

VITEEE 2020 Question Paper with Solutions for Chemistry

Time Allowed :90 Minutes	Maximum Marks :80	Total Questions :80
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The question paper contains a total of 80 questions divided into four parts:
 - Part I: Physics (Questions 1 to 25)
 - Part II: Chemistry (Questions 26 to 50)
 - Part III: Mathematics (Questions 51 to 75)
 - Part IV: English & Logical Reasoning (Questions 76 to 80)
2. All questions are multiple-choice with four options, and only one of them is correct.
3. For each correct answer, the candidate will earn 1 mark.
4. There is no negative marking for incorrect answers.
5. The test duration is 12 hours.

1. As per the Bohr's model, the minimum energy (in eV) required to remove an electron from the ground state of doubly ionized Li atom ($Z = 3$) is

- (A) 1.51
(B) 13.6
(C) 40.8
(D) 122.4

Correct Answer: (D) 122.4

Solution:

The energy of an electron in the n -th orbit of a hydrogen-like species is given by the Bohr formula: $E_n = -13.6 \frac{Z^2}{n^2}$ eV.

For a doubly ionized Lithium atom (Li^{2+}), the atomic number $Z = 3$.

The electron is in the ground state, so $n = 1$.

Substituting the values into the formula: $E_1 = -13.6 \times \frac{3^2}{1^2}$ eV.

$$E_1 = -13.6 \times 9 = -122.4 \text{ eV.}$$

The energy required to remove this electron (Ionization Energy) is the magnitude of the binding energy, which is +122.4 eV.

💡 Quick Tip

The ionization energy scales with Z^2 . For hydrogen ($Z = 1$) it is 13.6 eV; for Li^{2+} ($Z = 3$) it is 13.6×9 .

2. The hybridization of Xe in XeF_4 is

- (A) sp^3d
- (B) dsp^2
- (C) sp^3d^2
- (D) sp^2d^3

Correct Answer: (C) sp^3d^2

Solution:

Xenon (Xe) has 8 valence electrons.

In XeF_4 , Xenon forms 4 sigma bonds with 4 Fluorine atoms, using 4 electrons.

The remaining valence electrons on Xenon are $8 - 4 = 4$ electrons, which form 2 lone pairs.

The steric number (total electron domains) is the sum of sigma bonds and lone pairs: $4 + 2 = 6$.

A steric number of 6 corresponds to sp^3d^2 hybridization.

The geometry is octahedral, and the molecular shape is square planar.

💡 Quick Tip

Formula for Steric Number: $\frac{1}{2}(V + M - C + A)$. For XeF_4 : $\frac{1}{2}(8 + 4 - 0 + 0) = 6 \rightarrow \text{sp}^3\text{d}^2$.

3. The X-ray beam coming from an X-ray tube will be

- (A) monochromatic
- (B) having all wavelengths smaller than a certain maximum wavelength
- (C) having all wavelengths larger than a certain minimum wavelength
- (D) having all wavelengths lying between a minimum and a maximum wavelength

Correct Answer: (C) having all wavelengths larger than a certain minimum wavelength

Solution:

The spectrum of X-rays emitted from an X-ray tube consists of a continuous spectrum (Bremsstrahlung)

and a characteristic spectrum.

When electrons strike the target, their kinetic energy is converted into photons. The maximum energy of a photon corresponds to the complete conversion of the electron's kinetic energy (eV).

Since energy is inversely proportional to wavelength ($E = hc/\lambda$), the maximum energy corresponds to a minimum wavelength (λ_{min}).

$$\lambda_{min} = \frac{hc}{eV}.$$

No photon can have a wavelength shorter than this cutoff. Therefore, the beam contains wavelengths larger than this minimum limit.

💡 Quick Tip

The "cutoff wavelength" (λ_{min}) depends inversely on the accelerating voltage (V).
 $\lambda_{min}(\text{\AA}) \approx \frac{12400}{V(\text{volts})}.$

4. Which one of the following causes increase in entropy?

- (A) A liquid crystallizes into a solid
- (B) Water vapor condensation into liquid
- (C) Decomposition of NaHCO_3 at 102°C
- (D) Diffusion of two similar gas mixture into each other in a closed container isolated from the surroundings

Correct Answer: (C) Decomposition of NaHCO_3 at 102°C

Solution:

Entropy (S) is a measure of disorder. The order of entropy is usually Gas $>$ Liquid $>$ Solid.

(A) Liquid $\rightarrow$ Solid: Disorder decreases, so entropy decreases.

(B) Gas $\rightarrow$ Liquid: Disorder decreases, so entropy decreases.

(C) Decomposition of NaHCO_3 : $2\text{NaHCO}_3(s) \xrightarrow{\Delta} \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(g).$

This reaction produces gaseous products from a solid reactant. The generation of gas significantly increases disorder.

Therefore, entropy increases in option (C).

💡 Quick Tip

Look for the reaction where the number of moles of gaseous products is greater than the moles of gaseous reactants ($\Delta n_g > 0$).

5. The reaction that takes place at anode is

- (A) ionization
- (B) reduction
- (C) oxidation
- (D) hydrolysis

Correct Answer: (C) oxidation

Solution:

In an electrochemical cell (both galvanic and electrolytic), the electrodes are defined by the reactions occurring at them.

The Anode is the electrode where oxidation (loss of electrons) takes place.

The Cathode is the electrode where reduction (gain of electrons) takes place.

Therefore, the reaction at the anode is oxidation.

💡 Quick Tip

Remember the mnemonics: "An Ox" (Anode Oxidation) and "Red Cat" (Reduction Cathode).

6. Which of the following statement(s) is/are correct about trans-1,2-dimethylcyclohexane?

- I. Two methyl groups can exist in diaxial orientation.**
- II. Two methyl groups can exist in axial-equatorial or equatorial-axial orientation.**
- III. Two methyl groups can exist in diequatorial orientation.**

- (A) I only
- (B) II only
- (C) I and II only
- (D) I and III only

Correct Answer: (D) I and III only

Solution:

For 1,2-disubstituted cyclohexanes, the relative positions (cis/trans) determine the conforma-

tional possibilities (axial/equatorial).

In the *trans*-1,2 isomer, the substituents are on opposite sides of the ring plane.

To maintain the trans relationship (dihedral angle approx 180° or 60° projection), the groups must be either both axial (a, a) or both equatorial (e, e).

The ring flip converts the diaxial conformer ($1a, 2a$) to the diequatorial conformer ($1e, 2e$).

The *cis*-1,2 isomer exists in (a, e) or (e, a) conformations.

Therefore, statements I (diaxial) and III (diequatorial) are correct for the trans isomer.

 Quick Tip

For 1,2-substitution: Trans = aa or ee; Cis = ae or ea. Diequatorial is generally the most stable conformer.

7. Find the correct order of their boiling points of the following alcohols: methanol, n-propyl alcohol, iso-propyl alcohol

(A) methanol < n-propyl alcohol < iso-propyl alcohol

(B) methanol > n-propyl alcohol > iso-propyl alcohol

(C) methanol < iso-propyl alcohol < n-propyl alcohol

(D) methanol > iso-propyl alcohol > n-propyl alcohol

Correct Answer: (C) methanol < iso-propyl alcohol < n-propyl alcohol

Solution:

Boiling point generally increases with molecular mass due to stronger Van der Waals forces.

Methanol (CH_3OH , Mass ≈ 32) has a lower molecular mass than propyl alcohols ($\text{C}_3\text{H}_7\text{OH}$, Mass ≈ 60). Thus, methanol has the lowest boiling point.

Between isomers, branching decreases the surface area, which weakens Van der Waals forces and lowers the boiling point.

n-propyl alcohol is a straight chain, while iso-propyl alcohol is branched.

Therefore, n-propyl alcohol has a higher boiling point than iso-propyl alcohol.

The correct order is: methanol < iso-propyl alcohol < n-propyl alcohol.

💡 Quick Tip

Boiling Point Rules: 1. Increases with Molar Mass. 2. Decreases with Branching (for isomers).

8. Reaction of _____ with Grignard reagent followed by hydrolysis yields ketone.

- (A) esters
- (B) aldehyde
- (C) alkyl nitrile
- (D) acid chloride

Correct Answer: (C) alkyl nitrile

Solution:

The reaction of Grignard reagents (RMgX) varies with different substrates:

- (A) Esters usually react with 2 equivalents of Grignard reagent to yield tertiary alcohols.
- (B) Aldehydes yield secondary alcohols (Formaldehyde yields primary).
- (C) Alkyl nitriles (R-CN) react with Grignard reagents to form an imine salt intermediate ($\text{R}-\text{C}(\text{R}') = \text{NMgX}$). Upon acid hydrolysis, this imine converts to a ketone ($\text{R}-\text{C}(=\text{O})-\text{R}'$).
- (D) Acid chlorides usually react with 2 equivalents to yield tertiary alcohols.

Therefore, alkyl nitriles are the correct substrate to produce ketones.

💡 Quick Tip

Nitriles stop at the ketone stage because the intermediate formed is a stable imine salt that does not react further with Grignard reagent. Hydrolysis then releases the ketone.

9. Benzoic acid can be prepared from toluene by treatment with

- (A) $\text{KMnO}_4\text{-KOH}$
- (B) Grignard reagent in ether followed by dry ice and acid hydrolysis
- (C) Tollens' reagent
- (D) HBr/KCN followed by acid hydrolysis

Correct Answer: (A) $\text{KMnO}_4\text{-KOH}$

Solution:

Alkylbenzenes containing at least one benzylic hydrogen can be oxidized to benzoic acid by

strong oxidizing agents.

Alkaline Potassium Permanganate ($\text{KMnO}_4\text{-KOH}$) followed by acidification is a standard reagent for this transformation.

Toluene (Methylbenzene) is oxidized directly to the benzoate ion, which gives Benzoic acid upon acidification.

Option (B) would require starting with a halobenzene, not toluene.

Option (C) oxidizes aldehydes.

Option (D) converts Toluene to Phenylacetic acid (adding an extra carbon).

 Quick Tip

Side-chain oxidation of alkylbenzenes always yields Benzoic acid, regardless of the length of the alkyl chain, provided there is a benzylic hydrogen.

10. The number of amino acid units present in insulin is

- (A) 42
- (B) 51
- (C) 8
- (D) 32

Correct Answer: (B) 51

Solution:

Insulin is a peptide hormone responsible for regulating blood glucose levels.

It is composed of two polypeptide chains connected by disulfide bridges.

Chain A consists of 21 amino acid residues.

Chain B consists of 30 amino acid residues.

The total number of amino acid units is $21 + 30 = 51$.

 Quick Tip

Insulin structure: Chain A (21) + Chain B (30) = 51 amino acids. It was the first protein to have its sequence determined (by Frederick Sanger).

