

ORGANIC CHEMISTRY



SOME SOURCES OF ORGANIC COMPOUNDS

There are many sources of organic compounds, both natural sources and artificial sources. Organic compounds can be gotten from living things. They can also come from crude oil (fossil remains), coal and fermentation process, etc.

Organic compounds can also be synthesized from inorganic

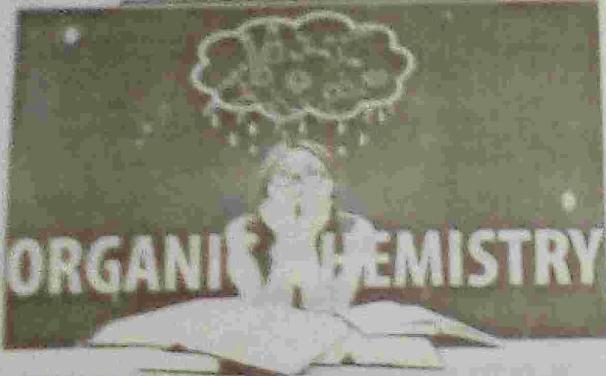
compounds. Example is the production of urea $\text{CO}(\text{NH}_2)_2$ from ammonium cyanate (NH_4CNO) by a German chemist Friedrich Wohler in 1828.



SOME PROPERTIES OF ORGANIC COMPOUNDS

- Most organic compounds have low boiling and melting points
- Organic compounds are generally insoluble in water (except those that contain polar groups such as $-\text{OH}$, $-\text{COOH}$, $-\text{SO}_3$) but they are soluble in organic solvents like benzene, ethoxyethane, trichloromethane (chloroform), 1,1,1-trichloroethane, etc.

ORGANIC CHEMISTRY



DEFINITION:

Although the original meaning of the term **organic chemistry** no longer applies, it has been retained because of wide usage and also because so many of the substances involved in organic chemistry do come directly or indirectly from living matter. The modern definition of organic chemistry says that:-

Organic chemistry is the study of carbon compounds.

NB: - there are several compounds of carbon which are not included in organic chemistry. They are not considered to be organic compounds. Examples:- carbon monoxide(CO), carbon dioxide(CO₂), carbon disulphide(CS₂), carbonates(CO₃²⁻), bicarbonates(HCO₃⁻), cyanides(CN⁻), thiocyanates (SCN⁻), cyanates(OCN⁻), carbides(e.g.CaC₂).

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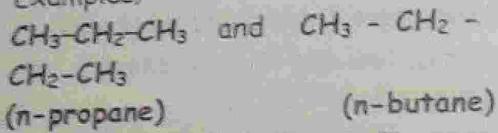
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- Organic compound form covalent bonds.

CLASSIFICATION OF ORGANIC COMPOUNDS

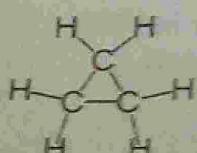
ALIPHATIC COMPOUNDS:- These are those organic compounds that have open chain structures.

Examples:-

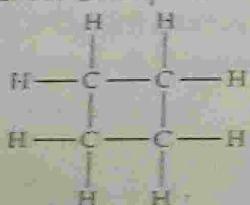


Where n stands for "normal"

ALICYCLIC COMPOUNDS:- These are those organic compounds that have cyclic or ring structures. Examples:-



(cyclopropane)

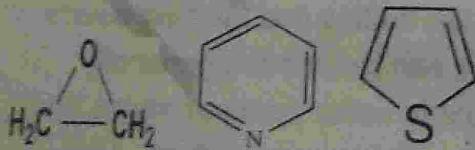


(cyclobutane)

NB:- the prefix "cyclo" is used to show that they have a cyclic shape.

HETEROCYCLIC COMPOUNDS:

These are those organic compounds in which a carbon atom in a cyclic ring is replaced with oxygen or nitrogen or sulphur atom. Examples:-



NB: it is called a heterocyclic compound only when the carbon atom replaced is among the carbons that form the cyclic ring. It is not

heterocyclic if the carbon replaced is not among the ring carbons.

AROMATIC COMPOUNDS:- These are those organic compounds that behave like benzene. They are also known as benzene derivatives. Examples; benzene, Aniline, naphthalene etc

Now, the question is; what conditions must a given compound satisfy in order to be called an aromatic compound?

CONDITIONS FOR A COMPOUND TO BE AROMATIC

- The compound must be cyclic in structure
- The compound must be completely conjugated or all the carbon atoms in the ring must be SP^2 hybridized (having double bonds in an alternating manner, example; C-C=C-C=C-C=C)
- The compound must be planar (it must be flat)
- The compound must obey Huckel's rule of aromaticity.

HUCKEL'S RULE OF AROMATICITY

It states that; "for a compound to be aromatic, the compound must have a total of $(4n + 2)$ pi-electrons". Where 'n' is a positive whole number. More of this will be treated in CHM 204.

HYDROCARBONS

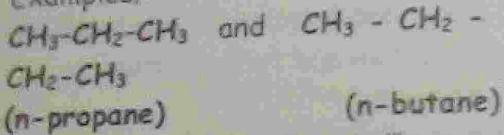
Hydrocarbons are those organic compounds that contain only hydrogen

Organic compound form covalent bonds.

CLASSIFICATION OF ORGANIC COMPOUNDS

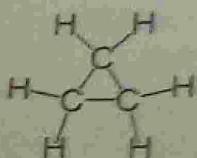
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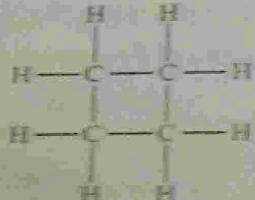


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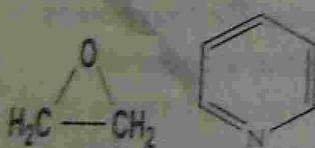
(cyclopropane)



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HYDROCARBONS

Hydrocarbons are those organic compounds that contain only hydrogen

and carbon Example:- methane(CH_4), ethene(C_2H_4), ethyne (C_2H_2), etc.

NB:- methane is called a hydrocarbon because it contains only hydrogen and carbon in it.

CLASSES OF HYDROCARBONS

The 3 classes of hydrocarbons are:-

The alkanes

The alkenes

The alkynes

EMPIRICAL AND MOLECULAR FORMULAR

Empirical formula of a compound is the simplest formula of the compound. Empirical formula of a compound can also be defined as the formula that shows the smallest ratio in which the atoms of a given compound can combine together.

For instance:- Since the molecular formula of benzene is C_6H_6 , then empirical formula of benzene is CH (dividing through by 6).

Alternatively, if the molecular formula of a compound is given as $\text{C}_2\text{H}_4\text{O}_2$, then the empirical formula will be CH_2O (dividing through with 2). **Molecular formula** of a compound is the formula which shows the actual number of the individual atoms in one mole of the compound.

Example:- The molecular formula of benzene is C_6H_6 . This means that one mole of benzene contains 6 atoms of carbon and 6 atoms of Hydrogen. Etc. The structural formula of a compound is the formula that shows how the

atoms of a compound are arranged within the compound or molecule.

Now let us solve some questions on this.

QUESTION 1

A hydrocarbon X_1 has a relative molecular mass of 56 and consists of 87.5% by mass of carbon. What is the molecular formula of X_1 ?

Solution

A hydrocarbon contains only hydrogen and carbon in it.

$$\text{Hydrocarbon} = \text{H} + \text{C}$$

$$\text{Since } \text{C} = 87.5\%,$$

$$\text{Therefore, H} = 100 - 87.5 = 12.5\%.$$

Before finding molecular formular, we need to find the empirical formula first.

Remember: [C=12, H=1]

$$\begin{array}{r} \text{C} \\ 87.5 \\ \hline 12 \end{array} \quad \begin{array}{r} \text{H} \\ 12.5 \\ \hline 1 \end{array} \quad \therefore \text{Emp. formula} = \text{CH}_2.$$

$$\begin{array}{r} 7.292 \\ \hline 7.292 \end{array} \quad \begin{array}{r} 12.5 \\ 7.292 \\ \hline 1.7 \end{array} \quad \begin{array}{l} \text{To find the} \\ \text{molecular} \\ \text{formular of} \\ \text{the compound,} \\ \text{we say that} \end{array}$$

$$[\text{Empirical}]n = \text{Molar mass}$$

$$n = \frac{\text{Molar mass}}{[\text{Empirical}]} = \frac{56}{[12+2]}$$

$$n = \frac{56}{14} = 4. \text{ Therefore,}\\ \text{molecular formula} = [\text{CH}_2] \times 4 \\ = \text{C}_4\text{H}_8.$$

QUESTION 2

2.4mg of an organic acid gave 3.52mg and 1.44mg of CO_2 and H_2O respectively on combustion.

What is the:

i) Empirical formula

ii) Molecular formula,

If the relative molecular mass is 60g.

Solution

Total mass of compound = 2.4mg

Mass of CO_2 given = 3.52mg

Mass of H_2O given = 1.44mg

In order to solve this problem, we need to find the mass of C and mass of H contained in 3.52mg of CO_2 and 1.44mg of H_2O respectively.

FINDING MASS OF C

Molar mass of CO_2 = 12 + 32 = 44g

NB; Inside every 44g of CO_2 , carbon is 12g [C=12]

We say that;

44g of CO_2 contains 12g of C

3.52mg of CO_2 will contain x of C

$$44x = 12 \times 3.52$$

$$x = \frac{12 \times 3.52}{44} = 0.96 \text{ mg of C}$$

Therefore, the mass of C we will work with is 0.96mg

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FINDING MASS OF H

Molar mass of H_2O = 1(2) + 16 = 18g

NB; inside every 18g of H_2O ,

Hydrogen is 2g [H=1, O=16]

So we say that;

18g of H_2O contains 2g of H

∴ 1.44mg of H_2O will contain x of H

Let us now find value of x

$$\frac{18}{1.44} = \frac{2}{x} \Rightarrow 18x = 2 \times 1.44$$

$$x = \frac{2 \times 1.44}{18} = 0.16 \text{ mg of H.}$$

Now, mass of H = 0.16mg

Before we start finding the empirical formula we check if there will be oxygen or not.

Total mass given = 2.4mg

Mass of C alone = 0.96mg

Mass of H alone = 0.16mg

Sum of masses of C and H

$$= 0.96 + 0.16 = 1.12 \text{ mg.}$$

COMMENT:- Since the sum of C and H is not equal to the total mass of the compound, we will use oxygen to complete it.

Mass of oxygen = Total mass - [C + H]

$$\text{Mass of O} = 2.4 - [0.96 + 0.16]$$

$$= 2.4 - 1.12 = 1.28 \text{ mg}$$

Now we solve;

C	H	O
0.96	0.16	1.28
12	1	16
0.08	0.08	0.08
0.08	0.08	0.08
1	2	1

① Empirical formula = CH_2O .

II)

$$[\text{CH}_2\text{O}]_n = 60$$

$$n = \frac{60}{[\text{CH}_2\text{O}]} = \frac{60}{[12+1(2)+16]}$$

$$n = \frac{60}{30} = 2. \text{ Therefore,}$$

$$\text{Molecular formula} = [\text{CH}_2\text{O}]_2$$

$$= [\text{CH}_2\text{O}]_2 = \text{C}_2\text{H}_4\text{O}_2$$

QUESTION 3

A sample of methane weighing 9.67mg produced 26.53mg of CO_2 and 21.56mg of H_2O .

Calculate the % compositions of carbon and hydrogen in it.

Solution

$$\text{Total mass} = 9.67\text{mg}$$

$$\text{Mass of } \text{CO}_2 \text{ given} = 26.53\text{mg}$$

$$\text{Mass of } \text{H}_2\text{O} \text{ given} = 21.56\text{mg}$$

We have to find the mass of carbon from CO_2 and find the mass of Hydrogen from water(H_2O).

FINDING MASS OF C

$$\text{Molar mass of } \text{CO}_2 = \text{C} + 2(\text{O}) \\ = 12 + 2(16) = 44\text{g}$$

$$44\text{g of } \text{CO}_2 \text{ Contains} \rightarrow 12\text{g of C}$$

$$26.53\text{mg of } \text{CO}_2 \text{ will contain} \rightarrow x\text{g of C}$$

$$\frac{44}{26.53} = \frac{12}{x} \Rightarrow 44x = 12 \times 26.53$$

$$x = \frac{12 \times 26.53}{44} = 7.24\text{mg of C}$$

FINDING MASS OF H

$$\text{Molar mass of } \text{H}_2\text{O} = \text{H}_2 + \text{O} \\ = 1(2) + 16 = 18\text{g}$$

18g of H_2O contains $\rightarrow 2\text{g of H}$

21.56mg of H_2O will contain $\rightarrow x\text{g of H}$

$$\frac{18}{21.56} = \frac{2}{x} \Rightarrow 18x = 2 \times 21.56$$

$$\therefore x = \frac{2 \times 21.56}{18} = 2.396\text{mg of H}$$

Sum of masses of C and H

$$= 7.24 + 2.396 = 9.64\text{mg}$$

It is the same with the total mass given in the question. Therefore, we can now go ahead and solve

$$\% \text{ C} = \frac{\text{mass of C}}{\text{Total mass}} \times \frac{100}{1} \\ = \frac{7.24}{9.67} \times \frac{100}{1} = 74.9\%$$

$$\% \text{ H} = \frac{\text{mass of H}}{\text{Total mass}} \times \frac{100}{1} \\ = \frac{2.396}{9.67} \times \frac{100}{1} = 24.8\%$$

QUESTION 4

An organic compound contains 38.7% C and 9.75% H. What is its molecular formula if it has a molecular weight of 62.07g?

Solution

$$\text{C} = 38.7\%$$

$$\text{H} = 9.75\%$$

$$\text{Sum of C and H} = 38.7 + 9.75 =$$

$$48.45\%$$

Since the sum of C and H is not up 100%, we will bring in Oxygen.

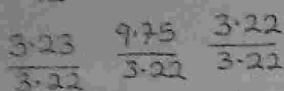
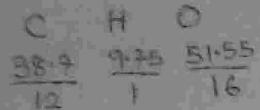
$$\% \text{ of O} = 100 - [\text{C} + \text{H}]$$

$$= 100 - 48.45$$

$$= 51.55\%$$

Now, we can start solving

NB; [C = 12, O = 16, H = 1]



1 : 3 : 1

Empirical formula = CH_3O

$$[\text{CH}_3\text{O}]_n = 62.07$$

$$\therefore n = \frac{62.07}{[\text{CH}_3\text{O}]} = \frac{62.07}{[12+3+16]}$$

$$n = \frac{62.07}{31} = 2$$

Molecular formula = $\text{C}_2\text{H}_6\text{O}_2$

QUESTION 5

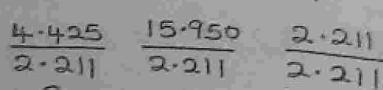
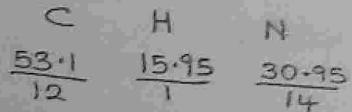
Determine the empirical and molecular formula of a compound containing Carbon, Hydrogen and Nitrogen given that C is 53.1% and H is 15.9% [C = 12, H = 1, N = 14, R.M.M = 90].

Solution

$$C = 53.1\%, H = 15.95\%$$

$$\therefore N = 100 - [C + H] \\ = 100 - [53.1 + 15.95]$$

$$N = 30.95\%$$



Empirical formula = $\text{C}_2\text{H}_7\text{N}$

$$[\text{C}_2\text{H}_7\text{N}]_n = 90$$

$$\therefore n = \frac{90}{[\text{C}_2\text{H}_7\text{N}]} = \frac{90}{[12(2)+1(7)+14]} \\ n = \frac{90}{45} = 2 \Rightarrow [\text{C}_2\text{H}_7\text{N}]_2$$

Molecular formula = $\text{C}_4\text{H}_{14}\text{N}_2$

QUESTION 6

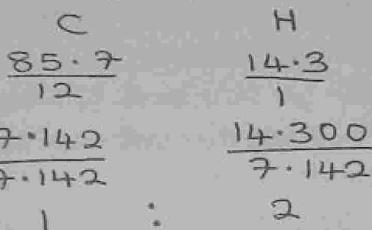
A hydrocarbon contains 85.7% C by weight and it has a density of 1.25 g/dm^3 at S.T.P find the empirical and molecular formula of the compound.

Solution

A hydrocarbon contains only C and H.

$$C = 85.7\%$$

$$\therefore H = 100 - 85.7 = 14.3\%$$



Empirical formula = CH_2

$$[\text{CH}_2]_n = \text{molar mass}$$

From Density = mass/volume

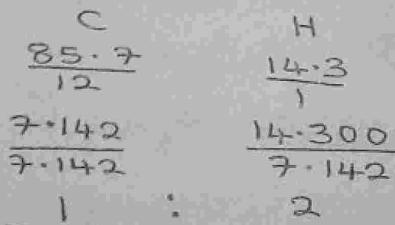
mass = Density \times Volume

$$= 1.25 \times 22.4 = 28\text{ g}$$

$$\text{NB: At S.T.P, Volume} = 22.4\text{ dm}^3 \\ [\text{CH}_2]_n = 28 \Rightarrow n = \frac{28}{12+1(2)} = 2$$

Therefore:-

Molecular formula = C_2H_4 .



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Therefore:-

Molecular formula = C_2H_4 .

QUESTION 7

If the empirical formula of a compound is given as CH. Find the molecular formula of the compound given that it's vapour density is 39.

Solution

$$[\text{CH}]_n = \text{molar mass}$$

$$\text{But molar mass} = 2 \times \text{Vapour density} \\ = 2 \times 39 \\ = 78$$

$$[\text{CH}]_n = 78 \therefore n = \frac{78}{[\text{CH}]}$$

$$n = \frac{78}{12+1} = \frac{78}{13} = 6$$

$$\Rightarrow [\text{CH}]_6$$

Therefore:-
Molecular formula = C₆H₆

QUESTION 8

The compound dioxane contains carbon, and oxygen only. 0.956g on analysis gave 1.91g of CO₂ and 0.782g of H₂O.

In another analysis of it, 6.04×10⁻³ mol of the compound weighed 0.532g. Calculate it's molecular formula.

Solution

$$\text{Total mass} = 0.956\text{g}$$

$$\text{Mass of CO}_2 \text{ given} = 1.91\text{g}$$

$$\text{Mass of H}_2\text{O given} = 0.782\text{g}$$

FINDING MASS OF C

$$\text{Molar mass of CO}_2 = 44\text{g}$$

$$44\text{g of CO}_2 \quad 12\text{g of C}$$

$$1.91\text{g of CO}_2 \quad X \text{ of C}$$

$$44/1.91 = 12/X$$

$$44X = 12 \times 1.91$$

$$X = \frac{12 \times 1.91}{44} = 0.521\text{g of C.}$$

44

FINDING MASS OF H

$$\text{Molar mass of H}_2\text{O} = 18\text{g}$$

$$18\text{g of H}_2\text{O} \quad 12\text{g of H} \\ 0.782\text{g of H}_2\text{O} \quad X \text{ of H}$$

$$18X = 2 \times 0.782$$

$$X = \frac{2 \times 0.782}{18} = 0.087\text{g of H}$$

$$\text{Therefore:- } C + H = 0.521 + 0.087 \\ = 0.608\text{g.}$$

But total mass is given as 0.956g

COMMENT:- Since the sum of the mass of C and H is not equal to the total mass of the compound given in the Question, we will bring in oxygen to complete it.

$$\text{Mass of O} = \text{Total} - [C + H] \\ = 0.956 - 0.608 \\ = 0.348\text{g of O.}$$

C	H	O
0.521	0.087	0.348
12	1	16
0.043	0.087	0.022
0.022	0.022	0.022

2 : 4 : 1

Empirical formula = C₂H₄O

$$[C_2H_4O]_n = \text{Molar mass}$$

Here, molar mass is not given, but mole and mass are given.

Therefore we can find the molar Mass.

$$\text{Mole} = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{Molar mass} = \frac{\text{mass}/\text{mole}}{0.532} = 6.04 \times 10^3$$

$$\therefore \text{molar mass} = 88.08$$

$$[\text{C}_2\text{H}_4\text{O}]n = 88.08$$

$$n = \frac{88.08}{[\text{C}_2\text{H}_4\text{O}]} = \frac{88.08}{12(2) + 1(4) + 16}$$

$$n = \frac{88.08}{44} = 2$$

$$\Rightarrow [\text{C}_2\text{H}_4\text{O}]_2$$

Molecular formula = $\text{C}_4\text{H}_8\text{O}_2$

QUESTION 9

5.24mg of an organic compound yielded 7.65mg and 1.56mg of CO_2 and H_2O respectively on combustion and on further reaction with AgNO_3 , 8.31mg of AgCl was precipitated. Calculate the empirical formula of the organic compound.

Solution

Total mass = 5.24mg

Mass of CO_2 given = 7.65mg

Mass of H_2O given = 1.56mg

Mass of AgCl given = 8.31mg

FINDING MASS OF C

Molar mass of CO_2 = $12 + 2(16) = 44$

4.4g CO_2 contains $\rightarrow 12\text{g of C}$
7.65mg CO_2 will contain $\rightarrow x\text{ of C}$

$$x = \frac{12 \times 7.65}{44} = 2.09\text{mg of C}$$

$$\begin{array}{cccc} \text{C} & \text{H} & \text{O} & \text{Cl} \\ \frac{2.09}{12} & \frac{0.173}{1} & \frac{0.917}{16} & \frac{2.06}{35.5} \\ \frac{0.174}{0.057} & \frac{0.173}{0.057} & \frac{0.057}{0.057} & \frac{0.058}{0.057} \end{array}$$

$$3 : 3 : 1 : 1$$

Empirical formula = $\text{C}_3\text{H}_3\text{OCl}$.

FINDING MASS OF H

Molar mass of $\text{H}_2\text{O} = 18\text{g}$

18g H_2O contains $\rightarrow 2\text{g of H}$

1.56mg H_2O will contain $\rightarrow x\text{ of H}$

$$x = \frac{2 \times 1.56}{18} = 0.173\text{mg of H}$$

FINDING MASS OF Cl

Molar mass of $\text{AgCl} = 108 + 35.5$
 $= 143.5\text{g}$

143.5g of AgCl contains $\rightarrow 35.5\text{g of Cl}$

$\therefore 8.31\text{mg of AgCl will contain} \rightarrow x\text{ of Cl}$

$$x = \frac{35.5 \times 8.31}{143.5} = 2.06\text{mg of Cl}$$

FINDING MASS OF O

$$\begin{aligned} \text{Mass of O} &= \text{Total mass} - [\text{C} + \text{H} + \text{Cl}] \\ &= 5.24 - [2.09 + 0.1731 + 2.06] \end{aligned}$$

Mass of O = 0.917mg

BOND BREAKING AND BOND FORMATION

The reactions of organic compounds involve the breaking of existing bonds and formation of new bonds. This bond breaking involves the conversion of molecular orbitals (lower energy system) to atomic orbitals (higher energy system) by the action of heat or other agents. In order to break the molecular orbitals into atomic orbitals, energy is supplied to break the bond. There are two ways of breaking bonds, namely:-

- (i). HOMOLYTIC BOND BREAKING OR HOMOLYTIC FISSION (HOMOLYSIS).
- (ii). HETEROLYTIC BOND BREAKING OR HETEROLYTIC FISSION (HETEROLYSIS).

HOMOLYTIC BOND BREAKING OR HOMOLYTIC CLEAVAGE (HOMOLYSIS).

In homolytic bond breaking, each of the two bonding atoms acquires one of the two bonding electrons after the breaking of the bond.



The products of homolytic cleavage (A^+ and B^-) are called free radicals. They are electrically neutral and have one unpaired (odd) electron in them. Free radicals are very reactive due to the tendency of the unpaired electron to be paired. This type of bond breaking is common in vapour phase. Homolytic reactions are initiated by heat or light or peroxides.

HETEROLYTIC BOND BREAKING OR HETEROLYTIC CLEAVAGE (HETEROLYSIS).

In this process, only one of the bonding atoms acquires the two bonding electrons alone when the bond is broken.



The products of heterolytic fission are ion which possess electrical charges. Heterolytic cleavage occurs mainly with polar compounds in polar solvents.

FUNCTIONAL GROUPS

INTRODUCTION: When you enter into a taxi as a traveller, you relax yourself on the passenger's seat while the taxi driver drives you to your destination. Let us imagine that the car is the chemical compound while you and the driver are the atoms present in the compound, then your destination is the final product of the compound during a reaction. Now tell me, between you (the passenger) and the driver, who controls the movement of the car from your initial position to your final destination?

I believe you know that it is the driver. Now you see? Both you and the driver are present in the car but only the driver controls the movement of the car. This means that generally, in an organic compound, there is a particular atom or group of atoms that controls the reactions of the compound. This particular atom or group of atoms that control the reactions of the entire compound is

known as the **functional group**.

Therefore we can simply say that:-

A **functional group** is an atom or group of atoms responsible for the chemical reactions of a compound.

The functional group is the **reactive site** of an organic molecule. It is the part of a molecule or compound where chemical reactions take place. The nature of the reaction an organic compound will undergo depends on the type of functional group present in the compound.

There are types of functional groups in organic compounds. Two or more compounds that have the same type of functional group in them are said to come from the same family and are called **homologues**. Below are some of the functional groups to be studied at this level.

Types of Organic Compounds

Classified according to functional group

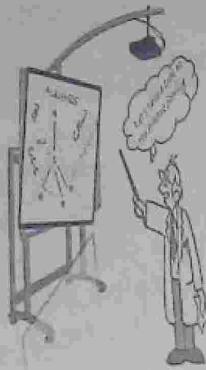
Hydrocarbons (H & C only)	Alkane	Alcohol	Carboxylic acid
Alkane			
Alkene			
Alkyne			
Haloalkanes or Alkanehalides X-Halogen			
Acylhaide			

FUTO 2014/2015 EXAM.

The reactive portion of a molecule that undergoes predictable reactions is called -----?

Ans = functional group

ALKANES



Alkanes are those hydrocarbons that contain carbon-carbon single bond (C-C). Alkanes are the simplest organic compounds made up of only hydrogen and carbon. The functional group present in an alkane is the carbon to carbon single bond (C-C). The geometry or shape of the alkanes is tetragonal or tetrahedral. Alkanes have the bond angle of 109.5° . The general molecular formula of alkanes is $C_nH_{(2n+2)}$ where n is the number of carbon atoms present in the alkane. Due to the presence of single bonds, alkanes are said to be saturated and SP^3 hybridized. Alkanes are called saturated hydrocarbon because each of the carbon atoms in an alkane is fully saturated with hydrogen atoms which makes alkanes to be inert or unreactive. Therefore alkanes are called paraffins which mean little affinity. The carbon-hydrogen(C-H)

bond length in an alkane is approximately 1.09 \AA while the carbon-carbon (C-C) bond length in an alkane is approximately 1.54 \AA . Alkanes contain only sigma bonds and sigma(\square) electrons in them. NB:- Alkanes do not have a π -bond because they do not have an unhybridized p-orbital's. Remember that the number of π -bonds in a compound is equal to the number of unhybridized p-orbital's in the compound because the unhybridized p-orbital's are used to form the π -bonds.

NOTE

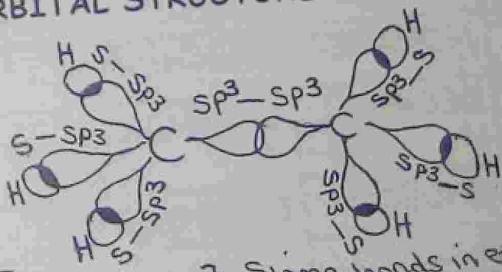
Number of π -electrons = $2 \times$

Number of π -bonds present.

Number of \square -electrons = $2 \times$

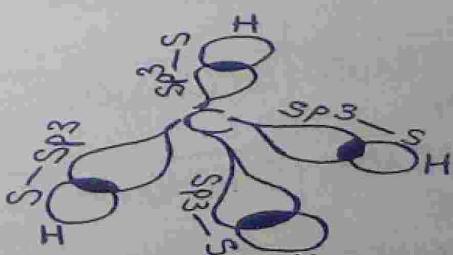
Number of \square -bonds present.

ORBITAL STRUCTURE OF ETHANE



There are 7 Sigma bonds in ethane

ORBITAL STRUCTURE OF METHANE



There are 4 Sigma bonds in methane

NAMING OF ALKANES

The parent name of an alkane depends on the number of carbon atoms that make up the longest carbon-carbon chain. An alkanes that contains only one carbon atom is called

	NAME	COMPOUND
1	METHANE	CH_4
2	ETHANE	CH_3CH_3
3	PROPANE	$\text{CH}_3\text{CH}_2\text{CH}_3$
4	BUTANE	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
5	PENTANE	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
6	HEXANE	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
7	HEPTANE	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
8	OCTANE	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
9	NONANE	$\text{CH}_3(\text{CH}_2)_7\text{CH}_3$
10	DECANE	$\text{CH}_3(\text{CH}_2)_9\text{CH}_3$
11	UNDECANE	$\text{CH}_3(\text{CH}_2)_{10}\text{CH}_3$
12	DODECANE	$\text{CH}_3(\text{CH}_2)_{11}\text{CH}_3$
13	TRIDECANE	$\text{CH}_3(\text{CH}_2)_{12}\text{CH}_3$
14	TETRADECANE	$\text{CH}_3(\text{CH}_2)_{13}\text{CH}_3$
15	PENTADECANE	$\text{CH}_3(\text{CH}_2)_{14}\text{CH}_3$
16	HEXADECANE	$\text{CH}_3(\text{CH}_2)_{15}\text{CH}_3$
17	HEPTADANE	$\text{CH}_3(\text{CH}_2)_{16}\text{CH}_3$

7	NE	
1	OCTADEC	$\text{CH}_3(\text{CH}_2)_{16}\text{CH}_3$
8	ANE	
1	NONADEC	$\text{CH}_3(\text{CH}_2)_{17}\text{CH}_3$
9	ANE	
2	EICOSANE	$\text{CH}_3(\text{CH}_2)_{18}\text{CH}_3$
0		

methane. The alkane that contains two carbon atoms is called ethane. The one that contains three carbon atoms is called propane, etc. Below are formulae and names of the first-twenty alkanes

ALKYL GROUP

An alkyl group is formed when one hydrogen atom is removed from an alkane.

Alkyl group are named by replacing the last "ane" in the name of the alkane with "yl". EXAMPLE:-

ALKANE	ALKYL GROUP
CH_4 Methane	CH_3 methyl
C_2H_6 Ethane	C_2H_5 Ethyl
C_3H_8 Propane	C_3H_7 Propyl
C_4H_{10} Butane	C_4H_9 Butyl

BELOW ARE THE FIRST-TWENTY ALKANE

Before naming any organic compound, we should always remember the rules that should be obeyed while naming an

organic compound according to the IUPAC system. The rules of naming organic compounds are as follows:-

RULE 1.

Identify the longest continuous carbon to carbon longest chain in the compound.

RULE 2.

Number only the carbon atoms in the longest chain starting from the side that would give the attachments or substituents or functional group a lower number.

NB:- Attachments are those carbon branches which are not included as part of the longest chain in the compound.

RULE 3.

Locate the positions and names of the attachments or functional groups along the longest chain in the compound.

RULE 4.

When written the name of the compound, write the position and the name of the attachments first and then write the name of the longest chain.

NOTE

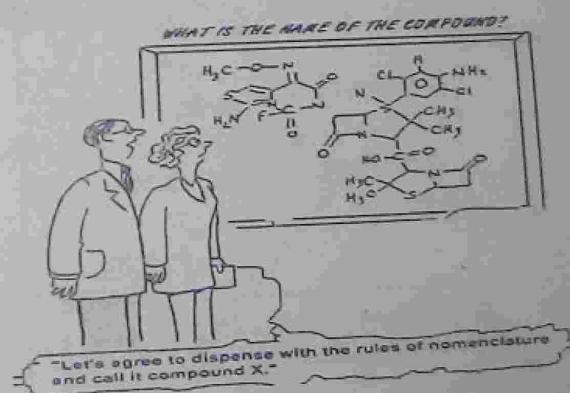
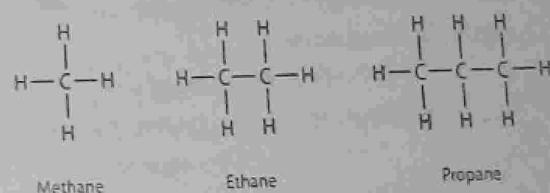
- If there are more than one different attachments present in the compound, the name of the attachment that should be written first depends on the alphabetical order of their names. Example; Ethyl is written before Methyl because

letter E comes first in the alphabets before letter M.

If the same type of attachment is present twice in the compound, we use "di" but if it appears three times, we use "tri" and if four times, we use "tetra" etc.

Example, if two methyl groups are attached to positions 2 and 4, we say 2, 4-dimethyl.

NOW LET US NAME SOME ALKANES.



TEST YOURSELF

(1.) which of the following names is not correctly written?

- (A) 2-Methylbutane (B) 3-Ethylheptane (C) 2-Methyl-3-Ethylheptane (D) 3-Ethyl-2-Methylheptane.

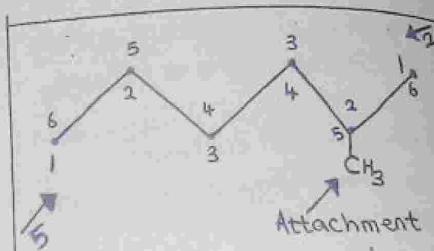
Ans = C.

REASON:- ethyl should be written before methyl according to alphabetical order.

(2). The elimination of one hydrogen atom from propane produces -?

- (A) methyl (B) propyl (C) propane (D) butyl

Ans = B



In this structure above, if we number from the left hand side, the attachment will be at position 5, but if we number from the right hand side, the attachment will be at position 2.

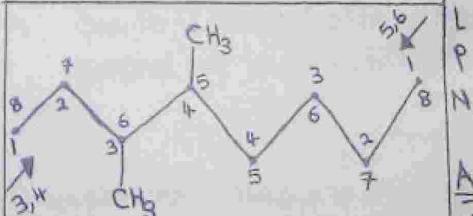
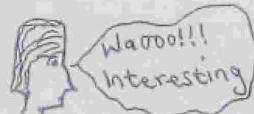
Since 2 is smaller than 5, we will number from the right hand side according to the rule. Therefore,

LONGEST CHAIN = 6 (Hexane)

POSITION OF ATTACHMENT = 2

NAME OF ATTACHMENT = methyl

ANSWER: 2-Methyl hexane



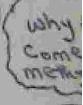
Here, if we number from the right, attachments will be at positions 5 and 6 which is 56. If we number from the left, attachments will be at positions 3 and 4 which is 34. Therefore we

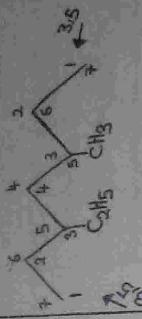
will name left since than 56.
LONGEST POSITIONS OF NAME OF P
ANSWER: 3,



From the be at 5 is 26. From th will be which Since we wi LONGE POSITI NAMES

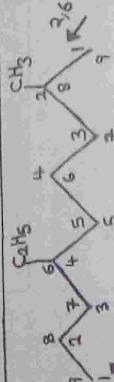
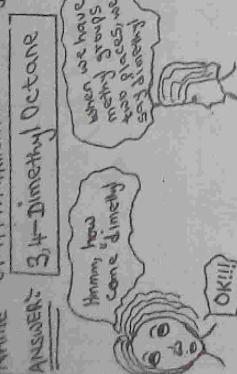
ANSWER





Well number from the left since 3 & 4 is lower than 5 &. Therefore,
LONGEST CHAIN = 8 (Octane)
POSITIONS OF ATTACHMENTS = 3 & 4
NAME OF ATTACHMENTS = dimethyl

ANSWER:



From the right, attachment will be at positions 2 and 6 which is 26.

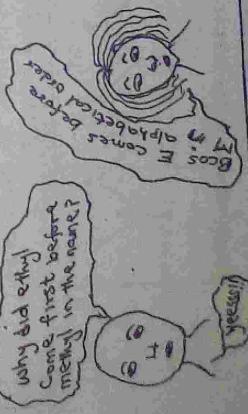
From the left, attachment will be at positions 4 and 8 which is 48. Since 26 is smaller than 48, we will number from the right.

LONGEST CHAIN = 9 (Nonane)

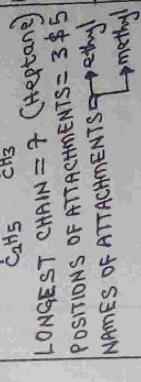
POSITIONS OF ATTACHMENTS = 2 & 6

NAME OF ATTACHMENTS = Ethyl & methyl

ANSWER: 6-Ethyl-2-methyl Nonane



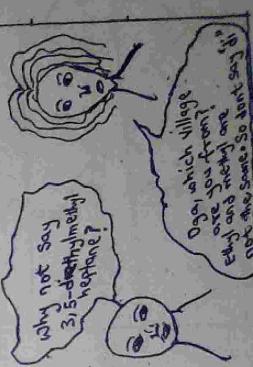
In this compound above, if we number the chain from the right hand side, the attachments will be at positions 3 & 5. If we number from the left, the attachments will be at positions 3 & 5. Since the attachments will have the same positions from both sides, we will consider the alphabetical order of the different attachments. C₂H₅ is ethyl while C₃H₇ is methyl. We have to start numbering from the side of ethyl because letter "e" comes before letter "m" in alphabetical order. Therefore, we have



LONGEST CHAIN = 7 (Heptane)
POSITIONS OF ATTACHMENTS = 3 & 5
NAME OF ATTACHMENTS = Ethyl & methyl

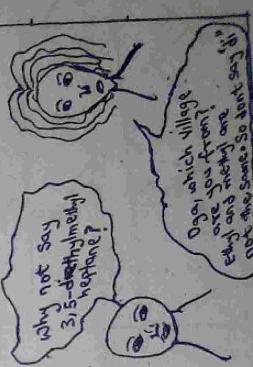
ANSWER:

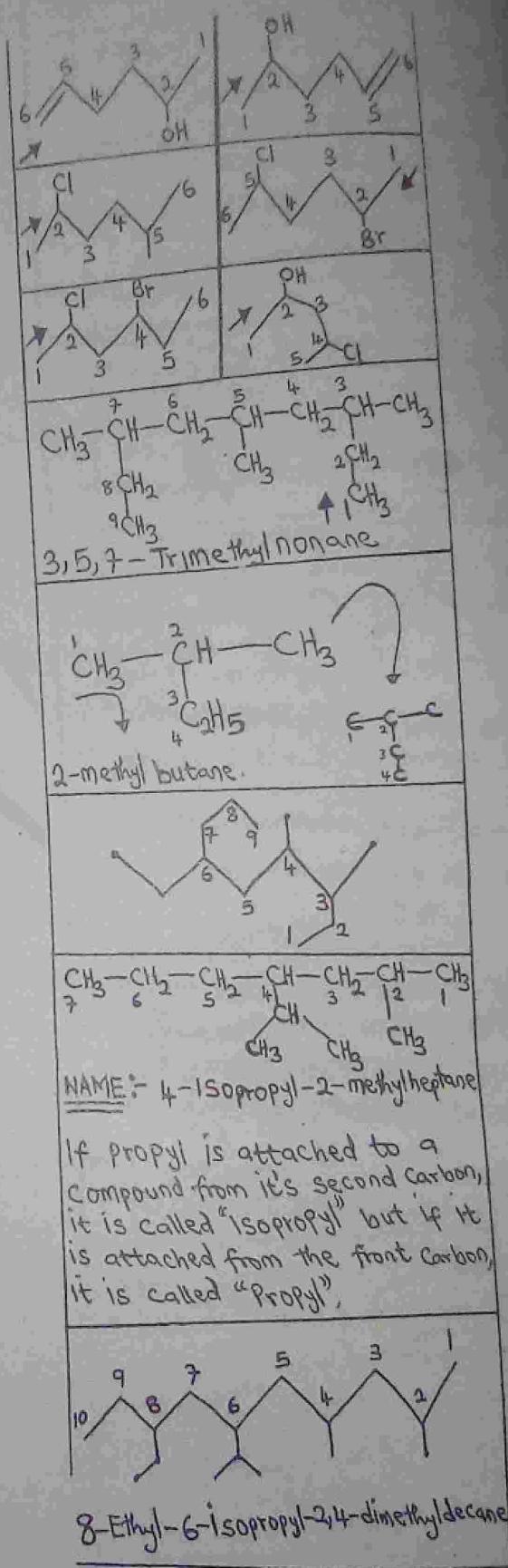
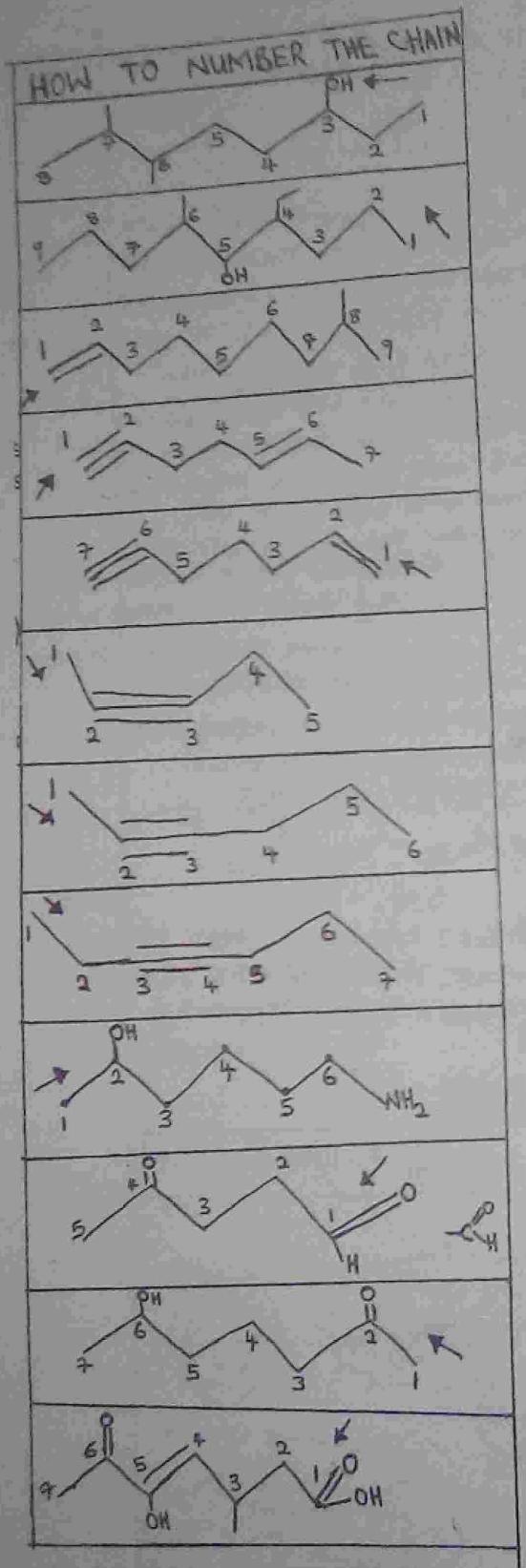
3-Ethyl-5-Methyl Heptane



ANSWER:

3-Ethyl-5-Methyl Heptane

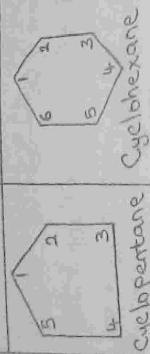
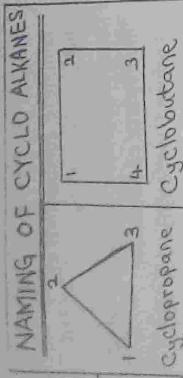




PHYSICAL PROPERTIES OF ALKANES

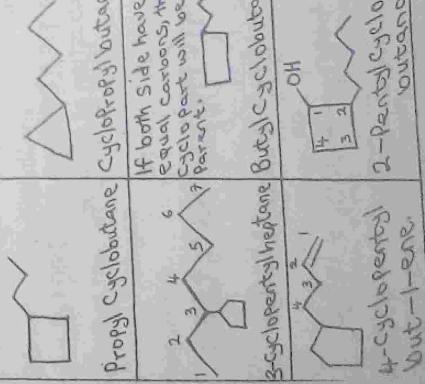
- From methane to butane are colourless gases at room temperature.
- C_5-C_7 are liquids. Above C_7 are solids.
- The boiling and melting points of alkanes increases as the molecular weight increases.
- The density of alkanes is about $0.79/cm^3$. It means that the density of alkanes is lower than the density of water.

NB: If two or more alkanes have equal number of carbon and hydrogen atoms, the one that has more branches will have a lower boiling point. Branched hydrocarbons have lower boiling points than their corresponding straight chain hydrocarbons due to lower surface area created by branching. Boiling point decreases as the number of branches increases.



NOTE: When a cyclo alkane is joined together with an open chain alkane, the side chain will be the side that has higher number of carbon atoms while the side that has lower number of carbon atoms will be the attachment chain. Also, the part that carries the functional group is the parent chain.

Examples:



FUTO PAST QUESTION 2015/2016

Arrange the following isomeric alkanes in order of decreasing boiling points:- pentane, 2,2-dimethyl propane, and 2-methyl butane

ANSWER= pentane \rightarrow 2-methyl butane
 \rightarrow 2,2-dimethyl propane.

- Alkanes are insoluble in water,
- but they dissolve in organic

NAMING OF CYCLO ALKANES

Cyclopropane	Cyclobutane
Cyclopentane	Cyclohexane

NOTE :- When a Cyclo alkane is joined together with an open chain alkane, the side of the compound that has higher number of carbon chain will be the parent chain while the side that has lower number of carbon chain will be the attachment. Also; the part that carries the functional group is the parent chain.

Examples:-

Propyl Cyclobutane	Cyclopropyl butane
	If both sides have equal carbons, the cyclo part will be the parent.
3-cyclopentyl heptane	
Butyl Cyclobutane	
4-cyclopentyl but-1-ene	
	2-Pentyl cyclobutanol

PHYSICAL PROPERTIES OF ALKANES

- From methane to butane are colourless gases at room temperature.
- C_5-C_7 are liquids. Above C_{17} are solids.
- The boiling and melting points of alkanes increases as the molecular weight increases.
- The density of alkanes is about 0.7 g/cm^3 . It means that the density of alkanes is lower than the density of water.

NB: If two or more alkanes have equal number of carbon and hydrogen atoms, the one that has more branches will have a lower boiling point. Branched hydrocarbons have lower boiling points than their corresponding straight chain hydrocarbons due to lower surface area created by branching. Boiling point decreases as the number of branches increases.

FUTO PAST QUESTION 2015/2016

Arrange the following isomeric alkanes in order of decreasing boiling points:- pentane, 2,2-dimethyl propane, and 2-methyl butane

ANSWER = pentane > 2-methyl butane > 2,2-dimethyl propane.

- Alkanes are insoluble in water, but they dissolve in organic

solvents such as benzene and ether.

Viscosity of alkanes increase as the number of carbon atoms increases.

The density of the n-alkanes is around 0.7g/ml. It means that the density of water is higher than the density of the alkanes.

NB:- the density of alkane's increases as the number of carbon atom increases. It means that, ethane is denser than methane because ethane has more carbon atoms than methane.

TEST YOURSELF

Arrange the following in their increasing order of boiling points;

C_4 , C_3H_8 , C_8H_{18} , C_5H_{12} , C_2H_6

ANSWER

more the number of carbon atoms, the more the boiling point.

ANSWER = $C_8H_{18} > C_5H_{12} > C_3H_8 > C_2H_6 > C_4$

CHEMICAL PROPERTIES OF ALKANES

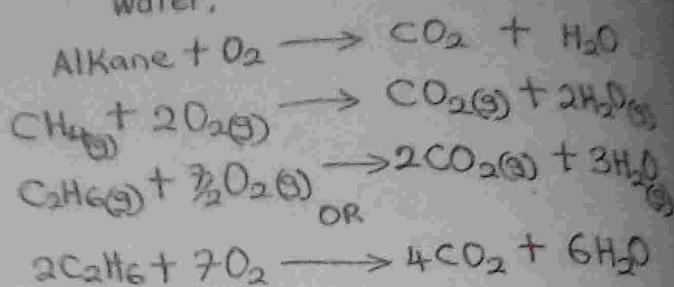
Alkanes are generally unreactive. This is because alkanes are highly saturated.

Under certain conditions, alkanes generally undergo substitution reaction.

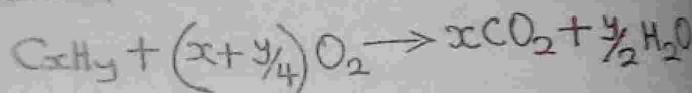
COMBUSTION REACTION

Combustion of alkane is the reaction of an alkane with

oxygen gas. The products of complete combustion of hydrocarbon's are carbon(iv)oxide and water while incomplete combustion produces carbon(ii)oxide and water.



If you are asked to balance the equation of combustion reaction of an alkane, use this formula:



Where X = number of carbon atoms present.

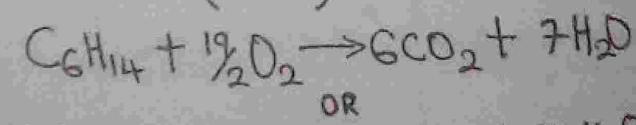
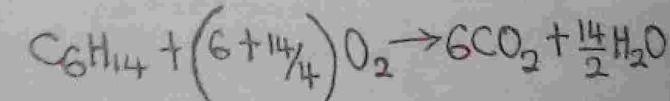
Y = numbers of hydrogen atoms present.

Example:

Let us write a balanced equation for the combustion of Hexane.

Hexane $\Rightarrow C_6H_{14}$

Here, X = 6 and Y = 14

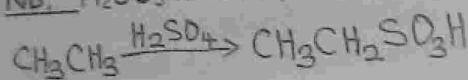


alkanes will not take place in a dark condition (absence of light).
NOTE:- halogenations of alkanes occur through a free radical mechanism

5. SULFONATION OF ALKANES

This is the addition of SO_3H to alkanes.

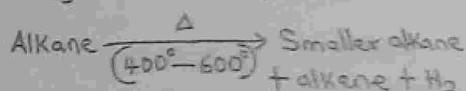
NB: H_2SO_3 is used (fuming)



CRACKING OF ALKANES

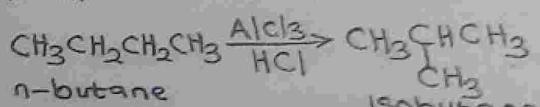
Cracking is the breaking down of higher molecular weight hydrocarbons into smaller fractions.

Cracking is also called pyrolysis.



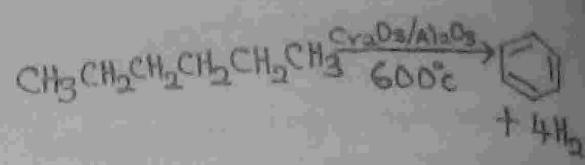
ISOMERIZATION OF ALKANES

This is the conversation of a normal alkane into its branched chain isomer in the presence of aluminum chloride (AlCl_3) and HCl at 25°C .



AROMATIZATION OF ALKANES

This is the conversion of an alkane into a cyclic benzene or benzene derivative in the presence of $\text{Cr}_2\text{O}_3/\text{Al}_2\text{O}_3$.



SOURCES OF ALKANES

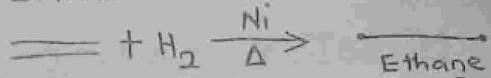
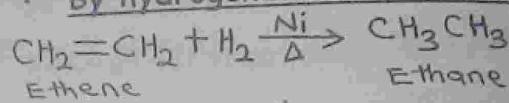
The two major sources of alkanes are:

Natural gas

-Petroleum

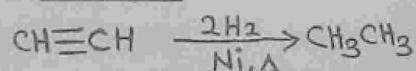
PREPARATION OF ALKANES

By hydrogenation of alkenes



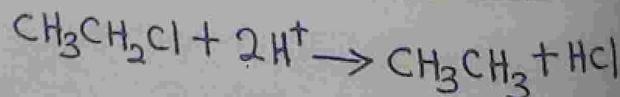
NB:- The catalysts used in hydrogenation are Nickel (Ni), Platinum (Pt) and Palladium (Pd).

By complete hydrogenation of an alkyne



In Order to prevent complete hydrogenation of an alkyne, we use palladium Poisoned with Calcium Carbonate in Quinoline. This is called LINDLAR'S CATALYST. We shall see this reaction in the reactions of alkynes.

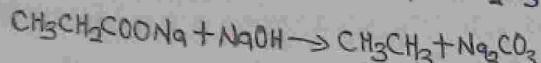
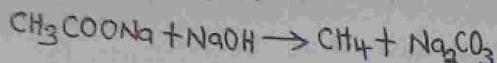
- By reduction of alkyl halides



By decarboxylation of Carboxylic acid salts.

This is the removal of CO_2 from an alkanoate salt to produce an alkane.

NB:- Decarboxylation of ethanoate produces methan.
Decarboxylation of propanoate produces ethane.
Decarboxylation of butanoate produces propane, etc.



FUTO PAST QUESTION

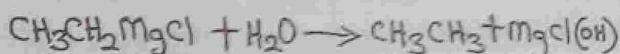
The decarboxylation of sodium ethanoate produces...? (A)methanol
(B)ethane (C)methane (D)ethanoic acid

ANSWER = C

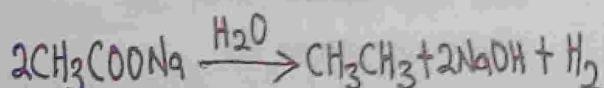
- By Wurtz reaction



- By hydrolysis of Grignard reagent



- By Kolbe's synthesis



ALKENES

Alkenes are the unsaturated hydrocarbons that contains carbon to carbon double bond along the chain. Alkenes have the general molecular formula C_nH_{2n} (n = number of carbon atoms).

Alkanes have two hydrogen atoms more than their corresponding alkenes.

Alkenes are SP₂-hybridized.

Alkenes have trigonal or planar shape with a bond angle of 120° .

Alkenes are also called olefins which mean oil formers. The double bond in an alkene is made up of one sigma bond and one pi-bond.

NB: One pi-bond contains two pi-electrons.

The first member of the alkenes family is Ethene.

NOMENCLATURE OF ALKENES

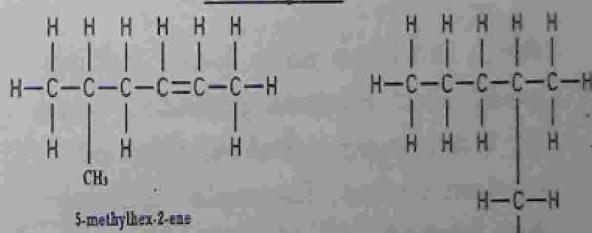
We follow the same rules of naming as in alkanes.

In naming alkenes, we number the carbon atoms in the longest chain in a way that will give the double bond the smallest number.

The position of the double bond in the longest chain should be indicated when writing the name of the alkene.

- The last "ane" in the name of an alkane is replaced with "ene" for an alkene.

Examples



STABILITY AND REACTIVITY OF ALKENES

More substituted alkenes are more stable than the less substituted alkenes. Example, but-2-ene is more stable than but-1-ene.

Less substituted alkenes are more reactive than the more substituted alkenes. Example, but-1-ene is more reactive than but-2-ene. It means that, the lower the position of the double bond, the more reactive the alkene.

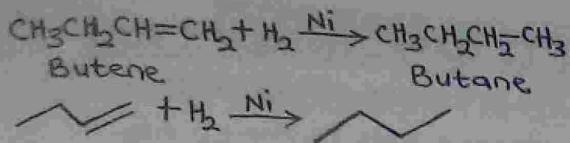
CHEMICAL PROPERTIES OF ALKENES

Generally, alkenes are more reactive than alkanes. This is due to the presence of pi-electrons (electron cloud) present in alkenes.

Hydrogenation of alkenes

Hydrogenation is the addition of hydrogen to a substance. The hydrogenation of an alkene produces an alkane. Example, hydrogenation of ethane produces ethane. Hydrogenation of butane produces butane.

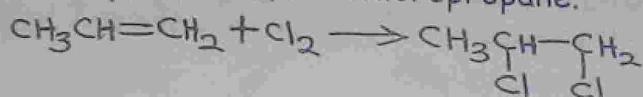
NB:- The catalysts used in hydrogenation of alkenes are Nickel, palladium and Platinum.



Halogenation of alkenes

Halogenation of alkene

produces dihaloalkane. Example:-
chlorination of prop-1-ene will
produce 1,2-dichloropropane.



FUTO PAST QUESTION

2016/2017

What is the product formed by the bromination of 2-methyl pent-1-ene?

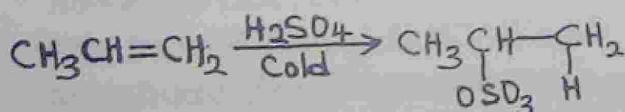
- (a) 2,2-dibromo-2-methyl heptane
- (b) 1,2-dibromo-2-methyl pentane
- (c) 2-bromo-2-methyl pent-1-ene
- (d) 1-bromo-2-methyl pent-1-ene

ANSWER = B

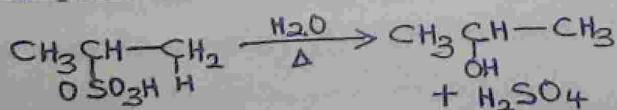
Reaction with H_2SO_4

The reaction of an alkene with H_2SO_4 has two stages. The final product is an alcohol.

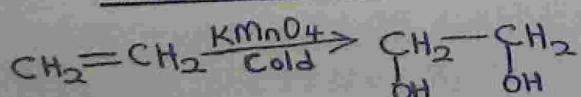
Stage 1



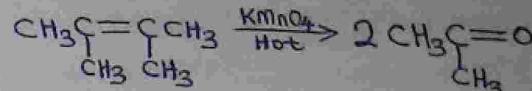
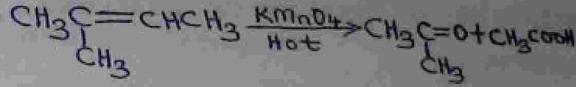
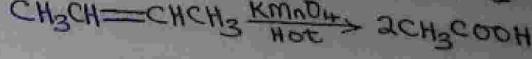
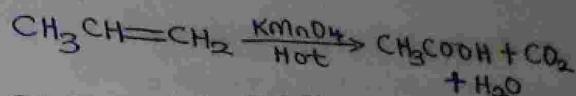
Stage 2



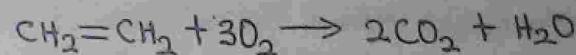
Reaction with KMnO_4



NB: Cold and hot conditions of alkene with KMnO_4 gives different products.

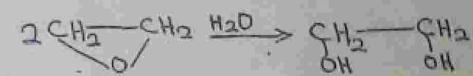
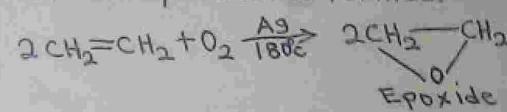


Reaction with oxygen

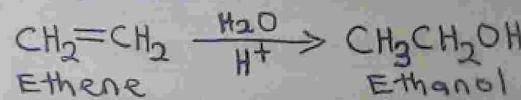


This is combustion reaction.

=> In the presence of silver, a different product is formed.

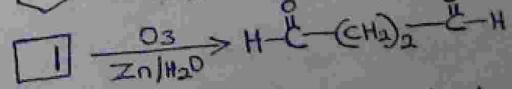
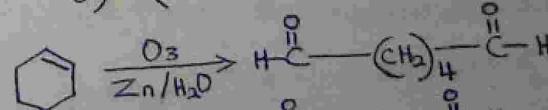
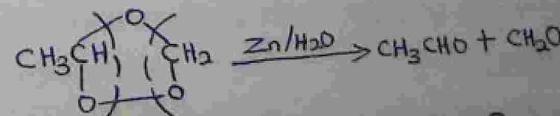
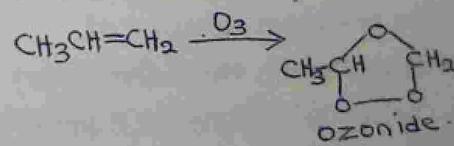


Hydration of alkenes



Reaction with Ozone (O_3)

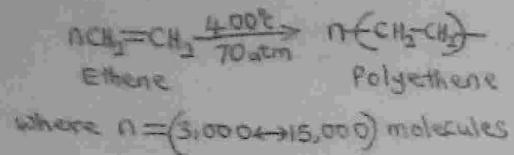
The reaction of an alkene with ozone is called ozonolysis.



NB: the intermediate product of ozonolysis is called ozonide

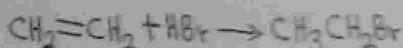
Polymerization reaction

Polymerization is the process of forming a giant molecule (polymer) by combination of many smaller molecules (monomers).



Hydrohalogenation of alkenes

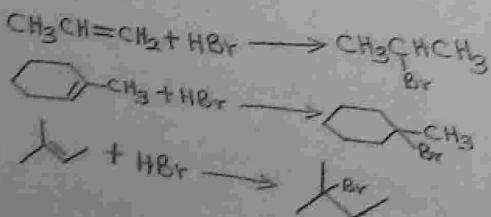
Hydrohalogenation is the addition of hydrogen and halogen to a substance



MARKOVNIKOV'S RULE

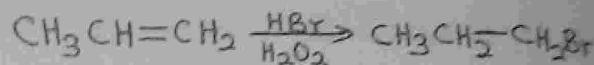
The rule states that "in the addition of a hydrogen halide (H_x) to an unsymmetric alkene, the H of the H_x goes to the double-bonded carbon that has the greatest number of hydrogen atoms while the halogen (x) joins the carbon with smaller number of hydrogen atoms".

Examples:



ANTI MARKOVNIKOV'S RULE

In the presence of peroxide (H_2O_2), the hydrogen goes to the double-bonded carbon with smaller number of hydrogen atoms while the halogen goes to the one with more hydrogen atom.



*NB: Anti markovnikov's rule also occurs in the presence of diakyl, diacyl and alkyl.

FUTO PAST QUESTION

2016/2017

Predict the product of pent-1-ene and excess HCl in the presence of hydrogen peroxide

- (a) 1,2-dichloropentane
- (b) 1,2-dichloropentane
- (c) 2,2-dichloropentene
- (d) 2-chloro-1-pentene

ANSWER = B

FUTO PAST QUESTION

QUESTION
2016/2017

The reaction between $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)_2$ and HBr in the presence of H_2O_2 produces

ANSWER = A

FUTO PAST QUESTION

2016/2017

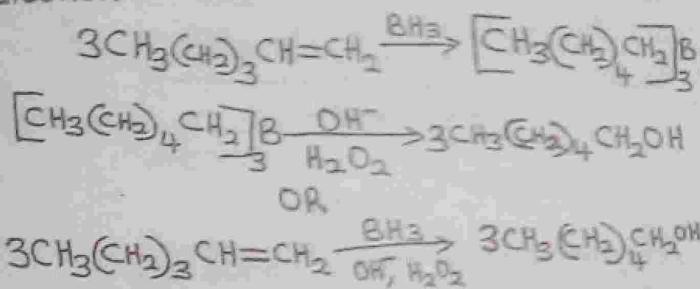
What is the product formed in the peroxide catalysed hydrobromination of 1-methylcyclohexene?

- (a) 4-bromo-1-methylcyclohexane (b)
 2-bromo-1-methyl-1-methyl
 cyclohexane (c) 1-bromo-1-methyl
 cyclohexane (d) 5-bromo-2-methyl
 cyclohexane

ANSWER = 1-bromo-2-methyl cyclohexane (no correct option).

*NB; There is a reaction known as Oxymercuration of alkenes.

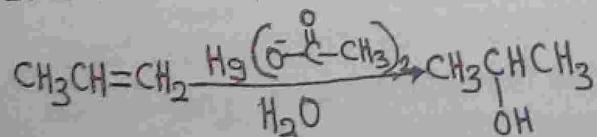
The final product of this oxymercuration of alkene is an alcohol.



There is also another reaction of alkenes called hydroboration of alkenes.

The end-product of hydroboration of alkene is an alcohol.

It is a two step reaction.



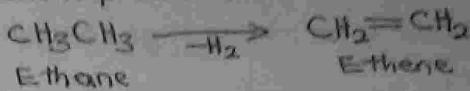
PREPARATION OF ALKENES

Generally, alkenes are prepared by elimination reaction.

• By dehydrogenation of alkanes

Dehydrogenation is the removal of hydrogen molecule from a substance.

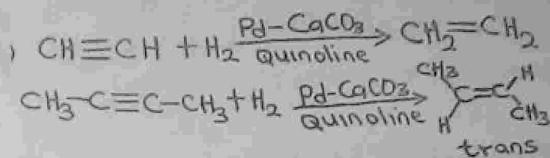
If an alkane is dehydrogenated, an alkene is produced.



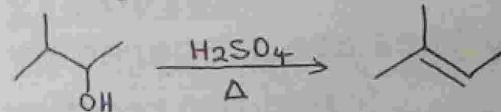
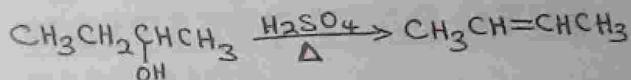
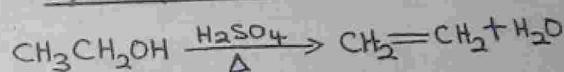
By hydrogenation of alkynes

Hydrogenation of a substance is the addition of hydrogen molecule to the substance.

The addition of hydrogen molecule (H_2) is an alkyne.

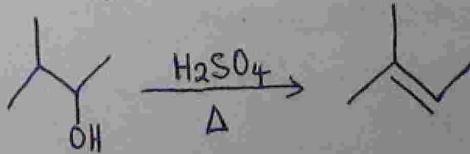
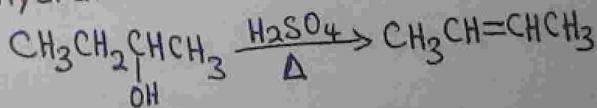


• By dehydration of alcohols



Dehydration is the removal of water molecule from a substance.

Dehydration is the opposite of hydration.



By dehydrohalogenation of haloalkanes

Dehydrohalogenation is the removal of a molecule of hydrogen halide from a substance.

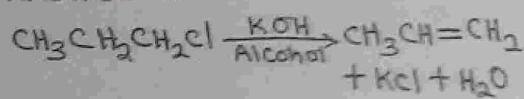
A haloalkane is an alkane that contains a halogen.

**FUTO PAST QUESTION
2016/2017**

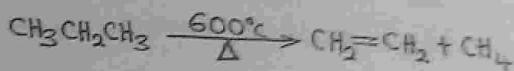
The loss of a halide atom to generate an alkene is known as

- (a) dehydro-halogenation (b) dehydration (c) reduction (d) oxidation

ANSWER = A



• By cracking of alkane



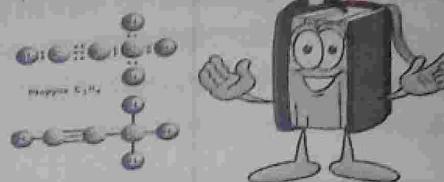
**FUTO PAST QUESTION
2016/2017**

Alkenes are prepared by

- (a) addition reaction
- (b) substitution reaction
- (c) elimination reaction (d) free radical reaction

ANSWER = C

Alkynes



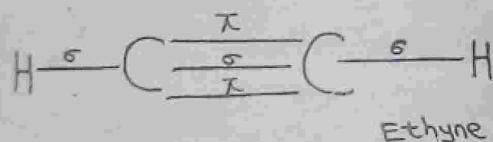
Alkynes are hydrocarbons that contain carbon to carbon triple bond.

Alkynes have the general molecular formula C_nH_{2n-2} .

Alkynes are SP-hybridized.

Alkynes have Linear shape with bond angle of 180° .

The triple bonds of an alkyne is made up of one sigma bond and two pi-bonds.



NOTE

Alkynes whose triple bonds are located at position one are called TERMINAL ALKYNES and they are more reactive than other alkynes.

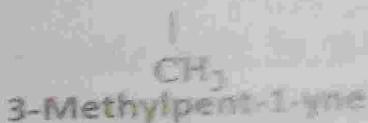
NOMENCLATURE OF ALKYNES

Alkynes are named in this manners are alkenes.

In naming alkynes, the the last "ane" of alkane is replaced with "yne" for an alkyne.

The triple bond position is given the smallest number when numbering the carbon atoms in the longest chain.

Alkyne is the first member of the alkenes.



ALKYNES

IUPAC naming system:

Name the following alkynes:



hex-4-en-1-yne



3-ethylhept-1-en-4-yne

Alkenes are ordered first in the name, and the 'e' ending is dropped.

Generally, double bonds and triple bonds have equal numbering priority* (aim to get the lowest numbers).



cyclobutylethyne

PHYSICAL PROPERTIES OF

ALKYNES

- Boiling and melting points of alkynes increases as the number of carbon atoms increases.

NB:- alkynes have higher boiling points than alkenes and alkanes of the same number of carbon atoms. For boiling points,

ALKYNE > ALKANE > ALKENE

- Alkynes are slightly polar and therefore are slightly soluble in water but they dissolve in organic solvents.
- From C₁-C₃ alkynes are gases, C₄-C₁₁ are liquids while others are solids at room temperature.

CHEMICAL PROPERTIES OF

ALKYNES

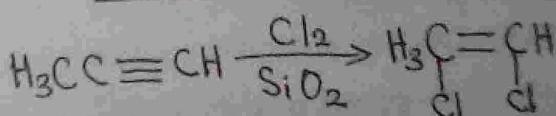
Combustion reaction



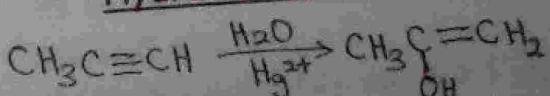
Hydrogenation of alkynes



Halogenation of alkynes



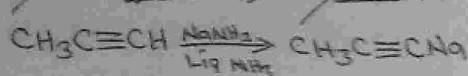
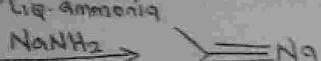
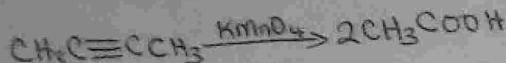
Hydration of alkynes



Hydrohalogenation of alkynes



Oxidation of alkynes



Formation of salts

(Acetylides)

Hydrogen atom bonded to a carbon carrying a triple bond is called an **acidic hydrogen**. Acidic hydrogens are very reactive. Acidic hydrogen in alkynes are usually substituted by metals like sodium, silver, copper.

*NB: Alkynes that have acidic hydrogens (terminal alkynes) are more reactive than those without acidic hydrogen.

FUTO PAST QUESTION

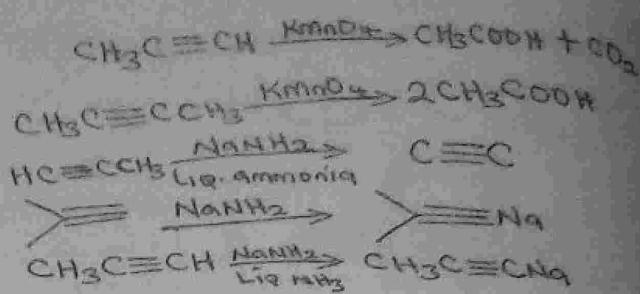
2016/2017

Which of the following is more acidic

(a) 1-butyne (b) 2-butyne (c) 1-

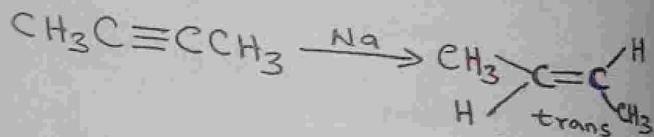
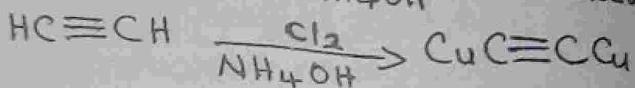
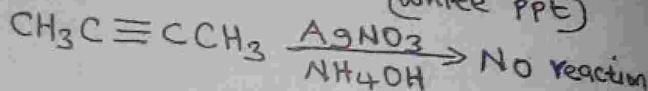
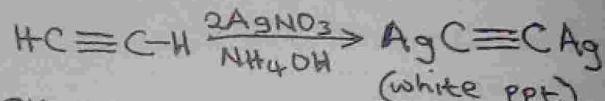
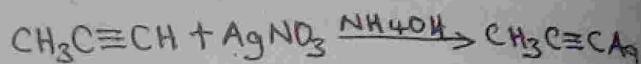
butene (d) butane

ANSWER = A..(a terminal alkyne).

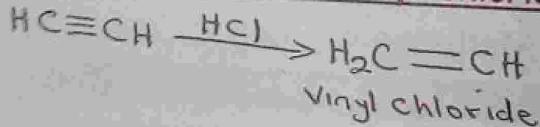


Cu

Na, NH₃

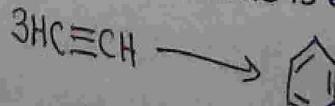


Production of Vinyl chloride



Polymerization of Ethyne

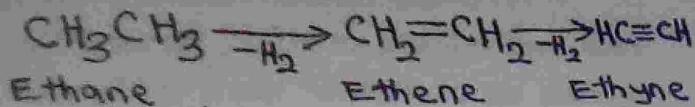
Polymerization is the combination of smaller molecules called monomers to produce a giant molecule called polymer. Example, when molecules of ethyne combine together, they form benzene molecule. Therefore, the monomer of benzene is ethyne.



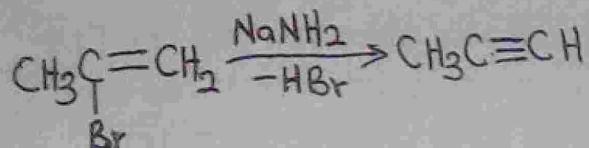
Benzene

PREPARATION OF ALKYNES

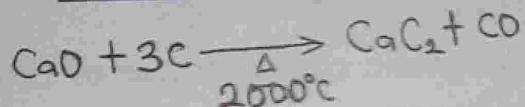
- By dehydrogenation of alkanes or alkenes.



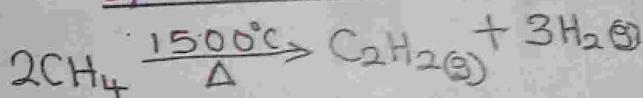
- From dehydrohalogenation of haloalkenes.



- From coke



- By thermal cracking of alkanes



FUTO PAST QUESTION.

2016/2012.

CaC₂ on hydrolysis gives ?
 (a) alkanes (b) alkenes (c) alkynes
 (d) alcohols

ANSWER = alkynes...C

TEST FOR ALKANES, ALKENES AND ALKYNES

Alkanes do not change the colour of bromine water because alkanes are saturated.

Alkenes and alkynes decolourise bromine water because they are unsaturated.

Alkenes and alkynes also change the purple colour of KMnO₄ to colourless.

Alkynes react with a solution of silver trioxonitrate(v) while alkenes do not react with it.

HOMOLOGOUS SERIES

Homologous series is a series of compounds in which each member differs from its successive member by a constant amount.

Members of a homologous series are called "homologous". A given homologous series is made up of compounds of the same family or functional group.

CHARACTERISTICS OF HOMOLOGOUS SERIES

- They differ from each successive member by CH₂ or 14g (C=12, H= 1)
- They have similar chemical properties.
- Their physical properties gradually vary on going down the series.
- Boiling and melting points as well as viscosity increases down the series.

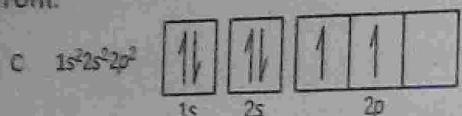
Example:

- CH₄
- C₂H₆
- C₃H₈ etc

HYBRIDIZATION

Hybridization is the process of mixing of two or more pure different orbitals to form new equivalent orbital.

Now, let us take a look at the electronic configuration of carbon atom.



If energy is applied to this ground state configuration of carbon, one electron will be transferred from 2S-orbital to the empty P-orbital (Pz).

We then have the excited state configuration of carbon atom as;



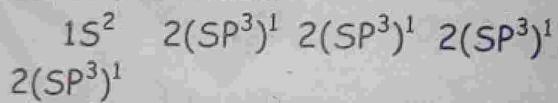
equivalent orbitals. These new orbitals are known as SP^3 hybrid orbitals.

HYBRID ORBITALS are those new equivalents orbitals formed by mixing up of two or more different orbitals.

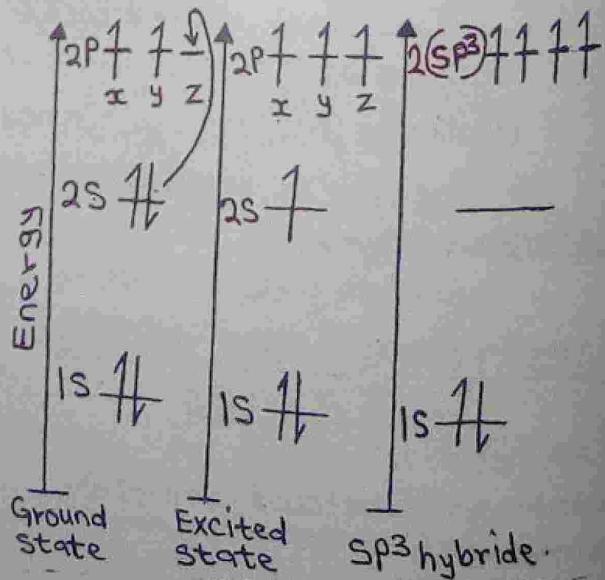
***N/B:-** SP^3 orbitals are formed when one S-orbital (S^1) mixes up with three P-orbital (P^3).

It is just like when you mix one liter of a pure red paint with three Liters of white paint and you form four liters of pink paint (Red +white=pink)
i.e $S^1 + P^3 \rightarrow SP^3$

The electronic configuration of SP^3 of carbon becomes;



Now, let us take a look at the formation of SP^3 hybrids in terms of energy levels,



SP^3 HYBRIDIZATION

Ground state(C)



Excited state



In order to produce four identical bonds, carbon must contribute a set of four equivalent orbitals. This is done when the 2S orbital and the three 2P-orbitals in the excited state of carbon are mixed together or hybridized to form four new

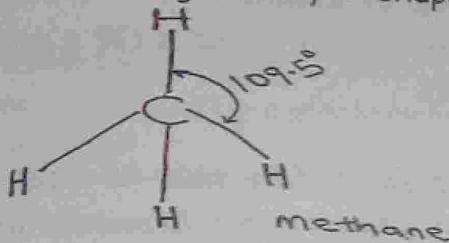
In SP^3

$$\% S = \frac{S}{SP^3} \times 100 = \frac{1}{1+3} \times \frac{100}{1} = 25\%$$

$$\% P = \frac{P^3}{SP^3} \times 100 = \frac{3}{1+3} \times \frac{100}{1} = 75\%$$

NB:- The higher percentage S-character, the more acidic the compound

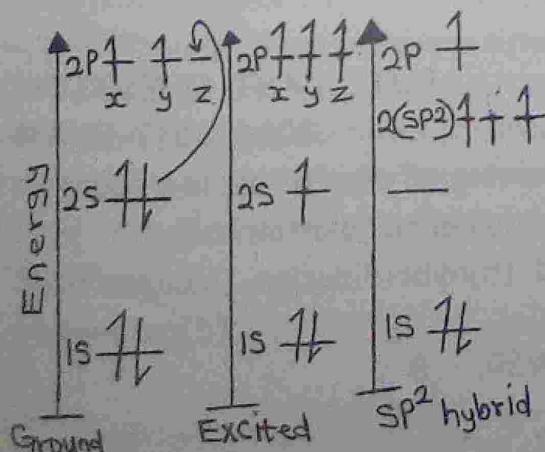
The shape of an SP^3 hybrid orbital is tetrahedral. Examples, alkanes are SP^3 hybridized and they have tetrahedral geometry or shape.



N/B: The tetrahedral shape is obtained because the electrons move as far as possible away from each other because they are like charges.

SP^2 HYBRIDIZATION

In SP^2 hybridization, one electron of 2S-orbital mixes up with two from 2P-orbital leaving one of P-orbital unhybridized.



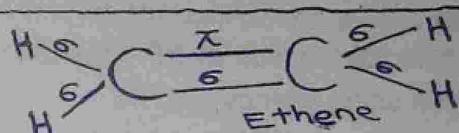
The configuration in SP^2 is:
 $1S^2 2(SP^2)^1 2(SP^2)^1 2(SP^2)^1 2P^1$

Unhybridized

The bond angle in an SP^2 hybrid is 120° and it has a trigonal shape. SP^2 hybridization is found in alkenes.

The unhybridized orbital in P-orbital (P_z) is used to form a pi-bond. Since only one is unhybridized, one pi-bond (π) is found in a simple alkene.

EXAMPLE:



π pi-bond

σ sigma bond

The percentage S and P in SP^2 are as follows:

In SP^2

$$\% S = \frac{S}{SP^2} \times 100 = \frac{1}{1+3} \times \frac{100}{1} = 25\%$$

$$\% P = \frac{P^2}{SP^2} \times 100 = \frac{2}{1+3} \times \frac{100}{1} = 50\%$$

SP HYBRIDIZATION

Here, only one orbital of the P-orbital is hybridized.

SP-hybrid orbital is formed when one electron from the 2S-orbital of carbon atoms mixes up with only one orbital of 2P-orbital.

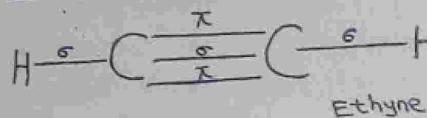
The other two orbitals in P-orbital (P_y and P_z) are left unhybridized.

The two unhybridized orbitals are used to form pi-bond. Simple alkynes

have two pi-bonds because there are two unhybridized p-orbitals in alkynes (SP).

There are two pi-bonds in this case. SP-hybridization is found in alkynes. They have Linear shape with a bond angle of 180°.

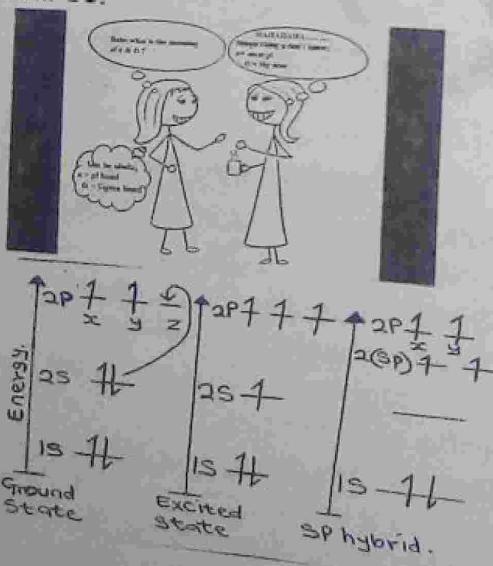
EXAMPLE:



Now let us take a look at SP-orbitals formation using energy profile.

NOTE

SP hybridization is more acidic followed by SP^2 hybridization and then SP^3 hybridization because SP hybridization is more electronegative. The more the electronegativity, the more acidic it will be.



The %S and %P in SP hybrid are as follows:

In SP

$$\%S = \frac{S}{SP} \times \frac{100}{1} = \frac{1}{1+1} \times \frac{100}{1} = 50\%$$

$$\%P = \frac{P}{SP} \times \frac{100}{1} = \frac{1}{1+1} \times \frac{100}{1} = 50\%$$

NB: Sigma bond is stronger than pi-bond.

NOTE

Sigma bond is formed by end-to-end overlap of atomic orbitals (overlap of s and s OR s and p orbitals).

Pi-bond is formed by side-to-side overlap of atomic orbitals (overlap of p-orbitals)

2016/2017 EXAM

Which compound contains an sp hybridized C atom?

- (a) CH_3CO_2H
- (b) CH_3HO
- (c) CH_3CN
- (d) CH_3NH_2

ANSWER = C... (this is due to the presence of triple bond in between C and N in the compound CH_3CN)

FUTO PAST QUESTION

2016/2017 EXAM

The mixing of atomic orbitals is a quantum mechanical calculation called? (a) pi bond (b) hybridization (c) sigma bond (d) catenation

ANSWER = B

FUTO PAST QUESTION

2016/2017 EXAM

Pi bonds are formed by

- (a) overlap of two s-orbital
- (b) overlap of an s and a p orbital
- (c) End to end overlap of two p orbitals
- (d) side to side overlap of two p orbitals

ANSWER = D

FUTO EXAM 2016/2017

What orbitals are involved in C-O bond in alcohols? (a) C sp^2 , O sp^2 (b) C sp , O sp^2 (c) C sp^2 , O sp^2 (d) C sp^3 , O sp^3

ANSWER = D. in alcohols, C and O are connected by a single bond which means sp^3

FUTO PAST QUESTION

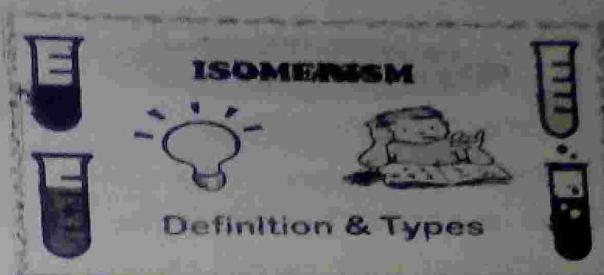
2016/2017 EXAM

Which atomic orbital overlap to form the carbon-carbon triple bond

- (a) sp^2+sp^2 , $sp+sp$, $p+p$ (b) $s+s$, $sp+sp$, $p+p$
- (c) $sp+sp$, $p+p$, $p+p$ (d) $sp+sp$, $sp+sp$, $p+p$

ANSWER = C

In a carbon to carbon triple bond system, we have SP hybridization. In each of the two carbon atoms involved, only one p-orbital is hybridized in each of the two carbons. It means that we have a total of two hybridized orbitals (SP), while there are two unhybridized orbitals (P) present in each of the two carbons. Therefore we have a total of four unhybridized p-orbitals.



This is the phenomenon in which two or more different compounds have the same molecular formula but with different structures,

Isomerism is caused as a result of the different arrangement of the atoms of the compound within the compound.

TYPES OF ISOMERISM

There are two main types of isomerism:

- Structural or constitutional isomerism
- Stereoisomerism

STRUCTURAL ISOMERISM

Structural isomers are compounds that have the same molecular formula but differ in their structures.

Another name for structural isomerism is constitutional isomerism.

Structural isomerism occurs as a result of difference in the method of arrangement of atoms within the molecule of the given compound.

There are five types of structural isomerism namely;

- (a) Chain Isomerism
- (b) Positional isomerism
- (c) Functional group Isomerism
- (d) Metamerism

FUTO PAST QUESTION

2016/2017 EXAM

Pi bonds are formed by
(a)overlap of two s-orbital (b)overlap
of an s and a p orbital (c)End to end
overlap of two p orbitals (d)side to
side overlap of two p orbitals

ANSWER = D

FUTO EXAM 2016/2017

What orbitals are involved in C-O
bond in alcohols? (a) $C\ sp^2, O\ sp^2$ (b) $C\ sp, O\ sp^2$ (c) $C\ sp^2, O\ sp^2$ (d) $C\ sp^3, O\ sp^3$

ANSWER = D. in alcohols, C and O
are connected by a single bond which
means sp^3

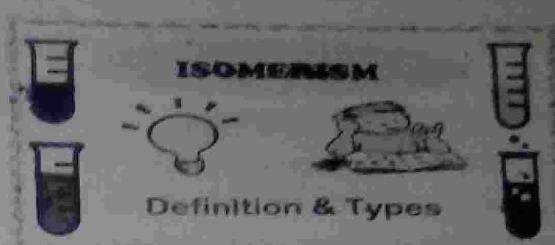
FUTO PAST QUESTION

2016/2017 EXAM

Which atomic orbital overlap to form
the carbon-carbon triple bond
(a) $sp^2+sp^2, sp+sp, p+p$ (b) $s+s, sp+sp,$
 $p+p$ (c) $sp+sp, p+p, p+p$ (d) $sp+sp, sp+sp,$
 $p+p$

ANSWER = C

In a carbon to carbon triple bond system,
we have SP hybridization. In each of the
two carbon atoms involved, only one p-
orbital is hybridized in each of the two
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- (a) Chain Isomerism (b) Positional
isomerism
- (c) Functional group Isomerism
- (d) Metamerism

(e) Tautomerism

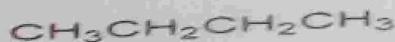
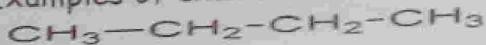
CHAIN ISOMERS

These are isomers that have different carbon skeletal arrangement.

Chain isomers differ only in the structure of their carbon chains. Chain isomers have different carbon to carbon longest chain.

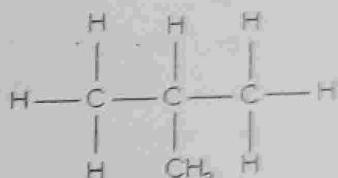
NB: The more the number of carbon branches in a compound, the lower the boiling point of the compound.

Examples of chain Isomers:



Butane (C_4H_{10})

And



2-methyl propane (C_4H_{10})

The two compounds above are isomers because they have equal number of total atoms of H and C in them (C_4H_{10}) which means they have the same molecular formula.

They are called chain isomers because the difference between them is only the method in which their carbon chains are arranged.

Another example of chain Isomers;



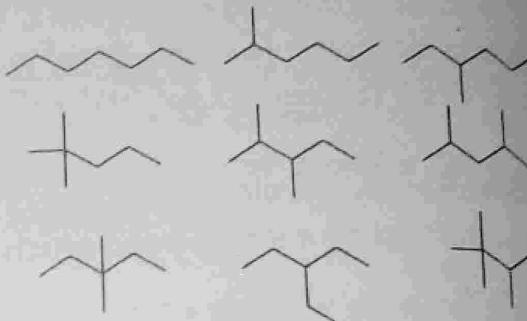
Butan-2-ol ($C_4H_{10}O$)

And

2-methyl propan-2-ol ($C_4H_{10}O$)

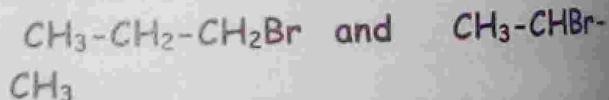
STRUCTURAL ISOMERS

Draw all of the structural isomers of heptane using line structures: C_7H_{16}



POSITIONAL ISOMERISM

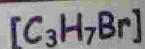
These are those isomers that differ only in the position of their attachments or substituent on the carbon chain. **EXAMPLE:**



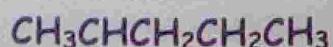
1-Bromo Propane



2-Bromo Propane



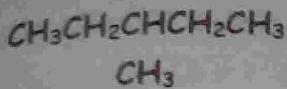
the difference between the two compounds above is the position of the attachment (Br) on the carbon chains. Another example;



2-methyl pentane



And



Isomeric pentene

[C4H8]

NOTE
Chain isomers belong to the same family. Also, positional isomers belong to the same family.

FUTO PAST QUESTION 2016/2017

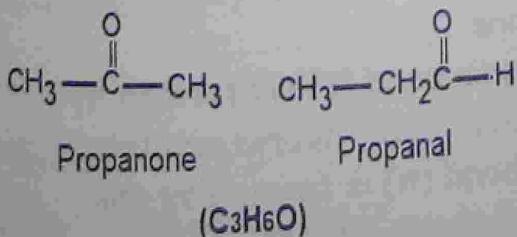
Pent-1-ene and Pent-2-ene are examples of
(A) enantiomers (B) constitutional isomers (C) stereoisomers (d) E-(Z)-isomers of pentene

ANSWER = B (constitutional is the same as structural)

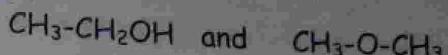
FUNCTIONAL GROUP ISOMERISM

These are those isomers that have different functional groups in them. Functional group isomers do not belong to the same family.

Examples:



Also:

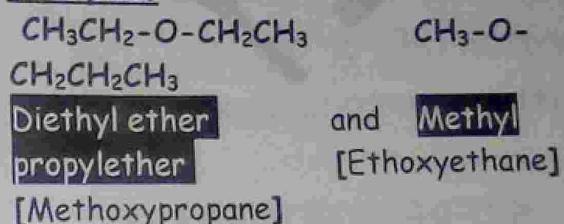


Isopropyl alcohol
Methyl propanoate

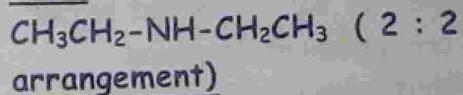
METAMERISM

This is the type of isomerism caused as a result of unequal distribution of carbon atoms on either side of the functional group. Metamers belong to the same homologous series.

Examples:

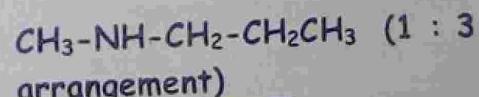


Also:



Diethylamine

and

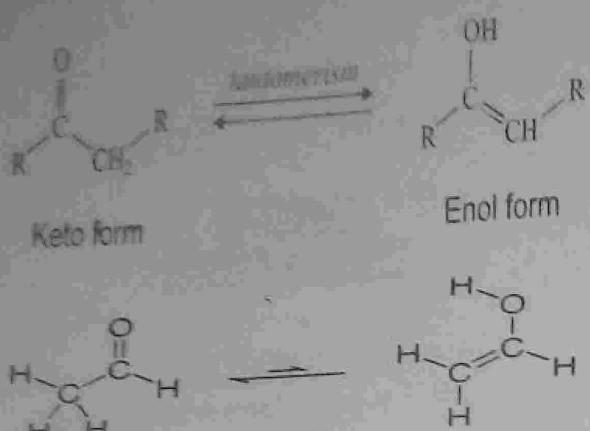


Methypropylamine

TAUTOMERISM

This is a form of functional group isomerism in which the isomers are in dynamic equilibrium with each other. The two forms of tautomerism are (i) keto form and (ii) enol form

EXAMPLE: Ethanal and
Ethenol



NB: They are called tautomers.

Tautomers are formed as a result of the movement of a proton (H^+) or a pi electron within the compound.

STEREOISOMERISM

This is the phenomenon whereby isomers have the same link but with different arrangement in space.

Molecules that have the same number of atoms in them or the same molecular formula but different structures or arrangement in space are called **stereoisomers**.

Stereoisomerism is divided into

- Geometric Isomers and
 - Optical Isomerism.
 - Enantiomers
 - Diastereomers

FUTO PAST QUESTION

2016/2017

Stereoisomers are ?
(a) molecules with the same number of atoms but different structures
(b) molecules with

the same structure (c) linear molecules with single bonded carbon atoms (d) molecules with different conformations due to a double bond

ANSWER = A

FUTO PAST QUESTION

2016/2017

Propane and 2-propanone
are.....

(a) positional isomers (b) functional group isomers (c) a dnd c (d) none of the above

ANSWER = D

Propane ($\text{CH}_3\text{CH}_2\text{CH}_3$) and propanone (CH_3COCH_3) are not isomers because they do not have the same molecular formula.

GEOMETRIC ISOMERISM



What is **GEOMETRICAL ISOMERISM**

This is the type of isomerism caused as a result of the lack of rotation around a double bond. Free rotation is not allowed around a carbon to carbon double bond. Geometric isomerism is mainly possible in alkenes and some cycloalkanes.

NB:- Sigma bond (\square) is formed by the overlap of SP^2 hybrid orbitals while pi-bond (π) is formed by the overlap of the P-orbital.

Geometric isomerism is also called Cis-trans Isomerism.

NOTE THIS

Cis and trans isomerism is only possible in alkenes in which the two carbon atoms carrying the double bond are bonded to two different atoms or groups. If both or one of the carbon atoms carrying the double bond has the same type of atoms or groups bonded to it, then such compound will not exhibit cis and trans isomerism. Example, $\text{CH}_3\text{CH}=\text{CH}_2$ will not show geometric isomerism because among the two carbon atoms carrying the double bond, one of the carbons has two different attachments on it (CH_3 and H), but the other carbon carrying the double bond has two same atoms (H and H) attached to it. Since one of those two carbons carrying the double bond has two same atoms attached to it, the compound will not show geometric isomerism.

FUTO PAST QUESTION 2016/2017

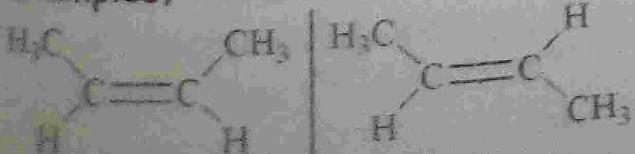
Which of the following compounds does not have cis/trans isomers?

- (a) $\text{CH}_3\text{CH}=\text{CHCH}_3$ (b) $\text{ClCH}=\text{CHCl}$
 (c) $\text{H}_2\text{C}=\text{CHC}_2\text{H}_5$ (d) $\text{CH}_3\text{CH}=\text{CHCH}_3$

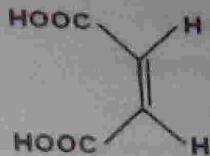
ANSWER = C...

(One of the carbons carrying the double bond has the same thing attached to it, i.e. H and H)

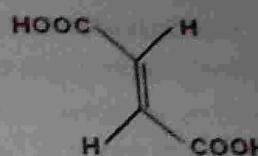
Examples:



NB: when the same group is located on the same side, it is called "Cis" but when the same group is located on opposite side, it is called "trans"



cis-butenedioic
(maleic acid)

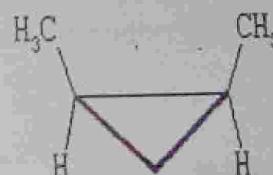


trans-butenedioic acid
(fumaric acid)

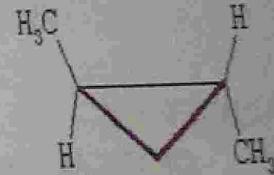
NB: "Cis" isomers are stronger acids than "trans" Isomers.

Geometric isomerism is also possible in some cyclic compounds.

Example:



cis-1,2-dimethylcyclopropane
(bp 37°C)



trans-1,2-dimethylcyclopropane
(bp 29°C)

***NB:** Trans isomerism does not exist in cycloalkenes whose carbon atoms are less than 8 due to angle strain. therefore, the smallest cycloalkene that has a trans isomer is cyclooctene (trans cycloalkene).

***NB:** -trans isomers have higher melting point than their cis isomer while cis isomer has higher boiling point than the trans isomer.

Also, trans isomers are more stable than their cis isomers due to the lesser force of repulsion between like charges in trans isomers...

Cis- and trans-isomers have almost equal densities, but not exactly equal.

Cis isomers are more soluble than their trans isomers. Another name for geometric isomerism is CIS and TRANS isomerism.

**FUTO PAST QUESTION ON
STEREOISOMERISM**
2016/2017

Which compound has stereoisomer?

- (a) Butane (b) Propyne (c) But-2-ene
(d) Propene

ANSWER = C

OPTICAL ISOMERISM

these are those isomers that have the ability to rotate the direction of a plane-polarised light.

NB: A substance is said to be "optically active" if the substance has the ability to rotate the direction of a plane-polarised light.

The substance is said to be "optically inactive" if it cannot rotate a plane-polarised light.

A substance that rotates light to the right (clockwise) is said to be **dextro-rotatory** while the one that rotates light to the left (anticlockwise) is said to be **Levorotatory**.

"NOTE"

The instrument used to measure optical activity is a polarimeter, called POLARIMETRY.

RACEMIC MIXTURE

A racemic mixture is a mixture which contains equal amount of enantiomers (dextro and levo).

***N/B:** A racemic mixture is optically inactive because the components of a racemic mixture oppose the action of the other in the mixture.

A racemic mixture is also defined as a mixture of two enantiomers.

***NB:** The process of separating a racemic mixture is known as **RESOLUTION**.

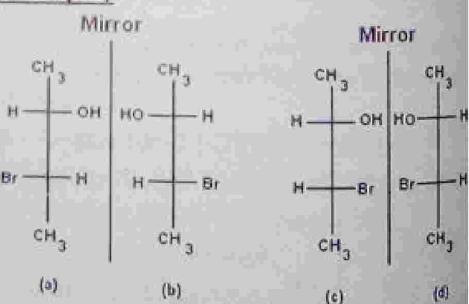
The process of producing a racemic mixture is known as
RACEMIZATION

ENANTIOMERS

Enantiomers are isomers that are mirror images of each other.

Enantiomers are not superimposable to each other.

Example:

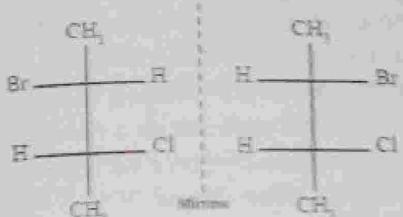


DIASTEREOMERS

Diastereomers are isomers that are non-enantiomers of each other. Diastereomers are not superimposable on each other. Diastereomers have more than one chiral centre.

Example of Diastereomers:

Diastereomers



NB: The condition for a compound to be optically active is that the compound must be dissymmetric (unsymmetric) which means that the compound must have a chiral centre.

CONFORMATION

Conformation is defined as the different spatial arrangement of a molecule that can be obtained by the rotation around carbon to carbon single bond.

Free rotation is possible around carbon to carbon single bond.

NB:- molecules that have different conformations due to the presence of single bond are called conformers.

TYPES OF CONFORMATION

The two major types of conformation are:

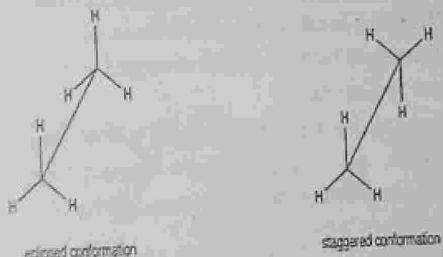
- Staggered conformation and
- Eclipsed conformation

These two conformations can be represented as sawhorse or Newman projections.

CONFORMATIONS OF ETHANE

The carbon atoms in ethane are not frozen in space. The two methyl groups in ethane can rotate about the C-C bond. As a result of the free rotation, different arrangements of ethane can be obtained.

SAWHORSE REPRESENTATION OF ETHANE



In sawhorse eclipsed conformation, the two H atoms are located opposite to each other just like in trans isomerism (up and down) while in sawhorse staggered conformation, the two H atoms are on the same side just like in cis isomerism (up, up or down, down).

The staggered and eclipsed conformations of ethane can be called "Rotational Isomer" or "Rotamers" because staggered and eclipsed

conformations can be converted into one another by rotation about C-C bond.

A 60° rotation converts a staggered conformation into an eclipsed conformation and vice versa.

NB:- the two types of hydrogens in cyclohexan conformation are axial hydrogen (vertical position) and equatorial hydrogen (horizontal position).

ANS:- The staggered conformation is more stable than the eclipsed conformation. This is because, in staggered conformation, the similar atoms are far apart from one another thereby leading to a decrease in repulsion between like charges within the molecule.

In eclipsed conformation, the atoms are closer to one another leading to an increase in repulsion between atoms of same charge.

NB:- The points of intersection of lines in sawhorse representation is carbon atom position.

NEWMAN REPRESENTATION OF ETHANE

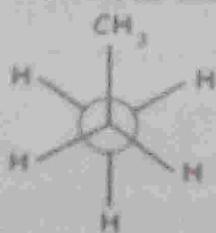


In Newman projection, a circle is used to represent the carbon atom at the back while the point of intersection of the lines at the centre represents the front carbon atom.

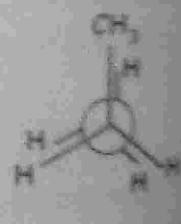
As shown in sawhorse projection, in the staggered conformation of Newman projection the atoms are far apart from one another leading to higher stability of the molecule unlike in the eclipsed conformation where the atoms are closer to one another leading to less stability of the molecule as a result of the higher repulsion force between the atoms of same charge.

In summary, the staggered conformation is more stable than the eclipsed conformation.

CONFORMATIONS OF PROPANE



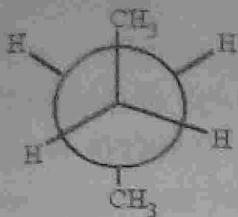
Staggered propane



Eclipsed propane

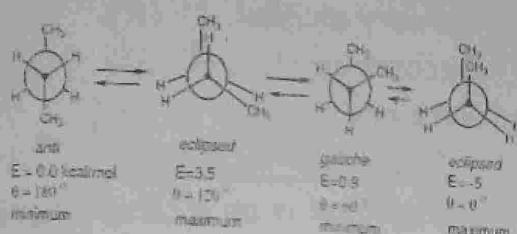
The above two structures are the staggered and eclipsed conformations of propane ($\text{C}_3\text{H}_8 = \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$)

CONFORMATIONS OF BUTANE



Anti (Staggered)
Dihedral Angle = 180 degrees

Butane Conformations



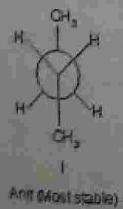
The above two structures represent the staggered and eclipsed conformations of butane ($\text{CH}_3\text{-CH}_2\text{-CH}_3\text{-CH}_3$).

There are two forms of staggered eclipsed conformations of butane known as "Anti" and "Gauche" conformations.

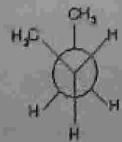
The staggered conformation in which the methyl groups are closer to each other is known as Gauche conformation.

The one in which the methyl groups are far from each other is known as Anti conformation.

NB: Anti conformation is more stable. Energy is highest in the eclipsed Gauche conformation.



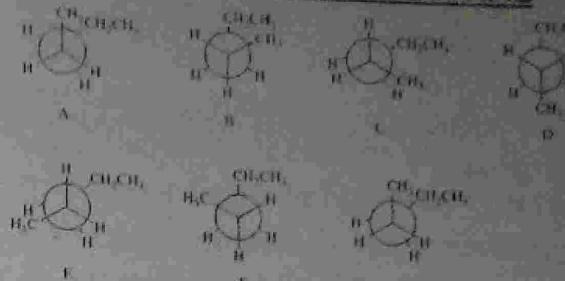
Anti (Most stable)



Gauche

Staggered conformations of n-butane

CONFORMATIONS OF PENTANE

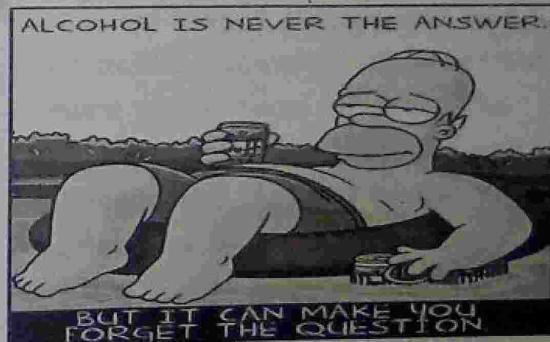


The staggered form is more stable.

FUTO PAST QUESTION ON CONFORMATION 2013/2014 EXAM

Different arrangement of atoms that can be converted into other form by the rotation about single bond is called ...
ANSWERS = Conformation

ALCOHOLS



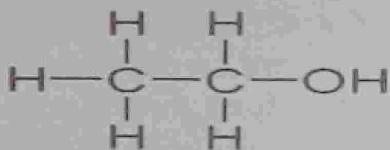
These are organic compounds that have the hydroxyl functional group (-OH). They have the general molecular formula $C_nH_{(2n+1)}OH$ where n represents the number of carbon atoms present.

TYPES OF ALCOHOLS

- Monohydric alcohol (b) Dihydric alcohol
- c) Trihydric alcohol (d) Polyhydric alcohol.

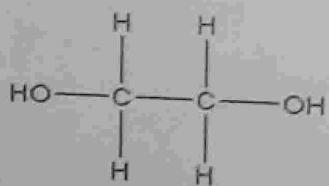
MONOHYDRIC ALCOHOL

A Monohydric alcohol is an alcohol that has only one hydroxyl group in it. An example of a Monohydric alcohol is ethanol.



DIHYDRIC ALCOHOL

A dihydric alcohol is an alcohol that has only two hydroxyl groups in it. Example is Ethan-1,2-diol.

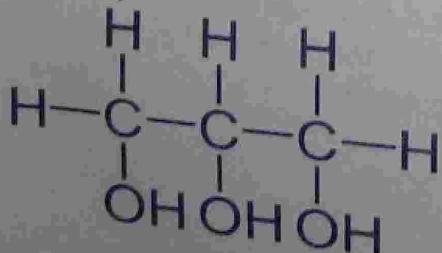


Ethan-1,2-diol (Glycol)

TRIHYDRIC ALCOHOL

This is an alcohol that contains three hydroxyl groups in it.

Example is propan-1,2,3-triol (Glycerol)



Propan-1,2,3-triol (Glycerol)

A polyhydric alcohol is an alcohol that contains more than three hydroxyl groups in it.

CLASSES OF ALCOHOLS

There are three classes of Alcohols namely;

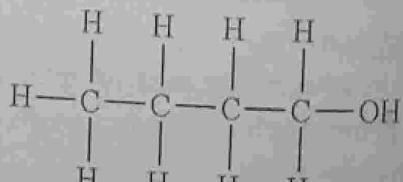
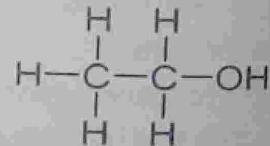
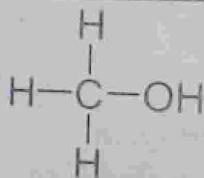
- Primary alcohol. (1°)
- Secondary alcohol (2°)
- Tertiary alcohol. (3°)

PRIMARY ALCOHOL

A primary alcohol is an alcohol whose OH group is attached to a primary carbon.

NB:- A primary carbon is a carbon atom in a compound that has only one or no other carbon atom or alkyl group directly bonded to it.

EXAMPLES:-



(n-butanol)

NB:- 1° means primary

2° means secondary

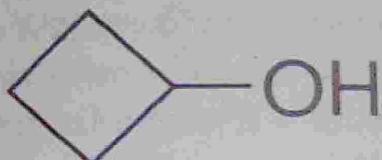
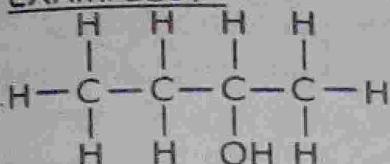
3° means tertiary

SECONDARY ALCOHOL

A secondary alcohol is an alcohol whose -OH group is attached to a secondary carbon.

NB: A secondary carbon is a carbon atom that has two other carbon atoms or two alkyl group directly bonded to it.

EXAMPLES:-

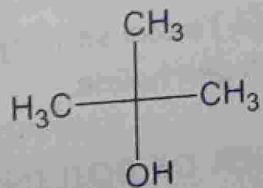
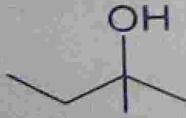


TERTIARY ALCOHOL

A tertiary alcohol is an alcohol whose -OH group is attached to a tertiary carbon in a compound.

NB: A tertiary carbon is a carbon atom that has three other carbon atoms or two alkyl group directly bonded to it.

Examples:-



TEST USED TO DISFFERENTIATE BETWEEN THE 3 CLASSES OF ALCOHOLS

Alcohols react with Lucas reagent to produce alkyl halides. Lucas reagent is a combination of zinc (ii) chloride in HCl (ZnCl_2/HCl). It is used to

differentiate the 3 classes of alcohols where ZnCl_2 serves as the catalyst.. Tertiary alcohols react immediately and very rapidly with Lucas reagent. Secondary alcohols take about 5mins before they reacts with Lucas reagent. Primary alcohols do not react or take a longer time to reacts with Lucas reagent at a temperature above room temperature. Therefore, the decreasing order of reactivity of the classes of alcohols with Lucas reagent is

tertiary > secondary > primary.

ACIDITY OF ALCOHOLS

primary > secondary > tertiary

NB:- the presence of a halogen in an alcohol makes the alcohol to be more acidic. Example;- chloroethanol is more acidic than ethanol. The more the number of halogens and the closer the halogen to the functional group, the more the acidity.

SOLUBILITY OF ALCOHOLS AND DEGREE OF HYDROGEN BONDING IN ALCOHOLS

Primary > secondary > tertiary

NB;- the lesser the number of carbon atoms in an alcohol, the more soluble the alchol will be. It means that methanol is more soluble than butanol.

NOTE

the more the number of atoms of a halogen present in an alcohol, the more acidic the alcohol will be.

RATE OF DEHYDRATION OF THE 3 CLASSES OF ALCOHOLS.

Tertiary > Secondary > Primary

REACTIVITY OF THE 3 CLASSES OF ALCOHOLS TOWARDS HX (X= halogen)

tertiary > secondary > primary.

**FUTO PAST QUESTION
2012/2013 EXAM**

Classify each of the following alcohols as 1° , 2° , 3° .



(III). $(CH_3)_3C-OH$

(IV). $CH_3CH_2CH(OH)CH_3$

ANSWERS

(I) is a primary alcohol (II) is a secondary alcohol (III) is a tertiary alcohol.

(IV) is secondary alcohol.

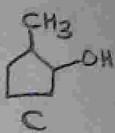
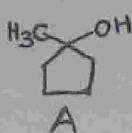
**FUTO PAST QUESTIONS
2016/2017**

Which of the following alcohols is most acidic?
(a) 1-chloroethanol (b) ethanol (c) 1,1-dichloroethanol (d) 2-chloroethanol

ANSWER = C (it has more halogen atoms)

**FUTO PAST QUESTION
2016/2017 EXAM**

Arrange the following alcohols in order of their decreasing reactivity with HBr (most reactive).



- (a) A > B > C (b) A > C > B (c) C > A > B
(d) B > C > A

ANSWER = B... $(3^\circ > 2^\circ > 1^\circ)$

**FUTO PAST QUESTION
2016/2017 EXAM**

For reacting with HCl, the alcohol which does not require $ZnCl_2$ is (a) CH_3CH_2OH (b) $CH_3CH(CH_3)CH_2OH$ (c) $CH_3CH(CH_3)OH$ (d) $(CH_3)_3C-OH$

ANSWER = $(CH_3)_3C-OH$...D

this is because tertiary alcohols react with HX (x=halogen) fastest. Tertiary alcohols may not require the catalyst ($ZnCl_2$) because they easily react with hydrogen halide.

ORDER OF BOILING POINT AND ABILITY TO FORM HYDROGEN BONDING HYDROGEN BOND FOR THE 3 CLASSES OF ALCOHOLS.

Primary > Secondary > Tertiary

**FUTO PAST QUESTION
2015/2016**

Arrange the following in the decreasing order of ease of dehydration, 2° , 1° , 3° alcohols.
ANSWER = $3^{\circ} > 2^{\circ} > 1^{\circ}$

NOMENCLATURE OF ALCOHOL

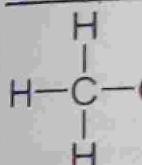
Alcohols are named in the same manner as alkanes, alkenes and alkynes.

In naming alcohols, we show the position of the carbon atom that carries the -OH group in the longest chain.

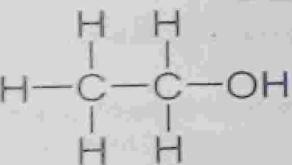
When numbering, we start from the side that gives the -OH group the smallest number.

In writing the name of the alcohol, we replace the last "e" in the name of the corresponding alkane with "ol".

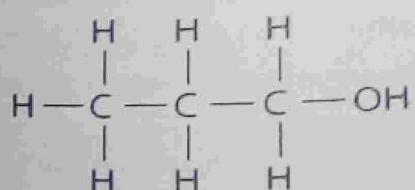
Examples:



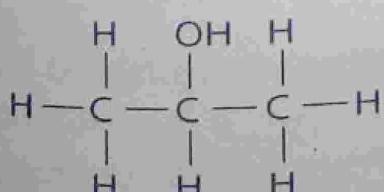
Methanol



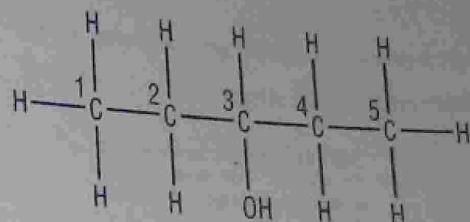
Ethanol



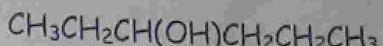
1-Propanol (*n*-propanol)



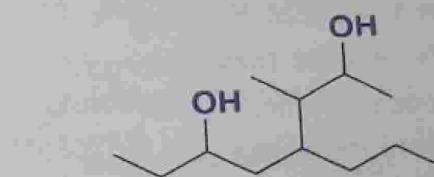
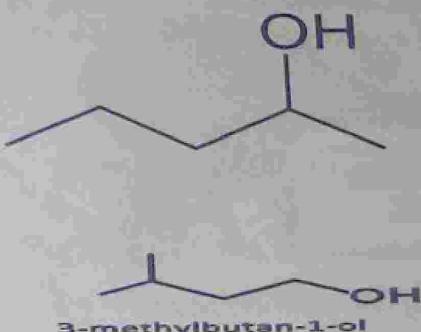
2-Propanol (isopropanol)



Pentan-3-ol OR 3-pentanol.



Hexan-3-ol

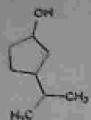


3-methyl-4-propyl-octane-2,6-diol



Cyclopentanol

Naming cyclic alcohols



The -OH group is assigned the C1 position. The second substituent then gets the lowest number.

The name of the compound is 3-isopropylcyclopentanol

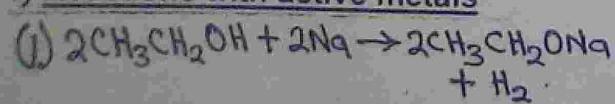
PHYSICAL PROPERTIES OF ALCOHOLS



- Boiling and melting points increases as the number of carbon atoms increases.
- Alcohols have high boiling points because they undergo hydrogen bonding.
- Viscosity increases as number of carbon atoms increases while volatility decreases as number of carbon atoms increases.
- Alcohols with lower number of carbon atoms (C_1 to C_4) are soluble in water due to hydrogen bonding.

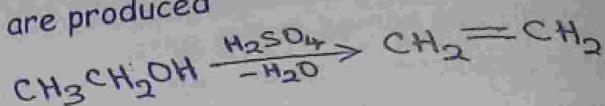
CHEMICAL PROPERTIES OF ALCOHOL

i) Reactions with active metals



ii) Dehydration of alcohol at 180°C

When alcohols are dehydrated with H_2SO_4 at a temperature of 180°C , alkenes are produced

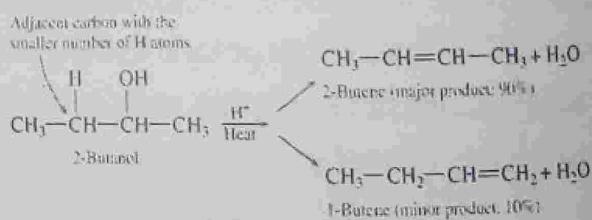


At a temperature of about 170°C to 180°C , alcohols react with H_2SO_4 to produce alkene but at 140°C , it produces an ether.

NB:- POCl_3 (phosphorus oxychloride) is also used to dehydrate alcohols to form alkene. POCl_3 is used in order to prevent the decomposition in the presence of strong acids like H_2SO_4 .

Saytzeff's Rule

According to Saytzeff's rule, the dehydration of a secondary alcohol favors the product in which hydrogen is removed from the carbon atom in the chain with the smaller number of H atoms



NB:- A reaction is said to be **regioselective** if a particular product of the reaction predominates over the other product. Example of a

regioselective reaction is the Saytzeff reaction above in which 2-butene predominates over 1-butene because 2-butene produced was 90% while 1-butene was 10% which means that 2-butene is preferred over 1-butene.

FUTO PAST QUESTION

2016/2017

A regioselective reaction is one in which

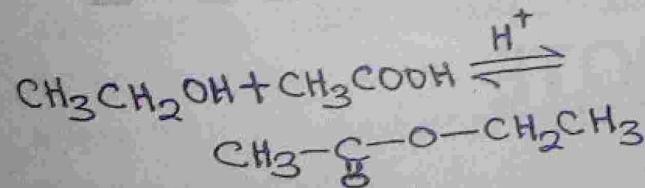
- (a) A single product is formed
- (b) multiple products are made in equal amounts
- (c) multiple products are made with one in excess of the other
- (d) involves oxidation

ANSWER = C

iii) Reaction with carboxylic acid.

(Esterification reaction)

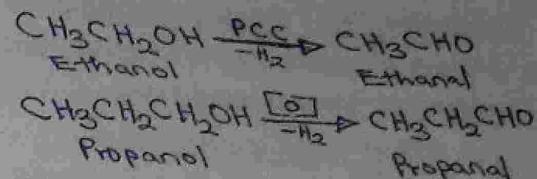
When alcohols react with carboxylic acids, esters are formed. The reaction is called esterification reaction.



iv) Oxidation of alcohols

Oxidation of a primary alcohol produces an aldehyde. Partial oxidation of a primary alcohol produces an aldehyde while complete oxidation of a primary alcohol produces carboxylic acid. Oxidation

of a secondary alcohol produces a keton.



NB:- When a mild oxidizing agent such as pyridinium chlorochromate (PCC) is used to oxidize an alcohol, an aldehyde will be produced.

If a strong oxidizing agent such as $\text{K}_2\text{Cr}_2\text{O}_7$ or $\text{Na}_2\text{Cr}_2\text{O}_7$ or KMnO_4 is used to oxidize an alcohol, a carboxylic acid will be produced.

FUTO PAST QUESTION

2016/2017

For which of the following oxidations does one need to use pyridinium chlorochromate?

- (a) Methanol to formic acid
- (b) Ethanol to acetic acid
- (c) Ethanol to acetaldehyde
- (d)

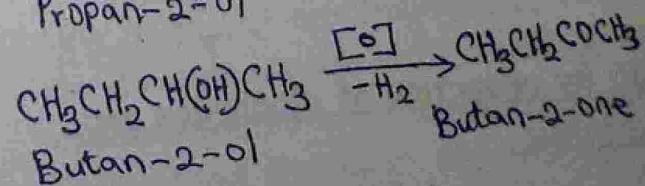
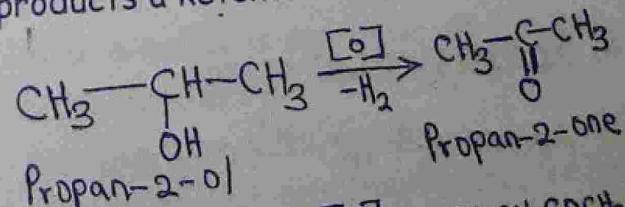
Acetaldehyde to acetic acid

ANSWER = C... (alcohol to aldehyde)

NB:- acetaldehyde is ethanal.

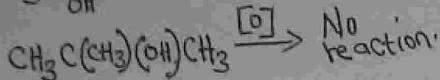
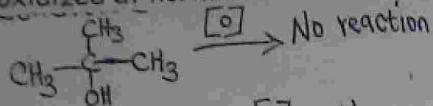
oxidation of secondary alcohols

oxidation of secondary alcohols products a ketone.



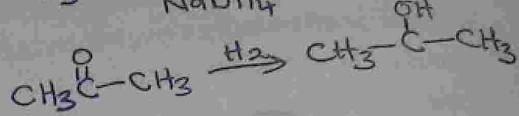
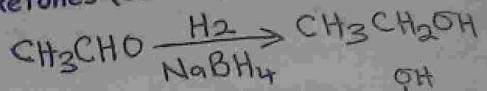
Oxidation Of Tertiary Alcohols

Tertiary alcohols are not easily oxidized at normal conditions.

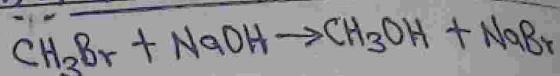


[O] Means oxidation or oxidizing agent.

LiAlH_4 and NaBH_4 (reducing agents) are used to reduce aldehydes and ketones (carbonyl compounds).



iv) By hydrolysis of alkyl halide



FUTO PAST QUESTIONS 2016/2017 EXAM

The product of the reaction of alcohols with H_2SO_4 at 140°C (a) an ether (b) an alkene (c) an alkane (d) an aldehyde

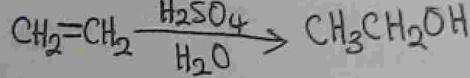
ANSWER = A

vi) By fermentation of glucose

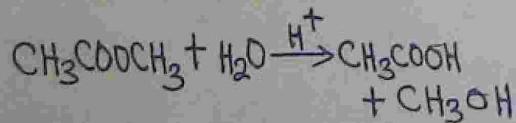


vii) By adding of Grignard reagent to aldehyde and ketone.

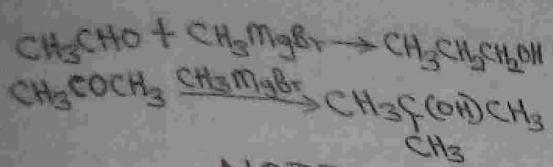
NOTE



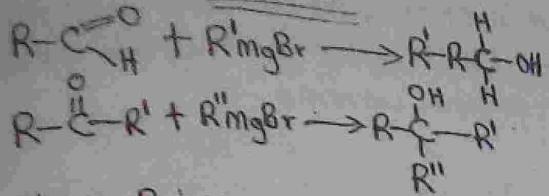
ii) By hydrolysis of esters.



iii) By reduction of aldehydes and ketones.



NOTE



where R is an alkyl group.

Where R Alkyl group.

NB:- whwn Grignard reagent reacts with an aldehyde, a secondary alcohol is produced but when Grignard reagent reacts with a ketone, a tertiary alcohol is produced.

ALKYL HALIDES OR HALOAKANES (R-X).

Alkyl halides are organic compounds in which a halogen (X) is attached to carbon atom. They have the general molecular formula $\text{C}_n\text{H}_{2n+1}\text{X}$ where "n" is the number of carbon atoms present while

CLASSES OF ALKYL HALIDES

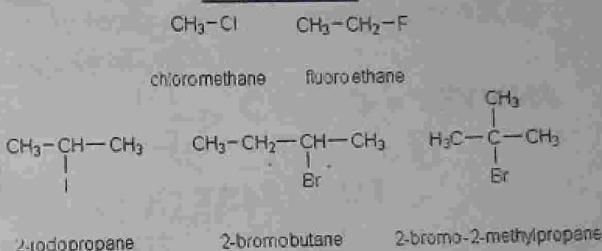
There are 3 classes of alkyl halides namely
(a)primary alkyl halides (b)secondary alkyl halides (c)tertiary alkyl halides.

A primary alkyl halide is an alkyl halide in which the halogen is bonded to a primary carbon, example is 1-Bromopropane ($\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$).

A secondary alkyl halide is an alkyl halide in which the halogen is bonded to a secondary carbon, example 2-Bromopropane ($\text{CH}_3\text{CHBrCH}_3$).

A tertiary alkyl halide is an alkyl halide in which the halogen is bonded to a tertiary carbon, example 2-Bromo-2-methylpropane $\text{CH}_3\text{CBr}(\text{CH}_3)\text{CH}_3$.

NONMENCLATURE OF ALKYL HALIDES



NOTE THIS

An alkyl halide that contains two halogen atoms is called a dihalide.

The two types of dihalides are (i) geminal dihalide and (ii) vicinal dihalide

gem-dihalide is one in which the two halogen atoms are attached to the same carbon atom, Example:

CH_3CHBr_2 (1,1-dibromoethane) while a

vic-dihalide is one in which the two halogen atoms are attach to adjacent carbon atoms, Example: $\text{CH}_2\text{BrCH}_2\text{Br}$ (1,2-dibromoethane).

NB:- in order to remove the two halogen atoms (dehalogenation) from a vic-dihalide, we use zinc dust in acetic acid.

Also, reaction of a vic-dihalide with excess NaNH_2 produces an alkyne but when NaNH_2 is not in excess, alkene is produced. This reaction is called DEHYDROHALOGENATION reaction because hydrogen halide is removed during the reaction.

FUTO PAST QUESTION 2016/2017

What conditions are best for dehalogenation of vicinal dibromide? (a) Zn in acetic acid (b) Zn in acetone (c) Zn in alcohol (d) Zn in toluene

ANSWER = C

FUTO PAST QUESTION 2016/2017

The major product of the reaction of 1,2-dibromobutane and excess NaNH_2 is (a) 2-bromo-1-butyne (b) 1-bromo-1-butene (c) 1-butyne (d) 1,2-butadiene

ANSWER = C...(when NaNH_2 is in excess, alkyne is produced).

PHYSICAL PROPERTIES OF ALKYL HALIDES

i) Haloalkanes or alkyl halides with only one carbon atom is gaseous at room temperature.

Other alkyl halides up to C_{18} are colourless liquids. Those greater than C_{18} are colourless solids.

ii) Alkyl halides are insoluble in water because they do not form hydrogen bond with water but they are soluble in organic solvents.

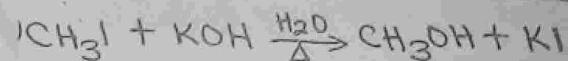
iii) The decreasing order of boiling points of alkyl halides is;



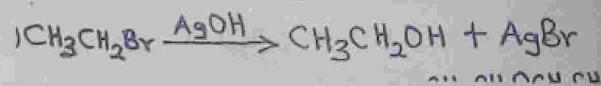
where R is alkyl group.

CHEMICAL PROPERTIES OF ALKYL HALIDES

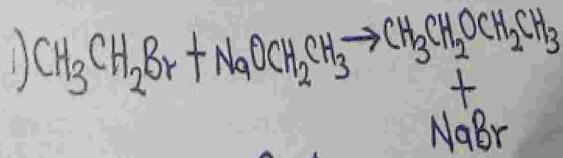
Reaction with aqueous KOH



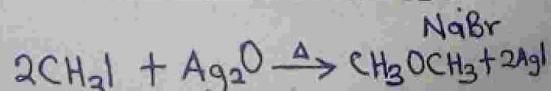
Reaction with moist silver oxide



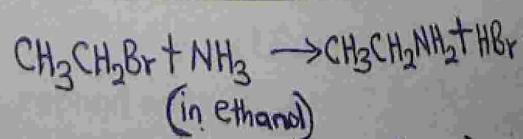
Reaction with sodium alkoxide



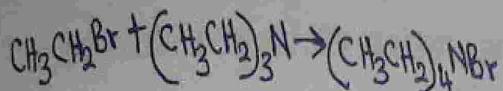
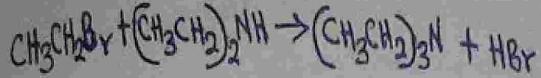
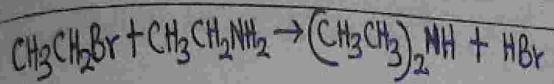
Reaction with dry Ag_2O



Reaction with Ammonia

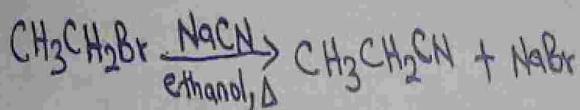


Reaction with amine

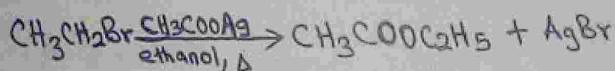


Tetraethylammonium bromide

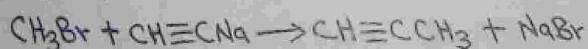
Reaction with NaCN



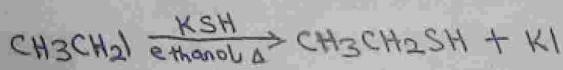
Reaction with RCOOAg



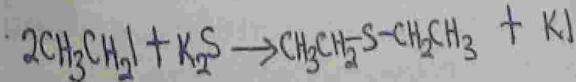
Reaction with acetylides



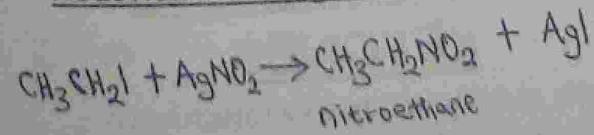
Reaction with KSH



Reaction with K₂S

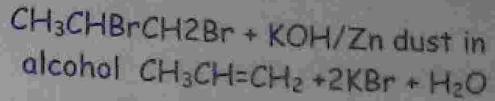
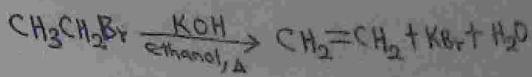


Reaction with AgNO₂



Reaction with alcoholic KOH

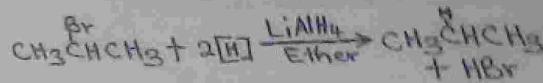
This reaction is known as dehydrohalogenation of alkyl halides.



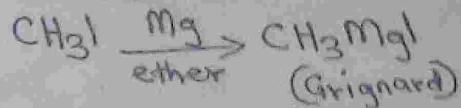
Reduction with hydrogen



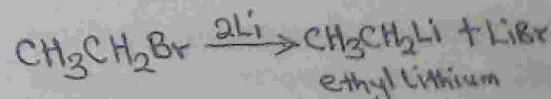
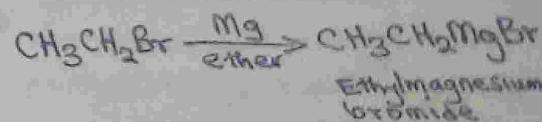
NB:- This reaction occurs in the presence of reducing agents such as Zn + HCl or LiAlH₄ or H₂ or Ni or Pd.



Reaction with Mg

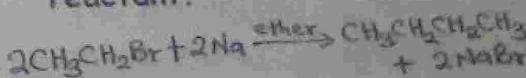


Reaction with Lithium

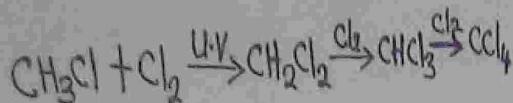


Wurtz reaction

In Wurtz reaction, the carbon longest chain of the product is always twice that of the reactant.

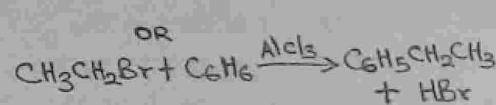
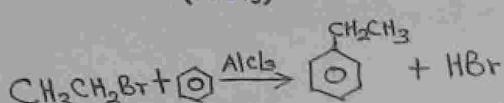


Halogenation of alkyl halide



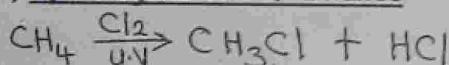
Friedel-crafts Alkylation

The catalyst used in Friedel craft alkylation is Aluminium trihalide (AlCl_3)

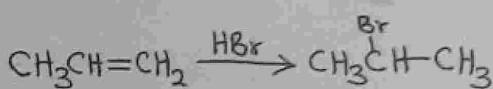


PREPARATION OF ALKYL HALIDES

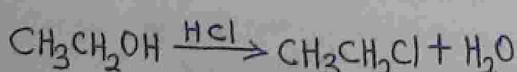
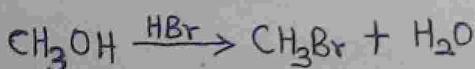
i) By halogenation of alkanes



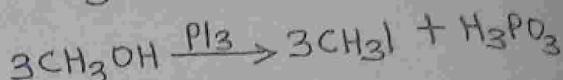
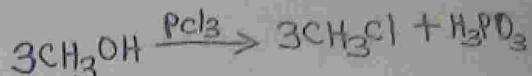
ii) By addition of halogen acids to alkenes



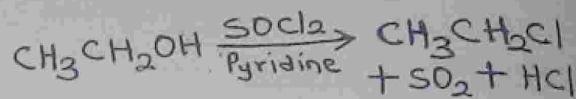
iii) By action of halogen acids on alcohols



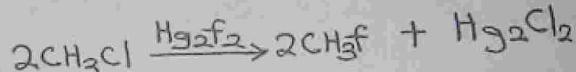
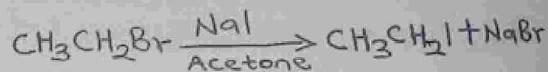
iv) By the action of phosphorus halides on alcohols



v) By the action of thionyl chloride on alcohols.



vi) By halogen exchange reaction.



ORDER OF LEAVING GROUP ABILITY

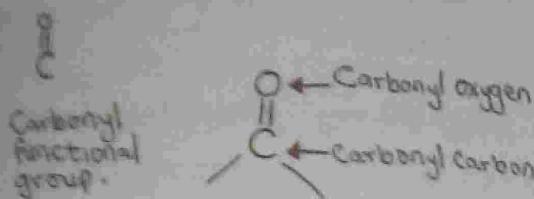
Alkyl halides are leaving groups.



ALDEHYDES AND KETONES

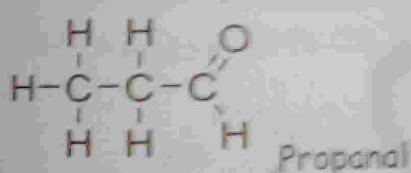
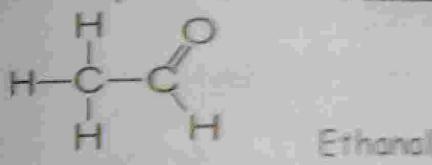
Both aldehydes and ketones have the carbonyl functional group. Both aldehydes and ketones are jointly called carbonyl compounds.

NB: A carbonyl group is a carbon-oxygen double bond present in a compound.



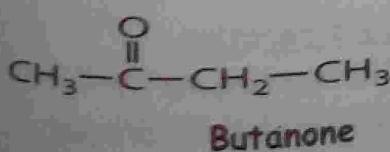
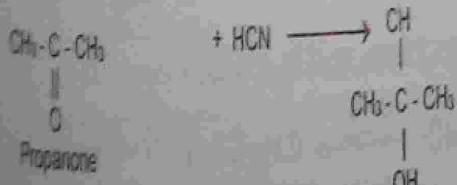
Aldehydes and ketones are jointly called carbonyl compounds.

In aldehydes, only one alkyl group (or carbon atom) is directly bonded to the carbonyl carbon and the carbonyl functional group is located in front of the compound ($\text{R}-\text{CHO}$). Examples:

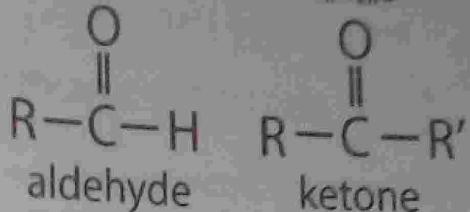


In ketones, two alkyl groups (or carbon atoms) are directly attached to the carbonyl carbon and the carbonyl functional group is located inside the compound.

Example:

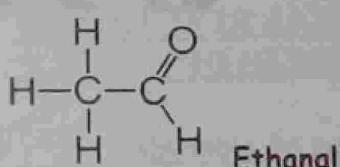
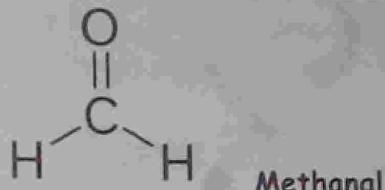


Both aldehydes and ketones have the same molecular formula $\text{C}_n\text{H}_{2n}\text{O}$

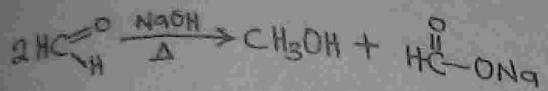


Where R and R' are alkyl groups.

NOMENCLATURE OF ALDEHYDES AND KETONES

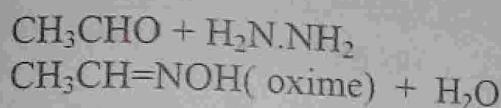


In naming aldehydes and ketones, the carbonyl carbon is given the smallest number when numbering the chain. In writing the name of an aldehyde, we replace the last "ane" in the name of the corresponding alkane with "anal". The position of the aldehyde functional group (CHO) is not shown when writing the name of an aldehyde because it is always at position one along the carbon chain. In writing the name of a ketone, we give the smallest number to the ketone group and show the position of the functional group in the chain. The position of the ketone functional group (CO) is indicated when writing the name of the ketone.



Wolf Kishner reaction

This is the reaction of an aldehyde or ketone with hydrazine. Wolf Kishner's reagent is known as hydrazine ($\text{H}_2\text{N.NH}_2$).



FUTO PAST QUESTION 2016/2017

The reaction between aldehydes and ketones with hydrazine in the presence of KOH is called?

- (a) Clemmensen reduction
- (b) Wolf Kishner reduction
- (c) hydrogenation
- (d) condensation

ANSWER = B

ALDOL CONDENSATION

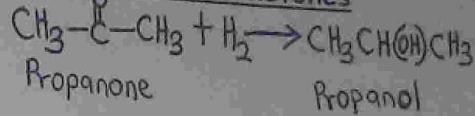
This is the reaction of an aldehyde with another aldehyde to produce an ALDOL (an aldol is a compound that contains both the alcohol functional group and an aldehyde functional group).

The two types of aldol condensation reactions are

(i) self (the same aldehyde) and (ii) mixed aldol (different aldehydes) condensation.

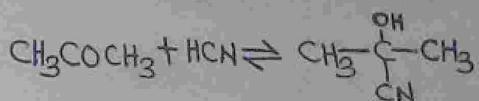
CHEMICAL REACTIONS OF KETONES

Reduction of ketones

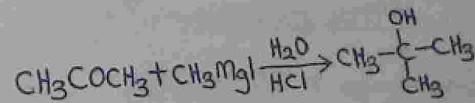


NOTE:- LiAlH_4 and NaBH_4 are used to reduce carbonyl compounds (aldehydes and ketones).

Reaction with hydrogen cyanide

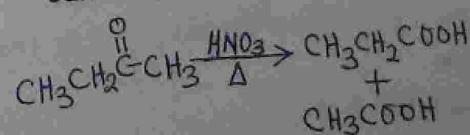


Reaction with Grignard reagent

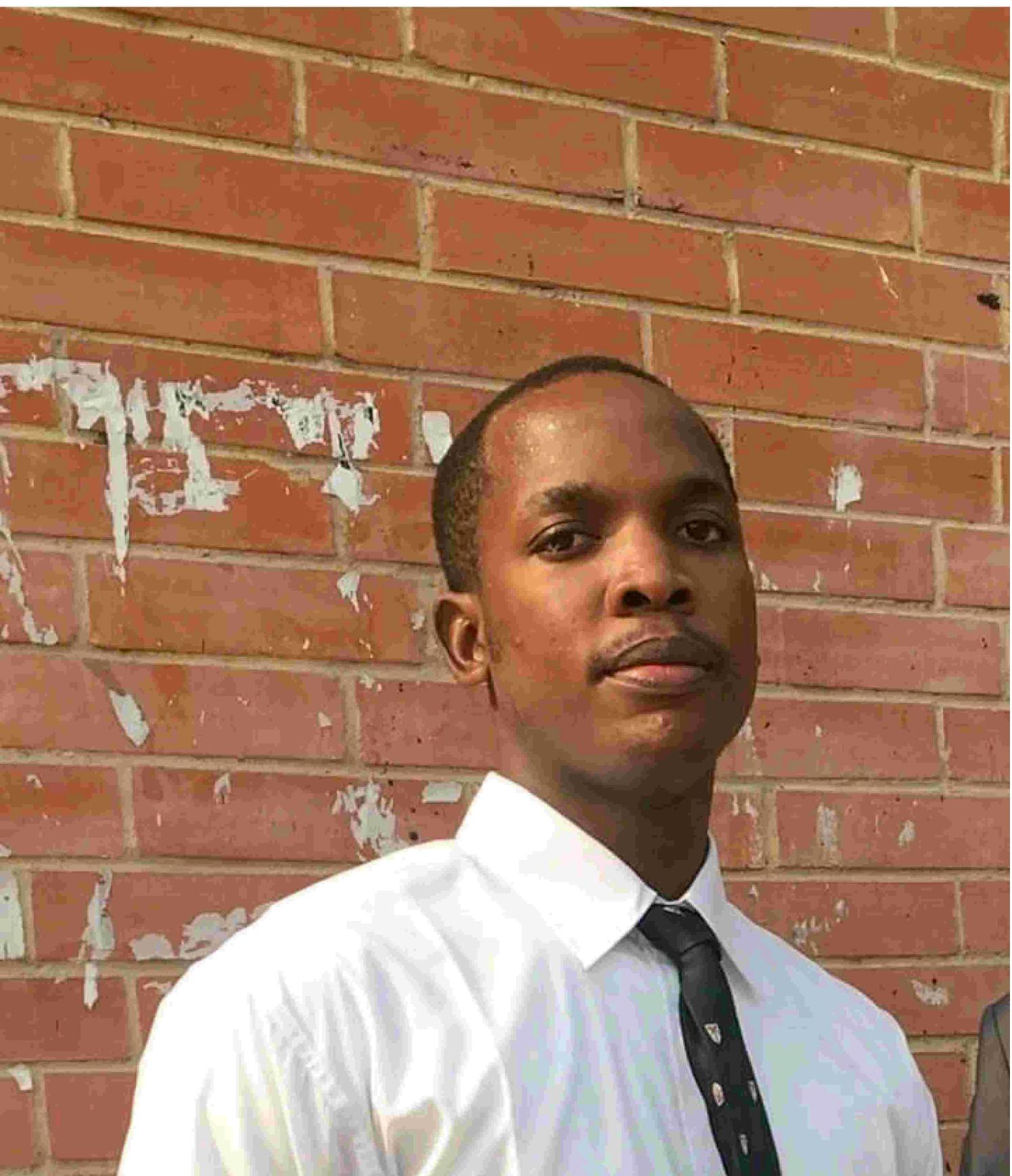


Oxidation of ketones by strong acids

Ketones are not easily oxidized. Only very strong oxidizing agents like HNO_3 can do so.

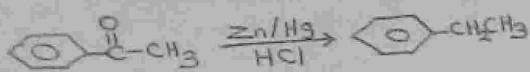
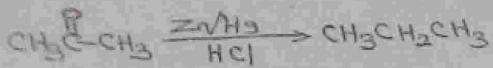


NB: Bond breaking can occur from any side of the functional group.



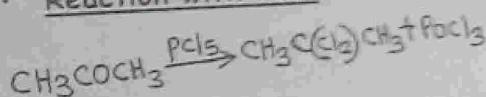
Clemmensen reduction of ketones

Reaction of Clemmensen reagent ($Zn/Hg, HCl$) reacts with a ketone, an alkane is produced.

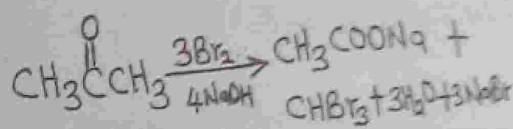


$Zn/Hg, HCl$ is called clemmensen reagent, used to convert a ketone to an alkane.

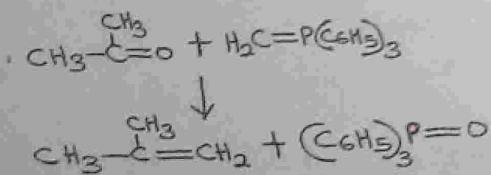
Reaction with PCl_5



Haloform reaction



Wittig reaction



FUTO PAST QUESTION 2016/2017

LiAlH_4 and NaBH_4 are used to
(a) reduce carbonyl groups (b) reduce
alkenes (c) reduce arenes (d) all of the
above

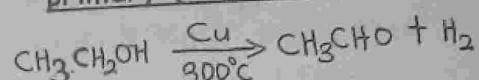
ANSWER = A

PREPARATION OF ALDEHYDES

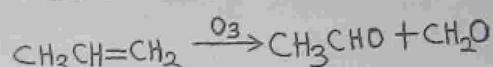
Oxidation of 1° alcohols



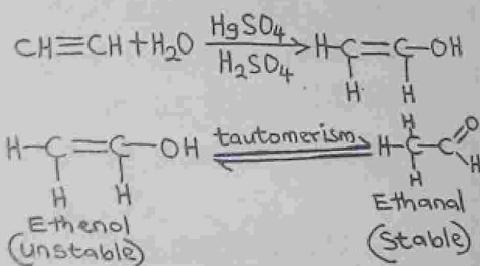
Catalytic dehydrogenation of primary (1°) alcohols



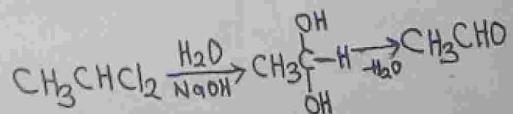
Oxidation of alkenes (ozonolysis)



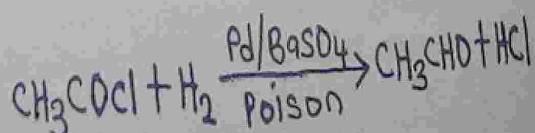
Hydrolysis of Ethyne



Hydrolysis of gem-dihalide

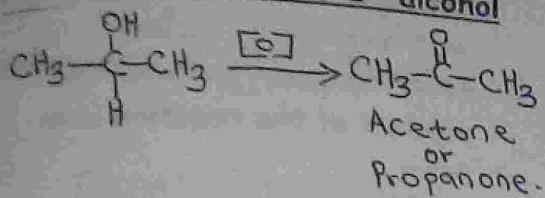


Reduction of acid chloride

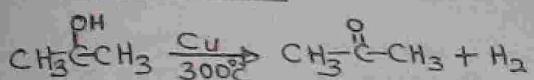


PREPARATION OF KETONES

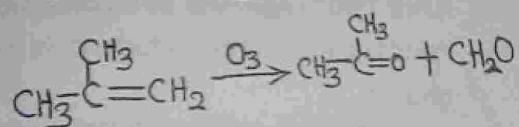
- By Oxidation of 2° alcohol



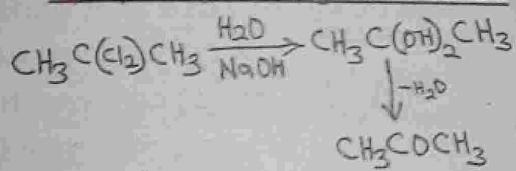
- By catalytic dehydrogenation of 2° alcohol



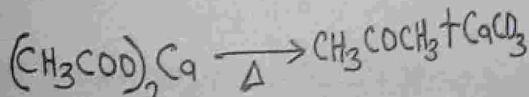
- By Ozonolysis



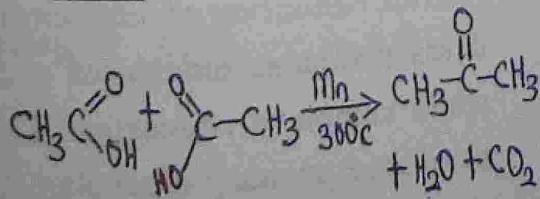
- By hydrolysis of gem-dihalide



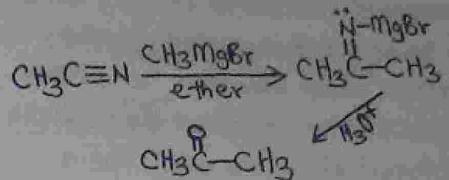
- Pyrolysis of calcium salts of acids



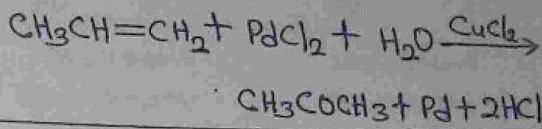
- Catalytic decomposition of acids.



From Nitride and Grignard reagent



By wacker process.



CARBOXYLIC ACIDS

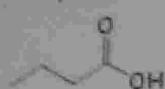
Carboxylic acids are organic compounds that contains the carboxyl functional group [-COOH].

Carboxylic acids have the general molecular formula $\text{C}_n\text{H}_{2n}\text{O}_2$.

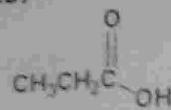


NOMENCLATURE OF CARBOXYLIC ACIDS

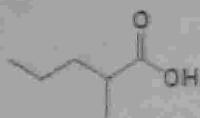
In naming carboxylic acids, the carboxyl functional group ($\text{C}(=\text{O})\text{OH}$) is given ~~the suffix -oic acid~~ the carbon chain. The last "e" in the name of the corresponding alkane is replaced with "oic acid" for a carboxylic acid. Examples:



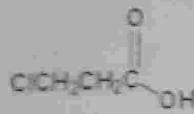
Butanoic acid
(Butyric Acid)



Propanoic acid
(Propionic Acid)



2-Methylpentanoic acid



3-Chloropropanoic acid

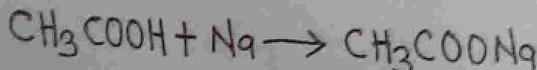
TEST FOR CARBOXYLIC ACIDS (COOH group).

When carboxylic acids react with sodium bicarbonate (NaHCO_3), carbon(ii)oxide gas is released.

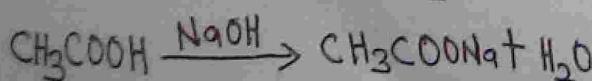
$$\text{RCOOH} + \text{NaHCO}_3 \rightarrow \text{RCOONa} + \text{CO}_2 + \text{H}_2\text{O}$$

CHEMICAL PROPERTIES OF CARBOXYLIC ACIDS

Reaction with sodium metal

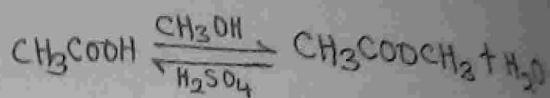


Neutralization reaction



Reaction with alcohol (Esterification)

This reaction of carboxylic acid with an alcohol is called esterification reaction. The product of the reaction is an ester.



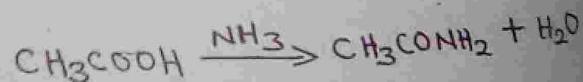
Reaction with ammonia or amine

This reaction is a condensation reaction and the product is an amide.

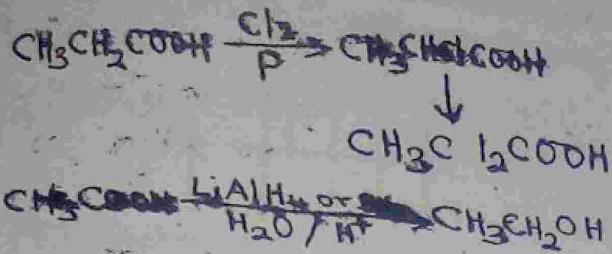
FUTO PAST QUESTION 2016/2017

The reaction between carboxylic acid and amine is an example of
 (a) addition (b) condensation
 (c) esterification (d) hydrogenation

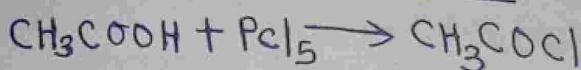
ANSWER = B (water is lost during the reaction)



Reduction of carboxylic acids
 Partial reduction of carboxylic acids produces aldehydes while complete reduction produces primary alcohols.

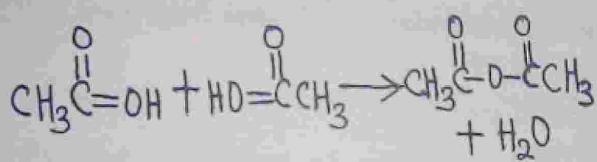


- Formation of acyl halide



- Formation of anhydride

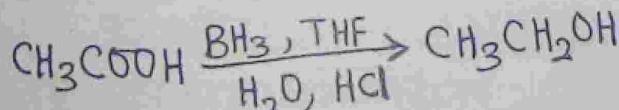
When two molecules of carboxylic acid combine together, an anhydride is formed.



- Halogenation

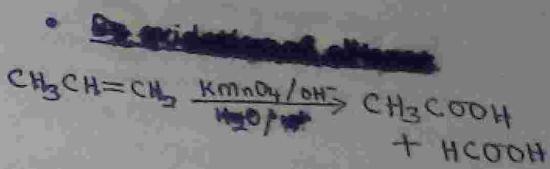
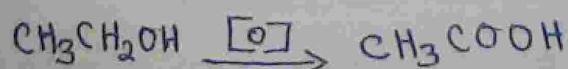
Halogenation of carboxylic acids occur at the alpha carbon (the carbon closest to the functional group carbon).

- Reduction with diborane

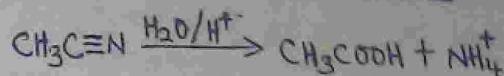


PREPARATION OF CARBOXYLIC ACIDS

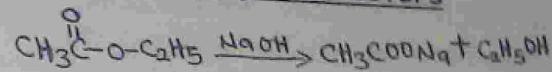
- By oxidation of primary alcohol



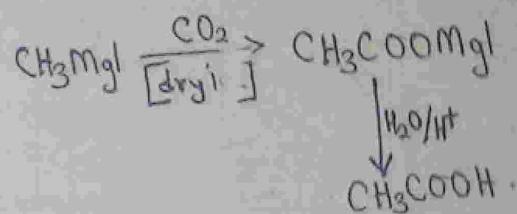
- By hydrolysis of nitriles



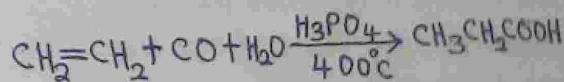
- By hydrolysis of esters



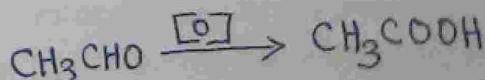
- By Grignard method



- By carboxylation of alkenes



- By oxidation of aldehyde



Carboxylation acids have high boiling points due to their ability to undergo hydrogen bonding they dissolve in water.

ESTERS

Esters are organic compounds with the functional group $-CO-O-C$

Esters are formed by the reaction between a carboxylic acid and an alcohol. This reaction between a carboxylic acid and an alcohol to produce an ester is known as **ESTERIFICATION REACTION**.

Esters are formed by replacing the $-OH$ of a carboxylic acid with " $-OR$ " where R is an alkyl group. Esters have sweet smell.



NOMENCLATURE OF ESTERS

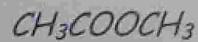
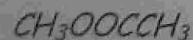
When naming an ester, we call the name of the alkyl group part first followed by the name of the alkanoate part. Examples:



Methylmethanoate
(Methyl formate)



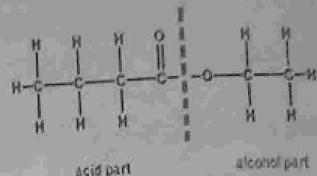
Ethylethanoate
methanoate
(ethyl acetate)



Ethyl



Methylethanoate
propylbutanoate



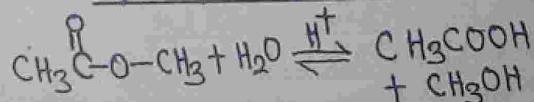
Ethylbutanoate

Many esters of simple carboxylic acids have fragrance, fruity smells and they are used as flavouring agents. Examples:-

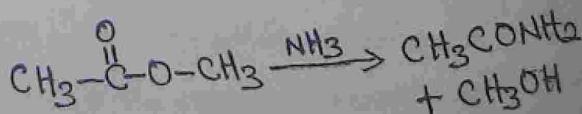
- (a). Pentyl ethanoate.....Banana fragrance
- (b). 3-Methyl butyl ethanoate.....Banana fragrance
- (c). Ethyl butanoate....Pineapple fragrance
- (d). Octyl ethanoate.....Orange fragrance
- (e). Methyl butanoate.....Apple fragrance
- (f). Ethyl formate.....Rum(wine) fragrance

CHEMICAL PROPERTIES OF ESTERS

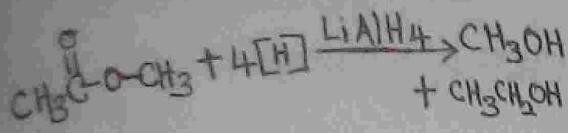
• Hydrolysis of esters



• Reaction with ammonia

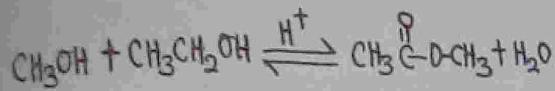


Reduction to alcohol

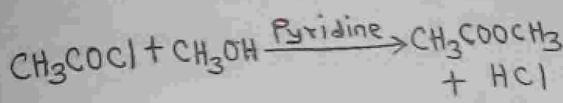


PREPARATION OF ESTERS

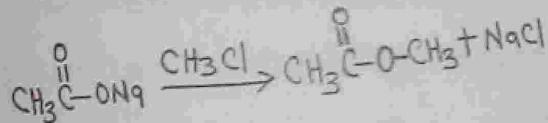
By esterification reaction



Reaction of acid chloride with alcohol



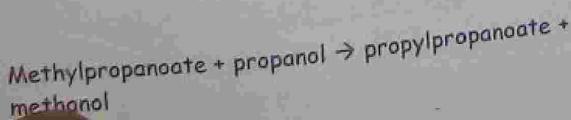
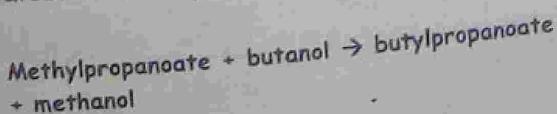
By the reaction of carboxylation salt with an alkyl halide



NOTE

The process by which an ester is converted into another ester is known as **TRANSESTERIFICATION**.

Transesterification occurs when an ester reacts with excess alcohol. Examples,



Ethylpentanoate + propanol \rightarrow propylpentanoate + ethanol

Propylethanoate + butanol \rightarrow butylethanoate + propanol.

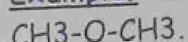
ETHERS

Ethers are organic compounds with the functional group C-O-C. The oxygen atom of an ether is bonded to two alkyl groups.

If the two alkyl groups of an ether are same, the ether is said to be symmetric. If the two alkyl groups are not the same, it is said to be non-symmetric.

Ethers are SP^3 hybridized.

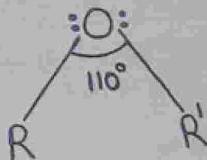
Example:



Symmetric.



Non-symmetric

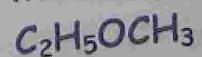
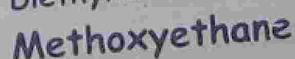


R is an alkyl group.

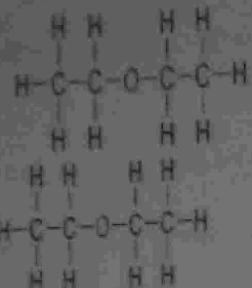
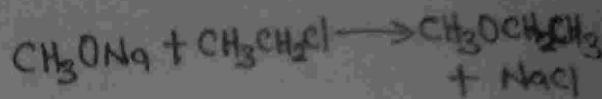
NOMENCLATURE OF ETHERS

Ethers are named as alkoxyalkanes. The longer of the two alkyl groups is taken to be the alkane.

For instance:



Williamson ether synthesis



Definition

Ether is a class of organic compounds that contain an ether group (an oxygen atom bonded to two alkyl groups) of general formula R-O-R'

Classification of ethers

(i) Aliphatic Ethers

Aliphatic ethers are those in which R and R' are both alkyl groups.

Example



Aliphatic ethers are those in which one R is alkyl and the other is general.

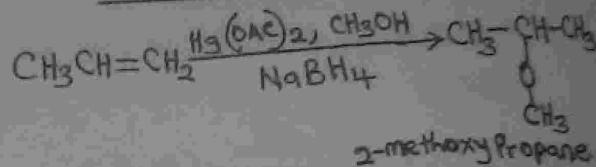
Example



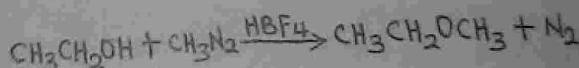
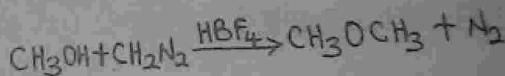
Example



Alkoxymercuration-demercuration

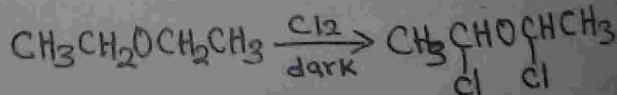


Action of diazomethane on alcohols

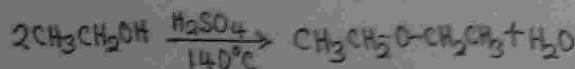
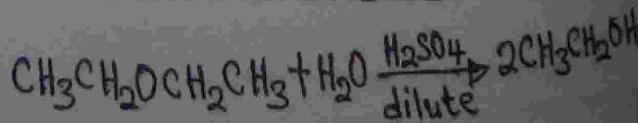


CHEMICAL PROPERTIES OF ETHERS

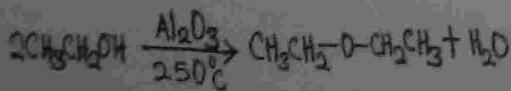
Halogenation of ethers



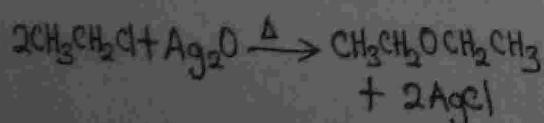
Reaction with H₂SO₄

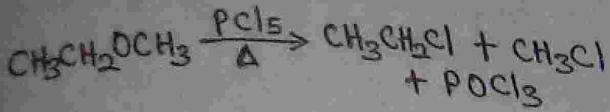


Passing alcohol vapour over hot Al₂O₃

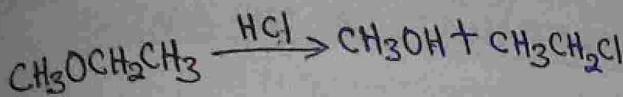


Heating alkyl halides with dry silver oxide

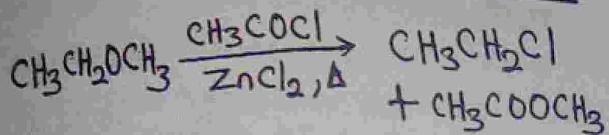




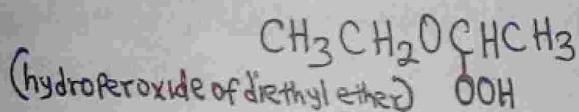
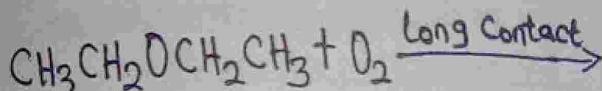
Cleavage by acid



Reaction with Acyl Chloride



Formation of peroxide



NB: Esters have higher boiling points than ethers.

AMINES

Amines are derivatives of ammonia in which one or more hydrogen atoms of ammonia (NH_3) have been replaced by alkyl group or groups.

Amines have the functional group of the $-\text{NH}_2$. Amines are basic.

Tertiary amines are more basic than secondary amines while primary amine are the least basic.

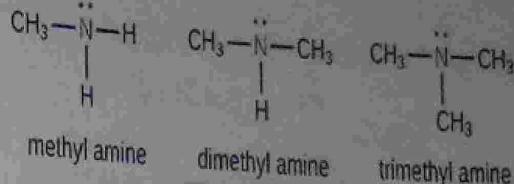
CLASSES OF AMINES

- Primary amine. (1°)
- Secondary amine (2°)
- Tertiary amine. (3°)

PRIMARY AMINE (1°)

A primary amine is an amine that has only one carbon atom or alkyl group directly attached to the nitrogen atom of the amine.

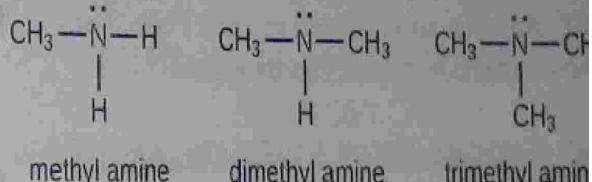
Examples:



SECONDARY AMINE

A secondary amine is an amine that has two carbon atoms or alkyl groups directly attached to the nitrogen atom of the amine.

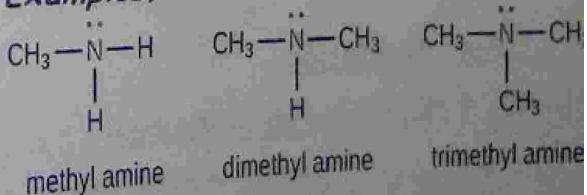
Examples:



TERTIARY AMINE

A tertiary amine is an amine that has three carbon atoms or alkyl groups directly attached to the nitrogen atom of the amine.

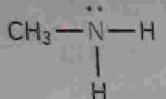
Examples:



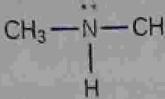
NOMENCLATURE OF AMINES

Amines are named by naming the alkyl groups attached to the nitrogen atom followed by the ending "amine".

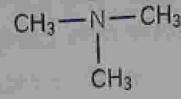
Examples:



methyl amine

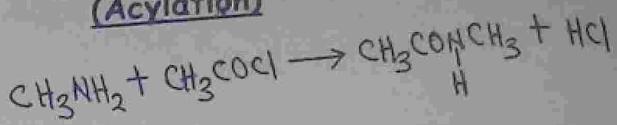


dimethyl amine

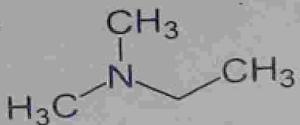


trimethyl amine

Reaction with acid chloride (Acylation)



PREPARATION OF AMINES



PHYSICAL PROPERTIES OF AMINES

I. Amines undergo hydrogen bonding and therefore are soluble in water, but alcohols undergo hydrogen bonding more than amines. Therefore, the O-H bond undergoes hydrogen bonding more than the N-H bond.

II. Amines smell like a rotten fish. They have the same smell as ammonia.

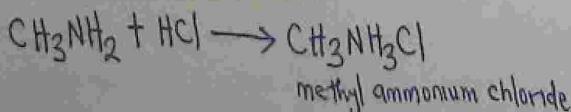
CHEMICAL PROPERTIES OF AMINES

Amines are generally basic in nature due to the presence lone of lone pair of electron on the nitrogen atom of amines.

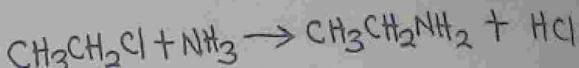
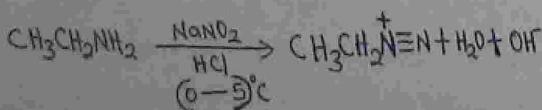
INCREASING ORDER OF BASICITY OF AMINE.



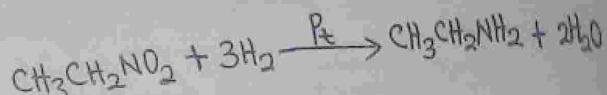
Salt formation



Reaction with nitrous acid

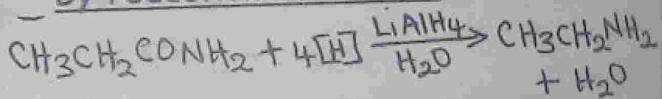


By reduction of alkyl halides with ammonia

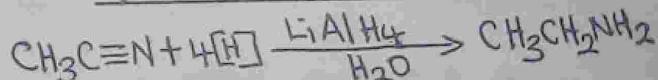


By reduction of nitro alkanes

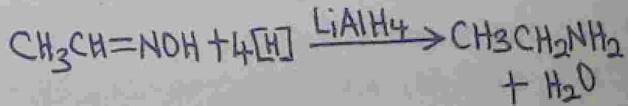
By reduction of amides



By reduction of nitriles



Reduction of oximes

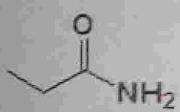


N/B: In naming priority of a poly-functional group compound in which there are multiple functional groups present, $-\text{NH}_2 > =$
but, $-\text{OH} > \text{NH}_2 > =$

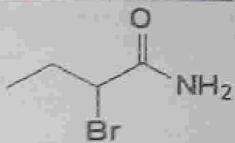
AMIDES

Amides are organic compounds that contains the functional group as - CONH₂. Amides are formed by replacing the OH group in the carboxylic acid functional group with NH₂ group. Therefore, amides are carboxylic acid derivatives. Amides are the most stable derivatives of carboxylic acids because they are unreactive like other carboxylic acid derivatives. The stability of amides is as a result of resonance in amides. Amides are obtained principally from the reaction of carboxylic acid and ammonia. Amides are acidic.

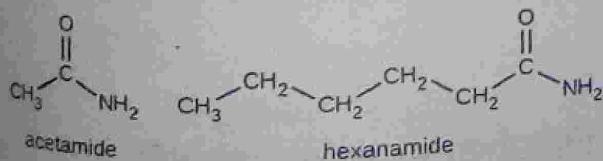
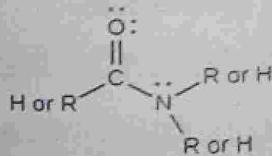
NOMENCLATURE OF AMIDES



Propanamide

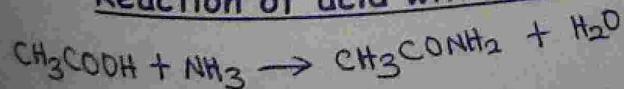


2-Bromobutanamide

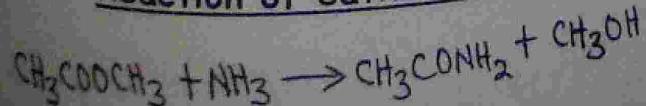


PREPARATION OF AMIDES

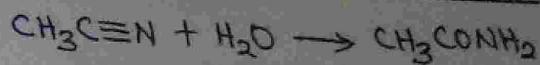
Reaction of acid with NH₃



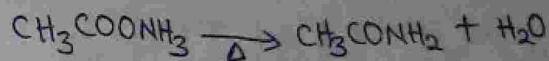
Reaction of ethers with NH₃



Controlled hydrolysis of nitrile



Heating ammonium salt of the acid.



Reaction of acid chloride with NH₃

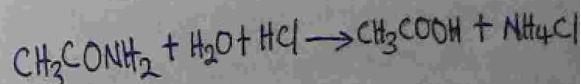


CHEMICAL PROPERTIES OF AMIDES

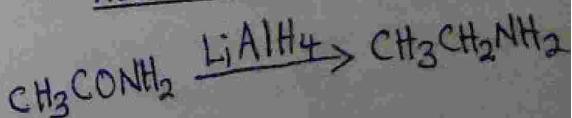
Generally, amides are stable and unreactive. Amides are the least reactive compared to the other derivatives of carboxylic acids.

Amides are acidic.

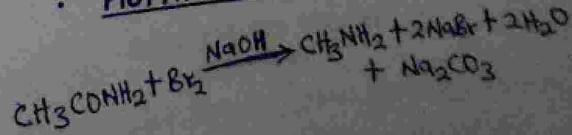
Hydrolysis of amides



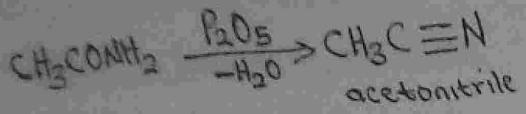
Reduction of amides



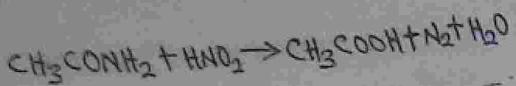
Hoffman degradation



Dehydration with P₂O₅



Reduction using nitrous acid



ACYL HALIDES

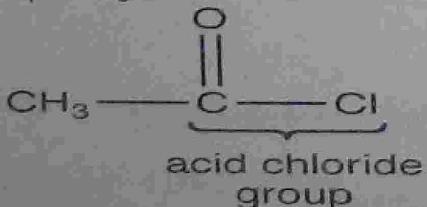


Acyl halides are organic compounds with the functional group of -COX where X is a halogen. Acyl halides are carboxylic acid derivatives. Acyl halides are formed by replacing the -OH group of a carboxylic acid with a halogen.

Acyl halides are formed by replacing the -OH group of a carboxylic acid with a halogen.

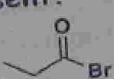
Acyl halides are insoluble in water but they dissolve slowly in water due to hydrolysis.

Acyl halides have lower boiling points compared to their corresponding acids.



NOMENCLATURE OF ACYL HALIDES.

In naming acyl halides, the last "e" in the name of the corresponding alkane is replaced with "oyl" followed by the name of the halogen present.

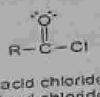


Propanoyl Bromide

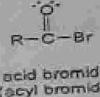


2-Methylbutanoyl chloride

Acid Halides



acid chloride
(acyl chloride)

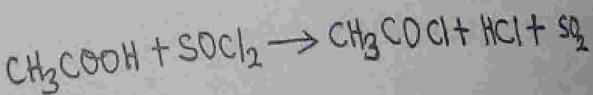


acid bromide
(acyl bromide)

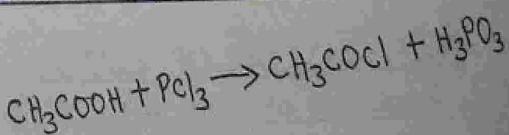
- Also called acyl halides.
- These are more reactive than carboxylic acids, so they are used to synthesize other acid derivatives such as esters and amides.
- Used in the Friedel-Crafts acylation to make acylbenzenes.

PREPARATION OF ACYLHALIDES

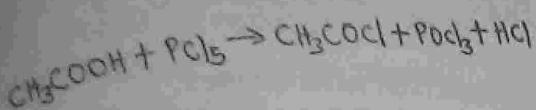
Reaction of acid with SOCl₂



Reaction of acid with PCl₃

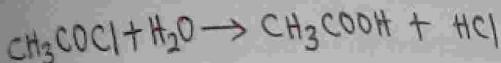


Reaction with PCl_5

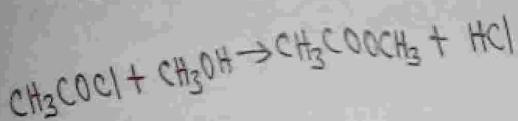


CHEMICAL PROPERTIES OF ACYL HALIDES

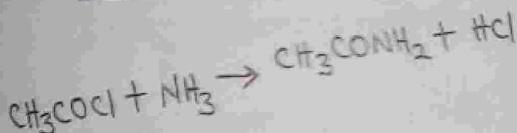
Hydrolysis



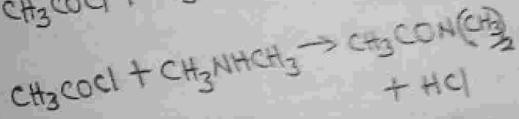
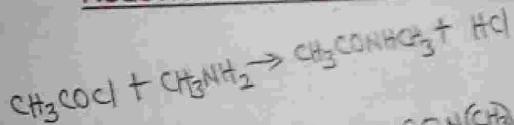
Reaction with alcohol



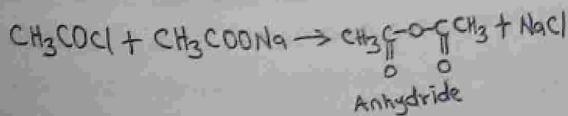
Reaction with NH_3



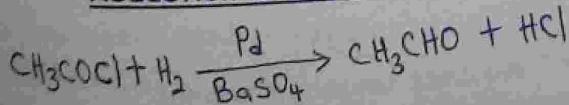
Reaction with amine



Reaction with carboxylic acid salts



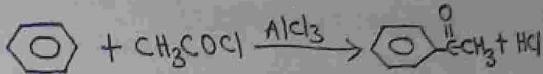
Reduction of Acyl halide



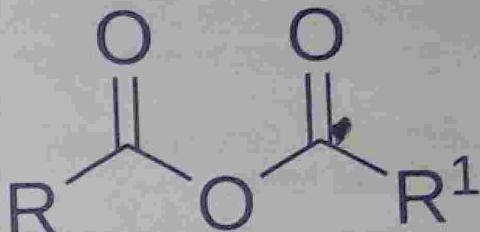
Reaction with organocopper compounds



Friedel-Crafts acylation



ANHYDRIDES



Anhydrides are organic compounds having two molecules having two carbonyl groups joined together by a single oxygen atom. Anhydrides are carboxylic acid derivatives.

Anhydrides are derived by the loss of water molecule between two molecules of carboxylic acid. Anhydrides combine with water to produce acids. Anhydrides have the functional group $-COOOC-$.

Anhydrides are insoluble in water and they have higher boiling points than the acids from which they are derived.

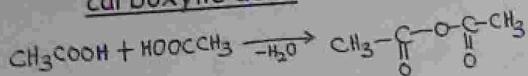
NOTE

Anhydrides have higher boiling points than their corresponding carboxylic

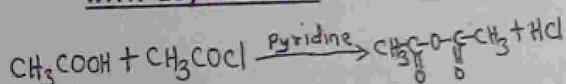
acides due to the large size of anhydrides and presence of Van Der Waal's interaction in them.

PREPARATION OF ANHYDRIDES

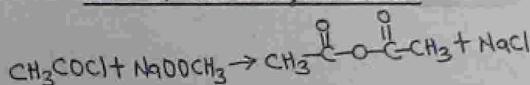
- By removing of water molecule from two molecules of carboxylic acid.



- Reaction of Carboxylic acid with acyl halide.

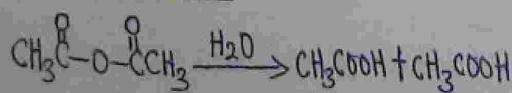


- Reaction of acid halide with a salt of Carboxylic acid.

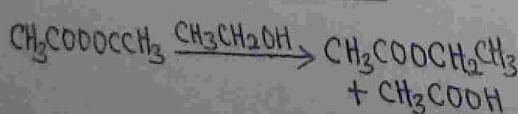


CHEMICAL PROPERTIES OF ANHYDRIDES

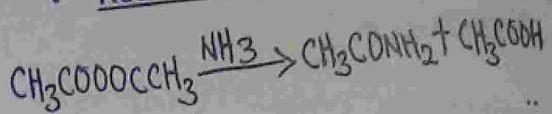
- Hydrolysis



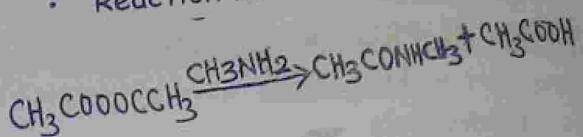
- Reaction with alcohol



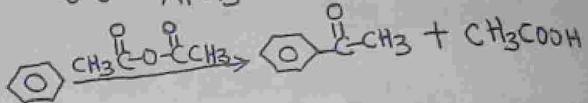
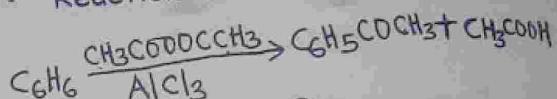
Reaction with NH₃



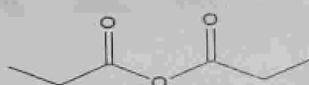
Reaction with amines



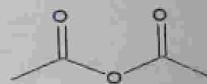
Reaction with Benzene



NOMENCLATURE OF ANHYDRIDES



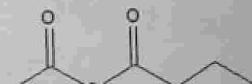
Propanoic anhydride
(Propionic anhydride)



Ethanoic anhydride
(Acetic anhydride)



Ethanoic propanoic anhydride
(Acetic propionic anhydride)



Butanoic ethanoic anhydride
(Acetic butyric anhydride)

NOTE

The derivatives of carboxylic acids are,

Amides (least reactive of them)

Esters

Acyl halides

Anhydrides

NOTE

Alkanes undergo mainly substitution reaction.

Alkenes undergo mainly addition reaction.

- Alkynes undergo mainly addition reaction.
- Benzene undergo mainly substitution reaction.

Adipic acid $\text{HOOC-(CH}_2\text{)}_4\text{-COOH}$, etc.

SOME REAGENTS

- Grignard reagent RMgX
R=alkyl group
X=halogen
- Baeyer's reagent KMnO_4 (used to test for unsaturation)
- Clemmensen reagent ZnCl_2/HCl
- Wolf Kishner reagent $\text{H}_2\text{N.NH}_2$ (Wolf Kisher reagent is hydrazine)
- Lucas reagent ZnCl_2/HCl
(Anhydrous ZnCl_2 in concentrated HCl)

SAYTZEFF RULE

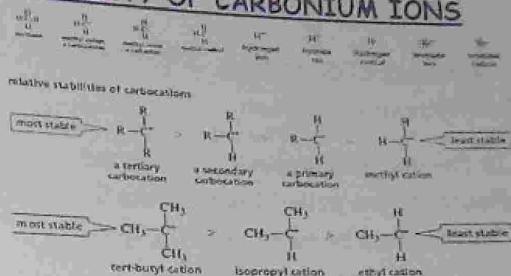
"In the reaction of an alkyl halide with alcoholic KOH, the main product is the most substituted alkene"

DICARBOXYLIC ACIDS

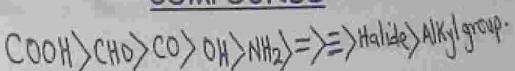
Dicarboxylic acids are those carboxylic acids that contain two carboxylic acid functional groups in them. Dicarboxylic acids are dibasic acids because they produce two hydrogen ions on ionization. Examples, Ethanedioic acid (Oxalic acid) ... HOOC-COOH

Malonic acid ... $\text{HOOC-CH}_2\text{-COOH}$
Succinic acid ... $\text{HOOC-(CH}_2\text{)}_2\text{-COOH}$
Glutaric acid ... $\text{HOOC-(CH}_2\text{)}_3\text{-COOH}$

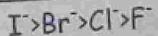
STABILITY OF CARBONIUM IONS



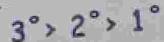
PRIORITY OF CITATION OF FUNCTIONAL GROUP IN NAMING POLY-FUNCTIONAL GROUP COMPOUNDS



ORDER OF LEAVING GROUP ABILITY AND RATE OF REACTIVITY TOWARDS ALCOHOL



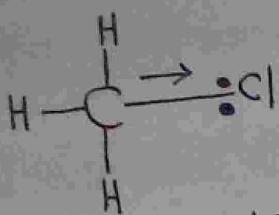
RATE OF DEHYDRATION OF ALCOHOLS.



INDUCTIVE EFFECT

This is the pull of electron density through sigma bonds caused by the electronegativity difference between atoms.

Example:



Electrons move towards chlorine atom.

In the above compound, the shared electrons are pulled towards the chlorine atom because chlorine is far more electronegative than carbon atom.

Atoms that draw electrons away from carbon are said to have -1 effect while those that loose electrons towards carbon are said to have +1 effect.

Examples:

-1 effect: NO_2^- , F^- , Cl^- , Br^- , I^- , OH^- etc

+1 effect: COO^- , $-\text{CH}_3$, O^- , etc

MESOMERIC EFFECT

This is the polarity produced in a molecule as a result of the interaction between two π -bond or a π -bond and a lone pair of electrons.

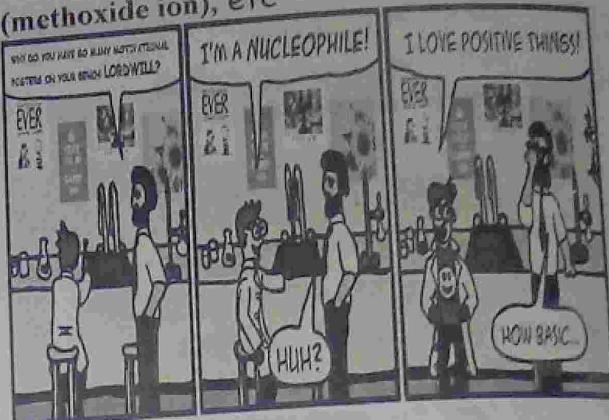
Atoms that draw electrons away from carbon have $-M$ effect while loosing to carbon is $+M$ effect.

NUCLEOPHILE

A nucleophile is an electron rich substance that donates a pair of electrons to an electron deficient substance forming a covalent bond.

Example is of nucleophiles;

OH^- , NH_3^+ , I^- , Br^- , Cl^- , H_2O^- , CH_3O^-
(methoxide ion), etc



ELECTROPHILE

An electrophile is an electron deficient substance that can accept a pair of electrons from a nucleophile forming a covalent bond.

NB: Lewis acids are electrophiles

Examples; H^+ , NO_2^+ , BF_3 , BH_3 , AlCl_3 , Cl^+ , Br^+ , I^+ etc

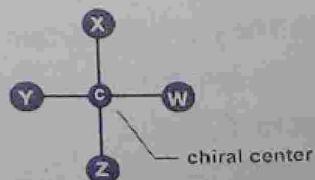
FUTO PAST QUESTION ON ELECTROPHILES

2016/2017

Which of the following act as an electrophile? (a) HO^- (b) $(\text{CH}_3)_2\text{N}$ (c) Cl^- (d) ${}^*\text{BH}_3$

ANSWER = D

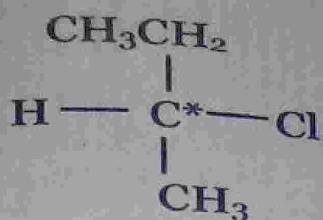
CHIRAL CARBON



A chiral carbon is a carbon atom that is bonded to four other non-identical

groups. Another name for a chiral centre is **stereogenic centre**.

Example:



GIVE THE STRUCTURE OF THE FOLLOWING COMPOUNDS.

9) 2-Chloro-4-ethyl-heptanes

10) 2,3-dimethyl pentane

11) Non-6-ene-3-yne

12) 4,4-dimethyl pent-1-yne

14) 5-fluoro hexan-3-ol

15) ethane-1,2-diol

**FEDERAL UNIVERSITY OF
TECHNOLOGY OWERRI
DEPARTMENT OF CHEMISTRY
CHM102 GENERAL CHEMISTRY 11**

TEST 2016/2017

TIME: 50 Minutes

**INSTRUCTIONS: ANSWER ALL
QUESTIONS, SOLVE YOUR
QUESTIONS AT THE BACK OF THE
QUESTION PAPER.**

1) The compound ethylene glycol is often used as an antifreeze, it contains 38.7% carbon, 9.75% hydrogen and the rest oxygen. The molecular weight of ethylene glycol is 62.07g. What is the molecular Formula of ethylene glycol.

2) Why does propanol boil at higher temperature than the corresponding hydrocarbons.

3) Markovnikov's rule states that.....

4) Terminal alkynes are alkyne.....

5) Tautomerism is defined as;.....

6) Catenation is defined as;.....

7) Tertiary carbocation is

8) Hybridization in Organic Chemistry is define as

SOLUTION TO 2016/2017 CHM102 TEST

$$\begin{array}{l} \text{C} = 38.7\%, \text{H} = 9.75\% \\ \text{O} = 100 - (38.7 + 9.75) \\ = 51.55\% \end{array}$$

C	H	O
38.7	9.75	51.55
12	1	16

3.225	9.750	3.222
3.222	3.222	3.222

Empirical formula = CH_3O

$$[\text{CH}_3\text{O}]_n = 62.07$$

$$n = \frac{62.07}{\text{CH}_3\text{O}} = \frac{62.07}{12 + (\text{O} \times 16)}$$

$$n = \frac{62.07}{31} = 2$$

Molecular formula =

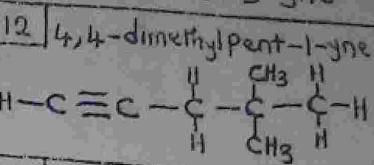
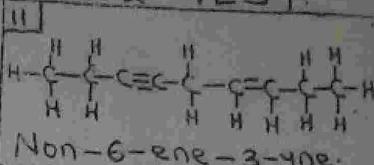
$$[\text{CH}_3\text{O}]_n = [\text{CH}_3\text{O}]_2 = \text{C}_2\text{H}_6\text{O}_2$$

2] Propanol boils at a higher temperature than the corresponding hydrocarbon (Propane) due to hydrogen bonding in propanol.

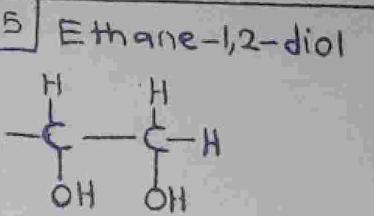
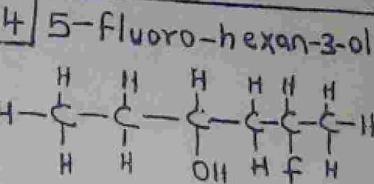
3] Markovnikoff's rule States that "during the addition of hydrogen halide (HX) to an unsymmetrical alkene, the H atom goes to the carbon that has higher hydrogens while the halogen (X) bonds to the carbon with lower number of hydrogens"

4] Terminal alkyne is an alkyne whose triple bond is at position one along the carbon chain.

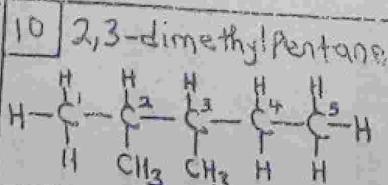
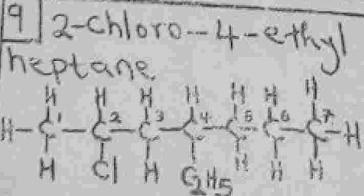
5] Tautomerism is defined as the phenomenon by which isomers or tautomers are in dynamic equilibrium with each other as a result of movement of proton and π -bond or π -electron.



13 No question No:13



8] Hybridization in organic chemistry is defined as the combination of two or more atomic orbitals to produce an entirely new equivalent orbital



THE CATALYST

08068113736

- 13) CuC_2 , on hydrolysis gives
a) alkenes b) alkenes c) alkynes d) alcohols

- 14) For reacting with HCl , the alcohol which does not require ZnCl_2 is

- a) $\text{CH}_3\text{CH}_2\text{OH}$ b)
 $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$

- c) $\text{CH}_3\text{CH}(\text{CH}_3)_2\text{OH}$ d) $\text{C}(\text{CH}_3)_3\text{C-OH}$

- 15) Arrange the following alcohols in order of decreasing reactivity with HBr (most reactive first).

- a) $\text{A} > \text{B} > \text{C}$ b) $\text{A} > \text{C} > \text{B}$ c) $\text{C} > \text{A} > \text{B}$ d) $\text{B} > \text{C} > \text{A}$



- 16) Which of the following compound contains an sp hybridized C atom?

- a) $\text{CH}_3\text{CO}_2\text{H}$ b) CH_3CHO c) CH_3CN d) CH_3NH_2

- 17) Which compound has stereoisomers?

- a) Butane b) Propyne c) But-2-ene d) Propene

- 18) Pent-1-ene and pent-2-ene are examples of

- a) enantiomers b) constitutional isomers
c) stereoisomers d) (E)-and (Z)-isomers of pentane

- 19) Which of the following can act as an electrophile?

- a) HO^- b) $(\text{CH}_3)_3\text{N}^-$ c) Cl^- d) BH_3

- 20) π bonds are formed by the?

- a) overlap of two orbitals b) overlap of an s and p orbital c) end-to-end overlap of two orbitals d) side-to-side overlap of two p orbitals

- 21) Stereoisomers are a) molecules with the same numbers of atoms but different structures
b) molecules with the same structure
c) linear molecules with single bonded carbon atoms
d) molecules with different conformation due to a double bond

- 22) A regio selective reaction is one which?

- a) a single product is produced b) multiple products are made in equal amounts c) multiple products are made with one in excess of the others d) involves an oxidation

- 23) LiAlH_4 and NaBH_4 are used to?

- a) reduce carbonyl groups b) reduce alkenes
c) reduce arenes d) all of the above

- 24) Alkenes are prepared by?

- a) addition reactions b) substitution reactions

- c) elimination reactions d) free radical reactions

- The loss of a halide atom to generate an alkene is known as? a) a dehydrohalogenation b) a dehydration

- c) a reduction d) an oxidation

- LiAlH_4 and NaBH_4 are used to _____

- a) reduce carbonyl groups b) reduce alkenes
c) reduce arenes d) reduce amines

- The reaction between a carboxyl acid and an amine is an example of this type of reaction

- a) addition b) condensation c) esterification
d) hydrogenation

- The mixing of orbitals, which is quantum mechanical calculation process is termed

- a) pi bond b) hybridization c) sigma bond d) catenation

- 17) Propane and 2-propanone are _____

- a) positional isomers b) functional group isomers
c) a and b d) none of the above

- 18) The reaction between aldehydes and ketones with hydrazine in the presence of KOH is called _____
a) Clemmensen's reduction b) Wolf Kishner's reduction
c) hydrogenation d) condensation

- 19) The product of the reaction of alcohols with H_2S_6 at 140°C is _____ a) an ether b) an alkene c) an alkane d) an aldehyde

- 20) The reaction between $\text{CH}_3\text{CH}=\text{C}(\text{CH}_3)_2$ and HBr in the presence of H_2O_2 produces
a) $\text{CH}_3\text{CHBrCH}(\text{CH}_3)_2$ b)
 $\text{CH}_3\text{CH}_2\text{CHBr}(\text{CH}_3)_2$

- c) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2$ d) none of the above

- 21) Which of the following statements is false?

- a) alkanes have lower density than water
b) the density of alkanes increases with increasing number of carbon atoms c) cis/trans isomerism affects density slightly d) for compounds with same number of carbon atoms alkenes have higher boiling points than alkanes

- 22) Which of the following compounds does not have cis/trans isomers?

- a) $\text{CH}_3\text{CH}=\text{CHCH}_3$ b) $\text{ClCH}=\text{CHCl}$
c) $\text{H}_2\text{C}=\text{CHC}_2\text{H}_5$ d) $\text{CH}_3\text{CH}=\text{CHCH}_3$

- 23) What conditions are best for dehalogenation of vicinal dibromide

- a) Zn in acetic acid b) Zn in acetone
c) Zn in alcohol d) Zn in toluene

- 24) What product is obtained from the oxidation of hex-2-ene with warm conc. potassium solution

- a) acetate and butanone b) acetaldehyde and butanoic
c) acetaldehyde and butanal d) acetate and butanoic

- 25) What is the product formed by bromination of 2-methyl pent-1-ene?

- a) 2,2-dibromo-2-methyl heptanes
b) 1,2-dibromo-2-methyl pentane
c) 2-bromo-2-methyl pent-1-ene
d) 1-bromo-2-methyl pent-1-ene

- 26) What is the product formed in the peroxide catalyzed hydrobromination of 1-methylcyclohexene

- a) 4-bromo-1-methyl cyclohexane
b) 2-bromo-1-methyl cyclohexane
c) 1-bromo-1-methylcyclohexane
d) 5-bromo-1-cyclohexane

- 27) Which atomic orbital overlap to form the carbon triple bond a) sp^2+sp^1 , $\text{sp}+\text{sp}$, $\text{p}+\text{p}$ b) $\text{s}+\text{s}$, $\text{sp}+\text{sp}$, $\text{p}+\text{p}$ c) $\text{sp}+\text{sp}$, $\text{p}+\text{p}$, $\text{p}+\text{p}$ d) $\text{sp}+\text{sp}$, $\text{sp}+\text{sp}$, $\text{p}+\text{p}$

- 28) The major product of the reaction of 1,2-dibromobutane and excess NaBH_4

- a) 2-bromo-1-butyne b) 1-bromo-1-butene
c) 1-butyne d) 1,2-butadiene

- 29) Which of the following is more acidic?

- a) 1-butyne b) 2-butyne c) 1-butene d) butane

- 30) Predict the product of the reaction of pent-1-ene and excess HCl in the presence of hydrogen peroxide

- a) 1,2-dichloropentane b) 1,2-dichloropentane
c) 2,2-dichloropentane d) 2-chloro-1-pentene

- 31) Which nucleophile is required to convert 1-bromobutane to butyl methyl ether?

- a) ethoxide ion b) methoxide ion
c) butoxide ion d) hydroxide ion

- 32) What type of orbitals are involved in C=O bond in alcohols? (A) $\text{sp}^2, \text{O sp}^2$ (B) Csp, Osp^2 (C) C sp^2 (D) $\text{Csp}^2, \text{O}, \text{sp}^2$
33. Which of the following is an isomer of the structure below?
-
- (A) (B) (C) (D)
34. A specific arrangement of atoms which gives characteristic properties of an organic molecule is known as a(an) (A) carbonyl group (B) functional group (C) group (D) alkyl group
35. The compound $\text{C}_4\text{H}_9\text{OH}$ is an isomer of (A) $\text{C}_2\text{H}_5\text{OCH}_3$, (B) $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$, (C) $\text{CH}_3\text{COOC}_2\text{H}_5$, (D) $\text{CH}_3\text{COOCH}_3$
36. Molecules of 1-propanol and 2-propanol have different (A) percentage composition (B) molecular mass (C) molecular formula (D) structural formula
37. Which of the following is not a catalyst for the hydrogenation of an alkene? (A) Pd (B) Pt (C) Na (D) Ni
38. The angle formed between any two carbon-hydrogen bonds in a molecule of an organic compound is a(an) (A) dihedral angle (B) right angle (C) acute angle (D) tetrahedral angle
39. Which alcohol has the lowest solubility in water? (A) pentanol (B) methanol (C) butanol (D) ethanol
40. Which of the following alcohols cannot be oxidized to a carbonyl compound? (A) 3-methyl-3-pentanol (B) propanol (C) 2-butanol (D) 2-pentanol
41. Which product is formed in the catalytic hydrogenation of 2,2-dimethyl-4-pentenol? (A) 2,2-dimethyl-1-pentanol (B) 2,2-dimethyl-4-pentanol (C) 2,2-dimethylpentanal (D) none of the above
42. Which of the following aldehydes used alone can undergo Aldol condensation? (A) formaldehyde (B) butanal (C) benzaldehyde (D) none of the above
43. An unknown compound on ozonolysis gave acetaldehyde and benzophenone. What is the name of the compound? (A) 1,2-diphenylpropane (B) 1,1-diphenylpropene (C) 2-phenyl-2-hexene (D) 1,2-diphenylhexane
44. Which of the following acid derivatives is the most stable? (A) acid chlorides (B) esters (C) amides (D) anhydrides
45. Which of the following compounds does not form an imine upon reaction with an amine? (A) benzaldehyde (B) benzamide (C) acetophenone (D) benzophenone
46. What conditions are best for dehalogenation of vicinal dibromide? (A) Zn in acetic acid (B) Zn in acetone (C) Zn in alcohol (D) Zn in toluene
47. What is the product of the reaction of acid chloride with primary amine? (A) an amine (B) an ester (C) amides (D) a secondary amine

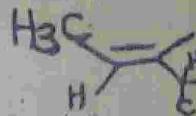
49. The type of substitution reaction that takes place when methane is treated with Cl₂ in the presence of light is (A) ionic (B) electrophilic (C) nucleophilic (D) radical

50. When the same group are on the same or opposite sides of the bonds in alkenes, the isomerism is called (A) chain isomerism (B) geometrical isomerism (C) positional isomerism (D) optical isomerism

51. Which of the following best describes the carbon-chlorine bond of an alkyl chloride? (A) nonpolar, no dipole (B) polar, d' at carbon and d' at chlorine (C) ionic (D) none of the above

52. Which of the following alcohols is the most acidic? (A) 1-chloroethanol (B) ethanol (C) 1,1-dichloroethanol (D) 2-ethanol

53. An alkene reacts with ozone to form (A) alkyne (B) alcohol (C) ketone (D) aldehyde



54. The IUPAC name for this compound is

- (A) 4-bromopent-2-ene (B) 3-bromo-2-methylbut-1-ene
(C) 4-bromo-3-methylpent-2-ene (D) 1-bromo-2-methylbut-2-ene

55. How many structural isomers of heptanes exist? (A) 2 (B) 4 (C) 6 (D) 8 (E) 9

56. Which of the following groups of products is formed when methane and chlorine reacts in the dark? (A) CH_2Cl , CH_3Cl_2 , CHCl_3 , and CCl_4 (B) CH_2Cl and HCl (C) CCl_4 and HCl (D) no product formed

57. The hybridization indicated by (*) in $\text{CH}_3\text{-CH}_2\text{CH}_2\text{-}$, $\text{CH}=\text{CH}_2$, and CHCCH_3 respectively (A) $\text{sp}^2, \text{sp}^3, \text{sp}$ (B) $\text{sp}^3, \text{sp}^2, \text{sp}^2$ (C) $\text{sp}, \text{sp}^2, \text{sp}^3$ (D) $\text{sp}^2, \text{sp}^3, \text{sp}$

58. Which of these is the most stable? (A) acyl halides (B) esters (C) amides (D) acid anhydrides

59. The hybridization of the central carbon in CH_3CN and the bond angle respectively are (A) $\text{sp}^3, 180^\circ$ (B) $\text{sp}, 180^\circ$ (C) $\text{sp}^2, 120^\circ$ (D) $\text{sp}^3, 109^\circ$

60. An unknown compound on ozonolysis gave acetaldehyde and benzophenone. What is the name of the compound? (A) 1,2-diphenylpropane (B) 1,1-diphenylpropene (C) 2-phenyl-2-hexene (D) 1,2-diphenylhexane

SOLUTIONS TO 2016/2017 EXAM QUESTIONS.

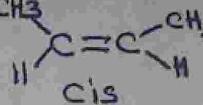
1] Hydrolysis of CaC_2 means the addition of water to it.



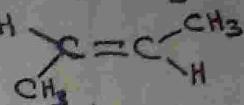
NB:- C_2H_2 is ethyne $\text{H}-\text{C}\equiv\text{C}-\text{H}$ which belongs to alkyne family

ANSWER = Alkyne.

5] A compound that has stereoisomer is the one that can exist as "cis" and "trans" isomers. But-2-ene is $\text{CH}_3\text{CH}=\text{CHCH}_3$.



cis



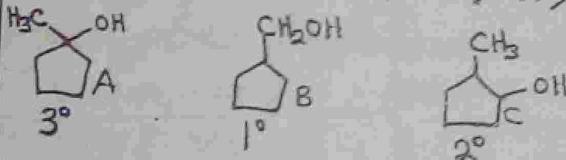
trans.

ANSWER = But-2-ene.

2] ZnCl_2 in HCl (ZnCl_2/HCl) is called Lucas reagent used to differentiate between the three classes of alcohols. Tertiary alcohol reacts fastest with Lucas reagent while Secondary alcohol takes little time about 5 mins to react with it. Primary alcohol reacts very slow with it.

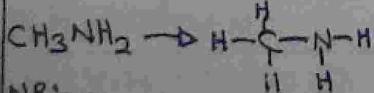
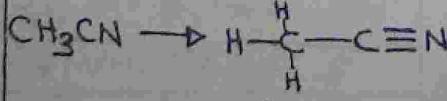
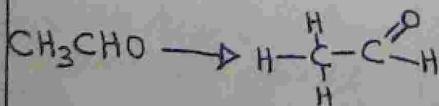
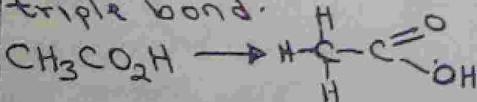
ANSWER = $(\text{CH}_3)_3\text{C}-\text{OH}$ (3° alcohol)

3] In terms of reactivity of alcohols with HBr , $3^\circ > 2^\circ > 1^\circ$



ANSWER = A > C > B

4] SP hybridization is present in a compound that has a triple bond.



NB:- Carbon always have four bonds while nitrogen has three.

ANSWER = CH_3CN .

6] The difference between Pent-1-ene and Pent-2-ene is the position of their double bonds. Therefore, both of them are called Positional Isomers.

NB:- Positional isomerism is part of structural isomers and another name for structural isomers is Constitutional Isomers.

ANSWER = Constitutional Isomers.

7] Electrophiles are electron deficient substances.

ANSWER = BH_3

8] Pi bonds (π) are formed by the side by side overlap of p-orbitals.

ANSWER = Side by side overlap of two p-orbitals.

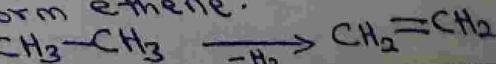
9] A

10] C

11] To reduce Carbonyl groups.

12] Elimination reaction.

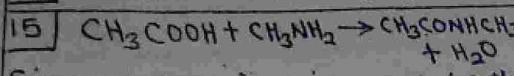
Example:- If we eliminate (remove) two hydrogen atoms from ethane, we form ethene.



13] Dehydrohalogenation is the removal of hydrogen halide from a haloalkane to form an alkene.

ANSWER = Reduction.

14 Reduce Carbonyl groups.



Since water is given out in the reaction of a carboxylic acid and amine, it is a condensation reaction.

16 Hybridization

17 Propane $\text{CH}_3\text{CH}_2\text{CH}_3$ and Propanone CH_3COCH_3 are not isomers because they do not have the same number of atoms of the same elements in them.
ANSWER = none of the above.

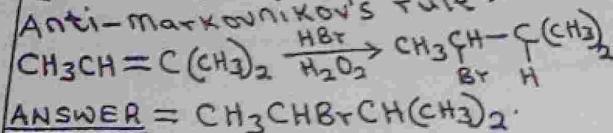
18 Wolf Kishner's reduction

19 At a temperature of 140°C H_2SO_4 reacts with alcohols to produce ethers.

At 180°C , the product is an alkene.

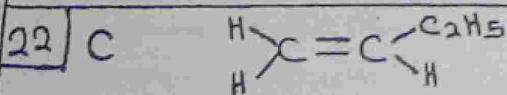
ANSWER = Ether.

20 In the presence of H_2O_2 (peroxide), it will follow the Anti-Markovnikov's rule.

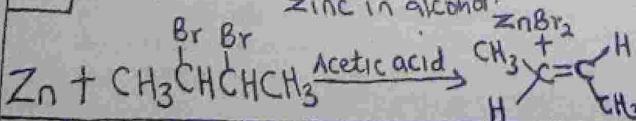


ANSWER = $\text{CH}_3\text{CHBrCH}(\text{CH}_3)_2$.

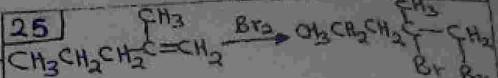
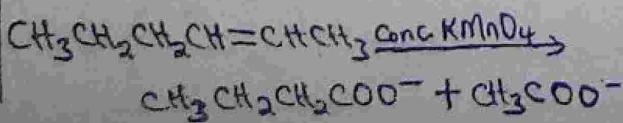
21 D



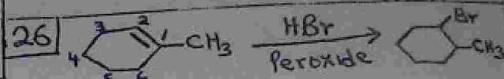
23 Zinc in acetic acid or zinc in alcohol.



24 Acetate and Butanoate

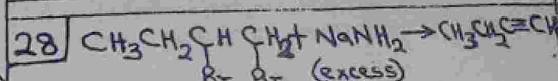


ANSWER = 1,2-dibromo-2-methyl Pentane



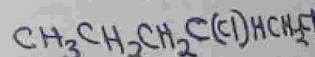
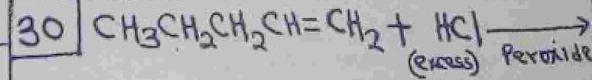
ANSWER = 2-Bromo-1-methyl Cyclohexane

27 In a Carbon-Carbon triple bond system ($\text{C}\equiv\text{C}$) each of the two carbon atoms contributes one sp orbital and two p -orbitals. It means that will be a total of two sp orbitals and four p -orbitals.
ANSWER = $\text{sp}+\text{sp}$, $\text{p}+\text{p}$, $\text{p}+\text{p}$

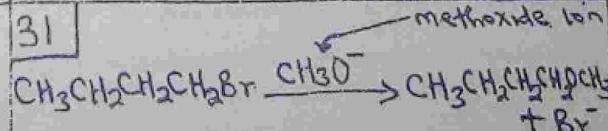


ANSWER = 1-Butyne or But-tyne.

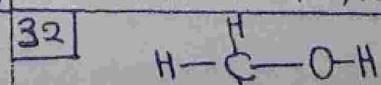
29 Acidic hydrogen is present in an alkyne whose triple bond is at position one, along the carbon chain.
ANSWER = 1-Butyne



ANSWER = 1,2-dichloro Pentane



ANSWER = methoxide ion.



In alcohol, we have only single bonds all over.
ANSWER = Csp^3 , O, sp^3

33 ANSWER

34 ANSWER

35 ANSWER

36 ANSWER

37 ANSWER

38 ANSWER

39 ANSWER

numb atom

the ' Solv

Cor

ANSWER

40 ANSWER

41 ANSWER

CH₃

2

4

5

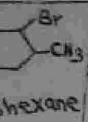
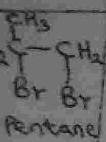
6

7

8

9

10



n
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 SP
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 YOR

33 ANSWER = A

34 ANSWER = B

35 ANSWER = A

36 ANSWER = D

37 ANSWER = C

38 ANSWER = D

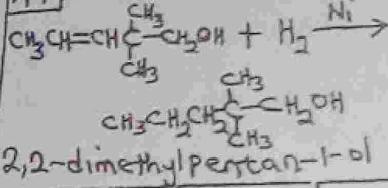
39 The higher the number of carbon atoms in a compound, the lower the solubility of the compound.

ANSWER = A

40 Tertiary alcohols are not easily oxidized.

ANSWER = A

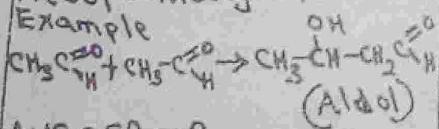
41 ANSWER = A



42 Aldehydes that contain alpha hydrogens undergo self addition forming an aldol. This reaction is known as Aldol condensation. It occurs in the presence of a base.

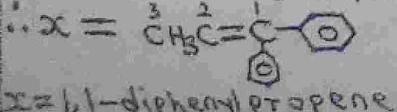
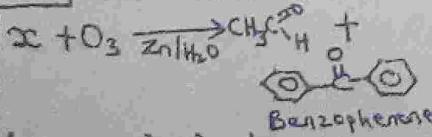
Aldol = Aldehyde + Alcohol

Example



ANSWER = B

43 Let unknown be X.



ANSWER = B.

44 Amides are the most stable acid derivatives because they are not very reactive.

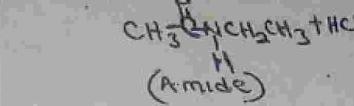
ANSWER = C

45 ANSWER = B

46 ANSWER = A

Zn in acetic acid.

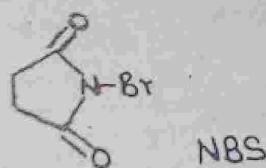
47 ANSWER = C



48 N-Bromosuccinimide (NBS) is used to supply bromine to allylic systems.

because NBS prevents further chain reaction

ANSWER = B



49 ANSWER = D

50 ANSWER = B

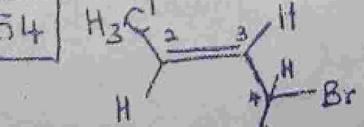
It is "trans isomerism"

51 ANSWER = B

52 The more halogen atoms, the more the acidity

ANSWER = C

53 ANSWER = D



ANSWER = A

55 ANSWER = E.

Check the note on Isomerism. You will see a table of isomers of C_7H_{16}

56 Halogenation of alkanes does not take place in the dark.

ANSWER = D

57 ANSWER = A

$\text{sp}^3 = \text{sp}^2 = \text{sp}$

58 ANSWER = C

Amides are stable as a result of resonance in them.

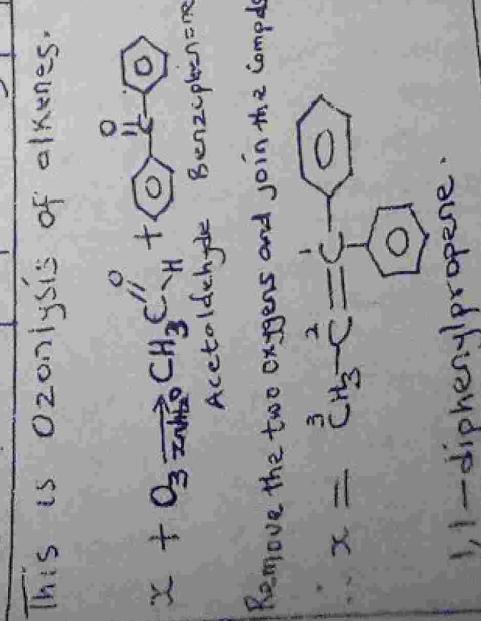
59 $\text{CH}_3-\text{C}^{\bullet}\text{EN}$

The central carbon atom is the carbon with a dot on it. It has triple bond which is sp hybridization (180°)

ANSWER = B

60 ANSWER = B

Repeated Question.



FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI, DEPARTMENT OF CHEMISTRY

Rain semester

2011/2012 session

CHM 102: GENERAL CHEMISTRY II:

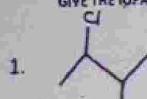
time: 1hr.

Date: 29/08/12

Instruction: Answer all questions in the spaces provided.

Name: _____ Reg No: _____

GIVE THE IUPA NAMES OF THE FOLLOWING ORGANIC STRUCTURES.



2-Chloro-3-methylpentane



Hex-1,3-diene



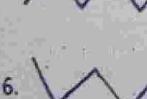
4-Ethylhept-6-ene-3-one



4-Cyclobutylpent-1-ene



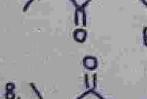
9-methyldec-1,3-diene



Heptan-2-one OR 2-Heptanone.



4,5-dibromo-2,7-dimethyl Oct-5-ene-3-one



4-Chloro-2-ene-5-one-heptanoic acid.
OR
4-chloro-5-one-2-heptenoic acid.

TEST

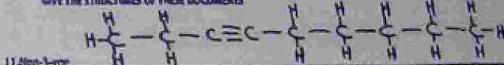


5-Cyclopentylhex-1-ene



1-cyclohexyl ethyne OR Cyclohexylacetylene

GIVE THE STRUCTURES OF THESE DOCUMENTS

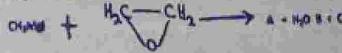


Find the molecular formula of an organic liquid consisting of carbon, hydrogen and oxygen with the following composition CH₅X, H: 13.33%, and vapour density 8.495. Ans = C₄H₈O

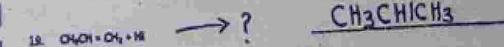
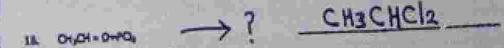
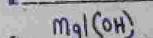
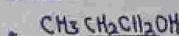
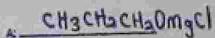
Write a possible structure of this compound: 3-ethyl-1-oxo-3-one.

How many π -bonds is this compound: CH₃COCH₃. One π -bond

Complete the following chemical reaction:



What are



Federal University of Technology Owerri, Department of Chemistry

Rain Semester Examination 2011/2012 Session

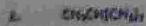
CHM 102: General Chemistry II

Time: 2hrs

Date: 16/08/12

Instructions: Answer all questions in the spaces provided.

Complete the following reactions.



Ans: $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$



OR
OH 4-chloro-5-one-2-heptenoic
acid.

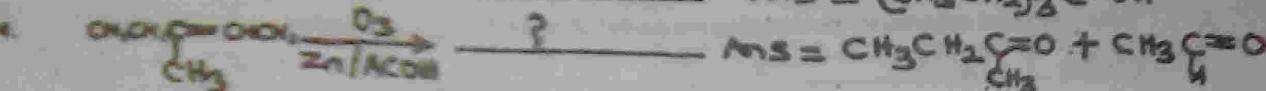
Federal University of Technology Owerri, Department of Chemistry

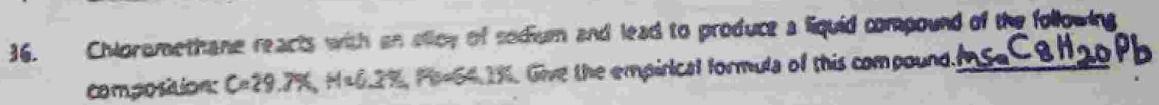
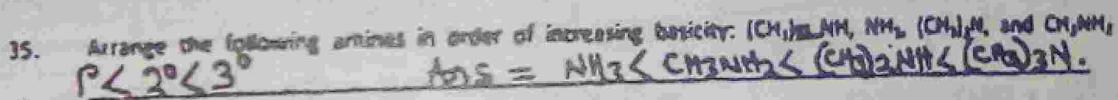
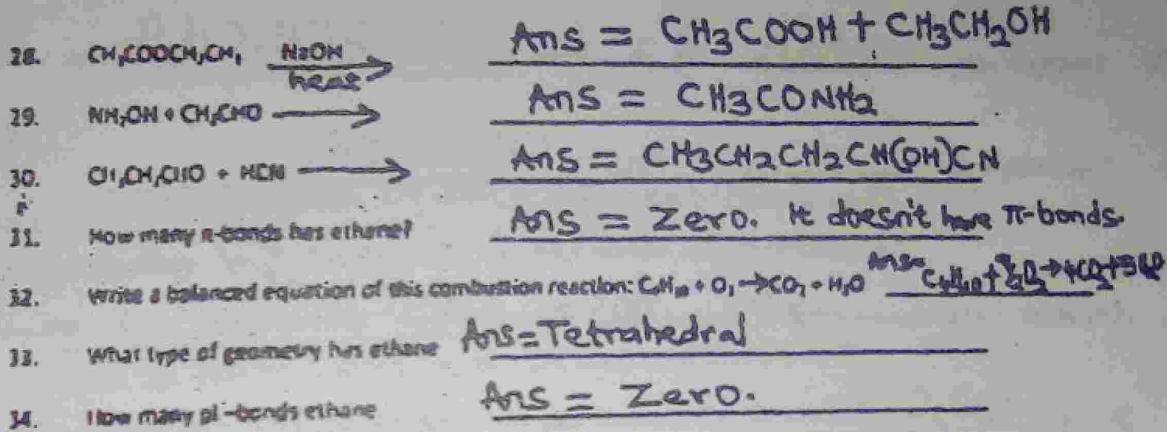
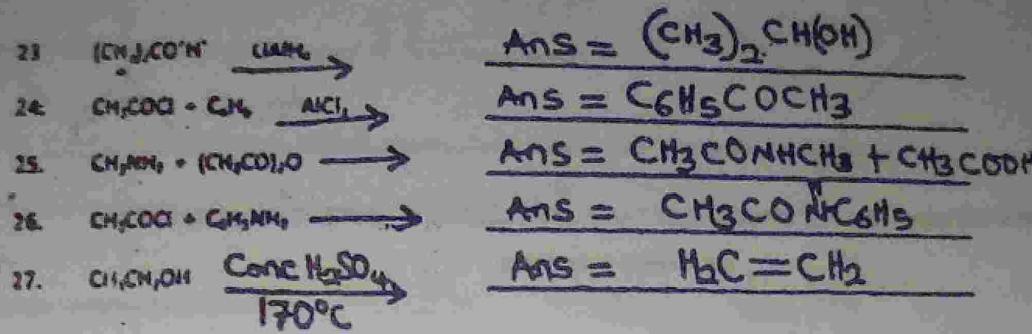
Main Semester Examination 2011/2012 Session

Course: GSC2: General Chemistry II Time: 2hrs Date: 18/09/12

Instruction: Answer all questions in the spaces provided.

Complete the following reactions.

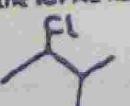


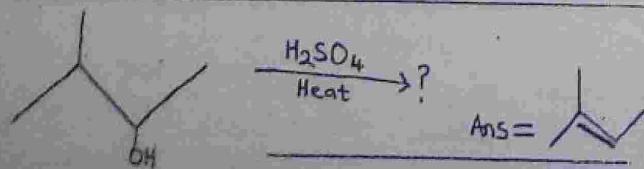
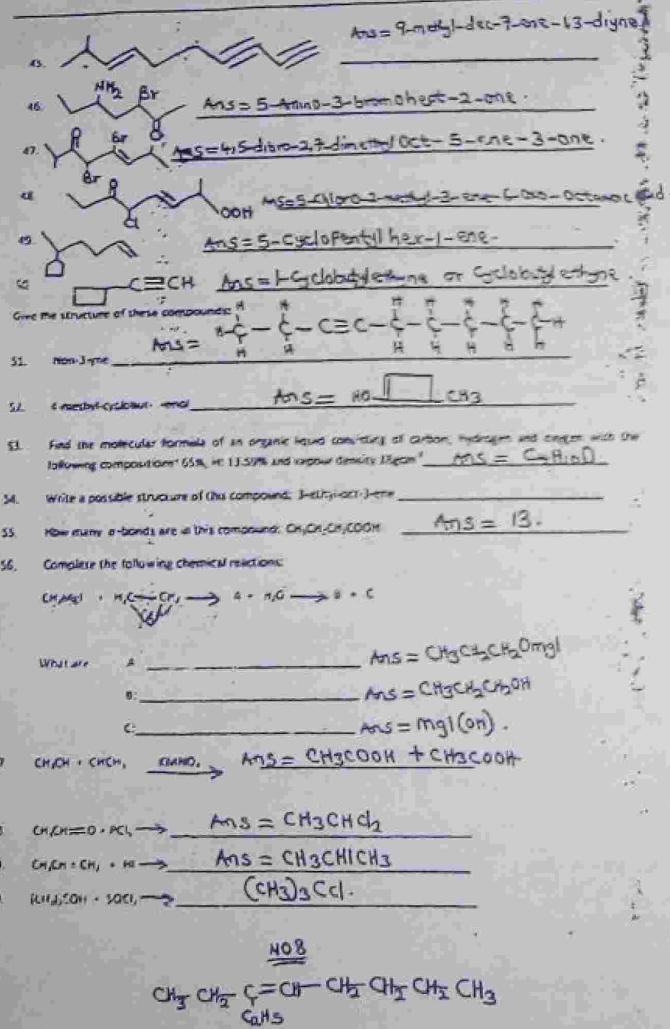


Distinguish between the following pairs of compound

37. $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$ and $\text{CH}_3\text{C}\equiv\text{CC}_2\text{H}_5$ Ans = They are Positional Isomers.
 38. Hexene and Hexane Ans = They have different functional groups.
 39. Ethanoic acid and phenol Ans = They have different functional groups.
 40. CH_3COOH and HCOOH Ans = They differ in there longest chain.

Give the IUPAC names of the following structure:

41.  Ans = 2-Chloro-3-methylpentane
 42.  Ans = Hex-1,3-diyne.
 43.  Ans = 4-Ethylhept-6-ene-3-one
 44.  Ans = 4-Cyclobutylpent-1-ene.



FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI, DEPARTMENT OF CHEMISTRY
 RAIN SEMESTER EXAMINATION 2012/2013 SESSION
 CHM 102: GENERAL CHEMISTRY II: TEST
 TIME: 45 MINS DATE: 12/05/13

INSTRUCTION: ANSWER ALL QUESTIONS IN THE SPACES PROVIDED.

NAME: _____ Reg No: _____

GIVE THE STRUCTURE OF THE FOLLOWING COMPOUNDS:

1. 4-Ethyl-2-methylheptane
 2. 3,6-dibromo-2,8-dimethylnon-6-en-3-one
 3. 1-Ethynylcyclohexanol
 4. 3-Hydroxy-2-ethylpentanal

Give the IUPAC name of the following structures.

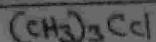
5. OH₂CH₂C≡C-OH(CH₃)₂ Non-3-yne
 6. OH₂CH(OH)CH₂CH₂COCH₃ 4-Chloro-6-methylheptan-3-one

WHAT IS THE BEST REAGENT TO MAKE THE FOLLOWING PRODUCT?

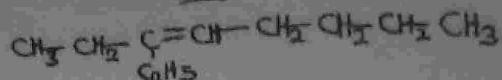
7. $\xrightarrow{?}$ Ans = NaNH₂/Liquid
 8. $\xrightarrow{?}$ Ans = H₂

WHAT IS THE MAJOR PRODUCT OF THE FOLLOWING REACTION?

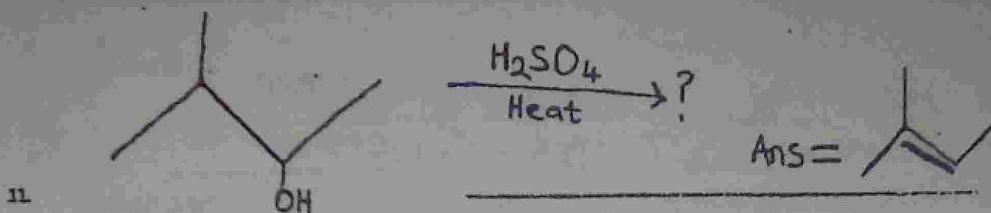
9. $\xrightarrow[\text{Light}]{\text{Br}_2}$? Ans = 2-bromo-2-methylbutane
 10. $\xrightarrow[\text{Pyridine}]{\text{SOCl}_2}$? Ans = 2-chloro-2-methylbutane



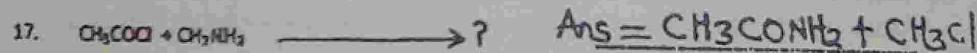
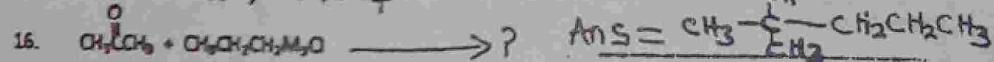
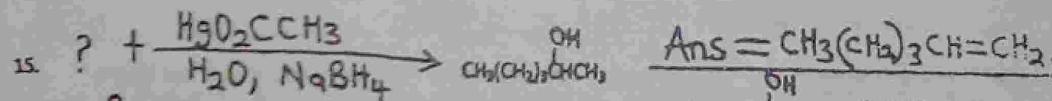
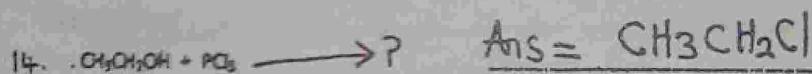
NO8



C_6H_{15}



GIVE THE NAME AND THE STRUCTURE OF THE MAIN PRODUCTS OR STARTING MATERIAL FOR THE FOLLOWING REACTIONS



18. Write a balanced equation for the complete combustion of hexane.



19. Rank the following ions in terms of their leaving group reactivity: $\text{Br}^- > \text{Cl}^- > \text{I}^- > \text{F}^-$



20. The empirical formula of compound X is CH_2O and its molecular formula is $\text{C}_6\text{H}_{12}\text{O}_6$. Calculate the molecular formula of compound X.

$$[\text{CH}_2\text{O}]_n = \frac{[179+5] + [179-5]}{2}$$

$$[\text{CH}_2\text{O}]_n = 179$$

$$\therefore n = \frac{179}{[\text{CH}_2\text{O}]} = \frac{179}{[12+(2\times 2)+16]} = \frac{179}{30}$$

$$n = 6$$

$$\therefore \text{Molecular formula} = [\text{CH}_2\text{O}]_n$$

$$= \text{C}_6\text{H}_{12}\text{O}_6$$

Federal University of Technology Owerri, Department of Chemistry

Rain Semester Examination 2012/2013 Session

CHM 102: General Chemistry II: Time: 1hr 30mins

Date: 21/01/14

Instruction: Answer all questions in the spaces provided.

Name _____

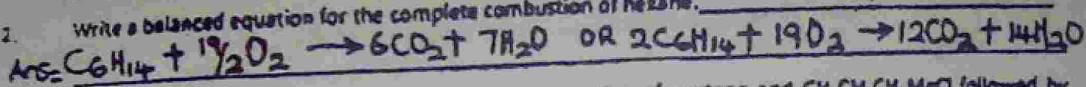
Reg. No. _____

1. Determine the molecular formula of an organic compound with the following composition:

Carbon 65%, Hydrogen 13.9% and vapour density 38cm³. NB: Molar mass = $2 \times \text{Vapour density}$

Ans = C₄H₁₀O

2. Write a balanced equation for the complete combustion of hexane.

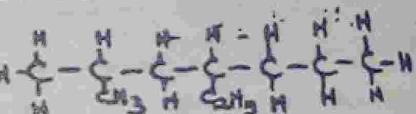


3. Name the product that will be obtained from the reaction of acetone and CH₃CH₂CH₂MgCl followed by treatment with acid? Ans = 3-methyl Pentan-2-ol

4. In the reaction of propan-2-ol with HCl, the leaving group is? Ans = H₂O

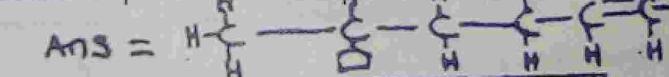
5. What would be the major product of the reaction of butanoic with SOCl₂? Ans = CH₃CH₂COCl

6. The Geometry of the carbon atoms in an alkyne are? Ans = Linear Shape

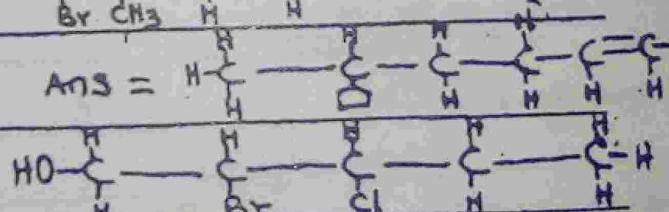
- Give the structure of the following compound: Ans = 

7. 4-Ethyl-2-methylbutane

8. 4-Eromo-3-methylbutanol Ans = 

9. 5-Cyclopentyl-1-hexene. Ans = 

10. 2-Bromo-3-chloropentanol



Give the IUPAC name of the following structures:

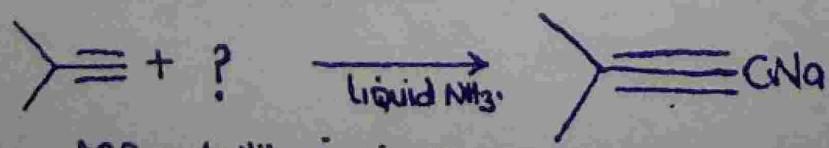
11. CH₃CH₂C≡C-CH₂(CH₃)₂CH₃ Ans = Non-3-yne

12. CH₃CH₂(CH₃)CH₂CH₂ClCOCH₂CH₃ Ans = 4-chloro-6-methylhept-3-one

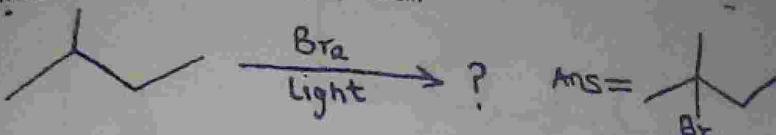
13. State the order of stability in the following carbonium ions: CH₃H₂C⁺, (CH₃)₂NC⁺, (CH₃)₃C⁺

Ans = (CH₃)₃C⁺ > (CH₃)₂HC⁺ > CH₃H₂C⁺

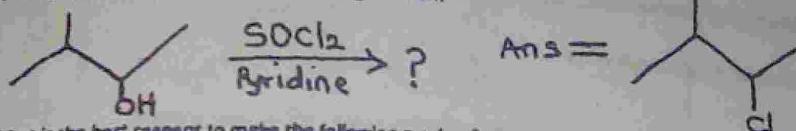
14. What is the best reagent to make the following product?



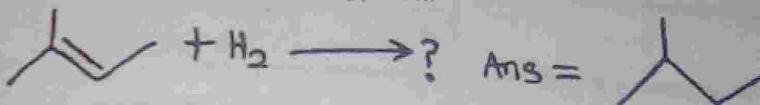
15. What is the major product of the following reaction?



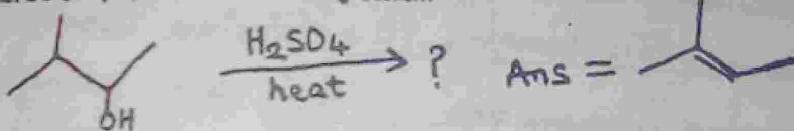
16. What is the major product of the following reaction?



17. What is the best reagent to make the following product?



18. What is the major product of the following reaction?

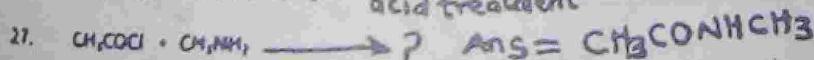
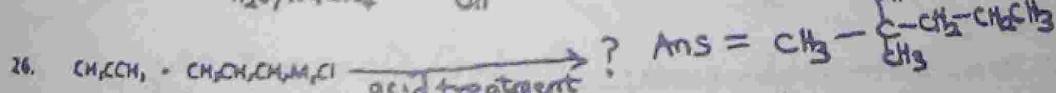
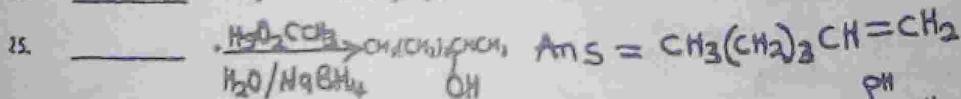
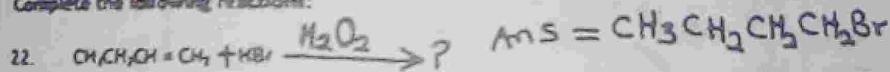


19. How many isomeric structures are possible in C_4H_8 ? Ans = Nine.

20. The loss of a halide to generate an alkene is known as Ans = Dehalogenation

21. Rank the following ions in terms of their leaving group reactivity: $\text{Br}^- > \text{O}^- > \text{Cl}^- > \text{F}^-$ Ans = $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$

Complete the following reactions:



28. The empirical formula of compound X is CH_2O and its molecular formula is $\text{C}_7\text{H}_8\text{O}_2$: Calculate the molecular formula of compound X. $[\text{CH}_2\text{O}]_n = \frac{(79+15)}{2} + \frac{(179-5)}{30} = 179$, $n = \frac{179}{179} = 1$. $\therefore \text{Ans} = \text{C}_7\text{H}_8\text{O}_2$.

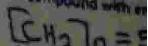
29. Calculate the percentage of nitrogen in Morphine, $\text{C}_{17}\text{H}_{21}\text{NO}_3$.

$$\% \text{N} = \frac{\text{N}}{\text{C}_{17}\text{H}_{21}\text{NO}_3} \times 100$$

$$\% \text{N} = \frac{14}{(17 \times 7) + (21 \times 1) + 14 + (3 \times 1)} \times 100 = 4.9\%$$

30. The combustion of a compound with empirical formula of C_2H_3 gives

31. A compound with empirical formula of C_2H_3 gives



32. The chlorination of C_2H_3 in SbCl_3 reaction

33. How many H_2 (g) are required to reduce C_2H_3 to C_2H_6 ?

34. The compound O material?

(a) 2-methylpropane

35. Ethyl butanoate, i

(a) Ethanol and p

and butanoic acid

36. What is the perc

37. Arrange the fol

(d) CH3CH2SH

38. Arrange the fol

(c) propanal (d)

39. Which alky hal

Classify each of the fo

40. (CH3)2COH

41. CH3CH2NHCN

NHCH₃

42. CH3CH2NHCN

OH

43. H-C(=O)-CH2-CH2-OH

H

44. CH3-NH2

30. The combustion of 6.31g of an organic compound yields 8.36g of H_2O and 20.47g of CO_2 . Determine the empirical formula of the compound. [C = 12, H = 1, O = 16]. Ans = C_2H_2 .

31. A compound with empirical formula as CH_2 , has a molecular weight of 56g. What is the molecular formula? $[CH_2]_n = 56 \therefore n = \frac{56}{14} = 4$. \therefore Ans = C_4H_8

32. The Chlorination of an alkane is _____
[a] an S_N1 reaction [b] an S_N2 rxn [c] a free radical rxn [d] an oxidation rxn. Ans = C

33. How many π (p) are present in the molecule $CH_3CH_2CH = CHCH_2CH \equiv CH$? Ans = 6 π -electrons.

34. The compound CH_3CH_2COOH was produced by oxidation. Which one of the following is likely starting material? Ans = Propan-1-ol.

[a] 2-methylpropanol [b] Butan-2-ol [c] Propan-1-ol [d] propan-2-ol.

35. Ethyl butanoate, the pineapple flavor, can be prepared by esterification of: _____
[a] Ethanol and pentanoic acid [b] Methanol and butanoic acid [c] Ethanol and ethanoic acid [d] Ethanol and butanoic acid. Ans = D

36. What is the percentage character in an sp^2 hybridized carbon atom? $\% S = \frac{S}{Sp^2} \times 100 = \frac{1}{1+2} \times 100 = 33\%$

37. Arrange the following compounds in order of increasing acidity: (a) CH_3CO_2H (b) CCl_3CO_2H (c) CH_3CH_2OH (d) CH_3CH_2SH Ans = C < d < a < b

38. Arrange the following compounds in order of increasing boiling point: (a) Chloroethane (b) propene (c) propane (d) propanes. Ans = a < c < d < b

39. Which allyl halide has the most polar allyl-halogen bond? (a) RF (b) RCl (c) RBr (d) RI

Ans = RF

Classify each of the following compounds as primary, secondary or tertiary alcohols/amines

40. $(CH_3)_3COM$ 3° alcohol

41. $CH_3CH_2CH_2CH_2OH$, 2° alcohol

42. $CH_3CH_2N(CH_3)_2$ 3° amine

43. $CH_3CH_2CH_2NH_2$, 2° amine

44.  2° amine

NB:- 1° = Primary

45.  1° alcohol

2° = Secondary.

46.  2° alcohol

3° = Tertiary.

47.  1° amine

48.  1° amine

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERE

DEPARTMENT OF CHEMISTRY

RAINY SEMESTER 2013/2014 SESSION

TEST ON CHIN 102-GENERAL CHEMISTRY

DATE: 20/08/2014

INSTRUCTION: ATTEMPT ALL THE QUESTIONS AND GIVE THE ANSWER IN THE SPACE PROVIDED.

Time allowed: 45mins

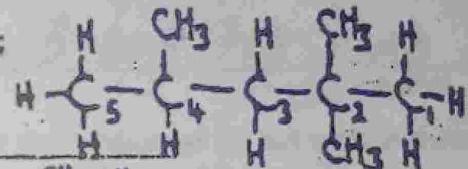
1. A hydrocarbon, X has a relative molecular mass of 22 and consists of 87.5% by mass of carbon and 12.5% of hydrogen. What is the molecular formula of X



2. Write a balanced equation for the complete combustion of propane



Draw the structures for the following compounds;



3. 2,2,4-Trimethyl pentane

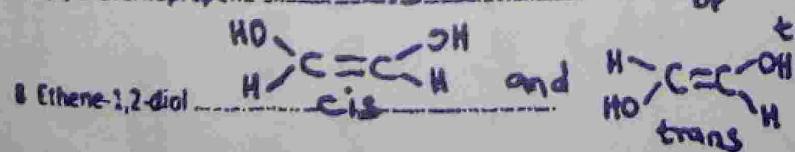
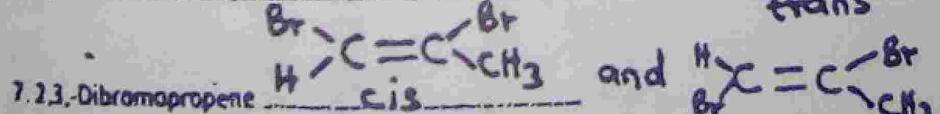
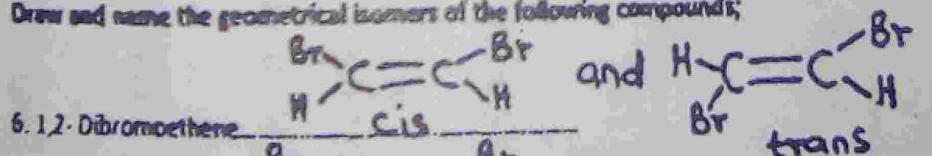


4. 2,2-Dimethyl pentan-3-one



5. Indicate the hybridization of the carbon atoms in a benzene structure

Draw and name the geometrical isomers of the following compounds;



9. Enantiomers are molecules that are mirror images of each other and are not superimposable on each other.

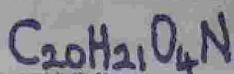
10. The metal catalyst for the hydrogenation of an alkene is Nickel or Palladium

11. A liquid of molecular weight of 60g was found to contain 40% carbon and

6.7% Hydrogen what is the molecular formula of the compound.....

$$\text{Ans} = \text{C}_2\text{H}_4\text{O}_2$$

12. A qualitative analysis of papaverine an alkaloid, showed 70.8% carbon, 6.2% Hydrogen and 4.1% Nitrogen



calculate the empirical formula of papaverine.....

13. The percentage composition of ethanol is 52.2% C 13% H 34.8% O.

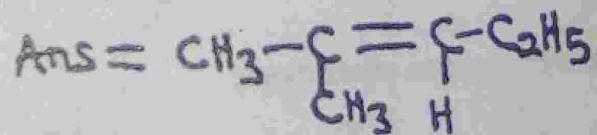
14. The number of sigma electrons and shape of bonding orbitals in Ethyne are 6 and Linear respectively.

15. Isomerism is defined as phenomenon by which different compounds have molecular formulae but different molecular structures.

16. _____ and _____ are the two main types of isomerism in organic chemistry.

Ans = Structural and Stereoisomerism.

17. An alkene C_4H_8 on ozonolysis yielded two products acetone and propanal. Give the structure of the alkene.....



Complete the following equation of reaction

18. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2 + \text{HBr} \longrightarrow \text{Ans} = \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}-\overset{\text{H}}{\underset{\text{By}}{\text{CH}_2}}$

19. Why is the boiling point of a branched chain compound lower than that of its straight chain isomer.

This is due to the lower Surface area created by branching and lower intermolecular force of attraction.

20. In a free radical reaction, the following step:

- $\text{Cl}^- + \text{CH}_3\text{CH}_2\text{OH} \longrightarrow \text{CH}_3\text{CH}_2\text{OH}$ is called? Ans = Propagation.

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI

DEPARTMENT OF CHEMISTRY

RAINY SEMESTER EXAMINATION 2013/2014 SESSION

CHM 102-GENERAL CHEMISTRY II

DATE: 30/09/2014

Instruction: Provide the solution to each of the following questions in the appropriate space.

Time allowed: 2 hours

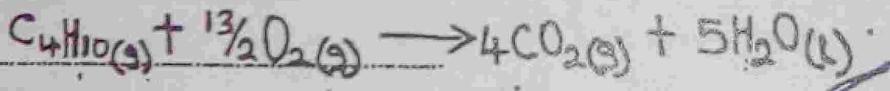
1. The combustion of 8.00mg of squalene sample produced 25.6mg CO₂ and 8.75mg H₂O. Calculate the empirical formula of squalene if it has a molecular weight of 410g.



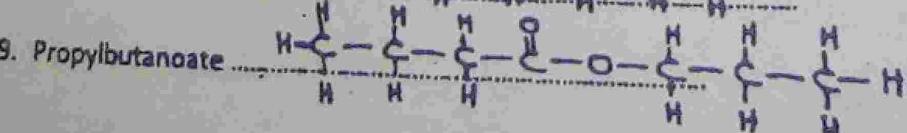
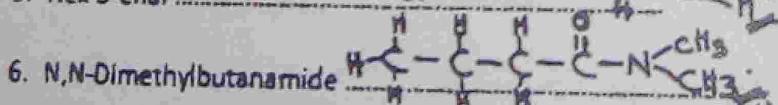
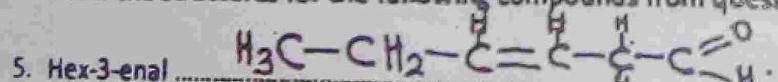
2. Calculate the percentage of each element in quinine C₂₀H₂₄O₂. C = 74.07%, H = 7.41%, N = 8.64%, O = 9.88%.

3. A hydrocarbon X has a relative molecular formula of x.

4. A balanced equation for the complete combustion of butane is written as;



Draw the structures for the following compounds from questions 5-12.



10. 2-Methyl

11. 3-*Isopropyl*

12. N-Ethyl-

Indicate the type

13. Butan-2-

14. Propan-

15. Ethene

16. The reac-

17. Carbon

Illustrate and

18. _____

H₃

19. _____

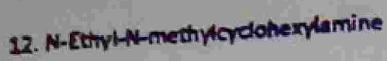
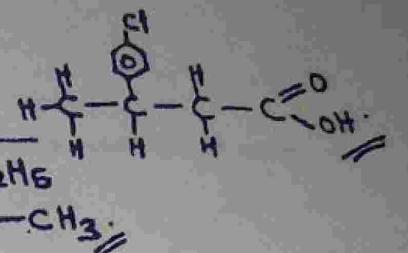
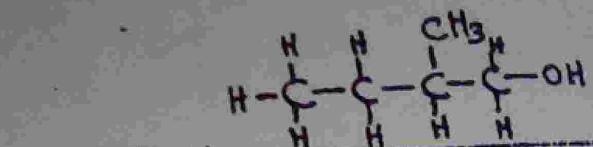
20. _____

21. The a-

22. Calcula-

as C₂₀

23. The p-



Indicate the type of relationship that exists between the following pair of compounds;

Chain isomers //

13. Butan-2-ol and 2-methyl-propan-2-ol

Functional group isomers //

14. Propenoic acid and methyl ethanoate

Tautomers [Equilibrium isomers]

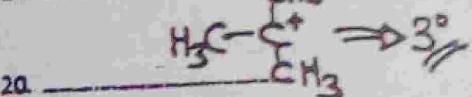
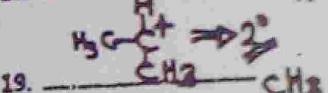
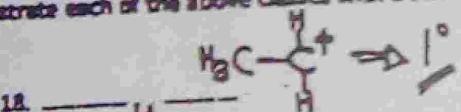
15. Ethanol and ethanal

Enantiomers //

16. The two structures of 2-methylbutanol are $\begin{array}{c} \text{H} \\ | \\ \text{H}_3\text{C}-\text{C}^+ \\ | \\ \text{H} \end{array}$. They are enantiomers.

17. Carbocation ions are classified as 1° , 2° , and 3° .

Illustrate each of the above classes with a structure of your choice



21. The addition of HBr to 2-butene is called Hydrohalogenation.

22. Calculate the percentage composition of an organic compound with its empirical formula given as $\text{C}_{20}\text{H}_{21}\text{O}_4\text{N}$: $\text{C}=70.8\%$, $\text{H}=6.2\%$, $\text{N}=4.1\%$, $\text{O}=18.9\%$.

$$\text{as } \text{C}_{20}\text{H}_{21}\text{O}_4\text{N}: \quad \text{C} = 70.8\%, \quad \text{H} = 6.2\%, \quad \text{N} = 4.1\%, \quad \text{O} = 18.9\%.$$

23. The percentage composition of chlorine in Propylchloride is 45.2%.



$$\% \text{ Cl} = \frac{\text{Cl}}{\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}} \times 100$$

$$[\text{Cl} = 35.5, \text{C} = 12, \text{H} = 1]$$

24. What orbital's are used for the formation of C-H bonds in a propane compound.

sp^2 from C and S from H

OR

$C(sp^2), H(s)$

25. The number of sigma electrons in $CH_3CH=CH_2$ is given as $8+2=16$ Sigma electrons.

26. How can propane be distinguished from propene? Propene decolorises cold

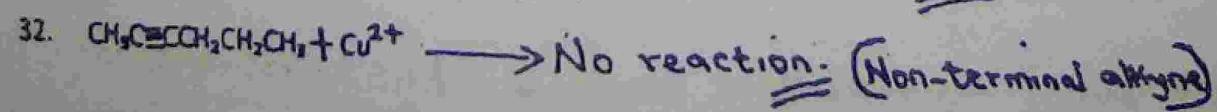
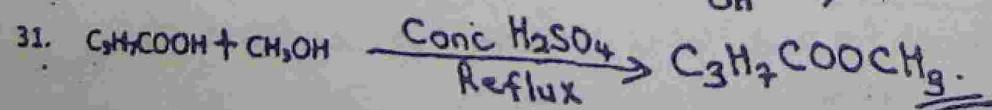
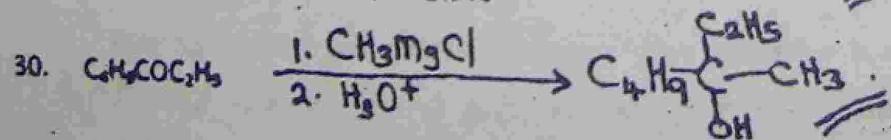
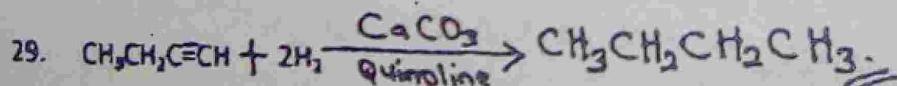
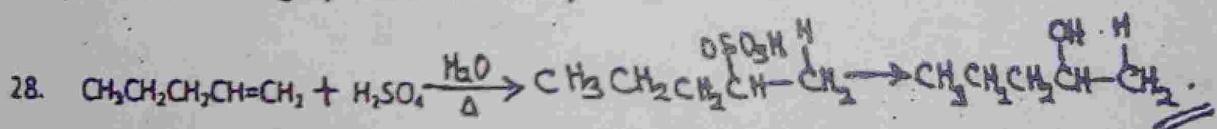
Solution of $KMnO_4$ (purple) or Br_2/CsI_4 solution (pink) but Propane does not

27. An alkene C_6H_{12} on ozonolysis yielded two products- acetone and propanal. Give the



structure of the alkene.

Complete the following equation of reactions;



33. Why is the boiling point of a branched chain compound lower than that of its straight chain isomer.

This is because of the small surface area created by branching.

34. The major product of the chlorination of methane in large excess of methane is given as

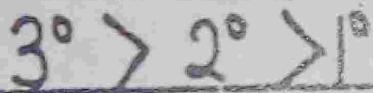


35. The major product of the chlorination of methane in large excess of chlorine is given as



36. The reagent for Wolff-Kishner reaction is _____

37. The order of reactivity for the dehydration of 1°, 2° and 3° alcohols is given as



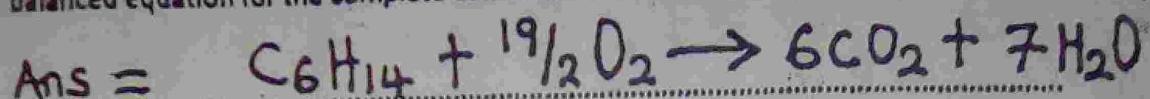
38. Enantiomers are molecules that are mirror images of each other yet they are not superimposable on each other.

39. Different arrangement of atoms that can be converted into by rotation about single bonds are called Conformation.

40. What is the chemical combination of Lucas reagent HCl and ZnCl₂

1. An hydrocarbon X₁ has a relative molecular mass of 56g and consist of 87.8% by mass of carbon and 12.5% of hydrogen. What is the molecular formular of X₁?
Ans = C₄H₈

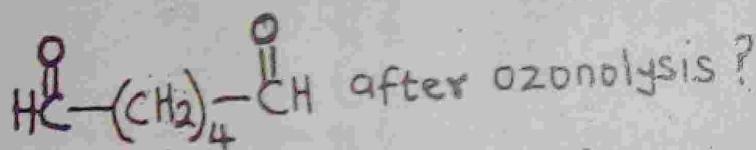
2. A balanced equation for the complete combustion of HEXANE is written as :



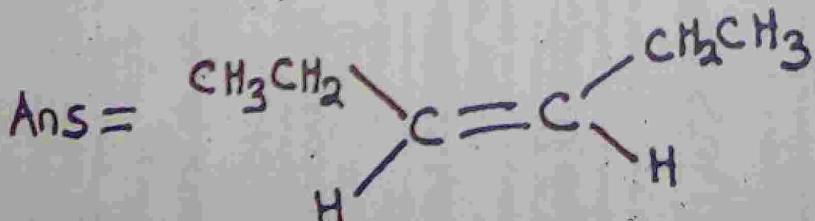
3. 2-Bromo-4-methyl pentane
Ans = CH₃-CH(Br)-CH₂-CH(CH₃)-CH₃

4. 2-methylbutanol
Ans = CH₃-CH₂-CH(CH₃)-CH₂OH

5. Predict the structure of a hydrocarbon(C₆H₁₀) that produces



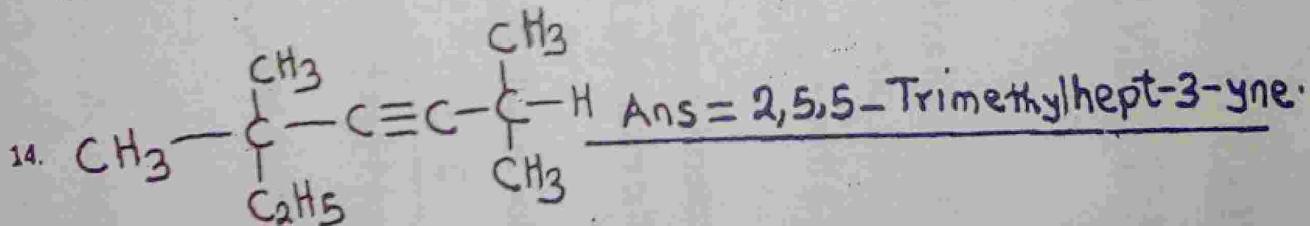
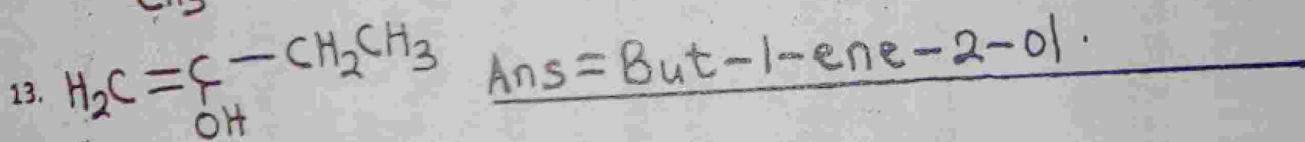
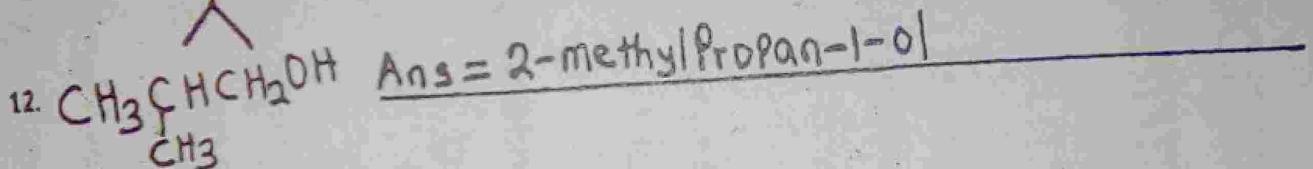
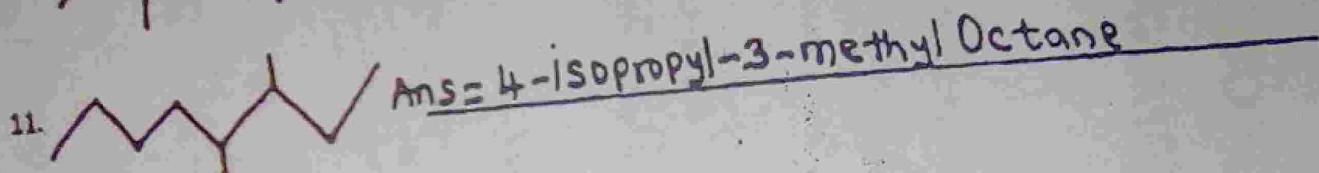
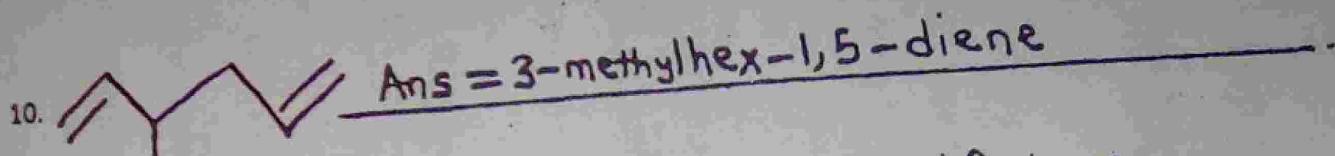
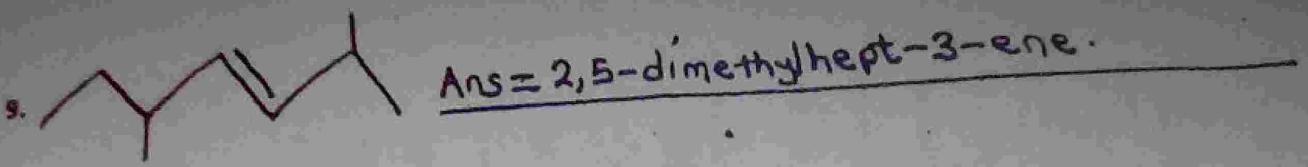
6. write the structural formular cis-hex-3-ene



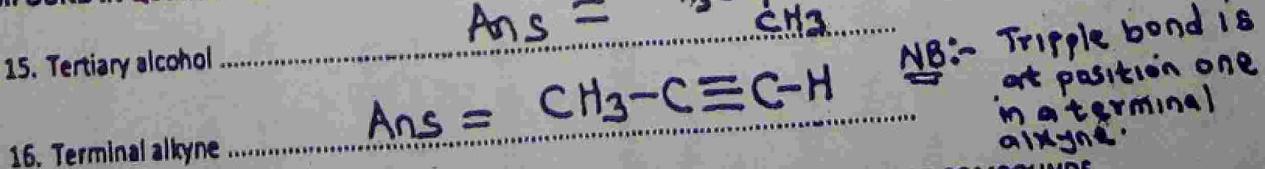
7. Why are alkene insoluble in water?
Ans = Alkenes are non-Polar.

8. What are hybrid orbitals in a carbon compound?

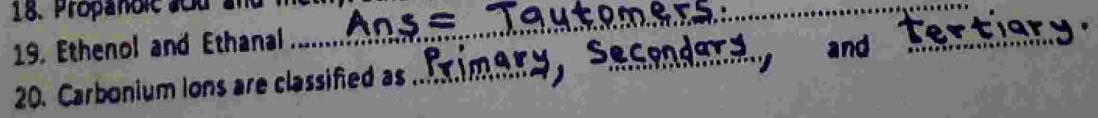
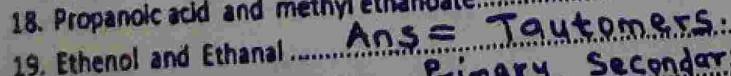
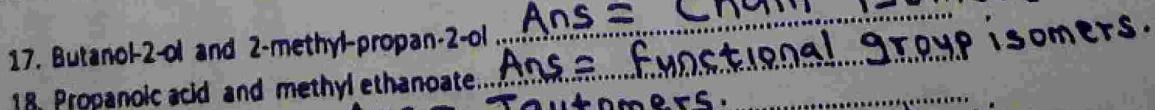
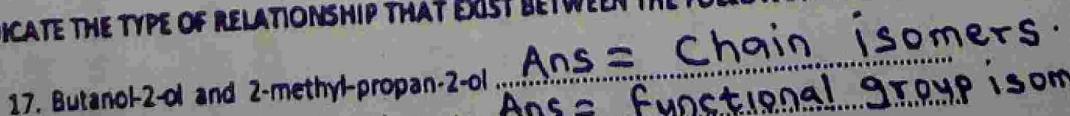
Ans = Hybrid Orbitals are those new equivalent orbitals formed by mixing up of the S and P orbitals of carbon atoms.



GIVE THE STRUCTURAL FORMULAR FOR A COMPOUND THAT REPRESENT EACH CLASS OF ORGANIC COMPOUND IN QUESTION 14 AND 15



INDICATE THE TYPE OF RELATIONSHIP THAT EXIST BETWEEN THE FOLLOWING PAIR OF COMPOUNDS



FEDERAL UNIVERSITY OF TECHNOLOGY
2014/2015 CHM102 RAIN SEMESTER EXAMINATION

1. A compound X contains carbon, hydrogen and possibly oxygen. Combustion analysis of 6.24mg X gave 10.766mg of CO₂ and 3.684mg of H₂O. Analysis of 3.669mg of X gave 6.850mg of silver chloride. What is the empirical formula of X ?

2. A hydrocarbon Y has a relative molecular mass of 56 and contains 87.8% by mass of carbon and 12.5% of hydrogen. What is the molecular formula of Y ? Ans = C₄H₈

3. What is the percentage composition of Na in the compound NaHCO₃ ?

$$\text{Ans} = \% \text{Na} = \frac{\text{Na}}{\text{NaHCO}_3} \times \frac{100}{1} = \frac{23}{23+1+12+16(3)} \times \frac{100}{1} = 27.38\%$$

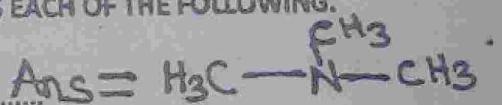
4. An organic compound was said to have 42.90% C, 2.4% H, 16.7% N and 38% O. What is its empirical formula ? Ans = C₃H₂NO₂

5. The reactive portion of a molecule that undergoes predictable reactions is called Ans = functional group .

6. What are free radicals. Ans = They are the reactive molecular fragments with an unpaired electron.

DRAW THE STRUCTURES OR EQUATIONS THAT REPRESENTS EACH OF THE FOLLOWING.

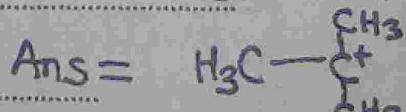
7. Tertiary amine



8. Functional group isomers Ans = CH₃CH₂CHO and CH₃COCH₃

9. Stereoisomers Ans = $\begin{array}{c} \text{HOOC} \\ | \\ \text{H} > \text{C}=\text{C} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$ and $\begin{array}{c} \text{H} \\ | \\ \text{H} < \text{C}=\text{C} \\ | \quad | \\ \text{HOOC} \quad \text{H} \end{array}$

10. Tautomers Ans = CH₃C⁻^OH and H-C=O-H



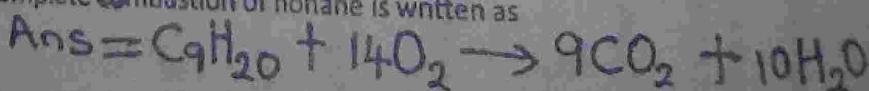
11. Tertiary carbonium ion

12. Anti-markovnikov's addition Ans = CH₃CH=CH₂ $\xrightarrow[\text{H}_2\text{O}_2]{\text{HBr}}$ CH₃^HCH-CH₂^{Br}

ability

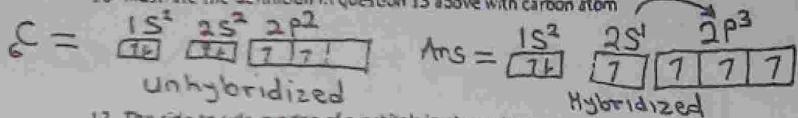
13. Carbon's ability to covalently bond with itself to form straight long chains is called Ans = Catenation .

14. A balanced equation for the complete combustion of nonane is written as



15. What is hybridization. Ans = Hybridization is the mixing up of two or more different orbitals to form entirely new equivalent orbitals.

16. Illustrate the definition in question 15 above with carbon atom



17. The side to side overlap of p-orbitals in phase gives

Ans = π -bonding molecular orbitals.

18. The geometric shape and bond angle of ethyne are and

Ans = Linear and 180°

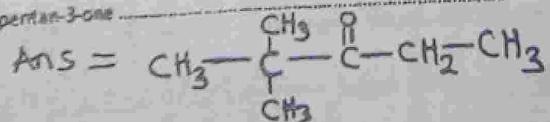
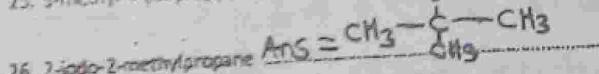
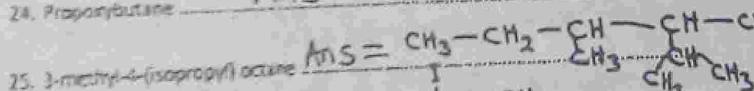
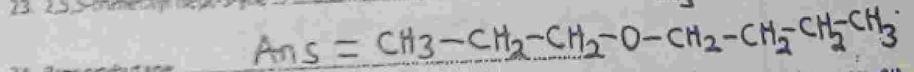
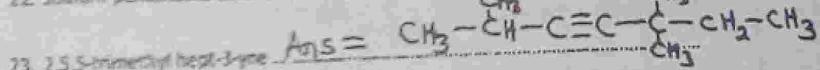
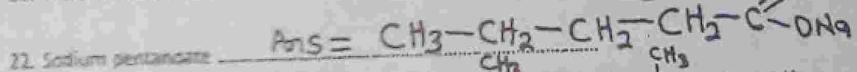
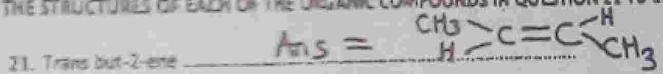
19. Why are alkenes insoluble in water?

Ans = Because alkenes are non-polar.

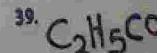
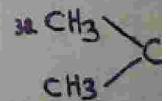
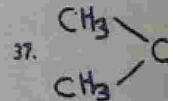
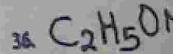
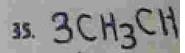
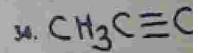
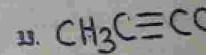
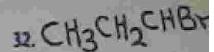
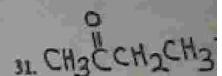
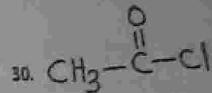
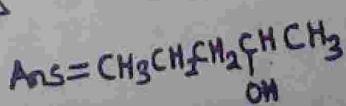
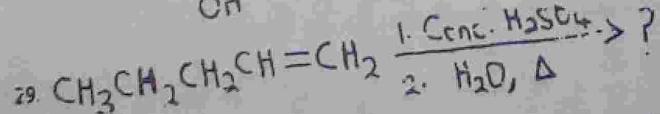
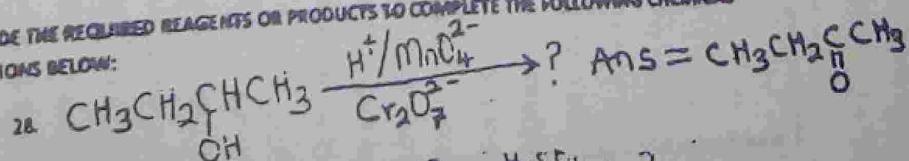
20. Write the equation of reaction for the commercial production acetylene from methane



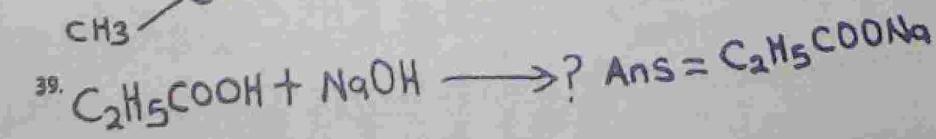
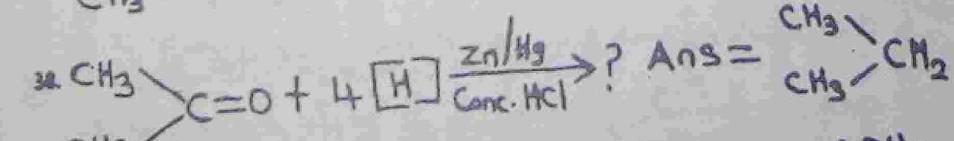
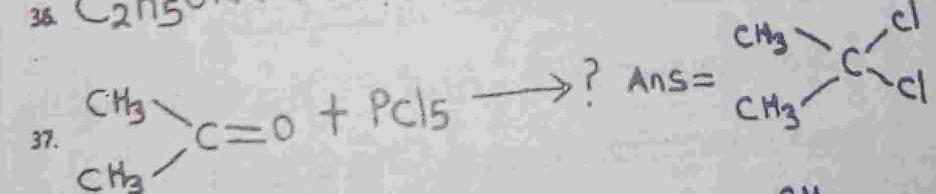
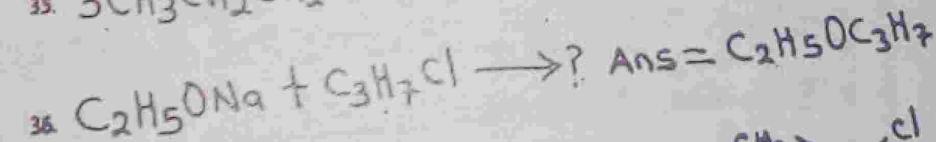
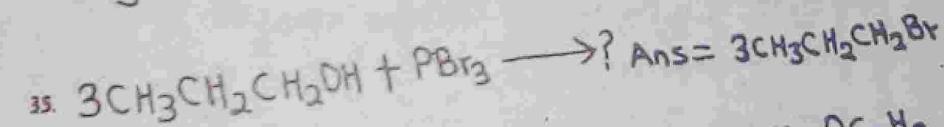
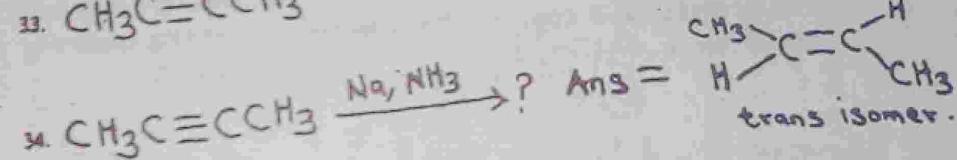
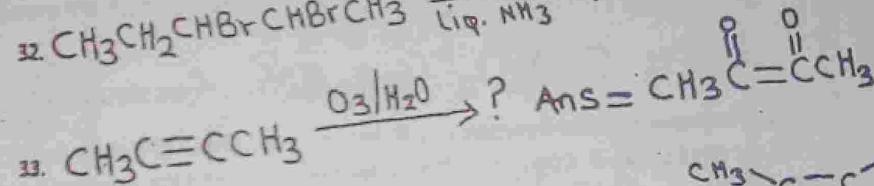
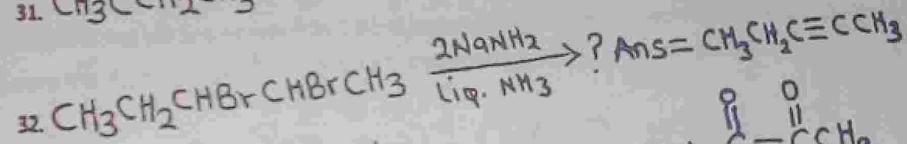
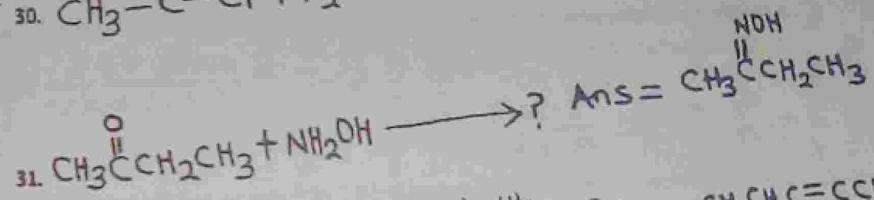
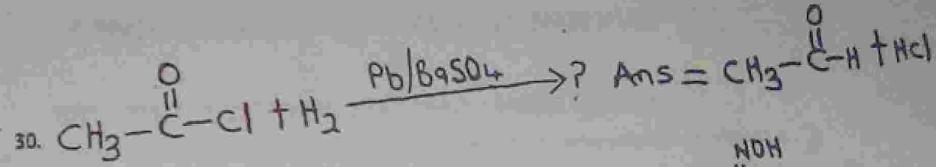
DRAW THE STRUCTURES OF EACH OF THE ORGANIC COMPOUNDS IN QUESTION 21 TO 27.

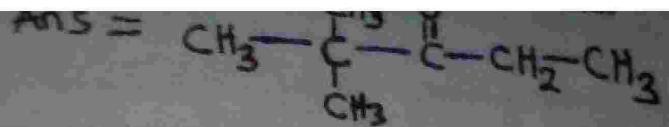


PROVIDE THE REQUIRED REAGENTS OR PRODUCTS TO COMPLETE THE FOLLOWING CHEMICAL REACTIONS BELOW:

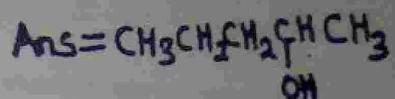
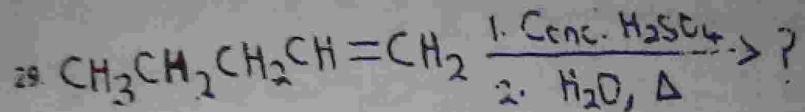
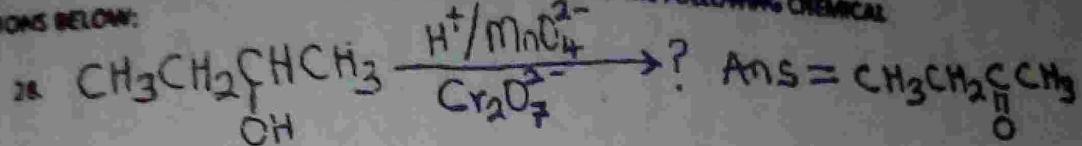


up of
at orbitals.

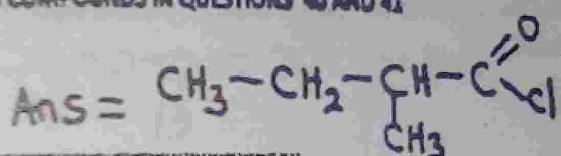




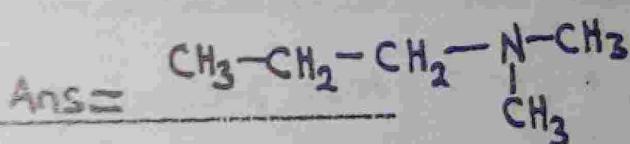
PROVIDE THE REQUIRED REAGENTS OR PRODUCTS TO COMPLETE THE FOLLOWING CHEMICAL REACTIONS BELOW:



DRAW THE STRUCTURE OF THE FOLLOWING COMPOUNDS IN QUESTIONS 40 AND 41



40. 2-Methylbutanoyl chloride



41. N,N-Dimethylacetamide

DEPARTMENT

1. Draw the

Ans = CH

2. Give the

Ans = Cl

3. The com

1.91g of

0.532g

42. Arrange the following compounds in their order of increasing boiling point.

(a) pentanoic acid (b) pentanol (c) pentane (d) pentanone Ans = c < d < b < a

43. What product is formed by the acid-catalyzed addition of water to 2-methylpropane.

2-methylPropan-2-ol Ans = 2-methylPropan-2-ol

Ans =

4. Pent-1-

5. Tetrane

NB

6. POCl_3 , ca

A

7. How mu

8. Give the

64. An unknown compound decolorizes bromine water and on reaction with ozone it gave propanal and benz-2-one. What is the structure of the unknown compound? Ans = $\text{CH}_3-\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}=\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{CH}_3$

45. Name the compound in question 44. Ans = 2,3-dimethylPent-2-ene.

9. In the ad

CH₃CO

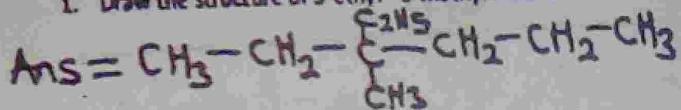
10. What is the

difference

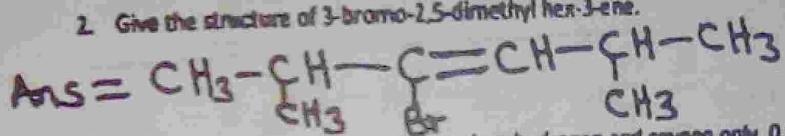
FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

DEPARTMENT OF CHEMISTRY CHM 102 TEST 2015/2016 SESSION

1. Draw the structure of 3-ethyl -3-methyl hexane.



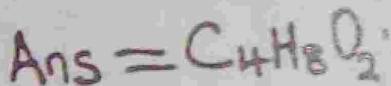
2. Give the structure of 3-bromo-2,5-dimethyl hex-3-ene.



3. The compound diisane contains carbon hydrogen and oxygen only. 0.956g on analysis gave 1.91g of CO_2 and 0.782g of H_2O . In another analysis, 6.04×10^{-3} mol of the compound weighed 0.532g. calculate its molecular formula.

$$\text{Mole} = \frac{\text{mass}}{\text{molar mass}}$$

$$\therefore \text{Molar mass} = \frac{\text{mass}}{\text{mole}} = \frac{0.532}{6.04 \times 10^{-3}}$$



4. Pent-1-one and pent-2-one are examples of

5. Treatment of pentan-1-ol with potassium chlorate in CH_3Cl , is expected to give



NB:- PCC is a mild oxidizing agent.

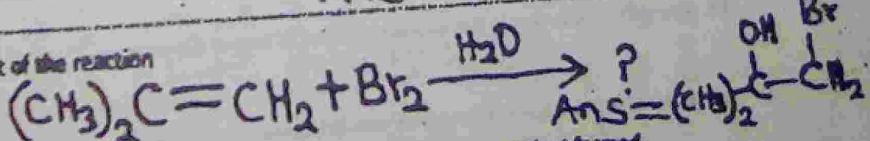
6. POCl_3 can be used in the presence of a base to convert alcohols to



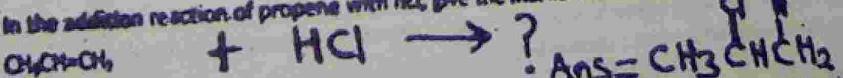
7. How many isomers has this compound C_4H_8 ?

Ans = 5 isomers.

8. Give the product of the reaction



9. In the addition reaction of propane with HCl , give the Markownikoff product formed



10. Why is the boiling point of a branched chain alkanes lower than that of a straight chained alkanes.

Ans = Branched Compounds have lower surface area and lower intermolecular force than the straight chain alkane.

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI, DEPARTMENT OF
CHEMISTRY
RAIN SEMESTER EXAMINATION 2015/2016 SESSION

CHM 102 EXAM : GENERAL CHEMISTRY 2 TIME : 2HR

1. A sample of methane weighing 9.67mg produced 26.53mg of CO₂ and 21.56mg of H₂O. Calculate the % composition of carbon.

$$\text{Ans} = \% \text{C} = \frac{\text{mass of C}}{\text{Total mass}} \times 100$$

$$\% \text{C} = \frac{7.243}{9.636} \times 100 = 75.17\%$$

2. An organic compound contains 38.7% carbon and 9.75% hydrogen and the rest is oxygen, what is its molecular formula if its molecular weight is 62.078. Empirical formula = CH₄O

$$\text{Ans} = \text{C}_2\text{H}_6\text{O}_2 \text{ (molecular formula)}$$

3. 0.956g of an organic compound contains carbon, hydrogen, and oxygen gave on analysis 1.52g of CO₂ and 0.782 of H₂O. If 6.04 × 10⁻³ mol of the substance weighs 0.532g, calculate its molecular formula.

$$[\text{C}_2\text{H}_4]_n = \text{Molar mass}$$

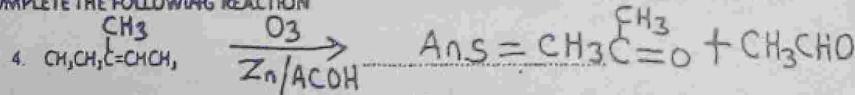
$$\text{Ans} = \text{C}_4\text{H}_8\text{O}_2$$

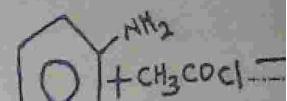
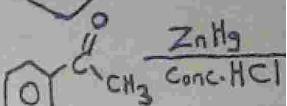
$$\text{Molar mass} = \frac{\text{mass/mole}}{6.04 \times 10^{-3}} = \frac{0.532}{6.04 \times 10^{-3}}$$

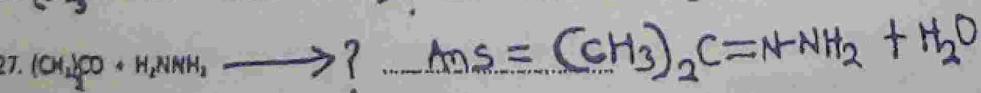
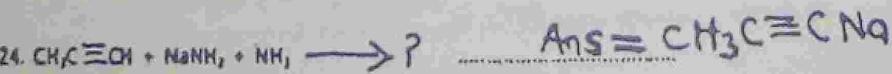
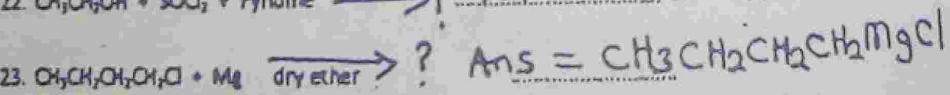
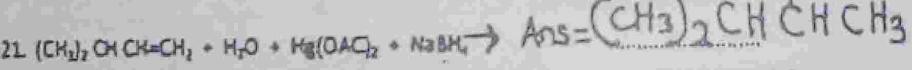
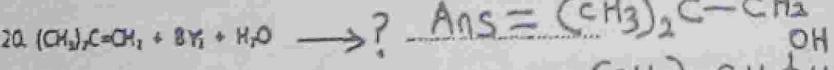
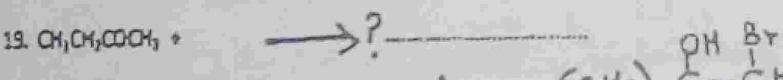
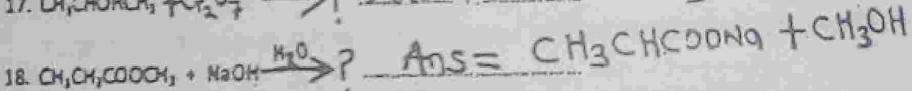
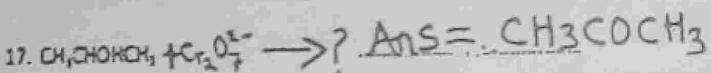
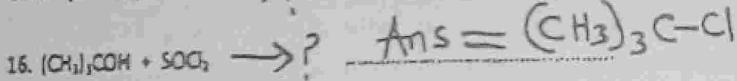
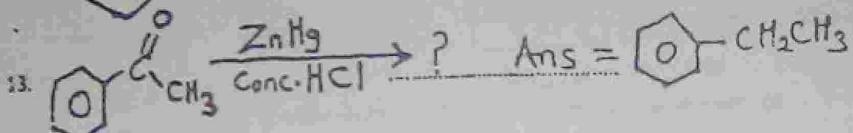
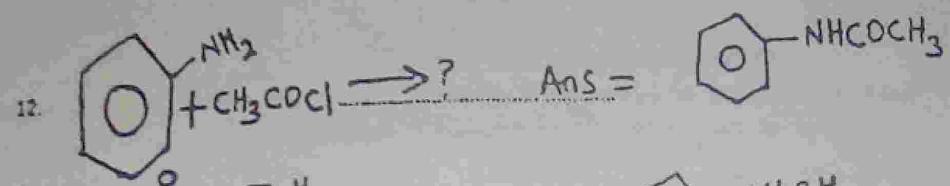
$$\text{Molar mass} = 88$$

$$\text{Molar mass} = 88$$

COMPLETE THE FOLLOWING REACTION



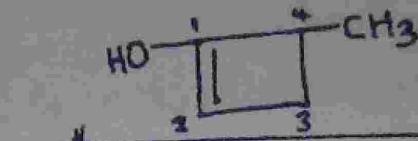
12. 
13. 
14. $\text{CH}_3\text{CH}_2\text{CHO} + \text{Br}_2 \xrightarrow{\text{NaOH}} ?$
15. $\text{CH}_3\text{CH}_2\text{CH}_2 + \text{HI} \rightarrow ?$
16. $(\text{CH}_3)_2\text{COH} + \text{SOCl}_2 \rightarrow ?$
17. $\text{CH}_3\text{CH}_2\text{OK} + \text{Cr}_2\text{O}_7^{2-} \rightarrow ?$
18. $\text{CH}_3\text{CH}_2\text{COOCH}_3 + \text{NaOH} \xrightarrow{\text{H}_2\text{O}} ?$
19. $\text{CH}_3\text{CH}_2\text{COOCH}_3 + ? \rightarrow ?$
20. $(\text{CH}_3)_2\text{C}=\text{CH}_2 + \text{Br}_2 + \text{H}_2\text{O} \rightarrow ?$
21. $(\text{CH}_3)_2\text{OH} \text{ CH}=\text{CH}_2 + \text{H}_2\text{O} + \text{Hg(OA)}_2 \rightarrow ?$
22. $\text{CH}_3\text{CH}_2\text{OH} + \text{SOCl}_2 + \text{Pyridine} \rightarrow ?$
23. $\text{CH}_3\text{CH}_2\text{OH} + \text{Mg} \xrightarrow{\text{dry ether}} ?$
24. $\text{CH}_3\text{C}\equiv\text{CH} + \text{NaNH}_3 + \text{NH}_3 \rightarrow ?$
25. $3\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH} + \text{PBr}_3 \rightarrow ?$
26. $(\text{CH}_3)_2\text{CBr} + \text{CrF}_5 + \text{Alcohol} \rightarrow ?$
27. $(\text{CH}_3)_2\text{CO} + \text{H}_2\text{NNH}_2 \rightarrow ?$
- Give the structural diagram of these com
28. Non-3-yne $\rightarrow \text{Ans} :$



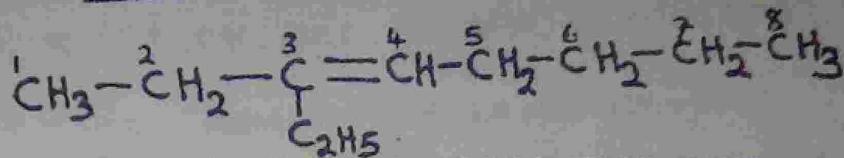
Give the structural diagram of these compounds:

$\text{CH}_3-\text{CH}_2-\text{CH}_3$

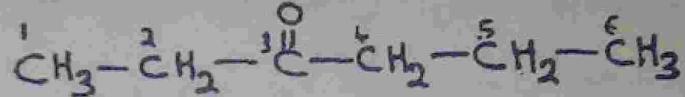
29. 4-methyl-cyclobut-enol



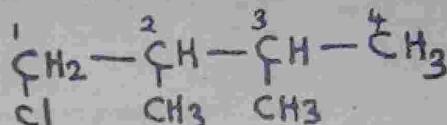
30. 3-ethyl-oct-3-ene



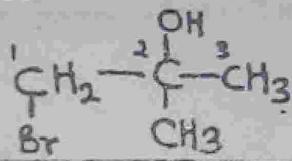
31. Hexan-3-one



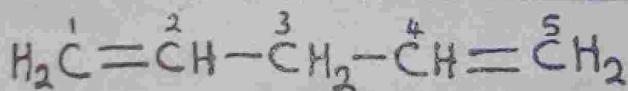
32. 1-chloro-2,3-dimethyl butane



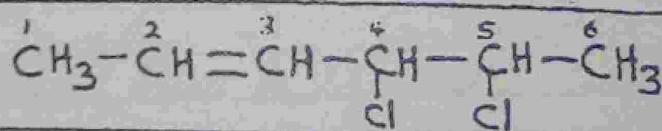
33. 1-bromo-2-methylpropan-2-ol



34. Penta-1,4-diene



35. 4,5-dichloro hex-2-ene



36. How many structural isomers are there in $C_6H_{12}O$

5.

37. Arrange the following in the decreasing order of ease of dehydration. 2° , 1° , 3° , alcohols

$3^\circ > 2^\circ > 1^\circ$

38. In the addition reaction of propene with HCl, name the markownikov product formed

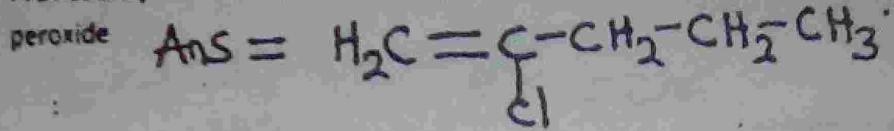
Ans = 2-Chloropropane. $CH_3CHClCH_3$

39. Arrange the following isomeric alkanes in order of decreasing boiling points : pentane, 2,2-dimethyl propane and 2-methyl butane

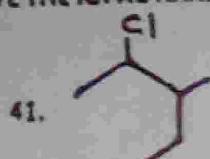
Ans = Pentane > 2-methylbutane > 2,2-dimethyl Propane.

NB:- The more the branches, the lower the boiling point.

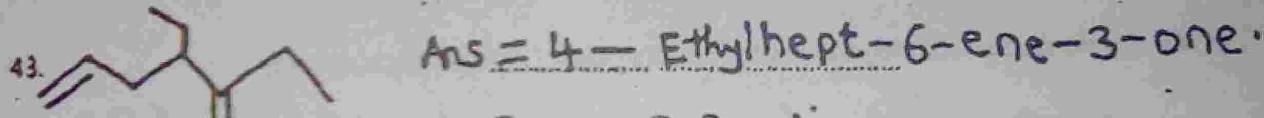
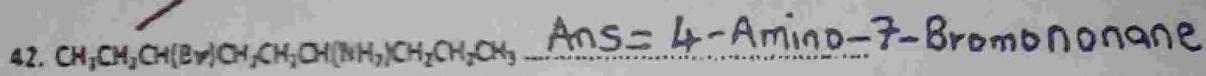
40. Predict the product of the reaction of pent-1-yne and excess HCl in the presence of hydrogen peroxide



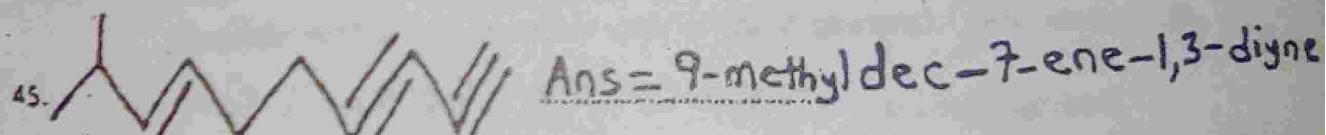
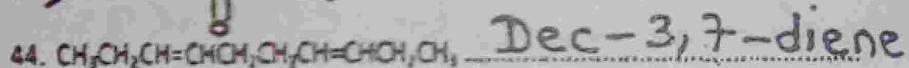
GIVE THE IUPAC NAMES OF THE FOLLOWING ORGANIC STRUCTURES



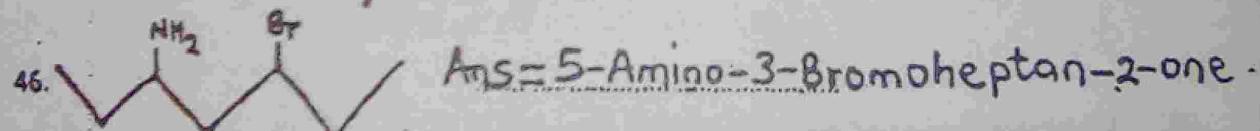
Ans = 2-chloro-3-methyl Pentane



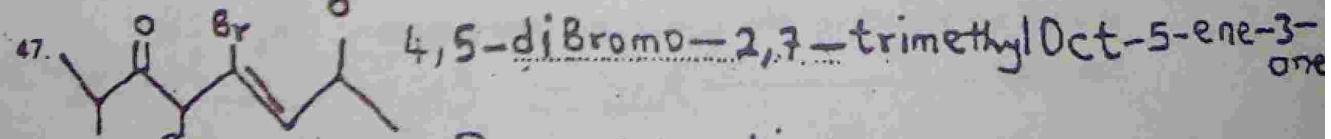
Ans = 4-Ethylhept-6-ene-3-one



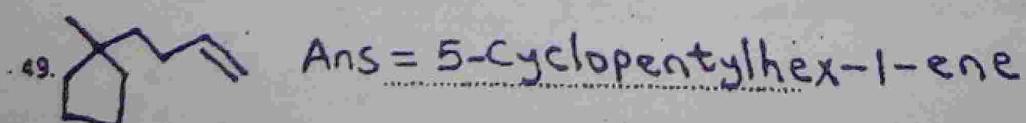
Ans = 9-methyldec-7-ene-1,3-dyne



Ans = 5-Amino-3-Bromoheptan-2-one



4,5-dibromo-2,7-trimethylOct-5-ene-3-one



Ans = 5-Cyclopentylhex-1-ene



OR
3-Bromo hexanol

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI

SCHOOL OF SCIENCE

2008/2009 RAIN SEMESTER PRE-DEGREE EXAMINATIONS
CHM 002: BASIC CHEMISTRY II TIME: 1/4 HOURS

2008/2009

INSTRUCTION: ANSWER ALL QUESTIONS

- 1) Find the molecular formula of a compound with molecular weight of 60 containing 40.0% carbon and 6.7% hydrogen. (a) CH_2O (b) CH_3CHO (c) $\text{C}_2\text{H}_4\text{O}_2$ (d) CHO (e) None
- 2) How many sigma bonds are contained in CH_3OCH_3 ? (a) 8 (b) 10 (c) 6 (d) 7 (e) 4
- 3) A gaseous compound of carbon and hydrogen contains 80% carbon by weight. If one dm³ of the compound at s.t.p weighs 1.35g, calculate the molecular formula. [C = 12, 1] = 1, molar vol. at s.t.p = 22.4dm³] (d)
- 4) The first hydrocarbon to exhibit structural isomerism is? (a) Methane (b) Ethane (c) Propane (d) Butane (e) None
- 5) How many isomers are possible with the compound Hexane? (a) 5 (b) 6 (c) 4 (d) 8 (e) 3
- 6) Geometrically isomerism is common in compounds containing —— bonds?
- a) Single (b) Double (c) Triple (d) Covalent bonds (e) Ionic
- 7) Structures that are mirror images of one another are called...?
- a) Asymmetric (b) Chiral (c) Enantiomers (d) Racemic (e) None
- 8) One method of separating racemic mixture is by...?
- a) Reconciliation (b) racemification (c) resolution (d) resourcification (e) None
- 9) The region in which an electron is most probably to be found and is clearly and closely related to the well defined orbit of the Bohr theory is called?
- a) Hybridization (b) orbital (c) dumb bell (d) quantum number (e) None
- 10) SP³ hybridization is also called? (a) Diagonal hybridization (b) Trigonal hybridization (c) Octahedral hybridization (d) tetragonal hybridization (e) none
- 11) The bond angle in diagonal hybridization is? (a) 109.5° (b) 180° (c) 120° (d) 200° (e) none
- 12) How many sigma bonds are found in ethyl? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5
- 13) Cyclohexane and the higher cycloalkanes can relieve bond strain by?
- a) Isomerization (b) Puckering (c) Polarisation (d) thermal cracking (e) none
- 14) The main product obtained when —— points of unsaturation is called?
- (a) Ozonide (b) Ozonolysis (c) Hydrolysis (d) Oxidation (e) none
- 15) In the hydration of alkynes using water in the presence of mercury salt, movement of both electrons and atoms are involved. This is called? (a) Warpping (b) Isotopy (c) Tautomerism (d) Isomerism
- 16) Ethanol with 40% concentration is called?
- (a) Rectified alcohol (b) Spirit (c) Absolute alcohol (d) bad liquor (e) none
- 17) What type of nuclear reaction is given by the equation? $^{27}\text{Al} + \frac{1}{2}\alpha = ^{30}\text{Si} + \frac{1}{2}\text{H}$
- (a) y, n (b) p, y (c) α , p (d) n, α (e) none
- [18] Which one of the following reagents does propanone undergo a different type of reaction to ethanol? (a) HCN (b) NaHSO_3 (c) NH_3 (d) NH_3NH_2 (e) NH_3OH
- (19) Which one of the following compounds does not give triiodomethane (iodoform) test?
- (a) CH_3CHO (b) $\text{CH}_3\text{CH}_2\text{OH}$ (c) $\text{CCl}_3\text{COCH}_3$ (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OHCH}_3$ (e) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{OH}$
- 20) A certain compound is a viscous high boiling point liquid, miscible with water. The compound is most likely to be (a) $\text{CH}_3\text{CH}_2\text{OH}$ (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (c) $\text{CH}_3\text{CHOHCH}_3$ (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (e) $\text{CH}_3\text{ONCHOHCH}_2\text{OH}$
- 21) Bromoethane is best hydrolysed to ethanol by refluxing it with? (a) Water (b) aqueous sulphuric acid (c) alcoholic potassium hydroxide (d) Aqueous potassium hydroxide (e) Silver (I) oxide in moist ethoxyethane
- Which one of the following reagents does not undergo a reaction with ethene? (a) Acidified potassium manganate v. hydrogen cyanide (c) aqueous ammonia (d) Bromine in tetrachloromethane (e) hydrogen chloride (23) In which of the following properties will cis-hex-3-ene not differ from trans hex-3-ene? (a) Boiling point (b) melting point (c) dipole moment (d) Product of hydrogenation (e) infra-red spectrum (24) Which one of the molecules of the following compounds possesses a dipole moment?
- (a) CH_4 (b) CHCl_3 (c) CCl_4 (d) CH_3CH_3 (e) $\text{CH}_3\text{CH}_2\text{CH}_3$
- (25) Mesomeric effects are only operative in molecules which

- (1) are saturated (b) are unsaturated (c) are highly polar (d) contain oxygen (e) contain electron donating group
- (26) Which one of the following best describes the type of species formed as a result of heterolytic fission? (a) Atoms (b) free radicals (c) electrophiles and nucleophiles (d) acids (e) bases
- (27) Ethoxyethane (b.p.35°C) is more volatile than ethanol (b.p.78°C) largely because of? (a) The greater relative molecular mass of the ether (b) the strength of C—O bonds in the ether (c) the highly polar —OEt group in ethanol (d) the different shapes of the molecules (e) intramolecular hydrogen bonding between the ether molecules
- (28) Which one of the following does not represent alkanes? (a) C₆H₁₄ (b) C₁₃H₂₈ (c) C₁₈H₃₆ (d) C₁₉H₄₀
- (29) Which one of the following alkanes does not contain a secondary carbon atom? (a) CH₃CH₂CH₃ (b) (CH₃)₂CHCH₂CH₃ (c) (CH₃)₂CHCH₂CH(CH₃)₂ (d) (CH₃)₂CCH₂CH₃ (e) (CH₃)₂CCN(CH₃)₂
- (30) Which of the following alcohols forms a ketone when oxidized? (a) 1 - propanol (b) ethanol (c) 2 - methyl - 2 - propanol (d) 2 - propanol
- (31) Which of the following substances is an ether? (a) CH₃CH₃ (b) CH₃CHO (c) CH₃CH₂OCH₂CH₃ (d) CH₃COP(=O)CH₃
- (32) What is the expected product formed from the reaction between 2 - butene and Cl₂? (a) 1 - Chlorobutane (b) 2 - Chlorobutane (c) 2,3 - dichlorobutane (d) 2,2 - dichlorobutane
- (33) Given an organic compound with molecular formula C₅H₈. What is the percentage of C and H? (a) 88.16%C; 13.23%H (b) 80.21%C; 11.86%H (c) 88.16%C; 11.84%H (d) 86.54%C; 13.24H
- (34) The order of boiling point values of the alkyl halides is? (a) I > Br > Cl > F (b) F > Cl > Br > I (c) I > Br > Cl > F (d) I < Br < Cl < F
- (35) What are the products of the following reaction CH₃COCH₃ + PCl₅ → ? (a) CH₃Cl₃CH₃; PCl₅ (b) CH₃COCl₅; PCl₅ (c) CH₃CCl₂CH₃; POCl₃ (d) PCOCH₃; CH₃Cl₃
- (36) (?) + KOH → RCO₂K + (?) → (a) ROOR; OH (b) ROH; KOH (c) RCOOR; ROH (d) RCO₂R; ROH
- (37) C₂H₄ + (?) → CH₃CH₂OH (a) OH₂ (b) Cl₂; OH (c) COII (d) OH
- (38) What is the catalyst used for this reaction: C₆H₆ + Cl₂; COCl → C₆H₅COCl + HCl (a) Nickel (b) Aluminium Chloride (c) Copper (d) Silver
- (39) Supply the missing organic substance in the reaction: CH₃COOCH₃ → CH₃CH₂NHCOC₂H₅ (a) CH₃CH₂NH₂ (b) CH₃NH₃ (c) CH₃CH₂NHOH (d) CH₃CH₂CONH₂
- (40) A compound contains 52.13%C; 13.15%H; 35.15%O. The empirical formula will be? (a) C₂H₄O (b) C₂H₅O (c) C₃H₈O (d) C₄H₈O
- (41) What is the product of the reaction 2CH₃CH₂I + 2Na → ? (a) CH₃CH₂ (b) CH₃CH₃ (c) CH₃(CH₂)₂CH₃ (d) CH₃CH₂CH₃
- (42) CH₃NH₂ + HNO₂ → ? + N₂ + H₂O (a) CH₃NH₃ (b) CH₃OF (c) CH₃NCH₂ (d) CH₃CH₂N₂
- (43) Given that the rate constant for a 2nd order reaction is 2.80×10^{-3} L.mol⁻¹min⁻¹, if the initial concentration is 1.00m. Calculate the half life (a) 6.8×10^{-1} min (b) 68 min (c) 35.7 min (d) 24 min
- (44) For the reaction N₂ + 3H₂ → 2NH₃, if the concentration of [N₂] = 1.0M, [H₂] = 0.51M, and [NH₃] = 0.095M. Calculate the equilibrium constant (a) 6.6×10^1 (b) 6.8×10^2 (c) 6.92×10^1 (d) 6.77×10^1

Complete the following nuclear equations

- (45) $^{238}_{92}U \rightarrow ? + {}_2^4He$ (a) $^{234}_{90}Th$ (b) $^{235}_{92}Th$ (c) $^{234}_{90}Th$ (d) $^{233}_{90}Th$ Ans = C
- (46) $^{212}_{84}Po \rightarrow {}_{82}^{208}Pb + ?$ (a) ${}_{-1}^0e$ (b) ${}_{-2}^4He$ (c) ${}_{-1}^1H$ (d) ${}_{-1}^0e$
- (47) ${}_{-1}^0e + {}_{-1}^0e \rightarrow ?$ (a) ${}_{-1}^0e$ (b) ${}_{-1}^1N$ (c) ${}_{-1}^1H$ (d) ${}_{-2}^0Y$
- (48) ${}^{228}_{88}Ra \rightarrow {}^{228}_{88}Ac + Z$ (a) ${}_{-1}^0e$ (b) ${}_{-2}^4He$ (d) ${}_{-1}^0e$

- (49) Calculate the empirical formula of the compound represented with "Y" containing carbon, hydrogen, and oxygen which was subjected to combustion analysis; given that 0.1g of the compound on combustion gave 0.228g of carbon dioxide and 0.0931g of water. (a) C₂H₄O (b) C₂H₄O (c) C₂H₆O (d) C₂H₆
- (50) Determine the reaction rate in a reaction between acidified hydrogen peroxide and potassium iodide to form iodine if the concentration of iodine rises from 0 to 10^{-3} mole dm⁻³ in 10 seconds. (a) 10^{-3} mol dm⁻³ sec⁻¹ (b) 10^{-4} mol dm⁻³ sec⁻¹ (c) 10^{-1} mol dm⁻³ sec⁻¹ (d) 10^{-6} mol dm⁻³ sec⁻¹ (e) none

PAPER OPTION 2

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF SCIENCE, PRE-DEGREE UNIT

2013/2014 RAIN SEMESTER EXAMINATION TIME ALLOWED: 2HOURS

CHM 002: BASIC CHEMISTRY II

DATE: 27/08/2014

ATTEMPT ALL QUESTIONS

2013/2014

Exam

01. What is the product of treatment of methane with excess molecules of chlorine? (a) Cl_1Cl (b) Cl_2 , Cl_2 (c) CCl_4 (d) CH_3Cl_2 02. The product of the reaction between propyne and sodamins is one of the following: (a) $\text{CH}_3\text{CH}_2\text{CH}_3$, (b) $\text{CH}_3\text{C}\equiv\text{CNa}$ (c) $\text{CH}_3\text{C}\equiv\text{CH}$ (d) $\text{CH}_3\text{CH}_2\text{OH}$.03. Heating n-heptane with platinum in the presence of alumina at 600°C and 10-12 atm pressure will give one of the following products

(a) Benzene (b) Toluene (c) Aniline (d) Propyne

04. What conditions are best for the dehalohydrogenation of vicinal dihal alkanes. (a) Zinc in acetic acid (b) Zinc in Acetone (c) Zinc in Alcohol (d) Zinc in Toluene

05. Give the product of peroxide catalyzed bromination of pent-1-ene. (a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$, (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ (c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$ (d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$ 06. Which of the following is not an electrophile? (a) $\text{CH}_2=\text{CH}_2$ (b) CH_3^+ (c) AlCl_3 (d) $\text{CH}_3'\text{CH}_2\text{CH}_3$ Ans = A07. Which of the following contains an acid hydrogen? (a) $\text{C}_2\text{H}_5\text{C}\equiv\text{CH}$ (b) $\text{C}_2\text{H}_5\text{CH}=\text{CH}_2$ (c) C_2H_5 , CH_2CH_3 (d) $\text{C}_2\text{H}_5\text{CH}_3$ 08. Give the product of the reaction between Ethanol and Acetic acid. (a) $\text{CH}_3\text{CH}_2\text{OH}$ (b) CH_3COOH (c) $\text{CH}_3\text{COOC}_2\text{H}_5$ (d) CH_3OCH_3 09. Which of the following is a good nucleophile? (a) NH_3 (b) HBr (c) Br_2 (d) BH_3

10. Which of the following have the highest boiling point? (a) Formaldehyde (b) Ethanol (c) Ether (d) Propane

11. What is the product of the reaction between Ethanoic acid and phosphorus pentachloride (a) CH_3COOCl (b) PCl_5 (c) COCl (d) $\text{CH}_3\text{COOC}_2\text{H}_5$

12. Which of the following will react most readily with water

(a) Ketone (b) Acetyl chloride (c) Acetic anhydride (d) Ethyl acetate Ans = C

Complete the following reaction

13. + KOH $\xrightarrow{\text{H}_2\text{O}}$ $\text{C}_4\text{H}_8 + \text{H}_2\text{O}$: (a) C_4H_8 (b) $\text{C}_4\text{H}_8\text{O}$ (c) C_3H_8 (d) C_4H_6 14. $\text{C}_2\text{H}_5\text{Cl} + \text{C}_2\text{H}_5\text{ONa} \rightarrow$ (a) Ether (b) Alcohol (c) Ester (d) Organic Acid15. $\text{RNH}_2 + (\text{RCO})_2\text{O} \rightarrow$ (a) Amine (b) Amino (c) Amide (d) ammonia16. $\text{C}_3\text{H}_8\text{O} + \text{KCN} \rightarrow$ (a) $\text{C}_3\text{H}_8\text{CN}$ (b) $\text{C}_2\text{H}_5\text{CN}$ (c) $\text{C}_3\text{H}_8\text{CN}$ (d) $\text{C}_3\text{H}_8\text{C}_2\text{N}$ 17. $\text{C}_4\text{H}_{10} \xrightarrow{\text{KMnO}_4}$ (a) Monohydric alcohol (b) Dihydric alcohol (c) Trihydric alcohol (d) Polyhydric alcohol18. $\text{C}_3\text{H}_7\text{Br} \xrightarrow{\text{Mg/ether}}$ (a) C_3H_7 (b) $\text{C}_3\text{H}_7\text{MgCl}$ (c) $\text{C}_3\text{H}_7\text{mgBr}$ (d) $\text{C}_3\text{H}_7\text{Mg}$

Mg

19. $\text{C}_3\text{H}_8\text{O} + \text{HCl} \rightarrow$

(a) Propane chloride (b) Propyl chloride (c) Propene chloride (d) Propyne chloride

20. $\text{C}_2\text{H}_6\text{O} + \text{C}_2\text{H}_4 \rightarrow$

(a) Ether (b) Ester (Acid) (d) Alcohol

21. $\text{R}_3\text{COH} + \text{SOCl}_2 \rightarrow$ (Product is what term of carbon)

(a) Primary (b) Secondary (c) Tertiary (d) None of the above Ans = Tertiary = C

22. $\text{C}_2\text{H}_5\text{I} + \text{HI} \rightarrow$ (a) $\text{CH}_2\text{ICH}_2\text{CH}_3$ (b) $\text{CH}_2\text{CHIICH}_3$,(c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$ (d) $\text{CH}_3\text{ClICH}_3$ 23. How many σ -bonds are in $\text{C}_3\text{H}_5\text{COOH}$? (a) 2 (b) 5 (c) 7 (d) 924. How many π -bonds are in $\text{CH}_3\text{C}\equiv\text{C}-\text{CH}=\text{CH}-\text{C}\equiv\text{C}$? (a) 4 (b) 5 (c) 8 (d) 1025. What is the length of $\text{C}=\text{C}$ bond in Ethene. (a) 1.66\AA (b) 1.33\AA (c) 1.77\AA (d) 1.88\AA

26. How many delocalized electrons are present in naphthalene? (a) 2 (b) 4 (c) 5 (d) 10

27. Estimate the number of asymmetric carbons that are found in the amino acid, serine

(a) zero (b) two (c) one (d) two

28. Geometric isomerism is common in compounds containing bond. (a) Single (b) double (c) triple (d) none

29. The technique of evolution

30. Determination of hydrogen content

(a) CH_2O

31. The structure

(a) butanone

32. How many

 $\text{CH}_3\text{CH}_2\text{O}$

(a) 1 minute

33. In order

(a) Grignard

34. How many

35. Determination

reaction: C

36. What is t

37. Which

(a) Lactic

38. In one

What is c

B

39. Which

(a) Planar

40. How

(a) 2 (b)

41. What is

(a) 90°

42. n-B

(a) Stere

43. Wh

(a) Pro

44. in

(a) De

45. W

(a) C

46. T

(a) A

47. (a)

48. (a)

49. for

50. (a)

(a)

2013/2014

EXAM(b) CH_2 CH_2CH_3

are will

acetic acid

(b)

Ans=A

 C_2H_5

COOH

(d)

 H_3

Acid

 H_3

29. The technique used to separate racemic mixture is called (a) Resolution (b) resolution (c) evolution (d) restoration
30. Determine the molecular formula of a compound with molecular mass of 60 and whose carbon and hydrogen contents are 40.0% and 6.7% respectively.
(a) CH_4O (b) CH_3OH (c) $\text{C}_2\text{H}_4\text{O}_2$ (d) CH_3OCH_3
31. The storage problem of ethyne is solved by using to store it.
(a) butanone (b) propanone (c) ethanol (d) methanol
32. How many minutes does the reaction below take to accomplish?
 $\text{CH}_3\text{CH}_2(\text{OH})\text{CH}_3 + \text{Conc HCl} \xrightarrow{\text{ZnCl}_2} \text{CH}_3\text{CH}_2\text{CH}(\text{Cl})\text{CH}_3 + \text{H}_2\text{O}$
(a) 1 minute (b) 3 minutes (c) 5 minutes (d) 10 minutes
33. In order to do silver mirror test, what reagent should be used?
(a) Grignard reagent (b) Fehlings reagent (c) Jones reagent (d) Tollens reagent
34. How many π -bonds are in ethane? (a) 6 (b) 7 (c) 1 (d) none
35. Determine the stoichiometric coefficient of oxygen in the balanced combustion reaction: $\text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$. (a) 2 (b) 8 (c) 13 (d) 10
36. What type of geometry has ethane? (a) Tetragonal (b) Hexagonal (c) Trigonal (d) Octagonal
37. Which of the following compounds will not be able to rotate plane polarized light?
(a) Lactic acid (b) carboxylic acid (c) valine (d) alanine
38. In one of the methods of producing carboxylic acid, crushed dry ice is used at one stage.
What is crushed dry ice? (a) ice block (b) particles of cold water ice block (c) solid carbon dioxide (d) None
39. Which of the following represents the arrangement of the sp^3 hybrid orbitals in methane?
(a) Planar (b) tetrahedral planar (c) Tetrahedral (d) bipyramidal
40. How many electrons are actually involved in the carbon - carbon bond of acetylene?
(a) 2 (b) 3 (c) 4 (d) 6
41. Which of the following best represent the hydrogen - carbon - hydrogen bond angles in methane?
(a) 90° (b) 109.5° (c) 120° (d) 180°
42. n-Butane and isobutane are best described as
(a) Stereoisomers (b) anomers (c) diastereomers (d) constitutional isomers
43. Which of the following choices represents the product of ozonolysis of 3 - Hexyne?
(a) Propanone (b) prepanal (c) Hexanoic acid (d) propanoic acid
44. The process by which an alkyne can be directly converted into an alkane is called:
(a) Dehydrohalogenation (b) dehydration (c) hydrolysis (d) hydrogenation
45. Which of the following is the most reactive by substitution mechanism?
(a) CH_3I (b) CH_3F (c) CH_3Cl (d) all are equally reactive
46. The conjugate base of chlorides are generally called?
(a) Alkyl ions (b) alcoholic ions (c) alkoxide ions (d) vinyl ions
47. Choose the correct product formed as a result of the reduction of a ketone
(a) primary alcohol (b) a secondary alcohol (c) tertiary alcohol (d) none of the above
48. Which of the following has the highest boiling point?
(a) Pentanoic acid (b) pentanol (c) pentane (d) pentanone
49. Formaldehyde can be converted to formic acid. What is the correct hybridization of the carbon in formic acid? (a) SP (b) SP^3 (c) SP^3d (d) SP^2
50. Which of the following compounds has the highest pKa value?
(a) $\text{FCH}_2\text{CH}_2\text{COOH}$ (b) $\text{F}_2\text{CHCH}_2\text{COOH}$ (c) $\text{FCH}_2\text{CH}_2(\text{CH}_3)\text{CH}_2\text{COOH}$ (d) FCH_2COO

Attempt all the questions and give the solutions on the provided computer sheet

1. The reaction $\text{RCOCl} + 2\text{NH}_3 \rightarrow \text{RCONH}_2 + \text{NH}_4\text{Cl}$, is an example of? (a) acylation (b) acetylation
 (c) ammonolysis (d) acetyl-amidation
2. Decarboxylation of sodium ethanoate in the presence of an alkali gives (a) methanol (b) methane
 (c) ethanol (d) ethane
3. $(X) + \text{KOH} \rightarrow \text{RCO}_2\text{K} + (Y)$; What is X and Y? (a) $\text{RCOR}'\text{OH}$ (b) ROH (c) $\text{RCOOR}'\text{OH}$ (d) $\text{RCO}_2\text{R}'\text{OH}$
4. The products of the following reaction; $\text{CH}_3\text{CHO} + \text{NH}_3 \rightarrow (?)$
 (a) $\text{CH}_3\text{NH}_2 + \text{NH}_3$ (b) $\text{CH}_3\text{NH}_2 + \text{CH}_3\text{O}$ (c) $\text{CH}_3\text{CHNH}_2 + \text{H}_2\text{O}$ (d) $\text{CH}_3\text{CH}(\text{OH})\text{NH}_2$
5. The loss of a halide atom to generate an alkene is known as? (a) A dehydrohalogenation (b) A dehydration
 (c) A reduction (d) An oxidation
6. Alkenes are prepared from alkanes and substituted alkanes by (a) Addition reactions (b) Substitution reactions
 (c) Elimination reactions (d) Free radical reactions
7. The geometry of the carbon atoms in an alkyne are? (a) Linear. (b) Bent. (c) trigonal plane. (d) Tetrahedral
8. Which pairing of alcohol and class is incorrect? (a) Butan-2-ol; secondary alcohol (b) Propan-1-ol; primary alcohol
 (c) 2-Methylpropan-2-ol; tertiary alcohol (d) Pentan-3-ol; tertiary alcohol
9. $(?) + \text{KOH} \rightarrow \text{CH}_3\text{CH}=\text{CH}_2 + \text{KBr} + \text{H}_2\text{O}$. This reaction would be completed by using (a) $\text{C}_1\text{H}_9\text{Br}$ (b) $\text{C}_4\text{H}_9\text{Br}$
 (c) $\text{C}_5\text{H}_11\text{Br}$ (d) $\text{C}_5\text{H}_11\text{Br}$
10. $\text{C}_2\text{H}_5\text{OH} + \text{H}_2 \rightarrow (?)$ (a) $\text{C}_2\text{H}_5\text{O} + \text{H}_2$ (b) $\text{C}_2\text{H}_5 + \text{H}_2\text{O}$ (c) $\text{C}_2\text{H}_{10}\text{O}$ (d) $\text{C}_2\text{H}_5 + \text{C}_2\text{H}_5\text{O}$
11. What is the IUPAC name for $\text{HCOOCH}_2\text{CH}_2\text{CH}_3$? (a) Butanal (b) Butanoic acid (c) Methylpropanoate
 (d) Propyl methanoate
12. How many molecules of water are required to hydrolysed RCONH_2 to an acid and amine? (a) one (b) two (c) three (d) four
13. The following reaction, $\text{C}_3\text{H}_8 + \text{H}_2 \rightarrow \text{C}_5\text{H}_{10}$, is called? (a) substitution (b) elimination (c) addition (d) polymerization
14. Which of the following will decolorize KMnO_4 ? (a) ethene (b) ethyne (c) ethanol (d) propene
15. Benzene is a polymer of which of the following? (a) ethane (b) ethyne (c) propene (d) propyne
16. Only one benzene ring is present in compounds of (a) aryl (b) acryl (c) carboxylic (d) ketone
17. For complex molecules, a chemist usually represents a molecule by (a) molecular formula (b) skeletal formula
 (c) structural formula (d) b and c
18. Aromatic compounds are known as (a) benzenes (b) arenes (c) cyclic alkenes (d) alkenes
19. $\text{CH}_3\text{COOC}_2\text{H}_5$ is structural formula for (a) ethyl ethanoate (b) propane (c) ethanoic acid (d) methylamine
20. Breakdown of any molecule with water (H_2O) is (a) addition reaction (b) elimination reaction
 (c) substitution reaction (d) hydrolysis
21. Carbonyl group in aldehyde is (a) $\text{C}=\text{O}$ (b) $\text{C}-\text{O}$ (c) CO (d) CHO
22. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$ is formula for (a) methanol (b) propanal (c) butanol (d) pentanal
23. Ketones react with reducing agent to make (a) primary alcohols (b) secondary alcohol (c) tertiary alcohol (d) all of them
24. Reducing agent used for reduction of aldehydes and ketone is (a) tetrafluororate (b) tetrahydridoborate
 (c) tetrafluoroborane (d) tetrachloride
25. A compound of empirical formula CH_2 has a molecular weight of 56g. What is the molecular formula?
 (a) C_3H_6 (b) C_4H_8 (c) C_2H_4 (d) C_3H_{12}
26. The reaction $\text{CS}_2 + 3\text{Cl}_2 \rightarrow \text{CCl}_4 + \text{S}_2\text{Cl}_2$ is catalysed by (a) Pd (b) Ni (c) CuO (d) AlCl_3
27. The order of boiling point values of the alkyl halides is? (a) $\text{I} > \text{Br} > \text{F} > \text{Cl}$ (b) $\text{F} > \text{Cl} > \text{Br} > \text{I}$ (c) $\text{I} > \text{Br} > \text{Cl} > \text{F}$ (d) $\text{Br} > \text{Cl} > \text{I} > \text{F}$
28. The following are all monobasic except (a) ethanoic acid (b) ethanol (c) ethanedioic acid (d) trioxonitrate (V) acid
29. Which of the following compounds will form a white precipitate with aqueous solution of AgNO_3 ? (a) but-2-ene
 (b) but-1-yne (c) but-2-yne (d) butane

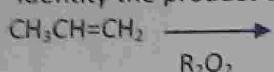
30. Substances which are basis of human life on earth are (a) atom (b) molecules (c) matter (d) organic compounds
31. Due to presence of double bonds, alkenes are (a) saturated (b) polar (c) unsaturated (d) non-polar
32. Alkane molecules are not attacked by electrophiles or nucleophiles because they are
 (a) polar (b) unstable (c) volatile (d) non-polar
33. Carbon atom which is further attached to four different atoms is called (a) nucleus centre (b) neutral centre
 (c) chiral centre (d) all of them
34. Wide range of different hydrocarbons are separated by (a) fractional decomposition (b) fractional distillation
 (c) fractional filtration (d) fractional polarization
35. Oxidation of primary alcohols give (a) aldehydes (b) ketones (c) both A and B (d) alcohols
36. Reduction reactions of carbonyl compounds is known to be (a) Nucleophilic addition (b) Nucleophilic substitution
 (c) addition reaction (d) elimination reaction
37. Almond essence in cakes and pudding is made from (a) ester (b) alcohol (c) benzaldehyde (d) ketone
38. Which compound can exist as stereoisomers? (a) $\text{CH}_3\text{CH}_2\text{CHO}$ (b) $\text{CH}_3\text{CH}_2\text{COCH}_3$ (c) $\text{CH}_3\text{CH}(\text{CH}_3)_2$
 (d) $\text{CH}_3\text{CH}_2\text{CHOHCH}_3$
39. When a molecule of water is removed from two molecules of organic acids, the compound formed is? (a) Primary alcohol
 (b) Secondary alcohol (c) Tertiary alcohol (d) acid anhydride
40. The compound $\text{CH}_3\text{CH}_2\text{COOH}$ was produced by oxidation. State the starting substance.
 (a) 2-methylpropanol (b) butan-2-ol (c) propan-1-ol (d) propan-2-ol
41. The chlorination of an alkene is? (a) an S_N1 reaction (b) an S_N2 reaction (c) Free radical reaction (d) reduction reaction
42. When phosphorus pentachloride reacts with simple carbonyls, the compounds formed?
 (a) $\text{R}_2\text{CCl}_3 + \text{PCl}_3$ (b) $\text{RCCl}_2 + \text{PCl}_2 + \text{Cl}$ (c) $\text{R}_2\text{CCl}_2 + \text{POCl}_3$ (d) $\text{R}_2\text{CCl}_2 + \text{PCl}_3 + \text{O}_2$
43. Monocarboxylic acids act upon phosphorus trichloride to form?
 (a) RCOCl and POCl_3 (b) 3RCOCl and H_3PO_3 (c) RCOOH and POCl_3 (d) RCOOH , H_3PO_3 and 2Cl_2
44. Which of the following reactions is not an example of addition reaction? (a) Combustion of propane
 (b) Reaction of Cl_2 with propene (c) Polymerization of ethene (d) Reaction of HBr with but-2-ene.
45. The carbon atoms in an alkyne are? (a) sp^1 hybridized (b) sp^3 hybridized (c) sp^2 hybridized (d) sp hybridized.
46. Which of the following is a tertiary alkyl halide, halogenoalkane? (a) 2-Chloro-2-methylpropane (b) 2-Chloropropane
 (c) 1-Chloropropane (d) 1-Chloro-2-methylpropane
47. What is the expected product of the reaction of butanal with NaBH_4 ? (a) Butanoic acid (b) Butan-2-ol (c) Butan-1-ol
 (d) Butanone
48. Complete the following reaction: $\text{CH}_3\text{COCH}_3 + 3\text{Cl}_2 \rightarrow (?)$
 (a) $\text{CHClCOCH}_3 + 1\text{HCl}$ (b) $\text{CCl}_2\text{COCH}_3 + 3\text{HCl}$ (c) $\text{CCl}_3\text{COCH}_3 + 3\text{HCl}$ (d) $3\text{CCl}_3\text{COCH}_3 + \text{HCl}$
49. The reaction of a Grignard reagent RMgX with a ketone, $\text{R}'_2\text{CO}$, followed by treatment with H_3O^+ , would give which of the following products? (a) A secondary alcohol (b) A mixture of secondary and tertiary alcohols (c) A primary alcohol
 (d) A tertiary alcohol
50. What is the IUPAC name for $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{CH}(\text{CH}_3)_2$? (a) 1,3-dimethyl pentane (b) 1,1,3,3-tetramethyl butane
 (c) 2,4,4-trimethylpentane (d) 2,2,4-trimethylpentane

Federal University of Technology Owerri, Department of Chemistry
Rain Semester test 2017/2018 Session

CHM 102: General Chemistry 22 Time: 1 Hr

Instruction: Answer all question in the spaces provided. Do your calculation at the back of the sheet
Name Reg. No. Dept.

1. Identify the product of this reaction



2. 0.203g of a gave on combustion 0.361g of CO_2 and 0.147 of H_2O . Calculate the molecular formula. If the relative molecular mass is 148
3. 0.956g of an organic compound contains carbon, hydrogen and oxygen gave on analysis 1.92g of CO_2 and 0.782g of H_2O . If 6.04×10^{-3} mol of the substance weighs 0.532g, calculate its molecular formula
4. Give the structure of 4-ethyl-3-methylcyclohexene
5. Why does propanol boil at higher temperature than the corresponding hydrocarbons.....

6. Markownikoff's rule states that

7. Terminal alkynes are alkynes.....

8. Tautomerism is defined as

9. Ozonolysis is defined as.....

10. Catenation is defined as.....

SOLUTION TO 2017/2018 CHM102 TEST

1. This will follow the "Anti-Markovnikoff's rule since peroxide (R_2O_2) is present



2. Mass of compound given = 0.203g
 Mass of C = $\frac{12 \times 0.361}{44} = 0.0985\text{g}$ of C

$$\text{Mass of H} = \frac{2 \times 0.147}{18} = 0.0163\text{g}$$
 of C

$$\text{Mass of C} + \text{mass of H} = 0.0985 + 0.0163 = 0.1148\text{g}$$

Since C+H is not up to the mass of the compound given, it means that will come in.

$$\begin{aligned}\text{Mass of Oxygen} &= \text{Mass of compound} - (\text{C} + \text{H}) \\ &= 0.203 - (0.0985 + 0.0163) \\ &= 0.0882\text{g of Oxygen.}\end{aligned}$$

C	H	O
0.0985	0.0163	0.0882
12	1	16
0.0082	0.0163	0.0055
0.0055	0.0055	0.0055
1.49	2.96	1

Multiply through by 2.

$$\begin{aligned}(1.49 \times 2) & (2.96 \times 2) & (1 \times 2) \\ 2.98 & 5.9 & 2 \\ 3 & 6 & 2\end{aligned}$$

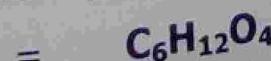
Empirical formula = $C_3H_6O_2$

$$[C_3H_6O_2] n = 148$$

$$n = \frac{148}{C_3H_6O_2} = \frac{148}{12(3)+1(6)+16(2)}$$

$$n = \frac{148}{74} = 2$$

Molecular formula = $[C_3H_6O_2] 2$



3. Mass of compound given = 0.203g

$$\text{Mass of C} = \frac{12 \times 1.92}{44} =$$

$$\text{Mass of H} = \frac{2 \times 0.782}{18} =$$

$$\text{Then C} + \text{H} = 0.524 =$$

$$= 0.611\text{g}$$

Since 0.611 is less than the molar mass of the compound given, oxygen will

Mass of Oxygen present = 0.345g

= 0.345g of oxygen

C	H
0.524	0.087
12	1
0.044	0.087
0.022	0.022
2	3.95
2	4

Empirical formula = $C_3H_6O_2$

[Empirical formula] n = Molar mass

Here molar mass is not given

Mole is given and mass is given

From mole = 148

❖ Molar mass = 148

$$= \frac{0.532}{6.04 \times 10^{-3}} = 88\text{g}$$

$$[C_2H_4O] n = 88$$

SOLUTION TO 2017/2018 CHM102 TEST

e "Anti-Markovnikoff's
is present

CH_3
iven = 0.203g
0.0985g of C

0.0163g of C

.0985 +

mass of the
that will come in.

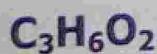
compound - (C + H)

0.0163)

Oxygen.

O			
0.0882			
16			
0.0055			
0.0055			
1			

x 2)



$6 \times 12 + 6 \times 1 + 2 \times 16$

2

O_2] 2

C_{12}O_4

3. Mass of compound given = 0.956g

$$\text{Mass of C} = \frac{12 \times 1.92}{44} = 0.524\text{g}$$

$$\text{Mass of H} = \frac{2 \times 0.782}{18} = 0.085\text{g}$$

$$\begin{aligned} \text{Then C + H} &= 0.524 + 0.087 \\ &= 0.611\text{g} \end{aligned}$$

Since 0.611 is less than the mass of the compound given, oxygen will come in.

$$\begin{aligned} \text{Mass of Oxygen present} &= 0.956 - 0.611 \\ &= 0.345\text{g of oxygen} \end{aligned}$$

C	H	O
0.524	0.087	0.345
12	1	16
0.044	0.087	0.022
0.022	0.022	0.022
2	3.95	1
2	4	1

Empirical formula = $\text{C}_2\text{H}_4\text{O}$.

[Empirical formula] n = Molecular mass

Here molar mass is not given.

Mole is given and mass is given

$$\text{From mole} = \frac{\text{mass}}{\text{Molar mass}}$$

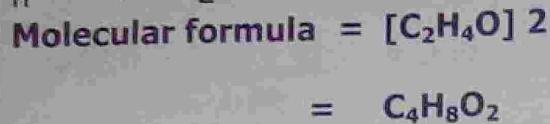
$$\diamond \text{ Molar mass} = \frac{\text{mass}}{\text{Mole}}$$

$$= \frac{0.532}{6.04 \times 10^{-3}} = 88\text{g/mol}$$

$$[\text{C}_2\text{H}_4\text{O}] n = 88$$

$$n = \frac{88}{C_2H_4O} = \frac{88}{12(2) + 1(4) + 16} = \frac{88}{44}$$

$$n = 2$$



4. 4 - Ethy-3- methyl cyclohexene



5. Propanol boils at higher temperature than the corresponding hydrocarbons due to its ability to undergo **hydrogen bonding** (presence hydroxy group in it)

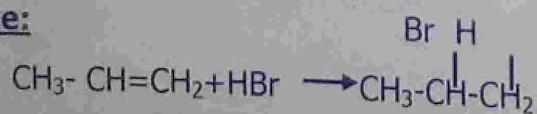
6. **Markovnikoff's rule** states that "in the addition of HX to an unsymmetric alkene, the hydrogen atom (H) bonds to the less substituted carbon atom while the halogen (X) bonds to the more substituted carbon atom".

Or

In the addition HX to an unsymmetric alkene, it goes to the carbon that has more it atoms while X goes to the carbon that has less it atoms.

Where X is a halogen.

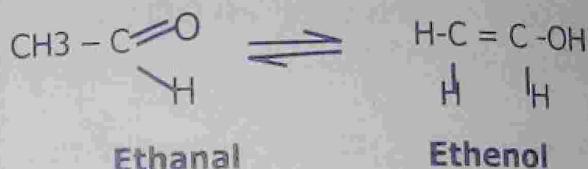
Example:



7. **Terminal alkynes** are alkynes whose triple bond is located at position one along the carbon chain.

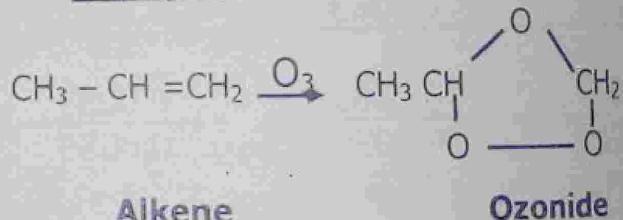
8. **Tautomerism** is defined as the type of isomerism in which the isomers are in dynamic equilibrium with each other as a result of the movement of the pi electrons within the molecule.

Example:



9. **Ozonolysis** is an oxidation reaction in which ozone reacts with an alkene or alkyne to produce an ozonide as the intermediate product.

Example:



10. **Catenation** is defined as the ability of carbon atom to bond covalently with other carbon atoms to form a long carbon chain

Example:



- FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI, DEPARTMENT OF CHEMISTRY
CHM102 GENERAL CHEMISTRY 11 2017/2018 SESSION TIME ALLOWED 1HR 30MINUTES TYPE 5
INSTRUCTION ANSWERS ALL QUESTIONS. DO NOT DETACH THE QUESTION PAPER FROM THE OMR SHEET**
- How many pi and sigma orbitals are in the compound $\text{H}_2\text{O}=\text{C}=\text{CH}_2$ (A) 6 sigma and 2 pi (B) 4 sigma and 4 pi
(c) 8 sigma and 4 pi (d) 5 sigma and 4 pi
 - Which of the following has the shortest carbon -carbon bond length (A) $\text{CH}_2=\text{CH}_2$ (B) CH_3CH_2 (c) $\text{CH} \equiv \text{CH}$
D) C_4H_{10}
 - Which of the following decolorize bromine water in carbon tetra chloride (A) 1, 2-dimethyl cyclopropane
(B) cyclopropane (C) 1,2-dimethyl cyclobutane (D) cyclohexane
 - Which of the following compounds do not have cis-trans isomerism (A) $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$
(B) $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$ (C) $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$ (D) $\text{CH}_3\text{CH}=\text{CHCH}_3$
 - Which of the following is not an electrophile (A) $\text{H}_2\text{O}=\text{CH}_2$ (B) H^+ (C) $\text{CH}_3\text{CH}+\text{CH}_3$ (D) AlCl_3
 - What product are obtained from oxidation of 2-hexene with warm KMnO_4 (A) acetate and butanone (B)
acetaldehyde and butanone (C) acetaldehyde and butanal (D) Acetate and butanoate
 - What orbitals is used for the formation of C-H bond in ethane (A) $\text{C}(\text{sp})\text{H}(\text{s})$ (B) $\text{C}(\text{sp}^2)\text{H}(\text{s})$ (C) $\text{C}(\text{sp}^3)\text{H}(\text{s})$
(D) $\text{C}(\text{sp}^2)\text{H}(\text{p})$
 - What is the product of peroxide catalyzed hydroboration of 1methyl cyclohexene
(A) 4-bromo-1-methylcyclohexane (B) 2-bromo-1-methylcyclohexane (c) 1-bromo-1-cyclohexane
(d) 5-bromo-1-methylcyclohexane
 - Which atomic orbital overlaps to form carbon -carbon triple bond (A) $s+s; sp+sp; p+p$ (B) $sp^2+sp^2; sp+sp; p+p$
(C) $Sp+Sp; p+p; p+p$ (D) $Sp+Sp; Sp+SP; P+P$
 - Which of the following is most acidic (A) 1-butyne (B) 2-butyne (C) 1-butene (d) 2-butene
 - Which of the following will react with sodamine (A) cyclodecyne (b) 2-pentyne (C) 2-butyne (D) 1-hexyne
 - Predict the product of the of 1-pentyne With excess Br_2 (A) 1,1-dibromo-1-pentene (B) 1,2-dibromo 1-pentene
(C) 1,1,2,2-tetrabromopentane (D) 2,2-dibromo -1-pentene
 - A compound has a molecular formula C_4H_6 . When treated with excess hydrogen and a catalyst gave a compound C_4H_{10} when treated with ammonical silver nitrate a precipitate was formed. the compound is
(A)1,3-butadiene(b) 2-butyne c) 1-bulyne (d) but-2-ene
 - Which reagent is a good nucleophile A) NH_3 B) HBr C) Br_2 D) BH_3
 - Compound A $\text{C}_4\text{H}_8\text{Cl}_2$ undergoes hydrolysis with aqueous KOH to give compound B. Compound B undergoes iodoform reaction to an oxime but does not react with tollens reagent. What is compound B (A) 2-2-dichlorobutane (B) hexanone(C) 2-butanone (D) 3 pentanone
 - Which of these has the highest boiling point (A) $\text{CH}_3\text{CH}_2\text{COOH}$ (B) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ (C) $\text{CH}_3(\text{CH}_2)_2\text{COOH}$
(D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

17. All of the following will react with acid chloride to yield substituted amides EXCEPT (A) CH_3NH_2 , (B) $\text{CH}_3(\text{CH}_2)_5\text{NH}_2$ (C) $\text{CH}_3\text{N}(\text{CH}_3)\text{CH}_3$ (D) $\text{CH}_3\text{CH}_2\text{NHCH}_3$
18. The following will release nitrogen on reaction with nitrous oxide except (A) Ethylamine (B) Diethylamine (C) methylamine (D) propylamine
19. Many amines in the liquid state have odours resembling that of (A) onion (B) garlic (C) rotten fish (D) fruits
20. The boiling points of amines are lower than those of alcohols of similar molecular mass because (A) amines do not contain oxygen atoms (B) amines cannot hydrogen bond to each other's (C) N-H hydrogen bonds are weaker than O-H hydrogen bonds (D) amines do not contain hydrogen
21. The process of converting one ester to another is called (A) Esterification (B) Transesterification (C) Saponification (D) hydrolysis
22. Give the name of the alcohol that will react with methyl propanoate to yield butyl propanoate in the presence of HCl (A) n-butanol (B) n-propanol (C) methanol (D) n-pentanol
23. A reversible process has the forward reaction as esterification, the backward reaction is (A) saponification (B) transesterification (C) decomposition (D) hydrolysis
24. These emit pale fumes of HCl when exposed to air due to reacting with moisture (A) carboxylic acid (B) acid chlorides (C) acid anhydrides (D) amides
25. Acid anhydrides have higher boiling points than the acids due to (A) their large sizes (B) covalent bonds (C) hydrogen bonds (D) their small sizes
26. Which of these is a secondary amine? (A) $\text{CH}_3\text{CH}_2\text{N}(\text{CH}_3\text{CH}_2)\text{CH}_3\text{CH}_2$ (B) $\text{CH}_3\text{CH}_3\text{NHCH}_3\text{CH}_2$ (C) $\text{CH}_3\text{CH}_2\text{NH}_2$ (D) $\text{CH}_2\text{CH}_2\text{N}(\text{CH}_3)_2$
27. These homologues are identified by reaction with sodium bicarbonate, NaHCO_3 (A) amides (B) amines (C) carboxylic acid (D) nitriles
28. What type of orbital's are involved in C-O bonds in alcohols (A) $\text{C}(\text{SP}_2), \text{O}(\text{SP}_2)$ (B) $\text{C}(\text{SP}), \text{O}(\text{SP}_2)$ (C) $\text{C}(\text{SP}_2), \text{O}(\text{SP})$ (D) $\text{C}(\text{SP}_3), \text{O}(\text{SP}_3)$
29. Which of the following oxidation does one need to use pyridinium chlorochromate
A) Methanol to formic acid (B) Ethanol to acetic acid (C) ethanol to acetaldehyde (D) acetaldehyde to acetic acid
30. Which of the following constitutes lucas reagent (A) NaCl , HCl , CuCl_2 (B) HCl , ZnCl_2 (C) HCl , SnCl_2 (D) HCl
31. Which of the following has highest boiling point (A) CH_3OCH_3 (B) $\text{CH}_3\text{CH}_2\text{OH}$ (C) CH_3CHCH_3 (D) $\text{CH}_2=\text{CHCH}_3$
32. Which of the following has lowest solubility in water (A) pentanol (B) methanol (C) butanol (D) ethanol
33. Suppose you want to synthesize 3-phenyl-3-pentanol from an acid derivative, which acid derivative would you use (A) phenyl acetic acid anhydride (B) benzoic acid (C) phenyl acetic acid chloride (D) methyl benzoate

34. Which product is catalytic hydrogenation of 2,2-dimethyl-4-pentenal (A) 2,2-dimethyl pentanal (B) 2,2-dimethyl -3-pentanol (C) 2,2-dimethyl-4-pentanol (D) none of the above
35. Which compound can be reduced easily with sodium borohydride (A) amides (B) esters (C) aldehydes and ketones (D) alkenes
36. Which of the following is a good method for preparing aldehydes (A) Jones reagent and 1° alcohols (B) Jones reagent and 2° alcohols (C) PCC and 1° alcohols (D) H_2SO_4 and 1° alcohols
37. Which of the following aldehydes used alone will undergo aldol condensation (A) formaldehyde (B) butanal (C) benzaldehyde (D) 2-propanal
38. An unknown compound on ozonolysis gave acetaldehyde and benzophenone. What is the unknown (A) 1,2-diphenyl propane (B) 1,1-diphenyl propene (C) 2-phenyl-2-hexene (D) 1,2-diphenyl hexane
39. What is the function of acid catalyst in the esterification of carboxylic acid (A) protonation of the carbonyl oxygen (B) protonation of the OH group (C) protonation of the carbonyl carbon (D) protonation of the OH oxygen of the carbonyl group
40. Which of the following reagent will not reduce the carboxylic acid to primary alcohol under mild condition (A) BH_3 in ether (B) $NaBH_4$ in ethanol (C) H_2O_2 in water (D) $LiAlH_4$ in ether
41. Which of the following will react with Tollens reagent (A) formic acid (B) acetic acid (C) propanoic acid (D) butanoic acid
42. Which of the following has banana flavor (A) ethyl formate (B) pentyl ethanoate (C) 3-ethyl ethanoate (D) octyl ethanoate
43. The ester with pineapple flavor is (A) ethyl formate (B) pentyl ethanoate (C) 3-methyl ethanoate (D) ethyl butanoate
44. Basic hydrolysis of esters is known as (A) saponification (B) acidification (C) esterification (D) acetylation
45. Which of the following acid derivatives is most stable (A) acid chlorides (B) esters (C) anhydrides (D) amides
46. Which of these is not affected by the lone pair of electron on an amine nitrogen (A) basicity (B) melting point (C) solubility (D) hydrogen bond formation
47. What is the product of the reaction between primary amines and acid chloride (A) an amine (B) an ester (C) an amide (D) secondary amine
48. Which of the following is least soluble in water (A) ethylamine (B) methylamine (C) propylamine (D) cyclohexylamine
49. Which of the following is a reagent in Gabriele amine synthesis (A) acyl or aryl halide (B) hydroxylamine (C) phthalimide (D) sodium azide
50. Which converts methyl bromide to ethylamine (A) $NaCN$, $LiAlH_3 \cdot H_2O$ (B) $NaNO_3$, HCl (C) large excess NH_3 (D) NaN_3 then catalytic hydrogenation

51. The molecular formula of a compound with molecular weight 62.07 and which contains 9.75% H, 38.7% C and 51.53% O is (A) $C_3H_6O_2$ (B) $C_4H_{12}O_4$ (C) $C_6H_{16}O_5$ (D) $C_5H_{14}O_2$
52. When 0.9559 g of an organic compound was burned, 1.919 g of CO_2 and 0.7829 g of water was produced. The empirical formula is (A) $C_3H_6O_2$ (B) $C_4H_8O_2$ (C) C_3H_6O (D) C_2H_4O
53. How many carbon atoms are contained in undecane (A) 10 (B) 11 (C) 12 (D) 13
54. A sample of methane weighing 9.67 mg produced 26.53 mg of CO; and 21.56 mg of H_2O what is the % composition of carbon (A) 68% (B) 74.9% (C) 78% (D) 47.9%
55. Give the schematic name for the compound $CH_3(CH_2)_7CH_3$ (A) iso nonane (B) n- nonane (C) bis nonane (D) t-nonane
56. The structural formula of trichloroacetic acid is (A) CH_2Cl_3COOH (B) CCl_3COOH (C) $CHCl_3COOH$ (D) CCl_2COOH
57. How many structural isomers are in this compound C_4H_8O (A) 6 (B) 7 (C) 8 (D) 9
58. The molecular formula $CHOCl$ is called (A) formyl chloride (B) methyl chloride (C) ethanoyl chloride (D) butanoyl chloride
59. The following are various ways of drawing structural formula of an organic molecule except (A) displayed formula (B) 3D-structural formula (C) skeletal formula (D) semi-structural formula.
60. A reaction in which a carboxylic acid reacts with a base to form a salt and water is called (A) saponification (B) neutralization (C) esterification (D) hydrolysis

SOLUTION TO 2017/2018 CHM102 EXAMINATION



There are 2 pi and 6 sigma orbitals present.

Answer: A

- | | | | | |
|-----------|---|-----|---|--------|
| 2. Alkane | C | C — | → | 1.54A° |
| Alkene | C | C = | → | 1.34A° |
| Alkyne | C | C ≡ | → | 1.20A° |

Shortest carbon to carbon bond length is
Alkyne.

Answer: C

3. Alkenes decolorized bromine water in the presence of CCl_4 .

Also **cyclopropane** and **cyclobutane** reacts with bromine in the presence of CCl_4 .

Answer: B

4. For a compound to have a geometric isomer, the compound must
i. Be an alkene or a cycloalkane
ii. Not have the same two groups attached to the same carbon carrying the double bond.

Like $\text{CH}_2 = \text{CHBr}$

This means that the two carbon atoms carrying the double bond must have different atoms or groups bonded to it.

Example: $\text{CHBr} = \text{CHBr}$

Answer: A

Compound "A" is incorrect.

NB: Another name for geometric isomerism is Cis-trans isomerism.

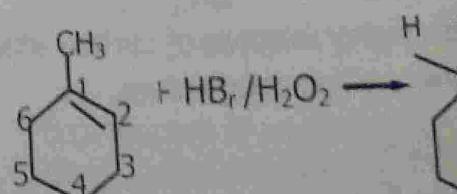
5. **Answer:** A

6. **Answer:** D

7. In C—H, the bond is a single bond. Carbon uses hybridization in single bond and hydrogen remains S.
[NB:- H = 1S¹]

Answer: C

8. **Answer:** B



Anti-Markovnikov

9. **Answer:** C

SP + SP, P + P, P + P

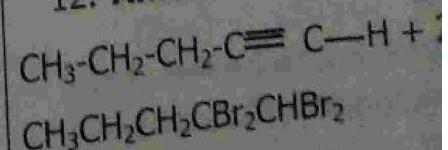
10. Terminal alkynes are acetylide.

Answer: A

11. Terminal alkynes
sodamine

Answer: D

12. **Answer:** C



13. Terminal alkynes
ammonical silver nitrate
precipitate (Silver Mirror)

Answer: C

CHM102 EXAMINATION

NB: Another name for geometric isomerism is Cis-trans isomerism.

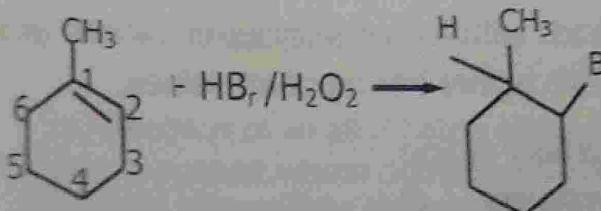
5. Answer: A

6. Answer: D

7. In C-H, the bond is a single bond. Carbon uses SP₃ hybridization in single bonds while hydrogen remains S.
[NB:- H = 1S¹]

Answer: C

8. Answer: B



Anti- Markovnikoff's

9. Answer: C

SP + SP, P + P, P + P

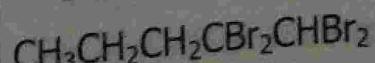
10. Terminal alkynes are acidic

Answer: A

11. Terminal alkynes react with sodamine

Answer: D

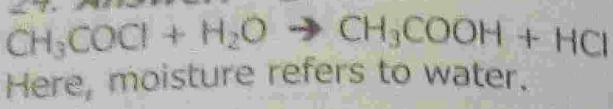
12. Answer: C



13. Terminal alkynes react with ammonical silver nitrate to form a precipitate (Silver Mirror).

Answer: C

24. Answer: **B**



25. Answer: **A**

26. Answer: **B**

27. Answer: **C**

Carboxylic acids react with NaHCO_3 (Sodium bicarbonate) to give out CO_2 gas.

28. C - O

The bond is a single bond in single bonds, $\text{C} = \text{SP}^3$, $\text{O} = \text{SP}^3$ **Answer = D**

(29) **Pyridinium chlorochromate (PCC)** is used as a mild oxidizing agent to convert an alcohol to an aldehyde.

Answer = C

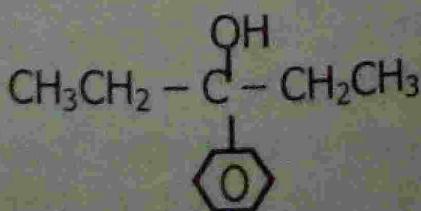
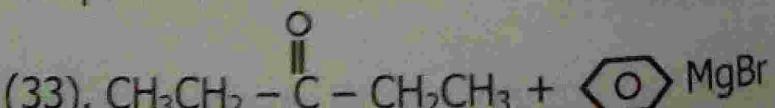
(30) **Answer = B**

ZnCl_2 in HCl

Lucas reagent

(31) **Answer = B**

(32) The higher the number of carbon atoms, the lower the solubility of a compound. **Answer = A**



3 - Phenyl - 3 - pentanol

(34). $\text{H}_2\text{C} = \text{CHCH}_2\text{COOC}_6\text{H}_5$

CH_3Cl

(2, 2)

(35) **Answer = C**

(36) $\text{PCC} + 1^\circ$ Alcohol
Answer = C

(37) **Answer = B**
 $2\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} \rightarrow$

(39) **Answer = A**

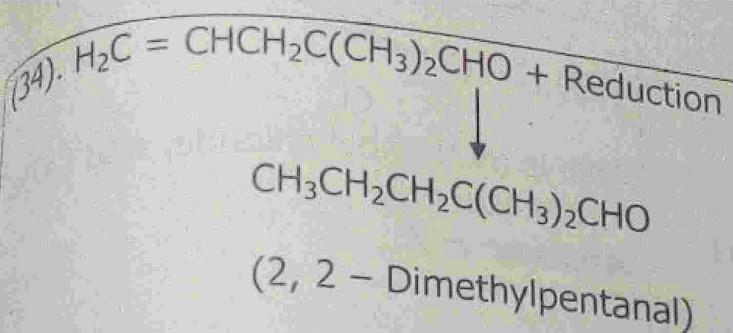
(40) NaBH_4 can reduce carboxylic acid
Answer = B

(41) Tollen's reagent
Tollen's reagent is AgNO_2

(42) **Pentylethane**
both have banana flavor
Answer = B

(43) **Ethylbutan**
Answer = D

(44) Basic hydro saponification
Answer = A



(35) **Answer = C** Aldehydes and ketones

(36) PCC + 1° Alcohol \longrightarrow Aldehyde
Answer = C

(37) **Answer = B**
 $2\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} \rightarrow \text{CH}_3\text{CH}_2\text{CH(OH)CH(C}_2\text{H}_5)$

(39) **Answer = A**

(40) NaBH_4 can reduce aldehydes and ketones but cannot reduce carboxylic acids.

Answer = B

(41) Tollen's reagent is used to detect aldehydes.

Tollen's reagent is $\text{Ag}(\text{NH}_3)_2\text{OH}$

(42) **Pentylethanoate** and **3-methylbutylethanoate** both have banana flavour

Answer = B

(43) **Ethylbutanoate** has pineapple flavour.

Answer = D

(44) Basic hydrolysis of an ester is called **saponification**.

Answer = A

(45) Amides are the most stable carboxylic acids.

Answer = D

(46) Melting point
Answer = D

(47) 1° amines react with acid amides

Answer = C

(48) The more the carbon atoms the solubility.

Answer = D

(49) Gabriel's amine synthesis
phthalimide

Answer = C

50) Reaction of an alkyl halide gives a product whose relative molecular mass is greater than that of the original one.

Answer = A

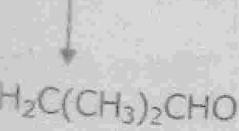
C	H
<u>38.7</u>	9.7
12	1
<u>3.225</u>	9.7
3.222	3.2
1	3

\rightarrow Empirical = CH_3
 $[\text{CH}_3\text{O}]n = 62.07$

$n = \frac{62.07}{\text{CH}_3\text{O}} = \frac{62.07}{12+1} = 5$

Molecular formula =
 $= \text{C}_2\text{H}_6\text{O}_2$. **Answer = C**

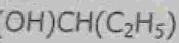
$\text{C}_2\text{H}_5\text{CHO} + \text{Reduction}$



(imethylpentanal)

Aldehydes and ketones

Aldehyde



des and ketones but cannot

detect aldehydes.

methylbutylethanoate

pineapple flavour.

ester is called

(45) Amides are the most stable derivatives of carboxylic acids.

Answer = D

(46) Melting point

Answer = D

(47) 1° amines react with acid chlorides to form amides

Answer = C

(48) The more the carbon atoms, the lower the solubility.

Answer = D

(49) Gabriel's amine synthesis uses

phthalimide

Answer = C

50) Reaction of an alkyl halide with cyanide gives a product whose number of carbon atoms is greater than that of the reactant by one.

Answer = A

(51)	C	H	O
	<u>38.7</u>	<u>9.75</u>	<u>51.55</u>
	12	1	16
	<u>3.225</u>	<u>9.750</u>	<u>3.222</u>
	3.222	3.222	3.222
	1	3	1

→ Empirical = CH_3O

$[\text{CH}_3\text{O}]_n = 62.07$

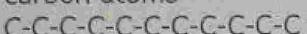
$$n = \frac{62.07}{\text{CH}_3\text{O}} = \frac{62.07}{12+1\times 3+16} = \frac{62.07}{31} = 2$$

Molecular formula = $[\text{CH}_3\text{O}]_n$

= $\text{C}_2\text{H}_6\text{O}_2$. Answer = A

(52) Answer = D

(53) **Undecane** is the hydrocarbon that has eleven (11) carbon atoms

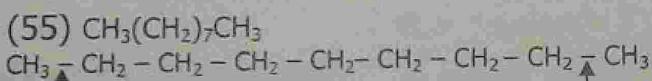


Answer = B

(54) Here, all we need to do is to find the mass of carbon present and then convert the mass to percentage.

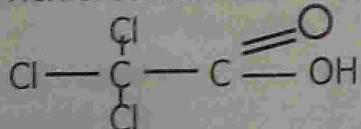
$$\text{Mass of carbon} = \frac{12}{144} \times 26.53 = 7.235$$

$$\% \text{ of C} = \frac{7.235}{144} \times 100 = 74.9\%. \text{ Answer = B}$$



Answer = B

(56) Trichloroacetic acid



Answer = B

(57) (i) $\text{C} - \text{C} - \text{C} - \text{C} - \text{OH}$

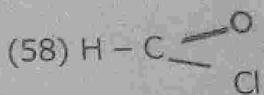
(ii) $\text{C} - \text{C} - \underset{\text{OH}}{\text{C}} - \text{C}$

(iii) $\text{C} - \text{C} - \text{O} - \text{C} - \text{C}$

(iv) $\text{C} - \text{O} - \text{C} - \text{C} - \text{C}$

(v) $\text{C} - \underset{\text{C}}{\text{C}} - \text{C} - \text{OH}$

(vi) $\text{C} - \underset{\text{OH}}{\text{C}} - \text{C}$



This is methanoyl chloride, a formyl chloride

Answer = A

(59) **types of formulae in**

--structural formula

--condensed or semi-s

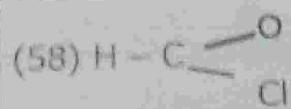
formula

--skeletal or line form

--three dimensional

(60) Acid + Base \longrightarrow I

Answer = B



This is methanoyl chloride, also called formyl chloride

Answer = A

(59) *types of formulae includes*

- structural formula
- condensed or semi-structural formula
- skeletal or line formula
- three dimensional

(60) Acid + Base \longrightarrow Neutralization

Answer = B