

NATIONAL BUSINESS AND TECHNICAL EXAMINATIONS BOARD
(GENERAL EDUCATION EXAMINATION)
CHEMISTRY 005-1 (100 Marks)

QUESTION AND ANSWER.

TIME: 1 HR 40 MINS

(1a) An atom has 14 neutrons in the nucleus and an atomic number of 13.

1. State the composition of the nucleus.
2. Describe the arrangement of the electrons
3. Name the element for which the atom is an isotope and
4. State its valency.

Solutions

1. Nucleus = 13 protons + 14 Neutrons, Atomic mass = 27
2. Electronic configuration = $1s^2 2s^2 2p^6 3s^2 3p^1$
OR K Shell = 2 electrons.

L Shell = 8 Electrons

M Shell = 3 Electrons

(iii) Aluminium (AL).

(iv) Valency = 3

(bi) In what ways are a sodium ion and a neon atom alike?

(iii) How do they differ?

Solutions.

Sodium ion, Na^+ , electronic configuration
 $= 1s^2 2s^2 2p^6$

Neon atom Ne, electronic configuration
 $= 1s^2 2s^2 2p^6$

Sodium ion Na^+ is like with neon atom Ne for each has 10 electrons OR has the same electronic configuration.

1.

- i. Sodium ion Na^+ is a metallic while Neon atom is non metallic.
- ii. sodium ion is very reactive while Neon atom is non-reactive
- iii. sodium ion has atomic mass 23 while Neon atom has atomic mass 20
- iv. They have different number of protons .

(1c) What is the arrangement of electrons in each of the following ions?

(i)

- i. Ca^{2+}
- ii. Fe^{3+}
- iii. Fe^{2+}
- iv. Al^{3+}

Solutions

1. $\text{Ca}^{2+} = 1s^2 2s^2 2p^2 3s^2 3p^6$
2. $\text{Fe}^{3+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
3. $\text{Fe}^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$
4. $\text{Al}^{3+} = 1s^2 2s^2 2p^6$

2a. Define each of the following terms.

1. Electrolysis
2. Electrolytes
3. Electrodes.

Solutions

1. Electrolysis: - is the chemical decomposition of a compound due to the passage of electricity through its solution or molten state.
2. Electrolytes: - are substances in solution or molten state that permit passage of electricity to undergo chemical decomposition.
3. Electrodes: - are solid conducts (metals or semi metal) through which electricity passes into or out of an electrolyte during electrolysis.

(2b) Differentiate between true electrolytes and POTENTIAL electrolytes.

Solution:

1. True Electrolytes are compounds which in solution or molten state will conduct electricity and decompose during the process.
2. Potential Electrolytes are compounds which are not conductors unless they react with another compound- (e.g. polar solvent), before conducting electricity and decomposing.

2(c) Complete the table below showing products obtained in a typical examples of electrolysis (identify A, B, C, D and E).

Electrolyte	Electrode	Product at cathode	Product at anode
Fused NaCl	carbon	Na	Cl ₂
Aq NaCl(conc)	carbon	A	Cl ₂
Aq NaOH	platinum	B	O ₂
Acidified H ₂ O	Platinum	H ₂	C
Aq CuSO ₄	D	Cu	-
Aq CuSO ₄	E	Cu	O ₂
(2c)			
Electrolyte	Electrode	Product at cathode	Product at anode
Fused NaCl	carbon	Na	Cl ₂
Aq NaCl(conc)	carbon	A(H ₂)	Cl ₂
Aq NaOH	platinum	B H ₂	O ₂

Acidified H ₂ O	platinum	H ₂	C(O ₂)
Aq CuSO ₄	D (Cu)	Cu	-
Aq CuSO ₄	E (PHC)	Cu	O ₂

A= H₂, B= H₂, C= O₂ and D = Copper anode

E= platinum/ carbon anode.

(2d) Calculate the mass of Cu deposited when a current of 0.9A is passed through a solution of copper salt for 1 hour 20 minutes.

(Cu= 63.5, 1 faraday = 96, 500c)

Solution:

$$Q = It$$

Where I = 0.9A

$$t = 1 \text{ hr } 20\text{mins} = 80 \text{ mins}$$

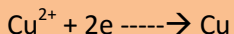
80 mins convert to secs.

$$= 80 \times 60 \text{ sec.}$$

$$= 4, 800 \text{ sec.}$$

$$It = 0.9 \times 4,800$$

$$= 4, 320 \text{ coulombs.}$$



If = 96 500 coulombs

2F will discharge 1 mole of Cu

$$\text{i.e. } 2 \times 96, 500 \text{ coulombs} = 63.5\text{gm}$$

$$4,320 \text{ coulombs} = 63.5 \times \frac{4,320}{2 \times 96,500} \text{ g}$$

$$= 1. 42\text{g.}$$

Explain the terms ENDOTHERMIC reaction and EXOTHERMIC reaction.

Solution:

i. Endothermic reaction is a chemical reaction in which heat is absorbed from the atom sphere or surrounding.

Endothermic reaction is a chemical reaction that required heat from the atmosphere to take place.

ii. Exothermic reaction is a chemical reaction that produces heat to the atmosphere.

(2f) what is the sign of ΔH in each of the reactions in (e) above.

Solution:

i. endothermic, ΔH = + ve

ii. exothermic, ΔH = - ve.

(3a) Define and give an example each of the following:

i. Acid salt

ii. Basicity of an acid

iii. Deliquescent substance

iv. Double salt

V. Efflorescent substances

vi. Hygroscopic substance

Solution:

Acid salt is a compound made up of a metallic cation and non metallic anion which dissolves in water to produce a weak acid E.g. KHSO_4 , $\text{Ca}(\text{HSO}_4)_2$.

ii. The basicity of acid is the number of hydrogen ions, 1 molecule of it can produce in solution, or molten state.

e.g., Basicity of $\text{HNO}_3 = 1$, $\text{H}_2\text{SO}_4 = 2$, $\text{H}_3\text{PO}_4 = 3$, $\text{HCl} = 1$.

iii. Deliquescent substance is that matter which absorbs water moisture, from the atmosphere to form a solution at the end Examples includes

Sodium hydroxide pellets.

Iron (II) Chloride crystals

Calcium chloride (fused)

Magnesium chloride

Phosphorous (v) oxide

(iv) Double salt is that which ionized to produce three different types of ions in solution

E.g. NaNH_4SO_4 , K_2MnO_4

(v) Efflorescent substance is that crystal that form one or more (some) molecules of water of crystallization when exposed to the atmosphere. Examples include.

$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$.

(vi) Hygroscopic substance is the substances which absorbs moisture from the atmosphere but does not dissolve in it Examples includes:

Sodium trioximitrate (v)

Copper (II) oxide

Calcium oxide

conc. H_2SO_4 .

3(b) Certain solution have the following PH values.

Z = 21, Y = 12.9, X = 7.3, W = 13.5, U = 4.8

Choose the solution which is

- i. the most acidic
- ii. the most alkaline
- iii. almost neutral

Solution:

1. Z

2. W

3. X

3C. A Hydrocarbon Y which decolorizes bromine water but has no action on aminonical silver trioxonitrate (V) solution was found to have a molar mass 56g mol^{-1}

1. Deduce the molecular formula of Y

2. Write the structure of the two isomers of Y

Solution:

Y is an alkene

$$\text{C}_n\text{H}_{2n} = 56$$

$$n(\text{CH}_2) = 56$$

$$14n = 56$$

$$n = 4$$

If $n = 4$

$$\therefore \text{C}_n\text{H}_{2n} = \text{C}_4\text{H}_8$$

$$= \text{C}_4\text{H}_8$$

The molecular formula of Y = C_4H_8

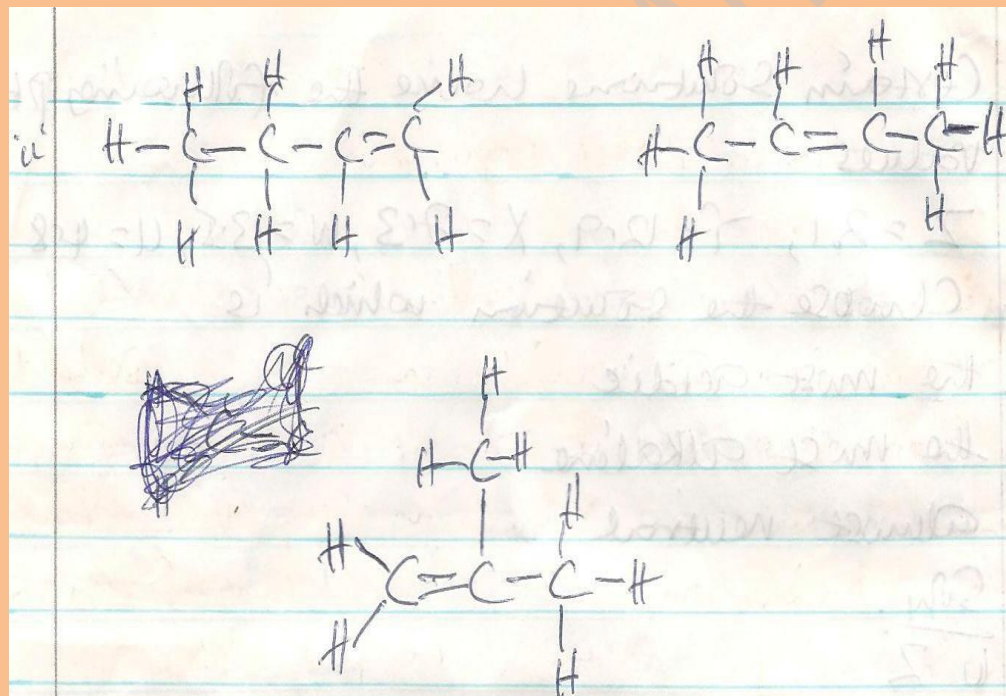


Figure (i)

4a. Describe with the aid of a labeled diagram, how you would determine the melting points of a solid x.

Solution:

Put a small portion of x in a hard test tube

(ii) Hold the test tube with a clamp stand in a beaker of paraffin oil

(iii) Insert a thermometer inside the test tube in the paraffin oil

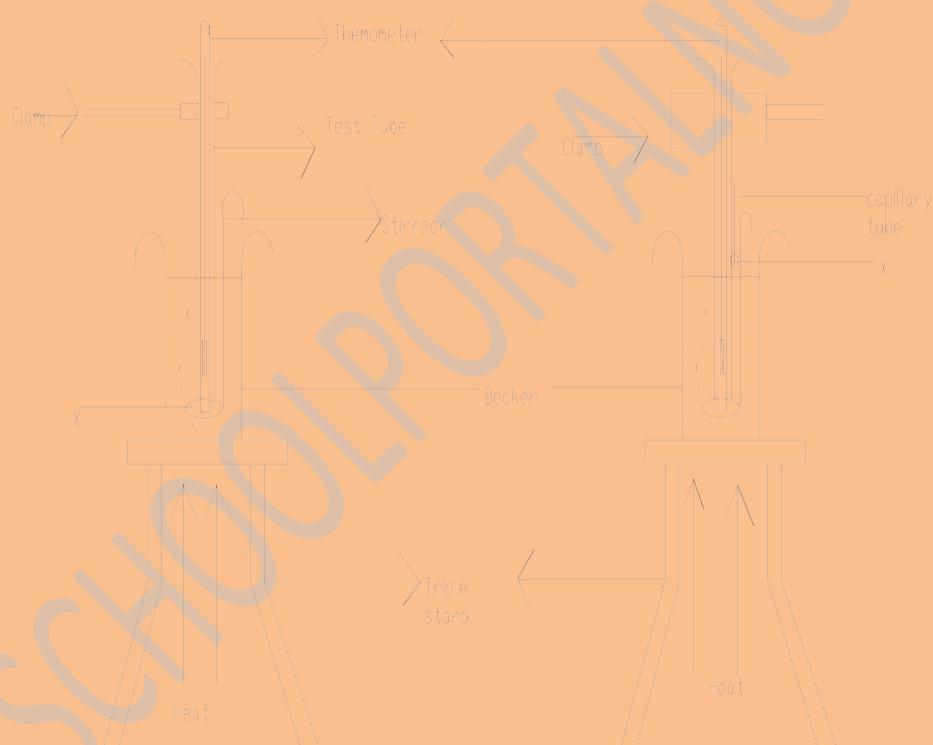
(iv) Heat the oil in the beaker until the solid inside the tube just begin to melt.

(v) Record the temperature that is the melting point of x.

ALTERNATIVE METHOD

1. Put a small portion of X in a capillary tube
2. Insert a thermometer inside the paraffin oil.
3. Attach the capillary tube to the thermometer in the oil
4. Heat the oil in the beaker until the solid in the tube melts
5. Record the temperature when the whole solid just becomes liquid. That is the melting point of X.

Determining the melting point of a solid



(4b) The graph below represents the phase change for the melting point determination of solid X.

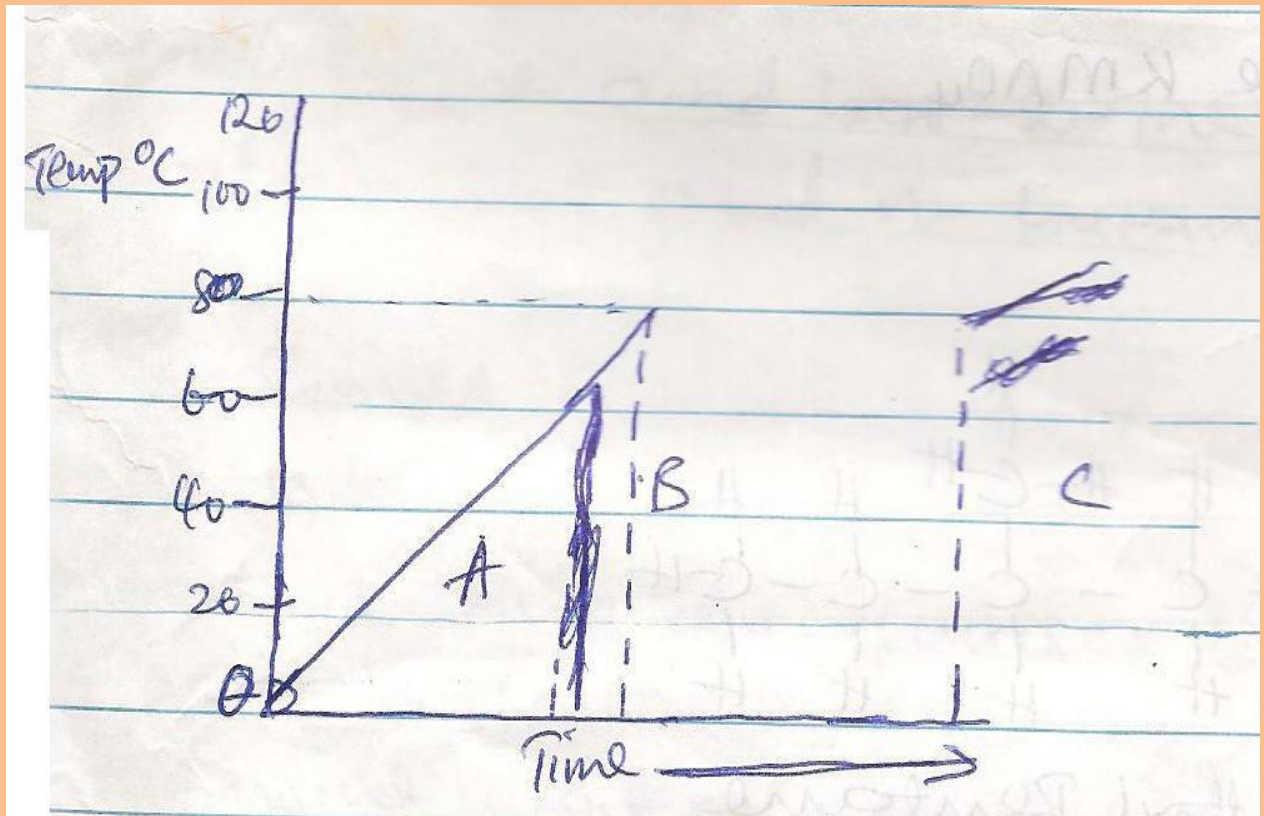


Figure (ii) : Determine the melting point of a solid

- i. What is the melting point of substance X?
- ii. What is the phase (state) of substance X in each of the portions labeled A, B, and C.

Solution:

1. Mpt of X = 80°C
2. Phase of X A = Solid x
 B = mixture of solid and liquid x
 C = Liquid X.

(4C). Name:

1. two methods that can be used to separate an insoluble solid from a liquid
2. three methods that can be used to separate soluble solid from a solution

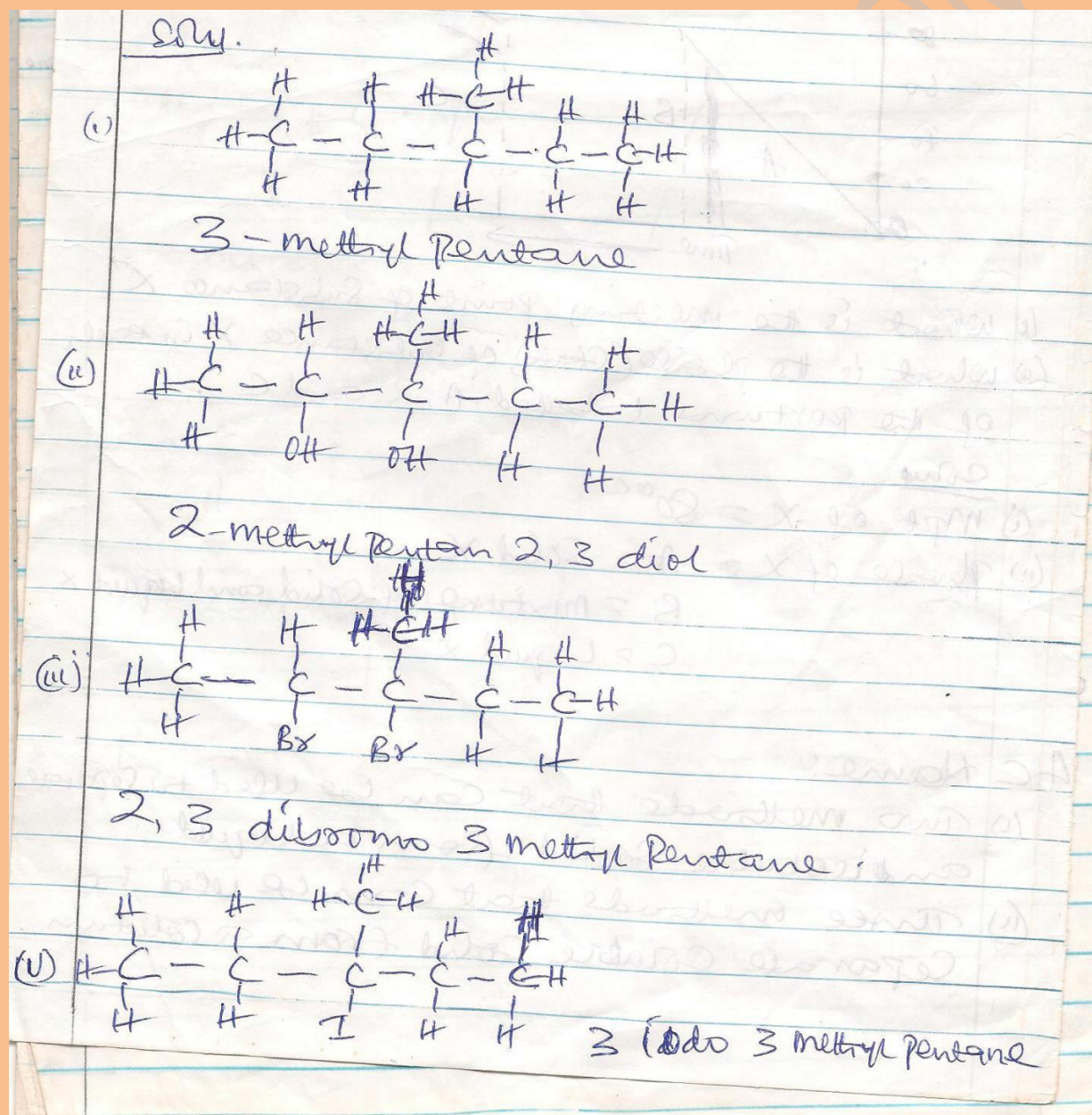
Solution:

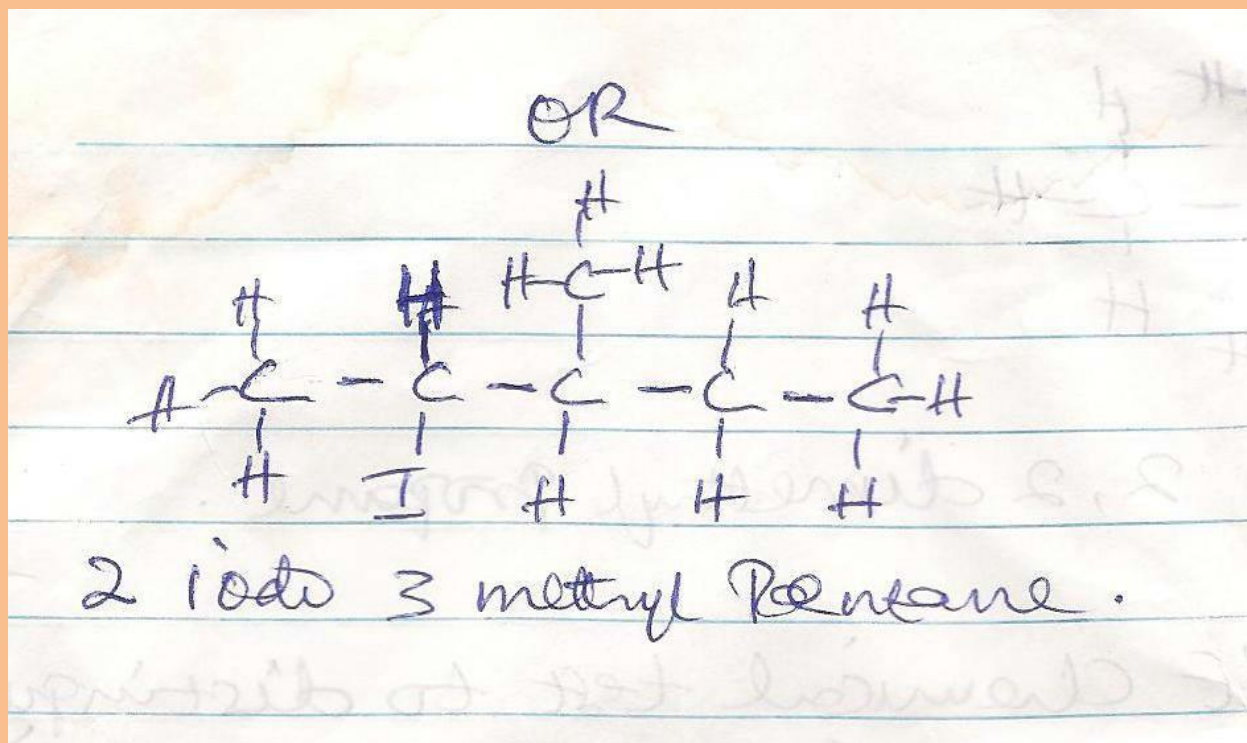
1. Filtration, centrifuging and decantation
2. Evaporation, Crystallization, Distillation, Precipitation

(5a) Give the structure and name of the principal organic product(s) obtained from 3 – methyl pentane under each of the following reaction conditions.

1. H_2/pt
2. Cold dilute $KMnO_4$
3. Br_2/H_2O
4. HI

Solution:





(5b) A hydrocarbon which has no action on a solution of Br_2 in CCl_4 was found to have a molecular mass of 72

1. Deduce the molecular formula of the compound.
2. Write and name all possible isomers of the compound.

Solution:

The hydrocarbon is an alkane $\text{C}_n\text{H}_{2n+2}$

$$\text{C}_n\text{H}_{2n+2} = 72$$

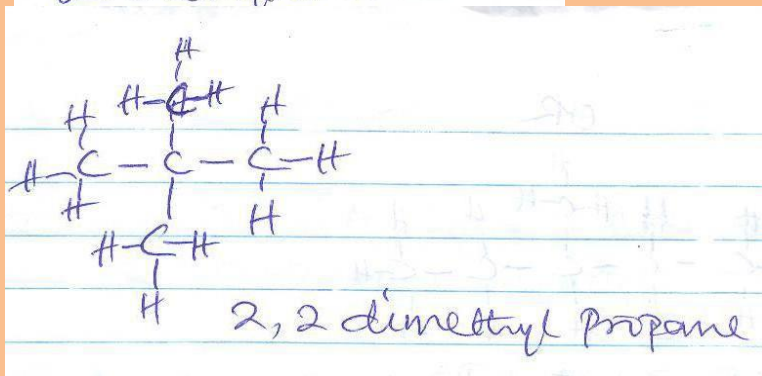
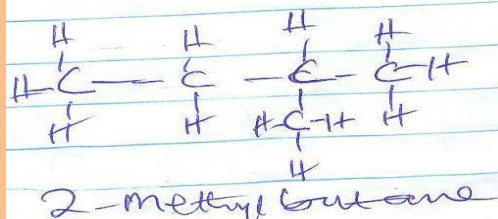
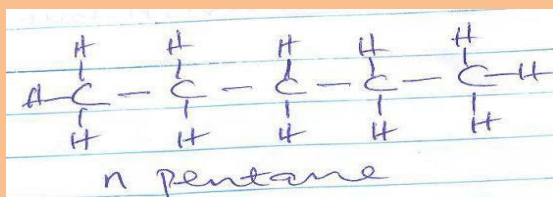
$$\text{C}_n\text{H}_{2n} = 70$$

$$(\text{CH}_2)_n = 70$$

$$14n = 70$$

$$n=5$$

\therefore Molecular formula C_5H_{12}



5c. Give ONE chemical test to distinguish between each pair of compounds given below.

1. But -1- yne and but -2-yne
2. But -1- ene and n- butane

Solution:

1. No simple chemical test to distinguish the two alkynes.
2. But -1- ene decolorizes bromine water, while n- butane does not react with bromine water.
 1. But -1-ene reacts with acidified KMnO_4 solution changing it from purple to colourless solution, n- butane does not but-1-ene react with alkaline KMnO_4 solution changing it from purple to green solution, n- butane does not.