2013

Question: 1 – 30

Question: 1

How many atoms constitute one unit cell of a face-centered cubic crystal? [1]

Answer:

Number of atoms in one face centered cubic unit cell can be determined from the number of atoms contributed from the faces and the corners of the unit cell as: (8 corners × $\frac{1}{8}$ atom per corner = $8 \times \frac{1}{8}$ = 1 atom) + (6 faces × $\frac{1}{2}$ atom per unit face = $6 \times \frac{1}{2}$ = 3 atoms). ∴ Total no. of atoms per unit cell = 4 atoms.

Question: 2

Name the method used for the refining of Nickel metal. [1]

Answer:

Method used for refining of nickel metal is Mond's process. In this process nickel is heated in a steam of carbon monoxide, which yields in the formation of nickel carbonyl. Nickel carbonyl on further heating decomposes to five pure nickel.

$$Ni + 4CO \xrightarrow{330\text{-}350K} Ni(CO)_4$$

$$Ni(CO)_4 \xrightarrow{450\text{-}470K} Ni + 4CO$$

Question: 3

What is the covalency of nitrogen in N_2O_5? [1]

Answer:

In N_2O_5, the covalency of N is restricted to 4 due to sp^2 hybridisation of nitrogen atom involving one 2s and three 2p orbitals.

Question: 4

Write the IUPAC name of

$CH_3 - CH(Cl) - CH_2 - CH = CH_2$ [1]

Answer:

5 4 3 2 1

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

IUPAC Name: 4-Chloropent-1-ene

Question: 5

What happens when CH_3-Br is treated with KCN? [1]

Answer:

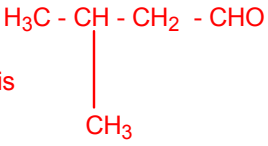
It is a nucleophilic substitution reaction. The nucleophile CN^- substitutes Br^-. The reaction is as follows: $CH_3Br + KCN \rightarrow CH_3CN + HBr$

Question: 6

Write the structure of 3-methyl butanal. [1]

Answer:

The structure of 3-Methyl butanal is



Question: 7

Arrange the following in increasing order of their basic strength in aqueous solution: [1]
$CH_3.NH_2$,$(CH_3)_3N$, $(CH_3)_2NH$

Answer:
$(CH_3)_3N$,CH_3NH_2, $(CH_3)_2NH$

Question: 8

What are three types of RNA molecules which perform different functions? [2]

Answer:
There are three different types of RNA molecules: Messenger RNA (mRNA), Transfer RNA (tRNA) and Ribosomal RNA (rRNA)

Question: 9

18g of glucose, $C_6H_{12}O_6$ (Molar Mass= 180g mol^{-1}) is dissolved in 1Kg of water in a sauce pan. At what temperature will this solution boil? [2]

Answer:
w_1 = weight of solvent (H_2O) = 1 kg and w_2 = weight of solute ($C_6H_{12}O_6$) = 18 gm
M_2 = Molar mass of solute (C6H12O6) = 180 g mol^{-1}
K_b = 0.52 K Kg mol^{-1}
$T_b^o = 373.15K$

$$\Delta DT_b = \frac{K_b \times 1000}{M_2 \times w_1} = \frac{0.52 \times 1000 \times 18}{180 \times 1000} = 0.052K$$

$\Delta T_b = T_b - T_b^o \Rightarrow 0.052 = T_b - 373.15 \Rightarrow T_b = 373.202K$

Question: 10

The conductivity of 0.20 M solution of KCl at 298 K is 0.025 S cm-1. Calculate its molar conductivity. [2]

Answer:
κ (S cm^{-1}) = 0.025 S cm^{-1} and molarity (mol L^{-1}) = 0.20 M

$$\text{Molar conductivity } (\Lambda_m) = \frac{K}{1000 \times \text{molarity}} = \frac{0.025}{1000 \times 0.20} = 1.25 \times 10 - 4 S cm^2 mol^{-1}$$

Question: 11

Write the dispersed phase and dispersion medium of the following colloidal system: [2]

i. Smoke

Answer:
Dispersed phase in smoke: Solid and dispersion medium in smoke: Gas

ii. Milk

Answer:
Dispersed phase in milk: Liquid Fat and dispersion medium in milk: Water

OR

What are lyophilic and lyophobic colloids? Which of these sols can be easily coagulated on the addition of small amounts of electrolytes?
#
Answer:
Lyophillic colloids: It is made up of two words; 'Lyo' meaning liquid and 'Phillic' meaning loving, so those colloids which are attracted by the liquid (solvent), are called as lyophillic colloids. These are also called reversible sols. These are quite stable and cannot be easily coagulated.

Lyophobic colloids: It is made up of two words; 'Lyo' meaning liquid and 'Phobic' meaning repelling, so those colloids which are repelled by the liquid (solvent), are called as lyophobic colloids. These are also called irreversible sols and these are unstable and can be easily coagulated due to lack of protecting layer around charged colloidal particles, they easily form cluster. Hence, they got easily coagulated on addition of small amount of electrolyte.

Question: 12

Write the differences between physisorption and chemisorption with respect to the following: [2]

i. Specificity
ii. Temperature dependence
iii. Reversibility and
iv. Enthalpy change

Answer:

S.No.	Point of difference	Physiosorption	Chemisorption
(i)	Specificity	This is not specific in nature.	This is highly specific in nature.
(ii)	Temperature dependence	Low temperature is favourable for physiosorption. It decreases with increase in temperature.	High temperature is favourable for chemisorption. It increases with the increase in temperature.
(iii)	Reversibility	This is reversible in nature.	This is irreversible in nature.
(iv)	Enthalpy change	Enthalpy of adsorption is low.	Enthalpy of adsorption is high.

Question: 13

1. Which solution is used for the leaching of silver metal in the presence of air in the metallurgy of silver? [1]

Answer:
Dilute solution of NaCN and KCN is used for leaching of silver metal in the presence of air in the metallurgy of silver.

2. Out of C and CO, which is a better reducing agent at the lower temperature range in the blast furnace to extract iron from the oxide ore? [1]

Answer:
Out of C and CO, CO is a better reducing agent at the lower temperature range because $\Delta G_{(CO,CO2)} < \Delta G_{(Fe,FeO)}$. So, CO will reduce FeO, and will itself be oxidized to CO_2.

Question: 14

What happens when. [2]

i. PCl_5 is heated?

Answer:
PCl_5 on heating gives PCl_3 and Cl_2: $PCl_5 \rightarrow PCl_3 + Cl_2$

ii. H_3PO_3 is heated?
Write the reaction involved.

Answer:
H_3PO_3 on heating gives orthophosphoric acid and phosphine : $4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$

Question: 15 [2]

1. Which metal in the first transition series (3d series) exhibits +1 oxidation state most frequently and why?

Answer:
Cu is the only metal in the first transition series (3d series) which shows +1 oxidation state most frequently. This is because the electronic configuration of Cu is $3d^{10}\ 4s^1$ and after losing one electron it acquires a stable $3d^{10}$ configuration.

2. Which of the following cations are colored in aqueous solutions and why? $Sc^{3+}, V^{3+}, Ti^{4+}, Mn^{2+}$ (At. nos. Sc = 21, V= 23, Ti = 22, Mn = 25)

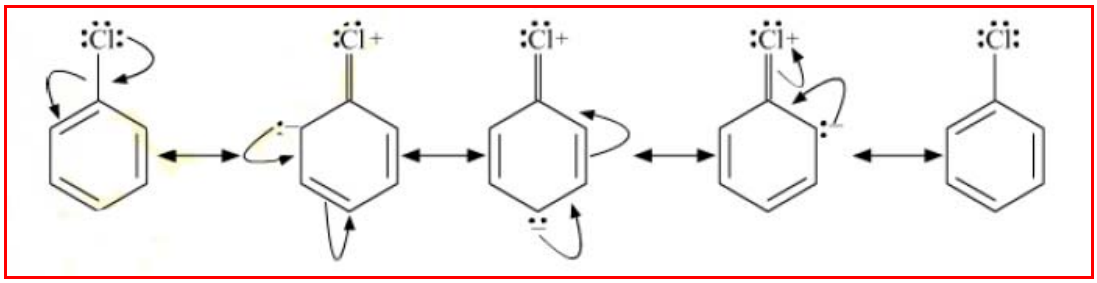
Answer:
The color of cations is dependent on the number of unpaired electrons present in d-orbital. The electronic configuration of the following cations is as follows:
Sc (Atomic number 21) = $3d^1\ 4s^2$ and $Sc^{3+} = 3d^0\ 4s^0$. As d-orbital is empty, it is colourless.
V (Atomic number 23) = $3d^3\ 4s^2$ and $V^{3+} = 3d^2\ 4s^0$. As d-orbital is having 2 unpaired electrons, it undergoes d-d transition and shows green colour.
Ti = (Atomic number 22) = $3d^2\ 4s^2$ and $Ti^{4+} = 3d^0\ 4s^0$. As d-orbital is empty, it is colourless.
Mn = (Atomic number 25) = $3d^5\ 4s^2$ and $Mn^{2+} = 3d^5\ 4s^0$. As d-orbital is having 5 unpaired electrons, it shows pink color.

Question: 16 [2]

Chlorobenzene is extremely less reactive towards a nucleophilic substitution reaction. Give two reasons for the same.

Answer:
Chlorobenzene is extremely less reactive towards a nucleophilic substitution reaction because of the following reasons:

1. Resonance effect: The electron pair on chlorine atom is in conjugation with the □ - electrons of the benzene ring which results in the following resonance structures:



2. This results in delocalization of the electrons of C – Cl bond and a partial double bond character develops in the bond, which makes it difficult for the nucleophile to cleave the C – Cl bond.

The nucleophile suffers repulsion from the increased electron density on the benzene ring as a result the nucleophile is unable to make a close approach for the attack on the molecule.

Question: 17

Explain the mechanism of the following reaction:### ** [2]

$$2CH_3 - CH_2 - OH \xrightarrow[413K]{H+} CH_3CH_2 - \ddot{O} - CH_2 - CH_3 + H_2O$$

Question: 18

How will you convert: [2]

1. Propene to Propan-2-ol?

Answer:

To convert from Propene to Propan-2-ol, the addition of H_2SO_4 takes place in accordance with Markovnikov's rule i.e.

$$CH_3CH = CH_2 + H_2SO_4 \xrightarrow[Boil]{H_2O} CH_3 - CH_2 - CH_3$$

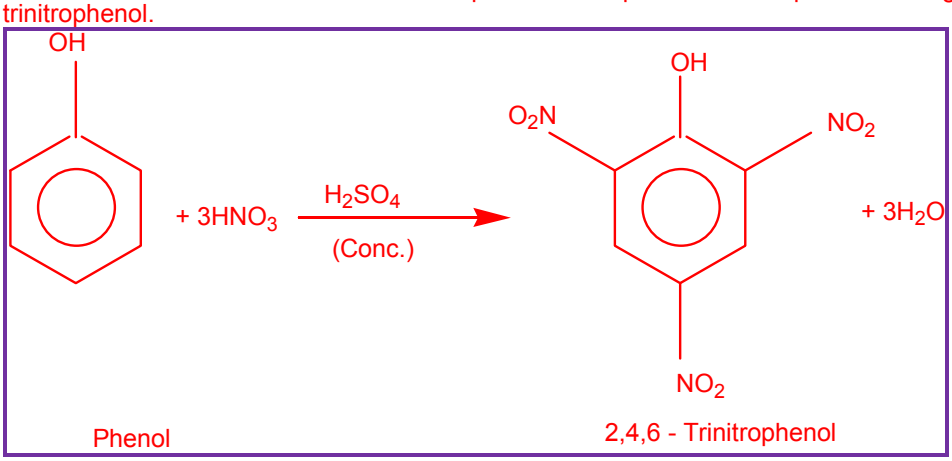
I

Propan – 2 – ol

2. Phenol to 2, 4, 6 – trinitrophenol?

Answer:

When concentrated nitric acid is added to phenol in the presence of sulphuric acid it gives 2, 4, 6-trinitrophenol.

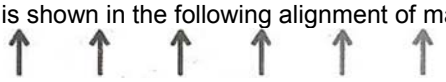


Question: 19 [3]

1. What type of semiconductor is obtained when silicon is doped with boron?

Answer:
When silicon is doped with boron, p-type semiconductor is obtained.

2. What type of magnetism is shown in the following alignment of magnetic moments?



Answer:
The magnesium shown in the alighment of magnetic moments is ferromagnetism.

3. What type of point defect is produced when AgCl is doped with $CdCl_2$?

Answer:
Imputiry defect is produced when AgCl is doped with $CdCl_2$.

Question: 20

Determine the osmotic pressure of a solution prepared by dissolving 2.5×10^{-2} g of K_2SO_4 in 2L of water at 25° C , assuming that it is completely dissociated. (R=0.0821 L atm $K^{-1}mol^{-1}$, Molar mass of K_2SO_4=174g mol^{-1}).

Answer:
W_2 = 2.5 x 10-2 (Mass of K2SO4) and M2 = 174 g mol-1(Molar mass K2SO4)
V = 2L, R = 0.0821 L atm K-1 mol-1 and T = 250C = 298 K

Osmotic pressure, $\pi = \frac{w_2RT}{M_2V}$

$$\pi = \frac{2.5 \times 10^{-2} \times 0.0821 \times 298}{174 \times 2} = \frac{61.1645 \times 10^{-2}}{348} = 1.76 \times 10^{-3} \text{ atm.}$$

Question: 21

Calculate the emf of the following cell at 298 K:
$Fe(s) \mid Fe^{2+}(0.001M) \parallel H^+(g) \mid H_2(g)(1bar), Pt(s)$
$(\text{Given } E^0_{cell} = +0.44V)$

Answer:
At anode: $Fe \rightarrow Fe^{2+} + 2e^-$
At cathode: $2H^+ + 2e^- \rightarrow H_2$
So, total number of electrons (n) transferred = 2
Given: E°_{cell} = +0.44 Volt
Temperature (T) = 298 K

$$E_{cell} = E^0_{cell} - \left(\frac{2.303RT}{nF}\right)\log\frac{a_{oxi}}{a_{Red}}$$

$$E_{cell} = E^0_{cell} - \left(\frac{0.05916V}{n}\right)\log\frac{a_{oxidation}}{a_{Reduction}} \Rightarrow E_{cell} = 0.44 - \frac{0.0.591V}{2}\log\frac{0.001}{1}$$

Therefore, E_{cell} = 0.44(–0.02955 × – 3) = 0.44 + 0.08865 = 0.53 Volt.

Question: 22 [3]

How would you account for the following?

i. Transition metals exhibit variable oxidation states.

Answer:
The variable oxidation states of transition elements are due to the participation of *ns* and (*n*−1)*d*-electrons in bonding. Lower oxidation state is exhibited when *ns*- electrons take part in bonding. Higher oxidation states are exhibited when (*n* − 1) *d*-electrons take part in bonding.

ii. Zr (Z=40) and Hf (Z=72) have almost identical radii.

Answer:
This is because the atomic radii of 4d and 5d transition elements are nearly same. This similarity in size is consequence of lanthanide contraction. Because of this lanthanide contraction the radii of Hf becomes nearly equal to that of Zr.

iii. Transition metals and their compounds act as catalyst.

Answer:
Transition elements act as good catalyst in chemical reaction because they can lend electrons or withdraw electrons from the reagent, depending on the nature of the reaction. The ability of transition metals to be in a variety of oxidation states, the ability to interchange between the oxidation states and the ability to form complexes with the reagents and be a good source for electrons make transition metals good catalysts.

OR

Complete the following chemical equations:

i. $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow$

Answer:
$Cr_2 + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

ii. $2CrO_4^{2-} + 2H^+ \rightarrow$

Answer:
$2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

iii. $2MnO_4^- + 5C2O_4^{2-} + 16H^+ \rightarrow$

Answer:
$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

Question: 23 [3]

Write the IUPAC names of the following coordination compounds:

i. $[Cr(NH_3)_3Cl_3]$

Answer:
Triamminetrichlorochromium (III)

ii. $K_3[Fe(CN)_6]$

Answer:
Potassium hexacyanoferrate (III)

iii. $[CoBr_2(en)_2]^+$, (en = ethylenediamine)

Answer:
Dibromidobis (ethane-1, 2-diammine) cobalt (III) ion

Question: 24

Give the structures of A, B and C in the following reactions: (**)

i. $C_6H_5N_2^+Cl^- \xrightarrow{CuCN} A \xrightarrow[H+]{H_2O} B \xrightarrow[\Delta]{NH_3} C$

ii. $C_6H_5NO_2 \xrightarrow{Sn + HCl} A \xrightarrow[273\ K]{NaNO_2 + HCl} B \xrightarrow[\Delta]{H_2O,\ H+} C$

Question: 25

Write the names and structures of the monomers of the following polymers:

i. Buna-S

Answer:
Tne monomers of the following polymers are as follows:

$CH_2=CH-C_6H_5$ $\qquad$ $CH_2=CH-CH=CH_2$

Syrene $\qquad$ Buta-1, 3-diene

ii. Neoprene

Answer:

$CH_2=CH-\underset{Cl}{C}=CH_2$

Chloroprene

iii. Which Nylone-6,6

Answer:

$HO-C-(CH_2)_4-C-OH$ $\qquad$ $H_2N-(CH_2)_6-NH_2$

Adipic acid $\qquad$ Hexamethylenediamine

Question: 26

After watching a programme on TV about the adverse effects of junk food and soft drinks on the health of school children, Sonali, a student of Class XII, discussed the issue with the school

principal. Principal immediately instructed the canteen contractor to replace the fast food with the fibre and vitamins rich food like sprouts, salad, fruits etc. This decision was welcomed by the parents and the students. After reading the above passage, answer the following questions:

i. What values are expressed by Sonali and the Principal of the school?

Answer:
The values showed by Sonali are awareness regarding adverse effect of junk food and concern for the health of her school mates.
The value showed by the principal is responsible behavior in listening to Sonali's views and taking prompt action in replacing junk food with healthy food.

ii. Give two examples of water-soluble vitamins.

Answer:
The water soluble vitamins are vitamin B-complex and vitamin C.

Question: 27

i. Which one of the following is a food preservative?

a. Equanil
b. Morphine
c. Sodium benzoate

Answer:
Sodium benzoate is used as a food preservative whereas equanil is a tranquillizer and morphine is a narcotic analgesic.

ii. Why is bithional added to soap?

Answer:
Bithional is an antiseptic so it is added to soaps to reduce odours producing bacterial decomposition of organic matter on the skin.

iii. Which class of drugs is used in sleeping pills?

Answer:
Tranquillizers relieve stress, fatigue by inducing sense of well being, so they are used in the making of sleeping pills.

Question: 28

a. A reaction is second order in A and first order in B.

i. Write the differential rate equation.

Answer:
A reaction is second order in A and first order in B.
Differential rate equation:– Rate = $\frac{-d[R]}{dt} = K[A]^2[B]$

ii. How is the rate affected on increasing the concentration of A three times?

Answer:
On increasing the concentration of A three times i.e. 3A:
Rate' $=k[3A]^2[B] = [A]^2[B] = 9k[A]^2[B] = 9$(Rate), i.e. 8 times the initial rate.

iii. How is the rate affected when the concentration of both A and B are doubled?

Answer:

On increasing the concentration of A and B as 2A and 2B:

$Rate_1 = k[2A]^2[2B] = k(4 \times 2)[A]^2[B] = 8k[A]^2[B] = 8$ (Rate) , i.e. 8 times the initial rate.

b. A first order reaction takes 40 minutes for 30% decomposition. Calculate $t^{\frac{1}{2}}$ for this reaction. (Given log 1.428=0.1548)

Answer:

	$A \rightarrow$	P
t = 0	a	0
t = t	(a-x)	x

Now, it takes 40min for 30% decomposition i.e reactant left after 40 min is 70% of its initial concentration.

So, $(a-x) = \frac{70}{100} \times a = \frac{7}{10}a$

$$k = \frac{2.303}{t}\log\frac{a}{a-x} \Rightarrow k = \frac{2.303}{40}\log\frac{a}{(\frac{7}{10})\,a} = \frac{2.303}{40}\log 1.428$$

$$\therefore k = 0.00891 min^{-1}$$

$$\therefore t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{0.008913} = = 77.78 min$$

OR

a. Explain For a first order reaction, show that time required for 99% completion is twice the time required for the completion of 90% of reaction.

Answer:

For a first order reaction

	$A \rightarrow$	P
t = 0	a	0
t = t	(a-x)	x

Case 1: If 't' is the time required for 99% completion then x = 99% of a (a □x) □1% of a

□□ $\frac{1}{100} \times a = \frac{a}{100}$

$$t = \frac{2.303}{k}\log\frac{a}{a-x} = \frac{2.303}{k}\log\frac{ax100}{a} = \frac{2.303}{k}\log 10^2$$

$$\therefore t = 2\left[\frac{2.303}{k}\right]$$

Case 2: If 't' is the time required for 90% completion then x = 90% of a (a □x) □10% of a□□ $\frac{10}{100}a = \frac{1}{10}a$

$$t = \frac{2.303}{k}\log\frac{a}{a-x} = \frac{2.303}{k}\log\frac{a.100}{a}$$

$$\therefore t = 2\left[\frac{2.303}{k}\right]$$

Therefore, the time required for 99% completion of 1st order reaction is twice the time required for 90% completion.

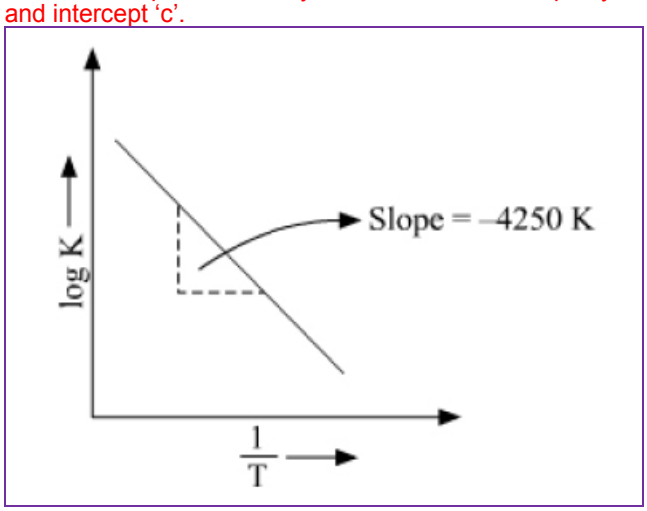
b. Rate constant 'k' of a reaction varies with temperature 'T' according to the equation: log k = log A - $\frac{E_a}{2.303R}(\frac{1}{T})$. Where Ea is the activation energy. When a graph is plotted for log k Vs. $\frac{1}{T}$, a straight line with a slope of -4250 K is obtained. Calculated 'Ea' for the reaction. ($R=8.314\ JK^{-1}mol^{-1}$)

Answer:

$\log k = \log A - \frac{E}{2.303R}\left[\frac{1}{T}\right]$

$E_a \rightarrow$ Activation energy

The above equation is like y = mx + c where if we plot y v/s x we get a straight line with slope 'm' and intercept 'c'.



So, slope id equal to $\frac{-E_a}{2.303R}$

$\Rightarrow \frac{-E_a}{2.303R} = -4250K \Rightarrow E_a = 4250 \times 2.303 \times 8.314 = 81,375.3535\ J\ mol^{-1}$

$\Rightarrow E_a = 81.3753\ KJ\ mol^{-1}$.

Question: 29

a. Give reasons for the following:

i. Bond enthalpy of F_2 is lower than that of Cl_2.

Answer:

Bond enthalpy of F_2 is lower than that of Cl_2 because F atom is small in size and due to this the electron-electron repulsions between the lone pairs of F-F are very large. Thus, the bond dissociation energy of F_2 is lower than that of Cl_2.

ii. PH_3 has lower boiling point than NH_3.

Answer:

PH_3 has lower boiling point than NH_3 because NH_3 molecule possess intermolecular hydrogen bondings which binds them strongly whereasPH_3 has weaker Vander Waal's forces. Thus, PH_3 has lower boiling point than NH_3.

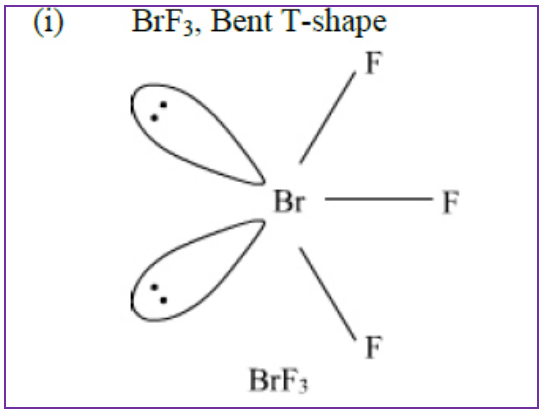
b. Draw the structures of the following molecules:#

#

i. BrF_3

Answer:

(i) BrF_3, Bent T-shape



ii. $(HPO_3)_3$

iii. XeF_4
(**)

OR

a. Account for the following:

i. Helium is used in diving apparatus.

Answer:
Helium mixed with oxygen under pressure is given to sea-divers for respiration. Air is not given to sea-divers because nitrogen present in air being soluble in blood will give a painful sensation called bends by bubbling out blood on moving from high pressure(in deep sea) to the atmospheric pressure.

ii. Fluorine does not exhibit positive oxidation state.

Answer:
Fluorine being the most electronegative atom does not exhibit positive oxidation state because the electrons in fluorine are strongly attracted by the nuclear charge because of small size of fluorine atom and therefore, removal of an electron is not possible.

iii. Oxygen shows catenation behavior less than sulphur.

Answer:
Sulphur shows catenation behavior more than that of oxygen because the oxygen atom is smaller in size as compared to sulphur, the O-O bonds in oxygen experiences repulsions due to the lone pairs present on oxygen atom and therefore, are weaker as compared to the S-S bonds.

b. Draw the structures of the following molecules.

i. XeF_2

ii. $H_2S_2O_8$

Question: 30

a. Although phenoxide ion has more number of resonating structures than Carboxylate ion, Carboxylic acid is a stronger acid than phenol. Give two reasons.

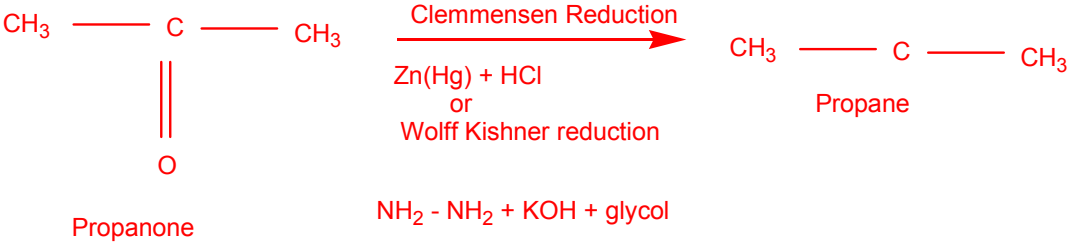
Answer:
On losing a proton, carboxylic acids forms carboxylate ion and phenol forms phenoxide ion as follows:

Now, the negative charge is delocalized in both molecules as follows:
The conjugate base of carboxylic acid has two resonance structures in which negative charge in delocalized over two oxygen atoms (since O is more electronegative than C) which stabilizes the carboxylate ion.

b. How will you bring about the following conversions?

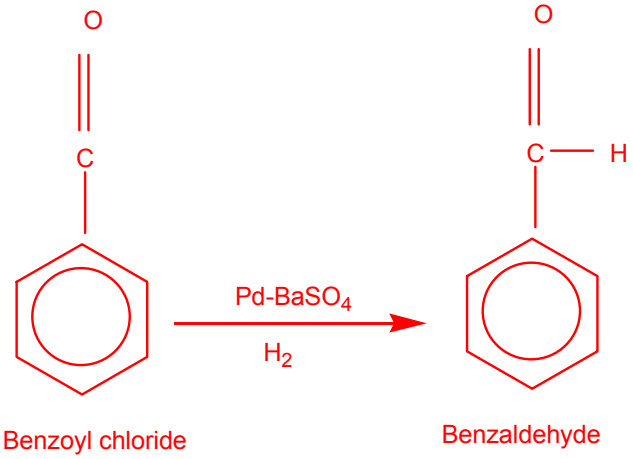
i. Propanone to propane

Answer:



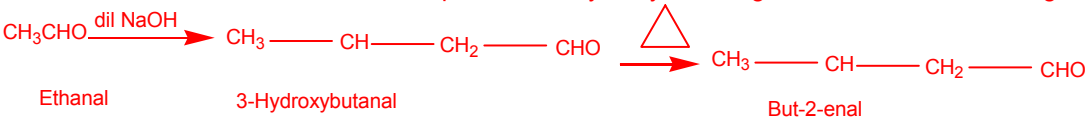
ii. Benzoyl chloride to benzaldehyde

Answer:



iii. Ethanal to but-2-enal

Answer:
On treatment with dilute alkali, ethanol produces 3-hydroxybutanal gives But-2-enal on heating.



OR

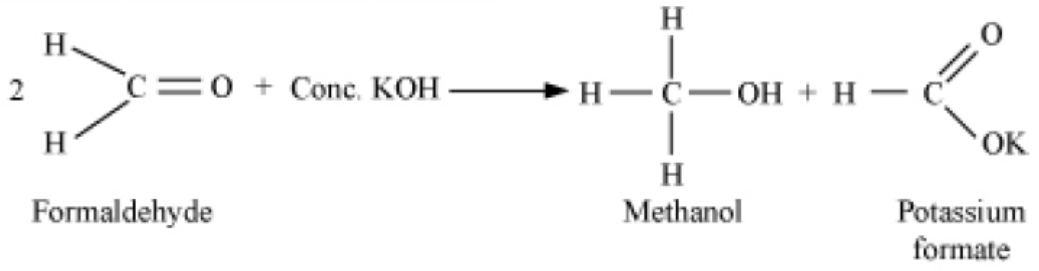
a. Complete the following reactions:

i. $2H-\underset{\underset{O}{\|}}{C}-H \xrightarrow{\text{Conc.KOH}}$

Answer:

It is an example of Cannizaro reaction.

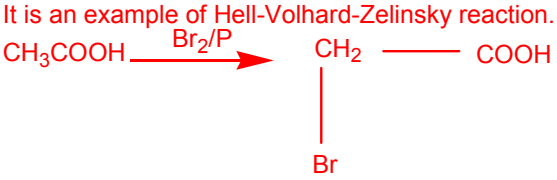
It is an example of **Cannizaro reaction.**



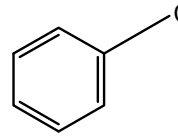
ii. $CH_3COOH \xrightarrow[P]{Br_2}$

Answer:

It is an example of Hell-Volhard-Zelinsky reaction.

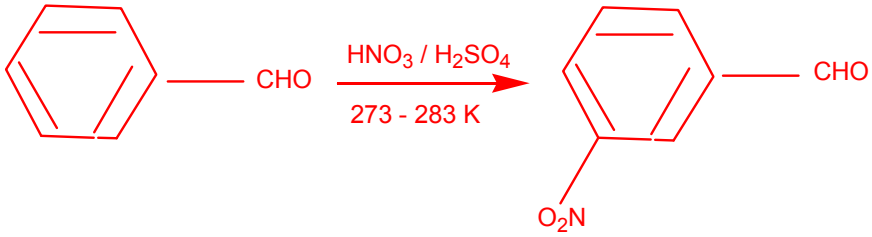


alpha - Bromoacetic acid

iii. 

$\xrightarrow[H_2SO_4]{HNO_3}$ 273 - 283 K

Answer:



m-Nitrobenzaldehyde

b. Give simple chemical tests to distinguish between the following pairs of compounds:#

i. Ethanal and Propanal

Answer:

Distinguish test between ethanal and propanal:

Iodoform Test: Ethanal gives iodoform test.
$CH_3CHO + 4NaOH + 3I_2 \rightarrow CHI_3$ (Yellow ppt.) $+ HCOONa + 3NaI + 3H_2O$
Propanal does not give this test. $CH_3CH_2CHO + 4NaOH + 3I_2 \rightarrow$ No Reaction.

ii. Benzoic acid and Phenol

Answer:
Distinguish test between Benzoic acid and Phenol:
$NaHCO_3$ Test: When Benzoic acid reacts with $NaHCO_3$, brisk effervescence of CO_2 gas evolved.

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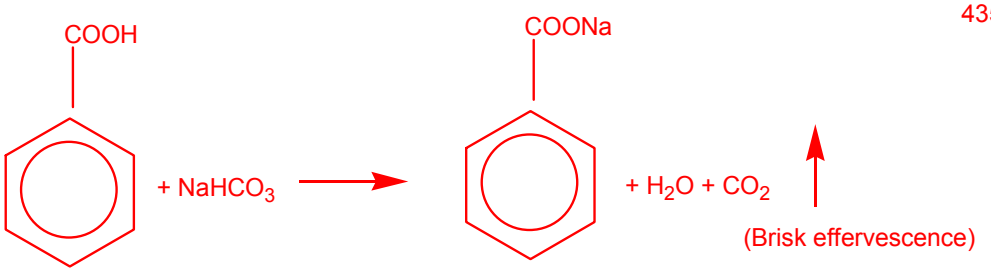

Phenol does not give this test.
$C_6H_5OH + NaHCO_3 \rightarrow$ No Reaction

(**) Currently out of syllabus. Answer can be provided up on request