

(b) Natural rubber

(c) Neoprene

(d) Cellulose

Sol: Teflon

Ans: (a)

58. Which of the following polymers has an amide linkage?

Options:

(a) Dacron

(b) Polystyrene

(c) Nylon-6,6

(d) Teflon

Sol: Nylon-6,6 has an amide linkage.

Ans: (c)

59. Which of the following is employed as Tranquilizer?

Options:

(a) Equanil

(b) Naproxen

(c) Tetracycline

(d) Dettol

Sol: Equanil is a tranquilizer

Ans: (a)

60. Which of the following is an anionic detergent?

Options:

(a) Sodium stearate

(b) Sodium lauryl sulphate

(c) Cetyltrimethyl ammonium bromide

(d) Glceryl oleate

Sol: Formula of sodium lauryl sulphate $C_{12}H_{25}SO_4Na$

Ans: (b)

## Mathematics

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

61. If $A$ and $B$ are finite sets and $A \subset B$ then

Options:

(a) $n(A \cup B) = n(A)$

(b) $n(A \cap B) = n(B)$

(c) $n(A \cup B) = n(B)$

(d) None of these

Sol: By data $A \subset B$. Thus $A \cup B = B$ $\therefore n(A \cup B) = n(B)$

Ans: (c)

62. If $f : N \times N \to N$ is such that $f(m,n) = m + n.$ for all $n \in N,$ where $N$ is the set of all natural numbers, then which of the following is true?

Options:

(a) $f$ is one - one but not onto

(b) $f$ is neither one – one not onto

(c) $f$ is one - one and onto

(d) $f$ is onto but not one – one

Sol: $f$ is not one – one for $\left.\begin{matrix} f(2,3) = 2+3 = 5 \\ f(3,2) = 3+2 = 5 \end{matrix}\right]$ but $(2,3) \neq (3,2)$

$f$ is not onto – for $1 \in N,$ but $\exists$ no $(a,b) \in N$ such that $a + b = 1,$ (i.e., $f(a,b) = 1$)

$(\because a \geq 1, b \geq 1 \Rightarrow a + b > 1)$

Ans: (b)

63. The domain of the function $f(x) = \dfrac{1}{\sqrt{(x-6)(x-9)}}$ is

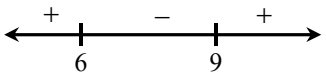
Options:

(a) $(-\infty, 6] \cup (9, \infty)$

(b) $(-\infty, 6] \cup [9, \infty)$

(c) $(-\infty, 6) \cup [9, \infty)$

(d) $(-\infty, 6) \cup (9, \infty)$




Sol: We have, $f(x) = \dfrac{1}{\sqrt{(x-6)(x-9)}}$

$f(x)$ is well defined from $(x-6)(x-9) > 0$

Now $(x-6)(x-9) > 0$ for $x < 6$ or $x > 9$ $\therefore$ domain of $f(x)$ is $(-\infty, 6) \cup (9, \infty)$

Ans: (d)

64. Let us define a relation $R$ on the set $R$ of real numbers as $a\,R\,b$ if $a \geq b$. Then $R$ is

Options:

(a) an equivalence relation

(b) reflexive, transitive but not symmetric

(c) symmetric, transitive but not reflexive

(d) neither transitive nor reflexive but symmetric

Sol: Clearly $a \geq a$ for all $a \in R$. Thus $R$ is reflexive.

Thus $R$ is not symmetric

Now $a \geq b, b \geq c$. Thus $R$ is transitive

Ans: (b)

65. Let $f:[2,\infty) \to R$ be the function defined by $f(x) = x^2 - 4x + 5$. Then the range of $f$ is

Options:

(a) $R$

(b) $[1,\infty)$

(c) $[4,\infty)$

(d) $[5,\infty)$

Sol: We have $f(x) = x^2 - 4x + 5$

$\Rightarrow f'(x) = 2x - 4 = 0 \Rightarrow x = 2$

$f''(x) = 2 > 0 \qquad \therefore f(x)$ attain minimum at $x = 2$

Min. value is $f(2) = 4 - 8 + 5 = 1$

Thus range is $[1,\infty)$

**OR**

$f(x) = x^2 - 4x + 4 + 1 = (x-2)^2 + 1$

$\geq 1$ as $(x-2)^2 \geq 0$

$\Rightarrow f(x) \geq 1$

$\Rightarrow$ Range is $[1,\infty)$

Ans: (b)

66. If $f: R \to R$ and $g: R \to R$ defined by $f(x) = 2x + 3$ and $g(x) = x^2 + 7$, then the values of $x$ such that $g(f(x)) = 8$ are

Options:

(a) $1, 2$

(b) $-1, 2$

(c) $-1. -2$

(d) $1, -2$

Sol: We have $f(x)=2x+3$ and $g(x)=x^2+7$

$g(f(x))=g(2x+3)=(2x+3)^2+7$

By data, $(2x+3)^2+7=8$

$\Rightarrow 4x^2+12x+8=0$ $\Rightarrow x^2+3x+2=0$ $\Rightarrow (x+1)(x+2)=0 \Rightarrow x=-1$ or $-2$

Ans: (c)

67. Let $p$ : 32 is multiple of 8

$q$ : 17 is a prime number

$r: 3+7=11$

The symbolic form of the statement : "32 is a multiple of 8 and 1 is a prime number but $3+7\neq 11$", is

Options:

(a) $(p\wedge q)\vee r$

(b) $(p\wedge q)\wedge r$

(c) $(p\wedge q)\wedge(\sim r)$

(d) $(p\vee q)\wedge\sim r$

Sol: $p$ : 32 is multiple of 8

$q$ : 17 is a prime number

$r: 3+7=11 : \sim r: 3+7=11$

The given statement in the symbolic form is $(p\wedge q)\wedge\sim r$ (sometimes "but" is used in lieu of "and")

Ans: (c)

68. If 12 and 9 are respectively AM & GM of two numbers, then the numbers are the roots of the equation

Options:

(a) $x^2-24x+81=0$

(b) $x^2+24x-81=0$

(c) $x^2-81x+24=0$

(d) $x^2-24x-81=0$

Sol: If $A$ and $G$ are AM and GM between the two positive quantities, $a$ and $b$ then these are the roots of the equation $x^2-2Ax+G^2=0$

Here $A=12$ and $G=9$.

The required equation is $x^2-24x+81=0$

**OR**

By data $a+b=2A$ and $ab=G^2$

$\therefore$ Equation whose roots are $a$ and $b$ is $x^2-24x+81=0$

Ans: (a)

69. If $n$ is a +ve integer, $4^n - 3n - 1$ is divisible by

Options:

(a) 6

(b) 9

(c) 8

(d) 27

Sol: For $n = 1; 4 - 3 - 1 = 0$

$n = 2: 16 - 6 - 1 = 9$

$n = 3: 64 - 9 - 1 = 54$

$\therefore 4^n - 3n + 1$ is divisible by 9

**OR**

$4^n = (1+3)^n = 1 + {}^nC_1 3 + {}^nC_2 3^2 + {}^nC_3 3^3 + .....$

$= 1 + 3n + 9[k]\ k \in N$

$\Rightarrow 4^n - 3n - 1 = 9k$

$\Rightarrow 4^n - 3n - 1$ is divisible by 9

Ans: (b)

70. If $2 + i\sqrt{3}$ is a root of the equation $x^2 + px + q = 0$, where $p, q$ are real, then $(p, q) =$

Options:

(a) $(4, -7)$

(b) $(4, 7)$

(c) $(-4, 7)$

(d) $(-4, -7)$

Sol: By data $p$ and $q$ are real, thus other root will be $2 - i\sqrt{3}$

Now, $\left(2 + i\sqrt{3}\right) + \left(2 - i\sqrt{3}\right) = -p$

$\Rightarrow 4 = -p \Rightarrow p = -4$

$\left(2 + i\sqrt{3}\right) \cdot \left(2 - i\sqrt{3}\right) = q$

$\Rightarrow 4 + 3 = q \Rightarrow q = 7$

Ans: (c)

71. If $m > n$, the number of ways $m$ men and $n$ women can be seated in a row, so that no two women sit together is

Options:

(a) $\frac{m!\,n!}{(m+n)!}$

(b) $\frac{(m+n)!}{m!(n+1)!}$

(c) $\frac{m!(n+1)!}{(m-n+1)!}$

(d) $\frac{m!(m+1)!}{(m-n+1)!}$

Sol: Clearly $m$ men can be seated in $m!$ ways.

$n$ women can be seated in $(m+1)$ gaps between $m$ men in ${}^{(m+1)}P_n$ ways

$\therefore$ required number $= \frac{m!(m+1)!}{(m-n+1)!}$

Ans: (a)

72. If the coefficients of second, third and fourth terms in the expansion of $(1+x)^{2n}$ are in AP, then,

Options:

(a) $2n^2 - 9n + 7 = 0$

(b) $2n^2 + 5n + 7 = 0$

(c) $n^2 - 9n + 7 = 0$

(d) $2n^2 - 5n - 7 = 0$

Sol: If 2nd, 3rd and 4th terms are in AP in the expansion of $(1+x)^{2n}$ then

$(2n)^2 - (4\cdot 2+1)2n + 4(2)^2 = 2$; $\quad 4n^2 - 18n + 14 \Rightarrow 2n^2 - 9n + 7 = 0$

Ans: (a)

73. For any $2\times 2$ matrix $A$, if $A \cdot adj\, A = \begin{pmatrix} 7 & 0 \\ 0 & 7 \end{pmatrix}$ then $|A|$ is equal to

Options:

(a) 7

(b) 14

(c) 49

(d) 0

Sol: Standard result: $A \cdot adj\, A = |A| \cdot I$

$\begin{pmatrix} 7 & 0 \\ 0 & 7 \end{pmatrix} = \begin{pmatrix} |A| & 0 \\ 0 & |A| \end{pmatrix} \Rightarrow |A| = 7$

Ans: (a)

74. If $A$ is symmetric as well as skew symmetric then $A$

Options:

(a) is a diagonal matrix

(b) is a null matrix

(c) is a triangular matrix

(d) such matrix does not exist

Sol: If $A$ is both symmetric and skew symmetric then $A$ is a null matrix

Ans: (b)

75. $\begin{vmatrix} 0 & p-q & p-r \\ q-p & 0 & q-r \\ r-p & r-q & 0 \end{vmatrix} =$

Options:

(a) 0

(b) $(p-q)(q-r)(r-p)$

(c) $pqr$

(d) $3pqr$

Sol: On expansion

$\Delta = (p-q)(q-r)(r-p)+(p-r)(q-p)(r-q)$

$= -(q-p)(r-q)(p-r)+(p-r)(q-p)(r-q) = 0$

Ans: (a)

76. The value of determinant $\begin{vmatrix} a-b & b+c & a \\ b-c & c+a & b \\ c-a & a+b & c \end{vmatrix}$ is

Options:

(a) $a^3+b^3+c^3$

(b) $3bc$

(c) $a^3+b^3+c^3-3abc$

(d) none of these

Sol: We have $\begin{vmatrix} a-b & b+c & a \\ b-c & c+a & b \\ c-a & a+b & c \end{vmatrix}$

$= \begin{vmatrix} a-b & a+b+c & a \\ b-c & a+b+c & b \\ c-a & a+b+c & c \end{vmatrix}$ $C_2 \to C_2 + C_3$

$= (a+b+c)\begin{vmatrix} a-b & 1 & a \\ b-c & 1 & b \\ c-a & 1 & c \end{vmatrix}$

$$= (a+b+c)\begin{vmatrix} -b & 1 & a \\ -c & 1 & b \\ -a & 1 & c \end{vmatrix} + (a+b+c)\begin{vmatrix} a & 1 & a \\ b & 1 & b \\ c & 1 & c \end{vmatrix}$$

$$= (a+b+c)\left[-b(c-b)-1\left(-c^2+ab\right)+a(-c+a)\right]$$

$$= (a+b+c)\left(a^2+b^2+c^2-ab-bc-ca\right)$$

$$= a^3+b^3+c^3-3abc$$

Ans: (c)

77. The solution set of $|x-4|<5,\ |2x+5|>7$ is

Options:

(a) $(-1,9)$

(b) $(-1,9)\cap(-\infty,-6)$

(c) $(1,9)$

(d) $(-\infty,-6)\cup(1,\infty)$

Sol: $|x-4|<5 \Rightarrow -5<x-4<5$

$\Rightarrow -1<x<9 \Rightarrow x\in(-1,9)$

$|2x+5|>7 \Rightarrow 2x+5<-7$ or $2x+5>7$

$\Rightarrow x<-6$ or $x>1$

$\Rightarrow (-\infty,-6)\cup(1,\infty)$

Solution is $(-1,9)\cap\{(-\infty,-6)\cup(1,\infty)\}=(1,9)$

Ans: (c)

78. Given that $|z|=4$ and $\text{amp}\, z=\frac{5\pi}{6}$, then $z=$

Options:

(a) $-2\sqrt{3}+2i$

(b) $2\sqrt{3}+2i$

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

(d) $-\sqrt{3}+i$

Sol: The required complex number is

$$z=4\left(\cos\frac{5\pi}{6}+i\sin\frac{5\pi}{6}\right)=4\left[\cos\left(\pi-\frac{\pi}{6}\right)+i\sin\left(\pi-\frac{\pi}{6}\right)\right]$$

$$=4\left(-\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)=4\left(-\frac{\sqrt{3}}{2}+i\frac{1}{2}\right)=-2\sqrt{3}+2i$$

Ans: (a)

79. The image of the point $P(3,5)$ w.r.t the line $y=x$ is the point $Q$ and the image of $Q$ along the line $y=0$ is the point $R(a,b)$, then $(a,b)=$

Options:

(a) $(5,3)$

(b) $(5,-3)$

(c) $(-5,3)$

(d) $(-5,-3)$

Sol: Image of $(x_1,y_1)$ along $y=x$ is $(y_1,x_1)$

Image of $(x_1,y_1)$ along $x-$axis$(y=0)$ is $(x_1,-y_1)$

Now image of $(3,5)$ along $y=x$ is $(5,3)$

Image of $(5,3)$ along $x-$axis is $(5,-3)$

Ans: (b)

80. Equation of diagonals of the square formed by the lines $x=0,\ y=0,\ x=1$ and $y=1$ are

Are Options:

(a) $y=x, y+x=1$

(b) $y=x,\ x+y=2$

(c) $2y=x, y+x=\frac{1}{3}$

(d) $y=2x,\ y+2x=1$

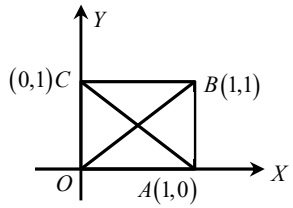
Sol: Form the figure we have

Equation of $OB$ is $x=y$

Equation of $AC$ is $x+y=1$

These are diagonals

Ans: (a)




81. The equation of the circle described on the common chord of the circle $x^2+y^2+2x=0$ and $x^2+y^2+2y=0$ as diameter is

Options:

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

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

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

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

Sol: $S_1 : x^2 + y^2 + 2x = 0$ ; $S_2 : x^2 + y^2 + 2y = 0$

Common chord is $S_1 - S_2 = 0$ i.e., $x - y = 0$

$\therefore$ Equation of the required circle is of the form

$x^2 + y^2 + 2x + \lambda(x - y) = 0 \quad \Rightarrow x^2 + y^2 + (2 + \lambda)x - \lambda y = 0$

Centre $\left(-\frac{2+\lambda}{2}, \frac{\lambda}{2}\right)$ lies on $x - y = 0$

$\Rightarrow -\frac{2+\lambda}{2} = \frac{\lambda}{2} \Rightarrow -1 - \frac{\lambda}{2} = \frac{\lambda}{2} \Rightarrow \lambda = -1$

$\therefore$ circle is $x^2 + y^2 + x + y = 0$

Ans: (d)

82. At 2.15 O′ clock, the hour hand and the minute hand of a clock form an angle

Options:

(a) $5°$

(b) $22\frac{1}{2}^\circ$

(c) $28°$

(d) $30°$

Sol: In one hour, hour hand rotates $30°$

$\therefore$ in two hours it rotates $60°$

In one minute hour hand rotates $\frac{1}{2}^\circ$

$\therefore$ 15 minutes hour hand rotates $7\frac{1}{2}^\circ$

$\therefore$ In 2 hour 15 min the hour hand rotates $67\frac{1}{2}^\circ$

In one minute, minute hand rotates $6°$

In 15 minutes, it rotates $90°$

$\therefore$ required angle $= 90° - 67\frac{1}{2}^\circ = 22\frac{1}{2}^\circ$

Ans: (b)

83. If $3\sin 2\theta = 2\sin 3\theta$ and $0 < \theta < \pi$ then $\sin\theta =$

Options:

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

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

(c) $\frac{\sqrt{15}}{4}$

(d) $\frac{\sqrt{2}}{\sqrt{5}}$

Sol: $3\sin 2\theta = 2\sin 3\theta$

$6\sin\theta\cdot\cos\theta = 2\left(3\sin\theta - 4\sin^3\theta\right) \quad \Rightarrow 6\cos\theta = 6 - 8\left(1-\cos^2\theta\right)$

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

$\Rightarrow \cos\theta = 1 \text{ or } -\frac{1}{4} \quad (\cos\theta \neq 1 \because \theta \neq 0)$

$\cos\theta = -\frac{1}{4} \Rightarrow \sin\theta = \sqrt{1-\cos^2\theta} = \frac{\sqrt{15}}{4}$

Ans: (c)

84. The tops of two poles of height $20\,\text{mt}$ and $14\,\text{mt}$ are connected by a wire. If the wire makes an angle $30°$ with the horizontal then the length of the wire is

Options:

(a) $12\,\text{mts}$

(b) $10\,\text{mts}$

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

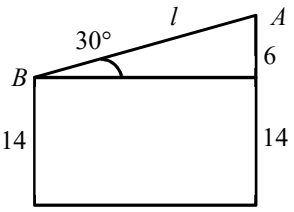
(d) None of these

Sol:

$AB = l$ be the length of the wire

From the figure we have

$\sin 30° = \frac{6}{l} \Rightarrow l = \frac{6}{1/2} = 12\,\text{mts}$




Ans: (a)

85. If $\sin A + \sin B = a$ and $\cos A + \cos B = b$ then $\cos(A+B) =$

Options:

(a) $\frac{a^2+b^2}{b^2-a^2}$

(b) $\frac{2ab}{a^2+b^2}$

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

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

Sol: We have $\sin A + \sin B = a$ and $\cos A + \cos B = b$

Now $a^2 + b^2 = 2 + 2\cos(A+B)$

$b^2 - a^2 = \cos 2A + \cos 2B + 2\cos(A+B) = 2\cos(A+B)\cos(A-B) + 2\cos(A+B)$

$= 2\cos(A+B)\left[\cos(A-B)+1\right] = 2\cos(A+B)\left[\frac{a^2+b^2-2}{2}+1\right]$

$\Rightarrow b^2 - a^2 = \cos(A+B)\left(a^2+b^2\right) \Rightarrow \cos(A+B) = \frac{b^2-a^2}{a^2+b^2}$

Ans: (c)

86. $\cos^{-1}\left(\frac{2}{\sqrt{5}}\right)+\tan^{-1}\frac{1}{3}=$

Options:

(a) $\tan^{-1}\frac{2}{3\sqrt{5}}$

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

(c) $\tan^{-1}\frac{1}{7}$

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

Sol: $\cos^{-1}\left(\frac{2}{\sqrt{5}}\right)+\tan^{-1}\frac{1}{3}=\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{3}=\frac{\pi}{4}$

Ans: (b)

87. $\tan^{-1}(\cot x)-\cot^{-1}(\tan x)=$

Options:

(a) 0

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

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

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

Sol: $\tan^{-1}(\cot x)-\cot^{-1}(\tan x)$

$\tan^{-1}\left[\tan\left(\frac{\pi}{2}-x\right)\right]-\cot^{-1}\left[\cot\left(\frac{\pi}{2}-x\right)\right]$

$=\frac{\pi}{2}-x-\frac{\pi}{2}+x=0$

Ans: (a)

88. If $\vec{a}$ and $\vec{b}$ are unit vectors and $\alpha$ is the angle between them, then $\vec{a}+\vec{b}$ is a unit vector when $\alpha=$

Options:

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

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

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

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

Sol: $|\vec{a}+\vec{b}|=1 \Rightarrow |\vec{a}+\vec{b}|^2=1 \Rightarrow |\vec{a}|^2+|\vec{b}|^2+2\vec{a}\cdot\vec{b}=1$

$\Rightarrow 1+1+2\cos\alpha=1 \quad \Rightarrow \cos\alpha=-\frac{1}{2}\Rightarrow \alpha=\frac{2\pi}{3}$

Ans: (c)

89. If $\vec{a}=\hat{i}+\hat{j}+\hat{k}, |\vec{b}|=1$ and $\vec{a}\times\vec{b}=\hat{j}-\hat{k}$ then $\vec{b}=$

Options:

(a) $\hat{i}$

(b) $\hat{i}-\hat{j}+\hat{k}$

(c) $2\hat{j}-\hat{k}$

(d) $2\hat{i}$

Sol: Let $\vec{b}=x\hat{i}+y\hat{j}+z\hat{k}$

$|\vec{b}|=1\Rightarrow x^2+y^2+z^2=1$

$\vec{a}\times\vec{b}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\1&1&1\\x&y&z\end{vmatrix}=\hat{i}(z-y)+\hat{j}(x-z)+k(y-x)=\hat{j}-\hat{k}\Rightarrow z-y=0$

$x-z=1$

$y-x=-1$

Solving we get $y=0$ or $-\frac{2}{3}$

Thus we get $y=0, x=1, z=0$

$\therefore \vec{b}=\hat{i}$

Ans: (b)

90. If $|\vec{a}|=10, |\vec{b}|=2$ and $\vec{a}\cdot\vec{b}=12$ then the value of $|\vec{a}\times\vec{b}|$ is

Options:

(a) 5

(b) 10

(c) 14

(d) 16

Sol: $\vec{a}\cdot\vec{b}=12 \Rightarrow |\vec{a}||\vec{b}|\cos\theta=12$

$\Rightarrow \cos\theta=\frac{12}{10\times 2}\ \left(\because \vec{a}=10, |\vec{b}|=2\right)$

$\Rightarrow \cos\theta=\frac{3}{5}\Rightarrow \sin\theta=\frac{4}{5}$

Now, $|\vec{a}\times\vec{b}|=|\vec{a}|\cdot|\vec{b}|\sin\theta=10\times 2\times\frac{4}{5}=16$

Ans: (d)

91. The vectors $\vec{a}=x\hat{i}+(x+1)\hat{j}+(x+2)\hat{k}$, $\vec{b}=(x+3)\hat{i}+(x+4)\hat{j}+(x+5)\hat{k}$, $\vec{c}=(x+6)\hat{i}+(x+7)\hat{j}+(x+8)\hat{k}$ are coplanar for

Options:

(a) all values of $x$

(b) $x=0$

(c) $x>0$

(d) none of these

Sol: $\vec{a},\vec{b},\vec{c}$ are coplanar $\Rightarrow\left[\vec{a}\quad\vec{b}\quad\vec{c}\right]=0$

$$\begin{vmatrix} x & x+1 & x+2 \\ x+3 & x+4 & x+5 \\ x+6 & x+7 & x+8 \end{vmatrix}=0$$

Consider $R_2\to R_2-R_1$ and $R_3\to R_3-R_1$

$$\Rightarrow\begin{vmatrix} x & x+1 & x+2 \\ 3 & 3 & 3 \\ 6 & 6 & 6 \end{vmatrix}=0$$

This is true for all values of $x$

Ans: (a)

92. The direction cosines of the line joining $A(2,-3,1)$ and $B(3,-1,2)$ are

Options:

(a) $\frac{1}{\sqrt{6}},\frac{-2}{\sqrt{6}},\frac{1}{\sqrt{3}}$

(b) $\frac{2}{\sqrt{6}},-\frac{3}{\sqrt{6}},\frac{1}{\sqrt{6}}$

(c) $\frac{3}{\sqrt{6}},\frac{3}{\sqrt{6}},\frac{2}{\sqrt{6}}$

(d) $\frac{1}{\sqrt{6}},\frac{2}{\sqrt{6}},\frac{1}{\sqrt{6}}$

Sol: $A=(2,-3,1)$ and $B=(3,-1,2)$

Direction ratios of $AB$ are, $1,2,1$.

Direction cosines of $AB$ are, $\frac{1}{\sqrt{6}},\frac{2}{\sqrt{6}},\frac{1}{\sqrt{6}}$.

Ans: (d)

93. The equation of the plane passing through the line $\frac{x-1}{5}=\frac{y+2}{6}=\frac{z-3}{4}$ and the point $(4,3,7)$ is

Options:

(a) $4x+3y+7z=41$

(b) $4x+8y+7z=41$

(c) $4x-8y-7z=41$

(d) $4x-8y+7z=39$

Sol: This line passes through $(1,-2,3)$.

The given point is $(4,3,7)$.

The plane on which both the points lie is $4x-8y+7z=41$, which is the required equation.

OR

The required plane passes through $(4,3,7)$ and $(1,-2,3)$ and parallel to the line whose d.r's are $5,6,4$.

$\therefore$ Equation of the plane is

$$\begin{vmatrix} x-4 & y-3 & z-7 \\ 4-1 & 3+2 & 7-3 \\ 5 & 6 & 4 \end{vmatrix}=0$$

$$\Rightarrow \begin{vmatrix} x-4 & y-3 & z-7 \\ 3 & 5 & 4 \\ 5 & 6 & 4 \end{vmatrix}=0 \Rightarrow 4x-8y+7z=41$$

Ans: (b)

94. The point of intersection of the plane $\frac{x+1}{1}=\frac{y+3}{3}=\frac{z-2}{-2}$ and the plane $3x+4y+5z=25$ is

Options:

(a) $(5,15,10)$

(b) $(5,-15,10)$

(c) $(5,15,-10)$

(d) $(-5,15,10)$

Sol: Any point on the line $\frac{x+1}{1}=\frac{y+3}{3}=\frac{z-2}{-2}=\lambda$ is of the form $(\lambda-1,3\lambda-3,-2\lambda+2)$.

This must lie on $3x+4y+5z=25 \Rightarrow 3(\lambda-1)+4(3\lambda-3)+5(2\lambda+2)=25$

$\Rightarrow 5\lambda-5=25 \Rightarrow \lambda=6$ $\quad\therefore$ The required point $=(5,15,-10)$

Ans: (c)

95. If $OA$ is equally inclined to $OX, OY$ and $OZ$ and if $A$ is $\sqrt{3}$ units from the origin, then $A$ is

Options:

(a) $(3,3,3)$

(b) $(-1,1,-1)$

(c) $(-1,1,1)$

(d) $(1,1,1)$

Sol: Direction cosines of the line, equally inclined to $OX, OY, OZ$ are $\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}},\frac{1}{\sqrt{3}}$.

$\therefore$ Unit vector along $OA=\frac{1}{\sqrt{3}}i+\frac{1}{\sqrt{3}}j+\frac{1}{\sqrt{3}}k$

$\therefore \quad \overrightarrow{OA} = \sqrt{3}\left(\frac{1}{\sqrt{3}}i + \frac{1}{\sqrt{3}}j + \frac{1}{\sqrt{3}}k\right) \qquad \left(\because \quad OA = \sqrt{3}\right)$

$\overrightarrow{OA} = i + j + k \Rightarrow A = (1, 1, 1)$

Ans: (d)

96. $\lim\limits_{x \to \frac{\pi}{3}} \frac{\sin\left(\frac{\pi}{3} - x\right)}{2\cos x - 1} =$

Options:

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

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

(c) $\sqrt{3}$

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

Sol: $\lim\limits_{x \to \frac{\pi}{3}} \frac{\sin\left(\frac{\pi}{3} - x\right)}{2\cos x - 1} \qquad \left(\frac{0}{0}\text{form}\right)$

$\Rightarrow \lim\limits_{x \to \frac{\pi}{3}} \frac{-\cos\left(\frac{\pi}{3} - x\right)}{-2\sin x} = \frac{1}{3\left(\sqrt{3}/2\right)} = \frac{1}{\sqrt{3}}$ [using LH Rule]

Ans: (b)

97. $\lim\limits_{n \to \infty} \frac{1 \cdot 2 + 2 \cdot 3 + 3 \cdot 4 + .... + n(n+1)}{n^3}$

Options:

(a) 1

(b) $-1$

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

(d) $\frac{1}{6}$

Sol: Given limit $= \lim\limits_{n \to \infty} \frac{\sum n(n+1)}{n^3} = \lim\limits_{n \to \infty} \frac{\sum n^2 + \sum n}{n^3}$

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

$= \frac{2}{6} + 0 = \frac{1}{3}$

Ans: (c)

98. For what value the function $f(x)=\frac{3x+4\tan x}{x}$ at $x=0$ is continuous

Options:

(a) 5

(b) 6

(c) 7

(d) 4

Sol: For $f(x)$ to be continuous at $x=0$

$\lim_{x\to 0} f(x)=f(0)$

$\Rightarrow f(0)=\lim_{x\to 0}\frac{3x+4\tan x}{x}$

$f(0)=\lim_{x\to 0}\left(3+4\frac{\tan x}{x}\right)=3+4=7$

Ans: (c)

99. $f(x)=2a-x$ in $-a<x<a$, $f(x)=3x-2a$ in $a\le x$. Then which of following is true?

Options:

(a) $f(x)$ is not differentiable at $x=a$

(b) $f(x)$ is discontinuous at $x=a$

(c) $f(x)$ is continuous at all $x<a$

(d) $f(x)$ is differentiable at all $x\ge a$

Sol: $f(x)=\begin{cases}2a-x & -a<x<a\\ 3x-2a & a\le x\end{cases}$

L.H. derivatives at $(x=a)=\lim_{x\to a^-}\frac{f(x)-f(a)}{x-a}=\lim_{x\to a}\left(\frac{2a-x-a}{x-a}\right)=-1$

R.H. derivative time at $(x=a)=\lim_{x\to a^+}\frac{f(x)-f(a)}{x-a}=\lim_{x\to a}\left(\frac{3a-2a-a}{x-a}\right)=3$

$\therefore$ $f(x)$ is not differential at $x=a$.

Ans: (a)

100. $y=\sqrt{ax}+\frac{a^2}{\sqrt{ax}}$ then $\frac{dy}{dx}$ at $x=a$ is

Options:

(a) $a$

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

(c) 1

(d) 0

Sol: $y=\sqrt{ax}+\frac{a^2}{\sqrt{ax}}$

$\frac{dy}{dx}=\frac{a}{2\sqrt{ax}}-\frac{a^3}{2(ax)^{3/2}}$ at $x=a, \frac{dy}{dx}=\frac{a}{2a}-\frac{a^3}{2a^3}=0$

Ans: (d)

101. $\frac{d}{dx}\left\{\sin^{-1}\left(\frac{3x}{2}-\frac{x^3}{2}\right)\right\}=$

Options:

(a) $\frac{3}{\sqrt{4-x^2}}$

(b) $\frac{-3}{\sqrt{4-x^2}}$

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

(d) $\frac{-1}{\sqrt{4-x^2}}$

Sol: $y=\sin^{-1}\left(\frac{3x}{2}-\frac{x^3}{2}\right)$

Put $x=2\sin\theta, y=\sin^{-1}\left(3\sin\theta-4\sin^3\theta\right)$

$\Rightarrow y=\sin^{-1}(\sin 3\theta)\Rightarrow y=3\theta=3\sin^{-1}\frac{x}{2}$

$\therefore \frac{dy}{dx}=\frac{3}{\sqrt{1-\frac{x^2}{4}}}\frac{1}{2}=\frac{3}{\sqrt{4-x^2}}$

Ans: (a)

102. If $3x^2+2xy+6y^2=6$ then $\frac{dy}{dx}$ at $(1,1)$ is

Options:

(a) 1

(b) $-1$

(c) 2

(d) $-\frac{4}{7}$

Sol: $3x^2+2xy+6y^2=6$

$\Rightarrow 3x^2+2xy+6y^2-6=0;\ f(x,y)=0$

Now, $\frac{dy}{dx}=-\frac{\partial f/\partial x}{\partial f/\partial x}=-\left(\frac{6x+2y}{2x+12y}\right)$

$\Rightarrow \left(\frac{dy}{dx}\right)_{(1,1)} = -\left(\frac{8}{14}\right) = -\frac{4}{7}$

**OR**

$3x^2 + 2xy + 6y^2 - 6 = 0$

$\therefore 6x + 2\left(y + x\frac{dy}{dx}\right) + 12y\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\left(\frac{6x + 2y}{2x + 12y}\right)$

$\therefore \frac{dy}{dx} = -\frac{8}{14} = -\frac{4}{7}$

Ans: (d)

103. $y = \left(\sin^{-1} x\right)^2 + \left(\cos^{-1} x\right)^2$, then $\left(1 - x^2\right)y_2 - xy_1 =$

Options:

(a) 0

(b) 1

(c) 4

(d) 3

Sol: $y = \left(\sin^{-1} x\right)^2 + \left(\cos^{-1} x\right)^2 \Rightarrow y_1 = \frac{2}{\sqrt{1-x^2}}\left(\sin^{-1} x - \cos^{-1} x\right)$

$\Rightarrow \sqrt{1-x^2} \cdot y_1 = 2\left(\sin^{-1} x - \cos^{-1} x\right) \Rightarrow \sqrt{1-x^2} \cdot y^2 - \frac{2x}{2\sqrt{1-x^2}} \cdot y_1$

$= 2\left(\frac{1}{\sqrt{1-x^2}} + \frac{1}{\sqrt{1-x^2}}\right) \Rightarrow (1 - x_2)y_2 - xy_1 = 4$ (multiple throughout by $\sqrt{1-x^2}$ )

Ans: (c)

104. Angle of intersection of the curves $y = 4 - x^2$ and $y = x^2$ is

Options:

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

(b) $\tan^{-1}\frac{4}{3}$

(c) $\tan^{-1}\frac{4\sqrt{2}}{7}$

(d) $\tan^{-1}\frac{3}{4}$

Sol: $y = 4 - x^2, x = \sqrt{2}$ and $y = 2$

$\therefore$ Point of intersection $= \left(\sqrt{2}, 2\right)$

$\frac{dy}{dx} = -2x, \frac{dy}{dx} = 2x$

$\Rightarrow \left(\frac{dy}{dx}\right)_{(\sqrt{2},2)} = -2\sqrt{2}, 2\sqrt{2}$ respectively

$\tan\theta = \left|\frac{4\sqrt{2}}{1-8}\right| = \frac{4\sqrt{2}}{7} \Rightarrow \theta = \tan^{-1}\frac{4\sqrt{2}}{7}$

Ans: (c)

105. An edge of a variable cube is increasing at the rate of $10$ cm per second. Then the volume of the cube is increasing when the edge is $5$ cm long, at the rate

Options:

(a) $650\ \text{cm}^3$/sec

(b) $550\ \text{cm}^3$/sec

(c) $750\ \text{cm}^3$/sec

(d) $900\ \text{cm}^3$/sec

Sol: Let $x$ be the length of the edge of the cube.

By data, $\frac{dx}{dt} = 10$ cm/sec

Now volume $v$ is given by $v = x^3$

$\Rightarrow \frac{dv}{dx} = 3x^2\frac{dx}{dt} \Rightarrow \frac{dv}{dt} = 30x^2$

$\Rightarrow \left(\frac{dv}{dt}\right)_{x=5} = 750\ \text{cm}^2/\text{sec}$

Ans: (c)

106. The function $f(x) = x^3 + \frac{3}{2}x^2 + 3x + 3$ is

Options:

(a) an increasing function

(b) a decreasing function

(c) an even function

(d) an odd function

Sol: $f(x) = x^3 + \frac{3}{2}x^2 + 3x + 3 \Rightarrow f'(x) = 3x^2 + 3x + 3 = 3\left(x^2 + x + 1\right)$

Now for $f'(x)$, $B^2 - 4AC = 1 - 4 = -3 < 0$

Thus $f'(x) > 0$ for all $x$. Hence $f(x)$ is an increasing function.

**OR**

$3\left(x^2 + x + 1\right) = \left(x^2 + 2\cdot\frac{1}{2}x + \frac{1}{4} + 1 - \frac{1}{4}\right) = 3\left[\left(x + \frac{1}{2}\right)^2 + \frac{3}{4}\right] > 0$

Ans: (a)

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

Options:

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

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

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

(d) none of these

Sol: Consider $\frac{d}{dx}\left(\tan^{-1}e^x\right)=\frac{e^x}{1+e^{2x}}$

$\therefore \quad I=\int\frac{f'(x)}{f(x)}dx=\log\left(\tan^{-1}e^x\right)$

Where, $f(x)=\tan^{-1}e^x$

Ans: (c)

108. $\int \frac{dx}{a\sec x+b\tan x} =$

Options:

(a) $\log\left(a\sec x+b\tan x\right)$

(b) $\frac{1}{b}\log\left(a+b\sin x\right)$

(c) $\frac{1}{a}\log\left(a+b\sin x\right)$

(d) $\log\left(a+b\sin x\right)$

Sol: $\int\frac{dx}{a\sec x+b\tan x}=\int\frac{\cos x dx}{a+b\sin x}$

$=\frac{1}{b}\int\frac{b\cos x dx}{a+b\sin x}=\frac{1}{b}\log\left(a+b\sin x\right)$

Ans: (b)

109. $\int \frac{\cos x dx}{(\sin x-1)(\sin x-2)}=1$

Options:

(a) $\log(\sin x-1)(\sin x-2)$

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

(c) $\log\left(\frac{\sin x-1}{\sin x-2}\right)$

(d) $\frac{1}{2}\log\left(\frac{\sin x-1}{\sin x-2}\right)$

Sol: $\int \frac{\cos x dx}{(\sin x-1)(\sin x-2)}$

$(\sin x = t \Rightarrow \cos x dx = dt)$

$= \int \frac{dt}{(t-1)(t-2)} = \int \left(\frac{1}{t-2} - \frac{1}{t-1}\right) dt$

$= \log(\sin x-2) - \log(\sin x-1) = \log\left(\frac{\sin x-2}{\sin x-1}\right)$

Ans: (b)

110. $\int_0^1 \frac{xe^x}{(1+x)^2} dx =$

Options:

(a) $e-2$

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

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

(d) $e+2$

Sol: $\frac{x}{(1+x)^2} = \frac{(1+x)-1}{(1+x)^2} = \frac{1}{1+x} - \frac{1}{(1+x)^2} \quad \therefore \quad I = \int_0^1 e^x \left(\frac{1}{1+x} - \frac{1}{(1+x)^2}\right) dx$

$e^x \left(\frac{1}{1+x}\right)\Big]_0^1 \left(\because \quad \int e^x \left(f(x)+f'(x)\right) dx = e^x \cdot f(x)\right)$

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

Ans: (c)

111. $\int_0^a \frac{x-a}{x+a} dx =$

Options:

(a) $a+2a\log 2$

(b) $a-2a\log 2$

(c) $2a\log 2$

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

Sol: $I = \int_0^a \frac{(x+a)-2a}{x+a} dx = \int_0^a \left(1 - \frac{2a}{x+a}\right) dx$

$= x - 2a\log(x+a)\Big]_0^a$

$= a - 2a\log 2a + 2a\log a$

$= a - 2a(\log 2a - \log a) = a - 2a\log 2$

Ans: (b)

112. $\int_0^{2\pi} \sin^{-4} x dx =$

Options:

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

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

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

(d) $-\frac{3}{2}$

Sol: $I = \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \sin^{-4} x dx = \int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \text{cosec}^4 x dx$

Let, $\cot x = t \Rightarrow -\text{cosec}^2 x dx = dt$

$x = -\frac{\pi}{4} \Rightarrow t = -1; \; x = \frac{\pi}{4} \Rightarrow t = 1$

$= I - \int_{-1}^{1} \left(1 + t^2\right) dt = -\left[t - \frac{t^3}{3}\right]_{-1}^{1}$

$= -\left[\left(1 + \frac{1}{3}\right) - \left(-1 - \frac{1}{3}\right)\right] = -\frac{8}{3}$

Ans: (a)

113. Area bounded by $xy = a^2$, the $x-$axis and the lines $x = a$ and $x = 4a(a > 0)$ is

Options:

(a) $2a^2 \log 2$

(b) $4a^2 \log 2$

(c) $2a \log 4$

(d) none of these

Sol: $xy = a^2 \Rightarrow y = \frac{a^2}{x}$

$A = \int_a^{4a} y dx = \int_a^{4a} \frac{a^2}{x} dx = a^2 \log x \Big]_a^{4a}$

$= a^2 \log 4a - a^2 \log a$

$= a^2 \log 4 = 2a^2 \log 2$

Ans: (a)

114. Solution of $\frac{dy}{dx}-y=1,\ y(0)=1$ is given by

Options:

(a) $xy=e^{-x}$

(b) $xy=-e^{-x}$

(c) $xy=-1$

(d) $y=2e^{x}-1$

Sol: We have, $\frac{dy}{dx}=1+y\Rightarrow\int\frac{dy}{1+y}=\int dx+c$

$\Rightarrow\log(1+y)=x+c$

By data, $y=1$ when $x=0$

$\therefore\ \log 2=c\ \ \therefore\log(1+y)=x+\log 2$

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

Ans: (d)

115. The mean of the numbers obtained on throwing a die having written $1$ on three faces, $2$ on two faces and $5$ on one face is

Options:

(a) 1

(b) 2

(c) 5

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

Sol: Let $X$ denote the number on the dice i.e., $X$ takes the values $1, 2, 5$.

$P(X=1)=\frac{3}{6}=\frac{1}{2},\ P(X=2)=\frac{2}{6}=\frac{1}{3},\ P(X=5)=\frac{1}{6}$

Probability distribution of $X$ is

| $X$ | 1 | 2 | 5 |
|---|---|---|---|
| $P(X)$ | $\frac{1}{2}$ | $\frac{1}{3}$ | $\frac{1}{6}$ |

Mean $X=\sum XP(X)$

$=\left(1\times\frac{1}{2}\right)+\left(2\times\frac{1}{3}\right)+\left(5\times\frac{1}{6}\right)=2$

Ans: (b)

116. If $A$ and $B$ are independent events such that $0 < P(A) < 1$ and $0 < P(B) < 1$, then which of the following is not correct?

Options:

(a) $A$ and $B$ are mutually exclusive

(b) $A$ and $B'$ are independent

(c) $A'$ and $B$ are independent

(d) $A'$ and $B'$ are independent

Sol: Clearly (a) is wrong.

Ans: (a)

117. A box $X$ contains $2$ white and $3$ black balls and another bag $Y$ contains $4$ white and $2$ black balls. One bag is selected at random and a ball is drawn from it. Then the probability for the ball chosen be white is

Options:

(a) $\frac{2}{15}$

(b) $\frac{7}{15}$

(c) $\frac{8}{15}$

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

Sol: Choosing a bag and a white ball from it are independent.

$\therefore$ Probability of choosing a white ball for $X = \frac{1}{2} \cdot \frac{2}{5} = \frac{1}{5}$

Probability of choosing a white ball from $Y = \frac{1}{2} \cdot \frac{4}{6} = \frac{1}{3}$

Both the events are mutually exclusive

$\therefore$ Required probability $= \frac{1}{5} + \frac{1}{3} = \frac{8}{15}$

Ans: (c)

118. The mean of $100$ observations is $50$ and their standard deviation is $5$. The sum of all squares of all the observations is

Options:

(a) $50000$

(b) $250000$

(c) $252500$

(d) $255000$

Sol: We know that variance $=(\text{S.D})^2$

$\Rightarrow \frac{\sum x_i^2}{n}-(x)^2=25 \Rightarrow \frac{\sum x_i^2}{n}-(2500)=25$

$\sum x_i^2=2500+2250000=252500$

Ans: (c)

119. If the mean deviation of the numbers $1, 1+d, 1+2d, .....1+100d$ from their mean is $255$, then $d$ is equal to

Options:

(a) 10.0

(b) 20.0

(c) 10.1

(d) 20.2

Sol: Now $X=\frac{\left(\frac{101}{2}\right)[1+1+100d]}{101}=1+50d$

$\text{M.D}=\frac{1}{101}\left\{\sum_{r=0}^{100}\left|(1+rd)-(1+50d)\right|\right.$

$=\frac{1}{101}\sum_{r=0}^{100}|r-50|d \Rightarrow \frac{d}{101}\times 2\sum_{r=0}^{50} r$

$\Rightarrow \frac{2d}{101}\cdot\frac{50\times 51}{2}=\frac{50\times 51}{101}d$

By data, M.D. = 255

$\therefore \quad 255=\frac{50\times 51}{101}d$

$\Rightarrow d=\frac{101\times 255}{50\times 51}=10.1$

Ans: (c)

120. The corner points of the feasible region determined by the system of linear constraints are $(0,10),(5,5),(15,15),(0,20)$. Let $Z=px+qy$, where $p,q>0$, condition on $p$ and $q$ so that the maximum of $Z$ occurs at both the points $(15,15)$ and $(0,20)$ is

Options:

(a) $p=q$

(b) $p=2q$

(c) $q=2p$ (d) $q=3p$

Sol: By data maximum value of Z occurs at $(15,15)$ and $(0,20)$. Thus,

$15p+15q=0\cdot p+20q$

$\Rightarrow 15p=5q \Rightarrow q=3p$

Ans: (d)

## Physics

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

121. Given radius of Earth '$R$' and length of a day '$T$' the height of a geostationary satellite is [$G$ – gravitational constant, $M$ – mass of earth]

Options:

(a) $\left(\frac{4\pi^2 GM}{T^2}\right)^{1/3}$

(b) $\left(\frac{4\pi GM}{R^2}\right)^{1/3} - R$

(c) $\left(\frac{GMT^2}{4\pi^2}\right)^{1/3} - R$

(d) $\left(\frac{GMT^2}{4\pi^2}\right)^{1/3} + R$

Sol: $T = 2\pi\sqrt{\frac{r^3}{GM}} \Rightarrow T^2 = \frac{4\pi^2}{GM}(R+h)^3 \Rightarrow R+h = \left[\frac{GMT^2}{4\pi^2}\right]^{1/3} \Rightarrow h = \left[\frac{GMT^2}{4\pi^2}\right]^{\frac{1}{3}} - R$

Ans: (c)

122. In steel, the Young's modulus and the strain at the breaking point are $2\times10^{11}\ \text{Nm}^{-2}$ and $0.15$ respectively. The stress at the breaking point for steel is therefore

Options:

(a) $1.33\times10^{11}\ \text{Nm}^{-2}$

(b) $1.33\times10^{12}\ \text{Nm}^{-2}$

(c) $7.5\times10^{-13}\ \text{Nm}^{-2}$

(d) $3\times10^{-13}\ \text{Nm}^{-2}$

Sol: Breaking stress $=\text{strain}\times\text{Young's modulus}\ = 0.15\times2\times10^{11} = 3\times10^{10}\ \text{Nm}^{-2}$

Ans: (d)

123. Two bodies of masses $2\ \text{kg}$ and $4\ \text{kg}$ are moving with velocities $2\ \text{ms}^{-1}$ and $10\ \text{ms}^{-1}$ respectively along same direction. Then the velocity of their centre of mass will be

Options:

(a) $8.1\ \text{ms}^{-1}$

(b) $7.3\ \text{ms}^{-1}$

(c) $6.4\ \text{ms}^{-1}$

(d) $5.3\ \text{ms}^{-1}$

Sol: $\vec{v}_{cm}=\frac{m_1\vec{v}_1}{m_1+m_2}=\frac{(2\times2)+(4\times10)}{2+4}=7.3\ \text{ms}^{-1}$

Ans: (b)

124. If two soap bubbles of different radii are connected by a tube

Options:

(a) air flows from the smaller bubble to the bigger

(b) air flows from bigger bubble to the smaller bubble till the sizes are interchanged

(c) air flows from the bigger bubble to the smaller bubble till the sizes become equal

(d) there is no flow of air

Sol: Let pressure outside be $P_0$

$\therefore\ P_1$ (in smaller bubble) $=P_0+\frac{4T}{r}$

$P_2$ (in bigger bubble) $=P_0+\frac{4T}{R}(R>r)$

$\therefore P_1>P_2$

Hence air moves from smaller bubble to bigger bubble.

Ans: (a)

125. If a graph is plotted taking the temperatur in Fahrenheit along $Y-$axis and the corresponding temperature in Celsius along the $X-$axis, it will be a straight line

Options:

(a) having a $+$ve intercept on $Y-$axis

(b) having a $+$ve intercept on $X-$axis

(c) passing through the origin

(d) having a $-$ve intercepts on both the axis

Sol: We know that, $\frac{C}{100}=\frac{F-32}{180}$ or $F=\frac{9}{5}C+32$

Equation of straight line is, $y=mx+c$

Hence, $m=(9/5)$, positive and $c=32$ positive

Ans: (a)

126. A balloon contains $500\,\text{m}^3$ of helium at $27°\text{C}$ and $1$ atmosphere pressure. The volume of the helium at $-3°\text{C}$ temperature and $0.5$ atmosphere pressure will be

Options:

(a) $500\,\text{m}^3$

(b) $700\,\text{m}^3$

(c) $900\,\text{m}^3$

(d) $1000\,\text{m}^3$

Sol: $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2} \Rightarrow \frac{1\times 500}{300}=\frac{0.5\times V_2}{270} \Rightarrow V_2=900\,\text{m}^3$

Ans: (c)

127. A Carnot engine absorbs an amount $Q$ of heat from a reservoir at an absolute temperature $T$ and rejects heat to sink at a temperature of $T/3$. The amount of heat rejected is

Options:

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

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

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

Sol: We know that efficiency of Carnot engine,

$\eta=1-\frac{T_L}{T_H}$

Also, efficiency of heat engine $=\frac{\text{Work output}}{\text{Heat input}}$

$\therefore 1-\frac{T_L}{T_H}=\frac{W}{Q_s} \Rightarrow W=Q_s\left(1-\frac{T_L}{T_H}\right) \Rightarrow W=Q\left(1-\frac{T/3}{T}\right)=\frac{2}{3}Q$

Hence heat rejected $=Q-\frac{2}{3}Q=\frac{Q}{3}$

Ans: (b)

128. The restoring force of SHM is maximum when particle

Options:

(a) displacement is maximum

(b) is half way between the mean and extreme position

(c) crosses mean position

(d) is at rest

Sol: We know that during SHM, the restoring force is proportional to the displacement from equilibrium position. Hence restoring force is maximum when the displacement is maximum at its extreme position.

Ans: (a)

129. The transverse wave represented by the equation $y=4\sin\left(\frac{\pi}{6}\right)\sin(3x-15t)$ has

Options:

(a) amplitude $=4$

(b) wavelength $=4\frac{\pi}{3}$

(c) speed of propagation $=5$

(d) period $=\frac{\pi}{15}$

Sol: Compare the given equation with standard form, $y = r\sin\left[\frac{2\pi x}{\lambda} - \frac{2\pi t}{T}\right]$

$\frac{2\pi}{\lambda} = 3,\ \lambda = \frac{2\pi}{3}$ and $\frac{2\pi}{T} = 15,\ T = \frac{2\pi}{15}$

Speed of propagation, $v = \frac{\lambda}{t} = \frac{2\pi/3}{2\pi/15} = 5$

Ans: (c)

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

Options:

(a) $F/2$

(b) $\sqrt{2}F$

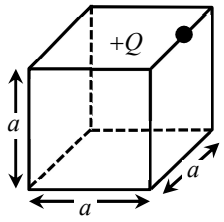
(c) $2F$

(d) zero

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

Ans: (d)

131. In the figure $+Q$ charge is located at one of the edge of the cube, then electric flux through cube due to $+Q$ charge is




Options:

(a) $\frac{+Q}{\varepsilon_0}$

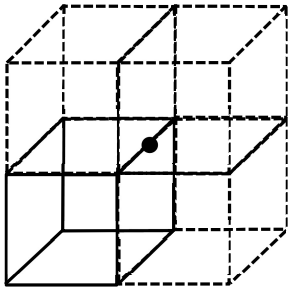
(b) $\frac{+Q}{2\varepsilon_0}$

(c) $\frac{+Q}{4\varepsilon_0}$

(d) $\frac{+Q}{8\varepsilon_0}$

Sol:

Assuming 3 more cubes to make it symmetric,



Total flux through the 4 cube

Using Gauss law, $\phi_{\text{total}} = \frac{\phi_{\text{inside}}}{\varepsilon_0} = \frac{+Q}{\varepsilon_0}$

$\phi_{\text{each}} = \frac{\phi_{\text{total}}}{4} = \frac{+Q}{4\varepsilon_0}$

Ans: (c)

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

Options:

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

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

(c) $\frac{4q^2}{\sqrt{2}\pi\varepsilon_0 l}$

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

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

$\therefore$ Distance of centre of cube from each corner $r = \frac{\sqrt{3}}{2}\ell$

P.E. at centre $= 8\times$ potential energy due to $A$

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

Ans: (d)

133. A total charge $Q$ is broken in two parts $Q_1$ and $Q_2$ and they are placed at a distance $R$ from each other. The maximum force of repulsion between them will occur when

Options:

(a) $Q_2 = \frac{Q}{R}, Q_1 = Q - \frac{Q}{R}$

(b) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{2Q}{3}$

(c) $Q_2 = \frac{Q}{4}, Q_1 = \frac{3Q}{4}$

(d) $Q_1 = \frac{Q}{2}, Q_2 = \frac{Q}{2}$

Sol: $Q_1 + Q_2 = Q$ … (i)

and $F = k\frac{Q_1Q_2}{r^2}$ … (ii)

From (i) and (ii)

$$F = \frac{kQ_1(Q-Q_1)}{r^2}$$

For $F$ to be maximum

$$\frac{dF}{dQ_1} = 0 \Rightarrow Q_1 = Q_2 = \frac{Q}{2}$$

Ans: (d)

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

Options:

(a) $4:1$

(b) $1:4$

(c) $1:2$

(d) $2:1$

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

P.E. = change in K.E.

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

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

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

Ratio of speed i.e.

$$v_A : v_B = 1:2$$

Ans: (c)

135. All six capacitors shown are identical. Each can withstand maximum 200 volts between its terminal. The maximum voltage that can be safely applied between $A$ and $B$ is

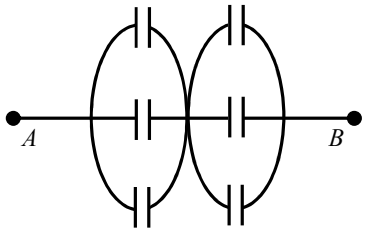
Options:

(a) 1200 V

(b) 400 V

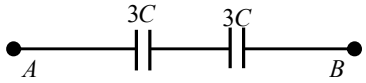
(c) 800 V

(d) 200 V




Sol:

Given circuit can be reduced as follows,



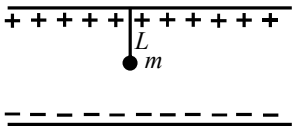

[$C$ = capacitance of each capacitor]

The capacitor 3C, 3C shown in figure can with stand maximum 200 V.

$\therefore$ So maximum voltage that can be applied across $A$ and $B$ equally shared. The maximum voltage applied across $A$ and $B$ be equally shared. Hence maximum voltage applied Across $A$ and $B$ will be $(200+200) = 400$ volt

Ans: (b)

136. A small sphere carrying a charge '$q$' is hanging in between two parallel plates by a string of length $L$. Time period of pendulum is $T_0$. When parallel plates are charged, the time period changes to $T$. The ratio $T/T_0$ is equal to




Options:

(a) $\left(g+\frac{\frac{qE}{m}}{g}\right)^{1/2}$

(b) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{3/2}$

(c) $\left(\frac{g}{g+\frac{qE}{m}}\right)^{1/2}$

(d) None of these

Sol: $T_0 = 2\pi\sqrt{\frac{L}{g}}$

When the plates are charged, the net acceleration is,

$g' = g + a$

$g' = g + \frac{qE}{m} \qquad \left(a = \frac{qE}{m}\right)$

$\therefore\ T = 2\pi\sqrt{\frac{L}{g+\frac{qE}{m}}} \Rightarrow \frac{T}{T_0} = \left(\frac{g}{g+\frac{qE}{m}}\right)^{1/2}$

Ans: (c)

137. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then

Options:

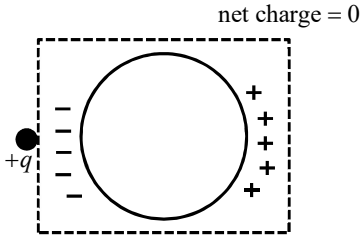
(a) negative and distributed uniformly over the surface of the sphere

(b) negative and appears only at the point on the sphere closest to the point charge

(c) negative and distributed non-uniformly over the entire surface of the sphere

(d) zero

Sol: When a positive point charge is placed outside a conducting sphere, a rearrangement of charge takes place on the surface. But the total charge on the sphere is zero as no charge has left or entered the sphere.




Ans: (d)

138. At room temperature, copper has free electron density of $8.4\times10^{23}$ per $m^3$. The copper conductor has a cross-section of $10^{-6}\ m^2$ and carries a current of $5.4$ A. The electron drift velocity in copper is

Options:

(a) $400\ ms^{-1}$

(b) $0.4\ ms^{-1}$

(c) $0.4\ mms^{-1}$

(d) $72\ ms^{-1}$

Sol: $v_d=\frac{I}{neA}$. Here, $I=5.4\,A,\ n=8.4\times10^{28}\,per\ m^3$

$A=10^{-6}\ m^2,\ e=1.6\times10^{-19}\ C$

$\therefore v_d=\frac{5.4}{8.4\times10^{28}\times1.6\times10^{-19}\times10^{-6}}=0.4\,m\,m\,s^{-1}$

Ans: (c)

139. A wire of length $l$ and resistance $R$ is stretched to get the radius of cross-section $\frac{r}{2}$. Then the new value of $R$ is

Options:

(a) $16R$

(b) $4R$

(c) $8R$

(d) $5R$

Sol: By stretching, the volume of wire remains constant

$A\times l=A\times l'\ \Rightarrow\ \pi r^2\times l=\pi\frac{r^2}{4}\times l'$

$\Rightarrow\quad l'=4l$

Now, $R=\frac{\rho l}{A},\ R'=\frac{\rho l'}{A'}=\frac{\rho 4l}{A/4}=16R$

Ans: (a)

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

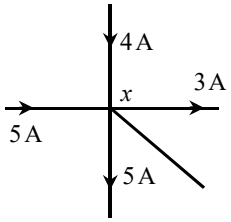
Options:

(a) $3\,A$ away from $x$

(b) $1\,A$ away from $x$

(c) $4\,A$ away from $x$

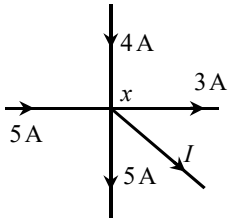
(d) $1\,A$ towards $x$



Sol: According to Kirchhoff's first law,

$(+5\,\text{A})+(+4\,\text{A})+(-3\,\text{A})+(-5\,\text{A})+I=0$

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




$-\text{ve}$ sign shows that current is flowing away from $x$

Ans: (b)

141. A cell of emf $E$ is connected across a resistance $R$. The potential difference between the terminals of the cell is found to be $V$ volt. Then the internal resistance of the cell must be

Options:

(a) $(E-V)R$

(b) $\dfrac{(E-V)}{V}R$

(c) $\dfrac{2(E-V)}{E}R$

(d) $\dfrac{2(E-V)V}{R}$

Sol:

$I=\dfrac{E}{R+r}$

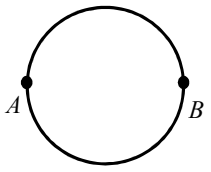
$V=\dfrac{E}{R+r}R \qquad [\because \ V=IR]$

$\Rightarrow \quad r=\dfrac{(E-V)}{V}R$

Ans: (b)

142. 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:



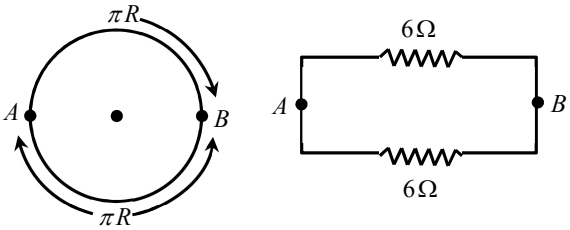

(a) $3\,\Omega$

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

(c) $6\,\Omega$

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

Sol: The resistance of length $2\pi R$ is $12\Omega$. Hence the resistance of length $\pi R$ 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)

143. Two sources of equal emf are connected to an external resistance $R$. The internal resistances of the two sources are $R_1$ and $R_2$ $(R_2 > R_1)$. If the potential difference across the source having internal resistance $R_2$ is zero then

Options:

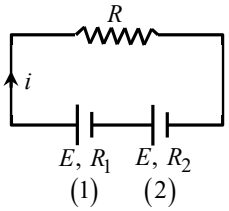
(a) $R = R_1R_2/(R_1+R_2)$

(b) $R = R_1R_2/(R_2-R_1)$

(c) $R = R_2\times(R_1+R_2)/(R_2-R_1)$

(d) $R = R_2 - R_1$

Sol: $i = \dfrac{2E}{R+R_1+R_2}$



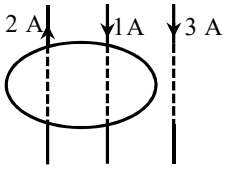

From cell $(2)$ $E = V + iR_2 = 0 + iR_2$

$\Rightarrow \quad E = \dfrac{2E}{R+R_1+R_2}\times R_2 \;\Rightarrow\; R = R_2 - R_1$

Ans: (d)

144. Two wires with currents $2$ A and $1$ A are enclosed in a circular loop. Another wire with current $3$ A is situated outside the loop as shown. The $\oint \vec{B}\cdot d\vec{l}$ around the loop is

Options:




(a) $\mu_0$

(b) $3\mu_0$

(c) $6\mu_0$

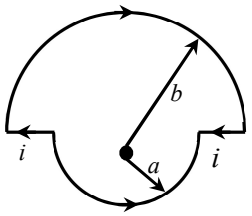
(d) $2\mu_0$

Sol: According to Ampere's circular law

$\oint \vec{B}\cdot d\vec{l} = m_0 I_{\text{enclosed}} = m_0(2\text{A} - 1\text{A}) = m_0$

Ans: (a)

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




Options:

(a) $\pi\left(a^2+b^2\right)i$

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

(c) $\pi\left(a^2-b^2\right)i$

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

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

Ans: (b)

146. Two long parallel wires $P$ and $Q$ are held perpendicular to the plane of the paper at a separation of $5\,\text{m}$. If $P$ and $Q$ carry currents of $2.5\,\text{A}$ and $5\,\text{A}$ respectively in the same direction, then the magnetic field at a point midway between $P$ and $Q$ is

Options:

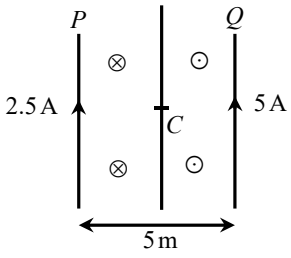
(a) $\frac{\mu_0}{\pi}$

(b) $\sqrt{3}\frac{\mu_0}{\pi}$

(c) $\frac{\mu_0}{2\pi}$

(d) $\frac{3\mu_0}{2\pi}$

Sol: When the current flows in both wires in the same direction then magnetic field at half way due to the wire $P$, $\vec{B}_p = \frac{\mu_0 I_1}{2\pi\times 5/2} = \frac{\mu_0 I_1}{\pi\cdot 5} = \frac{\mu_0}{2\pi}$ (where $I_1 = 5\,\text{A}$)




The direction of $\vec{B}_p$ is downward $\odot$

Magnetic field at half way due to wire $Q$

$\vec{B}_p = \frac{\mu_0 I_2}{2\pi\frac{5}{2}} = \frac{\mu_0}{\pi}$ [upward $\odot$] [where $I_2 = 5\,\text{A}$]

Net magnetic field at half way, $\vec{B} = \vec{B}_P + \vec{B}_Q = -\frac{\mu_0}{2\pi}+\frac{\mu_0}{\pi} = \frac{\mu_0}{2\pi}$ (upward)

Hence, net magnetic field at midpoint $= \frac{\mu_0}{2\pi}$

Ans: (c)

147. A galvanometer having a coil resistance of $100\Omega$ gives a full scale deflection, when a current of $1\text{mA}$ is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of $10\text{A}$, is

Options:

(a) $0.1\Omega$

(b) $3\Omega$

(c) $0.01\Omega$

(d) $2\Omega$

Sol: $I_g G = \left(I - I_g\right)s \qquad \therefore\ 10^{-3}\times 100 = \left(10 - 10^{-3}\right)\times S \qquad \therefore\ S \approx 0.01\Omega$

Ans: (c)

148. The work done in turning a magnet of magnetic moment $'M'$ by an angle of $90°$ from the meridian is $'n'$ times the corresponding work done to turn it through an angle of $60°$, where $'n'$ is given by

Options:

(a) $1/2$

(b) $2$

(c) $1/4$

(d) $1$

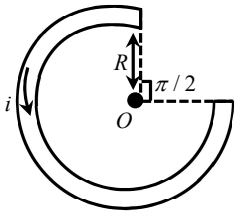
Sol: $W_1 = MB\left(\cos 0° - \cos 90°\right) = MB\left(1-0\right) = MB$

$W_2 = MB\left(\cos 0° - \cos 60°\right) = MB\left(1 - \frac{1}{2}\right) = \frac{MB}{2} \qquad \therefore\ W_1 = 2W_2 \ \Rightarrow\ n = 2$

Ans: (b)

149. A current $i$ ampere flows in a circular arc of wire whose radius is $R$, which subtends an angle $\frac{3\pi}{2}$ radian at its centre. The magnetic induction $B$ at the centre is

Options:




(a) $\frac{\mu_0 i}{R}$

(b) $\frac{\mu_0 i}{2R}$

(c) $\frac{2\mu_0 i}{R}$

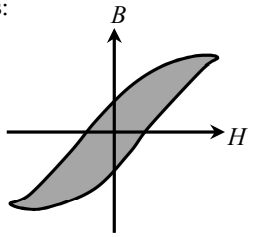
(d) $\frac{3\mu_0 i}{8R}$

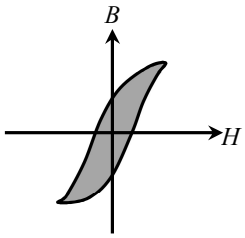
Sol: $B = \frac{\mu_0}{4\pi}\frac{(2\pi-\theta)i}{R} - \frac{\mu_0}{4\pi}\frac{\left(2\pi - \frac{\pi}{2}\right)\times i}{R} = \frac{3\mu_0 i}{8R}$

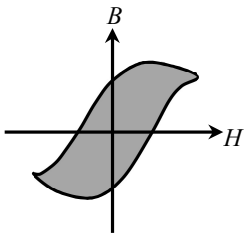
Ans: (d)

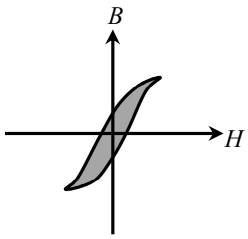
150. For substances hysteresis $(B-H)$ curves are given as shown in figure. For making temporary magnet which of the following is the best?

Options:

(a) 


(b) 


(c) 


(d) 


Sol: For a temporary magnet the hysteresis loop should be long and narrow.

Ans: (d)

151. If the number of turns per unit length of a coil of solenoid is doubled, the self-inductance of the solenoid will

Options:

(a) remain unchanged

(b) be halved

(c) be doubled (d) become four times

Sol: Self-inductance of a solenoid $=\frac{\mu n^2 A}{\ell}$

So, self-induction $\propto n^2$

So, inductance becomes 4 times when $n$ is doubled.

Ans: (d)

152. A wire of length $1\,\text{m}$ is moving at a speed of $2\,\text{ms}^{-1}$ perpendicular to its length in a homogeneous magnetic field of $0.5\,\text{T}$. The ends of the wire are joined to a circuit of resistance $6\,\Omega$. The rate at which work is being done to keep the wire moving at constant speed is

Options:

(a) $\frac{1}{12}\,\text{W}$

(b) $\frac{1}{6}\,\text{W}$

(c) $\frac{1}{3}\,\text{W}$

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

Sol: Rate of work

$= \frac{W}{t} = P = Fv$; also $F = Bil = B\left(\frac{Bvl}{r}\right)l$

$\Rightarrow \; P = \frac{B^2v^2l^2}{r} = \frac{(0.5)^2 \times (2)^2 \times (1)^2}{6} = \frac{1}{6}\,\text{W}$

Ans: (b)

153. A resistor of $500\,\Omega$, an inductance of $0.5\,\text{H}$ are in series with an a.c. which is given by $V = 100\sqrt{2}\sin(1000t)$. The power factor of the combination is

Options:

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

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

(c) $0.5$

(d) $0.6$

Sol:

Here, $R = 500\,\Omega,\; L = 0.5\,\text{H}$

Compare $V = 100\sqrt{2}\sin(1000t)$ with $V = V_0 \sin\omega t$,

we get, $\omega = 10000$

The inductive reactance is

$X_L = \omega L = (1000)(0.5) = 500\,\Omega$

Impedance of the RL circuit is

$Z = \sqrt{R^2 + X_L^2} = \sqrt{(500\,\Omega)^2 + (500\,\Omega)^2} = 500\sqrt{2}\,\Omega$

Power factor, $\cos\phi = \frac{R}{Z} = \frac{500}{500\sqrt{2}} = \frac{1}{\sqrt{2}}$

Ans: (a)

154. For an LCR series circuit with an A.C. source of angular frequency $\omega$

Options:

(a) circuit will be capacitive if $\omega > \frac{1}{\sqrt{LC}}$

(b) circuit will be inductive if $\omega = \frac{1}{\sqrt{LC}}$

(c) power factor of circuit will be unity if capacitive reactance equals inductive reactance

(d) current will be leading voltage if $\omega > \frac{1}{\sqrt{LC}}$

Sol: The circuit will have inductive nature if

$\omega > \frac{1}{\sqrt{LC}}$ $\left(\omega L > \frac{1}{\sqrt{LC}}\right)$

Hence (a) is false. Also if circuit has inductive nature the current will lag behind voltage. Hence (d) is also false.

If $\omega = \frac{1}{\sqrt{LC}}\left(\omega L = \frac{1}{\omega C}\right)$ the circuit will have resistance nature. Hence (b) is false.

Power factor $\cos\phi = \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} = 1$ if $\omega L = \frac{1}{\omega C}$

Ans: (c)

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

Options:

(a) 50%

(b) 90%

(c) 10%

(d) 30%

Sol: Efficiency of the transformer $\eta = \frac{P_{\text{output}}}{P_{\text{input}}} \times 100 = \frac{100}{220 \times 0.5} \times 100 = 90.9\%$

Ans: (b)

156. Light with an energy flux of $25 \times 10^4\ \text{Wm}^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is $15\ \text{cm}^2$, the average force exerted on the surface is

Options:

(a) $1.25 \times 10^{-6}$ N

(b) $2.50 \times 10^{-6}$ N

(c) $1.20 \times 10^{-6}$ N

(d) $3.0 \times 10^{-6}$ N

Sol: Average force

$F_{av} = \frac{\Delta p}{\Delta t} = \frac{2IA}{c} \quad (\because \text{ Power} = F.V)$

$= \frac{2 \times 25 \times 10^4 \times 15 \times 10^{-4}}{3 \times 10^8} = 2.50 \times 10^{-6} \text{ N}$

Ans: (b)

157. An object moving at a speed of $5 \text{ ms}^{-1}$ towards a concave mirror of focal length $f = 1\text{m}$ is at a distance of $9\text{m}$. The average speed of the image is

Options:

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

(b) $\frac{1}{10}\text{ms}^{-1}$

(c) $\frac{5}{9}\text{ms}^{-1}$

(d) $\frac{2}{5}\text{ms}^{-1}$

Sol: According to the mirror formula

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ or $v = \frac{fu}{u - f}$

When an object is at a distance of $9\text{m}$ from the concave mirror,

$\therefore u = -9\text{m}, f = -1\text{m} \Rightarrow v = \frac{(-1)(-9)}{-9+1} = -\frac{9}{8}\text{m}$

As the object moves at a constant speed of $5\text{ms}^{-1}$, after $1\text{s}$ the position of image is

$u = -9\text{m} + 5\text{m} = -4\text{m} \Rightarrow v' = \frac{(-1)(-4)}{-4+1} = -\frac{4}{3}\text{m}$

The shift in the position of image is $1\text{s}$ is $= v - v' = \frac{-9}{8} + \frac{4}{3} = \frac{-27+32}{24} = \frac{5}{24} = \frac{1}{4.8} \approx \frac{1}{5}$

Average speed of the image $= \frac{1}{5}\text{ms}^{-1}$

Ans: (a)

158. The refractive index of a glass is $1.520$ for red light and $1.525$ for blue light. Let $D_1$ and $D_2$ be angles of minimum deviation for red and blue light respectively in a prism of this glass. Then,

Options:

(a) $D_1 < D_2$

(b) $D_1 = D_2$

(c) $D_1$ can be less than or greater than $D_2$ depending upon the angle of prism

(d) $D_1 > D_2$

Sol: For a thin prism, $D = (\mu - 1)A$

Since $\lambda_b < \lambda_r$

$\Rightarrow \mu_r < \mu_b \Rightarrow D_1 < D_2$

Ans: (a)

159. A light ray from air is incident (as shown in figure) at one end of a glass fiber (refractive index $\mu = 1.5$) making an incidence angle of $60°$ on the lateral surface, so that it undergoes a total internal reflection. How much time would it take to traverse the straight fiber of length $1\,\text{km}$?

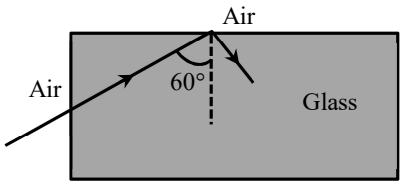
Options:

(a) $3.33\,\mu\text{s}$

(b) $6.67\,\mu\text{s}$

(c) $5.77\,\mu\text{s}$

(d) $3.85\,\mu\text{s}$




Sol: When total internal reflection just takes place from lateral surface $i = C$, i.e., $60° = C$

$\Rightarrow \sin 60° = \sin C = \frac{1}{\mu} \Rightarrow \mu = \frac{2}{\sqrt{3}}$

Time taken by light to traverse some distance in a medium

$$t = \frac{\mu x}{c} = \frac{\frac{2}{\sqrt{3}} \times 10^3}{3 \times 10^8} = 3.85\ \mu\text{s}$$

Ans: (d)

160. The focal length of a concave mirror is $f$ and the distance from the object to the principle focus is $x$. The ratio of the size of the image to the size of the object is

Options:

(a) $\frac{f+x}{f}$

(b) $\frac{f}{x}$

(c) $\sqrt{\frac{f}{x}}$

(d) $\frac{f^2}{x^2}$

Sol: $\frac{I}{O} = \frac{f}{f-u}$;

where $u = f + x$

$\therefore \frac{I}{O} = -\frac{f}{x}$

Ans: (b)

161. The ratio of resolving powers of an optical microscope for two wavelengths $\lambda_1 = 4000\,\text{Å}$ and $\lambda_2 = 6000\,\text{Å}$ is

Options:

(a) $9:4$

(b) $3:2$

(c) $16:81$

(d) $8:27$

Sol: Resolving power of a microscope $= \frac{2\mu \sin\theta}{\lambda}$

i.e., $R \propto \frac{1}{\lambda}$ or $\frac{R_1}{R_2} = \frac{\lambda_2}{\lambda_1}$ $\quad\therefore\quad \frac{R_1}{R_2} = \frac{6000\,\text{Å}}{4000\,\text{Å}} = \frac{3}{2}$

Ans: (b)

162. For what distance is ray optics a good approximation when the aperture is $4\ \text{mm}$ wide and the wavelength is $500\,\text{nm}$

Options:

(a) $32\,\text{m}$

(b) $64\,\text{m}$

(c) $16\,\text{m}$

(d) $8\,\text{m}$

Sol: Fresnel distance

$$Z_F = \frac{a^2}{\lambda} = \frac{\left(4\times10^{-3}\right)^2\,\text{m}^2}{500\times10^{-9}\,\text{m}} = 32\,\text{m}$$

Ans: (a)

163. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function $5.01\,\text{eV}$, when ultraviolet light of $200\,\text{nm}$ falls on it, must be

Options:

(a) 2.4 V

(b) –1.2 V

(c) –2.4 V

(d) 1.2 V

Sol: $K_{\max} = \frac{hc}{\lambda} - W = \frac{hc}{\lambda} - 5.01 = \frac{12375}{\lambda\left(\text{in Å}\right)} - 5.01 = \frac{12375}{2000} - 5.01 = 6.1875 - 5.01 = 1.17775 \simeq 1.2\,\text{V}$

Ans: (d)

164. A photon and an electron have equal energy $E$. $\lambda_{photon} / \lambda_{electron}$ is proportional to

Options:

(a) $\sqrt{E}$

(b) $1/\sqrt{E}$

(c) $1/E$

(d) Does not depend upon $E$

Sol: $\lambda_{photon} = \frac{hc}{E}$ and $\lambda_{electron} = \frac{h}{\sqrt{2mE}}$

$\Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} = c\sqrt{\frac{2m}{e}} \Rightarrow \frac{\lambda_{photon}}{\lambda_{electron}} \propto \frac{1}{\sqrt{E}}$

Ans: (b)

165. If the series limit frequency of the Lyman series is $v_L$, then the series limit frequency of the $P-$fund series is

Options:

(a) $25v_L$

(b) $16v_L$

(c) $v_L/16$

(d) $v_L/25\ v_L$

Sol: $hv_L = E_\infty - E_1$ … (i)

$hv_f = E_\infty - E_5$ … (ii)

$E \propto \frac{z^2}{n^2} \Rightarrow \frac{E_5}{E_1} = \left(\frac{1}{5}\right)^2 = \frac{1}{25}$

Eqn. (i)/(ii) $\Rightarrow \frac{hv_L}{hv_f} = \frac{E_1}{E_5} \Rightarrow \frac{v_L}{v_f} = \frac{25}{1} \Rightarrow v_f = \frac{v_L}{25}$

Ans: (d)

166. Excitation energy of a hydrogen like ion in its excitation state is $40.8$ eV. Energy needed to remove the electron from the ion in ground state is

Options:

(a) 54.4 eV

(b) 13.6 eV

(c) 40.8 eV

(d) 27.2 eV

Sol: Excitation energy $\Delta E = E_2 - E_1 = 13.6 Z^2 \left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$\Rightarrow \; 40.8 = 13.6 \times \frac{3}{4} \times Z^2 \;\Rightarrow\; Z = 2$

Now required energy to remove the electron from ground state

$= \frac{+13.6 Z^2}{(1)^2} = 13.6(Z)^2 = 54.4\,\text{eV}$

Ans: (a)

167. In a Rutherford scattering experiment when a projectile of charge $Z_1$ and mass $M_1$ approaches a target nucleus of charge $Z_2$ and mass $M_2$, the distance of closest approach is $r_0$. The energy of the projectile is

Options:

(a) directly proportional to $Z_1 Z_2$

(b) inversely proportional to $Z_1$

(c) directly proportional to mass $M_1$

(d) directly proportional to $M_1 \times M_2$

Sol: The kinetic energy of the projectile is given by $\frac{1}{2}mv^2 = \frac{Ze(2e)}{4\pi\varepsilon_0 r_0} = \frac{Z_1 Z_2}{4\pi\varepsilon_0 r_0}$

Thus energy of the projectile is directly proportional to $Z_1, Z_2$

Ans: (a)

168. The mass defect for the nucleus of helium is $0.0303$ a.m.u. What is the binding energy per nucleon for helium in MeV ?

Options:

(a) 28

(b) 7

(c) 4

(d) 1

Sol: $\frac{\text{Binding energy}}{\text{Nucleon}} = \frac{0.0303 \times 931}{4} \approx 7$

Ans: (b)

169. The activity of a freshly prepared radioactive sample is $10^{10}$ disintegration per second, whose mean life is $10^9$ s. The mass of an atom of this radioisotope is $10^{-25}$ kg. The mass $(\text{in mg})$ of the radioactive sample is

Options:

(a) 1

(b) 3

(c) 5

(d) 6

Sol: We know that, $\left|\frac{dN}{dt}\right| = \lambda N = \frac{1}{T_{\text{mean}}} N$

$\therefore\ 10^{10} = \frac{1}{10^{9}} \times N$

$\therefore\ N = 10^{19}$, i.e. $10^{19}$ radioactive atoms are present in the freshly prepared sample.

The mass of the sample $= 10^{19} \times 10^{-25}\ \text{kg} = 10^{-6}\ \text{kg} = 1\,\text{mg}$

Ans: (a)

170. A radioactive nucleus (initial mass number $A$ and atomic number $Z$ emits $3\alpha-$ particles and 2 positrons. The ratio of number of neutrons to that of protons in the final nucleus will be

Options:

(a) $\frac{A-Z-8}{Z-4}$

(b) $\frac{A-Z-4}{Z-8}$

(c) $\frac{A-Z-12}{Z-4}$

(d) $\frac{A-Z-4}{Z-2}$

Sol: As a result of emission of $1\alpha-$ particle, the mass number decreases by 4 units and atomic number decreases by 2 units. And by the emission of 1 positron the atomic number decreases by 1 unit but mass number remains constant.

$\therefore$ Mass number of final nucleus $= A-12$

Atomic number of final nucleus $= Z-8$

$\therefore$ Number of neutrons $= (A-12)-(Z-8) = A-Z-4$

Number of protons $= Z-8$

$\therefore$ Required ratio $= \frac{A-Z-4}{Z-8}$

Ans: (b)

171. In a full wave rectifier circuit from $50\,\text{Hz}$ mains frequency, the fundamental frequency in the ripple would be

Options:

(a) $25\,\text{Hz}$

(b) $50\,\text{Hz}$

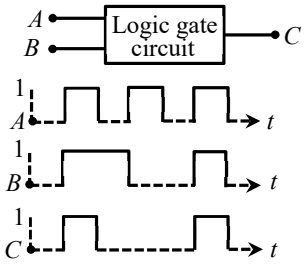
(c) $70.7\,\text{Hz}$ (d) $100\,\text{Hz}$

Sol: Input frequency, $f = 50\ \text{Hz} \Rightarrow T = \frac{1}{50}$

For full wave rectifier, $T_1 = \frac{T}{2} = \frac{1}{100} \Rightarrow f_1 = 100\,\text{Hz}$

Ans: (d)

172. The following figure shows a logic gate circuit with two inputs $A$ and $B$, and the output $C$. The voltage waveforms of $A, B$ and $C$ are as shown below. The logic gage is




Options:

(a) NAND gate

(b) NOR gate

(c) OR gate

(d) AND gate

Sol:

On the basis of given graph, following table is possible

| $A$ | $B$ | $C$ |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |

It is the truth table of AND gate.

Ans: (d)

173. Pure $Si$ at $500\,\text{K}$ has equal number of electron $(n_e)$ and hole $(n_h)$ concentrations of $1.5\times10^{16}\ \text{m}^{-3}$. Doping by indium increases $n_h$ to $4.5\times10^{22}\ \text{m}^{-3}$. The doped semiconductor is of

Options:

(a) $n$ – type with electron concentration $n_e = 5\times10^{22}\ \text{m}^{-3}$

(b) $p$ – type with electron concentration $n_e = 2.5\times10^{10}\ \text{m}^{-3}$

(c) $n$ – type with electron concentration $n_e = 2.5\times10^{23}\ \text{m}^{-3}$

(d) $p$ – type having electron concentration $n_e = 5\times10^{9}\ \text{m}^{-3}$

Sol: $n_i^2 = n_e n_h$

$\left(1.5\times10^{16}\right)^2 = n_e\left(4.5\times10^{22}\right)$

$\Rightarrow\ n_e = 0.5\times10^{10}$ or $n_e = 5\times10^{9}$

Given $n_h = 4.5\times10^{22}$ $\Rightarrow\ n_h >> n_e$

$\therefore$ Semiconductor is $p$ – type and

$n_e = 5\times10^{9}\ \text{m}^{-3}$

Ans: (d)

174. Mixed $He^+$ and $O^{2+}$ ions (mass of $He^+ = 4$ amu and that of $O^{2+} = 16$ amu) beam passes a region of constant perpendicular magnetic field. If kinetic energy of all the ions is same then

Options:

(a) $He^+$ ions will be deflected more than those of $O^{2+}$

(b) $He^+$ ions will be deflected less than those of $O^{2+}$

(c) All the ions will be deflected equally

(d) No ions will be deflected

Sol:

$$r = \frac{\sqrt{2mK}}{qB} \Rightarrow r \propto \frac{\sqrt{m}}{q}$$

$$\Rightarrow \frac{r_{He^+}}{r_{O^{++}}} = \sqrt{\frac{m_{He^+}}{m_{O^{++}}}} \times \frac{q_{O^{++}}}{q_{He^+}} = \sqrt{\frac{4}{16}} \times \frac{2}{1} = \frac{1}{1}$$

They will deflect equally.

Ans: (c)

175. A wire of length $\ell = 6 \pm 0.06$ cm and radius $r = 0.5 \pm 0.005$ cm and mass $m = 0.3 \pm 0.003$ g. Maximum percentage error in density is

Options:

(a) 4%

(b) 2%

(c) 1%

(d) 6.8%

Sol: $\rho = \frac{m}{l\pi r^2}$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \frac{2\Delta r}{r} + \frac{\Delta l}{l}$$

Putting the values $\Delta l = 0.06$ cm, $l = 6$ cm; $\Delta r = 0.005$ cm; $r = 0.5$ cm, $m = 0.3$ gm; $\Delta m = 0.003$ gm

We get, $\frac{\Delta\rho}{\rho} = \frac{4}{100}$ $\therefore$ $\frac{\Delta\rho}{\rho} \times 100 = 4\%$

Ans: (a)

176. Velocity time $(v-t)$ graph for a moving object is shown in the figure. Total displacement of the object during the time interval when there is non-zero acceleration and retardation is

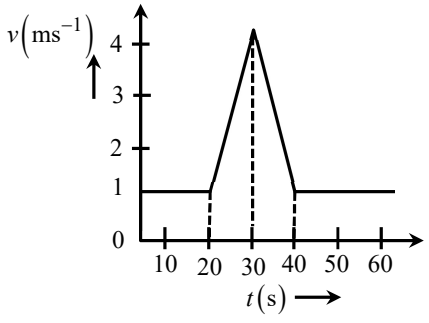
Options:

(a) 60 m

(b) 50 m

(c) 30 m

(d) 40 m



Sol: Between time interval $20\,s$ to $40\,s$, there is non-zero acceleration and retardation. Hence distance travelled during this interval = Area between time interval $20\,s$ to $40\,s$

$= \frac{1}{2} \times 20 \times 3 + 20 \times 1 = 30 + 20 = 50\,m$

Ans: (b)

177. A boat cross a river with a velocity of $8\ km\ h^{-1}$. If the resulting velocity of boat is $10\ km\ h^{-1}$ then the velocity of river water is

Options:

(a) $4\ km\ h^{-1}$

(b) $6\ km\ h^{-1}$

(c) $8\ km\ h^{-1}$

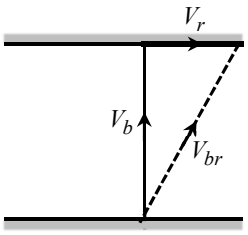
(d) $10\ km\ h^{-1}$

Sol: $\vec{v}_{br} = \vec{v}_b + \vec{v}_r$

$\Rightarrow v_{br} = \sqrt{v_b^2 + v_r^2}$

$\Rightarrow 10 = \sqrt{8^2 + v_r^2}$

$\Rightarrow v_r = 6\ km\ hr^{-1}$




Ans: (b)

178. Figure shows the positon-time graph of particle of mass $4\,kg$. Let the force on the particle for $t < 0,\ 0 < t < 4s, t > 4s$ be $F_1$, $F_2$ and $F_3$ respectively. Then

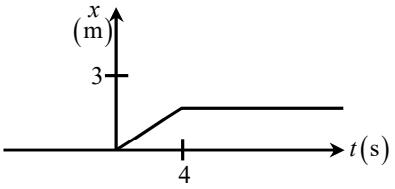
Options:

(a) $F_1 = F_2 = F_3 = 0$

(b) $F_1 > F_2 = F_3$

(c) $F_1 > F_2 > F_3$

(d) $F_1 < F_2 < F_3$




Sol: For $t < 0$ and $t > 4\,s$, the position of the particle is not changing i.e., the particle is at rest. So no forces is acting on the particle at these intervals. For $0 < t < 4\,s$, the position of the particle is continuously changing. As the positon-time graph is a straight line, the motion of the particle is uniform, so acceleration, $a = 0$. Hence no force acts on the particle during this interval also.

Ans: (a)

179. Two bodies $A$ and $B$ have masses $20\,\text{kg}$ and $5\,\text{kg}$ respectively. Each one is acted upon by force of $4\,\text{kg wt}$. If they acquire the same kinetic energy in times $t_A$ and $t_B$, then the ratio $\frac{t_A}{t_B}$ is

Options:

(a) $1/2$

(b) $2$

(c) $2/5$

(d) $5/6$

Sol: According to question, $\frac{1}{2}m_A v_A^2 = \frac{1}{2}m_B v_B^2$

$\Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}} = \sqrt{\frac{5}{20}} = \frac{1}{2}$

Using Impulse Momentum theorem

$\frac{F\Delta t_A}{F\Delta t_B} = \frac{m_A \Delta v_A}{m_B \Delta v_B} = \frac{\Delta t_A}{\Delta t_B}$

$\frac{20}{5} \times \frac{1}{2} = 2$

Ans: (b)

180. The angular velocity of a body changes from $\omega_1$ to $\omega_2$ without applying a torque but by changing the moment of inertia about its axis of rotation. The ratio of its corresponding radii of gyration is

Options:

(a) $\omega_1 : \omega_2$

(b) $\sqrt{\omega_1} : \sqrt{\omega_2}$

(c) $\omega_2 : \omega_1$

(d) $\sqrt{\omega_2} : \sqrt{\omega_1}$

Sol: $I_1\omega_1 = I_2\omega_2$

or, $mk_1^2\omega_1 = mk_2^2\omega_2$

$\therefore \frac{k_1}{k_2} = \sqrt{\frac{\omega_2}{\omega_1}}$

Ans: (d)

**Key Answers:**

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