Maharashtra State Board
Chemistry
Sample Question Paper - 1
Academic Year: 2024-2025

General Instructions: The question paper is divided into four sections.

1. **Section A**: Q.No.1 contains Ten multiple-choice types of questions carrying One mark each. Q.No.2 contains Eight very short answer type of questions carrying One mark each.
2. **Section B**: Q.No.3 to Q.No.14 are Twelve short answer type questions carrying Two marks each. (Attempt any Eight).
3. **Section C:** Q.No.15 to Q.No.26 are Twelve short answer type questions carrying Three marks each. (Attempt any Eight).
4. **Section D**: Q.No.27 to Q.No.31 are Five Long answer-type questions carrying Four marks each. (Attempt any Three).
5. Use of Log table is allowed. Use of calculator is not allowed.
6. Figures to the right indicate full marks.
7. For each multiple-choice type question, it is mandatory to write the correct answer along with its alphabet. e.g., (a) ..... /(b) ..... /(c) ..... /(d) ..... ,etc. No mark(s) shall be given if ONLY the correct answer or the alphabet of the correct answer is written.
   Only the first attempt will be considered for evaluation.

SECTION - A

Q1. Select and write the correct answer for the following multiple-choice type of questions:

1.1. Select the most appropriate option.

A gas is allowed to expand in a well-insulated container against a constant external pressure of 2.5 bar from an initial volume of 2.5 L to a final volume of 4.5 L. The change in internal energy, ΔU of the gas will be _____.

1. –500 J
2. + 500 J

3. −1013 J
4. + 1013 J

Solution

- 500 J

Explanation:

Since the container is insulated, this is an adiabatic process.
For adiabatic process,

$\Delta U = +W = - P_{ext} \Delta V = - P_{ext} (V_2 - V_1)$

Initial volume (V_1) = 2.5 L = 2.5 dm^3

Final volume (V_2) = 4.5 L = 4.5 dm^3

External pressure (P_{ext}) = 2.5 bar

$\Delta U = W = - 2.5 \text{ bar} \times (4.5 \text{ dm}^3 - 2.5 \text{ dm}^3)$

$$= - 5.0 \text{ dm}^3 \text{ bar} \times \frac{100 \text{J}}{1 \text{dm}^3 \text{bar}}$$

= - 500 J

1.2. Choose the most correct option.

Formula for the compound sodium hexacynoferrate (III) is _____.

1. $[NaFe(CN)_6]$
2. $Na_2[Fe(CN)_6]$
3. $Na[Fe(CN)_6]$
4. $Na_3[Fe(CN)_6]$

Solution

The formula for the compound sodium hexacynoferrate (III) is $\mathbf{Na_3[Fe(CN)_6]}$.

Explanation:

Rules for naming:-

1. Name the complex ion or neutral molecule first, then the metal.

2. Aniomic ligand with the ending ide changed to – O – and the ending ate changed to – ato.
3. It is only one word.
4. Write O.S. after the name of the metal.
5. More than one ligand of the same type is present prefix, di, tri, tetra.
6. The ligands are then written in alphabetical order.

1.3. Polonium has the half-Life of _____.

1. 13.8 days
2. 12 days
3. 5 days
4. 102 days

Solution

Polonium has the half-Life of **13.8 days**.

Explanation:

At normal temperatures, oxygen is a gas, whereas the other elements are solids. Nonmetals include oxygen and sulphur, metalloids like selenium and tellurium, and metals like polonium. Polonium has a half-life of 13.8 days and is radioactive. With increasing atomic numbers, melting and boiling points rise. All of the elements in Group 16 are allotropy.

1.4. Choose the most correct option.

The oxidation state of cobalt ion in the complex $[Co(NH_3)_5\ Br]SO_4$ is _____.

1. +2
2. +3
3. +1
4. +4

Solution

The oxidation state of cobalt ion in the complex $[Co(NH_3)_5Br]SO_4$ is **+3**.

Explanation:

We know, sulphate ion has a charge –2

i.e., SO_4^{2-}

Then, $[Co(NH_3)_5Br]^{2+}$

The oxidation state of NH_3 = 0

The oxidation state of Br = –1

Let the oxidation state of Cobalt ion is x

Then, x + (3 × 0) × 5 + (–1) = +2

⇒ x – 1 = +2

⇒ x = +3

Therefore, the oxidation state of cobalt ion is +3.

1.5. $CH_2OH\text{-}CO\text{-}(CHOH)_4\text{-}CH_2OH$ is an example of _____.

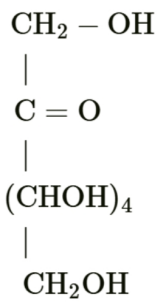
1. Aldohexose
2. Aldoheptose
3. Ketotetrose
4. Ketoheptose

Solution

$CH_2OH\text{-}CO\text{-}(CHOH)_4\text{-}CH_2OH$ is an example of **ketoheptose**.

Explanation:

Ketoheptose →



Aldohexose Glucose → $\begin{array}{l} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}$

Ketoheptose → Ketone group and 7 carbon present

Ketotetrose → Ketone group and 4 carbon present

1.6. Choose the most correct answer:

Which of the Na following is a buffer solution?

1. CH_3COONa + NaCl in water
2. CH_3COOH + HCl in water
3. **CH_3COOH + CH_3COONa in water**
4. HCl + NH_4Cl in water

Solution

CH_3COOH + CH_3COONa in water

Explanation:

A buffer solution is a water-based mixture of a weak acid and its conjugate base. It could potentially be a combination of a weak base and its conjugate base.

In the given, only option C has weak acid CH_3COOH and its conjugate base CH_3COONa

Option A has a strong base and its conjugate base.

Options D and B are not buffer solutions as they contain strong acids HCl.

1.7. Which cells is used as a source of power in flashlights?

1. **Dry cell**
2. Fuel cell
3. Hydrogen cell
4. None of them

Solution

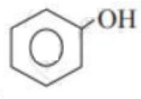
Dry cell

Explanation:

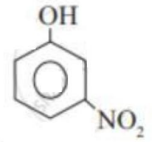
Dry cells are used to power flashlights, portable radios, tape recorders, clocks, and other devices.

1.8. Choose the correct option.

Which of the following is the least acidic compound?

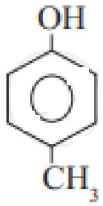
1. 

2. 

3. 

4. 

Solution



1.9. The boiling point of HCl is _____.

1. 189 K
2. 200 K
3. 210 K

4. 220 K

Solution

The boiling point of HCl is **189 K**.

1.10. Choose the correct option.

Which of the following substrate will give ionic organic products on reaction?

1. $CH_3 – CH_2 – OH + Na$
2. $CH_3 – CH_2 – OH + SOCl_2$
3. $CH_3 – CH_2 – OH + PCl_5$
4. $CH_3 – CH_2 – OH + H_2SO_4$

Solution

$CH_3 – CH_2 – OH + Na$

Explanation:

When sodium combines with alcohol, it produces sodium alkoxide, which is a salt, and results in the release of hydrogen gas.

Q2. Answer the following questions:

2.1. Answer the following in one or two sentences.

Comment on the statement:

no work is involved in an expansion of gas in a vacuum.

Solution

1. A free expansion means expansion against zero opposing force. Such expansion occurs in a vacuum.
2. When the gas expands in a vacuum, there is no opposing force, that is, $P_{ext} = 0$.
   The work done by a system during such expansion is
   $W = - P_{ext} \Delta V = 0$
   Thus, no work is done when the gas expands freely in a vacuum.

Note: Units of energy and work:

$1 J = 1 kg\ m^2\ s^{-2} = 1 Pa\ m^3$

1 Pa = 1 kg m^{-1} s^{-2}

From the equation, $W = -P_{ext}\Delta V$

If the pressure is expressed in bar and ΔV in dm^3, then the work has the units of bar dm^3.

1 bar = 10^5 Pa = 10^5 kg m^{-1} s^{-2}

1 dm^3 bar = $dm^3 \times 10^5$ kg m^{-1} s^{-2}

= $m^3 \times 10^{-3} \times 10^5$ kg m^{-1} s^{-2}

= 100 kg m^2 s^{-2} = 100 J

2.2. Name one amphoteric solvent.

Solution

Water (H_2O)

2.3. Presence of disulphide link gives rise to which structure of protein?

Solution

Tertiary structure of protein

2.4. Answer the following in one sentence.

Name some chain-growth polymers.

Solution

Chain growth polymers are polyacrylonitrile, polyvinylchloride, polythene, etc.

2.5. Give names of the purines.

Solution

Adenine and Guanine

2.6. Answer the following in one or two sentences.

What is standard cell potential for the reaction

$$3\,Ni_{(s)} + 2\,Al^{3+}\,(1\,M) \longrightarrow 3\,Ni^{2+}\,(1\,M) + 2\,Al\,(s),$$

if E°_{Ni} = –0.25 V and E°_{Al} = –1.66 V?

Solution

Given: E°_{Ni} = –0.25 V, E°_{Al} = – 1.66 V

To find: Standard cell potential

Formula: $E^{\circ}_{cell} = E^{\circ}_{cathode} - E^{\circ}_{anode}$

Calculation: Electrode reactions are

At anode: $\mathrm{Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2\,e^-}$

At cathode: $\mathrm{Al^{3+}_{(aq)} + 3\,e^- \longrightarrow Al_{(s)}}$

The standard electrode potential is given by

$E^{\circ}_{cell} = E^{\circ}_{cathode} - E^{\circ}_{anode}$

$E^{\circ}_{cell} = E^{\circ}_{Al} - E^{\circ}_{Ni}$

= (–1.66 V) – (–0.25 V)

= –1.41 V

The standard cell potential for the reaction is –1.41 V.

2.7. Answer the following.

Name two gases which deplete ozone layer.

Solution

Nitrogen oxide (NO) and chlorofluorocarbons are two gases that deplete the ozone layer (freons).

2.8. Answer the following.

What is the action of bromine on magnesium metal?

Solution

Bromine reacts with magnesium to form magnesium bromide.

$$\underset{\text{Magnesium}}{\mathrm{Mg_{(s)}}} + \underset{\text{Bromine}}{\mathrm{Br_{2(l)}}} \longrightarrow \underset{\text{Magnesium Bromide}}{\mathrm{MgBr_{2(s)}}}$$

SECTION – B

Attempt any EIGHT of the following questions:

Q3. Answer the following in one sentence.

Write reaction showing conversion of benzonitrile into benzoic acid.

Solution

$$\underset{\text{Benzonitrile}}{C_6H_5-C\equiv N}+2H_2O+\text{dil}\cdot HCl\xrightarrow{\triangle}\underset{\text{Benzoic acid}}{C_6H_5-COOH}+NH_4Cl$$

Q4. Solve

The half-life of a first-order reaction is 1.7 hours. How long will it take for 20% of the reactant to react?

Solution

Given:

Half-life $t_{1/2}$ = 1.7 hours, $[A]_0$ = 100%, $[A]_t$ = 100 - 20 = 80%

To find:

Time for 20% of reactant to react = t

Formulae:

i. $t_{1/2} = \frac{0.693}{k}$

ii. $t = \frac{2.303}{K}\log_{10}\frac{[A]_0}{[A]_t}$

Calculation:

$$t_{1/2} = \frac{0.693}{k}$$

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{1.7h} = 0.4076\ h^{-1}$$

$$t = \frac{2.303}{k}\log_{10}\frac{[A]_0}{[A]_t} = \frac{2.303}{0.4076h^{-1}}\log\frac{100}{80}$$

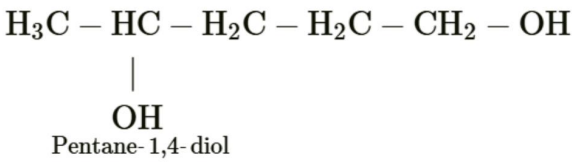
$$t = \frac{2.303}{0.4076\ h^{-1}} \times 0.0969 = 0.5475\ h \times \frac{60\ min}{1h} = 32.9\ min$$

The time required for 20% of reaction to react is 32.9 min.

Q5.

5.1. Write structural formulae for Pentane-1,4-diol

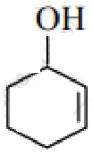
Solution



Pentane- 1,4- diol

5.2. Write structural formulae for Cyclohex-2-en-1-ol.

Solution



Cyclohex-2-en-1-ol

Q6. Answer the following

Which nanomaterial is used in sunscreen lotion? Write its use.

Solution

Sunscreen lotions contain nanoparticles of zinc oxide (ZnO) and titanium dioxide (TiO_2). These chemicals protect the skin against harmful UV (ultraviolet) rays by absorbing or reflecting the light. Hence, sunscreen lotions prevent the skin from damage.

Q7. Answer in brief.

Write two points of difference between the properties of phenol and ethyl alcohol.

Write four points of difference between the properties of phenol and ethyl alcohol.

Solution

	Phenol	Ethyl alcohol
i.	Phenol is a low melting solid.	Ethyl alcohol is liquid.
ii.	The aqueous solution of phenol turns blue litmus to red, i.e., phenol is weakly acidic.	The aqueous solution of ethyl alcohol is neutral to litmus, i.e, ethyl alcohol is neutral.

iii.	Phenol reacts with aqueous NaOH to form sodium phenoxide.	Ethyl alcohol does not react with aqueous NaOH.
iv.	Phenol reacts with neutral ferric chloride solution to give deep purple colouration of ferric phenoxide.	Ethyl alcohol does not react with neutral ferric chloride.

Q8. Give reason:

Reactions involving Grignard reagent must be carried out under anhydrous condition.

Solution

Grignard reagents are highly reactive compounds. They react with water or compounds containing hydrogen attached to the electronegative element. Hence, reactions involving the Grignard reagent must be carried out under anhydrous condition.

Q9. Write the reaction of conc. H_2SO_4 with sugar. What is the role of H_2SO_4 in this reaction?

Solution

The reaction is:

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} \xrightarrow{H_2SO_4} \underset{\text{Carbon}}{12\,C} + \underset{\text{Water}}{11\,H_2O}$$

H_2SO_4 acts as the catalyst in the reaction and helps to remove the water from the sugar molecule.

Q10.

10.1. Answer the following

What is diazotisation?

Solution

Aliphatic/aromatic primary amines react with nitrous acid to form corresponding diazonium salts. This reaction is called diazotisation.

10.2. Answer the following

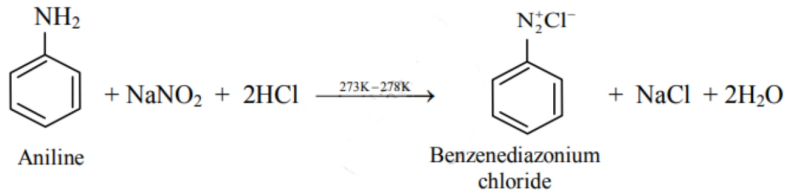
Write diazotisation reaction of aniline?

What is the action of nitrous acid on the following compound?

Aniline

Solution

Diazotisation reaction of aniline:



Q11. Answer the following in one or two sentences.

Why all collisions between reactant molecules do not lead to a chemical reaction?

Solution

All collisions of reactant molecules do not lead to a chemical reaction because the colliding molecules need to possess certain energy which is greater than the activation energy E_a of the molecule needed for the reaction to occur and proper orientation of molecules is needed for the reaction to occur.

Q12. Answer the following in one sentence.

Write reaction showing conversion of ethanenitrile into ethanol.

Convert the following:

Ethanenitrile into ethanal.

Solution

$$\underset{\text{ethanenitrile}}{CH_3-CN} + 2\,H_2O + HCl \xrightarrow{\Delta} \underset{\text{Ethanoic acid}}{CH_3-\overset{\overset{O}{\|}}{C}-OH} + NH_4Cl$$

$$\underset{\text{Ethanoic acid}}{CH_3-COOH} \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } LiAlH_4,\ \text{ether}} \underset{\text{ethanol}}{CH_3-CH_2-OH}$$

Q13. In NaOH solution $[OH^-]$ is 2.87×10^{-4}. Calculate the pH of the solution.

Solution

Given: $[OH^-] = 2.87 \times 10^{-4}$ M

To find: pH of the solution

Formulae:

i. $pOH = -\log_{10}[OH^-]$

ii. $pH + pOH = 14$

Calculation:

From formula (i),

$pOH = -\log_{10}[OH^-]$

$\therefore pOH = -\log_{10}[2.87 \times 10^{-4}]$

$= -\log_{10}2.87 - \log_{10}10^{-4}$

$\therefore -\log_{10}2.87 + 4 = 4 - 0.4579$

$pOH = 3.5421$

From formula (ii),

$pH + pOH = 14$

$pH = 14 - pOH$

$= 14 - 3.5421$

$= 10.4579$

pH of the solution is 10.4579

Q14. Give scientific reasons:

On complete hydrolysis DNA gives equimolar quantities of adenine and thymine.

Why on complete hydrolysis DNA gives equimolar quantities of adenine and thymine?

Solution

i. Both the strands of DNA double helix are complementary to each other.

ii. That is a number of bases on each strand are equal and complementary to each other.

iii. As adenine pairs with thymine; the number of adenine bases on one strand and thymine on another are equal in number.

Thus, on complete hydrolysis DNA gives equimolar quantities of adenine and thymine.

SECTION – C

Attempt any EIGHT of the following questions:

Q15. Answer the following in brief.

Obtain the relationship between the rate constant and half-life of a first-order reaction.

Solution

i. The integrated rate law for the first-order reaction is $k = \frac{2.303}{t}\log_{10}\frac{[A]_0}{[A]_t}$

Where $[A]_0$ is the initial concentration of the reactant at t = 0. The concentration falls to $[A]_t$ at time t after the start of the reaction.

The concentration of the reactant falls to $\frac{[A]_0}{2}$ at time $t_1/2$.

ii. The time required for $[A]_0$ to become $\frac{[A]_0}{2}$ is denoted as $t_{\frac{1}{2}}$ or $[A]_t = \frac{[A]_0}{2}$ at $t = t_{1/2}$

Putting this condition in the integrated rate law we write

$$k = \frac{2.303}{t_{\frac{1}{2}}}\log_{10}\frac{[A]_0}{\frac{[A]_0}{2}}$$

$$= \frac{2.303}{t_{\frac{1}{2}}}\log_{10}2$$

Substituting the value of $\log_{10} 2$,

$$k = \frac{2.303}{t_{\frac{1}{2}}} \times 0.3010$$

$$\therefore k = \frac{0.693}{t_{\frac{1}{2}}}$$

$$\therefore t_{\frac{1}{2}} = \frac{0.693}{k}$$

Q16.

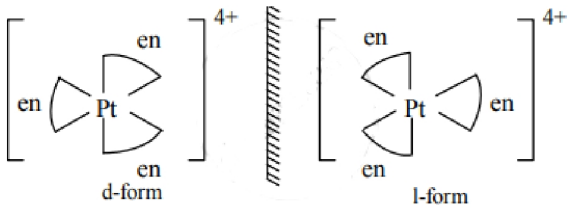
16.1. Answer the following question.

Draw geometric isomers and enantiomers of the following complex.

$[Pt(en)_3]^{4\oplus}$

Solution

$[Pt(en)_3]^{4+}$ shows only enantiomers as follows:



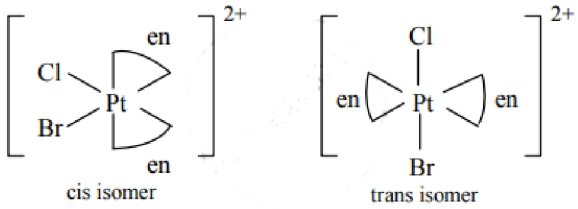
16.2. Answer the following question.

Draw geometric isomers and enantiomers of the following complex.

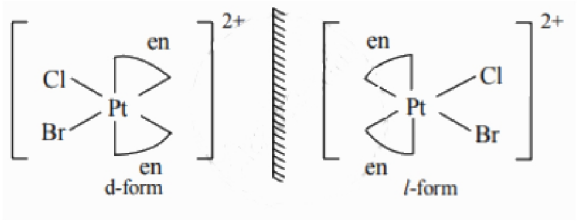
$[Pt(en)_2ClBr]^{2\oplus}$

Solution

Geometric isomers of $[Pt(en)_2ClBr]^{2\oplus}$:



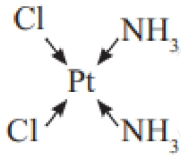
Enantiomers of $[Pt(en)_2ClBr]^{2\oplus}$:



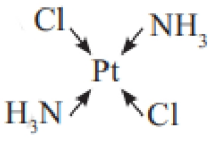
16.3. Draw geometric isomers of the following complex.

Geometrical isomers of $Pt(NH_3)_2Cl_2$

Solution



cis isomer

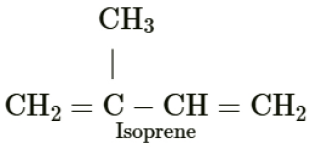
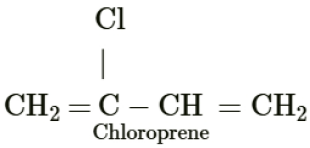
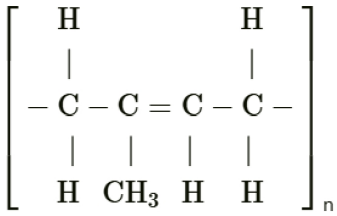
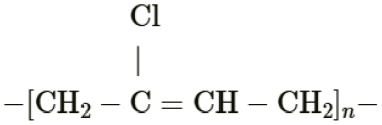


trans isomer

Q17. Answer the following.

Write structure of natural rubber and neoprene rubber along with the name and structure of their monomers.

Solution

Natural rubber	Neoprene
Monomer:  Isoprene	**Monomer:**  Chloroprene
Structure of natural rubber: 	**Structure of neoprene:** 

Q18. Obtain the relationship between ΔH and ΔU for gas phase reactions.

Solution

i. At constant pressure, ΔH and ΔU are related as

$\Delta H = \Delta U + P\Delta V$ ...(1)

ii. For reactions involving gases, ΔV cannot be neglected.

Therefore, $\Delta H = \Delta U + P\Delta V$

$= \Delta U + P(V_2 - V_1)$

$\Delta H = \Delta U + PV_2 - PV_1$ ...(2)

where, V_1 is the volume of gas-phase reactants and V_2 that of the gaseous products.

iii. We assume reactant and product behave ideally. Applying an ideal gas equation, PV = nRT. Suppose that n_1 moles of gaseous reactants produce n_2 moles of gaseous products. Then,

$PV_1 = n_1RT$ and $PV_2 = n_2RT$ ...(3)

iv. Substitution of equation (3) into equation (2) yields

$\Delta H = \Delta U + n_2RT - n_1RT$

$= \Delta U + (n_2 - n_1)\ RT$

$= \Delta U + \Delta n_g\ RT$ ...(4)

where, Δn_g is the difference between the number of moles of products and those of reactants.

Q19. Answer the following in brief.

It is impossible to measure the potential of a single electrode. Comment.

Why it is impossible to measure the potential of a single electrode?

Solution

i. Every oxidation reaction needs to be accompanied by a reduction reaction.

ii. The occurrence of only oxidation or only reduction is not possible.

iii. In galvanic cell oxidation and reduction occur simultaneously.

iv. The potential associated with the redox can be experimentally measured. For the measurement of potential two electrodes need to be combined together where the redox reaction occurs.

Hence, it is impossible to measure the potential of a single electrode.

Q20. Distinguish between S_N1 and S_N2 mechanism of substitution reaction.

Solution

Factor	S_N1	S_N2
Kinetics	1^{st} order	2^{nd} order
Molecularity	Unimolecular	Bimolecular

Number of steps	Two steps	One step
Bond making and bond breaking	First the bond in the reactant breaks and then a new bond in the product is formed.	Simultaneous
Transition state	Two steps, two transition states	One step, one transition state
Direction of attack of nucleophile	Back side attack and front side attack	Only back side attack
Stereochemistry	Racemisation (If the substrate is optically active)	Inversion of configuration (If the substrate is optically active)
Type of substrate	Mainly 3° substrates	Mainly 1° substrate
Polarity of solvent	Polar protic solvent favorable	Aprotic (non-polar) or solvent with low polarity favourable
Intermediate	Intermediate involved	No intermediate

Q21. Answer the following in brief.

Explain graphically the effect of temperature on the rate of reaction.

Solution

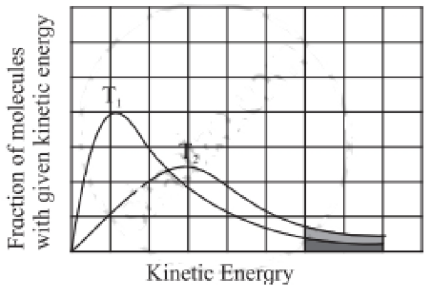
i. The average kinetic energy of molecules is proportional to temperature.

ii. At a given temperature, the fraction of molecules with their kinetic energy equal to or greater than E_a may lead to the product.

iii. With an increase in temperature, the fraction of molecules having their energies (E_a) would increases. The rate of the reaction thus would increase.

iv. This is depicted by plotting a fraction of molecules with given kinetic energy versus kinetic energy for two different temperatures T_1 and T_2 ($T_2 > T_1$). The area between the

curve and the horizontal axis is proportional to the total number of molecules. The total area is the same at T_1 and T_2.



Comparison of fraction of molecules activated at T_1 and T_2

v. The entire shaded area which represents a fraction of molecules with kinetic energy exceeding E_a is larger at T_2 than at T_1 (since $T_2 > T_1$).

vi. This indicates that a fraction of molecules possessing energies larger than E_a increase with temperature. The rate of reaction increases accordingly.

Q22. An element has a bee structure with unit cell edge length of 288 pm. How many unit cells and number of atoms are present in 200 g of the element?

Solution

For bcc unit cell, n = 2

Using formula (i),

Number of atoms in 200 g of element,

$$= \frac{200g \times 2}{14.44g\ cm^{-3} \times \left(2.88 \times 10^{-8}\ cm\right)^3}$$

$= 9.61 \times 10^{24}$

Using formula (ii),

∴ Number of atoms in 200 g element is 9.61×10^{24}

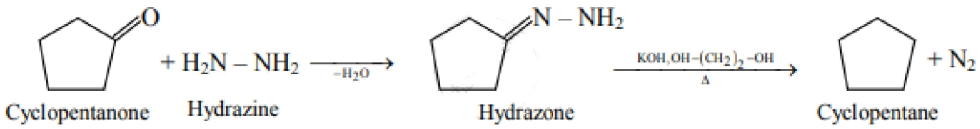
∵ Number of unit cells in 200 g element is 4.80×10^{24}

Q23.

23.1. Answer in brief.

What is the action of hydrazine on cyclopentanone in presence of KOH in ethylene glycol?

Solution



23.2. How ketones are prepared from nitriles?

Solution

Ketones are made by reacting nitriles with Grignard reagent in dry ether as a solvent, then acid hydrolyzing them.

$$\underset{\text{(Ehtanenitrile)}}{H_3C-C\equiv N}+H_3CMgCl \xrightarrow{\text{dry ether}} CH_3-\underset{\displaystyle H_3C}{\overset{\displaystyle |}{C}}=NMgCl \xrightarrow{H_3O^{\oplus}} \underset{\text{(Acetone)}}{CH_3-CO-CH_3}+NH_3+Mg(Cl)OH$$

$$\underset{\text{(Benzonitrile)}}{C_6H_5-C\equiv N}+C_6H_5-MgBr \xrightarrow{\text{dry ether}} C_6H_5-\underset{\displaystyle C_6H_5}{\overset{\displaystyle |}{C}}=NMgBr \xrightarrow{H_3O^{\oplus}} \underset{\text{(Benzophenone)}}{C_6H_5-CO-C_6H_5}+NH_3+Mg(Br)OH$$

Q24.

24.1. Answer the following:

What are anode and cathode for Leclanche' dry cell?

Solution

The container of the cell is made of zinc which serves as anode (–) and an inert graphite rod in the centre of the cell immersed in the electrolyte paste (manganese dioxide (MnO_2) and carbon black) serves as cathode (+).

24.2. Write electrode reactions and overall cell reaction when Leclanche's dry cell generates electricity.

Solution

Electrode reactions are as follows:

a. **Oxidation at anode:**

$$Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2\,e^-$$

b. **Reduction at cathode:**

$$2\,NH^+_{4(aq)} + 2\,MnO_{2(s)} + 2\,e^- \longrightarrow Mn_2O_{3(s)} + 2\,NH_{3(aq)} + H_2O_{(l)}$$

c. **Overall cell reaction:**

$$Zn_{(s)} + 2\,NH^+_{4(aq)} + 2\,MnO_2 \longrightarrow Zn^{2+}_{(aq)} + Mn_2O_{3(s)} + 2\,NH_{3(aq)} + H_2O_{(l)}$$

Q25. Answer in brief.

Write reaction showing conversion of Acetaldehyde into acetaldehyde dimethyl acetal.

Solution

Step 1:

$$\underset{\text{Acetaldehyde}}{\begin{array}{l} H_3C \\ | \\ C = O \\ | \\ H \end{array}} + CH_3 - OH \overset{\text{dry HCl}}{\underset{\text{dil}\cdot\text{HCl}}{\rightleftharpoons}} \underset{\text{Hemiacetal (unstable)}}{\begin{array}{l} H \\ | \\ H_3C - C - OCH_3 \\ | \\ OH \end{array}}$$

Step 2:

$$\underset{\text{Hemiacetal (unstable)}}{\begin{array}{l} H \\ | \\ H_3C - C - OCH_3 \\ | \\ H \end{array}} + CH_3 - OH \overset{\text{dry HCl}}{\underset{\text{dil}\cdot\text{HCl}}{\rightleftharpoons}} \underset{\text{Acetaldehyde dimethyl acetal (stable)}}{\begin{array}{l} H \\ | \\ H_3C - C - OCH_3 \\ | \\ OCH_3 \end{array}} + H_2O$$

Q26.

26.1. A solution of citric acid $C_6H_8O_7$ in 50 g of acetic acid has a boiling point elevation of 1.76 K. If K_b for acetic acid is 3.07 K kg mol^{-1}, what is the molality of solution?

Solution

Given: Boiling point elevation = ΔT_b = 1.76 K

K_b of acetic acid = 3.07 K kg mol^{-1}

Mass of acetic acid = 50 g

To find: Molality of the solution

Formula: $\Delta T_b = K_b\, m$

Calculation: Using the formula and rearranging, we get,

$$m = \frac{\triangle T_b}{K_b}$$

$$= \frac{1.76\text{K}}{3.07\text{K kg mol}^{-1}}$$

$$= 0.573 \text{ mol kg}^{-1}$$

= 0.573 m

The molality of the solution is 0.573 m.

26.2. 0.01 m aqueous formic acid solution freezes at – 0.021°C. Calculate its degree of dissociation, K_f = 1.86 K kg mol^{-1}.

Solution

$\Delta T_f = iK_f m$

ΔT_f = 0°C – (–0.021°C) = 0.021°C

m = 0.01 mol kg^{-1}

0.021 = i × 1.86 K kg mol^{-1} × 0.01 mol kg^{-1}

$$i = \frac{0.021}{1.86 \times 0.01} = 1.13$$

$$\alpha = \frac{i - l}{n - l} = i - l \text{ because } n = 2$$

Hence, α = 1.13 – 1 = 0.13 = 13%

SECTION – D

Attempt any THREE of the following questions:

Q27. Answer the following

What are the differences between cast iron, wrought iron, and steel?

Solution

Cast iron	Wrought iron	Steel
i. Hard and brittle	i. Very soft	i. Neither too hard nor too soft.
ii. Contains 4% carbon.	ii. Contains less than 0.2% carbon	ii. Contains 0.2 to 2% carbon
iii. Used for making pipes, manufacturing automotive parts, pots, pans, utensils, etc.	iii. Used for making pipes, bars for stay bolts, engine bolts and rivets, etc.	iii. Used in buildings infrastructure, tools, ships, automobiles, weapons, etc.

Q28. Answer the following :

Explain the relation between ionic product and solubility product to predict whether a precipitate will form when two solutions are mixed?

Solution

Condition of precipitation:

The ionic product (IP) of an electrolyte is defined in the same way as solubility product (K_{sp}). The only difference is that the ionic product expression contains a concentration of ions under any condition whereas the expression of K_{sp} contains only equilibrium concentrations. If,

i. IP = K_{sp}; the solution is saturated and solubility equilibrium exists.

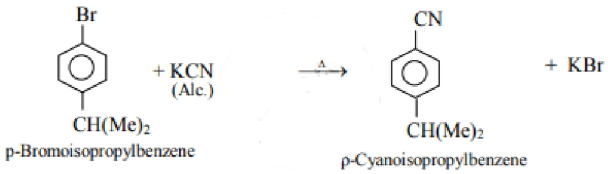
ii. IP > K_{sp}; the solution is supersaturated and hence precipitation of the compound will occur.

iii. If IP < K_{sp}, the solution is unsaturated and precipitation will not occur.

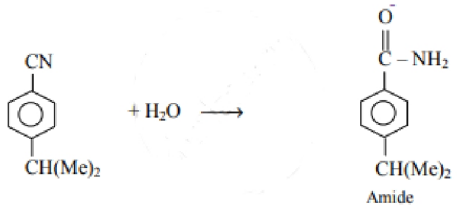
Q29. Write reaction showing conversion of p-bromoisopropylbenzene into p-isopropylbenzoic acid (3 steps).

Solution

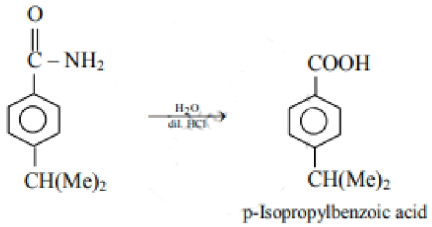
Step 1: Converting - Br group to - CN:



Step 2: Converting - CN group to - $CONH_2$:



Step 3: Converting - $CONH_2$ group to - COOH:



Q30. Answer the following

Explain trends in ionisation enthalpies of d-block elements.

Solution

i. The ionization enthalpies of transition elements are intermediate between those of s-block or p-block elements. This suggests that transition elements are less electropositive than elements of groups 1 and 2.

ii. As the atomic number increases across a transition series, the first ionization energy increases with some irregularities.

iii. Ionization enthalpies for a given element increases from the first ionization enthalpy, IE_1 to the third ionization enthalpy, IE_3.

iv. The atoms of elements of the third transition series possess filled 4f-orbitals. 4f orbitals show a poor shielding effect on account of their peculiar diffused shape. As a result, the valence electrons experience a greater nuclear attraction. A greater amount of energy is required to ionize elements of the third transition series. The ionization enthalpies of the elements of the third transition series are, therefore much higher than the first and second series.

Q31. Answer the following question.

What are cationic, anionic, and neutral complexes? Give one example of each.

Solution

On the basis of charge on complex ion, coordination complex is classified as:

i. Cationic complex: A positively charged coordination sphere or a coordination compound having a positively charged coordination sphere is called the cationic complex or cationic sphere complex.

e.g. $[Zn(NH_3)_4]^{2+}$

ii. Anionic complex: A negatively charged coordination sphere or a coordination compound having a negatively charged coordination sphere is called an anionic complex or anionic sphere complex.

e.g. $[Zn(CN)_6]^{3-}$

iii. Neutral sphere complexes: A coordination complex that does not possess a cationic or anionic sphere are neutral complexes of neutral sphere complexes.

e.g. $[Ni(CO)_4]$