2017

Part I *(Answer all questions)*

Question: 1

a. Complete the following statements by selecting the correct alternative from the choices Given: [5]

1. Indigo is an example of a :

    a. Direct dye
    b. Vat dye
    c. Mordant dye
    d. Azo dye

Answer:
Vat dye.

2. The bond angle in ammonia is : -

    a. 900
    b. 1070
    c. 1090
    d. 1200

Answer:
1070

3. Copper is extracted from its ore by:

    a. Electrolytic reduction
    b. Auto reduction
    c. Cyanide process
    d. Magnetic separation

Answer:
Auto reduction

4. Effervescence takes place when sodium carbonate solution is added to :

    a. Formaldehyde
    b. Acetaldehyde
    c. Acetic acid
    d. Phenol

Answer:
Acetic acid

5. An example of an electrophile is :

a. NO_2

b. NO_2+

c. NO_2-

d. NO_3 –

Answer:
NO_{2+}

b. Fill in the blanks choosing appropriate words given in brackets: [5]

[acidic, basic, active, oxidizing, reducing, bleaching, inductive, mesomeric, liquids, solids, oils, fats, sideways, head on, s,p,z, silver, zinc, higher, lower same].

1. Copper displaces _____ Form its solution because it has a _____ reduction potential.

Answer:
Silver, higher.

2. Pi bonds are formed by _____ Overlap of _____ orbital.

Answer:
Sideways, p.

3. $CaOCl_2$ acts as a _____ agent because of its _____ properties.

Answer:
Bleaching, lower oxidizing.

4. Methylamine is more _____ than ammonia because of _____ effect.

Answer:
Basic, inductive.

5. Glycerides in which unsaturated fatty acids predominate are _____ at room temperature and are called _____

Answer:
Liquids, oils.

c. Give reasons for the following in one or two sentences. [5]

1. Hydrogen sulphide has a lower boiling point than water.

Answer:
Hydrogen sulphide has a lowering point than water because in water strong hydrogen bonding exists, while H2S does not have that much of strong hydrogen bonding.

2. Adding common salt precipitates soap out.

Answer:

Addition of common salt in soap results into precipitation due to common ion effect.

3. Phenol is more easily nitrated than benzene.

Answer:

Phenol group strongly activates the benzene ring and increases the electron density at ortho- and para- positions hence it is easily nitrated than benzene.

4. Excess vitamin B and C are flushed out of the body easily while vitamin D and E are not. **

5. β - emission result in isobars which are placed one place to right, in the periodic table, of the parent element.

Answer:

Excess vitamins B and C are furshed out of the body easily while vitamins D and E are not because B and C are water soluble vitamins D and E are not water soluble rather fat-soluble.

d. Match the following:

i. Colligative property	a. Polysaccharide
ii. Nicol prism	b. Osmotic pressure
iii. Activation energy	c. Aldol condensation
iv. Starch	d. Polarimeter
v. Acetaldehyde	e. Arrhenius equation

Answer:

Colligative property-Osmotic pressure
Nicol prism-Polarimeter
Activation energy-Arrhenius equation
Starch-Polysaccharide
Acetaldehyde-Aldol condensation

Part II *(Answer six questions choosing two from section A, two from section B. And two from section C)*

Section A *(Answer any two questions)*

Question: 2

a.

i. Ethylene glycol is used as an antifreeze agent. Calculate the amount of ethylene glycol to be added to 4kg of water to prevent it from freezing at -6. [3]

Answer:

Given: Δ_{Tf} = -60c, w = 4kg, w' = ?

$$w' = \frac{\Delta T_f \times w \times M}{K_f \times 1000}$$

$$= \frac{6 \times 4 \times 62}{1.85 \times 1000}$$

w' = 0.8kg = 800 kg.

.

ii. The freezing point of a solution containing 0.3 gms of acetic acid in 30gms of benzene is

lowered by 0.45 K. calculate the Van't Hoff factor. [2]

(at. Wt. of C = 12, H = 1, O = 16, K_f for benzene = 5.12 K kg $mole^{-1}$).

Answer:

We know that $\Delta T_f = I\, K_f\, m$

Where i represents Van't Hoff factor,

molarlity , $m = \frac{w \times 1000}{M \times W}$

$m = \frac{0.3 \times 1000}{60 \times 30}$

Now, $i = \frac{\Delta T_f}{K_f \times m}$

$\frac{0.45}{5.12 \times 0.17}$

= 0.517.

b. Name the low or principle confirmed by the following observations:

i. . If the molality of an aqueous solution of cane sugar is 0.4445, what is the mole fraction of cane sugar.. [4]

Answer:

The mole fraction of cane sugar solution

$$\frac{\frac{w}{m}}{\frac{w}{m} + \frac{W}{M}} = \frac{0.4445}{0.4445 + \frac{1000}{8}} = \frac{0.4445}{0.4445 + 55.55}$$

$$= \frac{0.4445}{56}$$

Mole fraction = 0.0079

ii. Albumins are the most abundant proteins in blood. At 250C, 3,5 g of albumin in 100 ml of water produces an osmotic pressure of 0,014 atms. What is the molecular weight of albumin? [3]

Answer:

$m = \frac{wRT}{\pi V}$

W = 3.5 g , R = 0.0821 atm mol^{-1} k^{-1}, T = 273 + 25 = 298 K

π = 0.014 atm, V = 100 ml = 100 x 10^{-3} litre

$m = \frac{3.5 \times 0.0821 \times 298}{0.014 \times 100 \times 10^{-3}}$

$= \frac{3.5 \times 821 \times 298}{140}$

m = 61164.5

c. Arrange Ag, Cr and Hg metals in the increasing order of reducing power. Given:

$E^o_{Ag^+/Ag} = 0.80\,V \quad E^o_{cr^{+3}/cr} = -0.74\,V \quad E^o_{Hg^{+2}/Hg} = +0.79\,V$ [1]

Answer:

$E^{o}_{Ag^{+}/Ag} < E^{o}_{Hg} < E^{o}_{Cr^{3+}/Cr}$

d. Describe the unit cell of sodium chloride with a neat diagram stating: [3]

1. Type of bonding.

Answer:

Ionic (electrovalent) bonding holds, sodium and chloride ions together.

2. Type of unit cell.

Answer:

Sodium chloride has face centered cubic lattice.

3. Number of nearest neighbours around sodium and chloride.

Answer:

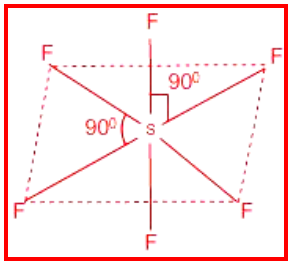
Nearest neighbours of sodium and chloride ions are six, i.e each sodium ion is surrounded by six chloride ions and similarly each chloride ion is surrounded by six sodium ions.

Question: 3

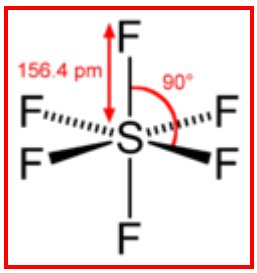
a.

i. Draw the structure of sulphure hexafluoride molecule. State the hybridization of the central atom and the geometry of the molecule. How many sigma bonds are present in the molecule? [2]

Answer:



Structure of sulphur hexafluoride, SF_6.
Hybridization of central atom S is sp^3d^2.
Geometry of the molecule is octahedral. There are six sigma bonds present. Four σ- bonds in the same plane, one above and one below the plane.



ii. Lead(II) sulphide has FCC crystal structure. The edge length of the unit cell of PbS crystal is 500 pm. What is its density ? [Pb = 207.2, S = 32]

Answer:

For a cubic crystal, density p is given by

$$p = \frac{Z \times M}{a^3 \times N_A}$$

Given: Z = 4 formula units for FCC arrangement.
M = (207.2 + 32) for Pbs.
A = 500pm = 500 x 10-10 cm.
NA = 6.02×10^{23}

$$\therefore \text{ Density of Pbs, } \rho = \frac{4 \times 239.2}{(500 \times 10 - 10)^3 \times 6.02 \times 10^{23}} = 12.715 \text{ g cm}^{-3}$$

b.

i. Explain the purification of common salt by bubbling hydrogen chloride through the aqueous solution.

Answer:

Purification of common salt by bubbling HCl through the aqueous solution is based on the concept of solubility product. In a saturated solution of NaCl following equilibrium exists.

$NaCl\ (s) \rightleftarrows Na^+_{(aq)} + Cl^-_{(aq)}$

For this $K_{sp} = [Na^+][Cl^-]$

When hydrogen chloride gas is bubbled through the saturated aqueous solution of impure NaCl, concentration of Cl- ions increases and the product $[Na^+][Cl^-]$ exceeds Ksp for NaCl. Therefore pure NaCl starts precipitating leaving the impurities in the solution.

ii. Calculate the pH of a buffer solution containing 0.45 moles of NH_4OH and 0.75 moles of NH_4Cl. Kb for NH_4OH is 1.8 x 10-5 [3]

Answer:

Basic buffer, Henderson's equation is

$$pOH = pKb + \log 10 \frac{[Salt]}{[Base]}$$

Given Kb = 1.8 x 10-5 [Salt] = 0.75, [Base] = 0.45

$$\therefore pOH = -\log_{10}(1.8 \times 10^{-5}) + \log_{10}\frac{0.75}{0.45}$$

= 4.745 + 0.2218
= 4.9668
Now pH = 14 – pOH
= 14 – 4.9668
= 9.033
So, pH of given basic buffer of NH_4Cl and NH_4OH is 9.033.

c. Will nickel displace copper form a 1M solution of copper sulphate? Justify your answer.
$\left[E^0_{Ni^{+2}/Ni} = 0.25V, E^0_{Cu^{+2}/Cu} = +0.34V\right]$ [1]

Answer:

Nickel will displace Cu^{++} ions from 1 M Copper solution between E0red for Nickel is less than that of Copper.

$Ni(s) + Cu^{++}_{(aq)} \rightarrow Ni^{++}_{(aq)} + Cu_{(s)} \downarrow$

Question: 4

a.

1. Calculate the solubility of AgCl in 0.2 M solution of sodium chloride
   K_{sp} of AgCl = 1.2×10^{-10} [6]

Answer:

Given K_{sp} AgCl = 1.2×10^{-10}
For AgCl $K_{sp} = s^2$ or $[Ag+]\,[Cl^-]$
In 0.2 M NaCl solution:
AgCl Δ Ag+ + Cl-

s s
$NaCl \rightarrow Na + Cl^-$
0.2 0.2
[Ag+] = s and [Cl0] = z + 0.2
Ksp = [Ag+] [Cl-] = s x (s + 0.2)

2. A current of 10 A is passed for 80 min. and 27 seconds through a cell containing dilute sulphuric acid.

   i. How many moles of oxygen gas will be liberated at the anode?
   ii. Calculate the amount of zinc deposited at the cathode when another cell containing $ZnSO_4$ solution is connected in series (Zn = 65).

Answer:

On passing electric current through dilute H2SO4 hydrogen gas is evolved at cathode and oxygen gas at anode.

Calculation of charge = Q = I x t = 10 (80 x 60 + 27)
Q = 48270 coulomb

(1) The number of moles of O_2 liberated will be:
Calculation of mole of O_2

96500 deposits one gm equivalent of element = 8g of O_2 = $\frac{1}{4}$ mole

96500 C = $\frac{1}{4}$ mole O_2

48270 C = 0.125 mole of O_2

(2) Calculation of mass of zinc:
96500 coulomb = 65/2 g zinc
48270 coulomb = 16.25 g zinc

3. Calculate: E_{cell} at 25°C for the reaction: $Zn + Cu^{2+}$ (0.20 M) $\rightarrow Zn^{2+}$ (M) + Cu. Given: E° (Zn^{2+} / Zn) = - 0.76 volt; E° (Cu^{2+} / Cu) = 0.34 volt.

Answer:

$$E_{cell} = E^0_{cell} - \frac{10591}{n} \log \frac{[Product]}{[Reactant]}$$

$$E_{cell} = 0.34 - (-0.76) - 0.00. \frac{0.0591}{n} \log \left[\frac{0.50}{0.20}\right]$$

$$E_{cell} = 1.10 - 0.02955 \times 0.3979$$

$E_{cell} = 1.088\ V$

b.

1. Specific conductance decreases with dilution where as equivalent conductance increases with dilution [2]

Answer:

Specific conductance decreases with dilution as the number of current carrying particles i.e ions present per cm^3 of solution becomes less and less.

Equivalent conductance increases with dilution because the degree of dissociation of an electrolyte increases on dilution.

2. Lead is precipitated as PbS while zinc is not precipitated when H_2S gas is passes through an acidic solution of lead nitrate and zinc nitrate.

Answer:

Lead is precipitated as PbS while zinc is not precipitated as ZnS when H_2S is passed in their acidic solution because the dissociation of H_2S is suppressed in acidic medium due to common ion effect and the concentration of Zn^{++} and S—ions (from H_2S) is not enough to exceed the Ksp of ZnS, therefore precipitatin does not take place.

c. Mention any two factors that influence the rate of a chemical reaction. [1]

Answer:

Rate of a chemical reaction can be affected by:

(i) Concentration.
(ii) Temperature.

Section B *(Answer any two questions)*

Question: 5

a. A gas cylinder of 5 litre capacity containing 4 kg of helium gas at 27°C developed a leak leading to the escape of gas into the atmosphere. If the atmosphere pressure was 1.0 atmosphere, calculate the work done by the gas, assuming ideal behaviour. [3]

Answer:

In irreversible isothermal process, $W = P\Delta V$ where P = 1.0 atmosphere, ΔV = 5 litre or W = 1 x 5 = 5 litre atm.

b. Arrange the following in increasing order of acidity and name the property which describes this order: [2]

i. $HCOOH$, CH_3COOH, $CH_2ClCOOH$.

Answer:

$CH_2ClCOOH < HCOOH < CH_3COOH$
Property: Inductive effect

ii. CH_3COOH, CH_3OH, C_6H_5OH.

Answer:

$CH_3OH < CH_3COOH < C_6H_5OH$

Property: Inductive effect

Both methyl alcohol and acetic acid contains methyl group which has +I effect but due to the presence of carbonyl group which has +I effect, acetic acid is stronger than methyl alcohol.

Due to the presence of electron withdrawing phenyl group phenols are acidic due to formation of phenoxide ions in aqueous solution.

Question: 6

a. Give balanced chemical equation for the following:

i. Chlorine gas is passed through cold, dilute NaOH [3]

Answer:

$2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$

ii. Sulphur dioxide gas is passed through NaOH solution.

Answer:

$2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$

iii. Zinc is added to sodium argentocyanide solution.

Answer:

$Zn + 2Na\,[Ag\,(CN)_2] \rightarrow Na_2[Zn(CN)_4] + 2Ag \downarrow$

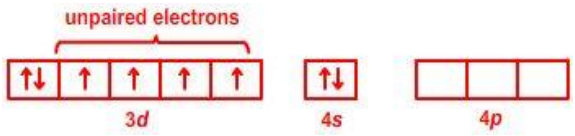
b. Iron is ferrogmagnetic in nature. Explain why. [2]

Answer:

Ferromagnetic substances have a larger number of unpaired electrons and are attracted strongly in a magnetic field.

$Fe2_6$ has $4s^2 3d^6$ valence shell configuration with four unpaired electrons in 3d. So it is ferromagnetic when all four unpaired electrons get aligned in the same direction in a given magnetic field.

Fe_{26} atom's valence shell



Question 7

a. In the extraction of zinc from zinc blende: [2]

i. Give an equation to show how zinc oxide is converted to zinc.

Answer:

ZnO + C → Zn + CO
Zinc oxide Coke Zinc

ii How is impure zinc finally electro refined?

Answer:
In electrolytic methods, on passing electric current pure zinc is obtained at cathode using impure rod of zinc as anode and zinc sulphate as electrolyte.

b. Explain why:

i. Transition elements form coloured compounds.

Answer:
Transition elements form coloured compounds due to d-d transitions taking place between the splitted d-orbitals.

ii. Interhalogen compounds are more reactive than their constituent elements. [2]

Answer:
Interhalogen compounds are more reactive than their constituent elements because x-y bonds present in them are weaker than x-x and y-y bonds.

iii. Cu^{+} is diamagnetic but Cu^{2+} is paramagnetic. (Z = 29)

Answer:
Cu^{+} is diamagnetic due to $3d^{10}$ configuration it has no unpaired electrons while Cu^{2+} has $3d^{9}$ configuration and one unpaired electron.

Section C *(Answer any two questions)*

Question: 8

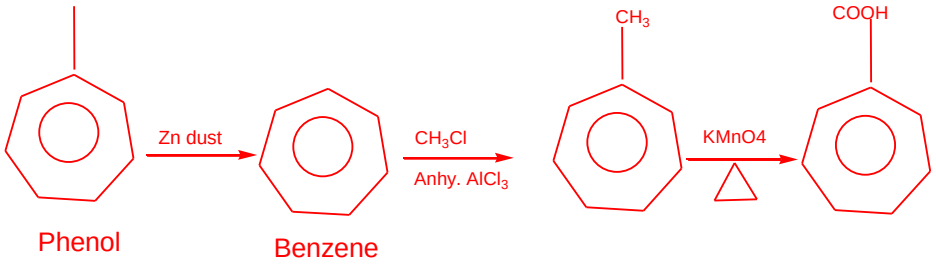
a. How will you carry out the following conversions:

i. Acetaldehyde to acetamide. [7]

Answer:
See topics on 'Amino acids'.

ii. Phenol to benzoic acid [2]

Answer:



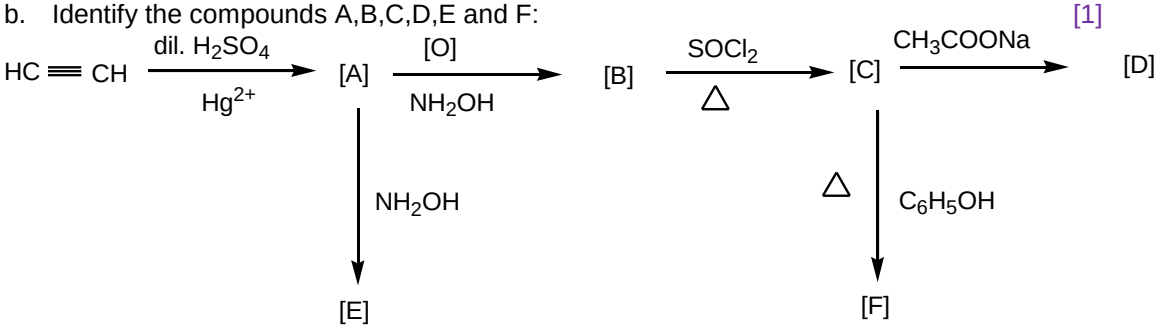
iii. Glucose to saccharic acid.

Answer:

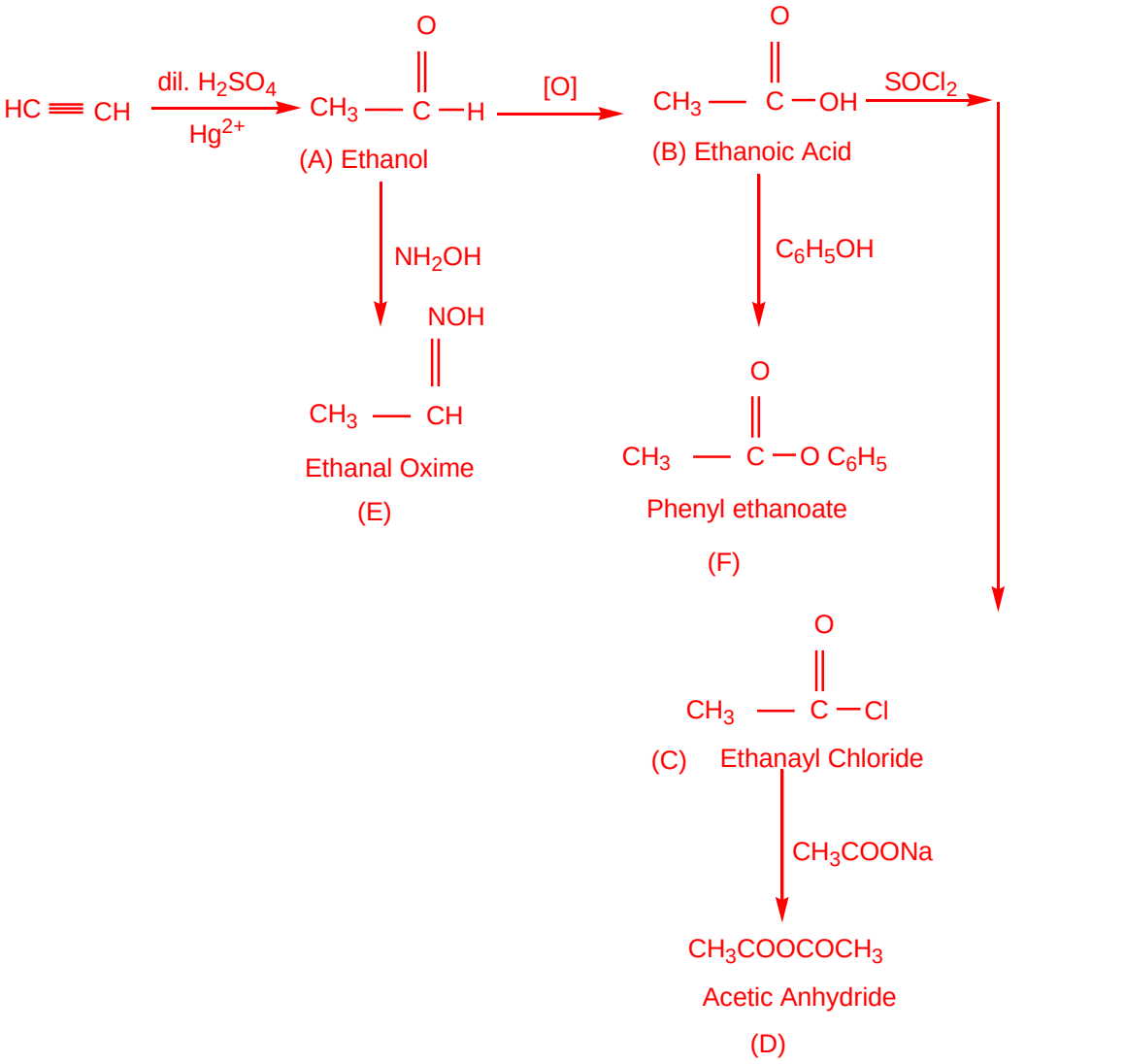
$HOCH_2.(CHOH)_4CHO + O \xrightarrow{\text{Conc. } HNO_3} HOOC(CHOH)_4COOH$

Saccharic acid

b. Identify the compounds A,B,C,D,E and F: [1]



Answer:



Question: 9

a. Give one test each to distinguish between: [3]

1. Acetaldehyde and formaldehyde.

Answer:

Acetaldehyde when heated gently with iodine and caustic alkali, gives a yellow ppt. of iodoform.

$CH_3CHO + 3I_2 + 4NaOH \rightarrow CHI_3 \downarrow HCOONa + 3NaI + 3H_2O$

Acetaldehyde Iodoform

Formaldehyde does not give this test.

2. Acetone and acetic acid.

Answer:

Acetic acid when heated with ethyl alcohol in presence of conc. H_2SO_4 from ethyl acetate which has a fruity smell (ester smell)

$$CH_3COOH + C_2H_5OH \xrightarrow[conc.H_2SO_4]{\text{with}} CH_3COOC_2H_5 + H_2O$$

Acetic acid Ethyl ethanoate

3. Starch and cellulose.

Answer:

Starch gives a deep blue-black color with iodine

b. Give one chemical test to distinguish between the following pairs of compounds: [3]

i. Acetone and phenol.

Answer:

Phenol gives violet colour with neutral $FeCl_3$ while neutral $FeCl_3$ while acetone does not give this test.

$C_6H_5OH + FeCl_3 \rightarrow$ Violet colour

Phenol

ii. Fromic and Acetic acid

Answer:

Formic acid gives silver mirror test with Tollen's reagent while acetic acid does not give this test.

$HCOOH + 2[Ag(NH_3)_2OH] \rightarrow 2Ag + 2H_2O + CO_2 + 4NH_3$

Formic acid Tollen's reagent Silver mirror

$CH_3COOH + 2[Ag(NH_3)_2OH] \rightarrow$ No reaction

Acetic acid

iii. Name the type of isomerism exhibited by the following pairs of compounds:

1. $(C_2H_5)_2NH$ and $CH_3\text{-}NH\text{-}C_3H_3$

Answer:

$(C_2H_5)_2NH$ and $CH_3NH\ C_3H_7$ exhibit Metamerism.

2. I-butanol and 2 methyl-1-propanol [2]

Answer:

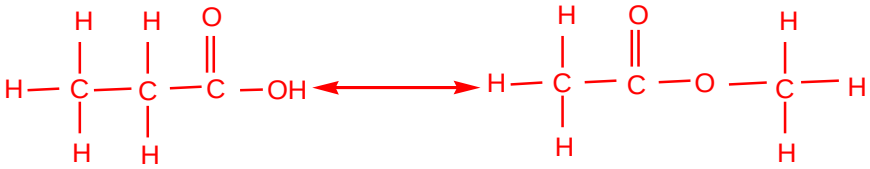
1-butanol and 2-methyl-1-propanol exhibit structural chain isomerism.

iv. Name the type of isomerism that the compound with molecular formula $C_3H_6O_2$ exhibits. Represent the isomers. [2]

Answer:

C_3H6O_2

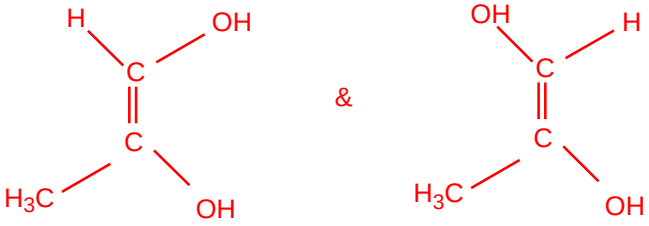
1. Functional isomerism: The isomers will be



Acetic Acid Methyl Acetate

These isomers exhibit functional group isomerism.

2. Geometrical isomerism: The isomers will be



cis form Trans form

Question: 10

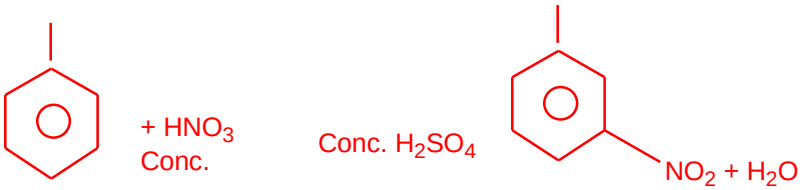
a. Write balanced equation for the following reactions: [4]

i. Oxalic acid is treated with acidified potassium permanganate solution.

Answer:

ii. Benzoic acid is treated with a mixture of concentrated nitric acid and concentrated sulphuric acid.

Answer:

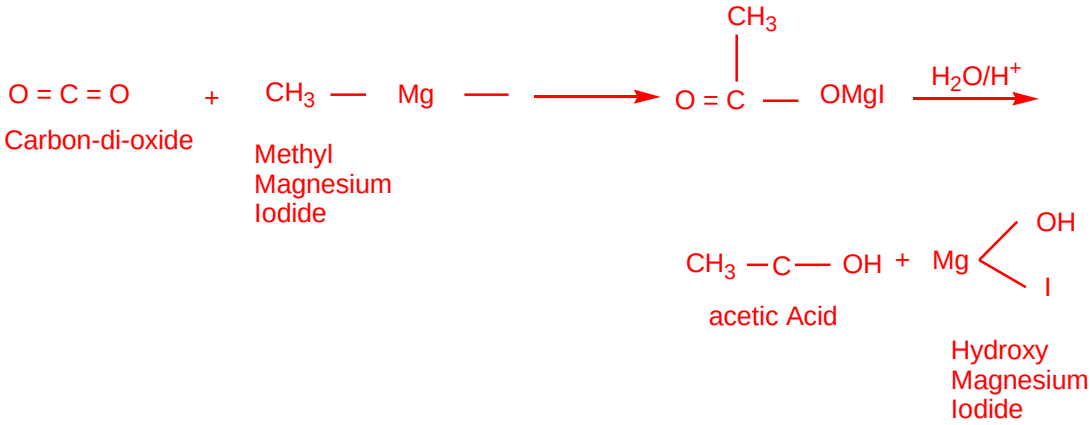


Benzoic Acid

m-nitro Benzoic Acid

iii. Methyl magnesium iodide is treated with carbon dioxide and the product hydrolysed in acidic medium.

Answer:



Carbon-di-oxide

Methyl Magnesium Iodide

acetic Acid

Hydroxy Magnesium Iodide

iv. Ethylacetate is treated with ammonia.

Answer:

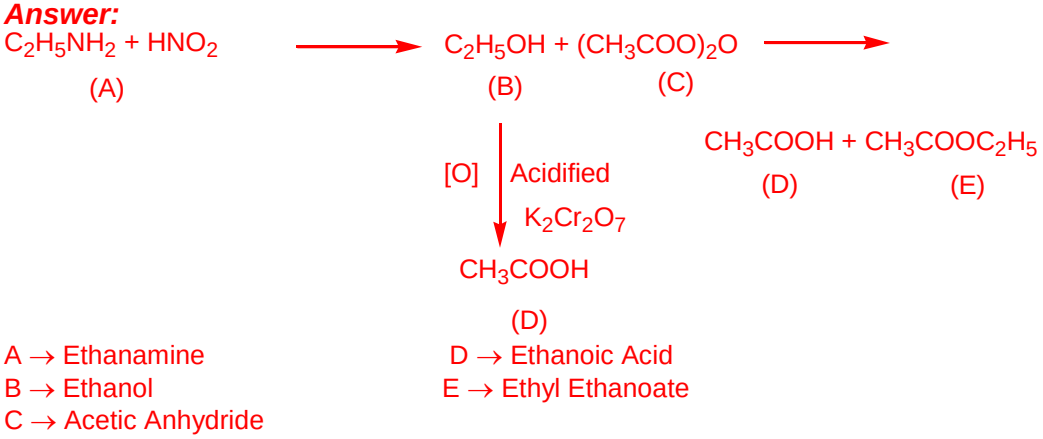
$CH_3COOC_2H_5 + NH_3 \rightarrow CH_3CONH_2 + C_2H_5OH$

Ethyl Acetate Ammonia Ethanamide Ethanol

b. An organic compound [A] having molecular formula C_2H_7N on treatment with nitrous acid gives a compound [B] having molecular formula C_2H_6O. [B] on treatment with an organic compound [C] gives a carboxylic acid [D] and a sweet smelling compound [E]. Oxidation of [B] with acidified potassium dichromate also gives [D]. [4]

i. Identify [A], [B], [C], [D] and [E].

Answer:



A → Ethanamine
B → Ethanol
C → Acetic Anhydride
D → Ethanoic Acid
E → Ethyl Ethanoate

ii. Write balanced chemical equation of [D] with chlorine in the presence of red phosphorus and name the reaction.

Answer:

$CH_3COOH + Cl_2 \xrightarrow{Red\ P} ClCH_2COOH$

(D)

Acetic Acid

This reaction is known as Hell Volhard – Zelinsky reaction.

c. Acetamide is amphoteric in nature. Give two equations to support this statement. [2]

Answer:

Acetamide is amphoteric in nature because it behave both as weak bases as well as weak acids.for ex.

Basic Nature:

$CH_3CONH_2 + HCl \rightarrow CH_3C\overset{+}{O}NH_3Cl^-$

Acetamide Ethanamide Hydrochloride

Acidic Nature:

$2CH_3CONH_2 + HgO \rightarrow (CH_3CONH_2)_2Hg + H_2O$

Acetamide Mercuric oxide Mercuric Acetamide