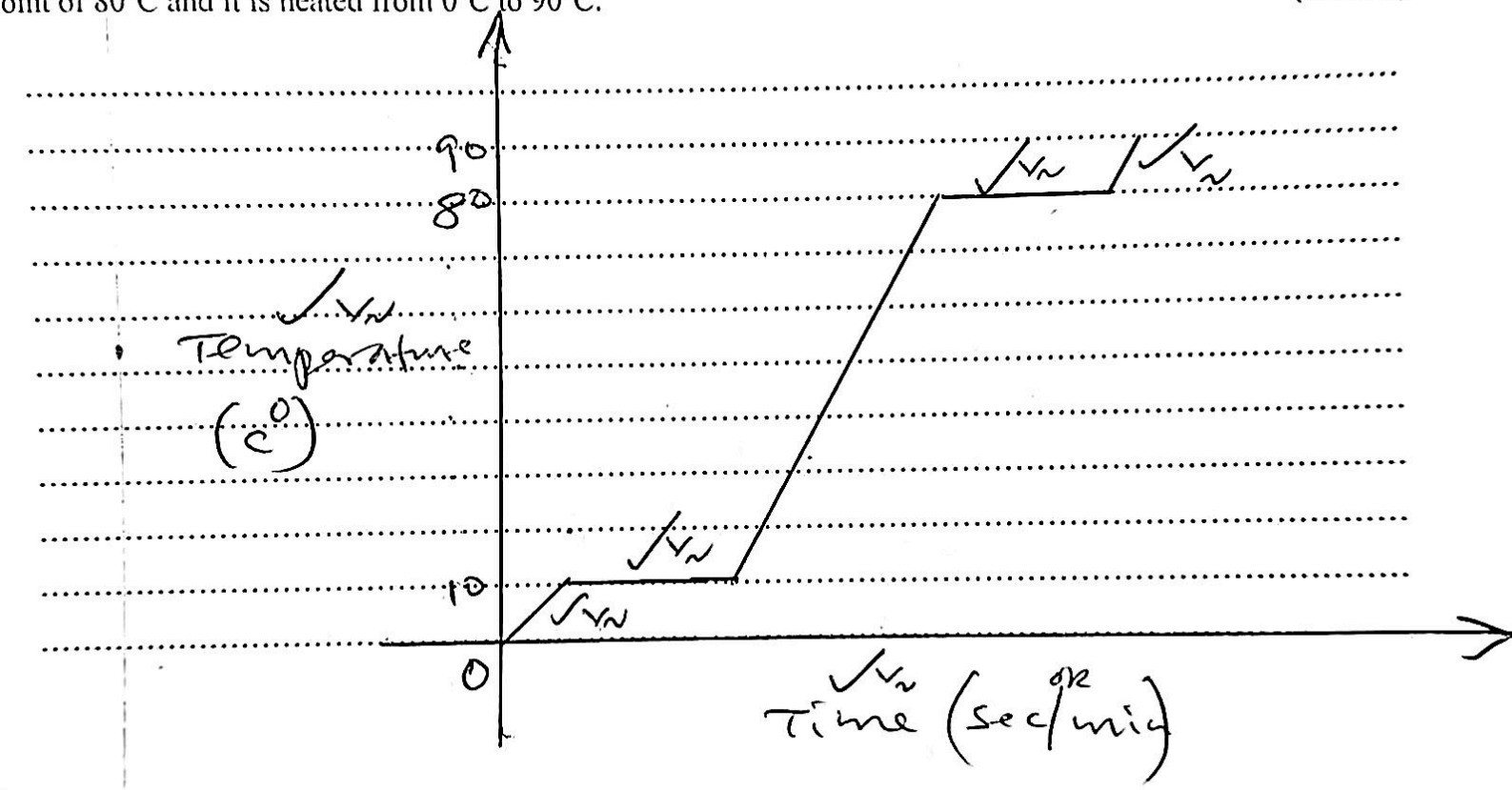
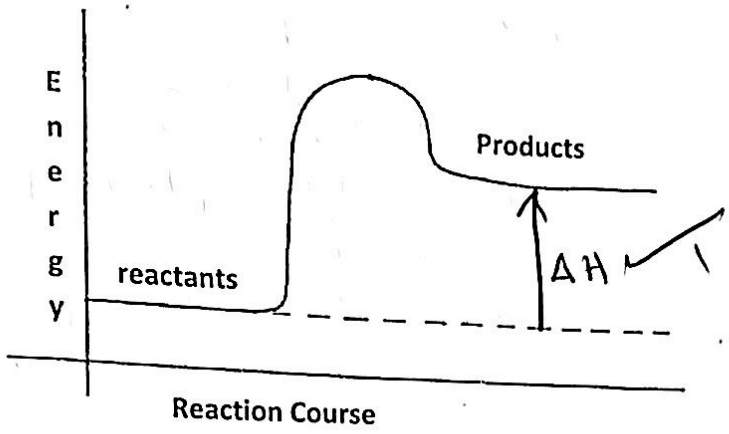
26. A sample of water is suspected to contain some dissolved chloride ions. Describe a chemical test for establishing the presence of the chloride ions in the water sample. (2mks)

To the sample of water in a test-tube, add about 3 drops of lead(II) nitrate solution ✓1 if a white precipitate is formed which is soluble on warming, then chloride ions are present, confirmed.

27. Sketch a graph of temperature against time for a pure substance A with a melting point of 10^0C and boiling point of 80^0C and it is heated from 0^0C to 90^0C. (3marks)



23. Below is a sketch of a reaction profile.



a) On the diagram show the heat of reaction ΔH (1mk)

b) State and explain the type of reaction represented by the profile (2mks)

Endothermic reaction because products have more heat energy than the reactants.

24. Describe how you would obtain oil from groundnuts. (2mks)

Place the groundnuts in a mortar and crush using a pestle. Add propanone or ethanol little by little as crushing continues. Decant the mixture into an evaporating dish. Place the evaporating dish and its contents in the sun for propanone/solvent to evaporate and leave behind the oil.

25. State any **two** differences between luminous and non-luminous flames (2mks)

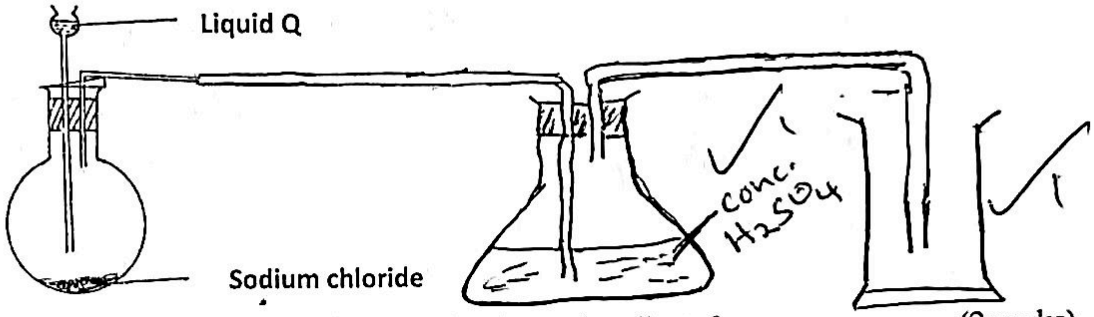
Luminous flame	Non-luminous flame
Long and wavy	Short and steady
Produces much light	Produces less light
Produces less heat	Produces more heat
Produces soot	not sooty
Burns quietly	burns noisily.
Has four zones	Has three zones

Any two correct = 2mks

(ii) Explain how increase in temperature affects the rate of a chemical reaction. (2mks)

An increase in temperature results in an increase in the kinetic energy of the reacting particles. This makes the particles to move faster and collide more frequently with sufficient energy to cause more successful collisions per unit time, thus increasing the rate of reaction.

21. The set up below was used to prepare dry hydrogen chloride gas.



(a) Complete the diagram to show how dry hydrogen chloride gas is collected. (2marks)

(b) Identify liquid Q (1mark)

conc. sulphuric (VI) acid

(c) Write a balanced equation for the reaction that produces hydrogen chloride gas in the above experiment (1mark)

$NaCl_{(s)} + H_2SO_{4(l)} \longrightarrow NaHSO_{4(aq)} + HCl_{(g)}$

22. The relative atomic mass of an element **R** is 10.28; it has two isotopes ^{10}R and ^{11}R. Calculate the relative percentage abundance of each isotope. (3marks)

Let the abundance of ^{10}R be $x\%$
hence abundance of ^{11}R will be $(100-x)\%$

$$10.28 = \left(\frac{x \times 10}{100}\right) + \left(\frac{11(100-x)}{100}\right)$$

$$10.28 = \frac{10x}{100} + \frac{1100-11x}{100}$$

$$10.28 = 10x + 1100 - 11x$$

$$10.28 - 1100 = 10x - 11x$$

$$-72 = -x$$

$$\frac{-72}{-1} = \frac{-x}{-1}$$

$$72 = x$$

Thus $^{10}R = 72\%$

$^{11}R = (100-72) = 28\%$

(b) (i) Why is it possible to collect sulphur (IV) Oxide as shown? (1mk)

SO_2 is denser than air ✓

(ii) What happened to the red flower? (1mk)

Turned ✓ to white / got bleached ✓

19. Hydrogen sulphide gas was passed through a solution of iron (III) chloride

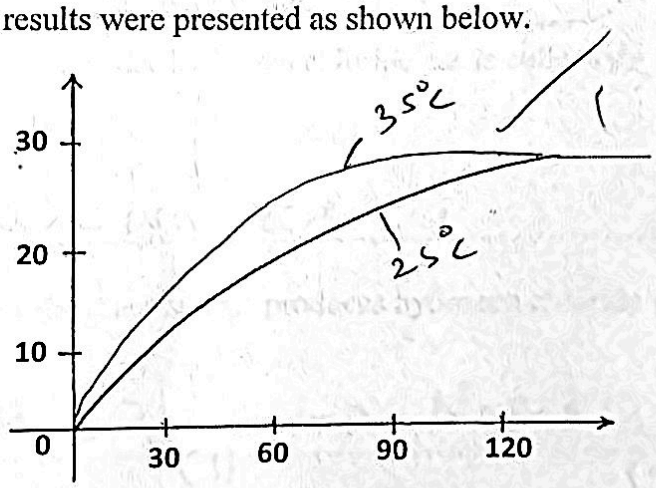
(i) State and explain the observations made (2mks)

- Yellow/brown solution of iron(III) chloride turns to pale green due to reduction to iron (II) chloride by H_2S.
- Yellow precipitate is formed due to oxidation of H_2S to sulphur

(ii) Write an ionic equation for the reaction taking place in (i) above (1mk)

$H_2S_{(g)} + 2Fe^{3+}_{(aq)} \longrightarrow 2Fe^{2+}_{(aq)} + S_{(s)} + 2H^+_{(aq)}$

20. A Certain mass of a metal reacted with excess dilute hydrochloric acid at **25^{0}C**. The volume was recorded after every 30secs. The results were presented as shown below.

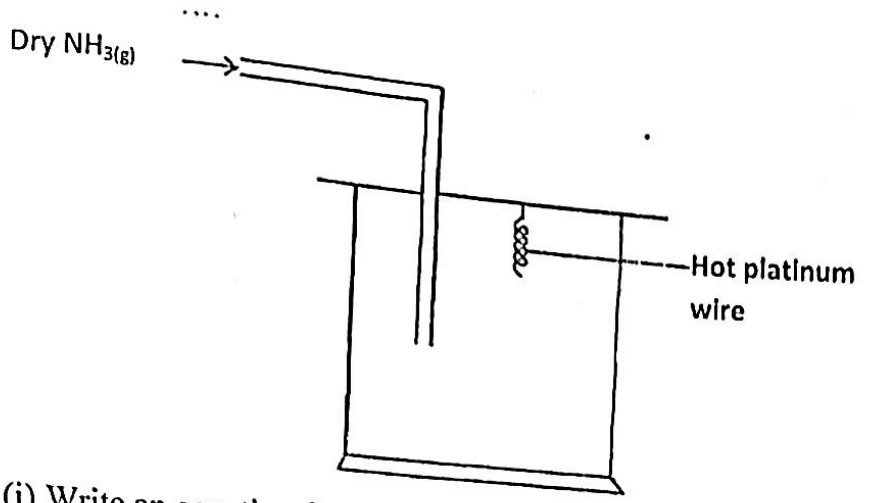


(a) Name **one** piece of apparatus that may be used to measure the volume of the gas liberated. (1mk)

Graduated syringe / graduated cylinder ✓

(b) (i) On the same axis, sketch the curve that would be obtained if the experiment was repeated at **35^{0}C** (1mk)

17. The apparatus below was set up to show the catalytic oxidation of ammonia. Study the diagram and answer the questions that follow



(i) Write an equation for the reaction that takes place in the gas jar (1mk)

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ ✓1

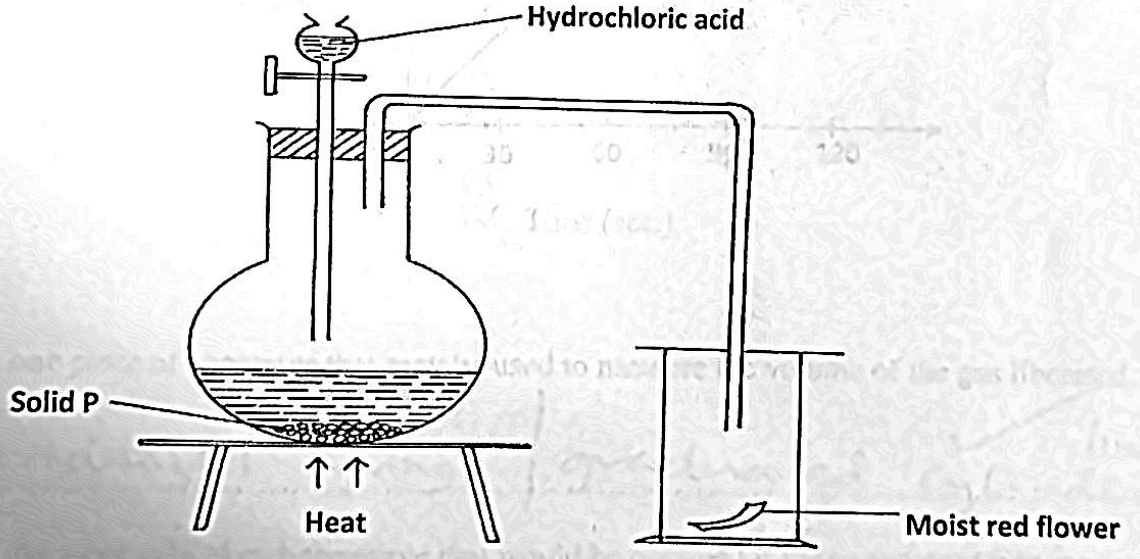
(ii) What is the role of hot platinum wire? (1mk)

It catalyses the reaction / is a catalyst ✓1

(iii) Write the formula of the complex ion formed when excess ammonia gas is passed through a solution containing Zn^{2+} ions. (1mk)

$[Zn(NH_3)_4]^{2+}$ ✓1

18. The diagram below shows the set-up that was used to prepare and collect sulphur (iv) oxide gas.



(a) Identify solid P (1mk)

Sodium sulphite or potassium sulphite. ✓1

(b) 60cm³ of oxygen gas diffused through a porous hole in 50 seconds. How long will it take 80cm³ of sulphur (IV) oxide, SO_2 to diffuse through the same hole under the same conditions. (S = 32, O=16). (2marks)

Time taken by 80cm³ of O_2 !

If 60cm³ of O_2 → 50 secs

∴ 80cm³ of O_2 → $\frac{80}{60} \times 50 = 66.67$ secs

$\frac{T_{O_2}}{T_{SO_2}} = \frac{\sqrt{MM_{O_2}}}{\sqrt{MM_{SO_2}}}$

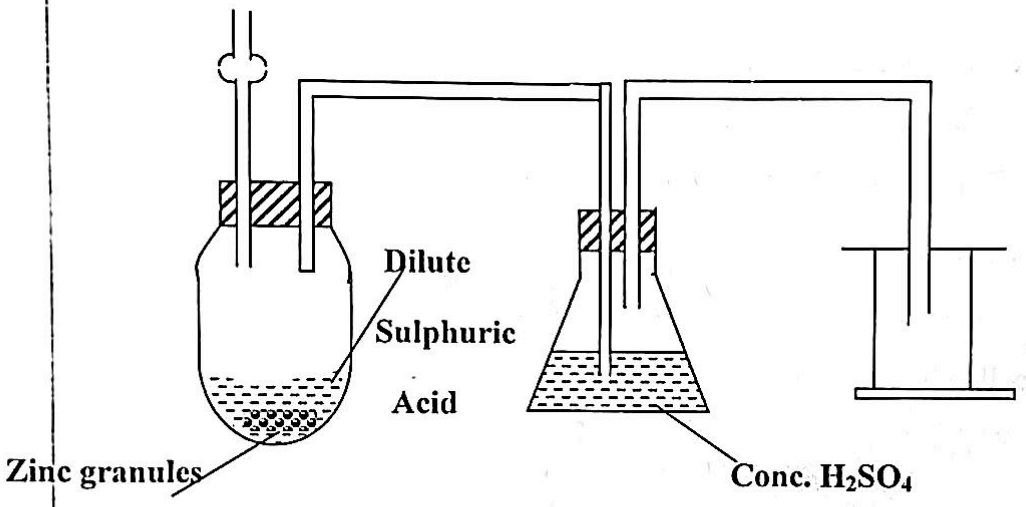
$\frac{66.67}{T_{SO_2}} = \frac{\sqrt{(16\times2)}}{\sqrt{32+(16\times2)}}$

$\frac{66.67}{T_{SO_2}} = \frac{\sqrt{32}}{\sqrt{64}}$

$T_{SO_2} \times \sqrt{32} = 66.67 \times \sqrt{64}$

$T_{SO_2} = 94.29$ sec

16. The set-up below shows laboratory preparation of hydrogen gas, use it to answer the questions that follow:



a) Identify **two** mistakes in the set-up (2 mks)

- The thistle funnel has not been dipped into the reacting mixture
- Wrong method of collecting hydrogen gas

b) Why is it not advisable to use potassium metal as an alternative of zinc for the preparation of hydrogen gas? (1 mks)

Potassium reacts explosively with with dilute acids

13. (a) Define the term solubility. (1mk)

The maximum mass of solute required to saturate 100g of the solvent at a particular temperature

(b) 35g of salt W were added to 60cm^3 of water at 25^{0}C. After stiring 5g of crystals of salt W were filtered out. Determine the solubility of salt W at 25^{0}C. (2mks)

Mass of salt dissolved = (35-5)g = 30g ✓ V_N

∴ 60cm^3 of water → 30g of salt ✓ V_N

∴ 100 cm^3 of water → $\frac{100}{60} \times 30 = 50g$ ✓ ✓

Thus Solubility = 50g/100g of water

14. Temporary water hardness can be removed by boiling

a) What is hard water? (1 mk)

Water that does not readily lather with soap ✓

b) Name the anion responsible for temporary hardness of water. (1 mk)

hydrogen carbonate ✓

c) State **one** advantage of hard water. (1 mk)

- Provides calcium which is essential for strengthening bones ✓
- Used in brewing ✓ Any one correct
- Forms a layer of carbonate as a lining in lead water pipes preventing lead poisoning

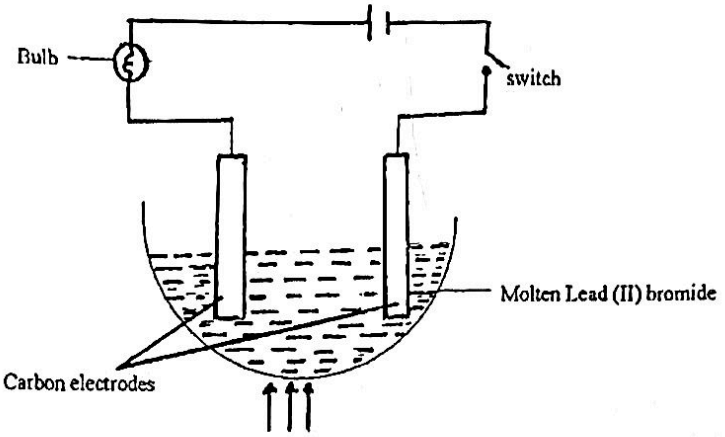
15. (a) State Graham's law. (1mark)

The rate of diffusion of a gas at a constant temperature and pressure is inversely proportional to the square root of its density. ✓

11. Below is a diagram of set-up of apparatus that is used to investigate the effect of electric current on a binary electrolyte, lead (II) bromide.

i) Explain what is meant by a 'binary electrolyte'. (1mark)

An Electrolyte which has only one type of anion and ~~the~~ cation



ii) State the importance of heating in the above experiment. (1mark)

To melt the ~~lead~~ solid lead (II) bromide so that the ions become free and mobile

iii) Give an observation made at the cathode (1 mark)

Grey beads are formed

12. a) (i) Name the following organic compounds. (2marks)

a) $CH_3 - CH{=}C(CH_3) - CH_2 - CH_2 - CH_3$

3-methylhex-2-ene

b) $CH_3CH_2CH_2CH_2CH_3$

Pentane

(ii) Describe one chemical test that can be used to distinguish between substances (a) and (b) above. (1 mark)

Add a few drops of bromine water to each seperately ; ~~Brown~~ orange/yellow bromine water will be decolourised by substance (a) while in substance (b) ; the brown colour remains brown.

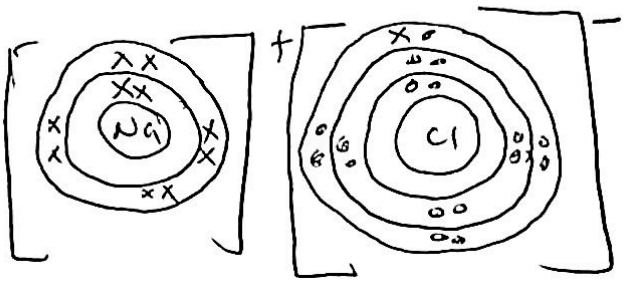
Note: acidified $KMnO_4$ or acidified $K_2Cr_2O_7$ can be used in place of bromine water.

b) State the condition necessary for the above reaction to occur. (1 mk)

Sunlight or U.V light ✓1

9. Using dots (.) and crosses (x) to represent electrons, show:

(a) bonding in sodium chloride (1 mk)

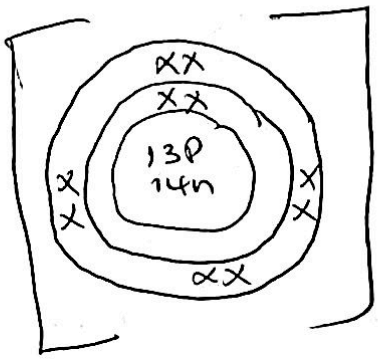


1

Distribution of electrons = ½

charge = ½

(b) the structure of an ion illustrated by the formula $^{27}_{13}Al^{3+}$ (1 mk)



1

10. On complete combustion of a hydrocarbon; 1.257g of carbon (IV) oxide and 0.514g of water were produced. If the relative molecular mass of the hydrocarbon is 84, determine the molecular formula of the hydrocarbon (*C=12, H=1,O=16*) (4mks)

Mass of carbon in the CO_2:

$\frac{12}{12+(2\times16)} \times 1.257 = 0.3428g$ ½

Mass of H in H_2O:

$\frac{2}{(1\times2)+16} \times 0.514 = 0.0571g$ ½

Element	C	H
Mass	0.3428	0.0571
Moles	$\frac{0.3428}{12} = 0.0286$	$\frac{0.0571}{1} = 0.0571$ ½ ½
Mole ratio	$\frac{0.0286}{0.0286} = 1$ ½	$\frac{0.0571}{0.0286} = 1.99 \simeq 2$ ½

Empirical formula is

CH_2 ½

$(CH_2)_n = 84$

$[12+(1\times2)]_n = 84$

$14n = 84$

$\frac{14n}{14} = \frac{84}{14}$

$n = 6$

Molecular formula is

$(CH_2)_6 = C_6H_{12}$ ½

a) Identify the substances:

Q ..... Air / oxygen ..... (2 mks)

P ..... Conc. Sulphuric(VI) acid .....

R ..... Sulphuric(VI) acid .....

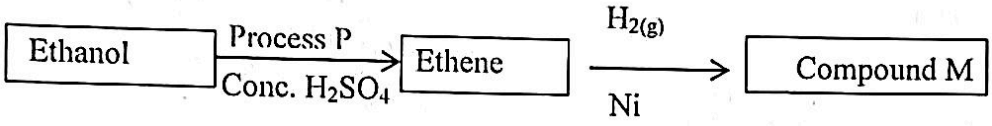
N ..... Sulphur (IV) oxide .....

b) Name solution M and state its colour.

Name ..... Copper (II) Sulphate ..... (1 mk)

Colour ..... blue .....

7. Use the reaction scheme below to answer the questions that follow.



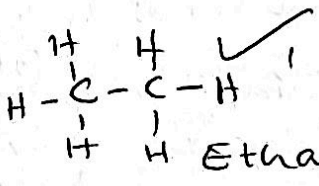
a) Give one necessary condition for process P (1 mark)

..... Heat of between 160° to 180°C ✓1 ; Reject a range of temperatures .....

b) Name the Process P. (½ mark)

..... Dehydration ✓½ .....

(c) Draw and name the structure of compound M (1½ mark)


✓1

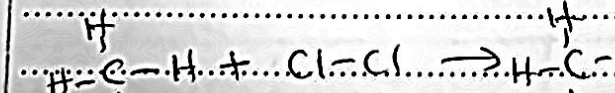
Ethane ✓½

8. Use the bond energies given below to answer the questions that follow.

Bond	Bong energy (KJ /mole)
C – H	414
Cl – Cl	244
C – Cl	326
H – Cl	431

a) Calculate the heat change for the reaction. (3 mks)

$CH_{4\,(g)} + Cl_{2\,(g)} \longrightarrow CH_3Cl_{(g)} + HCl_{(g)}$



Bonds broken:

Four H–C bonds = 4 X 414 = +1656

one Cl–Cl bond = 1 X 244 = +244

Total heat absorbed = +1900 ✓1

Bonds formed:

Three H–C bonds = 3 X 414 = -1242

one C–Cl bond = 1 X 326 = - 326

one H–Cl bond = 1 X 431 = - 431

Total heat released = -1999 ✓1

$\Delta H = +1900 + (-1999)$

$= -99$ KJ/mol ✓1

4. In a reaction $20cm^3$ of 0.1M sodium carbonate completely reacted with $12.5cm^3$ of dilute sulphuric (VI) acid. Find the concentration of suphuric (VI) acid in moles per litres. (3mks)

Moles of Na_2CO_3 used:
If $1000cm^3 \rightarrow 0.1$ moles
$\therefore 20cm^3 \rightarrow \frac{20}{1000} \times 0.1$ ½
$= 0.002$ moles

Equation:
$Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$
Mole ratio of $Na_2CO_3 : H_2SO_4$ is 1:1

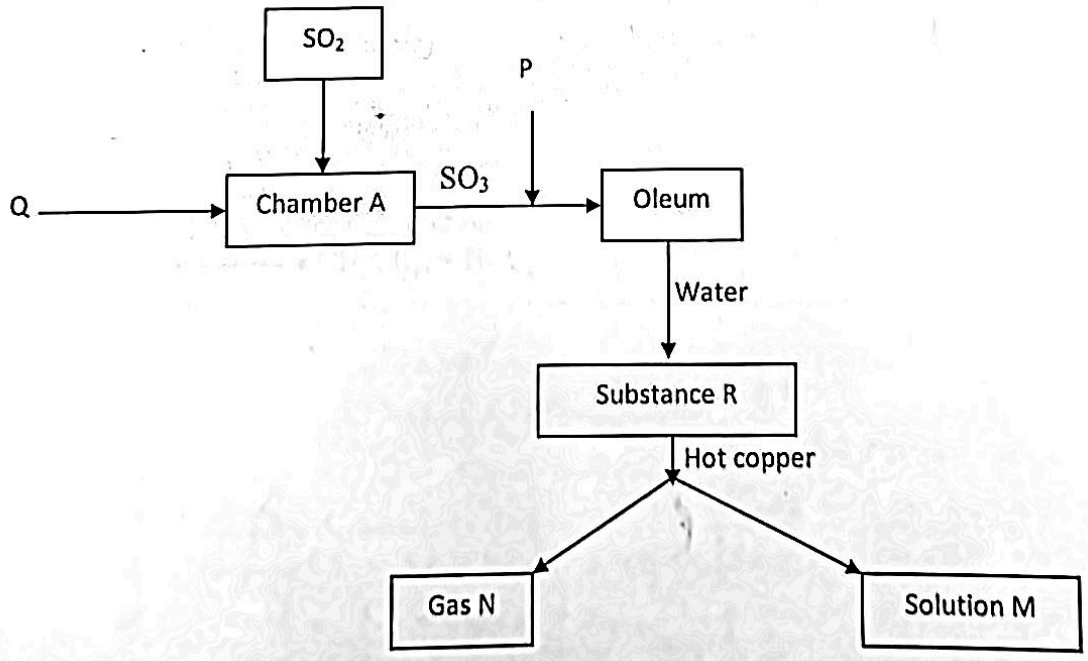
Moles of H_2SO_4 acid used:
If 1 mole of $Na_2CO_3 \rightarrow$ 1 mole of H_2SO_4
$\therefore 0.002$ moles of $Na_2CO_3 \rightarrow ?$ ½
$\frac{0.002}{1} \times 1 = 0.002$ moles

Molarity of H_2SO_4:
If $12.5cm^3 \rightarrow 0.002$ moles ½
$\therefore 1000cm^3 \rightarrow \frac{1000}{12.5} \times 0.002$
$= 0.16$ M ½

5. When calcium carbonate is placed in a solution of hydrogen chloride gas in water, there is effervescence while there is no effervescence when placed in a solution of hydrogen chloride gas dissolved in methylbenzene .Explain this observation (2 mk)

Water is a polar solvent which enables hydrogen chloride gas to dissolve and ionise into free hydrogen and chloride ions; the hydrogen ions are responsible for the acidity of the solution while methyl benzene is a non-polar solvent therefore HCl does not ionise in it after dissolving.

6. Study the chart below for the Contact process and other extensions.



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Equation:
$Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l) + CO_2(g)$
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Moles of H_2SO_4 acid used:
If 1 mole of $Na_2CO_3 \rightarrow$ 1 mole of H_2SO_4
$\therefore 0.002$ moles of $Na_2CO_3 \rightarrow ?$
$\frac{0.002}{1} \times 1 = 0.002$ moles

Molarity of H_2SO_4:
If $12.5cm^3 \rightarrow 0.002$ moles
$\therefore 1000cm^3 \rightarrow \frac{1000}{12.5} \times 0.002$
$= 0.16M$

5. When calcium carbonate is placed in a solution of hydrogen chloride gas in water, there is effervescence while there is no effervescence when placed in a solution of hydrogen chloride gas dissolved in methylbenzene .Explain this observation (2 mk)

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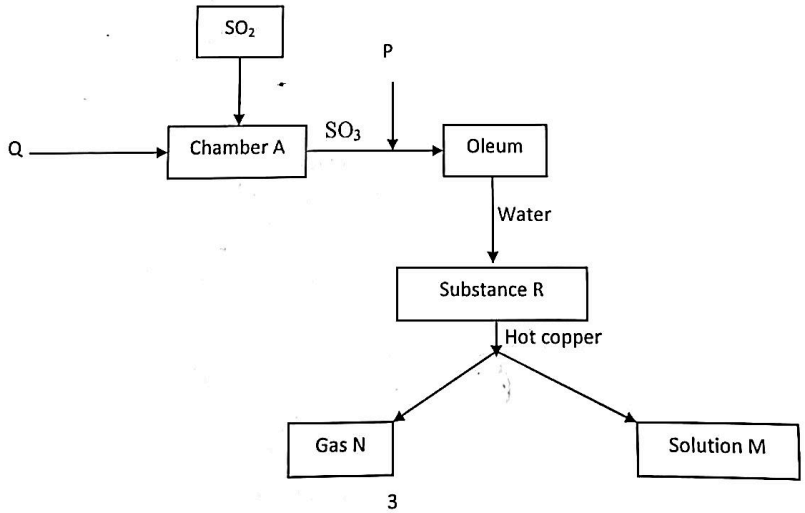
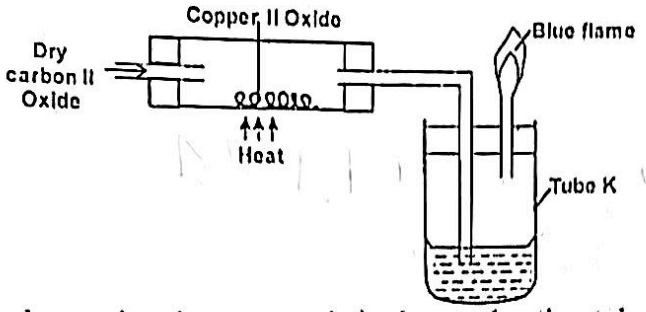


1. The apparatus shown below was used to investigate the effect of carbon (II) oxide on copper (II) oxide.



a) State the observation that was made in the combustion tube by the end of the experiment. (1 mark)

brown solid is formed ✓1

b) Write an equation for the reaction that took place in the combustion tube. (1mark)

$CuO_{(s)} + CO_{(g)} \rightarrow CO_{2(g)} + Cu_{(s)}$ ✓1

c) Why is it necessary to burn gas coming out of tube K? (1mark)

the gas is poisonous/toxic ✓1

2. Name the process which takes place when:

(i) Iodine changes directly from solid to gas (1mk)

sublimation ✓1

(ii) The process of hardening rubber by heating it together with sulphur (1mk)

Vulcanisation ✓1

(iii) White sugar changes to black solid when mixed with excess concentrated sulphuric (VI) acid (1mk)

Dehydration ✓1

3. A student was asked to prepare dry lead (II) sulphate salt using the following reagents; dilute nitric (V) acid, lead (II) carbonate and magnesium sulphate solution. Describe how the salt can be prepared. (3 mks)

Add excess lead (II) carbonate ✓1 to the dilute nitric (V) acid ✓1. Filter the mixture to get $Pb(NO_3)_2$ soln. ✓1 React the filtrate with magnesium sulphate solution. Filter the mixture to obtain lead (II) sulphate ✓1 as the residue. Rinse the residue with distilled water ✓1 and dry between filter papers.

Name.....Adm No: .....

233/1

Candidate's Signature .....

CHEMISTRY

Date: .....

PAPER 1, THEORY

SEPTEMBER, 2021

TIME: 2 HOURS

MARKING SCHEME

MOMALICHE FORM IV

Kenya Certificate of Secondary Education (K.C.S.E.)

233/1

Chemistry

Paper 1

2 Hours

INSTRUCTIONS TO CANDIDATES

- Write your **name** and **admission number** in the spaces provided above
- **Sign** and write the **date** of examination in the spaces provided.
- Answer ***all*** the questions in the spaces provided.
- Mathematical table and silent electronic calculators may be used.
- All working **must** be clearly shown where necessary.

FOR EXAMINERS USE ONLY

Question	Maximum score	Candidate's score
1-27	80	