Name ……..…… Index No. ..……..…….…….

School ……..... Candidates Sign: ……..…..…….

Date: ……

233/1

CHEMISTRY
THEORY
Paper 1
November/December
Time: 2 Hours

BUNAMFAN CLUSTER EXAMINATIONS 2021

Kenya Certificate of Secondary Education (K.C.S.E)
233/1
CHEMISTRY
Paper 1
THEORY
November/December
Time: 2 Hours

MARKING SCHEME

INSTRUCTIONS TO CANDIDATES

- Write your **name** and **index number** in the spaces provided above**.**
- **Sign and write the date of examination in the spaces provided above.**
- Answer **ALL** the questions in the spaces provided.
- **Mathematical tables and electronic calculators may be used.**
- All working **MUST** be clearly shown where necessary**.**

FOR EXAMINERS USE ONLY

Questions	Maximum Score	Candidate's Score
1 – 28	**80**	

This paper consists of 14 printed pages.
Candidates should check the question paper to ensure that all the Pages are printed as indicated and no questions are missing.

1. a) A hydrocarbon consists of 92.3% carbon. Its molecular mass is 26. Calculate it's Molecular formula. (2mks)

C	***H***	
92.3	***77***	***E.F = CH ½***
12	***1***	
7.69	***7.77***	***½(CH)n = 26 → 13n=26***
7.69	***7.69***	***n=2***
	1	***MF=C_2H_2√½***

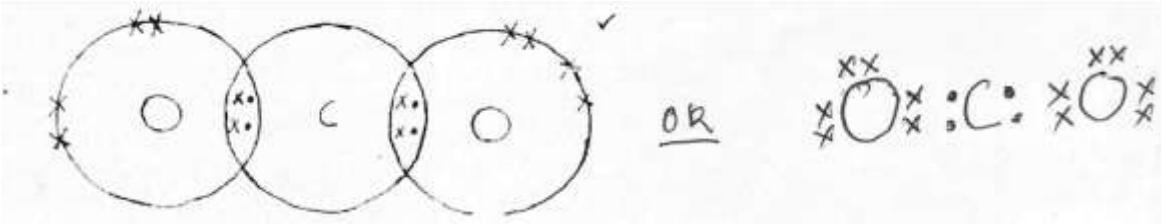
b) Draw the structure of the hydrocarbon. (1 mk)

H-C=C-H

2. a) Explain why melting point of chlorine gas is greater than that of Argon. (lmk)

Chlorine has stronger Van der waals forces than argon which is mono-atomic

b) Using dot(•) and cross (×) to represent electrons draw a diagram to show bonding in carbon (iv) oxide. (lmk)



c) In terms of structure and bonding.Explain why Graphite is used as a lubricant. (1 mk)

It has layers in its structures joined by weak 'van der waals forces which slide over each other.

3. a) What is observed when a few drops of phenolphthalein indicator is added to a solution whose pH value is 3.0? (lmk)

The solution is colourless.

b) Write an equation for the reaction between Lead (ii) oxide and dilute Nitric acid. (lmk)

$PbO_{(s)} + 2HNO_{3(aq)} \rightarrow Pb(NO_3)_{2(aq)} + H_2O_{(l)}$

4. State and explain the observation that would be made when zinc powder is heated with copper (II) oxide. (2 mks)

Colour changes from grey to yellow

Colour changes from black to brown.
Zinc oxidized to ZnO//CuO reduced to Cu// Zinc is higher in reactivity,
Reject displacement.

5. Why is it dangerous to run a motor car engine in a closed garage? (2mks)

Due to incomplete combustion CO is produced √1 This gas is poisonous√1

6. 2 grams of sodium hydroxide is added to 30 cm3 of IM sulphuric (VI) acid. What volume of 0. 1M potassium hydroxide solution will be needed to neutralize the excess acid. (Na23,016,H1) (3 mks)

1 mole of NaOH => 40g

$$\frac{2g}{1 \times 2}$$

40 0.05 mole

Original concentration of H_2SO_4

$1000cm^3$=> 1 mole

$$30cm = \frac{30x1}{1000}$$

$$=0.03 \text{ moles}$$

Moles of acid reacted with NaOH

Mole ratio of NaOH: H_2SO_4

2 : 1

But 2 => 0.05 moles

$$1 = 1x \frac{0.05}{2}$$

$$=0.025 \text{ moles}$$

Moles of acid reacted with KOH

0.03-0.025 =0.005 moles

Mole ratio KOH: H_2SO_4

2:1

But I mole => 0.005 moles

$$2 => \frac{2x0.005}{1}$$

=0.01 moles

KOH reacted 0.01 moles

But 0.1 mole of KOH => 1000cm^3

0.01 mole =>$\frac{0.01 \times 1000}{0.1}$

=l00cm^3

7. An aqueous solution of hydrogen chloride gas reacts with manganese (IV) oxide to form chlorine gas while a solution of hydrogen chloride gas in methylbenzene does not react with manganese (iv) oxide. Explain (2marks)

Because in water HCl gas forms HCl acid which ionizes to form H^+ which reacts with MnO_2 to form chlorine gas √

-In methylbenzene, HCl gas has No H^+ but it remains as discrete molecules hence no reaction with MnO_2√

8. A small piece of potassium Manganate (VII) was placed in a glass of water and was left standing for 6 hrs without shaking. State and explain the observations made. (2marks)

The solution turned purple $KMnO_4$ particles diffuse in water hence spreading to all the parts making the water turn purple √

9. Magnessium reacts with both dilute and concentrated sulphuric (VI) acid. Write a balanced equation for the two reactions. (2marks)

$$Mg_{(s)} + H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + H_{2\,(g)} \surd$$

$$Mg_{(s)} + 2H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + H_2O_{\,(g)} + SO_{2(g)} \surd$$

10. The table below gives the atomic numbers of elements W, X, Y and Z.

Element	W	X	y	Z
Atomic number	14	17	16	19

a) Name the type of bonding that exist in the compound formed when **X** and **Z** reacts. (1mark)

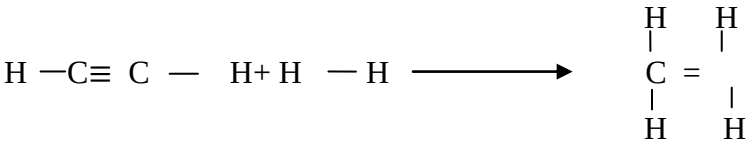
ionic bonding or Electrovalent bonding √

b) Select the letter representing the strongest reducing agent. Give a reason for your answer. (2marks)

Z √

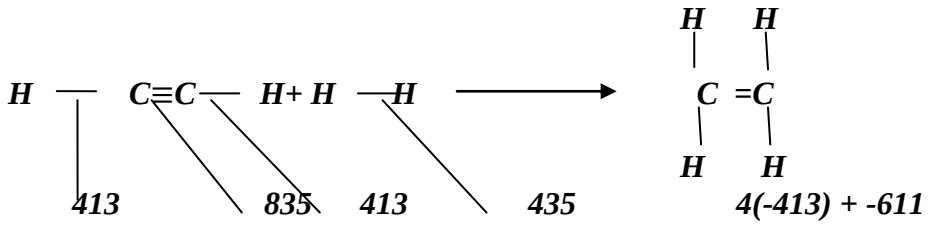
Because it losses electrons most readily√

11. Ethyne reacts with hydrogen as shown below



Use the bond energies below to calculate the enthalpy changes for the above reaction (3marks)

BOND	ENERGY
H-H	435
C-H	413
C ≡ C	835
C=C	611



2086-2263

= -177kJ

12.a) Explain the role of common salt in defrosting ice on roads in ice cold countries.

(1mark)

Addition of NaCl serves as an impurity that lowers the melting point √ ½ of ice making it move easily and leave the road. √ ½

b) Explain why the long term effects of use of common salt is costly to motorists

(1mark)

it makes parts of the vehicles rust faster.√

13. Given the equation below

$NH_{3(aq)} + H_2O_{(l)} \longrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$

Identify the species that acts as

i) A base. Explain (1mark)

NH_3 √

Because it accepts a proton √(H^+) forming NH_4^+

ii) An acid.

(½ mark)

H_2O√

14. a) State Grahams law of diffusion. (1mark)

The rate of diffusion of a gas is inversely proportional to the square root of its Density, temperature and pressure kept constant.

b) The rate of diffusion of sulphur(IV)oxide gas through a porous material is 40cm3s $^{-1}$.

Calculate the rate of diffusion of carbon(IV)oxide gas through the same porous material*(S=32,O=16,C=12)* (2marks)

CO_2=12 + 2 x 16=44 √

SO_2=32+ 2 x 16=64 √

Or

$$\frac{RCO_2}{40}\sqrt{\frac{64}{44}} = \frac{RCO_2}{RSO_2}\sqrt{\frac{RMMSO_2}{RMMCO_2}}$$

$\sqrt{1.45}$ **= 1.204** √

RCO_2 = 40 x 1.204

=48.167cm^3 5^{-1}√

15. Describe how a solid sample of lead(II) chloride can be prepared using the following reagents : dilute nitric acid, dilute hydrochloric acid and lead carbonate (3 mks)

-Add dilute HNO_3 to the lead (II) carbonate to obtain lead (II) nitrate solution

-Allow the reaction to go to completion

Add excess dilute HCl to the mixture to precipitate insoluble lead (II) chloride.

-Filter to obtain lead (II) chloride as the residue

16. The production of ammonia is given by the equation

$$3H2\,(g) + N_2(g) \rightleftharpoons 2NH_3\,(g);\ \Delta H\text{=-ve}$$

(i) State and explain the effect of addition of dilute hydrochloride acid on equilibrium. (2mks)

Reacts with ammonia , equilibrium will shift to the right , forward r x n favoured.

(ii) Explain the effect of increase in temperature on the yield of ammonia. (2mks)

Since the reaction is exothermic , increase in temperature would lead to decomposition of(NH_3(a) to form more of H_2 and N_2(g) yield of ammonia decreases.

17. $Cr_2O_7^{2-} + 14\ H^+(aq) + 6Fe^{2+} \longrightarrow Cr_2^{3+} + 7H_2O(l) + 6Fe^{3+}$.

The above equation show a redox reaction

(a) Calculate the oxidation staste of chromium in $Cr_2O_7^{2-}$ (2mks)

2(Cr) + 7(-2) = -2

2(Cr) + -14 = -2.

2Cr = -2 +14

$\frac{2Cr}{2} = \frac{12}{2}$ ***Cr = +6.***

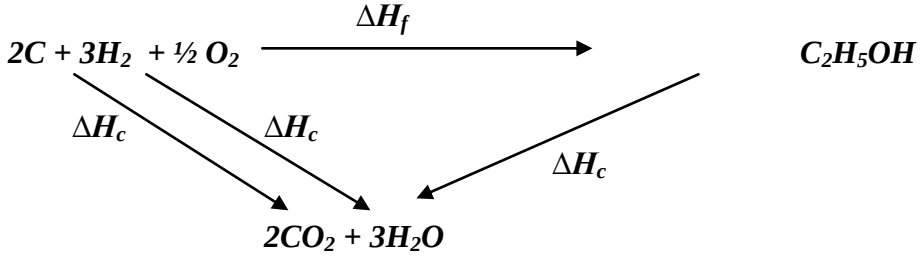
(b) What is the role of H^+ in the above reaction. (1mk)

Facilitate the visibility of colour changes during the reversible reactions.

18. a) Define the standard heat of formation. (1mark)

Energy involved in the formation of a compound from its elements in their standard state at standard conditions .

b) Draw energy cycle diagram to show how the standard heat of formation of ethanol (C_2H_5OH) can be determined from standard heats of combustion of its elements. (2mks)



c) Given that $\Delta H_C(C) = -393kJmole^{-1}$, $\Delta H_C(H_2) = -286kJmole^{-1}$ and $\Delta H_C(C_2H_5OH) = -1368kJmole^{-1}$. Calculate the enthalpy of formation of C_2H_5OH.

(2marks)

$$\Delta H_{f(ethanol)} + \Delta H_{c(ethanol)} = \Delta H_{c(Carbon)} + \Delta H_{c(hydrogen)}$$

$$\Delta H_f + -1368 = 2(-393) + 3(-286)$$

$$\Delta H_f = -276kJmole^{-1}$$

19. 3.78g of a hydrated salt of iron (II) sulphate, $FeSO_4$, in H_2O were heated until all the water of crystallization was driven off. The anhydrous salt left had a mass of 1.52g.
Determine the formula of the hydrated salt.
(Fe = 56, S = 32, H = 1, O = 16) (3 marks)

Mass of water contained in the salt = $3.78 - 1.52 = 1.26g$

Present	***$FeSO_4$***	***H_2O***
Masses	***1.52***	***1.26***
RFM	***152***	***18***
Moles	$\frac{1.52}{152} = 0.01$	$\frac{1.26}{18} = 0.07$
Mole ration	$\frac{0.01}{0.01} - 1$	$\frac{0.07}{0.07} = 7$

Ratio of cpds $FeSO_4 – H_2O$ = 1:7

Formula of the cpd is $FeSO_4 . 7H_2O$

20. A steady current of 0.2 Amperes was passed through molten silver bromide for 80 minutes.

a) Calculate the quantity of electricity that passed through the set up. (1 mark)

Q = IA
= 0.2 x 80 x 60 ***½ Mark***
= 960 coulombs ***½ Mark***

b) Calculate the mass of product deposited at the cathode. (1F = 96500C; Ag = 108, Br = 80) (2 marks)

Cathode:

$Ag^+(l) + e \longrightarrow Ag(s)$
96500C deposits 108g of Ag
960 C deposits $\frac{108g}{96500C} x 960C$

= 1.074 g

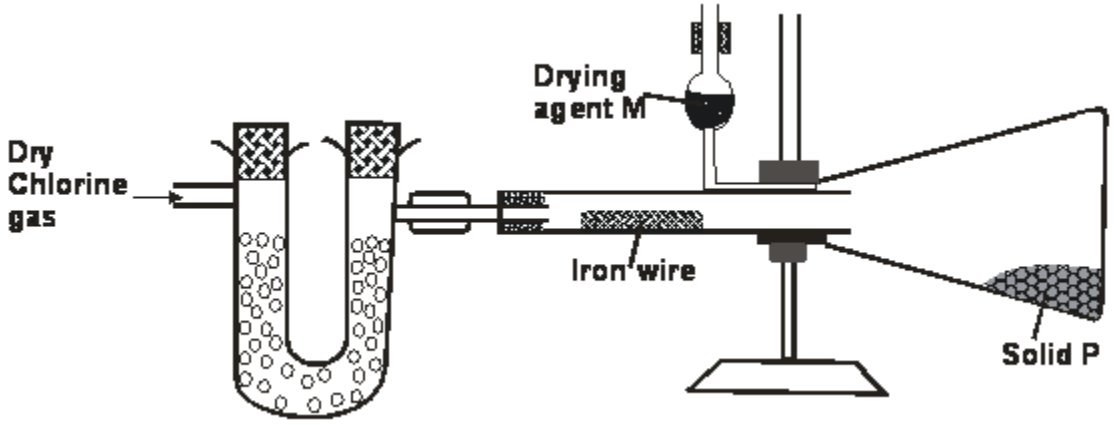
c) If a sample of cobalt has an activity of 1000 counts per minute, determine the time it would take for its activity to decrease to 62.50 if the half-life of the element is 30 minutes.
(2 marks)

1000 ⟶ 500 ⟶ 250 ⟶ 125 ⟶ 62.5 ***1 Mark***

Total half times = 4 x 30 ***1 Mark***

= 120 minutes

21. The apparatus set up below was used to prepare an anhydrous solid P



a) Write an equation for formation of solid P (1 mark)

2 Marks

2 Fe(s) + 3Cl$_2$(q) ⟶ ***2 FeCl$_3$ (s)*** 1 Mark

Equation must be balanced award 0 if not balanced, state omission of symbols give ½ Mark

b) Suppose the gas used in the set up was dry hydrogen chloride gas; what would be the product obtained after the reaction? Give a reason for your answer (1 mark)

FeCl$_2$ ***½ Mark***

Accept iron (II) chloride

Reasons: HCl gas is not a strong oxidizing agent hence may not oxidize Fe to its highest oxidation state.

22. Aluminium is obtained from the ore with the formula Al_2O_3. $2H_2O$. The ore is first heated and refined to obtain pure aluminium oxide (Al_2O_3). The oxide is then electrolysed to get Aluminium and oxygen gas using carbon anodes and carbon as cathode.

a) Give the common name of the ore from wherealuminium is extracted from (1 mark)

Baunxite

b) What would be the importance of heating the ore first before refining it? (1 mark)

It drives out water ½ from the Al2O3 2H2O leaving Al2O3, thus reducing it.

c) The refined ore has to be dissolved in cryolite first before electrolysis. Why is this necessary? (1 mark)

- It has a very high melting ½ point (2054) ^oC hence its lowered by cryolite to 900^oC
The molten Al_2O_3 has a high covalaricytendancy ½ hence not very good in electrical conductivity
Therefore cryolite improves its electrical conductivity ½

d) Why are the carbon anodes replaced every now and then in the cell for electrolysingaluminium oxide?

(1 mark)

The graphite (C) react with the oxygen liberated there forming CO_2 and CO escapes hence wearing out

23. Use the cell representation below to answer the questions that follow

$V(s) / V^{3+}(aq) // Fe^{2+}(aq) / Fe(s)$

i. Write the equation for the cell reaction (1 mark)

$$2V(s) + 3Fe^{2+}(aq) \longrightarrow 2V^{3+}(aq) + 3Fe(s)$$

ii. If the E.M.F of the cell is 0.30 volts and the E^{θ} value for $V^{3+}aq$ / V (s) is -0.74V, calculate the$E^{\theta}$of $Fe^{2+}(aq)$/ Fe(s) (2 marks)

$$Emf = E_{red} - E_{oxid}$$
$$+0.30 = x - {}^{-}0.74$$
x= -0.44V

24. When $50cm^3$ 1M potassium hydroxide was reacted with $50cm^3$ of 1M hydrochloric acid, the temperature rose by 8^0C. When the same volume of Potassium hydroxide was reacted with $50cm^3$ of 1M Pentanoic acid, the temperature rose by 3^0C.

i) Give reasons for the above difference in temperature. (2 marks)

- The reaction between KOH and HCl gives a higher temperature change because HCL is ½ releasing more H^+ ions which combines with OH^- ions to form water

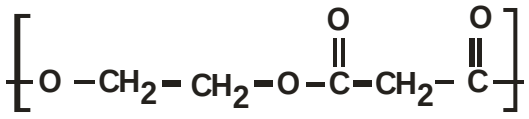
The reaction between KOH and pentanoic acid gives a lower temperature change because the acid is Partially dissociated ½ releasing fewer H^+ ions which will react with the OH^- ions hence part of the energy released goes to ionize the acid ½

ii) Write an equation to show dissociation of pentanoic acid? (1 mark)

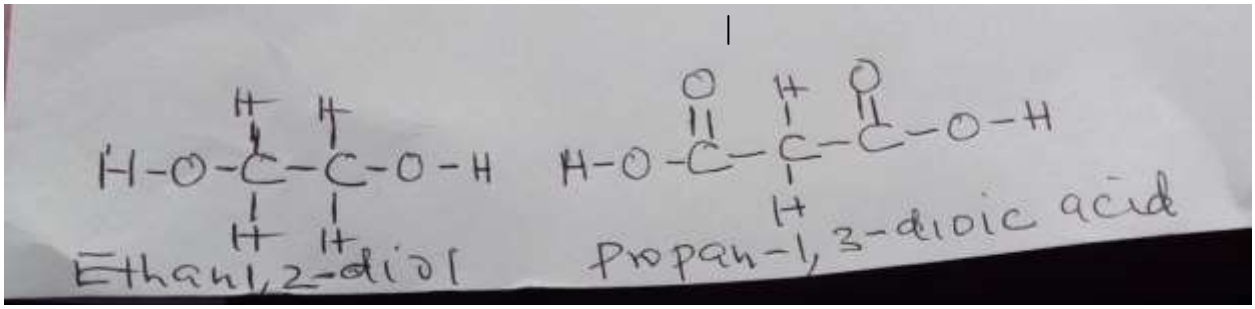
$$C_4H_9COOH_{(aq)} \rightleftharpoons C_4H_9COO^-_{(aq)} + H^+_{(aq)}$$

Reversible sign must appear

25. The following is structural formula of polyester.



a) Draw the structural formula and name the alkanoic acid and alkanol that react to form the polymer. (2marks)



b) Give **one** use of polyester. (1mark)

– making clothing
- making ropes
- plastic model kits

26. A heavy metal P was dissolved in dilute nitric acid to form a solution of compound $P(NO_3)_2$. Portions of the resulting solution were treated as follows:

a) To the first portion a solution of dilute hydrochloric acid is added, where a white precipitate (S) is formed, which dissolves on warming.

b) The second portion is treated with two drops of 2M Sodium hydroxide solution where a white precipitate T is formed. The white precipitate dissolved in excess sodium hydroxide to form a colourless solution.

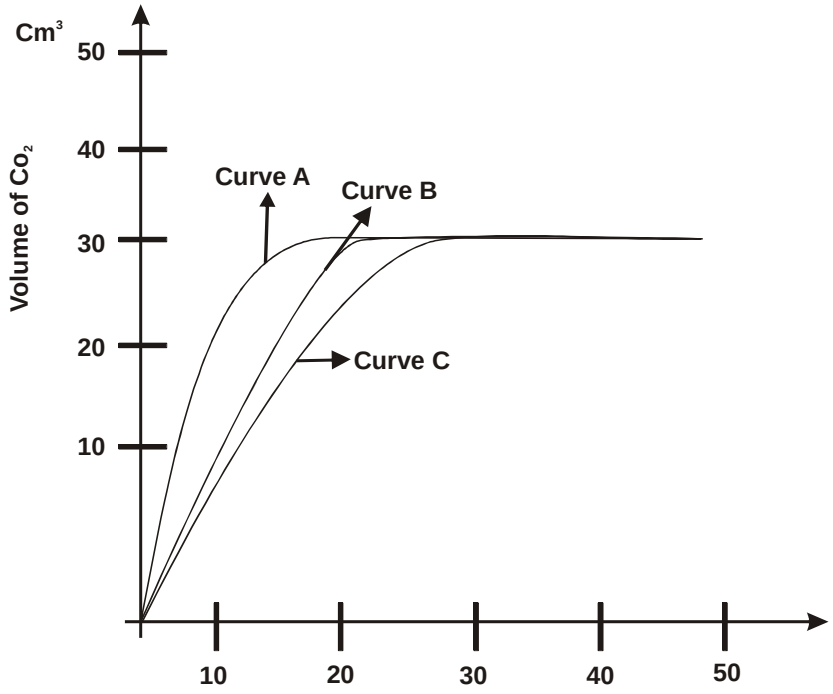
c) A solution of potassium iodide is added to the third portion where a yellow precipitate (U) is formed.

d) When the resulting solution is evaporated to dryness and heated strongly a yellow solid (V) is formed and a brown gas (W) and a colourless gas (X) are formed.

i. Identify the substances P, S, T, U, V, W (3 marks)

P – Pb
S – $PbCl_{2(aq)}$
T – $Pb(OH)_2$ (ppt)
U – $PbI_{2(s)}$
V – PbO
W – NO_2 ***(½ Mark) each NB Accept the name of the respective answers also***

27. The graphs below were drawn when 15g of marble chips in different physical states were reacted with $50cm^3$ of 2M Hydrochloric acid. They are drawn by measuring the volume of carbon (iv) oxide produced with time.



a) Which curves corresponds to the reactions involving powdered calcium carbonate and large sized marble chips with the dilute acid?

i. Powdered calcium carbonate (½ mark)

ii.

Curve A

iii.Large sized calcium carbonate (½ mark)

Curve C

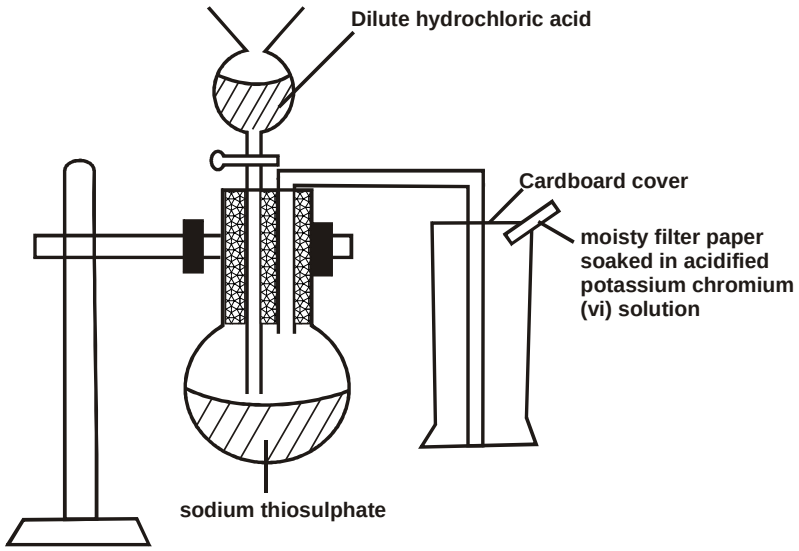
b) All the graphs eventually flatten out at the same level but at different time. Why do the graphs flatten out at the same level? (1 mark)

One of ½ the reactants has been used up in the reaction and the total amount of CO_2 produced will be the same ½ since all reactants remained same in each case.

c) Why is curve A very steep at any given point compared to the other curves (1 mark)

The powdered CaCO3 offers a very great surface ½ area in contact with the acid hence the rate of ½ reaction is very high at any given point

28. Sodium thiosulphate was reacted with dilute hydrochloric acid in a round bottomed flask as shown below. The gas evolved was collected by downward delivery in a gas jar.



a) Write an equation to show the reaction going on in the reaction in vessel. (1 mark)

$$Na_2S_2O_{3(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + S_{(s)} + SO_{2(g)}$$

Equations must be balanced otherwise award zero
State symbols missing

b) State the observation noted on the filter paper. Give a reason for your answer

(1 mark)

The filter paper is noted to turn to green in colour(½) the sulphur (IV) oxide produced reduces the chromium (VI) ions from oxidation number of (+6) to Cr3+ ions which are green in colour

c) Give a reason why the filter paper soaked in the acidified potassium chromium (VI) is used at the top of the flask (1 mark)

To show when the gas jar is filled with ½ gas, hence ensuring the gas does not escape ½ to the environment.