FORM THREE CHEMISTRY
TOPICAL QUESTIONS

Gas laws

1. A sample of unknown compound gas **X** is shown by analysis to contain Sulphur and Oxygen. The gas requires 28.3 seconds to diffuse through a small aperture into a vacuum. An identical number of oxygen molecules pass through the same aperture in 20seconds. Determine the molecular mass of gas X (O= 16, S= 32)

2. (a) State Graham's Law of diffusion

(b) Gas **V** takes 10 seconds to diffuse through a distance of one fifth of a meter. Another gas **W** takes the same time to diffuse through a distance of 10 cm. if the relative molecular mass of gas **V** is 16.0; calculate the molecular mass of **W**

3. (a) State Charles' Law

(b) The volume of a sample of nitrogen gas at a temperature of 291K and 1.0×10^5 Pascals was $3.5 \times 10^{-2} m^3$. Calculate the temperature at which the volume of the gas would be $2.8 \times 10^{-2} m^3$ at 1.0×10^5 pascals.

4. 60 cm^3 of oxygen gas diffused through a porous partition in 50 seconds. How long would it take 60 cm^3 of sulphur (IV) oxide gas to diffuse through the same partition under the sane conditions?
(S = 32.0, O = 16.0)

5. (a) State Graham's law of diffusion

(b) 30cm^3 of hydrogen chloride gas diffuses through a porous pot in 20seconds. How long
would it take 42cm^3 of sulphur(IV) oxide gas to diffuse through the same pot under
the same conditions (H =1 Cl = 35.5 S = 32 O =16)

6. a) State **Boyles law**

b) Sketch a graph that represents Charles' law

c) A gas occupied a volume of 250cm^3 at -23ºC and 1 atmosphere. Determine its volume
at 127ºC when pressure is kept constant.

7. A factory produces Calcium Oxide from Calcium Carbonate as shown in the equation below:-

$$CaCO_{3\,(s)} \xrightarrow{Heat} CaO_{\,(s)} + CO_{2\,(g)}$$

(a) What volume of Carbon (IV) Oxide would be produced from 1000kg of Calcium
Carbonate at s.t.p (Ca = 40, C = 12, O = 16, Molar gas volume at s.t.p = 22.4dm^3)

8. A fixed mass of gas occupies 200cm^3 at a temperature of 23^{o}C and pressure of 740mmHg.
Calculate the volume of the gas at -25^{o}C and 780mmHg pressure

9. Gas **K** diffuses through a porous material at a rate of 12cm^3 s^{-1} where as **S** diffuses through the same material at a rate of 7.5cm^{3}s^{-1}. Given that the molar mass of **K** is 16, calculate the
molar mass of **S**

10. (a) State Gay Lussac's law

11. (a) What is the relationship between the rate of diffusion of a gas and its molecular mass?

(b) A sample of Carbon (IV) Oxide takes 200 seconds to diffuse across a porous plug. How long will it take the same amount of Carbon (II) Oxide to diffuse through the same plug?(C=12, O=16)

MOLE CONCEPT

1. Zinc metal and hydrochloric acid react according to the following equation

$$Zn_{(s)} + 2HCl_{(aq)} \longrightarrow ZnCl_{(aq)} + H_{2(g)}$$

1.96g of zinc were reacted with 100cm^3 of 0.2M Hydrochloric acid,

(a) Determine the reagent that was in excess

(2mks)

(b) Calculate the total volume of hydrogen gas that was liberated at S.T.P conditions (Zn = 65.4, molar gas volume = 22.4 litres at S.T.P)

(2mks)

2. Calculate the mass of nitrogen (IV) oxide gas that would occupy the same volume as 10g of hydrogen gas at the same temperature and pressure. (H = 1.0, N = 14.0, O = 16.0)

(2mks)

3. Urea, $(NH_2)_2CO$ is prepared by the reaction between ammonia and carbon(IV) oxide

$$2NH_{3(g)} + CO_{2(g)} \longrightarrow (NH_2)_2CO_{(aq)} + H_2O_{(l)}$$

In one process, 340kg of ammonia were reacted with excess carbon (IV) oxide. Calculate the moles of urea that were formed. (H = 1.0, C = 12. 0, N = 14.0, O = 16.0)

(2mks)

4. In a filtration experiment 25cm^3 of solution of sodium hydroxide containing 8g per litre was required for complete neutralization of 0.245g of a dibasic acid. Calculate the relative molecular mass of the acid. (Na = 23.0, O = 16, H = 1)

(3mks)

5. 12.0 cm^3 of methane and 48cm^3 of oxygen were exploded together. The final volume measured under the original conditions was 36.0 cm^3 neglecting the water formed. 24.0cm^3 of this was unused oxygen. **Show** the ratio of reacting volume of the gases referred to and gaseous products formed.

(2marks)

6. 4. 9 g a tribasic acid was dissolved in water and the solution made up to 500cm^3. If the concentration of the hydrogen ions in the solution is 0.3M, **calculate** the relative molecular mass of the acid.

(3marks)

7. The mass of 1 dm^3 of gas **X** at room temperature and pressure is 2.667g. **Determine** the relative molecular mass of the gas (molar gas volume at r.t.p =24dm^3).

(2marks)

8. A solution was made by dissolving 7.5g of sodium hydroxide containing inert impurities in water and making it to 250cm^3 of solution. If 20cm^3 of this solution is neutralized exactly by 13cm^3 of 1M hydrochloric acid, calculate the percentage purity of sodium hydroxide.
(Na=23; O=16; H=1) (3mks)

9. a) An oxide of nitrogen contains 30.4% nitrogen. Its density at s.t.p is 4.11g/dm^3.
Determine the molecular formula of the compound.
(N=14; O=16; moles gas volume = 22.4dm^3) (2mks)

b) Magnesium ribbon was burnt in a gas jar of nitrogen. A few drops of water were added to the solid formed in the jar. Write an equation for the second reaction. (1mk)

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10. In a experiment, 10.6g of a mixture of Anhydrous Sodium Carbonate and Sodium Chloride were dissolved in water to make 100cm^3 of a solution required 20.0cm^3 of 0.5M Hydrochloric acid solution for complete neutralization. **What** is the mass of Sodium Carbonate in the mixture?
(Na = 23.0, C = 12.0, O = 16.0, Cl = 35.5) (3mks)

11. For the reaction

$Na_2SO_{3(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + SO_{2(g)} + H_2O_{(l)}$

Given that 25.2g of Na_2SO_3 were made to react with 700cm^3 of 0.5M HCl, which reagent was in excess? (3mks)

12. 9.42g of an organic acid RCOOH is dissolved in 600cm^3. 25.0cm^3 of this solution was found to require of 0.207M potassium hydroxide solution for complete neutralization.
(C = 12.0, O = 16.0, H = 1.0)

i) Determine the formula mass of the acid

(2mks)

ii) Hence the value of R

(1mk)

13. 25.0cm^3 of 0.12M potassium hydroxide solution required 30.0cm^3 of a solution of a dibasic acid (H_2Y) for complete neutralization. The acid contained 3.15g per 500cm^3 solution.

Calculate:

(a) The molarity of the acid solution (1½mks)

(b) The relative formula mass of the acid.

(1½mks)

14. Zinc Sulphate can be used as a dietary supplement in cases of suspected zinc deficiency. The compound crystallizes as anhydrated salt and is readily water soluble.

(b) In a simple experiment to **determine** the extent of hydration, a technician carefully heated 3.715g of crystals to a moderate temperature until no further loss in mass occurred. The anhydrous zinc had a mass of 2.08g.

(i) **How many** moles of zinc are there in 2.08g of anhydrous zinc Sulphate? **(Zn = 65, O = 16, S = 32, H = 1)**
(2mks)

(ii) **How many** moles of water were lost? (2mks)

(iii) **Determine** the value of n in the formula $ZnSO_4$. nH2O. (2mks)

(c) The daily intake of zinc in Kenya is 15mg per adult person.

(i) **What** mass of zinc Sulphate crystals would need to be taken to obtain this intake? (2mks)

(ii) If this is taken via a 5ml dose of aqueous zinc Sulphate, calculate the concentration of this solution in molcm^{-3} of the hydrated salt. (2mks)

ORGANIC CHEMISTRY 1

1. (a) In terms of molecular structure, explain why butane is described as a *saturated* hydrocarbon.

.....

.....[1]

(b) The main use of butane is a fuel in the form of liquefied petroleum gas.

(i) When butane is burnt completely in excess air, only two substances are formed.

Name these two substances.

substance 1 .....

substance 2 .....

[2]

(ii) Explain why butane can be described as a *clean* fuel when burnt completely.

.....

.....[2]

[Total 5m]

2. Methane belongs to a homologous series called the alkanes.
What do you understand by the term homologous series ?

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[2]

3. List **three** characteristics of an homologous series, and explain the term *functional group.*

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(3)

4. (a)(i) State and explain the trend in the boiling points of the first five alkanes.

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(2)

(ii) Explain why the enthalpies of combustion of alkanes are negative values.

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(1)

(b) State the products of the complete combustion of alkanes.

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(2)
(Total 5 marks)

5. Catalytic cracking is carried out by oil companies to produce high grade petrol. The process is carried out using an aluminium oxide catalyst.

The reaction is a type of thermal decomposition.

(a) Explain the meaning of

(i) *thermal decomposition.*

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.....

(ii) *catalyst.*

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..... [2]

(b) A typical 'cracking' reaction is

$$C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$$

State the name of the unsaturated compound in this equation.

..... [1]

(c) The table shows some of the products obtained by cracking 100g of different 'fractions'under the same conditions.

	products obtained / g per 100g of 'fraction' cracked			
'fraction'	hydrogen	methane	ethene	petrol
ethane	10	5	75	2
paraffin	1	15	30	23
diesel	0	6	20	17

(i) Which 'fraction' is the best source of fuel for cars?

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.....

(ii) Calculate the amount of paraffin 'fraction' needed to make 600g of methane.

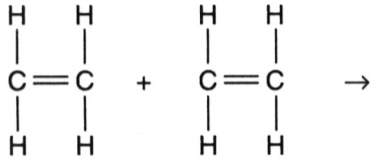
(iii) Complete the equation for the cracking of ethane to produce hydrogen and ethene.

$C_2H_6 \rightarrow$ ..... + ...

[4]

(d) Ethene can be polymerised to form poly(ethene).

(i) Complete the equation below to show the structure of **two** units in the poly(ethene) molecule.



(ii) State the name given to this type of polymerisarion.

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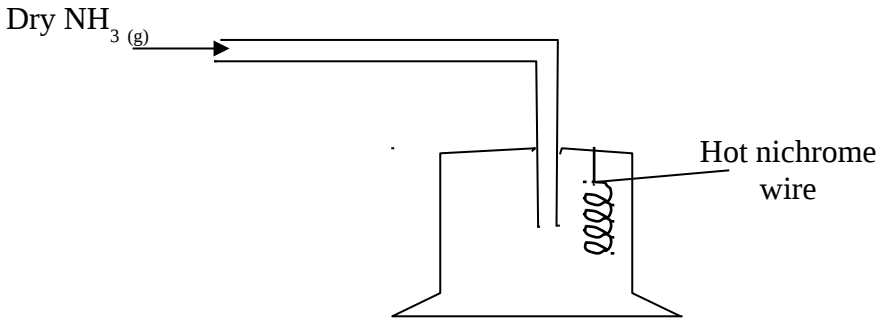
.....[2]

NITROGEN AND ITS COMPOUNDS

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

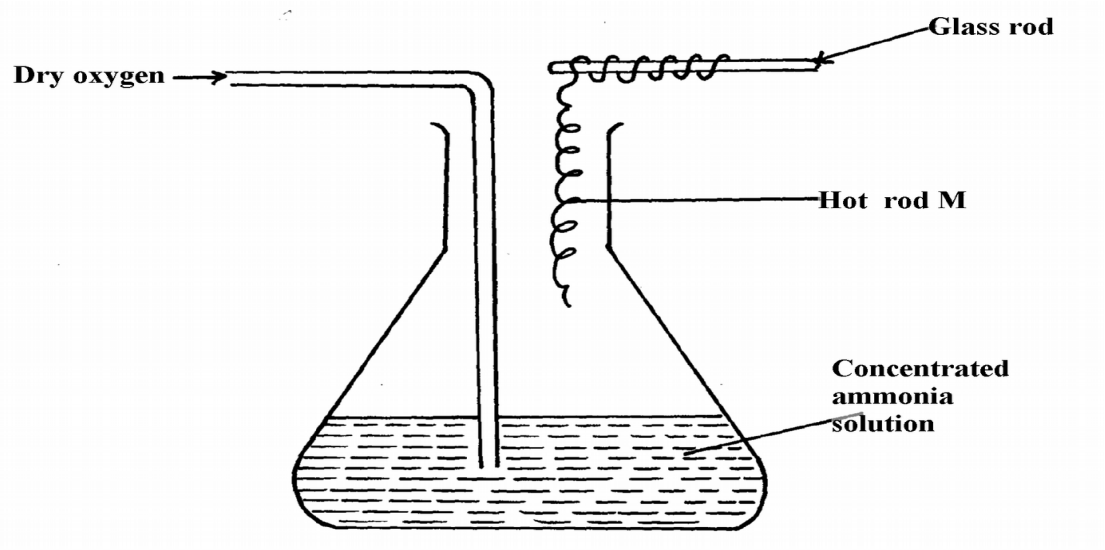


(i) Write an equation for the reaction that takes place

(ii) Why is it necessary to have a hot nichrome wire in the gas jar?

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

2. The diagram below shows the catalytic oxidation of ammonia gas. Use it to answer the questions that follow:-

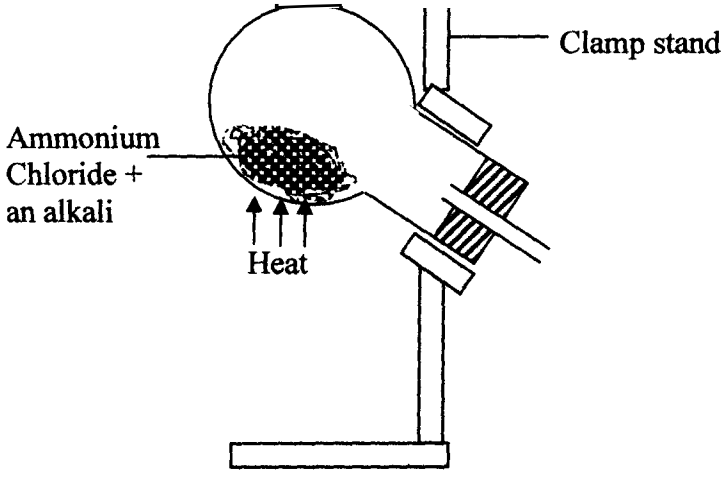


(a) What metal could rod **M** be made of?

(b) State and explain **two** observations made inside the conical flask

3. Ammonia gas is prepared in the laboratory by the action of an alkali on an ammonium salt.

A student wanted to prepare a sample of ammonia gas in the laboratory.



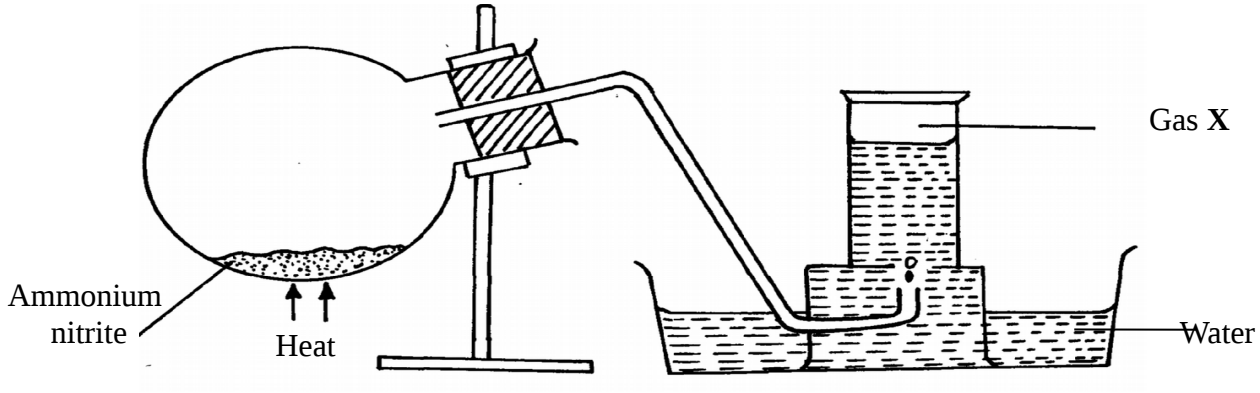
(a) Give **one** alkali that can be used in the above experiment

(b) Write an equation for the reaction that takes place in the above experiment

4. (a) Explain the importance of the high percentage of nitrogen in air

(b) Why is nitrogen used for storage of semen in artificial insemination?

5. The diagram below is used in preparation of a gas in the laboratory. Answer the questions that follow;

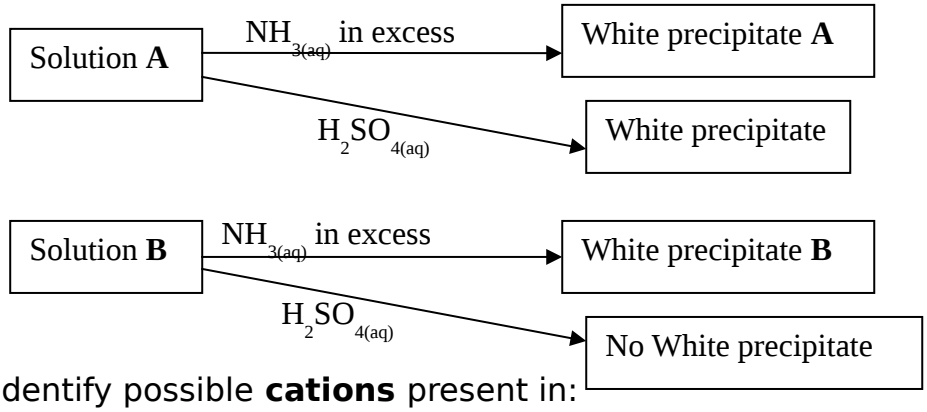


(a) Name gas **X** .....

(c) State **one** physical property which makes it possible for the gas to be collected as shown

(d) State **one** commercial use of gas **X**

6 Study the flow charts below and use them to answer the questions that follow:



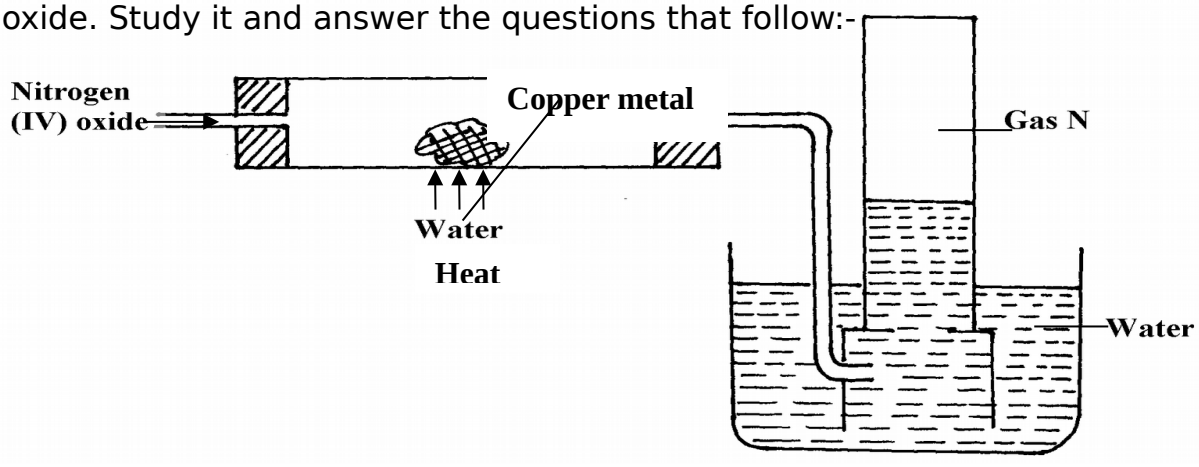
(a) Identify possible **cations** present in:

(i) Solution **A**

(ii) Solution **B**

(b) State and explain the observations made when a sample of dry white precipitate **B** is heated in a test-tube

7. The set-up below is an arrangement showing how metals react with nitrogen (IV) oxide. Study it and answer the questions that follow:-



(a) Nitrogen (IV) oxide is passed through the combustion tube before copper is heated. Give a reason for this

(b) State the observations that would be made at the end of the experiment in the combustion tube

(c) Name gas **N** .....

8. (a) In haber process hydrogen and nitrogen react in the presence of finely divided iron catalyst.
Explain why the catalyst is finely divided

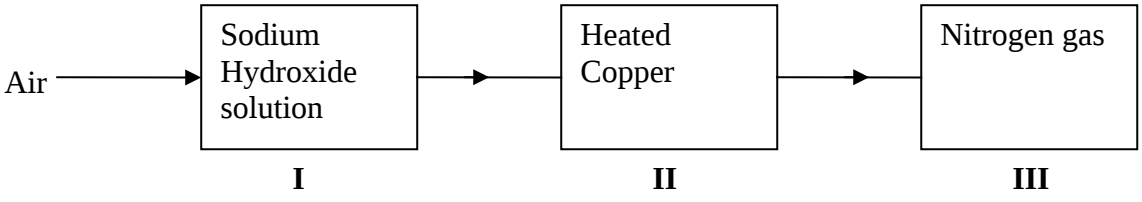
(b) A mixture of N_2, H_2 and NH_3 was bubbled through 0.2M hydrochloric acid solution.
The final concentration of the acid was found to be 0.1M. Give explanation

9. In an experiment, a few drops of concentrated nitric acid were added to aqueous iron II sulphate in a test-tube. Excess ammonia solution was then added to the mixture
(a) State the observations that were made when:-
(i) Concentrated nitric acid was added to aqueous iron (II) sulphate

(ii) Excess ammonia was added to the mixture

(b) Write an ionic equation for the reaction which occurred in a (ii) above

10. The chart below shows a summary for the preparation of nitrogen gas from air



(a) What is the purpose of the sodium hydroxide?

(b) Write an equation for the reaction taking place in chamber **II**

(c) The nitrogen gas obtained is not pure. Explain

SULPHUR AND ITS COMPOUNDS

1. In an attempt to prepare sulphur (IV) oxide gas, dilute sulphuric acid was reacted with barium carbonate. The yield of sulphur dioxide was found to be negligible. Explain (2mks)

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2. Explain why the bleaching action of chlorine is permanent while bleaching by Sulphur (IV) Oxide is temporary. (2marks)

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3. Write down the property of concentrated Sulpuric (VI) acid shown in the following reactions. (2marks)

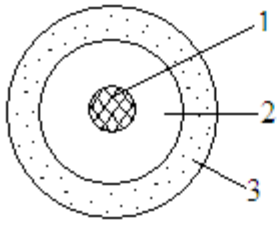
(iii) $H_2C_2O_4.2H_2O_{(s)} \longrightarrow 2H_2O_{(l)} + CO_{2(g)} + CO_{(g)}$

Property: ----------

(iv) $C_{(s)} + 2H_2SO_{4(l)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)} + 2SO_{2(g)}$

Property: .....

4. The diagram below represents pipes used in Frasch pump for the extraction of sulpur



Which substance passes through tube?

(iv) _____

(v) _____

(vi) _____ (3marks)

5. a) What property of concentrated sulphuric acid is illustrated by its action on:

(i) Sugar (½ mk)

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(ii) Copper metal (½ mk)

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b) Write the equation for the reaction of concentrated sulphuric acid with copper metal.

(1mk)

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6. A concentrated solution of Sulphuric (VI) acid contains 75% of H_2SO_4 with a specific gravity of 1.84.

c. **Wha**t is the molarity of the sulphuric acid?

(1½mks)

d. **What** volume of the acid is required to make 1 litre of 0.25M Sulphuric acid? (1 ½ mks)

(c) Concentrated sulphuric (VI) acid can be used to dry sulphur (IV) oxide gas.

(a) **Explain** why concentrated sulphuric (VI) acid cannot be used to dry ammonia gas. (1mk)

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(b) **Name** the dry agent for ammonia gas. (1mk)

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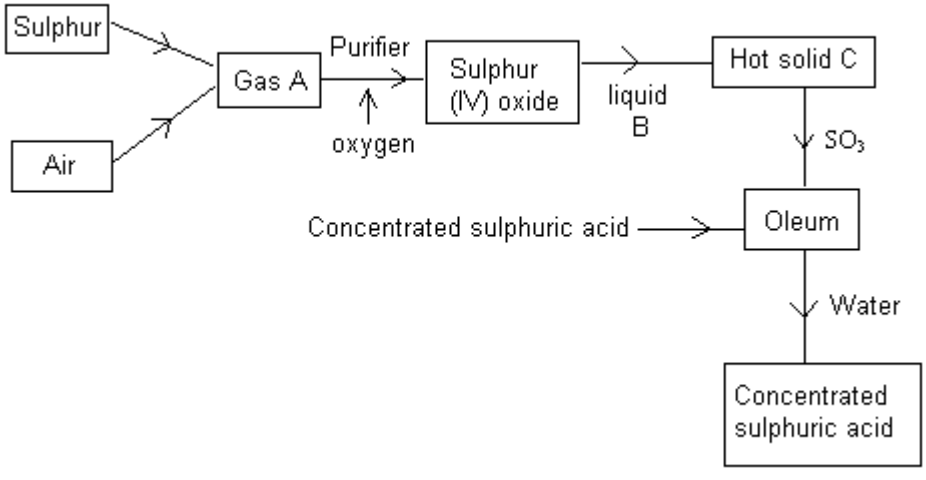
8. The flow chart below represents the main drops in the contact process.



(c) **Why** are the gases **A** and oxygen purified? (1mk)

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(d) **Write** an equation for the formation of Oleum. (1mk)

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(e) **What** is **C** likely to be? (1mk)

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9. Hydrogen sulphide gas was mistakenly dried using concentrated sulphuric (IV) acid.

a) Write an equation for the reaction that took place. (1mk)

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b) Using oxidation numbers, identify the reducing agent. (1mk)

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c) Write an equation for the chemical test of hydrogen sulphide. (1mk)

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10. A gas, G is prepared in the laboratory by adding concentrated sulphuric(VI)acid to a compound C. Gas G is denser than air and dissolves in water to form a solution which is strongly acidic.

(a) Name two gases that are most likely to be G. (2mks)

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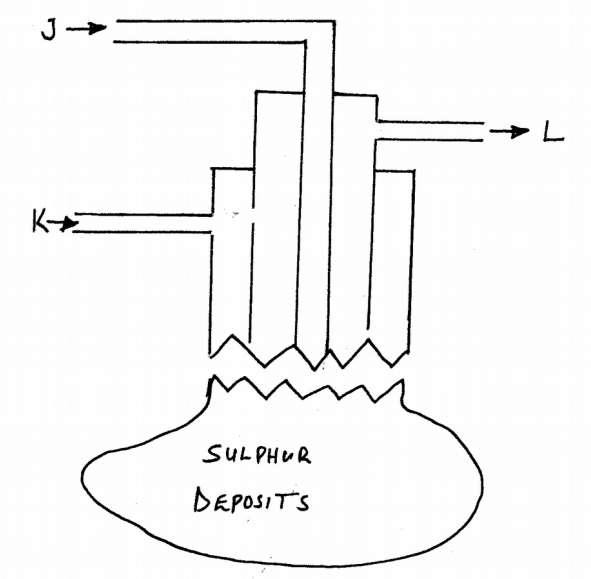
(v) Draw a diagram to show how gas G can be collected.

(1mk)

11. Sulphur is extracted from underground deposits by a process in which three concentric pipes are sunk down to the deposits as shown below.



(a) Name the process represented above. (1mk)

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(b) What is passed down pipe J? (1mk)

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(c) Name the two allotropes of sulphur (1mk)

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CHLORINE AND ITS COMPOUNDS

1.. (i) Name one drying agent for hydrogen chloride (1mk)

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(ii) State and explain the observation that would be made when hydrogen chloride gas is bubbled into a solution of silver nitrate. (2mks)

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2. a) State two substances that can be used separately to prepare chlorine gas with concentrated hydrochloric acid. (1mk)

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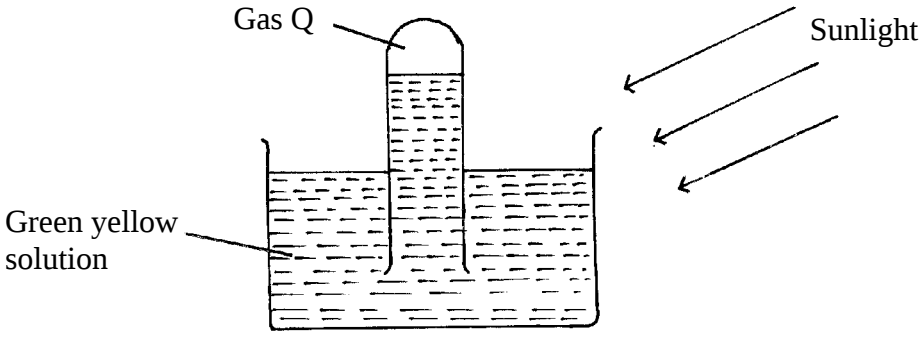
b) Chlorine gas was bubbled through water for some time. The green yellow solution formed was poured into a long glass tube as shown below.



Write the equation for the formation of substance Q. (1mk)

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c) State one use to which the green – yellow solution in (b) above can be put. (1mk)

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3. Chlorine may be prepared in the laboratory by the action of concentrated Hydrochloric acid on Manganese (IV) Oxide.

e. **What** is role of Manganese (IV) Oxide in this reaction?
(1mk)

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f. **Write** the chemical equation for the reaction taking place.
(1mk)

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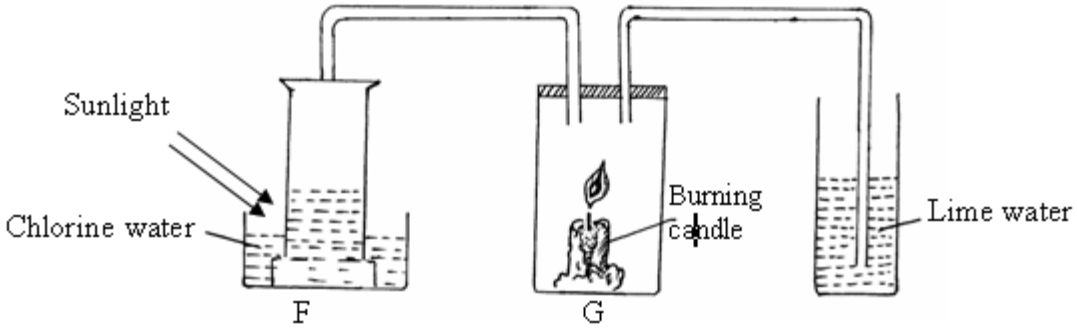
4. The diagram below was set-up to investigate a certain property of chlorine gas.



a) Write an ionic equation for the reaction taking place in part F. (1mk)

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b) State two observations made in part G. (2mks)

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