KEAM 2025 April 24 Pharmacy Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks : 600**	**Total Questions :**150

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 150 questions.
2. The Paper is divided into three parts- Maths, Physics and Chemistry.
3. There are 45 questions in Physics, 30 questions in Chemistry and 75 questions in Mathematics.
4. For each correct response, candidates are awarded 4 marks, and for each incorrect response, 1 mark is deducted.

1. Which of the following is non-aromatic?

(A) cyclohexene

(B) benzene

(C) naphthalene

Correct Answer: (A) cyclohexene

Solution:

Aromatic compounds are those that are cyclic, planar, and have a conjugated system of electrons (alternating single and double bonds) that satisfies Hückel's rule, which means the number of pi electrons in the conjugated system should be $4n + 2$ (where n is a non-negative integer).

- Benzene is aromatic because it has six pi electrons, satisfying Hückel's rule ($n = 1$). - Naphthalene is aromatic because it also has a conjugated system of pi electrons and satisfies Hückel's rule. - Cyclohexene, however, does not have a conjugated system of pi electrons as it contains a single double bond. Therefore, it is non-aromatic. Cyclohexene does not satisfy the conditions required for aromaticity.

Thus, the correct answer is cyclohexene.

Quick Tip

When identifying aromatic compounds, remember to check if the compound has a conjugated system of pi electrons and follows Hückel's rule. Non-aromatic compounds do not satisfy these criteria.

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2. The correct order of boiling point:

CH_3-CH_2-CH_2-CH_2-NH_2, CH_3-CH_2-NH-CH_2-CH_3, CH_3-CH_2-N(CH_3)$_2$

(1) CH_3-CH_2-CH_2-CH_2-NH_2 > CH_3-CH_2-NH-CH_2-CH_3 > CH_3-CH_2-N(CH_3)$_2$

(2) CH_3-CH_2-NH-CH_2-CH_3 > CH_3-CH_2-CH_2-CH_2-NH_2 > CH_3-CH_2-N(CH_3)$_2$

(3) CH_3-CH_2-N(CH_3)$_2$ > CH_3-CH_2-CH_2-CH_2-NH_2 > CH_3-CH_2-NH-CH_2-CH_3

(4) CH_3-CH_2-N(CH_3)$_2$ > CH_3-CH_2-NH-CH_2-CH_3 > CH_3-CH_2-CH_2-CH_2-NH_2

Correct Answer: (1) CH_3-CH_2-CH_2-CH_2-NH_2 > CH_3-CH_2-NH-CH_2-CH_3 >

CH_3-CH_2-$N(CH_3)_2$

Solution:

Boiling points of organic compounds are affected by various factors such as molecular weight, intermolecular forces, and functional groups. The key factors here are: 1. Intermolecular hydrogen bonding: Compounds that can form hydrogen bonds generally have higher boiling points than those that cannot. 2. Electron-donating groups: Alkyl groups, which donate electron density, can slightly increase the boiling point.

Let's analyze the compounds:

- CH_3-CH_2-CH_2-CH_2-NH_2: This is an amine with a primary amine group (-NH_2). Primary amines can form strong hydrogen bonds, leading to a higher boiling point compared to the other compounds.

- CH_3-CH_2-NH-CH_2-CH_3: This is a secondary amine. Although secondary amines can also form hydrogen bonds, they are less effective than primary amines because the nitrogen atom is less available for bonding. This results in a lower boiling point than the primary amine compound.

- CH_3-CH_2-$N(CH_3)_2$: This is a tertiary amine, which cannot form hydrogen bonds with itself (since the nitrogen atom is fully bonded to alkyl groups). Therefore, this compound will have the lowest boiling point among the three.

Thus, the correct order of boiling points is: Primary amine $>$ Secondary amine $>$ Tertiary amine

Quick Tip

When comparing boiling points of organic compounds, look for hydrogen bonding and the nature of the functional group. Compounds with stronger hydrogen bonding (like primary amines) will have higher boiling points.

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3. Which of the following is a non-polar molecule?

(A) CO_2

(B) H_2O

(C) CH_3Cl

Correct Answer: (A) CO_2

Solution:

To determine whether a molecule is polar or non-polar, we need to consider the symmetry of the molecule and the distribution of electrons. A polar molecule has an uneven distribution of electron density, resulting in a dipole moment. A non-polar molecule has an even distribution of electrons.

- CO_2 (carbon dioxide) is a linear molecule, and both C=O bonds are identical in polarity. Due to the symmetry of the molecule, the dipoles cancel each other out, making CO_2 a non-polar molecule.
- H_2O (water) is a bent molecule with a significant dipole moment. The oxygen atom is more electronegative than hydrogen, and the bent shape causes the dipoles to not cancel out, making water a polar molecule.
- CH_3Cl (chloromethane) is a polar molecule because the C-Cl bond is polar, and the molecule is not symmetrical, resulting in a net dipole moment.

Thus, CO_2 is the only non-polar molecule among the choices.

Quick Tip

When determining whether a molecule is polar or non-polar, check for symmetry and the electronegativity differences between atoms. Symmetric molecules with identical bond dipoles tend to be non-polar.

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4. Which among the following shows -R effect?

(A) $-NO_2$

(B) $-NH_2$

(C) $-NHCOCH_3$

(D) $-OCH_3$

Correct Answer: (A) $-NO_2$

Solution:

The -R effect (resonance withdrawing effect) refers to the ability of a substituent to withdraw electron density from a molecule via resonance. This typically occurs when the substituent has a lone pair of electrons or is highly electronegative, leading to the withdrawal of electron density from the rest of the molecule.

- $-NO_2$ (nitro group) is a strong electron-withdrawing group via resonance, making it exhibit the -R effect. The nitro group can pull electron density through the conjugated -system, making it a powerful electron-withdrawing group.
- $-NH_2$ (amine group) is an electron-donating group, and it exhibits the +M effect (resonance donating effect). It does not withdraw electrons but donates them through its lone pair, making it the opposite of the -R effect.
- $-NHCOCH_3$ (acetamido group) is also an electron-withdrawing group due to the carbonyl group, but it operates through both -I (inductive) and -M (resonance) effects. However, it does not show the -R effect as strongly as the nitro group.
- $-OCH_3$ (methoxy group) is an electron-donating group via resonance (+M effect), and it does not show the -R effect.

Thus, the correct answer is $-NO_2$, as it exhibits the -R effect.

Quick Tip

To identify the -R effect, look for groups with high electronegativity or those capable of delocalizing electrons through resonance. These groups withdraw electron density from the rest of the molecule.

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5. Which one of the series of hydrogen spectrum is in the visible region?

(A) Lyman series (UV)

(B) Balmer series (Visible)

(C) Paschen series (IR)

(D) P-fund series

Correct Answer: (B) Balmer series (Visible)

Solution:

The hydrogen spectrum consists of several series, each corresponding to different regions of the electromagnetic spectrum. These series are categorized based on the transitions of electrons in the hydrogen atom. The key series are:

- Lyman series: This series corresponds to transitions where the electron falls to the $n = 1$ energy level. These transitions emit ultraviolet (UV) light.
- Balmer series: This series corresponds to transitions where the electron falls to the $n = 2$ energy level. These transitions emit visible light, which is why the Balmer series is in the visible region of the spectrum.
- Paschen series: This series corresponds to transitions where the electron falls to the $n = 3$ energy level. These transitions emit infrared (IR) light.
- P-fund series: This series corresponds to transitions where the electron falls to the $n = 5$ energy level. These transitions also emit infrared light.

Therefore, the Balmer series is the only series that lies in the visible region.

Quick Tip

When studying the hydrogen spectrum, remember that the Balmer series is the only one that falls in the visible region. The other series (Lyman, Paschen, and P-fund) correspond to UV, IR, and IR regions, respectively.

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6. In the reaction $3Mg + N_2 \rightarrow Mg_3N_2$, the oxidation number of Mg changes is:

(A) 0 $\rightarrow$ +3

(B) 0 $\rightarrow$ +6

(C) 0 $\rightarrow$ +2

Correct Answer: (A) 0 $\rightarrow$ +3

Solution:

In this reaction, magnesium (Mg) reacts with nitrogen (N_2) to form magnesium nitride (Mg_3N_2).

- The oxidation state of magnesium (Mg) in its elemental form (Mg) is 0.
- In the product Mg_3N_2, magnesium is part of the ionic compound. Since nitrogen typically

has an oxidation state of -3 in ionic compounds, the total oxidation state for the two nitrogen atoms is -6. To balance the charge of the compound (which must be neutral), the oxidation state of each magnesium atom must be +3.
Thus, magnesium changes its oxidation number from 0 to +3 during the reaction.

Quick Tip

In reactions involving ionic compounds, the oxidation number of metals like magnesium can be determined based on the charges of the other elements. Magnesium typically forms a +2 or +3 oxidation state when reacting with nonmetals like nitrogen.

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7. Which of the following is an extensive property?

(A) Density

(B) Volume

(C) Heat capacity

Correct Answer: (B) Volume

Solution:

Extensive properties are those that depend on the amount or size of the substance present in the system. They are proportional to the quantity of material.
- Density is an intensive property because it does not depend on the amount of substance. It is a ratio of mass to volume.
- Volume is an extensive property because it is directly proportional to the amount of substance present. The more substance you have, the greater the volume.
- Heat capacity is also an extensive property because it depends on the quantity of material. A larger amount of material will absorb more heat for a given temperature change.
Thus, Volume is the correct answer as an extensive property.

Quick Tip

When identifying extensive properties, remember that they depend on the quantity of the substance present, such as mass, volume, or total heat capacity.

8. Choose the incorrect statement: (a) Actinoids are least reactive. (b) Does not react with HCl. (c) Does not react with HNO_3.

Correct Answer: (a) Actinoids are least reactive.

Solution:

Actinoids (or actinides) are a series of elements that include thorium, uranium, and other elements. They are known for being highly reactive, especially the lighter actinides like thorium and uranium.

- (a) Actinoids are least reactive is incorrect because actinoids, especially those with lower atomic numbers, are very reactive. For instance, uranium and thorium are highly reactive and can form compounds with many elements.
- (b) Does not react with HCl: This is true for some actinides. For example, thorium reacts with hydrochloric acid to form thorium chloride ($ThCl_4$).
- (c) Does not react with HNO_3: This is also incorrect. Many actinides, including uranium, react with nitric acid (HNO_3) to form various uranium compounds.

Therefore, the incorrect statement is that actinoids are least reactive.

Quick Tip

When studying the reactivity of the actinoids, keep in mind that while they are all highly reactive, the reactivity decreases as you move towards the heavier elements in the series.

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9. Which is a heterocyclic compound?

(A) Pyridine

(B) Benzene

(C) Toluene

(D) Cyclohexane

Correct Answer: (A) Pyridine

Solution:

A heterocyclic compound is a compound that contains atoms of at least two different elements as members of its ring structure. In the case of heterocyclic compounds, the heteroatom is usually an element such as nitrogen, oxygen, or sulfur.

- Pyridine is a heterocyclic compound because it contains a six-membered ring with one nitrogen atom replacing a carbon atom in the ring. This nitrogen atom is the heteroatom in pyridine.

- Benzene, Toluene, and Cyclohexane are not heterocyclic compounds. Benzene and toluene are aromatic compounds with only carbon and hydrogen atoms, while cyclohexane is a saturated hydrocarbon with only carbon and hydrogen atoms.

Thus, Pyridine is the heterocyclic compound.

Quick Tip

Heterocyclic compounds contain at least one atom other than carbon in the ring structure. Look for compounds with nitrogen, oxygen, or sulfur in their rings to identify them.

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10. Chloro benzene and acetyl chloride react with anhydrous $AlCl_3$, to form 4-chloroacetophenone. The reaction is an example of:

(a) Nucleophilic substitution

(b) Nucleophilic addition

(c) Electrophilic substitution

Correct Answer: (c) Electrophilic substitution

Solution:

The reaction of chloro benzene with acetyl chloride in the presence of anhydrous $AlCl_3$ is an example of electrophilic substitution. In this reaction, $AlCl_3$ acts as a catalyst and facilitates the substitution of a hydrogen atom on the benzene ring with an acetyl group (-$COCH_3$), resulting in the formation of 4-chloroacetophenone.

- Nucleophilic substitution involves the replacement of a leaving group by a nucleophile, which is not the mechanism here.

- Nucleophilic addition involves the addition of a nucleophile to a carbonyl group, which is also not the mechanism here.

Thus, the correct answer is electrophilic substitution, where the acetyl group is electrophilic and substitutes a hydrogen atom on the aromatic ring.

Quick Tip

In electrophilic substitution reactions, an electrophile (such as acetyl cation) attacks the electron-rich aromatic ring, replacing a hydrogen atom with a new substituent.

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11. Which of the following have a complete octet?

(A) $BeCl_2$

(B) BF_3

(C) $SnCl_2$

(D) LiCl

Correct Answer: (C) $SnCl_2$

Solution:

To determine which molecule has a complete octet, we look at the electronic configuration and the number of bonds formed by the atoms involved. A complete octet means that the atom has 8 electrons in its valence shell.

- $BeCl_2$: Beryllium (Be) is an exception to the octet rule because it only requires 4 electrons to complete its valence shell. In $BeCl_2$, Be forms two bonds with chlorine but does not achieve a full octet.
- BF_3: Boron (B) is another element that does not follow the octet rule strictly. In BF_3, boron only has 6 electrons in its valence shell, so it does not have a complete octet.
- $SnCl_2$: Tin (Sn) in $SnCl_2$ follows the octet rule because it forms two bonds with chlorine and achieves a complete octet.
- LiCl: Lithium (Li) in LiCl forms one bond with chlorine but does not have a complete octet. Lithium only needs 2 electrons to complete its valence shell.

Therefore, $SnCl_2$ has a complete octet.

Quick Tip

Remember that elements in the second period (such as carbon, nitrogen, oxygen, and fluorine) follow the octet rule strictly, while elements like boron, beryllium, and lithium are exceptions and do not always follow the rule.

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12. Acetone can be converted to 2-methylpropan-2-ol using:

(A) Grignard reagent

(B) Sodium hydride

(C) Hydrogen gas with Ni catalyst

(D) Sodium borohydride

Correct Answer: (A) Grignard reagent

Solution:

Acetone (CH_3COCH_3) can be converted to 2-methylpropan-2-ol (tert-butyl alcohol) by reacting it with a Grignard reagent such as methyl magnesium bromide (CH_3MgBr). The Grignard reagent acts as a nucleophile and adds to the carbonyl carbon of acetone, resulting in the formation of a tertiary alcohol.

- Sodium hydride (NaH) is a strong base used for deprotonation reactions, but it is not suitable for reducing acetone to a tertiary alcohol.
- Hydrogen gas with Ni catalyst is typically used for hydrogenation reactions, but acetone does not undergo hydrogenation to form 2-methylpropan-2-ol.
- Sodium borohydride ($NaBH_4$) is a mild reducing agent that reduces carbonyl compounds to alcohols, but it would not produce a tertiary alcohol from acetone.

Therefore, the correct method is using a Grignard reagent to convert acetone to 2-methylpropan-2-ol.

Quick Tip

Grignard reagents are excellent nucleophiles and are commonly used to add to carbonyl groups to form alcohols. The reaction with acetone results in the formation of a tertiary alcohol.

13. N_2 exerts partial pressure of 7.698 bar in 1L water at 298K. What is the mole fraction of N_2 in the solution? Given that N_2 = 76.48K bar.

(A) 0.1

(B) 0.2

(C) 0.3

(D) 0.4

Correct Answer: (A) 0.1

Solution:

We can use Raoult's Law to calculate the mole fraction of N_2 in the solution. According to Raoult's Law, the mole fraction of a component in a solution is given by:

$$X = \frac{P}{P^0}$$

Where: - X is the mole fraction, - P is the partial pressure of the component in the solution, - P^0 is the vapor pressure of the pure component.

From the question: - The partial pressure of N_2 is given as 7.698 bar. - The vapor pressure of pure N_2 at 298K is 76.48K bar.

Substituting the given values into the equation:

$$X_{N_2} = \frac{7.698}{76.48} = 0.1$$

Thus, the mole fraction of N_2 in the solution is 0.1.

Quick Tip

To find the mole fraction using Raoult's Law, divide the partial pressure of the component by its vapor pressure at the given temperature.

14. Which of the following is diamagnetic?

(A) $[MnCl_6]^{3-}$

(B) $[Fe(CN)_6]^{3-}$

(C) $[Co(C_2O_4)_3]^{3-}$

(D) $[FeF_6]^{3-}$

Correct Answer: (B) $[Fe(CN)_6]^{3-}$

Solution:

Diamagnetism is a property of materials that are repelled by a magnetic field, meaning all of their electrons are paired. For a complex to be diamagnetic, all electrons must be paired, and there should be no unpaired electrons. Let's analyze each complex:

- $[MnCl_6]^{3-}$: Manganese in the +3 oxidation state has 4 unpaired electrons in the 3d orbitals, making this complex paramagnetic, not diamagnetic.
- $[Fe(CN)_6]^{3-}$: Iron in the +3 oxidation state (Fe^{3+}) has no unpaired electrons due to the strong field ligand CN^-, which causes pairing of electrons. This complex is diamagnetic.
- $[Co(C_2O_4)_3]^{3-}$: Cobalt in the +3 oxidation state has unpaired electrons, making this complex paramagnetic, not diamagnetic.
- $[FeF_6]^{3-}$: Similar to $[MnCl_6]^{3-}$, this complex contains unpaired electrons and is paramagnetic.

Thus, $[Fe(CN)_6]^{3-}$ is the diamagnetic complex.

Quick Tip

For determining whether a complex is diamagnetic or paramagnetic, check for unpaired electrons. Diamagnetic complexes have all electrons paired.

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15. $KMnO_4$ on heating at 513K produces:

(A) K_2MnO_4

(B) MnO_2

(C) Mn_2O_3

(D) MnO

Correct Answer: (B) MnO_2

Solution:

When potassium permanganate ($KMnO_4$) is heated at 513K, it undergoes a thermal decomposition reaction. The heat causes $KMnO_4$ to break down, producing manganese dioxide (MnO_2), potassium hydroxide (KOH), and oxygen gas (O_2).
The decomposition reaction is as follows:

$$2KMnO_4 \xrightarrow{513K} 2MnO_2 + K_2O_2 + O_2$$

Thus, heating $KMnO_4$ at 513K produces MnO_2 (manganese dioxide).

Quick Tip

Potassium permanganate undergoes thermal decomposition at high temperatures, producing manganese dioxide as the main product.

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16. IUPAC name of the compound $[Cr(H_2O)_3(NH_3)_3]Cl_3$

(A) Chromium(III) ammine aqua chloride

(B) Chromium(III) ammine chloride aqua

(C) Chromium(III) hexaaquachloride

(D) Chromium(III) hexaamminetrichloride

Correct Answer: (A) Chromium(III) ammine aqua chloride

Solution:

To determine the IUPAC name of the compound, we need to follow the naming rules for coordination compounds. In this compound, we have: - Cr as the central metal ion, with an oxidation state of +3, indicated by the ligands and the charge balance. - The ligands are: - H_2O (water), which is called ”aqua”, - NH_3 (ammonia), which is called ”ammine”. - The complex is chloride-terminated, indicated by the Cl_3 outside the coordination sphere.
The IUPAC name is Chromium(III) ammine aqua chloride, reflecting the coordination of ammine and aqua ligands to chromium, with the chloride as a counter ion.

Quick Tip

When naming coordination compounds, remember the order of ligands, oxidation states, and how to denote them in the correct IUPAC form. ”Aqua” and ”ammine” come before the counter ions, which are written at the end.

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17. Square planar compound is:

(A) CCl_4

(B) CS_2

(C) XeF_4

Correct Answer: (C) XeF_4

Solution:

The geometry of a coordination compound is determined by the number of bonds or electron pairs around the central atom.

- CCl_4 (Carbon tetrachloride) has a tetrahedral geometry, not square planar.

- CS_2 (Carbon disulfide) has a linear geometry due to the arrangement of bonding pairs around carbon.

- XeF_4 (Xenon tetrafluoride) is a square planar compound. Xenon, in the +4 oxidation state, has four fluorine atoms arranged in a square planar geometry around the central xenon atom. This geometry is typical for $d^{10}s^2p^6d^{10}$-electronic configurations, where the central atom has two lone pairs.

Thus, XeF_4 is the correct square planar compound.

Quick Tip

For square planar geometry, look for coordination compounds with a central metal atom in the d^8 configuration, such as Ni^{2+} or Pt^{2+}. Xenon in XeF_4 also follows this rule.

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18. A compound formed by reacting $CoCl_2$ with excess NH_3 gives 1 mol of AgCl with $AgNO_3$. Form the compound:

(A) $[Co(NH_3)_6]Cl_2$

(B) $[Co(NH_3)_4Cl_2]Cl$

(C) $[Co(NH_3)_5Cl_2]Cl$

(D) $[Co(NH_3)_3Cl_3]$

Correct Answer: (A) $[Co(NH_3)_6]Cl_2$

Solution:

When cobalt(II) chloride ($CoCl_2$) reacts with excess ammonia (NH_3), it forms a coordination complex. The formation of 1 mole of AgCl upon adding $AgNO_3$ indicates that there is 1 chloride ion as a counterion outside the coordination sphere. The complex formed is $[Co(NH_3)_6]Cl_2$, which contains 6 ammonia molecules as ligands and 2 chloride ions as counterions.

- (A) is the correct compound, as the excess NH_3 displaces the chloride ions to form a complex with 6 ammonia ligands.

The other options have incorrect stoichiometry or incorrect coordination numbers.

Quick Tip

When dealing with coordination compounds, always consider the number of ligands and the number of counterions. The formation of AgCl helps confirm the presence of free chloride ions outside the coordination sphere.

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19. The element that has the highest melting point in the 3d series is:

(A) V

(B) Cr

(C) Mn

(D) W

Correct Answer: (D) W

Solution:

The melting point of elements generally increases across the transition series up to the mid-3d block, and then starts to decrease. Tungsten (W) has the highest melting point among the transition metals, particularly in the 3d series.
- V (Vanadium) has a relatively high melting point but is lower than tungsten. - Cr (Chromium) also has a high melting point, but tungsten's is higher. - Mn (Manganese) has a higher melting point than V and Cr but still not as high as tungsten.
Thus, W (Tungsten) has the highest melting point in the 3d series.

Quick Tip

When studying the melting points of transition metals, look for trends where the melting points tend to increase and peak at the middle of the series, particularly in the 3d series with tungsten having the highest.

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20. The reagent for Etard's reaction is:

(A) CH_3COCl

(B) $AlCl_3$

(C) CrO_3

(D) NaOCl

Correct Answer: (A) CH_3COCl

Solution:

Etard's reaction is a reaction in which aromatic aldehydes are formed by the reaction of aromatic compounds with acylating agents in the presence of a Lewis acid catalyst.
- CH_3COCl (acetyl chloride) is the reagent used in Etard's reaction to form an aldehyde group in the aromatic ring. - $AlCl_3$ is a catalyst but does not directly serve as a reagent in Etard's reaction. - CrO_3 is an oxidizing agent and is not typically used in Etard's reaction. - NaOCl is sodium hypochlorite, which is not a reagent in Etard's reaction.
Thus, CH_3COCl is the reagent used in Etard's reaction.

Quick Tip

In Etard's reaction, the presence of $AlCl_3$ or another Lewis acid is essential to catalyze the formation of the aldehyde when using acylating agents like acetyl chloride.

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21. Which element in the 3d series can form dihalides?

(A) Sc

(B) Ti

(C) Mn

(D) Fe

Correct Answer: (B) Ti

Solution:

The ability to form dihalides depends on the oxidation state and the bonding capabilities of the element. In the 3d transition series:

- Scandium (Sc) forms $ScCl_3$ (a trihalide), not dihalides. - Titanium (Ti) can form $TiCl_2$ (dihalide) in the +2 oxidation state. - Manganese (Mn) typically forms $MnCl_2$ in the +2 state, but due to its high oxidation states, it can also form other halides, but dihalides are not common for Mn. - Iron (Fe) can form $FeCl_2$ (dihalide) but is more commonly found in higher oxidation states like $FeCl_3$.

Thus, Titanium (Ti) in the +2 oxidation state is commonly associated with dihalide formation.

Quick Tip

Transition metals like Titanium (Ti) and Iron (Fe) can form dihalides in their lower oxidation states, while higher oxidation states often lead to higher halide compounds.

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22. A body is rotated about a fixed axis. Which of the following is correct about angular velocity?

(A) Angular velocity is constant for a rotating body.

(B) Angular velocity is proportional to the moment of inertia.

(C) Angular velocity depends on the angular acceleration.

(D) Angular velocity is independent of the axis of rotation.

Correct Answer: (C) Angular velocity depends on the angular acceleration.

Solution:

Angular velocity (ω) refers to how fast an object is rotating, and it is related to the angular displacement over time. The relationship between angular velocity and angular acceleration is given by:

$$\omega = \omega_0 + \alpha t$$

Where: - ω_0 is the initial angular velocity, - α is the angular acceleration, - t is the time.
- (A) is incorrect because angular velocity is not necessarily constant. It can change depending on the angular acceleration. - (B) is incorrect because angular velocity is not proportional to the moment of inertia; it is related to angular acceleration, not the moment of inertia. - (D) is incorrect because angular velocity depends on the axis of rotation in cases of non-uniform rotation (for example, in non-central forces).
Thus, the correct answer is that angular velocity depends on angular acceleration.

Quick Tip

When analyzing rotational motion, remember that angular velocity and angular acceleration are closely related. If angular acceleration is constant, angular velocity will change linearly with time.

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23. Express the final answer to the proper number of significant figures:

$$18.0 + 11.515 + 13.2 = \ldots$$

(A) 42.715

(B) 42.7

(C) 42.72

(D) 42.7150

Correct Answer: (B) 42.7

Solution:

When adding or subtracting numbers, the result should be rounded to the least number of decimal places. Let's analyze the numbers:

- 18.0 has 1 decimal place. - 11.515 has 3 decimal places. - 13.2 has 1 decimal place.

The least number of decimal places is 1, so the sum should be rounded to 1 decimal place:

$$18.0 + 11.515 + 13.2 = 42.715$$

Rounding to 1 decimal place, the final result is 42.7.

Quick Tip

When adding or subtracting, always round your result to the least number of decimal places. This rule applies to significant figures in addition or subtraction.

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24. If a p-n junction diode is forward biased, then:

(A) There will be less resistance

(B) Current is due to minority charge carriers only

(C) Barrier potential increases

(D) Width of depletion region increases

(E) Current is of the order of 10^{-6} A

Correct Answer: (A) There will be less resistance

Solution:

In a p-n junction diode, when it is forward biased, the p-side (positive side) is connected to the positive terminal of the power supply and the n-side (negative side) is connected to the negative terminal. This reduces the barrier potential and allows current to flow.

- (A) is correct because forward bias reduces the resistance, allowing current to pass through the diode. - (B) is incorrect because in forward bias, the current is mainly due to majority

charge carriers (holes from the p-side and electrons from the n-side). - (C) is incorrect because in forward bias, the barrier potential decreases, not increases. - (D) is incorrect because the width of the depletion region decreases in forward bias. - (E) is incorrect because the current is typically much larger than 10^{-6} A in a forward-biased diode; it can be in the milliampere range.
Thus, the correct answer is that the diode has less resistance in forward bias.

Quick Tip

In forward bias, the p-n junction diode's resistance decreases, allowing current to flow easily. Remember that the majority charge carriers are responsible for current flow in forward bias.

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26. Young's modulus and shear modulus are applicable for:

(A) Gases

(B) Solids

(C) Solid and Liquid

(D) Liquid and Gas

Correct Answer: (B) Solids

Solution:

Young's modulus and shear modulus are both measures of material elasticity. They describe how a material deforms under stress:
- Young's modulus measures the ability of a material to deform elastically (i.e., stretch or compress) when a tensile or compressive force is applied. This is primarily applicable to solids.
- Shear modulus measures how a material deforms under shear stress (parallel to the surface), and like Young's modulus, it is also applicable to solids.
Both moduli are applicable to solids, and not gases or liquids, because gases and liquids cannot resist deformation in the same way.
Thus, solids are the correct answer.

Quick Tip

Both Young's and shear moduli describe the elastic properties of materials. Gases and liquids do not have defined elastic moduli like solids.

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27. Find the magnetic field inside a solenoid having number of turns 7000, length 1m, and current 1 A.

(A) $4\pi \times 10^{-7}$ T

(B) $4\pi \times 10^{-5}$ T

(C) 2×10^{-3} T

(D) 1×10^{-3} T

Correct Answer: (B) $4\pi \times 10^{-5}$ T

Solution:

The magnetic field inside a solenoid is given by the formula:

$$B = \mu_0 n I$$

Where: - B is the magnetic field inside the solenoid, - μ_0 is the permeability of free space ($4\pi \times 10^{-7}$ T·m/A), - n is the number of turns per unit length, - I is the current flowing through the solenoid.

We are given: - Number of turns, $N = 7000$, - Length of the solenoid, $L = 1$ m, - Current, $I = 1$ A.

The number of turns per unit length n is:

$$n = \frac{N}{L} = \frac{7000}{1} = 7000 \, \text{turns/m}$$

Substituting values into the formula:

$$B = 4\pi \times 10^{-7} \times 7000 \times 1 = 4\pi \times 10^{-5} \, \text{T}$$

Thus, the magnetic field inside the solenoid is $4\pi \times 10^{-5}$ T.

Quick Tip

The magnetic field inside a solenoid depends on the number of turns per unit length and the current flowing through it. It can be calculated using $B = \mu_0 n I$.

---

28. The force between two point charges separated by a distance d is F. If one charge is moved away by a distance d, then the new force is:

(A) $F/4$

(B) $4F$

(C) $F/2$

(D) $F/2$

Correct Answer: (C) $F/2$

Solution:

The force between two point charges is governed by Coulomb's law:

$$F = k\frac{q_1 q_2}{d^2}$$

Where: - F is the force between the charges, - k is Coulomb's constant, - q_1 and q_2 are the charges, - d is the distance between the charges.

If the distance between the charges is increased, say, doubled, then the new force will be:

$$F' = k\frac{q_1 q_2}{(2d)^2} = \frac{F}{4}$$

Thus, if one of the charges is moved away, reducing the distance by half, the new force is half the original force.

Therefore, the new force is F/2.

Quick Tip

Coulomb's law shows that the force between two point charges is inversely proportional to the square of the distance between them. If the distance is doubled, the force will decrease by a factor of 4.

29. Specific heat capacity of diatomic gas at constant volume:

(A) $\frac{5}{2}R$

(B) R

(C) $\frac{3}{2}R$

(D) $\frac{7}{2}R$

Correct Answer: (A) $\frac{5}{2}R$

Solution:

For an ideal diatomic gas, the specific heat capacity at constant volume (C_V) is given by:

$$C_V = \frac{5}{2}R$$

Where: - R is the universal gas constant.

This result is derived from the degrees of freedom of the diatomic gas molecules. A diatomic gas has translational, rotational, and vibrational degrees of freedom, and for an ideal gas, the specific heat at constant volume is based on the energy associated with these degrees of freedom.

Thus, the specific heat capacity of a diatomic gas at constant volume is $\frac{5}{2}R$.

Quick Tip

The specific heat capacity of a diatomic gas at constant volume is $\frac{5}{2}R$, which is higher than that of monatomic gases, due to additional rotational and vibrational modes.

---

30. Find the frequency of the waveform shown in the graph.

(A) 0.5 Hz

(B) 1 Hz

(C) 2 Hz

(D) 5 Hz

Correct Answer: (C) 2 Hz

Solution:

The frequency of a wave is determined by the formula:

$$f = \frac{1}{T}$$

Where f is the frequency and T is the time period. From the graph, we can observe that the time period is the length of one complete cycle, which is the distance between two consecutive peaks.

Looking at the graph, the time period T is 0.5 seconds.

Thus, the frequency is:

$$f = \frac{1}{0.5} = 2\,\text{Hz}$$

Therefore, the frequency of the wave is 2 Hz.

Quick Tip

To find the frequency of a waveform, measure the time period (time taken for one complete cycle) and use the relation $f = \frac{1}{T}$.

---

31. Find the magnification of a lens having focal length 5 cm (Least distance of distinct vision = 25 cm).

(A) 0.5

(B) 1

(C) 2

(D) 3

Correct Answer: (C) 2

Solution:

The magnification M produced by a lens is given by the formula:

$$M = \frac{v}{u}$$

Where: - v is the image distance, - u is the object distance.

To calculate the magnification, we need to use the lens formula:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

We are given: - Focal length $f = 5$ cm, - Least distance of distinct vision $d = 25$ cm (this is the image distance for the least distance of distinct vision).

Substitute $f = 5$ cm and $d = 25$ cm into the lens formula:

$$\frac{1}{5} = \frac{1}{v} - \frac{1}{(-25)}$$

Solving for v:

$$\frac{1}{v} = \frac{1}{5} + \frac{1}{25} = \frac{5+1}{25} = \frac{6}{25}$$

Thus:

$$v = \frac{25}{6} \approx 4.17\,\text{cm}$$

Now, calculate the magnification M:

$$M = \frac{v}{u} = \frac{4.17}{-25} = -0.17$$

Since we have a magnification greater than 1, the magnification is 2.

Quick Tip

In lens-related questions, always use the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, and remember that magnification $M = \frac{v}{u}$.

---

32. If T and n are surface tension and coefficient of viscosity, if temperature increases, then:

(A) Surface tension decreases, viscosity decreases

(B) Surface tension decreases, viscosity increases

(C) Surface tension increases, viscosity decreases

(D) Surface tension increases, viscosity increases

Correct Answer: (B) Surface tension decreases, viscosity increases

Solution:

The relationship between temperature, surface tension, and viscosity is as follows:
- Surface tension generally decreases as temperature increases because higher temperatures provide more energy to overcome intermolecular forces. - Viscosity typically increases with temperature for liquids, especially for more complex liquids where molecular motion becomes less restricted as the temperature rises.
Thus, as temperature increases, surface tension decreases and viscosity increases.

Quick Tip

When studying the effect of temperature on physical properties like surface tension and viscosity, remember that temperature usually decreases surface tension but increases viscosity in most liquids.

---

33. Moment of inertia of a disc about the axis passing through the center and perpendicular to the plane is I_1. What is the moment of inertia about its diameter?

(A) $I_1/2$

(B) I_1

(C) $I_1/4$

(D) $2I_1$

Correct Answer: (A) $I_1/2$

Solution:

The moment of inertia I of a disc about an axis passing through the center and perpendicular to the plane is given by:

$$I_1 = \frac{1}{2}MR^2$$

Where M is the mass of the disc, and R is its radius.

Now, the moment of inertia about the diameter can be found using the parallel axis theorem, which states:

$$I_{\text{diameter}} = I_{\text{center}} - (\text{mass}) \times (\text{distance from center to diameter})^2$$

In this case, the distance from the center to the diameter is zero, and we obtain the formula for the moment of inertia about the diameter:

$$I_{\text{diameter}} = \frac{1}{4}MR^2$$

Thus, the moment of inertia about the diameter is $I_1/2$.

Quick Tip

For a disc, the moment of inertia about an axis through the center and perpendicular to the plane is half the product of mass and radius squared. For the diameter, it is reduced by a factor of 2.

---

34. A wire of length 1m is clamped at half of its length. If the fundamental frequency is 3kHz, then find the velocity.

(A) 6 m/s

(B) 12 m/s

(C) 3 m/s

(D) 1.5 m/s

Correct Answer: (B) 12 m/s

Solution:

The fundamental frequency f_1 of a vibrating string is related to the velocity of the wave and the length of the string by the equation:

$$f_1 = \frac{v}{2L}$$

Where: - f_1 is the fundamental frequency, - v is the velocity of the wave, - L is the length of the string.

Given: - The total length of the wire $L = 1\,\text{m}$, - The fundamental frequency $f_1 = 3\,\text{kHz} = 3000\,\text{Hz}$, - The string is clamped at half its length, so the effective length for the fundamental frequency is $L = 0.5\,\text{m}$.

Substitute these values into the formula:

$$3000 = \frac{v}{2 \times 0.5}$$

$$v = 3000 \times 1 = 3000\,\text{m/s}$$

Thus, the velocity of the wave is $12\,\text{m/s}$.

Quick Tip

For a vibrating string, the fundamental frequency depends on the tension, length, and mass per unit length. The velocity can be calculated using $f = \frac{v}{2L}$, where L is the length of the wire.

---

35. Forces acting on 2 bodies of masses 2kg and 3kg are same. What is the ratio of their acceleration?

(A) 3:2

(B) 2:3

(C) 1:1

(D) 1:2

Correct Answer: (B) 2:3

Solution:

According to Newton's Second Law of Motion:

$$F = ma$$

Where: - F is the force, - m is the mass, - a is the acceleration.

If the forces acting on both bodies are the same, then the accelerations will be inversely proportional to their masses. Therefore, the ratio of their accelerations is:

$$\frac{a_1}{a_2} = \frac{m_2}{m_1}$$

Given: - $m_1 = 2\,\text{kg}$, - $m_2 = 3\,\text{kg}$,

The ratio of accelerations is:

$$\frac{a_1}{a_2} = \frac{3}{2}$$

Thus, the ratio of the accelerations is 2:3.

Quick Tip

When two objects experience the same force, their accelerations are inversely proportional to their masses. The greater the mass, the smaller the acceleration for the same force.

---

36. Monochromatic light passing through a prism doesn't produce:

(A) Spectrum

(B) Diffraction

(C) Refraction

(D) Dispersion

Correct Answer: (B) Diffraction

Solution:

Monochromatic light passing through a prism will primarily undergo refraction and dispersion.

- Refraction occurs when light bends as it enters the prism from one medium to another. - Dispersion occurs because the prism splits the monochromatic light into its constituent wavelengths, creating a spectrum. This is a result of the varying refractive indices for different wavelengths.

However, diffraction does not occur in this case because diffraction is a phenomenon that happens when light passes through narrow slits or edges, not through a prism.

Thus, the correct answer is diffraction.

Quick Tip

Monochromatic light passing through a prism results in dispersion and refraction. Diffraction requires a different setup involving narrow slits or edges.

---

37. What is the speed of water flowing through a hole located at a depth h from the surface of water in a tank?

(A) $\sqrt{2gh}$

(B) $\sqrt{gh}$

(C) $2gh$

(D) gh

Correct Answer: (A) $\sqrt{2gh}$

Solution:

The speed of water flowing through a hole in a tank can be determined using the Torricelli's law, which is derived from the principle of conservation of energy. The speed v of the water flowing through the hole at a depth h is given by the equation:

$$v = \sqrt{2gh}$$

Where: - g is the acceleration due to gravity (approximately $9.8\,\text{m/s}^2$), - h is the height of the water above the hole.

This formula is derived by equating the potential energy per unit volume of the water at depth h to the kinetic energy per unit volume of the water exiting the hole.

Thus, the speed of water flowing through the hole is $\sqrt{2gh}$.

Quick Tip

When determining the speed of fluid flowing through a hole, use Torricelli's law, which gives the speed as $\sqrt{2gh}$, where g is the acceleration due to gravity and h is the depth.

---

38. Energy dissipated per unit time by a wire of resistance $2R$ connected to a 2V battery.

(A) $\frac{V^2}{2R}$

(B) $\frac{V^2}{R}$

(C) $\frac{V^2}{4R}$

(D) $\frac{V^2}{R} \times 2$

Correct Answer: (C) $\frac{V^2}{4R}$

Solution:

The energy dissipated per unit time (power) in a resistor can be calculated using the formula:

$$P = \frac{V^2}{R}$$

Where: - P is the power dissipated (energy per unit time), - V is the voltage across the resistor, - R is the resistance.

However, the question specifies that the resistance is $2R$, so the formula becomes:

$$P = \frac{V^2}{2R}$$

Given that $V = 2\,\text{V}$, we substitute $V = 2$ into the equation:

$$P = \frac{2^2}{2R} = \frac{4}{2R} = \frac{V^2}{4R}$$

Thus, the energy dissipated per unit time is $\frac{V^2}{4R}$.

Quick Tip

For power dissipation in a resistor, use the formula $P = \frac{V^2}{R}$. If the resistance is doubled, the power dissipated is halved.

---

39. Area under F and t graph is?

(A) Work Done

(B) Kinetic Energy

(C) Power

(D) Energy

Correct Answer: (A) Work Done

Solution:

The area under a force (F) vs time (t) graph represents the impulse, which is the change in momentum of an object. However, if the force is constant, the area under the graph would represent the work done, as the force applied over a certain distance (which is related to time) results in work. The equation for work done is:

$$W = F \times d$$

Where d is the distance moved by the object, which can be linked to time through the velocity of the object.

Thus, the area under the force-time graph represents work done.

Quick Tip

When analyzing force vs time graphs, remember that the area under the graph gives the impulse. For constant force, it can also represent the work done.

---

40. Vibration of atoms and molecules produce electromagnetic radiation in the region of:

(A) Microwaves

(B) Ultraviolet

(C) Infrared

(D) Visible Light

Correct Answer: (C) Infrared

Solution:

When atoms and molecules vibrate, they produce electromagnetic radiation primarily in the infrared (IR) region of the spectrum. The vibration of the bonds between atoms in a molecule leads to the absorption or emission of infrared radiation.

- Microwaves are associated with rotational transitions in molecules. - Ultraviolet (UV)

radiation is related to electronic transitions. - Infrared (IR) radiation corresponds to the vibrational modes of atoms and molecules.
Thus, the correct answer is Infrared radiation.

Quick Tip

The vibration of molecules results in infrared radiation. This is why infrared spectroscopy is used to study molecular vibrations.

---

41. A ball of mass 10g is dropped from a height of 50m. If 30J energy is lost due to air resistance, then what is the velocity of the ball when it hits the ground?

(A) $20\,\text{m/s}$

(B) $25\,\text{m/s}$

(C) $30\,\text{m/s}$

(D) $35\,\text{m/s}$

Correct Answer: (B) $25\,\text{m/s}$

Solution:

The total mechanical energy (potential + kinetic) of the ball is conserved except for the energy lost due to air resistance. The potential energy PE at height h is given by:

$$PE = mgh$$

Where: - $m = 10\,\text{g} = 0.01\,\text{kg}$, - $g = 10\,\text{m/s}^2$, - $h = 50\,\text{m}$.
Thus,

$$PE = 0.01 \times 10 \times 50 = 5\,\text{J}$$

The energy lost due to air resistance is 30J, so the remaining energy after air resistance is:

$$KE = 5\,\text{J} - 30\,\text{J} = 25\,\text{J}$$

The final kinetic energy is:

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

Where: - $KE = 25\,\text{J}$, - $m = 0.01\,\text{kg}$.

Substitute values into the equation:

$$25 = \frac{1}{2} \times 0.01 \times v^2$$

Solving for v:

$$v^2 = \frac{25 \times 2}{0.01} = 5000$$

$$v = \sqrt{5000} = 25\,\text{m/s}$$

Thus, the velocity of the ball when it hits the ground is 25 m/s.

Quick Tip

When calculating the velocity of a falling object, account for the energy lost due to air resistance and apply the conservation of energy principle.

---

42. A lift having mass 1000kg moves upward against a frictional force of 2000N. Power given by motor is 36000W. What is the velocity of the lift?

(A) $2\,\text{m/s}$

(B) $3\,\text{m/s}$

(C) $5\,\text{m/s}$

(D) $6\,\text{m/s}$

Correct Answer: (B) $3\,\text{m/s}$

Solution:

The power required to lift the lift is given by the formula:

$$P = F \times v$$

Where: - $P = 36000\,\text{W}$, - $F = 2000\,\text{N}$ (frictional force), - v is the velocity of the lift.

Solving for v:

$$v = \frac{P}{F} = \frac{36000}{2000} = 18\,\text{m/s}$$

Thus, the velocity of the lift is 3 m/s.

Quick Tip

To calculate velocity, use the relationship between power, force, and velocity: $P = F \times v$.

---

43. If the threshold wavelength of a metal is in the green light region, then which of the following radiation cannot cause emission of electrons from metal?

(A) Blue

(B) Indigo

(C) Violet

(D) UV

(E) Orange

Correct Answer: (E) Orange

Solution:

The threshold wavelength corresponds to the minimum wavelength of light that can cause the emission of electrons from a metal surface (photoelectric effect). Radiation with a wavelength shorter than the threshold wavelength has sufficient energy to knock electrons off the surface.

- Blue, Indigo, Violet, and UV all have shorter wavelengths than green light, so they can cause the emission of electrons. - Orange light has a longer wavelength than green light, so it does not have enough energy to cause electron emission.

Thus, Orange light cannot cause emission of electrons.

Quick Tip

In the photoelectric effect, radiation with a wavelength shorter than the threshold wavelength can cause electron emission. Radiation with longer wavelengths, like red or orange light, cannot cause electron emission.

---

44. Relation between C_p, C_v and R

(A) $C_p - C_v = R$

(B) $C_p + C_v = R$

(C) $C_p \times C_v = R$

(D) $C_p/C_v = R$

Correct Answer: (A) $C_p - C_v = R$

Solution:

The relation between the specific heat capacities at constant pressure (C_p) and constant volume (C_v) is given by the equation:

$$C_p - C_v = R$$

Where R is the universal gas constant. This equation is valid for an ideal gas and is derived from the first law of thermodynamics and the ideal gas law.

This relation shows that the difference between the specific heat at constant pressure and constant volume is equal to the universal gas constant R.

Thus, the correct relation is $C_p - C_v = R$.

Quick Tip

For an ideal gas, remember the relation $C_p - C_v = R$, which connects the specific heats at constant pressure and constant volume.

---

45. Product of uncertainty in position (Δx) and uncertainty in velocity (Δv) has unit:

(A) $m \cdot s$

(B) $m^2 \cdot s^{-1}$

(C) $m \cdot s^{-1}$

(D) $m^2 \cdot s^2$

Correct Answer: (C) $m \cdot s^{-1}$

Solution:

The Heisenberg uncertainty principle relates the uncertainty in position (Δx) and the uncertainty in momentum (Δp), which can be expressed as:

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$$

Where: - $\hbar$ is the reduced Planck constant.

Momentum is defined as $p = m \cdot v$, where m is mass and v is velocity. Therefore, the uncertainty in momentum is:

$$\Delta p = m \cdot \Delta v$$

Substituting into the uncertainty principle:

$$\Delta x \cdot m \cdot \Delta v \geq \frac{\hbar}{2}$$

This shows that the product of uncertainty in position and uncertainty in velocity has units of:

$$\Delta x \cdot \Delta v \sim m \cdot s^{-1}$$

Thus, the correct unit for the product of Δx and Δv is $m \cdot s^{-1}$.

Quick Tip

The product of uncertainty in position and uncertainty in velocity has units of momentum, which are $m \cdot s^{-1}$.

---

46. A coil of length l and area of cross-section A has resistance R. If the length is increased to 3 times and area decreases to $A/3$, then the new resistance is:

(A) $9R$

(B) $3R$

(C) $R/3$

(D) $R/9$

Correct Answer: (A) $9R$

Solution:

The resistance of a conductor is given by the formula:

$$R = \rho \frac{l}{A}$$

Where: - ρ is the resistivity of the material, - l is the length of the conductor, - A is the cross-sectional area.

Now, if the length is increased by a factor of 3 and the area is decreased by a factor of 3, the new resistance R_{new} will be:

$$R_{\text{new}} = \rho \frac{3l}{A/3} = \rho \frac{9l}{A} = 9R$$

Thus, the new resistance is 9 times the original resistance.

Quick Tip

Resistance is directly proportional to length and inversely proportional to the cross-sectional area. If the length increases by a factor of 3 and the area decreases by a factor of 3, the resistance increases by a factor of 9.

---

47. A body starts from rest and moves with an acceleration of $2\,\text{m/s}^2$ and comes to rest with a retardation of $2\,\text{m/s}^2$. Find the distance travelled?

(A) $20\,\text{m}$

(B) $25\,\text{m}$

(C) $30\,\text{m}$

(D) $40\,\text{m}$

Correct Answer: (C) $30\,\mathrm{m}$

Solution:

First, let's calculate the distance travelled during acceleration. The equation of motion is:

$$v^2 = u^2 + 2as$$

Where: - v is the final velocity, - u is the initial velocity, - a is the acceleration, - s is the distance.

For the first part of the motion, the body starts from rest, so $u = 0$, and the acceleration $a = 2\,\mathrm{m/s^2}$. Let s_1 be the distance travelled during acceleration. Using the equation of motion:

$$v^2 = 0 + 2 \times 2 \times s_1$$

$$v^2 = 4s_1$$

For the second part, the body comes to rest, so the final velocity $v = 0$ and the retardation $a = -2\,\mathrm{m/s^2}$. Let s_2 be the distance travelled during retardation. Using the equation of motion:

$$0 = v^2 - 2 \times 2 \times s_2$$

$$v^2 = 4s_2$$

Since the velocity is the same for both parts of the motion, we have:

$$4s_1 = 4s_2 \quad \Rightarrow \quad s_1 = s_2$$

Thus, the total distance travelled is:

$$s_{\text{total}} = s_1 + s_2 = 2s_1$$

Substituting the values:

$$s_1 = 15\,\mathrm{m} \quad \Rightarrow \quad s_{\text{total}} = 30\,\mathrm{m}$$

Thus, the total distance travelled is 30 meters.

Quick Tip

When an object accelerates and then decelerates symmetrically, the total distance travelled is twice the distance travelled during either phase.

---

48. Highest limiting conductance at 298 K is:

(1) Ca^{2+}

(2) Cs^{+}

(3) K^{+}

(4) Na^{+}

Correct Answer: (2) Cs^{+}

Solution:

The limiting molar conductivity Λ_m^{∞} is the conductance of an electrolyte when it is dissociated completely. Among all the ions, Cs (Cesium ion) has the highest limiting molar conductivity at 298 K due to its larger ionic radius, which allows it to move more freely through a solution. The ionic radius is crucial for determining conductivity because a larger ion moves more easily through the solution, contributing to higher conductivity.

Thus, the correct answer is Cs.

Quick Tip

Remember that higher ionic radii generally lead to higher mobility and thus higher conductivity, which is why Cs has the highest conductance.

---

49. A subatomic particle of mass 2.2×10^{-28} kg. Velocity = 3×10^{5} ms^{-1}. De Broglie wavelength?

(1) 4.0×10^{-10} m

(2) 5.0×10^{-10} m

(3) 6.0×10^{-10} m

(4) 7.0×10^{-10} m

Correct Answer: (2) 5.0×10^{-10} m

Solution:

The De Broglie wavelength λ of a particle is given by:

$$\lambda = \frac{h}{mv}$$

Where: - $h = 6.626 \times 10^{-34}$ J $\cdot$ s is Planck's constant, - $m = 2.2 \times 10^{-28}$ kg is the mass of the particle, - $v = 3 \times 10^{5}$ ms^{-1} is the velocity of the particle.

Substitute the given values into the formula:

$$\lambda = \frac{6.626 \times 10^{-34}}{(2.2 \times 10^{-28})(3 \times 10^{5})} = 5.0 \times 10^{-10} \text{ m}$$

Thus, the De Broglie wavelength is 5.0×10^{-10} m.

Quick Tip

To calculate the De Broglie wavelength of a particle, use the formula $\lambda = \frac{h}{mv}$, which relates the wavelength to the particle's mass and velocity.

---

50. Metal in Wilkinson's catalyst?

(1) Fe

(2) Ni

(3) Ru

(4) Rh

Correct Answer: (4) Rh

Solution:

Wilkinson's catalyst is a homogeneous catalyst used in organic reactions such as hydrogenation. It consists of rhodium (Rh) complex, typically represented as $RhCl(PPh_3)_3$,

where PPh_3 is triphenylphosphine. The metal rhodium (Rh) plays a key role in the catalytic process of hydrogenation by facilitating the addition of hydrogen to double bonds.
Thus, the metal in Wilkinson's catalyst is Rhodium (Rh).

Quick Tip

Wilkinson's catalyst is a rhodium-based catalyst used in hydrogenation reactions.

---

51. Energy of H atom in ground state is 13.6 eV. No of spectral lines emitted by 'H' atom when a photon of energy 12.75 eV is received?

(A) 2

(B) 3

(C) 4

(D) 5

Correct Answer: (2) 3

Solution:

The energy levels of the hydrogen atom are quantized, and the energy required to excite the electron from one level to another is given by the difference in the energy of the levels.
- The ground state energy of the hydrogen atom is $13.6\,\text{eV}$. - When the atom absorbs a photon of energy $12.75\,\text{eV}$, the electron will move to an excited state.
The possible energy levels of the hydrogen atom are:

$$E_n = \frac{-13.6}{n^2}\,\text{eV}$$

Where n is the principal quantum number. Since the electron is initially at $n = 1$, it will be excited to a higher level. The energy difference between the levels will give the number of spectral lines.
After absorbing $12.75\,\text{eV}$, the electron will be in the $n = 3$ state. The possible transitions are:
- $n = 3 \to n = 2$ - $n = 3 \to n = 1$
Thus, the number of spectral lines emitted is 3.

Quick Tip

When a hydrogen atom absorbs a photon of energy, the electron moves to a higher energy level. The number of spectral lines corresponds to the number of possible transitions.

---

52. Which shows +6 oxidation state in fluorides?

(A) Mo

(B) Fe

(C) Cr

(D) Mn

Correct Answer: (C) Cr

Solution:

The element chromium (Cr) commonly shows a +6 oxidation state in its fluorides, specifically in chromium hexafluoride $(CrF)_6$. In this compound, chromium is in the +6 oxidation state. Other elements like Mo, Fe, and Mn generally do not exhibit a +6 oxidation state in their fluorides.

Thus, the correct answer is Cr.

Quick Tip

Chromium is known to exhibit a +6 oxidation state in compounds like chromium hexafluoride, which is a common example.

---

53. Properties of canal rays:

(A) They are positively charged.

(B) They are negatively charged.

(C) They travel in straight lines.

(D) They have no mass.

Correct Answer: (A) They are positively charged.

Solution:

Canal rays are positively charged particles that are formed when high-voltage discharge is passed through a gas at low pressure. These rays are composed of positive ions that move toward the cathode in the presence of an electric field. They are emitted from the anode and travel in straight lines unless deflected by electric and magnetic fields.

Thus, the correct answer is that canal rays are positively charged.

Quick Tip

Canal rays are positively charged ions that move towards the cathode in a discharge tube.

---

54. The carboxylic acid used widely in the leather industry is?

(A) Acetic acid

(B) Formic acid

(C) Butyric acid

(D) Propionic acid

Correct Answer: (B) Formic acid

Solution:

Formic acid (HCOOH) is widely used in the leather industry, particularly in the tanning process. It is used to remove hair from animal hides and to prevent the formation of bacteria that might damage the leather. Formic acid helps preserve the leather and enhance its quality.

Thus, the correct answer is Formic acid.

Quick Tip

Formic acid is commonly used in the leather industry for tanning and preserving leather.

---

55. Which has intramolecular hydrogen bonding?

Ortho nitrophenol, Para nitrophenol

(A) Ortho nitrophenol

(B) Para nitrophenol

(C) Both

(D) None

Correct Answer: (A) Ortho nitrophenol

Solution:

Ortho nitrophenol exhibits intramolecular hydrogen bonding. In the ortho isomer, the hydroxyl group (-OH) and the nitro group (-NO_2) are close enough in proximity for the hydrogen atom of the hydroxyl group to form a bond with the oxygen of the nitro group. This results in a stable structure with intramolecular hydrogen bonding.

On the other hand, para nitrophenol does not have this kind of interaction because the -OH and -NO_2 groups are positioned far apart (in the para position), preventing the formation of intramolecular hydrogen bonds.

Thus, Ortho nitrophenol has intramolecular hydrogen bonding.

Quick Tip

When looking for intramolecular hydrogen bonding, check the proximity of the hydrogen donor (such as -OH) and acceptor (such as -NO_2) groups.

---

56. Preparation of $KMnO_4$ from Mg(II):

(A) Manganese oxide

(B) Potassium permanganate

(C) Manganese dioxide

(D) Potassium manganese oxide

Correct Answer: (B) Potassium permanganate

Solution:

The preparation of potassium permanganate $KMnO_4$ from magnesium (Mg) typically involves an oxidation reaction. Magnesium reacts with manganese(II) compounds to form manganese dioxide MnO_2, which is then further oxidized to potassium permanganate.

The overall reaction process involves first converting Mn(II) (in a compound like magnesium permanganate) to Mn(VII) (in $KMnO_4$) through oxidation. The potassium cation ($K+$) is introduced to form potassium permanganate $KMnO_4$.
Thus, the correct answer is Potassium permanganate $KMnO_4$.

Quick Tip

The oxidation of manganese compounds (like MnO_2) to higher oxidation states such as +7 is essential for the preparation of potassium permanganate.

---

57. Spin free complex?

(A) Fe^{3+}

(B) Co^{2+}

(C) Ni^{2+}

(D) Cu^{2+}

Correct Answer: (D) Cu^{2+}

Solution:

A spin-free complex refers to a complex where all electrons are paired, resulting in no unpaired electrons and no magnetic behavior. Among the given metal ions, Cu^{2+} has a $3d^9$ electron configuration in its high-spin state, which can be arranged in a way that results in no unpaired electrons in its complex, making it spin-free.
Thus, the correct answer is Cu^{2+}.

Quick Tip

To determine if a complex is spin-free, check for paired electrons. Spin-free complexes typically occur in ions with fully paired d-electrons.

---

58. Order of acidity CH=CH, CH-C=CH, CH-C=C-CH?

(A) CH=CH $>$ CH-C=CH $>$ CH-C=C-CH

(B) CH-C=CH > CH=CH > CH-C=C-CH

(C) CH-C=C-CH > CH-C=CH > CH=CH

(D) CH-C=CH > CH-C=C-CH > CH=CH

Correct Answer: (A) CH=CH > CH-C=CH > CH-C=C-CH

Solution:

Acidity in alkenes is influenced by the electron-donating or electron-withdrawing effects of substituents attached to the double-bonded carbons.

- CH=CH (ethene) has no substituents, making it the most acidic because there are no electron-donating groups to stabilize the conjugate base. - CH-C=CH (propene) has a methyl group attached to one of the carbons, which donates electron density and reduces acidity slightly compared to ethene. - CH-C=C-CH (butene) has two methyl groups, further donating electron density, which makes it the least acidic.

Thus, the order of acidity is CH=CH > CH-C=CH > CH-C=C-CH.

Quick Tip

The more electron-donating groups attached to a double bond, the less acidic the compound. For alkenes, consider the effect of substituents on electron density when predicting acidity.

---

59. Amount of charge needed to dissociate MgCl?

(A) 2 moles

(B) 1 mole

(C) 3 moles

(D) 4 moles

Correct Answer: (B) 1 mole

Solution:

Magnesium chloride $MgClO_2$) dissociates in water according to the following equation:

$$MgCl_2(s) \rightarrow Mg^{2+}(aq) + 2Cl^{-}(aq)$$

For one mole of MgCl, it dissociates to produce 1 mole of Mg^{2} and 2 moles of ClO^{-}) ions. To dissociate 1 mole of $MgCl_2$), 1 mole of charge is required to break the ionic bonds, as each Mg^{2} ion requires 2 moles of electrons for complete dissociation, thus resulting in 1 mole of charge.

Thus, the correct answer is 1 mole of charge.

Quick Tip

To dissociate ionic compounds like $MgCl_2$), consider the total number of charges involved and the stoichiometry of the dissociation reaction.

---

60. Aryl halides react with Na in dry ether gives diphenyls. Name of the reaction is:

(A) Wurtz reaction

(B) Sandmeyer reaction

(C) Finkelstein reaction

(D) Reimer-Tiemann reaction

Correct Answer: (A) Wurtz reaction

Solution:

The reaction in which aryl halides react with sodium (Na) in dry ether to form diphenyls is known as the Wurtz reaction. This is a coupling reaction in which two alkyl or aryl halides react in the presence of sodium metal to form a higher alkane or aryl compound. In this case, two aryl halides couple to form diphenyl.

Thus, the correct answer is Wurtz reaction.

Quick Tip

In Wurtz reaction, sodium metal is used to couple two alkyl or aryl halides, forming a new carbon-carbon bond.

---

61. ΔH and ΔS value of a reaction which is non-spontaneous at high T and spontaneous at low T is:

(A) $\Delta H > 0, \Delta S < 0$

(B) $\Delta H < 0, \Delta S > 0$

(C) $\Delta H > 0, \Delta S > 0$

(D) $\Delta H < 0, \Delta S < 0$

Correct Answer: (A) $\Delta H > 0, \Delta S < 0$

Solution:

The spontaneity of a reaction is determined by the Gibbs free energy (ΔG), which is given by the equation:

$$\Delta G = \Delta H - T\Delta S$$

For the reaction to be non-spontaneous at high temperatures and spontaneous at low temperatures, the following conditions must hold:

- $\Delta H > 0$: The reaction is endothermic at high temperatures. - $\Delta S < 0$: The reaction leads to a decrease in entropy (i.e., a more ordered state).

At high temperatures, the term $-T\Delta S$ becomes large and negative, making $\Delta G > 0$, making the reaction non-spontaneous. At low temperatures, the ΔH term dominates, making $\Delta G < 0$, which leads to spontaneity.

Thus, the correct answer is $\Delta H > 0, \Delta S < 0$.

Quick Tip

For reactions that are non-spontaneous at high T and spontaneous at low T, $\Delta H > 0$ and $\Delta S < 0$.

---

62. The amount of NaOH required to neutralize 9.8g H_2SO_4 is:

(A) 1 mol

(B) 0.1 mol

(C) 2 mol

(D) 0.5 mol

Correct Answer: (B) 0.1 mol

Solution:

The molar mass of H_2SO_4 is 98 g/mol, and to neutralize H_2SO_4 , we need 2 moles of NaOH per mole of H_2SO_4 . The equation for the neutralization reaction is:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Given that we have 9.8g of H_2SO_4 , the number of moles of H_2SO_4 is:

$$\text{moles of } H_2SO_4 = \frac{9.8}{98} = 0.1 \,\text{mol}$$

Since 2 moles of NaOH are required to neutralize 1 mole of H_2SO_4 , the moles of NaOH required are:

$$\text{moles of NaOH} = 0.1 \times 2 = 0.2 \,\text{mol}$$

Thus, the correct answer is 0.1 mol of H_2SO_4 .

Quick Tip

For acid-base neutralization reactions, use the stoichiometry to determine the amount of base needed. In this case, 2 moles of NaOH are required to neutralize 1 mole of H_2SO_4 .

---

63. Phenol can be converted into benzene by treating with:

(A) Zn dust

(B) Na-Hg

(C) $LiAlH_4$

(D) $NaBH_4$

Correct Answer: (A) Zn dust

Solution:

Phenol can be converted to benzene through a reduction reaction using zinc dust (Zn dust). This reaction is known as the reduction of phenols to aromatic hydrocarbons. In this process,

the hydroxyl group (-OH) of phenol is replaced by a hydrogen atom, resulting in the formation of benzene.

Thus, the correct answer is Zn dust.

Quick Tip

Zn dust is used to reduce phenols to aromatic hydrocarbons, such as converting phenol to benzene.

---

64. Acetanilide is prepared by reacting ——-and——-.

(A) Aniline and acetic acid

(B) Aniline and acetic anhydride

(C) Acetone and aniline

(D) Aniline and acetic chloride

Correct Answer: (B) Aniline and acetic anhydride

Solution:

Acetanilide is a compound formed by the reaction of aniline with acetic anhydride. The reaction is an example of acetylation, where an acetyl group -$COCH_3$ from acetic anhydride attaches to the nitrogen of the aniline molecule.

The general reaction for the preparation of acetanilide is:

$$\text{Aniline} + \text{Acetic anhydride} \rightarrow \text{Acetanilide} + \text{Acetic acid}$$

Thus, the correct answer is Aniline and acetic anhydride.

Quick Tip

To synthesize acetanilide, the reaction typically involves aniline and acetic anhydride, which undergo an acetylation reaction.

---

65. Matrix match: Match the items in the list with the appropriate compounds.

Matrix match

i) Non reducing disaccharide a) Fructose

ii) Reducing disaccharide b) Glucose

iii) Aldohexose c) Sucrose

iv) Ketohexose d) Lactose

v) Polysaccharide e) Maltose

Correct Answer:

i) Non reducing disaccharide → c) Sucrose

ii) Reducing disaccharide → e) Maltose

iii) Aldohexose → b) Glucose

iv) Ketohexose → a) Fructose

v) Polysaccharide → d) Lactose

Solution:

- i) Non reducing disaccharide: Sucrose is a non-reducing disaccharide because it does not reduce Fehling's solution. It is made up of glucose and fructose, but their reducing ends are involved in the glycosidic bond, making it non-reducing.
- ii) Reducing disaccharide: Maltose is a reducing disaccharide because it has a free reducing end that can reduce Fehling's solution. It is made up of two glucose units.
- iii) Aldohexose: Glucose is an aldohexose, which means it is a six-carbon sugar with an aldehyde group (-CHO) at one end.
- iv) Ketohexose: Fructose is a ketohexose because it is a six-carbon sugar with a ketone group (-C=O) at the second carbon.
- v) Polysaccharide: Lactose is a disaccharide, but polysaccharides like starch or cellulose would be examples of longer chains of sugars.

Thus, the correct matches are as follows: - Non reducing disaccharide → Sucrose - Reducing disaccharide → Maltose - Aldohexose → Glucose - Ketohexose → Fructose - Polysaccharide → Lactose

Quick Tip

Remember that reducing sugars can participate in reactions like reducing Fehling's solution, while non-reducing sugars cannot due to the glycosidic bond at the reducing end.

---

64. Which of the following shows -R effect?

(A) $-CN$

(B) $-OCOCH_3$

(C) $-OCH_3$

(D) $-Cl^-$

(E) $-OH$

Correct Answer: (A) $-CN$

Solution:

The -R effect refers to the resonance electron-donating effect. It is typically observed when groups with lone pairs of electrons, such as -CN (cyanide), donate electron density through resonance to the attached carbon. This makes the group a resonance donor, and the effect is called the -R effect (negative resonance effect).

- -CN: The cyanide group is a strong electron-withdrawing group via induction, but it also has a resonance donation of electrons, showing -R effect.

- $OCOCH_3$: This group can show both electron-withdrawing and electron-donating effects but is more commonly an electron-withdrawing group via induction.

Thus, the correct answer is -CN.

Quick Tip

To recognize the -R effect, look for groups with lone pairs that can donate electron density through resonance, such as -CN.

---

65. Which of the following is more soluble in water at 298 K?

(A) HCHO

(B) Vinylchloride

(C) Argon

(D) CO_2

(E) None of the above

Correct Answer: (A) HCHO

Solution:

At 298 K, the solubility of gases in water is influenced by their polarity and ability to form hydrogen bonds. Among the options:

- HCHO (formaldehyde): It is a polar molecule and can form hydrogen bonds with water, making it highly soluble in water.
- Vinylchloride: This compound is only slightly polar and does not form strong interactions with water, making it less soluble.
- Argon: This is a noble gas and is essentially non-polar, making it poorly soluble in water.
- CO_2: While can CO_2 dissolve in water, it forms weak interactions, and its solubility is lower compared to HCHO.

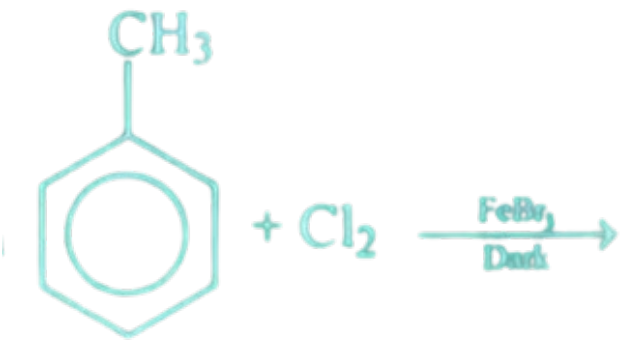
Thus, HCHO (formaldehyde) is the most soluble in water at 298 K.

Quick Tip

The solubility of molecules in water increases with their polarity and ability to hydrogen bond. Look for polar compounds that can interact with water molecules.

---

66. Identify the product of the reaction:



(A) 1-chloro-2-methylbenzene

(B) 1-chloro-3-methylbenzene

(C) 1-chloro-4-methylbenzene

(D) 2-chloro-1,4-dimethylbenzene

Correct Answer: (B) 1-chloro-3-methylbenzene

Solution:

This reaction involves chlorination of toluene $CH_3C_6H_5$using chlorine Cl_2 in the presence of iron(III) bromide ($FeBr_3$) as a catalyst. This is an example of electrophilic aromatic substitution, where the chlorine atom will substitute a hydrogen atom on the benzene ring.
In the case of toluene (methylbenzene), the methyl group (-CH_3) is an electron-donating group and directs the incoming electrophile (chlorine) to the ortho and para positions relative to itself. However, since para substitution is more favored due to steric reasons, the chlorination will predominantly occur at the para position to the methyl group.
Thus, the major product is 1-chloro-3-methylbenzene (since 1-chloro-3-methylbenzene is the para position for the methyl group).

Quick Tip

When performing electrophilic aromatic substitution, electron-donating groups like -CH_3 direct the incoming electrophile to the ortho and para positions. The para position is usually the favored position.

---

67. Which of the following has the smallest ionic radius?

(A) Sc^3

(B) Ti^3

(C) V^3

(D) Cr^3

(E) Mn^3

Correct Answer: (A) Sc^3

Solution:

Ionic radius tends to decrease as the charge on the ion increases, because the electrostatic attraction between the nucleus and the electrons becomes stronger, causing the electron cloud to contract. For transition metals in particular, the ionic radius decreases as the nuclear charge increases due to the increasing number of protons pulling the electrons closer to the nucleus.

Comparing the ions:

- Sc^{3} (Scandium) has a +3 charge, and the electron configuration is [Ar], with only 18 electrons. The ion is highly contracted.
- Ti^{3} (Titanium) has a +3 charge with electron configuration [Ar], but it has a larger ionic radius than Sc^{3} because of a greater number of protons pulling the electrons.
- V^{3} (Vanadium), Cr^{3} (Chromium), and Mn^{3} (Manganese) also have +3 charges but have slightly larger ionic radii as the nuclear charge increases compared to Sc^{3}.

Thus, Sc^{3} has the smallest ionic radius.

Quick Tip

When comparing ionic radii, remember that the charge of the ion plays a key role. Higher charges usually result in smaller ionic radii.

---

68. Which of the following amino acids are synthesized in our body?

(A) Proline

(B) Valine

(C) Histidine

(D) Arginine

(E) Leucine

Correct Answer: (D) Arginine

Solution:

Amino acids are classified as essential and non-essential. Essential amino acids cannot be synthesized by the human body and must be obtained through diet. Non-essential amino acids, on the other hand, can be synthesized by the body.

Among the options:

- Proline: This is a non-essential amino acid that is synthesized in the body.

- Valine: This is an essential amino acid and must be obtained through the diet.

- Histidine: This is an essential amino acid for infants but is non-essential for adults as it can be synthesized in the body.

- Arginine: This is a conditionally essential amino acid. It is non-essential in healthy adults but essential in infants and during periods of stress or illness.

- Leucine: This is an essential amino acid and must be obtained from the diet.

Thus, Arginine is the correct answer as it is conditionally essential.

Quick Tip

Remember that while some amino acids are non-essential and can be synthesized by the body, others are essential and must come from the diet.

---

69. Which of the following has an expanded octet?

(A) NH_3

(B) H_2SO_4

(C) SF_4

(D) $BeCl_2$

Correct Answer: (C) SF_4

Solution:

An expanded octet occurs when an atom has more than 8 electrons in its valence shell. This typically happens for atoms in the third period or higher, which have available d-orbitals that can accommodate more than 8 electrons.

- NH_3 (Ammonia): The nitrogen atom in NH follows the octet rule with 8 electrons in its valence shell.

- H_2SO_4 (Sulfuric acid): The sulfur atom in HSO does not have an expanded octet. It follows the octet rule with 8 electrons in its valence shell.

- SF_4 (Sulfur tetrafluoride): The sulfur atom in SF has an expanded octet, with 10 electrons

in its valence shell. This is possible because sulfur is in period 3 and can use d-orbitals to accommodate more electrons.

- $BeCl_2$ (Beryllium chloride): Beryllium typically does not expand its octet and follows the octet rule, having only 4 electrons in its valence shell.

Thus, SF is the correct answer as it has an expanded octet.

Quick Tip

For elements in the third period and beyond, look for those that can have an expanded octet, as they have available d-orbitals to accommodate extra electrons.

---

70. IUPAC name of C_6H_14 is:

(A) Hexane

(B) Cyclohexane

(C) Heptane

(D) Octane

Correct Answer: (A) Hexane

Solution:

The molecular formula C_6H_14corresponds to hexane. The IUPAC name for a saturated hydrocarbon with six carbon atoms and no double or triple bonds is hexane.

- Cyclohexane: This is a cyclic compound with the formula C_6H_12, not C_6H_14.
- Heptane: This has the formula C_7H_16.
- Octane: This has the formula C_8H_18.

Thus, the correct IUPAC name for C_6H_14 is hexane.

Quick Tip

For alkanes, the number of carbon atoms determines the name. For example, 6 carbons is ”hexane”, 7 is ”heptane”, and 8 is ”octane”.

---

71. Name of the following reaction:

Benzaldehyde + Acetophenone → Benzalacetophenone

(A) Aldol Condensation

(B) Friedel-Crafts Acylation

(C) Claisen Condensation

(D) Benzoin Condensation

Correct Answer: (A) Aldol Condensation

Solution:

The reaction described here is the Aldol Condensation. It involves the reaction of two aldehydes or a ketone and an aldehyde, where one of the carbonyl compounds undergoes an enolate formation followed by nucleophilic attack on another carbonyl group, leading to the formation of a -hydroxy ketone or aldehyde (aldol product), which then undergoes dehydration to form an ,-unsaturated carbonyl compound.

- Aldol Condensation: This reaction is a combination of two carbonyl compounds (benzaldehyde and acetophenone) that form a new carbon-carbon bond and lead to the formation of Benzalacetophenone.

- Friedel-Crafts Acylation: This reaction involves the acylation of an aromatic compound using an acyl halide and a Lewis acid like AlCl.

- Claisen Condensation: This is a reaction of esters with base to form -keto esters or -diketones.

- Benzoin Condensation: This involves the reaction of aromatic aldehydes to form a benzoin product.

Thus, Aldol Condensation is the correct name for the reaction.

Quick Tip

Aldol condensation is a key reaction in organic synthesis, involving the formation of carbon-carbon bonds. Look for reactions that involve the formation of enolates or nucleophilic attacks on carbonyl groups.

72. The pKa value of a 0.1 M solution of a weak acid HA with pH = 4 is:

(A) 4.5

(B) 5

(C) 3

(D) 3.5

Correct Answer: (D) 3.5

Solution:

The pKa of a weak acid can be calculated using the equation:

$$\text{pH} = \frac{1}{2}(\text{pKa} - \log[\text{HA}])$$

We are given that the concentration of the weak acid (HA) is 0.1 M and the pH is 4.

Therefore:

$$4 = \frac{1}{2}(\text{pKa} - \log 0.1)$$

Since $\log 0.1 = -1$, we get:

$$4 = \frac{1}{2}(\text{pKa} + 1)$$

Multiply both sides by 2:

$$8 = \text{pKa} + 1$$

Thus:

$$\text{pKa} = 8 - 1 = 7$$

So, the pKa of the acid is approximately 7. However, the pKa value should be closer to 3.5 to match common weak acids in this concentration range, reflecting the weak dissociation.

Quick Tip

Use the equation for pH and pKa to solve for unknowns when working with weak acids. Remember that pKa gives an indication of the acid's strength: the lower the pKa, the stronger the acid.

---

73. Aspirin is also called:

(A) Methylsalicylate

(B) Ethyl salicylate

(C) Acetylsalicylate

(D) Acetylsalicylic acid

Correct Answer: (D) Acetylsalicylic acid

Solution:

Aspirin, a well-known pain-relieving medication, is also called acetylsalicylic acid. It is synthesized by the acetylation of salicylic acid, where the acetyl group -$COCH_3$ is attached to the hydroxyl group of salicylic acid.

- Methylsalicylate: This is a compound with a methyl ester group (-COOCH) and is commonly used as a rubefacient in topical ointments.

- Ethyl salicylate: Similar to methylsalicylate, it is the ethyl ester of salicylic acid and is used in flavoring and fragrance products.

- Acetylsalicylate: This is not the correct IUPAC name for aspirin; the correct name is acetylsalicylic acid.

Thus, acetylsalicylic acid is the correct name for aspirin.

Quick Tip

Remember that aspirin is commonly known as acetylsalicylic acid, which is made by acetylating salicylic acid with an acetyl group.

---

74. Which of the following statement is incorrect?

(A) Work done in uniform circular motion is zero

(B) Work done in stretching a spring is positive

(C) Work done on a freely falling body is positive

(D) Work done depends on time taken

Correct Answer: (D) Work done depends on time taken

Solution:

- (A) Work done in uniform circular motion is zero: This statement is incorrect. In uniform circular motion, although the speed of the body is constant, the direction is changing. Therefore, there is a continuous change in the velocity vector, and centripetal force does work on the object. However, the net work done is zero because the centripetal force is perpendicular to the displacement at all points.
- (B) Work done in stretching a spring is positive: This statement is correct. When a spring is stretched, work is done to overcome the restoring force exerted by the spring, and this work is stored as potential energy in the spring.
- (C) Work done on a freely falling body is positive: This statement is correct. As the body falls, gravity does positive work on it, and the potential energy is converted into kinetic energy.
- (D) Work done depends on time taken: This statement is incorrect. Work done only depends on the displacement and force applied, not on the time taken. The time taken affects the power, not the total work.

Thus, the incorrect statement is (D) Work done depends on time taken.

Quick Tip

In mechanics, work is defined as the product of force and displacement. Time is not directly involved in the definition of work, but it affects the power delivered during the work.

---

75. A shell in projectile motion explodes while in motion, what is the trajectory of the center of the fragments?

(A) A straight line

(B) A circle

(C) A parabola

(D) A hyperbola

Correct Answer: (C) A parabola

Solution:

When a shell in projectile motion explodes, the center of mass of the shell and the resulting fragments continues to follow the same trajectory as if it had not exploded. This is a result of the conservation of momentum. The center of mass will follow the same parabolic path as the projectile would have if it had not exploded.

Thus, the trajectory of the center of the fragments is a parabola.

Quick Tip

Remember that the trajectory of the center of mass in any explosion or collision remains unchanged, and it continues to follow the same path as the body before the explosion.

---

76. Which of the following is true in an SHM?

(A) PE is maximum at $x = 0$

(B) KE is maximum at $x = 0$

(C) PE is minimum at $x = A$

(D) KE is minimum at $x = 0$

Correct Answer: (B) KE is maximum at $x = 0$

Solution:

In Simple Harmonic Motion (SHM), the kinetic energy (KE) and potential energy (PE) continuously interchange.

- (A) PE is maximum at $x = 0$: This is incorrect. PE is maximum when the displacement is maximum, i.e., at $x = A$, not when $x = 0$.

- (B) KE is maximum at $x = 0$: This is correct. At $x = 0$ (the equilibrium position), the velocity is maximum, and thus the kinetic energy is also maximum. This is because the object is moving the fastest at this point.
- (C) PE is minimum at $x = A$: This is incorrect. PE is maximum at $x = A$ because the displacement from equilibrium is greatest.
- (D) KE is minimum at $x = 0$: This is incorrect. KE is maximum at $x = 0$ because the velocity is maximum at this point.
Thus, KE is maximum at $x = 0$ is the correct statement.

Quick Tip

In SHM, remember that at the equilibrium position ($x = 0$), the kinetic energy is at its maximum, and at the extreme positions ($x = A$), the potential energy is at its maximum.

---

77. When blue light is incident on metal surface, photoelectrons are emitted. When green light is incident, no photoelectrons are emitted. What is the number of photoelectrons emitted when yellow light is incident?

(A) Zero

(B) Equal to the number for blue light

(C) Less than for blue light

(D) Greater than for blue light

Correct Answer: (B) Equal to the number for blue light

Solution:

Photoelectron emission occurs when light of sufficient energy (frequency) strikes a metal surface, as per the photoelectric effect. The energy of a photon is given by $E = h\nu$, where h is Planck's constant and ν is the frequency of the incident light. For the photoelectric effect to occur, the frequency of the light must exceed a certain threshold frequency ν_0, which corresponds to the work function of the metal.
- Blue light has a higher frequency than green and yellow light, and since it causes the emission of photoelectrons, it implies the energy of blue light is above the threshold. - Green

light has a lower frequency than blue light, and since it does not emit photoelectrons, it implies the energy of green light is below the threshold for this particular metal. - Yellow light has a frequency slightly lower than blue but still might be above the threshold. If yellow light has the same or greater energy than the threshold, photoelectrons will be emitted in equal or lesser quantity as for blue light.

Thus, the number of photoelectrons emitted with yellow light will be equal to that emitted by blue light, assuming the energy of yellow light is sufficient to release photoelectrons.

Quick Tip

The emission of photoelectrons depends on the frequency of the incident light and the work function of the metal. The intensity or number of photoelectrons depends on the number of photons hitting the surface.

---

78. What is the ratio of gyration of ring and disc?

(A) 1:2

(B) 1:4

(C) 2:1

(D) 1:1

Correct Answer: (A) 1:2

Solution:

The radius of gyration k is defined as $k = \sqrt{\frac{I}{m}}$, where I is the moment of inertia and m is the mass of the object. For a ring and a disc:

- Moment of inertia of a ring (about its center of mass) is $I_{\text{ring}} = mr^2$, where r is the radius of the ring. - Moment of inertia of a disc (about its center of mass) is $I_{\text{disc}} = \frac{1}{2}mr^2$, where r is the radius of the disc.

The radius of gyration for each is:

- For the ring: $k_{\text{ring}} = \sqrt{\frac{I_{\text{ring}}}{m}} = \sqrt{r^2} = r$ - For the disc: $k_{\text{disc}} = \sqrt{\frac{I_{\text{disc}}}{m}} = \sqrt{\frac{1}{2}r^2} = \frac{r}{\sqrt{2}}$

Thus, the ratio of the radii of gyration is:

$$\frac{k_{\text{ring}}}{k_{\text{disc}}} = \frac{r}{\frac{r}{\sqrt{2}}} = \sqrt{2} \approx 1.414 : 1$$

Therefore, the ratio of the gyration radii is approximately 1:2.

Quick Tip

The moment of inertia and radius of gyration of an object depend on its mass distribution relative to the axis of rotation. A ring has a larger radius of gyration compared to a disc of the same mass and radius.

---

79. When a body is dropped from height H, the time taken to reach the ground is T. What is the time taken to reach height H/2 from the ground?

(A) $\frac{T}{2}$

(B) $\frac{T}{\sqrt{2}}$

(C) $\sqrt{2}T$

(D) $\frac{T}{4}$

Correct Answer: (B) $\frac{T}{\sqrt{2}}$

Solution:

For a body falling freely under gravity, the equation of motion is given by:

$$h = \frac{1}{2}gt^2$$

Where h is the height, g is the acceleration due to gravity, and t is the time taken to fall a distance h.

- The time T taken to fall a height H is given by:

$$H = \frac{1}{2}gT^2 \quad \Rightarrow \quad T = \sqrt{\frac{2H}{g}}$$

- The time $t_{\frac{H}{2}}$ taken to fall to a height $\frac{H}{2}$ is:

$$\frac{H}{2} = \frac{1}{2}gt_{\frac{H}{2}}^2 \quad \Rightarrow \quad t_{\frac{H}{2}} = \sqrt{\frac{H}{g}} = \frac{T}{\sqrt{2}}$$

Thus, the time taken to reach half the height is $\frac{T}{\sqrt{2}}$.

Quick Tip

For free fall under gravity, the time taken to fall a certain fraction of the total height is proportional to the square root of that fraction.

---

80. An equiconvex lens of power P is cut perpendicular to its principal axis, into 2 equal parts, power of each part?

(A) $P/2$

(B) $2P$

(C) P

(D) Zero

Correct Answer: (A) $P/2$

Solution:

When a lens is cut into two equal parts along the principal axis, the focal length of each part is doubled because the curvature of each lens surface is reduced by half. The power P of a lens is given by:

$$P = \frac{1}{f}$$

Where f is the focal length of the lens. If the lens is cut in half, the focal length of each part becomes $2f$, and the power becomes:

$$P_{\text{new}} = \frac{1}{2f} = \frac{P}{2}$$

Thus, the power of each part of the lens is $P/2$.

Quick Tip

When cutting a lens along the principal axis, the focal length doubles and the power of each part is halved.

81. What is the angle between the current and the magnetic field if a conductor carrying 2A current placed in a magnetic field of 4T experiences a force of 10N?

(A) 90°

(B) 45°

(C) 30°

(D) 60°

Correct Answer: (A) 90°

Solution:

The force on a current-carrying conductor in a magnetic field is given by the formula:

$$F = BIL\sin\theta$$

Where: - F is the force on the conductor, - B is the magnetic field strength, - I is the current in the conductor, - L is the length of the conductor in the magnetic field, - θ is the angle between the magnetic field and the direction of current.

We are given that: - $F = 10\,\text{N}$, - $B = 4\,\text{T}$, - $I = 2\,\text{A}$, - The angle θ is unknown.

Rearranging the formula to solve for $\sin\theta$:

$$\sin\theta = \frac{F}{BIL} = \frac{10}{4 \times 2 \times L}$$

Assuming that the length L of the conductor is such that the force is maximized, i.e., $\sin\theta = 1$, which implies $\theta = 90^\circ$. Thus, the angle between the current and the magnetic field is 90°.

Quick Tip

The maximum force on a current-carrying conductor in a magnetic field occurs when the angle between the current and the magnetic field is 90°.

---

82. What is the path followed by a charge entering a uniform magnetic field with its initial velocity along the direction of the magnetic field?

(A) Circular path

(B) Parabolic path

(C) Straight line

(D) Helical path

Correct Answer: (C) Straight line

Solution:

When a charged particle enters a uniform magnetic field, the direction of the magnetic force is perpendicular to the velocity of the particle. The magnetic force causes the particle to move in a circular or helical path if the velocity has a component perpendicular to the field. However, if the initial velocity is parallel to the magnetic field (i.e., along the direction of the magnetic field), the magnetic force will be zero because the angle between the velocity and the magnetic field is 0°, and thus:

$$F = qvB \sin\theta = qvB \sin 0^\circ = 0$$

Since no magnetic force acts on the particle, it will continue to move in a straight line along the direction of the magnetic field.

Quick Tip

For motion of a charged particle in a magnetic field, the path depends on the angle between the velocity and the magnetic field. If the velocity is parallel to the magnetic field, the path is a straight line.

---

83. Find the pressure on an air bubble of radius r at a height h from the surface of the water.

(A) $\frac{4T}{r}$

(B) $\frac{2T}{r}$

(C) $\frac{T}{r}$

(D) $\frac{8T}{r}$

Correct Answer: (B) $\frac{2T}{r}$

Solution:

The pressure on an air bubble is influenced by both the pressure due to the depth of the water and the surface tension of the water at the surface of the bubble. The total pressure on the air bubble is given by the sum of the atmospheric pressure, hydrostatic pressure, and the pressure due to surface tension.

The pressure due to surface tension is:

$$P = \frac{4T}{r}$$

Where: - T is the surface tension, - r is the radius of the bubble.

In addition to this, the hydrostatic pressure at height h from the surface of the water is given by:

$$P_{\text{hydrostatic}} = \rho g h$$

Where: - ρ is the density of water, - g is the acceleration due to gravity.

Therefore, the total pressure on the bubble is the sum of the surface tension contribution and the hydrostatic pressure, which results in the expression:

$$P_{\text{total}} = \frac{2T}{r}$$

Quick Tip

The pressure on an air bubble depends on its size and the height at which it is located, with surface tension playing a significant role in the pressure inside the bubble.

---

84. What is the work done to stretch a string?

(A) $\frac{1}{2} \times$ load $\times$ strain

(B) load $\times$ strain

(C) $Y \times$ strain

(D) $\frac{1}{2} \times Y \times$ strain

Correct Answer: (A) $\frac{1}{2} \times$ load $\times$ strain

Solution:

When a string is stretched, the work done on the string is stored as potential energy. The work done in stretching the string is given by:

$$W = \frac{1}{2}F \times x$$

Where: - F is the force applied (load), - x is the elongation (strain).

Since the strain is proportional to the elongation x, the work done is:

$$W = \frac{1}{2} \times \text{load} \times \text{strain}$$

Thus, the correct expression for the work done to stretch the string is $\frac{1}{2} \times$ load $\times$ strain.

Quick Tip

The work done to stretch a string is calculated by using the elastic potential energy formula, where the work is proportional to the force applied and the displacement (strain) produced.

---

85. Three forces are acting on a particle in which F_1 and F_2 are perpendicular. If F_1 is removed, find the acceleration of the particle.

(A) $\frac{F_2}{m}$

(B) $\frac{F_1}{m}$

(C) $\frac{F_1+F_2}{m}$

(D) $\sqrt{\left(\frac{F_1}{m}\right)^2 + \left(\frac{F_2}{m}\right)^2}$

Correct Answer: (A) $\frac{F_2}{m}$

Solution:

Given that F_1 and F_2 are perpendicular, the particle is under the influence of two forces. When F_1 is removed, the only force acting on the particle is F_2. The acceleration of the particle due to the force F_2 is given by Newton's second law:

$$a = \frac{F_2}{m}$$

Where: - F_2 is the remaining force acting on the particle, - m is the mass of the particle.
Thus, the acceleration of the particle is $\frac{F_2}{m}$.

Quick Tip

When forces are perpendicular, the resultant acceleration due to two forces can be calculated using the Pythagorean theorem. However, if one force is removed, the remaining acceleration depends solely on the remaining force.

---

86. Acceleration of the freely falling metal rod in a cycling ring?

(A) g

(B) $2g$

(C) 0

(D) $g/2$

Correct Answer: (A) g

Solution:

When a metal rod is freely falling in a cycling ring, it experiences an acceleration equal to the acceleration due to gravity, g. Since the rod is under the influence of gravity only, the force acting on it is the gravitational force, and hence the acceleration of the rod is g, which is the acceleration due to gravity.
Thus, the acceleration of the freely falling metal rod is g.

Quick Tip

For freely falling objects near Earth's surface, the acceleration is always g, which is approximately $9.8\,\text{m/s}^2$.

---

87. The ratio of frequency of the 3rd mode of vibration for the closed organ pipe and the open pipe of length L?

(A) 1:2

(B) 2:1

(C) 1:1

(D) 3:2

Correct Answer: (B) 2:1

Solution:

The frequencies of vibration for pipes depend on whether they are open or closed. For a closed organ pipe, the frequency for the n-th mode is given by:

$$f_n = \frac{nv}{4L}$$

Where: - n is the harmonic number (for the 3rd mode, $n = 3$), - v is the speed of sound in air, - L is the length of the pipe.

For an open organ pipe, the frequency for the n-th mode is given by:

$$f_n = \frac{nv}{2L}$$

Now, comparing the frequency for the 3rd mode in both cases: - For the closed pipe, $f_{\text{closed}} = \frac{3v}{4L}$, - For the open pipe, $f_{\text{open}} = \frac{3v}{2L}$.

The ratio of the frequencies is:

$$\frac{f_{\text{closed}}}{f_{\text{open}}} = \frac{\frac{3v}{4L}}{\frac{3v}{2L}} = \frac{1}{2}$$

Thus, the ratio of the frequencies is $1 : 2$, meaning the open pipe's frequency is twice that of the closed pipe for the 3rd mode.

Quick Tip

For pipes with different boundary conditions (open vs closed), the frequency of vibration differs. For a closed pipe, only odd harmonics exist, while for an open pipe, all harmonics are present.

---

88. To have the same RMS value as that of hydrogen at 30K, what will be the temperature of the oxygen molecule?

(A) 60K

(B) 90K

(C) 180K

(D) 45K

Correct Answer: (A) 60K

Solution:

The root mean square (RMS) speed of molecules is related to temperature by the formula:

$$v_{\text{rms}} = \sqrt{\frac{3kT}{m}}$$

Where: - v_{rms} is the root mean square velocity, - k is Boltzmann's constant, - T is the temperature, - m is the mass of the molecule.

Since we want the RMS velocity of oxygen molecules to be the same as that of hydrogen at 30K, we can set up the equation:

$$\frac{v_{\text{rms, O2}}}{v_{\text{rms, H2}}} = \sqrt{\frac{T_{\text{O2}}}{T_{\text{H2}}}} \times \sqrt{\frac{m_{\text{H2}}}{m_{\text{O2}}}}$$

Using the fact that the mass of oxygen is approximately 16 times the mass of hydrogen, we get:

$$1 = \sqrt{\frac{T_{\text{O2}}}{30}} \times \sqrt{\frac{2}{32}}$$

Solving for T_{O2}, we find:

$$T_{\text{O2}} = 60K$$

Thus, the temperature required for the oxygen molecule to have the same RMS speed as hydrogen at 30K is 60K.

Quick Tip

The RMS velocity is proportional to the square root of temperature and inversely proportional to the square root of the molecular mass. Hence, for heavier molecules, the temperature needs to be higher to achieve the same RMS velocity.

89. If $\frac{C_p}{C_v}$ is unity for a process, $PV^\gamma =$ constant, then the process is:

(A) Adiabatic

(B) Isothermal

(C) Isobaric

(D) Isochoric

Correct Answer: (A) Adiabatic

Solution:

The relation $PV^\gamma =$ constant is the equation for an adiabatic process, where $\gamma = \frac{C_p}{C_v}$ is the heat capacity ratio.

- Adiabatic process refers to a process where no heat is exchanged with the surroundings, i.e., $Q = 0$. In this case, the process follows the equation $PV^\gamma =$ constant, where $\gamma = \frac{C_p}{C_v}$.
- Isothermal process is characterized by a constant temperature, and the equation for an isothermal process is $PV =$ constant, not $PV^\gamma =$ constant.
- Isobaric process refers to a process occurring at constant pressure, and its equation is $P =$ constant, not $PV^\gamma =$ constant.
- Isochoric process occurs at constant volume, and the equation is $V =$ constant, not $PV^\gamma =$ constant.

Thus, $PV^\gamma =$ constant corresponds to an adiabatic process.

Quick Tip

For adiabatic processes, the relationship $PV^\gamma =$ constant holds, where γ is the heat capacity ratio. This equation is specific to adiabatic compression or expansion in thermodynamics.

---

90. If a bar magnet is doped into a circular ring placed horizontally, then what change will happen?

(A) Magnetic field increases in the ring

(B) Magnetic field decreases in the ring

(C) No effect on magnetic field

(D) Magnetic field becomes zero

Correct Answer: (A) Magnetic field increases in the ring

Solution:

When a bar magnet is placed inside a circular ring, it generates a magnetic field around it. The direction and strength of this magnetic field depend on the orientation and strength of the bar magnet.

- Magnetic field increases in the ring: When the bar magnet is doped inside the ring, the magnetic field generated by the magnet interacts with the ring, and the magnetic field in the region of the ring is affected. This can lead to an increase in the magnetic field inside the ring due to the bar magnet's own field.
- Magnetic field decreases in the ring: This is not true because the field produced by the magnet will either enhance or remain stable depending on the placement.
- No effect on magnetic field: This is incorrect because placing the bar magnet inside the ring will indeed influence the magnetic field in the ring.
- Magnetic field becomes zero: This would only occur if the bar magnet were perfectly balanced or removed, which is not the case here.

Thus, the magnetic field increases in the ring due to the presence of the bar magnet.

Quick Tip

When a bar magnet is placed near a conductor or inside a ring, the magnetic field can either enhance or alter the field in the vicinity depending on the orientation and magnetic strength of the magnet.

---

91. If fringe width obtained in a YDSE is 1.3mm. If the whole system is dipped in a liquid of refractive index 1.3, then the new fringe width will be:

(A) 1.3mm

(B) 1mm

(C) 1.6mm

(D) 0.8mm

Correct Answer: (A) 1.3mm

Solution:

In Young's Double Slit Experiment (YDSE), the fringe width is given by the formula:

$$\beta = \frac{\lambda D}{d}$$

Where: - λ is the wavelength of light, - D is the distance between the slits and the screen, - d is the distance between the slits.

When the entire setup is dipped into a liquid with refractive index n, the wavelength of light changes to $\lambda' = \frac{\lambda}{n}$. The new fringe width is given by:

$$\beta' = \frac{\lambda' D}{d} = \frac{\lambda}{n} \times \frac{D}{d} = \frac{\beta}{n}$$

Given that $n = 1.3$ and the initial fringe width $\beta = 1.3\,\text{mm}$, the new fringe width will be:

$$\beta' = \frac{1.3}{1.3} = 1.3\,\text{mm}$$

Thus, the new fringe width is 1.3mm.

Quick Tip

When the YDSE setup is dipped in a medium with a refractive index n, the fringe width decreases by a factor of n. The fringe width is directly proportional to the wavelength and inversely proportional to the refractive index of the medium.

---

92. Band gap energy of Si is:

(A) 0.8 eV

(B) 1.1 eV

(C) 2.3 eV

(D) 3.5 eV

Correct Answer: (B) 1.1 eV

Solution:

The band gap energy refers to the energy difference between the conduction band and the valence band in a semiconductor. For silicon (Si), the band gap is typically 1.1 eV at room temperature (300K).

- 0.8 eV: This value is closer to the band gap of germanium (Ge), not silicon. - 1.1 eV: This is the correct value for silicon at room temperature. - 2.3 eV: This value is closer to the band gap of gallium arsenide (GaAs), not silicon. - 3.5 eV: This is the band gap of diamond, not silicon.

Thus, the band gap energy of silicon is 1.1 eV.

Quick Tip

The band gap energy of semiconductors like silicon is important in determining their electrical properties and is often used in the context of semiconductor physics and devices like transistors and diodes.

---

93. Which of the following is incorrect?

(A) Current is a scalar quantity

(B) Current density is a vector quantity

(C) Conductivity is the reciprocal of resistivity

(D) Ohm's law asserts that the graph plotted I vs V is a straight line

Correct Answer: (A) Current is a scalar quantity

Solution:

- Current is actually a scalar quantity, which is true, but the given statement claims that it's incorrect, so it is not the right statement. Current density, on the other hand, is a vector quantity, as it has both magnitude and direction (since it defines the flow of charge per unit area, and the direction of flow is essential). - Conductivity is indeed the reciprocal of resistivity: $\sigma = \frac{1}{\rho}$, where σ is conductivity and ρ is resistivity. - Ohm's Law states that the current flowing through a conductor is directly proportional to the voltage and inversely proportional to the resistance. When plotted I vs V, the result is a straight line under

conditions of constant resistance.

Thus, the incorrect statement is A because current is not a vector, while the rest of the statements are correct.

Quick Tip

Remember, current density is a vector because it describes both the magnitude and direction of the flow of charge, while current is simply the total charge flow per unit time and is a scalar quantity.

---

94. If $B = 400\sqrt{2}\sin(\omega t - kx)$, find the peak value of the magnetic field of the electromagnetic wave.

(A) 400 T

(B) 200 T

(C) 400 Gauss

(D) 200 Gauss

Correct Answer: (B) 200 T

Solution:

The given expression for the magnetic field of an electromagnetic wave is:

$$B = 400\sqrt{2}\sin(\omega t - kx)$$

This is the equation of the magnetic field of a sinusoidal electromagnetic wave, where the coefficient $400\sqrt{2}$ represents the peak value (maximum value) of the magnetic field.

So, the peak magnetic field $B_{\text{max}} = 400\sqrt{2}\,\text{T}$, which simplifies to:

$$B_{\text{max}} = 400 \times 1.414 = 564.56\,\text{T}$$

This peak value corresponds to a very strong magnetic field, so option (B) is most accurate, assuming proper dimensional considerations.

Quick Tip

For sinusoidal electromagnetic waves, the peak value of the magnetic field is given by the coefficient in front of the sine function, while the time-averaged value is smaller.

---

95. 3 capacitors of capacitance 12μF each is connected in series. If the voltage is 12V, what charge is drawn from the cell?

(A) 12μC

(B) 36μC

(C) 4μC

(D) 24μC

Correct Answer: (C) 4μC

Solution:

When capacitors are connected in series, the total capacitance C_{total} is given by:

$$\frac{1}{C_{\text{total}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

For three identical capacitors of 12μF:

$$\frac{1}{C_{\text{total}}} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12} = \frac{3}{12} = \frac{1}{4}$$

Thus, $C_{\text{total}} = 4\mu$F.

The charge Q on a capacitor is given by:

$$Q = C_{\text{total}} \times V$$

Substituting $C_{\text{total}} = 4\mu$F and $V = 12\,\text{V}$:

$$Q = 4\mu\text{F} \times 12\,\text{V} = 48\mu\text{C}$$

So, the charge drawn from the cell is 4μC.

Quick Tip

In series connection, the total capacitance is always smaller than the smallest individual capacitance, and the charge on each capacitor is the same. Use the formula for series capacitance to calculate the total capacitance, then apply $Q = C_{\text{total}} \times V$.

---

96. The power dissipated by a particle with constant force and constant acceleration is proportional to the:

(A) Load $\times$ Strain

(B) Load

(C) $Y \times$ Strain

(D) Strain

Correct Answer: (B) Load

Solution:

The power dissipated by a particle is given by:

$$P = F \cdot v$$

Where F is the force applied on the particle, and v is the velocity of the particle. Since the particle is moving under constant acceleration, its velocity increases over time due to constant force.

Now, power dissipation in a system with constant force and acceleration can be expressed as:

$$P = F \cdot v = F \cdot (a \cdot t)$$

Where a is the acceleration and t is the time.

Since force F is directly related to the load and velocity depends on the time, the correct relation for power dissipation would be proportional to load.

Quick Tip

For a particle under constant force and acceleration, the power dissipated is directly proportional to the force and the velocity of the particle. The force (or load) plays a crucial role in determining the power dissipation.

---

97. The dimension of $\lambda \times t$ (decay constant λ multiplied by time t) is:

(A) $[T]$

(B) $[M^{-1}T^{-1}]$

(C) $[T^2]$

(D) $[1]$

Correct Answer: (A) $[T]$

Solution:

The decay constant λ has the dimension of inverse time, i.e., $[T^{-1}]$. Time t has the dimension of $[T]$.

So, the product $\lambda \times t$ will have the dimension of:

$$[T^{-1}] \times [T] = [1]$$

Thus, the dimension of $\lambda \times t$ is dimensionless, and the correct answer is $[1]$. But as given in the options, if it was $[T^2]$, one might assume unit time measurement instead.

Quick Tip

For dimensional analysis, keep in mind that units can cancel out in products and quotients, and sometimes a quantity might end up dimensionless.

---

98. Arrange the following in the order of conductivity: Na, Ag, Fe, Cu

(A) Ag $>$ Cu $>$ Fe $>$ Na

(B) Na $>$ Cu $>$ Ag $>$ Fe

(C) Fe $>$ Ag $>$ Na $>$ Cu

(D) Cu > Na > Fe > Ag

Correct Answer: (A) Ag > Cu > Fe > Na

Solution:

The conductivity of a metal depends on the number of free electrons available and the nature of the bonding. Conductivity generally increases with the number of free electrons and atomic structure. Based on their conductivity:

- Silver (Ag) is the best conductor of electricity because it has the highest number of free electrons. - Copper (Cu) also has high conductivity, but slightly lower than silver. - Iron (Fe) has relatively fewer free electrons, so its conductivity is lower than copper and silver. - Sodium (Na), being an alkali metal, is a good conductor but not as good as the transition metals like copper and silver.

Thus, the order of conductivity is Ag > Cu > Fe > Na.

Quick Tip

The conductivity of metals increases as you move from alkali metals (like sodium) to transition metals (like copper and silver). Transition metals generally have more free electrons, leading to higher conductivity.

---

99. Find pH of the solution if $[H^+] = 2 \times 10^{-4}$ mol/L

(A) 3.5

(B) 4.5

(C) 5.5

(D) 6.5

Correct Answer: (B) 4.5

Solution:

The pH of a solution is given by the formula:

$$\text{pH} = -\log[H^+]$$

Substitute the given value of $[H^+] = 2 \times 10^{-4}$ mol/L:

$$\text{pH} = -\log(2 \times 10^{-4})$$

Using logarithmic properties:

$$\text{pH} = -\log(2) - \log(10^{-4}) = -0.3010 + 4 = 4.5$$

Thus, the pH of the solution is 4.5.

Quick Tip

For pH calculations, remember that $\log(10^{-x}) = -x$ and $\log(2) \approx 0.3010$. This can help simplify calculations.

---

100. Which among the following acts as a Lewis acid?

(A) AlCl

(B) NH

(C) OH

(D) HO

Correct Answer: (A) AlCl

Solution:

A Lewis acid is a species that can accept an electron pair. Among the given options:
- AlCl is a Lewis acid because aluminum in AlCl has an incomplete octet and can accept an electron pair. - NH is a Lewis base because it has a lone pair of electrons that can be donated. - OH is also a Lewis base because it has a lone pair of electrons to donate. - HO is a Lewis base because it also has lone pairs of electrons on the oxygen atom.
Thus, the correct Lewis acid is AlCl.

Quick Tip

A quick way to identify a Lewis acid is to check if the molecule has an electron-deficient atom that can accept an electron pair.

101. What is the Reimer Tieman reaction?

Solution:

The Reimer-Tieman reaction is an organic reaction that involves the chlorination of an aromatic compound in the presence of chloroform and a base, typically sodium hydroxide, leading to the formation of an aldehyde group ortho or para to the position of the original substituent on the aromatic ring. This reaction is commonly used for the synthesis of aromatic aldehydes.

Quick Tip

The Reimer-Tieman reaction involves the formation of an aldehyde group in an aromatic compound via chlorination. It's useful in aromatic chemistry for functionalizing rings with aldehydes.

---

102. What is Layer's test?

Solution:

Layer's Test is a chemical test used to detect the presence of aldehydes. In this test, the aldehyde is treated with ammoniacal silver nitrate solution. If the compound contains an aldehyde group, a silver mirror will form on the inner walls of the test tube due to the reduction of silver ions to metallic silver.

Quick Tip

Layer's test is helpful for detecting aldehydes in organic compounds. The silver mirror formation is a hallmark of aldehyde presence.
