

LAST LOOK

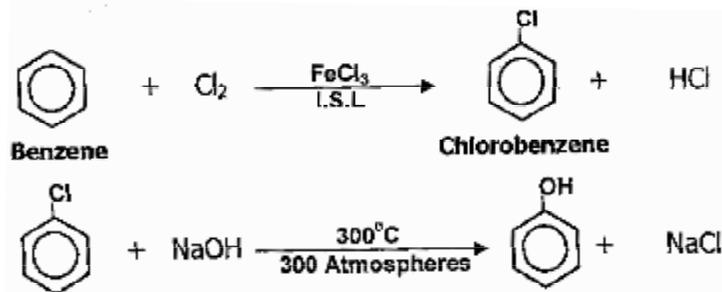
Question (no. 5)

Various questions

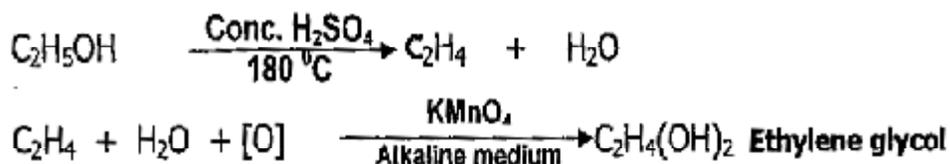
1- By using balanced symbolic chemical equations, how can you obtain :

1. Phenol from benzene .
2. Ethylene glycol from ethanol .

1- Obtaining phenol from benzene :

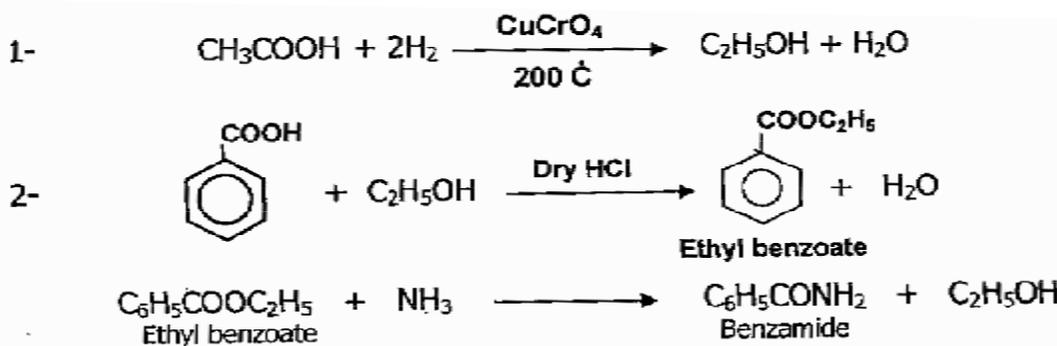


2- Ethylene glycol from ethanol



2- Show by balanced chemical equations : (Write the conditions of reaction):

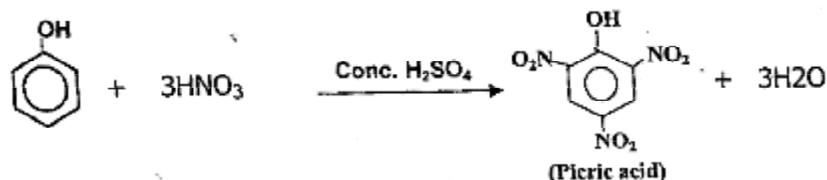
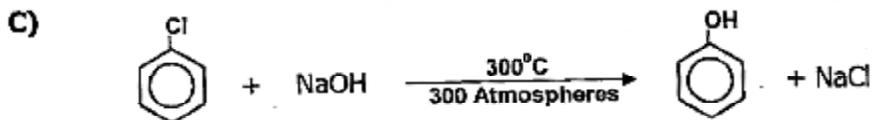
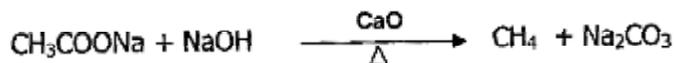
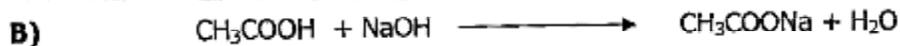
- 1- Conversion of carboxylic group of an organic compound into hydroxyl group
- 2- Conversion of an aromatic acid into an acid amide.



3- Show by balanced chemical equations, how to obtain :

A- Methane gas from ethanoic acid.

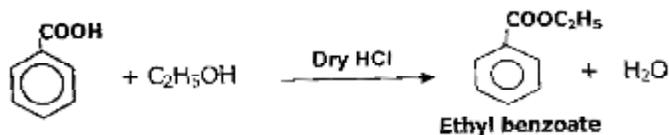
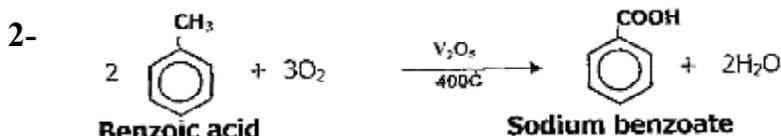
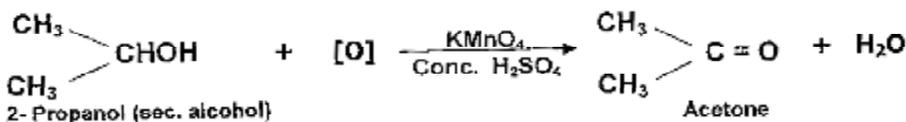
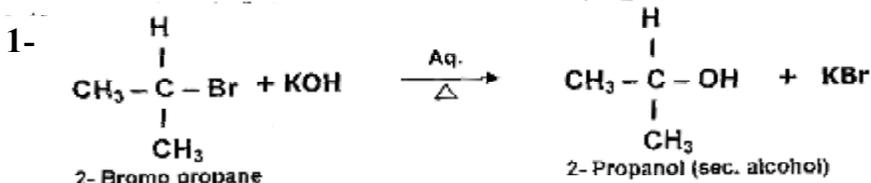
B- Picric acid from chlorobenzene .



4- Show by balanced chemical equations, how can you obtain each of the following:

1- aAcetone from 2- Bromopropane .

2- Ethyl benzoate ester from toluene.



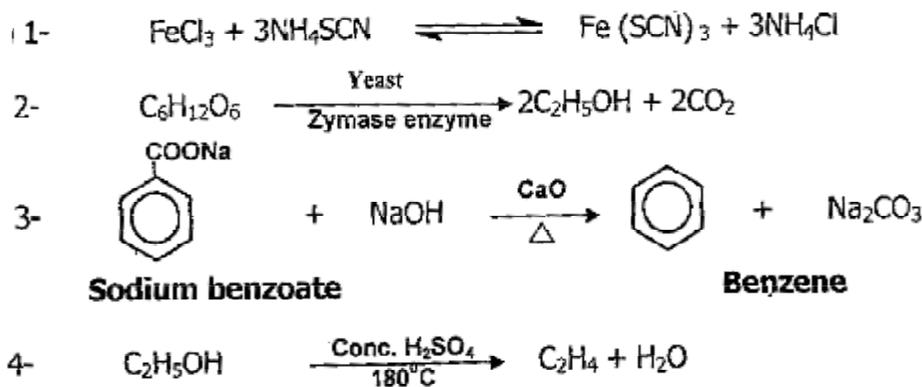
5- Show by balanced chemical equations what happens in each of the following cases:

1- Addition of iron (III) chloride solution to ammonium thiocyanate solution.

2- Addition of yeast (zymase enzyme) to glucose solution.

3- Dry distillation of sodium benzoate.

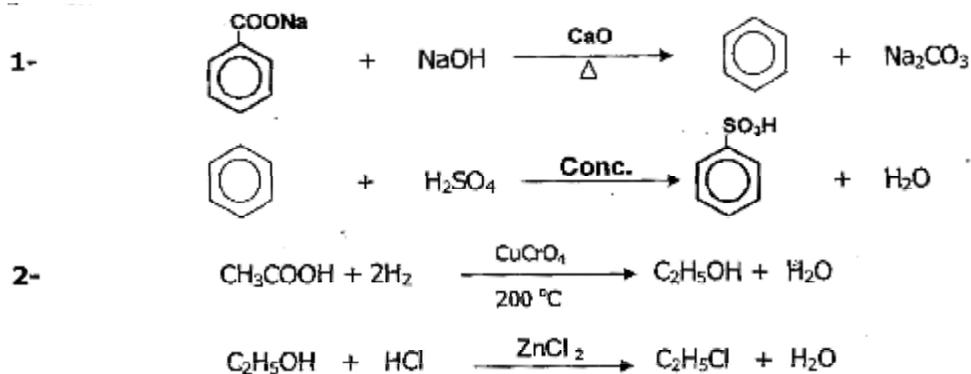
4- The reaction of ethanol with concentrated sulphuric acid at 180°C.



6- Show by balanced chemical equations, how can you obtain each of the following :

1- Benzene sulphonic acid from sodium benzoate.

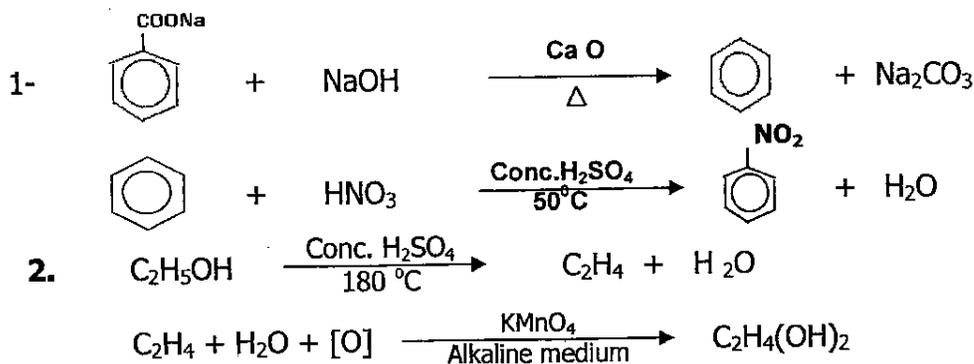
2- Ethyl chloride from acetic acid.



7- By using the balanced symbolic chemical equations, how can you obtain:

1- Nitrobenzene from sodium benzoate.

2- Dihydric alcohol from monohydric alcohol.



10-

Acetic acid	Formic acid	Oxalic acid
Ethyl formate	Methyl acetate	Ethyl acetate

From the above table find :

- 1- Two isomers.
- 2- Two compound that give acetamide on ammonolysis.
- 3- Compounds that give effervescence with NaHCO_3 (one enough).
- 4- Compound that is named according to IUPAC ethyl methanoate.

- 1) Ethyl formate-methyl acetate (Two isomers) .
- 2) Methyl acetate – ethyl acetate (Two compounds from acetamide)
- 3) Acetic acid- formic acid – oxalic give effervescence with sodium bicarbonate (One acid is enough)
- 4) Ethyl formate.

11-

Methyl acetate	Sodium acetate	Ethanoic acid
Methyl formate	Potassium acetate	Ethyl formate

From the previous table illustrate the following :

- 1) The esters .
- 2) The salts of the carboxylic acids.
- 3) The compounds which take a name according to IUPAC system .
- 4) The isomeric compounds.

12-

Formic acid	Ethanoic acid	Oxalic acid
Salicylic acid	Butyric acid	Benzoic acid

From the previous table mention the following :

- 1) Aromatic monocarboxylic acid .
- 2) Dicarboxylic acid.
- 3) An acid in which the number of carboxylic groups equals the number of carbon atoms .
- 4) An acid contains two functional groups.
 - 1) Benzoic acid. 2) Oxalic acid. 3) Oxalic acid. 4) Salicylic acid.

13- Give reason for each of the following :

1. Salt bridge must be used in Galvanic cells.
 2. Cone. Sulphuric acid is added in ester formation and nitration.
 3. The catalyst does not affect the position of equilibrium in the reversible reactions.
 4. density of oxygen gas is more than of nitrogen. [N = 14 , O = 16]
-
- 1) To neutralize of excess ions in both half cells. Thus, it prevents the formation of electric potential between two solutions.
 - 2) To absorb the water produced and prevent the reversible reaction.
 - 3) Catalyst decreases the activation energy required to accelerate reversible and irreversible reaction at the same time.
 - 4) Because molecular mass of O₂ which is (32) is more than of N₂ which is (28).

14- Give reasons for the following :

- Using a mixture of fluoride salts of aluminum, Sodium and calcium instead of cryolite containing a little amount of fluorspar in the extraction of aluminum from bauxite.
- Because this mixture gives with bauxite a melt which is characterized by a low melting point and a lower density compared to the melt obtained from Cryolite.

15- Mention the structural formula of :

1- Naphthaline.

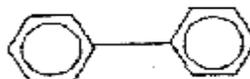
2- Diphenyl

Do you consider these two compounds isomers? Why ?

1) Structural formula for naphthaline is



2) Structural formula for diphenyl is



They are not isomers due to different molecular formula for each of them, where (C₁₀H₈) naphthaline – C₁₂H₁₀ diphenyl)

16- The molecular mass of a hydrocarbon is 58 grams, its mole contains 48 grams carbon (H= 1 , C = 12)

- 1- Write the molecular formula for this compound.
- 2- This compound has two isomers (isomerism), write the structural formula for each isomer.

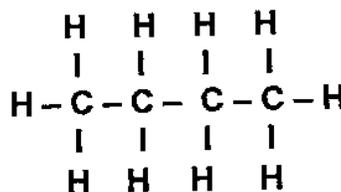
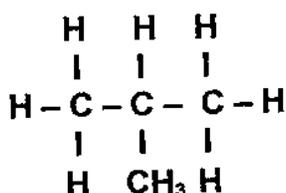
Mass of hydrogen = 58 – 48 = 10 grams

Number of carbon atoms = 48 ÷ 12 = 4 atoms

Number of hydrogen atoms = 10 atoms

The molecular formula of the hydrocarbon C₄H₁₀

The structural formulas for the two isomers are :



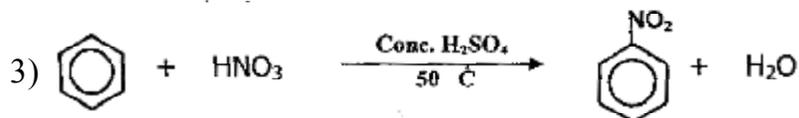
17- Read the following statement. Then answer the questions that follow it :

When glycerol reacts with nitric acid in the presence of concentrated sulphuric acid substance (x) is produced. Substance (x) is used to widen arteries in the treatment of heart crisis .

- 1- What is the name of the substance (x) ?
- 2- Mention another use for substance (x) .
- 3- Write the balanced chemical equation which describes the reaction of nitric acid with benzene in the presence of hot concentrated sulphuric acid (50°C).

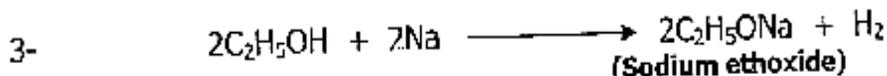
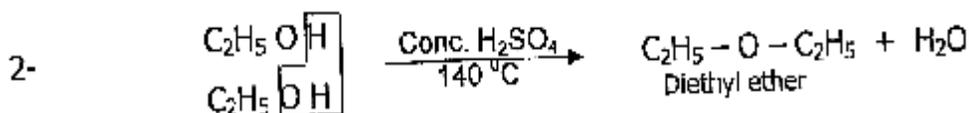
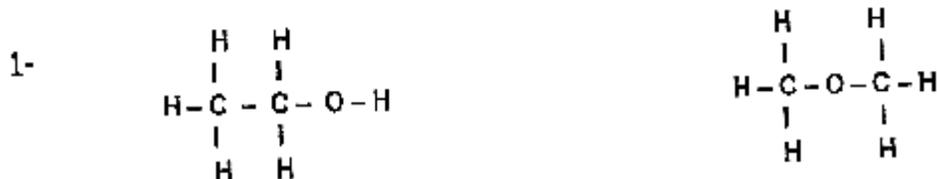
1) Tri-nitroglycerine.

2) It is used in the prearation of explosive substance.



18- A and B are two organic compounds having the molecular formula [C₂H₆O]

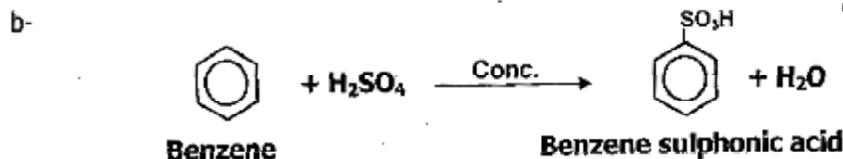
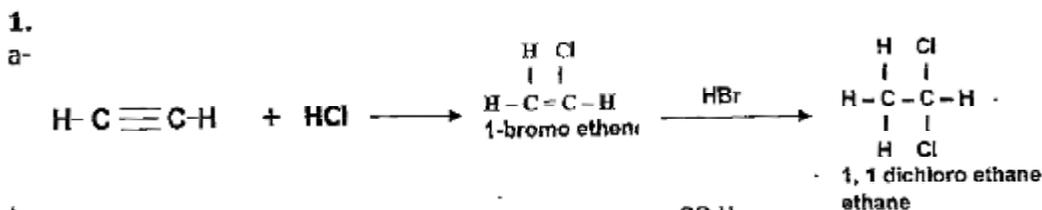
- 1- Write the structural formula for each compound.
- 2- If compound (A) responds to oxidation reactions and compound (B) does not. How can you convert compound (A) to a compound that has the function group of compound (B) ?
- 3- How can you obtain hydrogen from one of the two compounds?



19- When calcium reacts with carbon compound (A) is formed. On dropping water on compound (A) compound (B) is formed. On adding water to compound (B) in presence of catalyst and heating a liquid (C) is formed. On passing compound (B) through a red hot nickel tube a vapour of compound (D) is formed.

From the previous information :

- 1- Write the balanced chemical equations that illustrate the following :
 - a) How to obtain dichloroethane from compound (B) ?
 - b) The effect of concentrated sulphuric acid on compound (D).
- 2- Mention one use for compound (C).



2- Preparation of ethanoic acid (acetic)

20- An experiment was carried out on two organic compound (A) and (B). It was found that :

- Compound (A) reacts with sodium metal and not with sodium hydroxide.
- Compound (A) reacts with both sodium carbonate and sodium hydroxide.

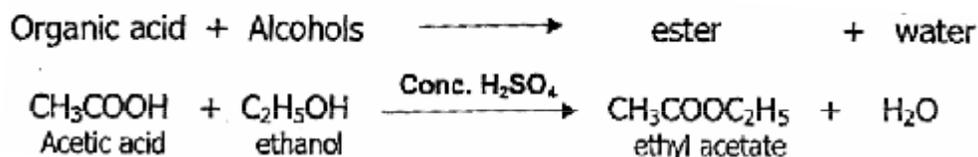
1- To which group of compounds do (A) and (B) belong? Give an example for each group.

2- Write a symbolic equation for the reaction between (A) and (B) with reference to the conditions of the reaction.

✗ Compound (A) is ethanol (C₂H₅OH)

✗ Compound (B) is acetic acid (CH₃COOH)

✗ The reaction between (A) and (B) :



21- Explain the role of each of the following :

- 1- Analytical chemistry in agriculture.
- 2- Catalysts in industry.

1- Analytical chemistry in agriculture :

It is possible to know the constituents of a soil and rocks to decide whether the soil is suitable or not for cultivation.

2- Catalysts in industry :

It is possible to accelerate most of the slow reactions by using catalysts which increase the reaction rate without raising the temperature. This tends to save energy. Catalysts are used in more than 90% of the industrial processes such as foods, petrochemicals and fertilizer industries.

22- What is the role of each of the following :

- 1) Potassium hydroxide in the mercury cell.
- 2) Soda lime in preparation of methane .
- 3) Potassium permanganate in Baeyer's reaction .
- 4) Concentrated sulphuric acid in the reaction of ester formation.

- 1- It is used as an electrolyte .
- 2- Soda lime is a mixture of sodium hydroxide and calcium oxide.
Sodium hydroxide reacts with sodium acetate forming methane and sodium carbonate calcium oxide helps in :
 - Reducing the melting point of the mixture.
 - Absorbing water vapour.
- 3- It acts as an oxidizing agent .
- 4- It absorbs the produced water and prevents the reversible reaction .

23- You are provided with three glasses containing : Ethanol – phenol – acetic acid. Explain how you can identify each of them practically.

Add acidified potassium dichromate dichromate to the same amount of the three solutions , heat the mixture in a water bath for 10 minutes. If the colour changes from orange to green then the solution is ethanol.

- Add iron III chloride to the three solutions. If violet colour appears then the solution is phenol.
- Acidic test: add sodium carbonate or bicarbonate, if effervescence takes place and carbon dioxide gas is evolved which turbids lime water then the solution is acetic acid.

24- How can you differentiate practically between ?

1. Dilute acetic acid and pure acetic acid.
2. Ethyl alcohol and phenol.
3. Methane and ethyne.
4. litmus solution and phenolphthalein solution.

1) By passing an electric current in each of them.

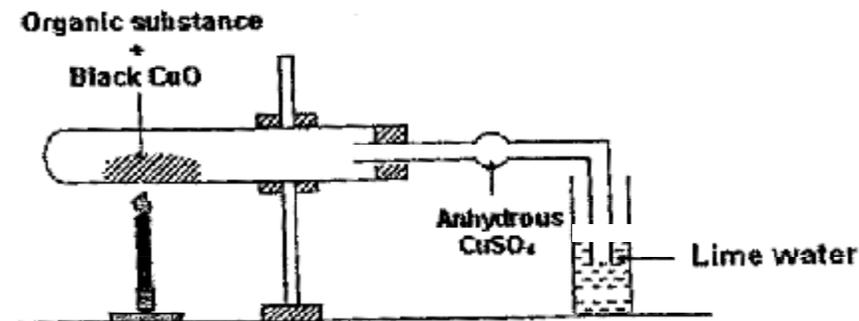
Electric conductivity of dilute acid is more than pure acid, In case of dilute acetic acid the lamp gives illumination – in case of pure acetic acid the lamp does not illuminate .

- 2) - BY adding FeCl_3 solution
 - If violet colour is formed, it is phenol .
 - If no violet colour is formed , it is ethanol.

3- Experiment	Methane gas	Acetylene gas
By adding bromine dissolved in (CCl_4) to each of them	No effect	The red colour of bromine disappears

- 4- By adding acid solution to both solutions,
 - If the colour turns colourless, the solution is phenolphthalein
 - If the colour turns red, the solution is litmus .

25- Show by practical experiment how you can detect the presence of carbon of carbon and hydrogen elements in an organic substance.



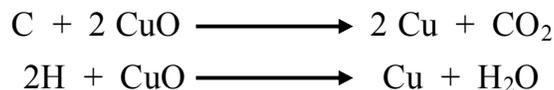
Put a small amount of an organic substance mixed with copper oxide in a glass tube and heat the test tube strongly then pass the resulting gases over anhydrous white copper sulphate , then through lime water.

Observation :

- 1- The white colour of anhydrous copper sulphate turns blue.
- 2- Lime water turns turbid.

Conclusion : The organic compound contains carbon and hydrogen elements.

The equations:



26- How can you differentiate practically between the following :

- 1- Methane and ethylene.
- 2- Ethanol and 2- methyl -2- butanol.

1- Experiment	Methane gas	Ethene (ethylene) gas
By adding bromine dissolved in (CCl ₄) to each of them	No effect	The red colour of bromine disappears

2- Experiment	Ethanol	2- Methyl -2- butanol
By adding KMnO ₄ solution and conc. H ₂ SO ₄ to each of them	The violet colour of potassium permanganate disappears	No effect

27- How can differentiate between :

(Illustrate your answer by observation and balanced chemical equations)

1- Ethanoic acid and carbolic acid (By acidity test).

2- Ethylene gas and methane gas (By using potassium permanganate solution)

3-

1- Experiment	Ethanoic acid	Carbolic acid
By adding Na ₂ CO ₃ solution to each of them	Effervescence takes places and CO ₂ evolves which turbids lime water	No effect
	$\text{CH}_3\text{COOH} + \text{NaHCO}_3 \longrightarrow \text{CH}_3\text{COONa} + \text{Ca}_2 + \text{H}_2\text{O}$	
	$\text{C}_6\text{H}_3\text{OH} + \text{NaHCO}_3 \longrightarrow \text{no effect}$	

2- Experiment	Methane gas	Ethene (ethylene) gas
b) By adding KMnO ₄ in an alkaline medium to each of them	No effect	The violet colour of KMnO ₄ disappears
	$\text{C}_2\text{H}_4 + \text{H}_2\text{O} + [\text{O}] \xrightarrow[\text{Alkaline medium}]{\text{KMnO}_4} \text{C}_2\text{H}_4(\text{OH})$	ethylene glycol

28- How can you differentiate practically between each of the following:

1-Litmus solution and phenolphthalein solution.

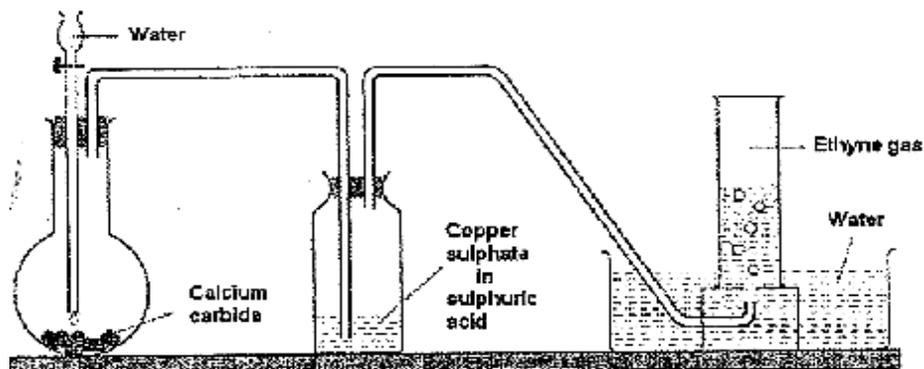
2- Ethanoic acid and carbolic acid.

1- Indicator	Colour in acidic medium	Colour in basic medium
Phenolphthalein	Colourless	Red
Litmus	Red	Blue

2- Experiment	Ethanoic acid	Carbolic acid
By adding Na ₂ CO ₃ solution to each of them	Effervescence takes places and CO ₂ evolves which turbids lime water	No effect

29- Draw the apparatus used for the preparation of ethyne in the laboratory then answer the following:

- 1- Show by practical experiment how you can detect ethyne gas.
- 2- Write the balanced chemical equation which describes the reaction of ethyne with hydrogen bromide.

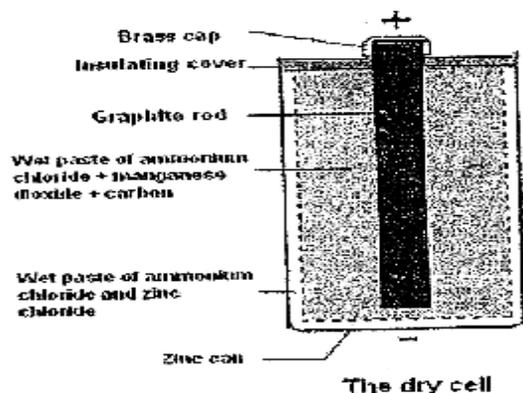


30- The apparatus used for preparation of ethane (ethylene) gas in laboratory:

- 1- Ethyne gas + bromine dissolved in CCl_4 the red colour of bromine disappears.
- 2- The reaction of ethyne with hydrogen bromide.

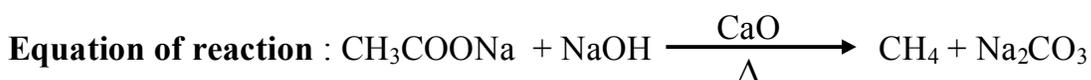
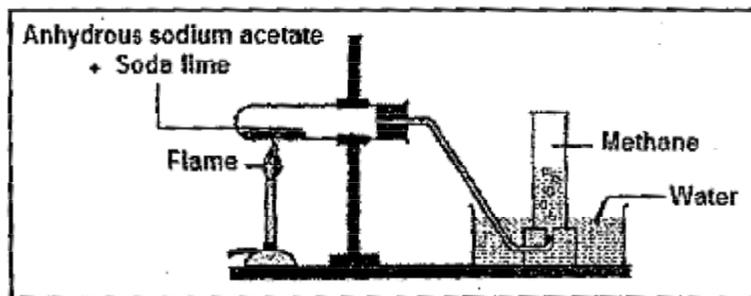


31- Draw a labeled diagram for sector in dry cell.



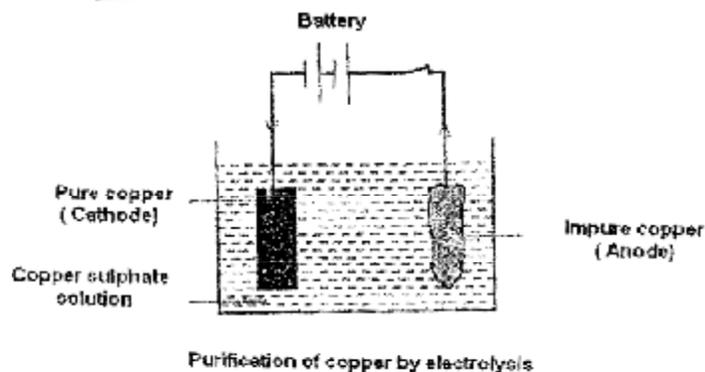
32- Write the balanced chemical equation for preparation of methane in laboratory then draw the apparatus used in the preparation.

✍ The apparatus used :



33- The degree of purity of metals which are prepared in industry is usually lower than the required degree of purity which is required for definite purposes.

Explain by drawing how to obtain copper of 99.95 % Purity degree.

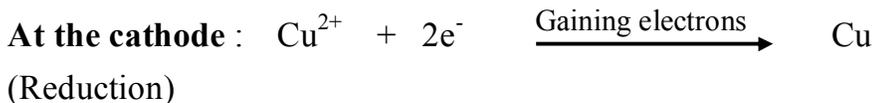
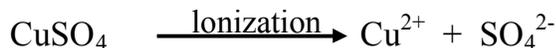


The steps :

1. Dip the pure copper and the impure copper in copper sulphate solution.
2. connect the pure copper to the negative pole of the battery.
(The pure copper acts as the cathode)
3. Connect the impure copper to the positive pole of the battery.
(The impure copper acts as the solution)
4. pass the electric current in the solution.

Observation :

Copper sulphate solution is ionized as follows :



Therefore, copper will dissolve from the impure copper (anode) as copper ions (Cu^{2+}), whereas copper ions in the solution will deposit (precipitate) as pure copper (Cu) at the pure copper (cathode).

✍ In this process 99.95 % pure copper can be obtained.

34- If you have a copper spoon what are the different steps you must follow it to plate it by a layer of silver. Write down the equations (reactions) which occur at each of the cathode and anode.

The electroplanting of copper spoon by a layer of silver .

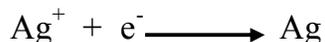
- 1) Clean the surface of the spoon completely.
- 2) Dip the spoon into electrolyte solution that contains silver ions.
- 3) Connect the spoon with the (-ve) electrode of the battery (cathode) and a rod of silver metal with the (+ve) electrode (anode).
- 4) Switch on the circuit.

When the electric current passes through the circuit :

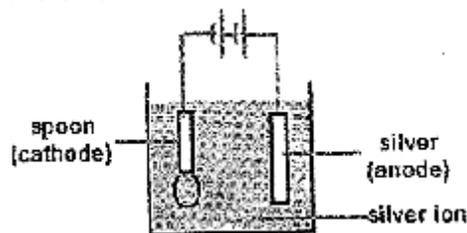
- Oxidation process takes place at anode.



- Reduction process takes place at cathode.



So, silver atoms precipitate on the surface of the spoon.



35- Compare between each of the following :

1- Acidity of alcohol and acidity of phenol.

2- Dry cell and lead acid battery.

1- Acidity of alcohol	Acidity of phenol
1- Alcohols are less acidic than phenols because the alkyl group decreases the length of bond between oxygen and hydrogen atom in (O-H) group and this makes the separation of H ⁺ ions is more difficult.	1- Phenols are more acidic than alcohols because the aryl group increases the length of bond between oxygen and hydrogen atom in (O-H) group and this makes the separation of H ⁺ ions is easier.
2- Alcohols react with active metals such as sodium but do not react with NaOH.	2- Alcohols react with active metals such as sodium and react with NaOH.

P.O.C	Dry cell	Lead acid battery
1- Anode	Zinc electrode	Lead electrode
2- Cathode	Graphite electrode	Lead tetra oxide electrode
3- Electolite	Ammonium chloride	Dilute sulphuric acid
4- E.M.F	1.5 volt	2.0535 volt
5- Reactions	$\text{Zn}^0 + 2\text{MnO}_2 + 2\text{NH}_4 \longrightarrow \text{Zn}^{2+} + 2\text{Mn}(\text{OH}) + 2\text{NH}_3$	<p>At anode (Oxidation) :</p> $\text{Pb} + \text{SO}_4^{2-} \longrightarrow \text{PbSO}_4 + 2\text{e}^-$ <p>At cathode (Reduction) :</p> $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4 + 2\text{e}^- \longrightarrow \text{PbSO}_4 + 2\text{H}_2\text{O}$ <p>Total reaction :</p> $\text{Pb} + \text{PbO}_2 + 4\text{H}^+ + 2\text{SO}_4 \longrightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$

36- Compare between each of the following :

1- Addition polymerization and condensation polymerization .

2- Chemical equilibrium and ionic equilibrium.

1- Addition polymerization	Condensation polymerization
Combination of a large number of unsaturated simple molecules (monomers) to give a giant molecule (polymer) having the same empirical formula. (e.g. Eghylene glycol)	Condensation of two different monomers to give a new monomer called copolymer which undergoes polymerization (e.g. Dacron)

2- Chemical equilibrium	Ionic equilibrium
It is a state of equilibrium in the reversible reaction at which the rate of forward reaction equals the rate of backward reaction.	It is the equilibrium arising between molecules of a weak electrolyte and the ions resulting from it .

37- Compare between each of the following:

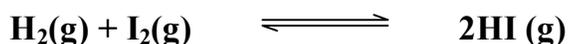
1. Irreversible reactions and reversible.

2. Alkaline hydrolysis of esters and acidic hydrolysis of esters

1. Complete (irreversible) reactions	Incomplete (reversible) reactions
1. The reactions which proceed in one direction (forward)	1. The reactions which proceed in both directions; forward and backward.
2. One of the products escapes from the system as evolving of a gas or forming a precipitate.	2. Both the reactants and products are always found in the reaction medium
Example: $\text{NaCl} + \text{AgNO}_3 \longrightarrow \text{NaNO}_3 + \text{AgCl}$ $\text{Mg} + 2\text{HCl} \longrightarrow \text{MgCl}_2 + \text{H}_2$	Example : $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \longrightarrow \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$ $2\text{NO}_2 \rightleftharpoons \text{N}_2\text{O}_4, \Delta\text{H} = -\text{ve}$

Alkaline hydrolysis of esters	Acidic hydrolysis esters
1. Hydrolysis of ester in presence of aqueous alkali e.g. (aqueous NaOH)	1. Hydrolysis of ester in presence of dilute mineral acid e.g. (H_2SO_4)
2. Gives an alcohol and the salt of the acid.	2. Gives an alcohol and organic acid.
3. Example: $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \longrightarrow \text{CH}_3\text{COONa} + \text{C}_2\text{H}_5\text{OH}$	3. Example: $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O} \longrightarrow \text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COOH}$

38- The following reaction has two equilibrium constant value at two different temperatures:



K_c at $850^\circ\text{C} = 67$ and at $448^\circ\text{C} = 50$

Is this reaction exothermic or endothermic? Why?

$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

The reaction is endothermic

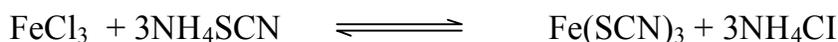
As the Value of K_c increases, concentration of products, concentration of products increases as the temperature increases, therefore the reaction is endothermic.

39- How each of the following changes affects the concentration of hydrogen in the following equilibrium system:



- a. Addition of more CO_2 gas,
- b. Addition of more water vapor.
- c. Addition of a catalyst.
- d. Increase the temperature.
- e. Decrease the vessel volume.

- a) Decreases the concentration of hydrogen.
- b) Increases the concentration of hydrogen.
- c) Does not affect the concentration of hydrogen.
- d) Decreases the concentration of hydrogen.
- e) Does not affect the concentration of hydrogen.



- 1- The red colour of the solution increase indicating to the formation of more iron (III) thiocyanate.
- 2- The intensity of the red colour decreases because the equilibrium shifts towards backward reaction to the formation of iron (III) chloride.

40- In the balanced reaction :



What happens to the equilibrium of this reaction in the following cases ?

- Adding excess of water .
- Adding drops of cone sulphuric acid .
- The equilibrium shifts in the opposite direction . (backward)
- The equilibrium shift in the forward direction .

41- Consider the reaction at equilibrium :



Explain the effect of each of the following changes on the concentration of acetate ion :

- 1) Adding drops of hydrochloric acid.
- 2) Adding drops of sodium Hydroxide solution .

- 1) Adding drops of HCl leading to increase the concentration of Hydronium ion in the Solution as a result of combination between the Hydrogen ion of the acid and water molecules in the solution, according to Le Chatelier's principle the reaction shifts in the direction which decreases the concentration of Hydronium ion then the concentration of acetate ion decrease.
- 2) Adding drops of Sodium Hydroxide neutralizes acetic acid, the concentration of the acid decrease, according to Le Chatelier's principle the reaction shifts in the direction which decreases the concentration of Hydronium ion then the concentration of acetate ion decrease .

42- Arrange the following in an ascending order as reducing agents :

- 1) $\text{Zn}^{2+} / \text{Zn}$ [-0.762 volt]
- 2) Mg/Mg^{2+} [2.375 volt]
- 3) $2\text{Cl}^- / \text{Cl}_2$ [-1.36 volt]
- 4) K^+ / K [-2.924 volt]
- 5) $\text{Pt}^{2+} / \text{Pt}$ [1.2 volt]

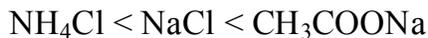
$\text{Cl} < \text{Pt} < \text{Zn} < \text{Mg} < \text{K}$

43- Arrange the following alcohols in ascending order according to their boiling points, give the scientific reason. (Ethylene Glycol – Sorbitol – Ethanol – Glycerol)

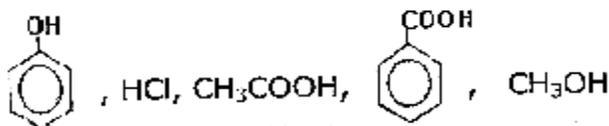
Ethanol < ethylene glycol < glycerol < sorbitol

Due to increase of the number of polar hydroxyl groups which have the ability to form hydrogen bonds between the molecules of alcohols causing increase of its boiling point.

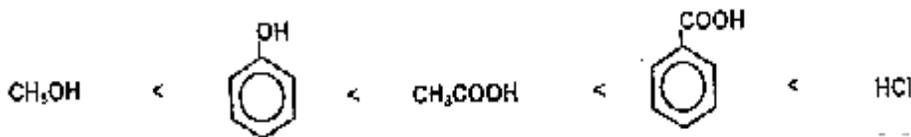
44- Arrange the following compounds according to the pH value of their aqueous solutions :



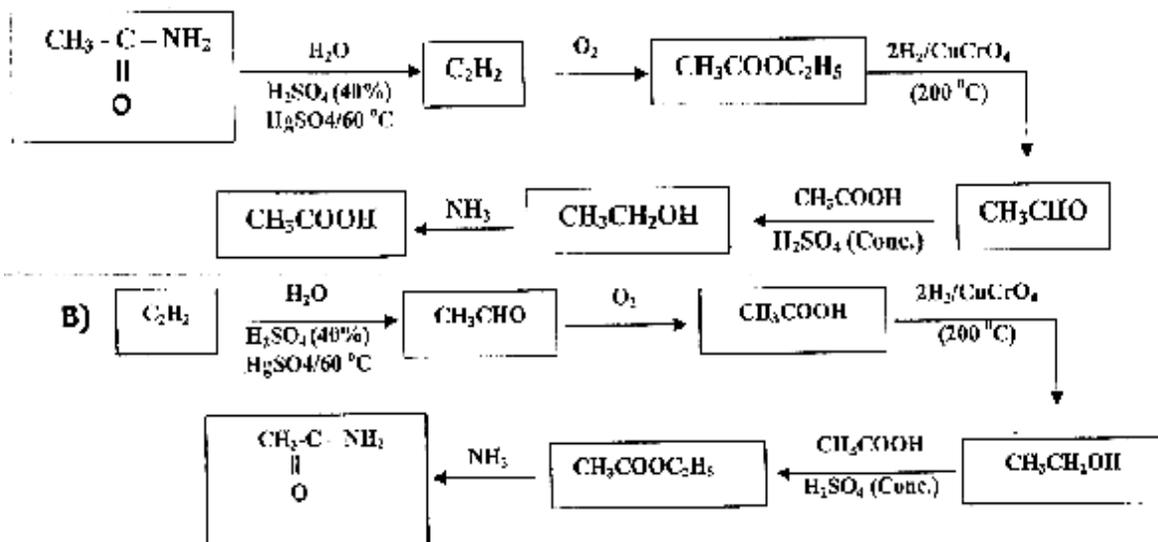
45- Arrange the following compounds in ascending order with respect to increase in their acidity :



Arrangement of the following compounds in ascending order with respect to increase in their acidity :



46- Rearrange correctly what are inside the boxes in the following diagram :



📖 Events of the scientific 📖

1) Berzelius:

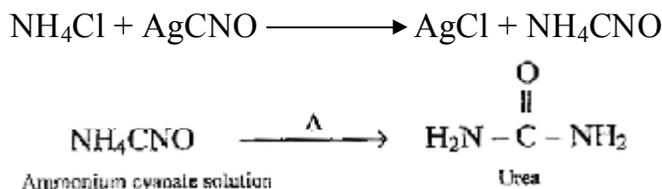
a) Classify the compounds into two types :

- 1- Organic compounds which are extracted from animal or plant origin.
 - 2- Inorganic compounds which are originated from mineral sources in the earth
- b) He thought that organic compounds are formed only under the influence of vital force, which is found in living cells of the body and he was the first scientist who classified the elements into metals and non-metals and non-metals.

2) Wohler :

Wohler performed an experiment which was considered to be the beginning of the end of Berzelius theory.

Wohler was able to prepare Urea, which is organic compound, by heating an aqueous solution of two inorganic compounds (Ammonium chloride and silver cyanate solution).



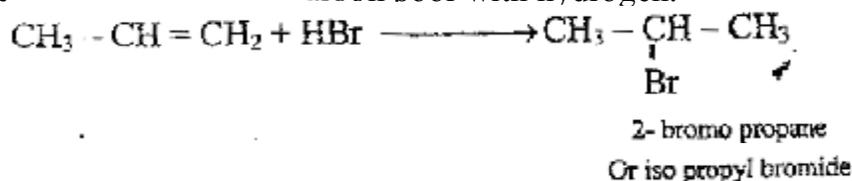
3) Baeyer "Baeyer's reaction" :

He discovered reaction of alkene with potassium in an alkaline medium. This reaction is used to detect the presence of double bond.



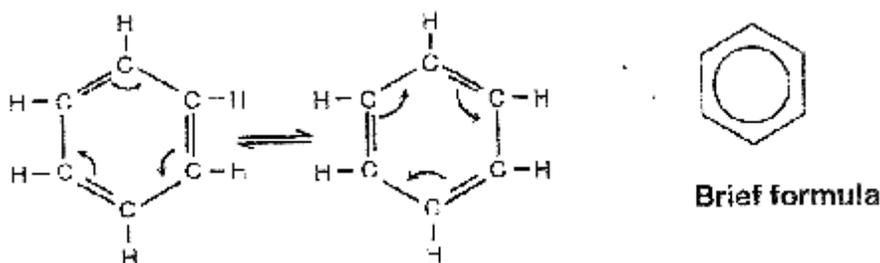
4) Markownikoff :

He discovered a rule which controls the addition of HX or HOSO₃H to unsymmetrical alkenes as propene. Where H is added to carbon rich with hydrogen and X is added to carbon poor with hydrogen.



5) Kekule:

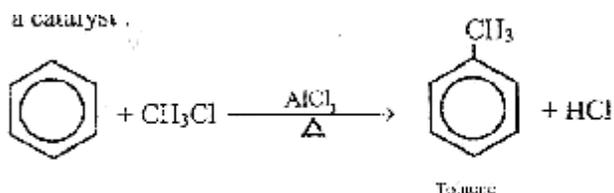
- He suggested a new idea about the bonding between carbon in the benzene molecule.
- He said carbon atoms form a ring, in which single and double bonds are exchanged, so that, all bonds between carbon atoms are similar in length, forming a hexagonal regular shape in which carbon atoms are there at every angle.



The ring in the figure indicates that 6 electrons are delocalized at certain carbon atoms.

6) Friedel craft's:

He introduced an alkyl group to a benzene ring in the presence of anhydrous AlCl_3 as a catalyst.

**7) Gaylussac's law:**

The volume of the reactant gases and produced are in a fixed ratio.

H) Avogadro's number:

Equal volumes of gases contain the same number of molecules under the same temperature and pressure.

8) Le chatelier:

He formulated a principle named after him. This principle states that "When a system at equilibrium is subjected to any change such as (Conc., temp. and pressure), the equilibrium will shift in the direction which will oppose this change.

9) guldberg and Waage:

He discovered the law of mass action which, the relation between the rate of chemical reaction and the concentration of the reactants low states that.

At constant temperature, the rate of chemical reaction is directly propotional to the product of multiplication of the reactant concentrated each is raised to the power of number of molecules or ions in the balanced chemical equations.

10) Ostwald:

He found the relation between the degree of ionization (a) and concentration (c) (mole/liter) K_a

$$K_a = \frac{a^2}{V(1 - a)}$$

11) Galvani:

He was the first scientist who changed the energy of the thermal energy into electrical energy.

12) Farady:

He discovered the relation between the amount of electricity is passed in the solution and the amount of matter which is released at the electrodes.