CBSE EXAMINATION PAPER-2023

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 17

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **17 questions.** All questions are **compulsory.**

ii. This question paper is divided into **3 sections.**

iii. **Section A** – questions number **1 to 14** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **15 to 16** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **17 to 17** are case based questions

vi. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

vii. Use of calculator is NOT allowed.

Section A

Question 1.

The conversion of an alkyl halide into an alkene by alcoholic KOH is classified as

[1 Marks]

(A) a dehydrohalogenation reaction

(B) an addition reaction

(C) a dehydration reaction

(D) a substitution reaction

Explanation:

The correct option is 'a dehydrohalogenation reaction' because the context states that alkyl halides react with alcoholic KOH to eliminate one molecule of halogen acid, forming alkenes. This process is specifically termed dehydrohalogenation, which involves the removal of halide and hydrogen, leading to the formation of a double bond in the alkene.

Question 2.

The oxidation state of Fe in $[Fe(CO)_5]$ is

[1 Marks]

(A) +5

(B) +3

(C) +2

(D) 0

Explanation: The correct answer is 0. In the complex $[Fe(CO)_5]$, carbon monoxide (CO) is a neutral ligand that does not contribute to the oxidation state. Since there are five CO ligands and they are neutral, the oxidation state of the iron (Fe) must also be 0 to balance the overall charge of the complex.

Question 3.

The slope in the plot of ln[R] vs. time for a first order reaction is

[1 Marks]

(A) + k

(B) – k

(C) + k/2.303

(D) – k/2.303

Explanation:

The correct answer is -k/2.303. In a first order reaction, the natural logarithm of the concentration of the reactant [R] versus time yields a straight line where the slope is equal to -k, the rate constant. The factor 2.303 is used to convert the natural logarithm to logarithm base 10, which is standard in reaction kinetics.

Question 4.

An α-helix is a structural feature of

[1 Marks]

(A) Nucleotides

(B) Starch

(C) Polypeptides

(D) Sucrose

Explanation:

The correct answer is Polypeptides. An α-helix is a common secondary structure found in proteins (which are made of polypeptides). It is characterized by a right-handed coil, stabilized by hydrogen bonds between the backbone of the polypeptide chain.

Question 5.

Racemisation occurs in

[1 Marks]

(A) S_n1 reaction

(B) S_n2 reaction

(C) S_n2 reaction as well as S_n1 reaction

(D) Neither S_n1 nor S_n2 reaction

Explanation:

Racemisation occurs in S_n1 reaction because this reaction involves the formation of a carbocation intermediate, which can lead to the production of both enantiomers, resulting in racemisation. In contrast, S_n2 reactions do not involve intermediates and therefore do not lead to racemisation.

Question 6.

Value of Henry's constant K_h:

[1 Marks]

(A) decreases with increase in temperature.

(B) remains constant.

(C) increases with increase in temperature.

(D) increases with decrease in temperature.

Explanation:

The correct answer is 'increases with decrease in temperature.' Henry's law states that the solubility of a gas in a liquid is inversely related to temperature. Therefore, as temperature decreases, more gas can dissolve in the liquid, resulting in an increase in Henry's constant.

Question 7.

Which of the following solutions of KCl will have the highest value of molar conductivity?

[1 Marks]

(A) 1 M

(B) 0.1 M

(C) 0.5 M

(D) 0.01 M

Explanation: The molar conductivity is highest for the 0.01 M KCl solution, as indicated in the context provided. According to Table 2.3, the molar conductivity for 0.01 M is 141.0 S m^2 mol^{-1}, which is greater than that of all other concentrations listed (0.1 M has 129.0, 0.5 M has 111.3, and 1 M has 111.3 S m^2 mol^{-1}). At lower concentrations, the number of ions per unit volume is higher relative to their interactions, leading to higher molar conductivity.

Question 8.

Which of the following reactions are feasible?

[1 Marks]

(A) Both (a) and (b)

(B) $CH_3CH_2Br + Na^+ O{-}C(CH_3)_3 \rightarrow CH_3CH_2{-}O{-}C(CH_3)_3$

(C) Neither (a) nor (b)

(D) $(CH_3)_3C{-}Cl + Na^+ O{-}CH_2CH_3 \rightarrow CH_3CH_2{-}O{-}C(CH_3)_3$

Explanation:

The correct answer is 'Both (a) and (b)'. Both reactions involve the reaction between alkyl halides and sodium alkoxide, which are feasible under appropriate conditions. $(CH_3)_3C–Cl$ can react with Na^+ $O–CH_2CH_3$ to form an ether, while CH_3CH_2Br can react with Na^+ $O–C(CH_3)_3$ to also form an ether. Both reactions are classified as nucleophilic substitutions, which are feasible in organic chemistry.

Question 9.

Which of the following is most reactive in nucleophilic addition reactions?

[1 Marks]

(A) $CH_3COC_2H_5$

(B) CH_3CHO

(C) CH_3COCH_3

(D) HCHO

Explanation:

HCHO (formaldehyde) is the most reactive in nucleophilic addition reactions due to its structure, which has a highly polarized carbonyl group. The carbon atom in formaldehyde is more electrophilic and thus more susceptible to attack by nucleophiles compared to the other options, which have steric hindrance or less polarization in their carbonyl groups.

Question 10.

For the reaction $3A \rightarrow 2B$, rate of reaction + $d[B]/dt$ is equal to

[1 Marks]

(A) $+(2d[A]/dt)$

(B) $-(3/2)d[A]/dt$

(C) $-(2/3)d[A]/dt$

(D) $-(1/3)d[A]/dt$

Explanation:

The correct option is $-(2/3)d[A]/dt$. This is because the stoichiometry of the reaction shows that for every 3 moles of A that react, 2 moles of B are produced. Hence, the rate of formation of B is related to the rate of consumption of A by the ratio of their coefficients in the balanced equation: $d[B]/dt = -(2/3)d[A]/dt$.

Question 11.

Which of the following characteristics of transition metals is associated with their catalytic activity?

[1 Marks]

(A) High enthalpy of atomisation

(B) Variable oxidation states

(C) Paramagnetic nature

(D) Colour of hydrated ions

Explanation:

The correct option is 'Variable oxidation states'. Transition metals exhibit variable oxidation states, which allow them to easily gain or lose electrons during reactions. This characteristic is essential for their role as catalysts in various chemical processes, as they can facilitate the conversion of reactants to products by providing alternate pathways with lower activation energies.

Question 12.

The formula of the complex dichloridobis(ethane–1, 2-diamine) platinum(IV) nitrate is

[1 Marks]

(A) $[Pt(en)_2(NO_3)_2]Cl_2$

(B) $[Pt\ Cl_2(en)_2\ (NO_3)]NO_3$

(C) $[Pt\ Cl_2(en)_2](NO_3)_2$

(D) $[Pt\ Cl_2(en)_2\ (NO_3)_2]$

Explanation:

$[Pt\ Cl_2(en)_2](NO_3)_2$ is correct because it indicates that the platinum is in the +4 oxidation state, has 2 chloride ligands (Cl_2), 2 ethane-1,2-diamine ligands (en), and is coordinated with 2 nitrate ions (NO_3) as counterions, matching the IUPAC nomenclature for the complex.

Question 13.

Assertion (A) : Osmotic pressure is a colligative property.

Reason (R) : Osmotic pressure is proportional to the molality.

(A) (A) is false, but (R) is true.

(B) Both (A) and (R) are true and (R) is the correct explanation of (A).

(C) (A) is true, but (R) is false

(D) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Explanation:

Both (A) and (R) are true, but (R) is not the correct explanation of (A). Osmotic pressure is indeed a colligative property, which depends on the number of solute particles in a solution rather than their identity. However, while osmotic pressure is related to the concentration of solute molecules, it is commonly expressed in terms of molarity rather than molality, thus making (R) inaccurate in directly explaining (A).

Question 14.

Assertion (A) : Copper is a non-transition element.

Reason (R) : Copper has completely filled d-orbitals in its ground state.

[1 Marks]

(A) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

(B) (A) is false, but (R) is true.

(C) (A) is true, but (R) is false.

(D) Both (A) and (R) are true and (R) is the correct explanation of (A).

Explanation:

(A) is false, but (R) is true. Copper is actually a transition element as it is found in the d-block of the periodic table. Although it has a stable electronic configuration of 3d10 4s1, the d-orbitals are not completely filled in a traditional sense, thus making (R) true since it discusses the configuration correctly, but (A) incorrect.

Section B

Question 15.

The vapour pressure of pure liquid X and pure liquid Y at 25 °C are 120 mm Hg and 160 mm Hg respectively. If equal moles of X and Y are mixed to form an ideal solution, calculate the vapour pressure of the solution.

[2 Marks]

Answer: Given: Vapour pressure of pure liquid X, P^0_X = 120 mm Hg, Vapour pressure of pure liquid Y, P^0_Y = 160 mm Hg, Mole fraction of X = Mole fraction of Y = 0.5 (equal moles mixed)
Using Raoult's Law: Vapour pressure of solution, $P = x_X P^0_X + x_Y P^0_Y$
Substitute values: $P = (0.5)(120) + (0.5)(160) = 60 + 80 = 140$ mm Hg
Therefore, the vapour pressure of the solution is 140 mm Hg.

Question 16.

Define fuel cell with an example. What advantages do the fuel cells have over primary and secondary batteries ?

[2 Marks]

Answer: (a) **Fuel cell:** A fuel cell is a device that produces electricity by converting the chemical energy of a fuel and an oxidizing agent directly into electrical energy. For example, a hydrogen-oxygen fuel cell uses hydrogen as fuel and oxygen as oxidant to produce electricity.
(b) **Advantages of fuel cells over batteries:** Fuel cells can produce electricity continuously as long as fuel is supplied, unlike primary and secondary batteries which store limited energy. Fuel cells have higher efficiency and are pollution free. They do not require recharging like secondary batteries and produce less harmful waste compared to batteries.

Section C

Question 17. The carbon – oxygen double bond is polarised in aldehydes and ketones due to higher electronegativity of oxygen relative to carbon. Therefore they undergo nucleophilic addition reactions with a number of nucleophiles such as HCN, NaHSO3, alcohols, ammonia derivatives and Grignard reagents. Aldehydes are easily oxidised by mild oxidising agents as compared to ketones. The carbonyl group of carboxylic acid does not give reactions of aldehydes and ketones. Carboxylic acids are considerably more acidic than alcohols and most of simple phenols.