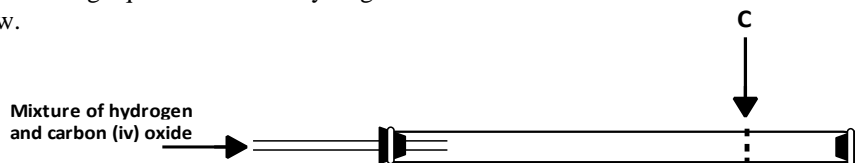


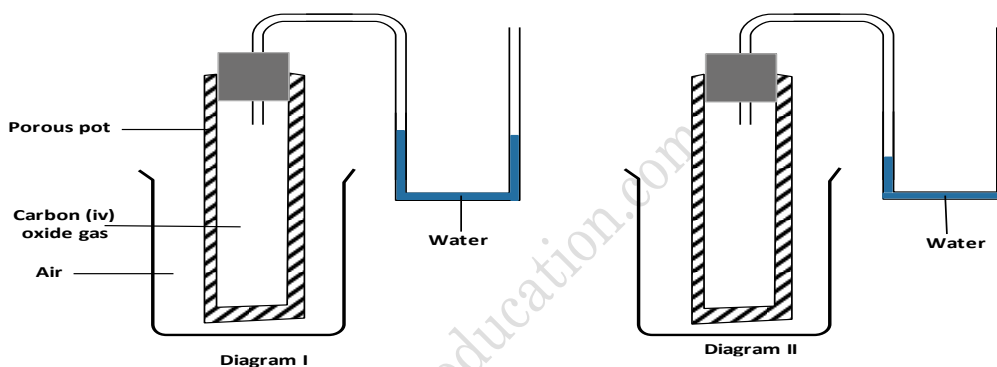
13. GAS LAWS

1. A mixture containing equal volumes of hydrogen and carbon dioxide was introduced at one end of a tube as shown below.



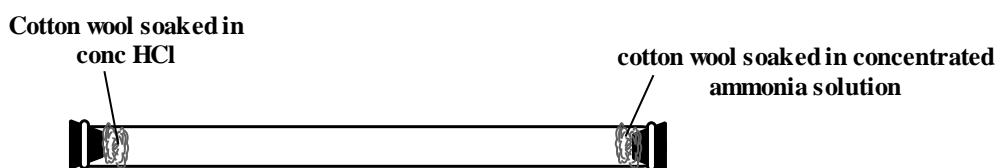
Which gas would be detected at appoint C first? Explain (2 marks)

2. In an experiment to study the diffusion of gases, a student set up the apparatus shown in diagram I. After sometime the student noticed a change in the water level as shown in the diagram II.

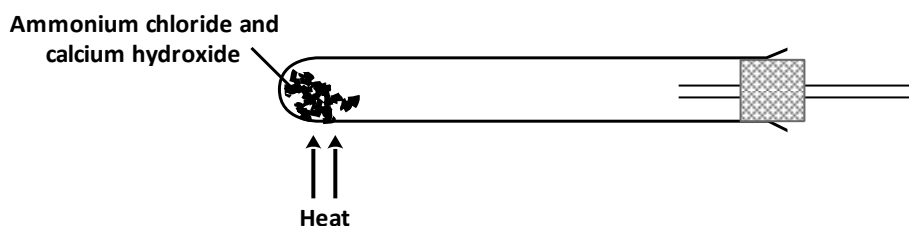


Give an explanation for the change in water level (2 marks)

3. A fixed mass of a gas has a volume of  $250\text{cm}^3$  at a temperature of  $27^\circ\text{C}$  and  $750\text{mm Hg}$  pressure. Calculate the volume the gas would occupy at  $42^\circ\text{C}$  and  $750\text{mm Hg}$  pressure. (2 marks)
4. Study the set – up below and answer the questions that follow.

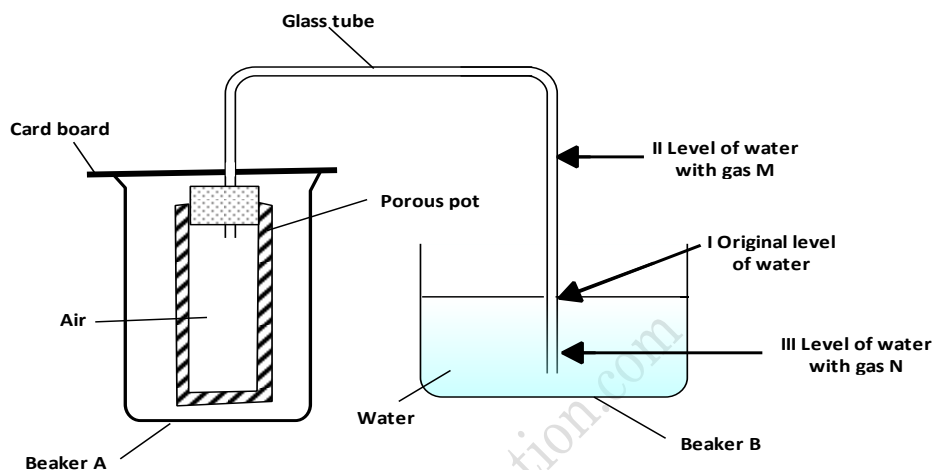


- (a) What observation would be made in the tube? (1 mark)
- (b) Indicate with across (x) on the diagram the likely position where the observation stated in (a) above would be made. (1 mark)
5. Complete the diagram below to show how a sample of aqueous ammonia can be prepare in the laboratory.



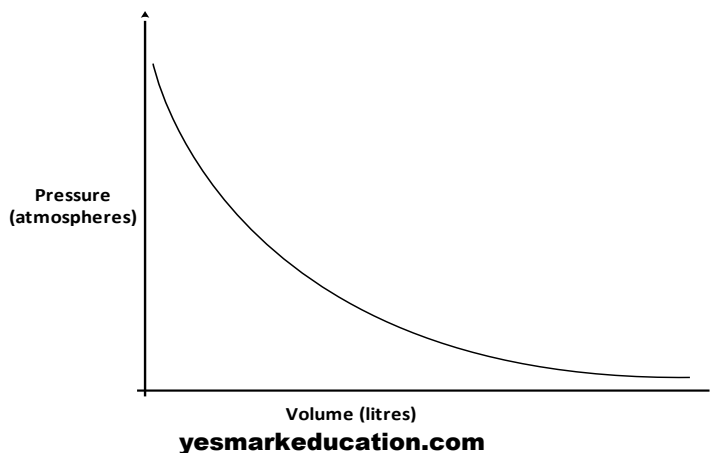
(2marks)

6. A gas occupies a volume of  $400\text{cm}^3$  at  $500\text{k}$  and  $1$  atmosphere pressure. What will be the temperature of the gas when the volume and pressure of the gas is  $100\text{cm}^3$  and  $0.5$  atmospheres respectively? (2 marks)
7. A sealed glass tube containing air at **s.t.p** was immersed in water at  $100^\circ\text{C}$ . Assuming that there was no increase in the volume of the glass tube due to the expansion of the glass, calculate the pressure of the inside tube. (standard pressure =  $760\text{mmHg}$ , standard temperature =  $273\text{K}$ ) (3 marks)
8. The set up below was used to investigate some properties of two gases M and N.

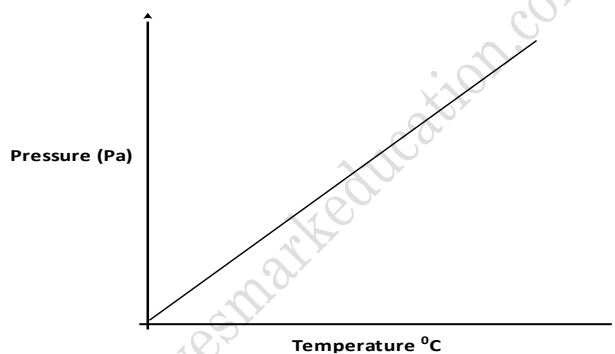


When beaker A was filled with gas M, the level of water in the glass tube rose to point II. When the experiment was repeated using gas N, the level of water dropped to point III. Explain these observations. (3 marks)

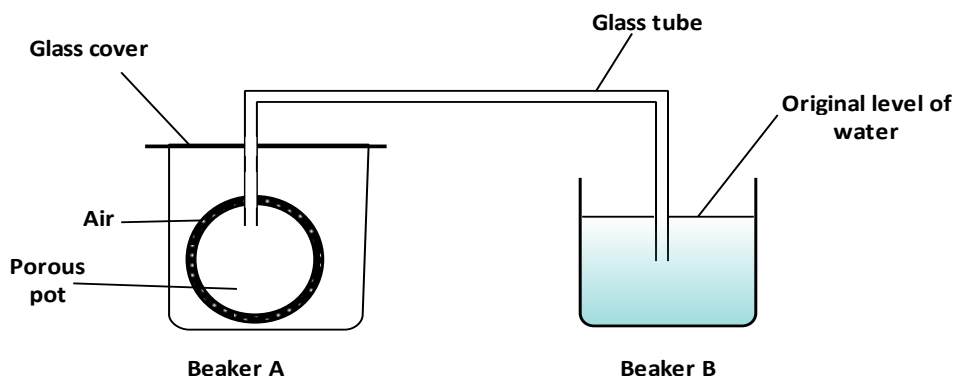
9. A given volume of ozone, ( $\text{O}_3$ ) diffused from a certain apparatus in  $96$  seconds. Calculate the time taken by an equal volume of carbon dioxide ( $\text{CO}_2$ ) to diffuse under the same conditions ( $\text{O} = 16.0$ ,  $\text{C} = 12.0$ ) (3 marks)
10. In an experiment, ammonia chloride was heated in a test tube. A moist red litmus paper placed at the mouth of the test tube first changed blue then red. Explain these observations. (3 marks)
11. A few crystals of potassium permanganate were carefully placed into water in a beaker at one spot. The beaker was left undisturbed for two hours. State and explain the observation that was made. (2 marks)
12. The graph below shows the behaviour of a fixed mass of a gas at constant temperature.



- (a) What is the relationship between the volume and the pressure of the gas? (1 mark)
- (b) 3 litres of oxygen gas at one atmosphere pressure were compressed to two atmospheres at constant temperature. Calculate the volume occupied by the oxygen gas (2 marks)
13.  $60\text{cm}^3$  of oxygen gas diffused through a porous partition in 50 seconds. How long would it take  $60\text{cm}^3$  of sulphur (IV) oxide gas to diffuse through the same partition under the same conditions? ( $S = 32.0$ ,  $O = 16.0$ ) (3marks)
14. (a) State the Charles law (1 mark)
- (b) The volume of a sample of nitrogen gas at a temperature of  $291\text{ K}$  and  $1.0 \times 10^5$  Pascal's was  $3.5 \times 10^{-2}\text{m}^3$ . Calculate the temperature at which the volume of the gas would be  $2.8 \times 10^{-2}\text{m}^3$  at  $1.0 \times 10^5$  Pascal. (2 marks)
15. A small crystal of potassium manganate (VII) was placed in a beaker water. The beaker was left standing for two days without shaking. State and explain the observations that were made. (2 marks)
16. (a) State the Graham's law diffusion. (1 mark)
- (c) The molar masses of gases W and X are  $16.0$  and  $44.0$  respectively. If the rate of diffusion of W through a porous material is  $12\text{cm}^3\text{s}^{-1}$  calculate the rate of diffusion of X through the same material. (2 marks)
17. The graph below shows the relationship between pressure and the temperature of a gas in a fixed volume container.



- (a) State the relationship between pressure and temperature that can be deduced from the graph. (1 mark)
- (b) Using kinetic theory, explain the relationship shown in the graph. (2 marks)
18. A certain mass of gas occupies  $0.15\text{dm}^3$  at  $293\text{K}$  and  $98,648.5\text{Pa}$ . Calculate its volume at  $101,325\text{Pa}$  and  $273\text{K}$ . (2 marks)
19. The set up shown below was used to investigate a property of hydrogen gas.

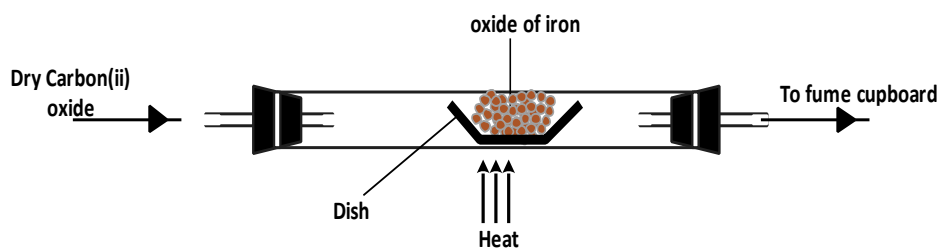


State and explain the observation that would be made in the glass tube if beaker A was filled with hydrogen gas. (3 marks)

20. (a) State Charles' Law (1 mark)  
(b) A certain mass of gas occupies 146dm<sup>3</sup> at 291 K and 98.31 kPa. What will be its volume is reduced to 133dm<sup>3</sup> at 101.325 kPa? (2 marks)
21. 100 cm<sup>3</sup> of a sample of ethane gas diffuses through a porous pot in 100 seconds. What is the molecular mass of gas Q if 100 cm<sup>3</sup> of the gas diffuses through the same porous pot in 121 seconds under the same conditions? (C = 12.0, H = 1.0) (3 marks)

#### 14. THE MOLE

1. Calculate the amount of calcium carbonate that would remain if 15.0g of calcium carbonate were reacted with 0.2 moles of hydrochloric acid. The equation for the reaction is
- $$\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$$
- (C = 12.0, O = 16.0, Ca = 40.0) (3 marks)
2. A compound has an empirical formula, C<sub>3</sub>H<sub>6</sub>O and a relative formula mass of 116.  
(a) Determine its molecular formula (H = 1.0, C = 12.0, O = 16.0) (2 marks)  
(b) Calculate the percentage composition of compound by mass in the compound (1 mark)
3. Zinc metal and hydrochloric acid reacts according to the following equation
- $$\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$$
- 1.96 g of zinc were reacted with 100cm<sup>3</sup> of 0.2M hydrochloric acid.  
(a) Determine the reagent that was in excess. (2 marks)  
(b) Calculate the total volume of hydrogen gas was liberated S.T.P (Zn = 65.4 Molar gas volume = 22.4 litres at S.T.P) (1 mark)
4. In an experiment, 2.4g of sulphur was obtained by reacting hydrogen sulphide and chlorine as shown by the equation below:
- $$\text{H}_2\text{S}(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{S}(\text{s}) + 2\text{HCl}(\text{g})$$
- (a) Which of the reactants acts as a reducing agent in the above reaction? Explain. (1 mark)  
(b) Given that the yield of sulphur in the above reaction is 75%, calculate the number of moles of H<sub>2</sub>S (g) used in the reaction (S = 32.0) (2 marks)
5. 0.63g of lead powder were dissolved in excess nitric acid to form lead nitrate solution. All the lead nitrate solution was reacted with sodium sulphate solution.  
(a) Write an ionic equation for the reaction between lead nitrate and sodium sulphate solutions. (1 mark)  
(b) Determine the mass of the lead salt formed in (a) above. (Pb = 207.0, S = 32.0, O = 16.0) (2 marks)
6. Calculate the mass of nitrogen dioxide gas that would occupy the same volume as 10g of hydrogen gas at same temperature and pressure. (H = 1.0, N = 14.0, O = 16.0) (2 marks)
7. On complete combustion of a sample of hydrocarbon, 3.52 gm of carbon dioxide and 1.44gm of water was formed. Determine the molecular formula of the hydrocarbon. (Relative molecular masses of hydrocarbon = 56, carbon dioxide = 44, water = 18 and relative atomic masses H = 1.0 and C = 12.0) (3 marks)
8. (a) An ore is suspected to contain mainly iron. Describe a method that can be used to confirm the presence of iron in the ore. (4 marks)  
(b) Excess carbon monoxide gas was passed over a heated sample of an oxide of iron as shown in the diagram below. Study the diagram and the data below it to answer the questions that follow.

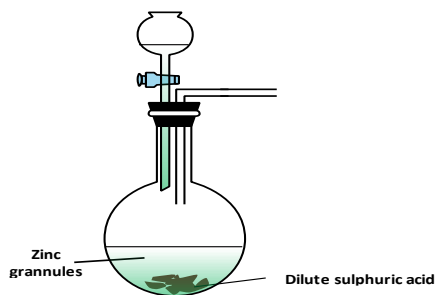


Mass of empty dish = 10.98g

Mass of empty dish + oxide of iron = 13.30g

Mass of empty dish + residue = 12.66g

- (i) Determine the formula of the oxide of iron. (relative formula mass of iron oxide = 232, Fe = 56.0, O = 16.0) (3 marks)
- (ii) Write an equation for the reaction which took place in the dish. (1 mark)
- (c) Corrosion is a destructive process in which iron which is converted into hydrated Iron (III) oxide. State:
- (i) **Two** conditions necessary for rusting to occur. (1 mark)
- (ii) **One** method used to protect iron from rusting (1 mark)
- (d) Explain why it is not advisable to wash vehicles using sea water. (2 marks)
9. 4.76g of liquid ammonia and 4.76g of liquid nitrogen were each allowed to warm up and expand into gas at room temperature and pressure. Relative atomic masses: H=1.0 and, N=14.0. Using the data given above, explain which gas occupied the greater volume (3 marks)
10. 5.6g of potassium hydroxide were dissolved in distilled water to make 100cm<sup>3</sup> of solution. 50cm<sup>3</sup> of the solution required 50cm<sup>3</sup> of 2M nitric (V) acid for complete neutralization. Calculate the mass **D**, of potassium hydroxide.  
 $\text{KOH(aq)} + \text{HNO}_3(\text{aq}) \rightarrow \text{KNO}_3(\text{aq}) + \text{H}_2\text{O(l)}$   
 Relative formula mass of KOH = 56 (3 marks)
11. 20.0cm<sup>3</sup> of a solution containing 4 gm per litre of sodium hydroxide was neutralized by 8.0cm<sup>3</sup> of dilute sulphuric (VI) acid. Calculate the concentration of sulphuric (VI) acid in moles per litre (Na = 23.0, O = 16.0, H = 1.0) (3 marks)
12. A weighed sample of crystalline sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>.nH<sub>2</sub>O) was heated in a crucible until there was no further change in mass. The mass of the sample reduced by 14.5%. Calculate the number of moles (n) of the water of crystallization. (Na = 23, O = 16, C = 12, H = 1) (3 marks)
13. In an experiment 30cm<sup>3</sup> of 0.1 M sulphuric acid were reacted with 30cm<sup>3</sup> of 0.1 M sodium hydroxide
- (a) Write an equation of the reaction that took place. (1 mark)
- (b) State the observations that were made when both red and blue litmus papers were dropped into the mixture. (1 mark)
- (c) Give a reason for your answer in (a) above. (1 mark)
14. When excess lead nitrate solution was added to a solution containing sodium chloride, the precipitate formed was found to weigh 5.56 g. Determine the amount of sodium chloride in the solution (Pb = 207, Cl = 35.5, Na = 23) (3 marks)
15. When excess dilute hydrochloric acid was added to sodium sulphite, 960cm<sup>3</sup> of sulphur (IV) oxide gas was produced. Calculate the mass of sodium sulphite that was used. (molar mass of sodium = 23 g and molar gas volume = 24000cm<sup>3</sup>) (3 marks)
16. The set-up below was used to prepare hydrogen gas.



- (a) Complete the diagram to show how a dry sample of hydrogen gas can be collected. (2 marks)
- (b) Write an equation for the reaction, which takes place when hydrogen gas burns in air. (1 mark)
- (c) (i) 1.2 litres of hydrogen gas produced at room temperature and pressure when 3.27g of zinc was used. Determine the relative atomic mass of zinc. (Molar gas volume is 24 litres). (4 marks)
- (ii) State two industrial uses of hydrogen gas. (2 marks)
- 17.** When  $X \text{ cm}^3$  of a solution of 0.5m magnesium carbonate was 8.4g.
- (a) Write the ionic equation for the reaction that took place. (1 mark)
- (b) Calculate the value of X. (C = 12.0, Mg 24.0; 016.0) (2 marks)
- 18.** A certain carbonate,  $\text{GCO}_3$ , reacts with dilute hydrochloric acid according to the equation given below:  

$$\text{GCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{GCl}_2(\text{aq}) + (\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}))$$
 If 1 g of the carbonate reacts completely with  $20 \text{ cm}^3$  of 1 M hydrochloric acid, calculate the relative atomic mass of G. (C = 12.0 = 16.0) (3 marks)
- 19.** When a hydrocarbon was completely burnt in oxygen, 4.2g of carbon dioxide and 1.71 g of water were formed. Determine the empirical formula of the hydrocarbon (H= 1.0; C= 12.0; O = 16.0) (3 marks)
- 20.** When 94.5g of hydrated barium hydroxide,  $\text{Ba}(\text{OH})_2 \cdot n\text{H}_2\text{O}$  were heated to constant mass, 51.3g of anhydrous barium hydroxide were obtained. Determine the empirical formula of the hydrated barium hydroxide. (Ba =137.0; O = 16.0; H =1.0). (3 marks)
- 21.** (a) Distinguish between isotopes and allotropes. (2 marks)
- (b) The chart below is part of the periodic table. Study it and answer the questions that follow. (The letters are not the actual symbols of the elements).
- |   |   |  |  |   |  |  |   |
|---|---|--|--|---|--|--|---|
|   |   |  |  |   |  |  |   |
| A |   |  |  | B |  |  |   |
| C | D |  |  |   |  |  | E |
|   |   |  |  |   |  |  |   |
- (i) Select the element in period three which has the shortest atomic radius. Give a reason for your answer. (2 marks)
- (ii) Element F has the electronic structure, 2.8.18.4 on the chart above, indicate the position of element F. (1 marks)
- (iii) State one use of the elements of which E is a member. (1 mark)
- (iv) Write an equation to show the action of heat on the nitrate of element C. (1marks)
- (c) When 3 litres of chlorine gas were completely reacted with element D, 11.875g of the product were formed. Determine the relative atomic mass of element D. (Atomic mass of chlorine = 35.5; molar gas volume = 24litres). (3 marks)
- 22.**  $15.0 \text{ cm}^3$  of ethanoic acid ( $\text{CH}_3\text{COOH}$ ) was dissolved in water to make  $500 \text{ cm}^3$  of solution. Calculate the concentration of the solution in moles per litre. (C=12.0; H = 1.0; O=16.0; density of ethanoic acid is  $1.05 \text{ g/cm}^3$ ) (3 marks)

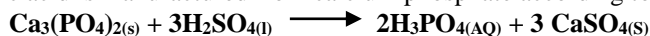
23. 6.84g of aluminium sulphate were dissolve in 150cm<sup>3</sup> of water. Calculate the molar concentration of the sulphate ions in the solution. (Relative formula mass of aluminium sulphate is 342). (3 marks)

24. When a hydrated sample of calcium sulphate, CaSO<sub>4</sub> XH<sub>2</sub>O was heated until all the water was lost, the following data recorded;

Mass of crucible	= 30.296 g
Mass of crucible +hydrated salt	= 33.111 g
Mass of crucible + anhydrous salt	= 32.781 g

Determine the empirical formula of the hydrated salt (Relative formula mass of CaSO<sub>4</sub>=136, H<sub>2</sub>O =18). (3 marks)

25. Phosphoric acid is manufactured from calcium phosphate according to the following equation.



Calculate the mass in (Kg) of phosphoric acid that would be obtained if 155 Kg of calcium phosphate reacted completely with the acid. (Ca=40, P=31, S=32, O=16, H=1)

(2 marks)

26. In an experiment to determine the percentage of magnesium hydroxide in an anti-acid, a solution containing 0.50 g of the anti-acid was neutralized by 23.0 cm<sup>3</sup> of 0.010M hydrochloric acid (Relative formula mass of magnesium hydroxide =58)

(a) Mass of magnesium hydroxide in the anti-acid; (2 marks)

(b) Percentage of magnesium hydroxide in the anti-acid (1 mark)

27. Starting with 50 cm<sup>3</sup> of 2.8M sodium hydroxide, describe how a sample of pure sodium sulphate crystals can be prepared. (3 marks)

28. When 8.53 of sodium nitrate were heated in an open test-tube the mass of oxygen gas produced was 0.83 g. Given the equation of the reaction as



Calculate the percentage of sodium nitrate that was converted to sodium nitrite (Na = 23.0 N = 14.0 O = 16.0)

(3 marks)

29. Aluminium oxide reacts with both acids and bases.

(a) Write an equation for the reaction between aluminium oxide and hydrochloric acid. (1 mark)

(b) Using the equation in (a) above, calculate the number of moles of hydrochloric acid that would react completely with 153.0g of aluminium oxide. (AL = 27.0, O= 16.0) (2 marks)

30. The pressure of nitrogen gas contained in a 1dm<sup>3</sup> cylinder at -196<sup>0</sup>C was 10<sup>7</sup> Pascal's.

Calculate the:

(a) Volume of the gas at 25<sup>0</sup>C and 10<sup>5</sup> Pascals. (1½ marks)

(b) Mass of nitrogen gas (Molar volume of gas is 24dm<sup>3</sup>, N = 14.0) (1½ marks)

31. Analysis of a compound showed that it had the following composition: 69.42% carbon, 4.13% hydrogen and the rest oxygen.

(a) Determine the empirical formula of the compound. (C = 12.0, H = 1.0, O = 16.0) (2 mark)

(b) If the mass of one mole of the compound is 242, determine its molecular formula. (1 mark)

32. Use the information in the table below to answer the questions that follow. The letters do not represent the actual symbols of the elements.

Element	Atomic number	Melting point ( <sup>0</sup> C)
R	11	97.8
S	12	650.0
T	15	44.0
U	17	-102
V	18	-189
W	19	64.0

- (a) Give the reasons why the melting point of:
- S is higher than that of R (1 mark)
  - V is lower than that of U (2 marks)
- (b) How does the reactivity of W with chlorine compare with that of R with chlorine? Explain, (2 marks)
- (c) Write an equation for the reaction between T and excess oxygen. (1 mark)
- (d) When 1.15g of R were reacted with water, 600cm<sup>3</sup> of gas was produced. Determine the relative atomic mass of R. (Molar gas volume = 24000cm<sup>3</sup>). (3marks)
- (e) Give **one** use of element V (1 mark)
- 33.** When lead (II) nitrate is heated, one of the products is a brown gas.
- Write the equation of the reaction that occurs. (1 mark)
  - If 0.290dm<sup>3</sup> of the brown gas was produced, calculate the mass of the lead (II) nitrate that was heated. (R .F.M of lead (II) nitrate =331; Molar gas volume = 24 dm<sup>3</sup>). (2 marks)
- 34.** 50kg of ammonium sulphate (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and 30kg of urea CO(NH<sub>2</sub>)<sub>2</sub> fertilizers were applied in two equal sizes of plots A and B to enrich their nitrogen content. Show by working, which plot was more enriched with nitrogen. (N =14; S = 32; O = 16; C = 12; H = 1). (3 marks)
- 35.** (a) State the Gay Lussac's Law. (1 mark)
- 10 cm<sup>3</sup> of gaseous hydrocarbon, C<sub>2</sub>H<sub>X</sub> required 30 cm<sup>3</sup> of oxygen for complete combustion if steam and 20cm<sup>3</sup> of carbon (IV) oxide were produced, what is the value of X? (2 marks)
- 36.** The data given below was recorded when metal M was completely burnt in air. M is not the actual symbol of the metal. (R.A.M; = 6, O= 16)
- Mass of empty crucible and lid = 10.240g  
 Mass of crucible, lid and metal M =10.352g  
 Mass of crucible, lid and metal oxide =10.4000g
- Determine the mass of:
    - metal M; (1mark)
    - oxygen
  - Determine the empirical formula of the metal oxide. (2 marks)
- 37.** 10cm<sup>3</sup> of concentrated sulphuric (VI) acid was diluted to 100cm<sup>3</sup>. 10cm<sup>3</sup> of the resulting solution was neutralised by 36cm<sup>3</sup> of 0.1M sodium hydroxide solution. Determine the mass of sulphuric (VI) acid that was in the concentrated acid. (S = 32.0; H = 1.0; O = 16.0). (3 marks)
- 38.** The empirical formula of A is CH<sub>2</sub>Br. Given that 0.470g of A occupies a volume of 56cm<sup>3</sup> at 546K and 1 atmospheric pressure, determine its molecular formula. (H = 1.0, C = 12.0, Br = 80.0, molar gas volume at STP = 22.4 dm<sup>3</sup>). (3 marks)
- 39.** Describe how the percentage by mass of copper in copper carbonate can be determined. (3 marks)
- 40.** Describe how a solid sample of potassium sulphate can be prepared starting with 200cm<sup>3</sup> of 2M potassium hydroxide. (3 marks)
- 41.** When 15 cm<sup>3</sup> of a gaseous hydrocarbon P, was burnt in 100cm<sup>3</sup> of oxygen, the resulting gaseous mixture occupied 70cm<sup>3</sup> at room temperature and pressure. When the gaseous mixture was passed through potassium hydroxide solution, its volume decreased to 25cm<sup>3</sup>.
- What volume of oxygen was used during the reaction? (1 mark)
  - Determine the molecular formula of the hydrocarbon (2 marks)
- 42.** A solution was made by dissolving 8.2g of calcium nitrate to give 2 litres of solution. (Ca= 40.0; N = 14.0; O = 16.0)
- Determine the concentration of nitrate ions in moles per litre. (2 marks)
- 43.** (a) The grid given below represent part of the periodic table. Study it and answer the question that follow. The letters do not represent the actual symbols of elements.

<b>M</b>				<b>N</b>	<b>P</b>	<b>T</b>		
<b>R</b>								

- (i) Select a letter which represents an element that loses electrons most readily. Given a reason for your answer. (2 marks)
- (ii) Explain why the atomic radius of P is found to be smaller than that of N. (2marks)
- (iii) Element M reacts with water at room temperature to produce  $0.2 \text{ dm}^3$  of gas. Determine the mass of M which was reacted with water. (Molar gas volume at room temperature is  $24 \text{ dm}^3$ , Relative atomic mass of M =7). (3 marks)
- (b) Use the information in the table below to answer the questions that follow.  
(The letters are not the symbols of the elements)

<b>Element</b>	<b>State of oxide at room temperature</b>	<b>Type of oxide</b>	<b>Bonding in oxide</b>
<b>U</b>	<b>Solid</b>	<b>Acidic</b>	<b>Covalent</b>
<b>W</b>	<b>Solid</b>	<b>Basic</b>	<b>Ionic</b>
<b>X</b>	<b>Liquid</b>	<b>Neutral</b>	<b>Covalent</b>
<b>Y</b>	<b>Gas</b>	<b>Neutral</b>	<b>Covalent</b>

Identify a letter which represent an element in the table that could be calcium, carbon or sulphur. Give a reason in each case.

- (i) Calcium: (2 marks)
- (ii) Carbon: (2 marks)
- (iii) Sulphur: (2 marks)
44.  $100 \text{ cm}^3$  of  $0.05 \text{ M}$  sulphuric (VI) acid were placed in a flask and a small quantity of anhydrous sodium carbonate added. The mixture was boiled to expel all the carbon (IV) oxide.  $25 \text{ cm}^3$  of the resulting solution required  $18 \text{ cm}^3$  of  $0.1 \text{ M}$  sodium hydroxide solution to neutralize it. Calculate the mass of sodium carbonate added. (Na = 23.0; O = 16.0; C = 12.0) (3 marks)
45. An organic compound had the following composition 37.21% carbon, 7.75% hydrogen and the rest chlorine. Determine the molecular formula of the compound, given that the molecular mass of the compound is 65. (C = 12.0; H = 1.0; Cl = 35.5). (1 marks)

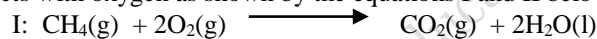
### 15. ORGANIC CHEMISTRY (I)

1. A Solution of chlorine in tetra chloromethane turns colourless when propene gas is bubble though it.
- (a) What type of reaction takes place? (1 mark)
- (b) Write an equation for the above reaction (1 mark)
2. (a) The table below gives information about the major constituents of crude oil. Study it and answer the questions that follow.

Constituent	Boiling point ( $^{\circ}\text{C}$ )
Gases	Below 40
Petrol	40-175
Kerosene	175-250
Diesel oil	250-350
Lubricating oil	350-400
Bitumen.	Above 400

- (i) Which one of the constituents of crude oil has molecules with the highest number of carbon atoms? (2 marks)
- (ii) Name the process you would use to separate a mixture of petrol and diesel and explain how the separation takes place. (2 marks)
- (iii) Explain why the constituent of crude oil and write its formula. (1 mark)
- (iv) Name one gas that is likely to be a constituent of crude oil and write its formula. (1 mark)
- (b) What condition could cause a poisonous gas to be formed when Kerosene is burnt? Explain (2 marks)
- (c) Give one use of bitumen (1 mark)
3. The reaction of propane with chlorine gas gave a compound of formula  $\text{C}_3\text{H}_7\text{Cl}$ .
- (a) What condition is necessary for the above reaction to take place? (1 mark)
- (b) Draw two structural formulae of the compound  $\text{C}_3\text{H}_7\text{Cl}$  (2 marks)

4. Methane reacts with oxygen as shown by the equations I and II below:



Which one of the two reactions represents the complete combustion of methane? Explain (2 marks)

5. Complete the table below by inserting the missing information in the space provided.

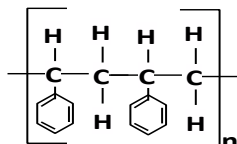
Name of polymer	Name of monomer	One use of the polymer
	_____	_____
_____	Vinyl chloride (Chloroethene)	_____

(2 marks)

6. The empirical formula of a hydrocarbon is  $\text{C}_2\text{H}_3$ . The hydrocarbon has a relative molecular mass of 54. ( $\text{H} = 1.0$ ,  $\text{C} = 12.0$ ).
- (a) Determine the molecular formula of the hydrocarbon. (1 mark)
- (b) Draw the structural formula of the hydrocarbon. (1 mark)
- (c) To which homologous series does the hydrocarbon drawn in (b) above belong? (1 mark)

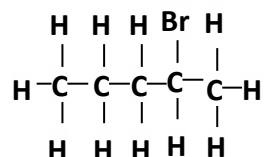
7. Name and draw the structure of the compound formed when methane reacts with excess chlorine in the presence of U.V light. (2 marks)

8. The formula given below represents a portion of a polymer Give:

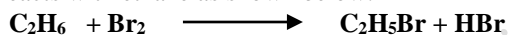


- (a) The name of the polymer. (1 mark)  
 (b) One disadvantage of continued use of this polymer. (1 mark)
9. A hydrocarbon slowly decolorizes bromine gas in the presence of sunlight but does not decolourise acidified potassium manganate (VII). Name and draw the structural formula of the fourth member of the series to which the hydrocarbon belongs. (2 marks)

10. Compound L reacts with hydrogen bromide gas to give another compound whose structure is

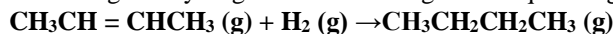


- (a) Give the structural formula and name of compound L. (2 marks)  
 (b) Write an equation for the reaction, which takes place between ethane and excess chlorine gas. (1 mark)
11. One of the fuels associated with crude oil is natural gas. Name the main constituent of natural gas and write an equation for its complete combustion (2 marks)
12. Bromine reacts with ethane as shown below.



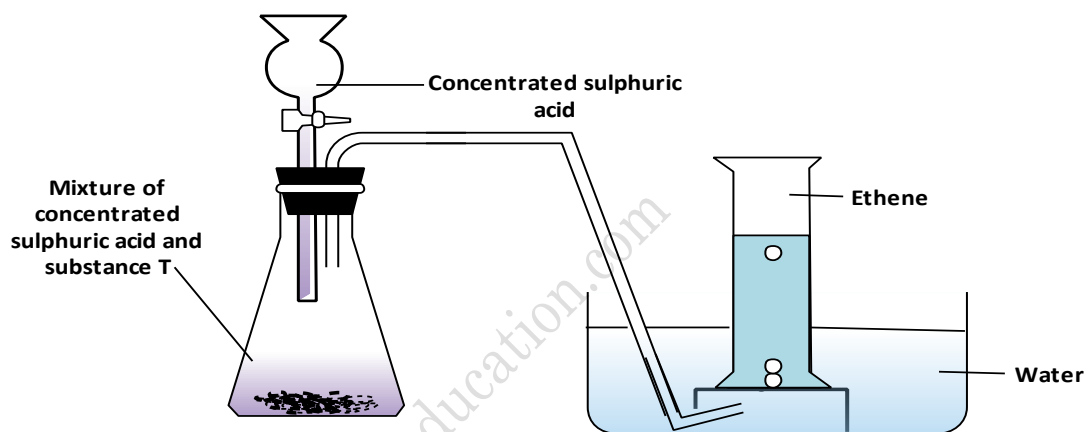
- (a) What condition is necessary for this reaction to occur? (1 mark)  
 (b) Identify the bonds which are broken and those that are formed. (2 marks)
13. A hydrocarbon P was found to decolourise bromine water. On complete combustion of 2 moles of P, 6 moles of carbon dioxide and 6 moles of water were formed.  
 (a) Write the structural formula of P. (1 mark)  
 (b) Give the name of P. (1 mark)  
 (c) Name one industrial source of P. (1 mark)
14. In the presence of U.V light, ethane gas undergoes substitution reaction with chlorine.  
 (a) What is meant by the term: Substitution reaction (1 mark)  
 (b) Give the structural formula and the name of the organic product formed when equal volumes of ethane and chlorine react together. (2marks)

15. But -2- ene undergoes hydrogenation according to the equation given below

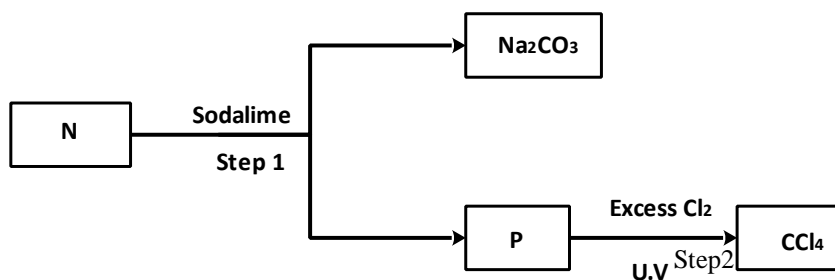


- (a) Name the product formed when but -2 - ene reacts with hydrogen gas. (1 mark)  
 (b) State one industrial use of hydrogenation. (1 mark)
16. (a) State the observation made when excess pentane is reacted with bromine gas. (1 mark)  
 (b) Name the compound formed in (a) above. (1 mark)
17. (a) What is the name given to the smallest repeating unit of a polymer. (1 mark)  
 (b) Draw the structure of the smallest repeating unit of a polyvinyl chloride (1 mark)
18. Name the organic compound formed when  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$  is reacted with concentrate sulphuric acid at  $170^\circ\text{C}$ . (1 mark)
19. (a) Crude oil is a source of many compounds that contain carbon and hydrogen only.

- (i) Name the processes used to separate the components of crude oil (1 mark)
- (ii) On what two physical properties of the above components does the separation depend? (2 marks)
- (b) Under certain conditions, hexane can be converted to two products.  
The formula of one of the products is  $C_3H_8$
- (i) Write the formula of the other product (1 mark)
- (ii) Describe a simple chemical reaction to show the difference between the two products formed in (b) above. (2 marks)
- (c) Ethyne,  $C_2H_2$  is another compound found in crude oil.  
One mole of ethane was reacted with one mole of hydrogen chloride gas and a product  $P_1$  was formed.  
 $P_1$  was then reacted with excess hydrogen gas to form  $P_2$ . Draw the structures  $P_1$  and  $P_2$ . (1 mark)
- (d) The set-up below was used to prepare and collect ethene gas. Study it and answer the questions that follow.

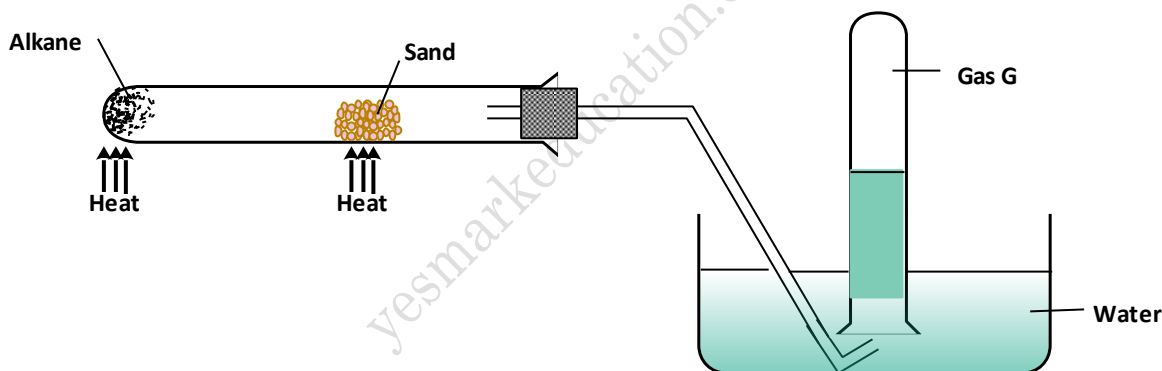


- (i) Name the substance **T**. (1 mark)
- (ii) Give the property of ethane that allows it to be collected as shown in the set up. (1 mark)
- (e) One of the reactions undergone by ethane is addition polymerization. Give the name of the polymer and one disadvantage of the polymer it forms. (2 marks)
- 20.** Give the name and draw the structural formula of the compound formed when one mole of ethane reacts with one mole of chlorine gas. (2 marks)
- 21.** Study the flow chart below and answer the questions that follow

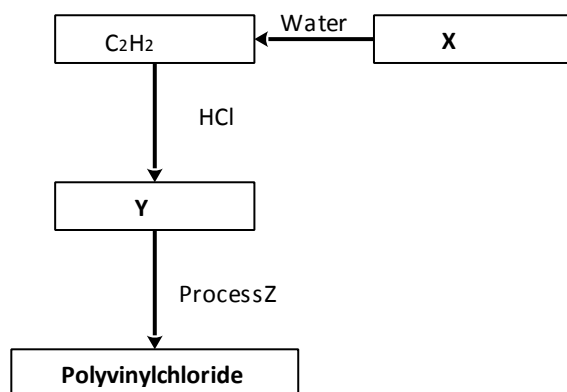


- (a) Identify **N** and **P** (2 marks)

- (b) What name is given to the type of halogenations/ chlorination reaction in step 2? (1 mark)
22. (a) What is meant by isomerism? (1 mark)  
 (b) Draw and name two isomers of butane. (2 marks)
23. A group of compounds called chlorofluorocarbons have a wide range of uses but they have harmful effects on the environment.  
 State **one**:  
 (a) Use of chlorofluorocarbons (1 mark)  
 (b) Harmful effect of chlorofluorocarbons on the environments. (1 mark)
24. The relative formula mass of a hydrocarbon is 58. Draw and name two possible structures of the hydrocarbon ( $C=12.0$ ;  $H=1.0$ ). (3 marks)
25. (a) Draw and name the structure of the compound formed when one mole of ethyne reacts with one mole of hydrogen bromide. (2 marks)  
 (b) Draw the structures of the alkynes whose molecular formula is  $C_4H_6$ . (1 mark)
26. The figure below represents the set up that was used to crack an alkane.



- (a) What was the purpose of the sand? (1 mark)  
 (b) After some time, a colourless gas G collected in the test-tube. Describe a chemical test and the observations that would be made in order to identify the class of compounds to which gas G belongs. (2 marks)
27. Draw the structure and give the name of the three alkanes having molecular formula  $C_5H_{10}$ . (3 marks)
28. Exhaust fumes of some cars contain carbon (ii) oxide and other gases.  
 (a) Explain how carbon (II) oxide is formed in the internal combustion engines. (1 mark)  
 (b) Name **two** gases other than carbon (II) oxide that are contained in the exhaust fumes and are pollutants. (2 marks)
29. Draw and name the isomers of pentane. (3 marks)
30. Study the flow chart below and answer the questions that follow:



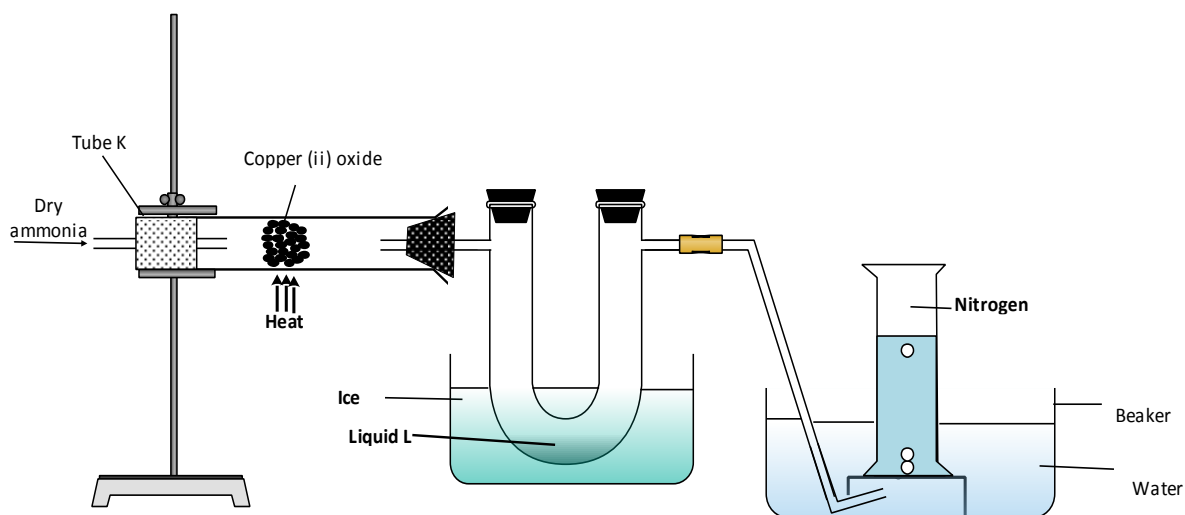
- (a) Identify:
- (i) X (1 mark)
- (ii) Y (1 mark)
- (c) State **two** use of polyvinylchloride. (1 mark)
31. (a) Draw and name the isomers of butyne. (2 marks)
- (b) State **one** use of polystyrene. (1 mark)

## 16. NITROGEN AND ITS COMPOUNDS

1. The table below gives some properties of gases D and E.

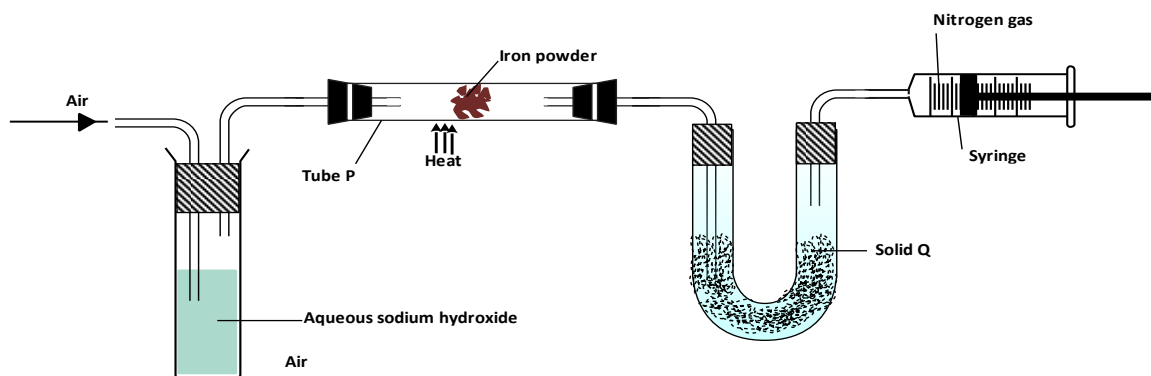
Gas	Density	Effects of H <sub>2</sub> SO <sub>4(aq)</sub>	Effects of NaOH <sub>(aq)</sub>
D	Lighter than air	Reacts to form a salt	Dissolves without reacting
E	Heavier than air	Not affected	Not affected.

- a) Describe how you would obtain a sample of E from a mixture of gases D and E. (2 marks)
- b) Suggest a possible identity of gas D. Give a reason for your answer. (1 mark)
2. Dilute nitric acid reacts with copper according to the equation;
- $$3\text{Cu}_{(s)} + 8\text{H}^+_{(aq)} + 2\text{NO}_3^- \longrightarrow 3\text{Cu}^{2+}_{(aq)} + 2\text{NO}_{(g)} + 4\text{H}_2\text{O}_{(l)}$$
- (a) What is the oxidation number of nitrogen in?
- (i) NO<sub>3</sub> (2 marks)
- (ii) NO (1 mark)
- (b) With respect to nitrogen, explain whether the above reaction is an oxidation or reduction process. (1 mark)
3. (a) The diagram below shows a set-up that can be used to obtain nitrogen gas in an experiment.



- (i) Name liquid L (1 mark)
- (ii) What observation would be made in tube K after heating for some time? (1 mark)
- (iii) Write an equation for the reaction that took place in tube K. (1 mark)
- (iv) If  $320 \text{ cm}^3$  of ammonia gas reacted completely with the copper?  
Calculate:
- Volume of nitrogen gas produced. (1 mark)
  - the mass of copper oxide that reacted (3 marks)
- (Cu = 63.5, O=16.0, one mole of gas occupies 24 liters at room temperature and pressure)
- (v) At the end of experiment the PH of the water in the beaker was found to be about 10. Explain (2 marks)
- (b) In another experiment a gas jar containing ammonia was inverted over a burning splint. What observation would be made? (1 mark)
- (c) Why is it advisable to obtain nitrogen from air instead ammonia? (1 mark)

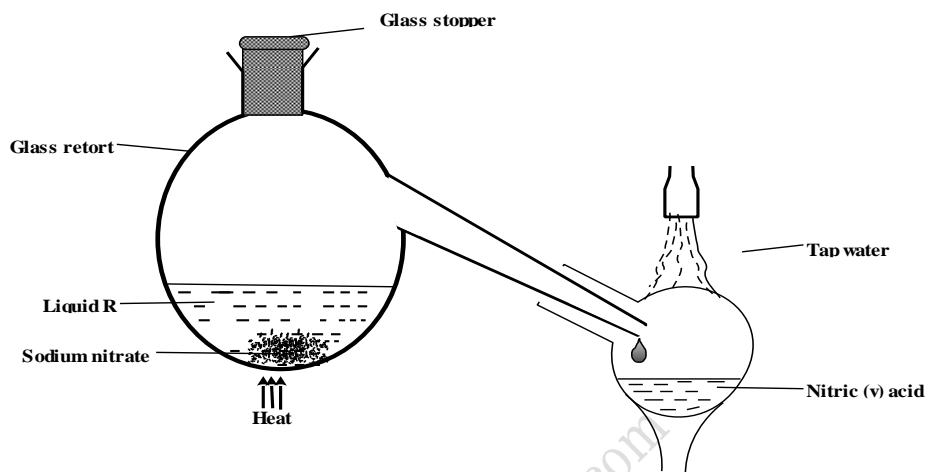
4. (a) The diagram below represents a set up that was used to obtain dry nitrogen from air. Study it and answer the questions that follow



- (i) Name solid Q (1 mark)

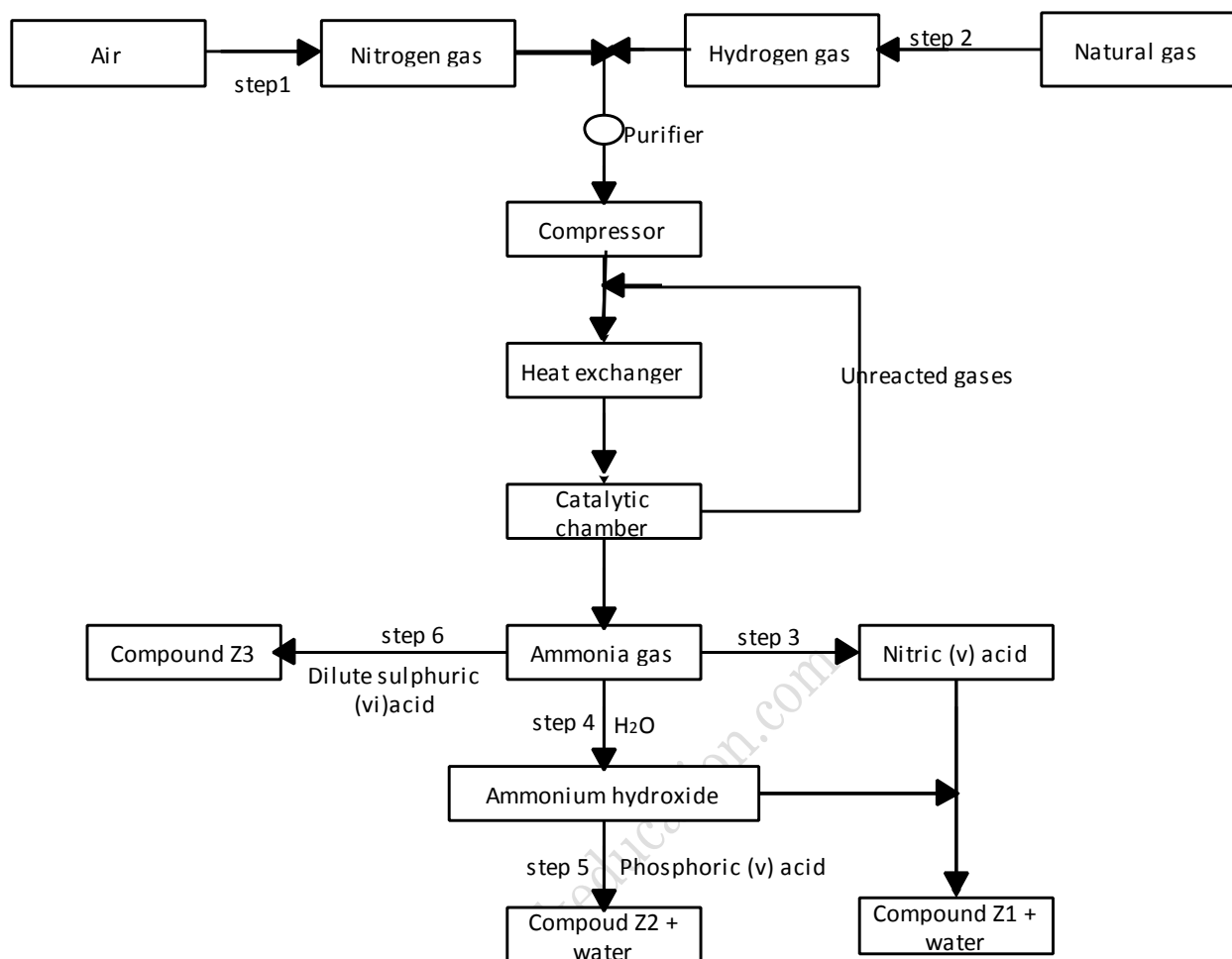
- (ii) What is the purpose of sodium hydroxide? (1 mark)
- (iii) Write an equation for the reaction which took place in tube **P**. (1 mark)
- (iv) Give the name of one impurity present in the nitrogen gas obtained. (1 mark)
- (v) Give a reason why liquid nitrogen is used for storage of semen for artificial insemination. (1 mark)

(b) The set up below was used to prepare nitric (V) acid

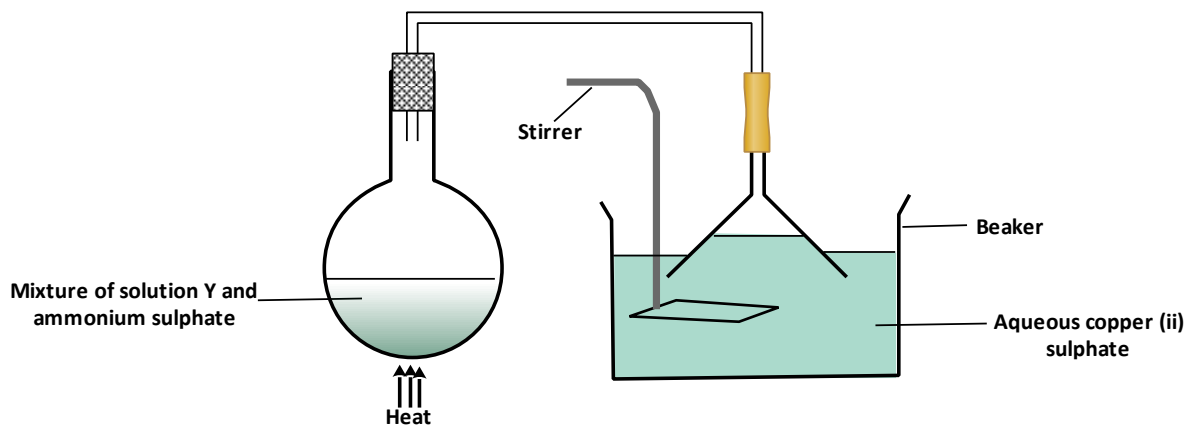


- (i) Give the name of liquid **R**. (1 mark)
- (ii) Write an equation for the reaction which took place in the glass retort. (1 mark)
- (iii) Explain the following
  - I. Nitric acid is stored in dark bottles. (1 mark)
  - II. The reaction between copper metal with 50% nitric acid (one volume of acid added to an equal volume of water) in an open test tube gives brown fumes. (2 marks)
- (c) A factory uses nitric acid and ammonia gas as the only reactants for the preparation of fertilizer. If the daily production of the fertilizer is 4800 kg, calculate the mass of ammonia gas used daily. (N= 14.0, O= 16.0, H=1.0) (3 marks)

5. The flow chart below shows the industrial preparation of ammonia and the process used in the manufacture of some ammonium compounds. Study and answer the questions that follow.

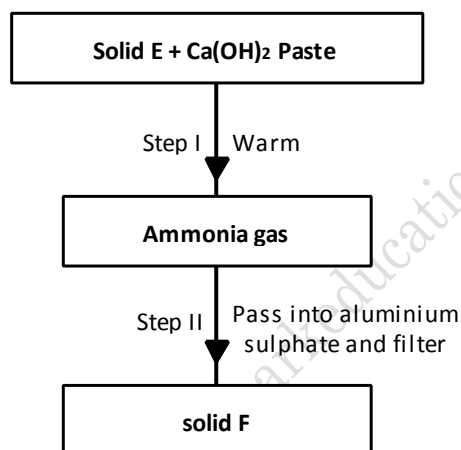


- (a) Give the name of the;
- Process in step 1. (1 mark)
  - Reaction that takes place in step 5. (1 mark)
- (b) State **one** other source of hydrogen gas apart from natural gas. (1 mark)
- (c) Explain why it necessary to compress nitrogen and hydrogen in this process. (2 marks)
- (d) Write an equation for the reaction which takes place in step 6. (1 mark)
- (e) Name the catalyst and the reagents used in step 3. (2 marks)
- (f) Name compound **Z1**. (1 mark)
- (g) Give one commercial use of compound **Z2**. (1 mark)
6. (a) A few drops of freshly prepared iron (II) sulphate solution were added to potassium nitrate solution in a test-tube. Concentrated sulphuric acid was then carefully added to the mixture. State the observation that were made. (1 mark)
- (b) Write an equation for the reaction that occurs when solid potassium nitrate is strongly heated. (1 mark)
7. A student set up the apparatus shown below to prepare ammonia gas and react it with copper (II) sulphate solution.



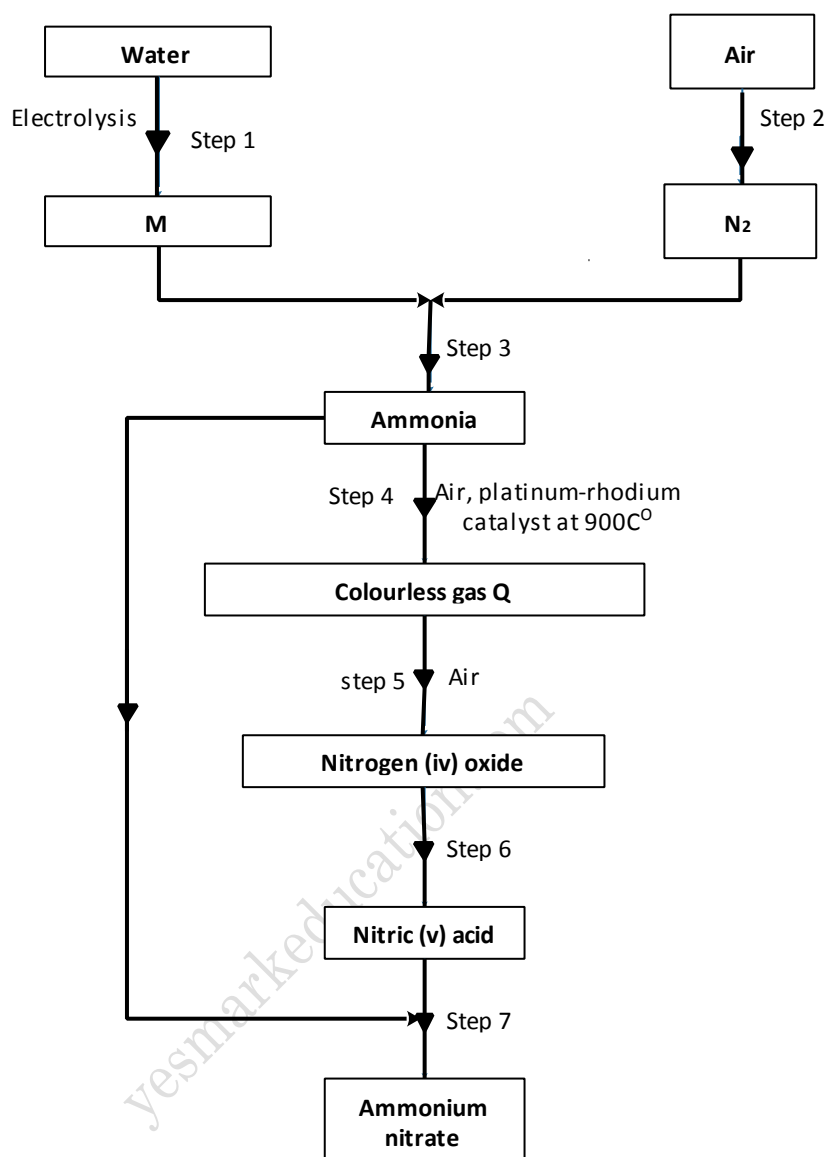
- (a) Identify solution V. (1 mark)  
 (b) State the observations which were made in the beaker. (2 marks)

8. Study the scheme below and answer the questions that follow.



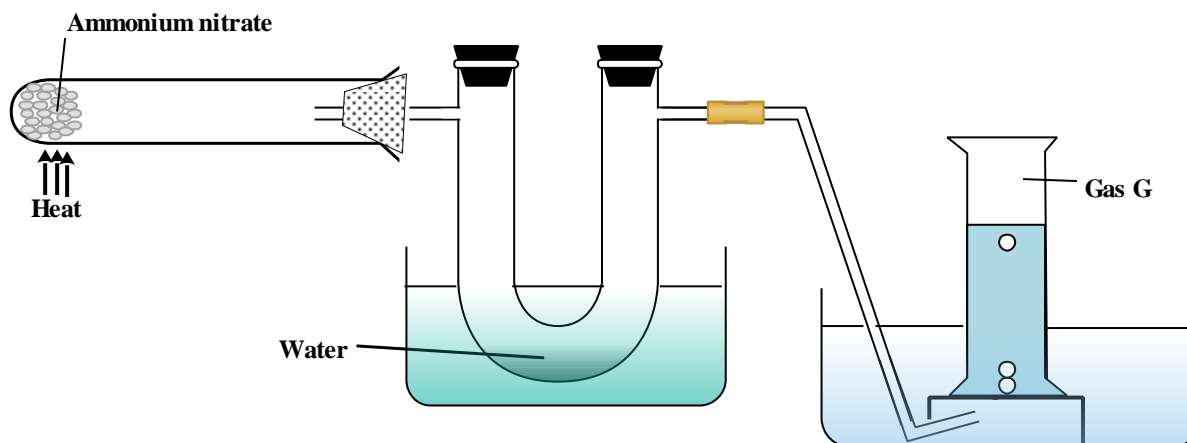
- (a) Identify solid E. (1 mark)  
 (b) Write an ionic equation for the reaction in step II that produces solid F. (1 mark)

9. Fraction distillation of liquid air usually produces nitrogen and oxygen as the major products.
- (i) Name one substance that is used to remove carbon dioxide from the air before it is changed into liquid. (1 mark)
- (ii) Describe how nitrogen gas is obtained from the liquid air. (Boiling points nitrogen =  $-196^{\circ}\text{C}$ , oxygen =  $-183^{\circ}\text{C}$ ) (2 marks)
- (b) Study the flow chart below and answer the questions that follow.



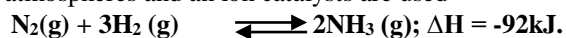
- (i) Name element M. (1 mark)
- (ii) Why is it necessary to use excess air in step 4? (2 marks)
- (iii) Identify gas Q. (1 mark)
- (iv) Write an equation for the reaction in step 7 (1 mark)
- (v) Give one use of ammonium nitrate. (1 mark)
- (c) State and explain the observations that would be made if a sampler of sulphur is heated with concentrated nitric (V) acid. (2 marks)
- 10.** Concentrated sulphuric acid was added to iron II sulphate acidified with sulphuric (VI) acid and the mixture heated. The solution turned from pale green to yellow with evolution of brown gas. Explain these observations. (3 marks)
- 11.** (a) Give a reason why concentrated sulphuric acid is not used to dry ammonia gas. (1 mark)
- (b) Name one suitable drying agent for ammonia gas. (1 mark)
- 12.** Nitrogen (II) oxide and nitrogen (IV) oxide are some of the gases released from car exhaust pipes. State how these gases affect the environment. (2 marks)

13. Ammonium nitrate was gently heated and the products collected as shown in the diagram below.



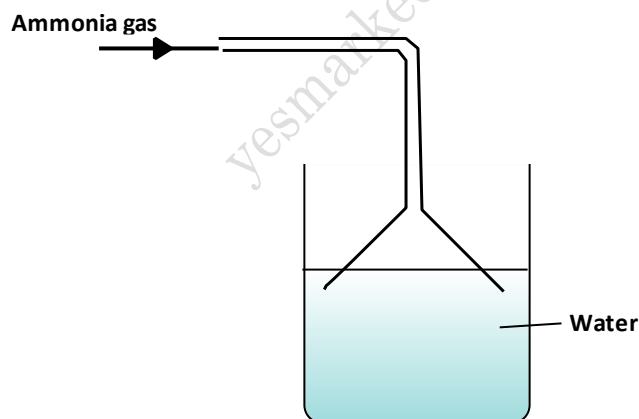
Describe one chemical and one physical method that can be used to identify gas G. (2 marks)

14. In the Haber process, the optimum yield of ammonia is obtained when a temperature of 450°C, a pressure of 200 atmospheres and an iron catalyst are used



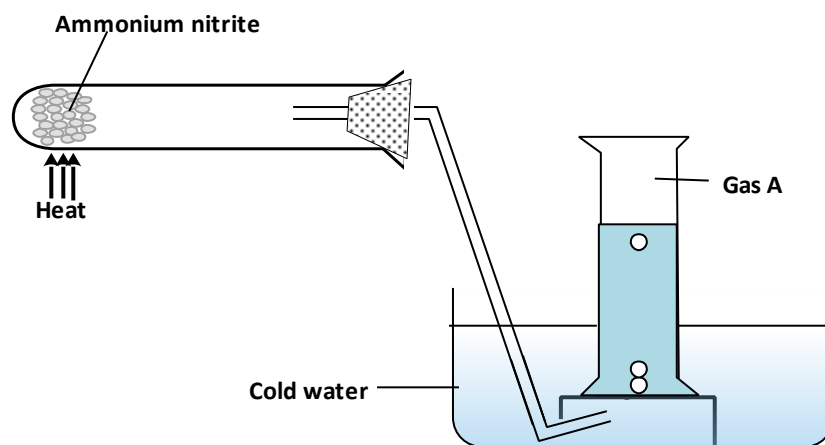
- (a) How would the yield of ammonia be affected if the temperature was raised to 600°C? (2 marks)  
 (b) Give one use of ammonia (1 mark)

15. Ammonia gas was passed into water as shown below



- (a) Explain why the pH of solution is above 7. (1 mark)  
 (b) What is the use of inverted funnel? (1 mark)

16. Ammonium nitrate was heated as shown in the set-up below (2 marks)



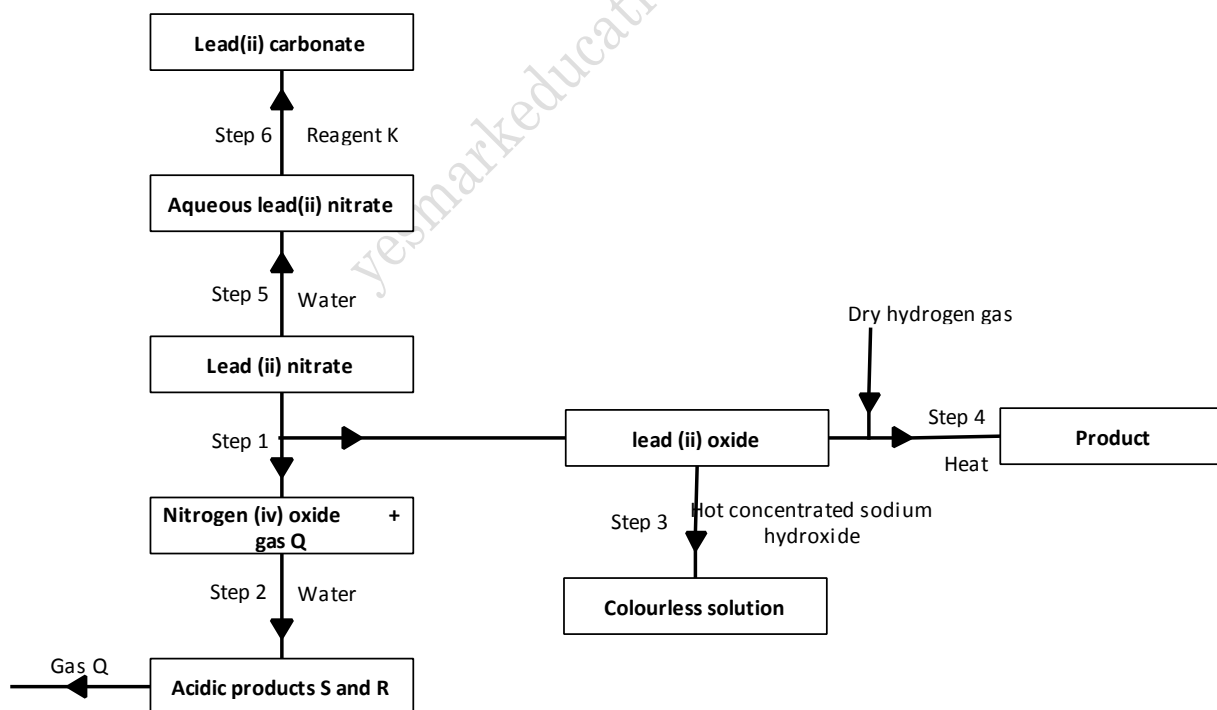
- (a) Identify gas A. (1 mark)  
 (b) State explain precaution that must be taken before heating id dropped. (2 marks)

17. Nitrogen forms many compounds in which its oxidation state varies.

- (a) What is meant by oxidation state? (1 mark)  
 (b) What is the oxidation state of nitrogen in  $Mg_3N_2$  (1 mark)

18. Explain why a high temperature is required for nitrogen of react with oxygen. (1 mark)

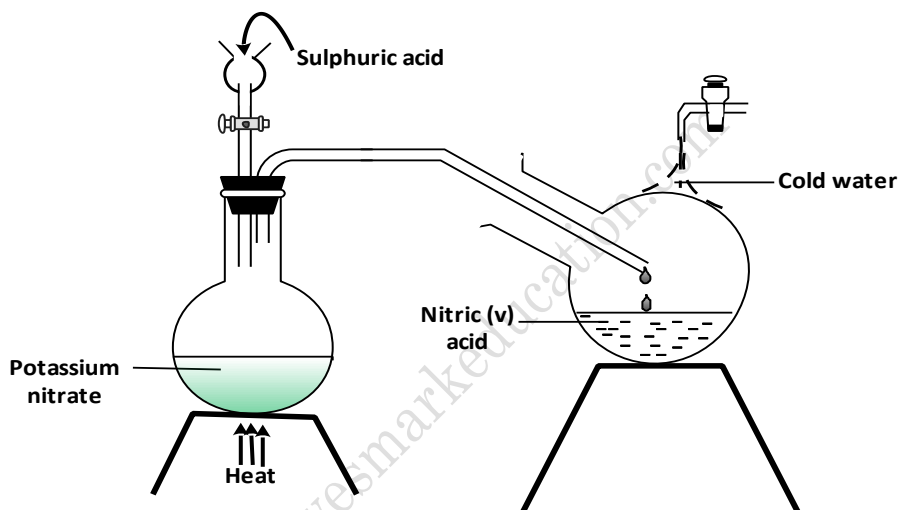
19. (a) The flow chart below shows some reactions starting with lead (II) nitrate Study it and answer the questions that follow.



- (i) State the condition necessary in step 1. (1 mark)  
 (ii) Identify:  
 I Reagent K. (1 mark)  
 II Gas Q. (1 mark)  
 III Acidic products S and R. (1 mark)

- (iii) Write:
- I. the formula of the complex ion formed in step 3. (1 mark)
  - II. the equation of the reaction in step 4 (1 mark)
- (b) The use of materials made of lead in roofing and in water pipes is being discouraged. State:
- (i) **two** reasons why these materials have been used in the past. (2 marks)
  - (ii) **one** reason why their use is being discouraged. (1 mark)
- (c) (i) The reaction between lead (II) nitrate and concentrated sulphuric (VI) acid starts but stops immediately. Explain. (2 marks)
- (ii) Name one suitable reagent that can be reacted with concentrated sulphuric (VI) acid to produce nitric (V) acid (1 mark)
- 20.** State one use of sodium hydrogen carbonate. (1 mark)

- 21.** The diagram below shows a set-up that was used to prepare and collect a sample of nitric (V) acid.



- (i) Give a reason why it is possible to separate nitric (V) acid from sulphuric (VI) acid in set-up (1 mark)
  - (ii) Name another substance that can be used instead of potassium nitrate. (1 mark)
  - (iii) Give **one** use of nitric acid. (1 mark)
- 22.** When a few drops of aqueous ammonia were added to copper (II) nitrate solution, a light blue precipitate was formed. On addition of more aqueous ammonia, a deep blue solution was formed. Identify the substance responsible for the:
- (i) Light blue precipitate (1 mark)
  - (ii) Deep blue solution (1 mark)
- 23.** (a) Name **one** raw material which sodium hydroxide is manufactured. (1 mark)
- (b) Sodium hydroxide pellets were accidentally mixed with sodium chloride. 17.6 g of the mixture were dissolved in water to make one litre of solution. 100cm<sup>3</sup> of the solution was neutralized by 40cm<sup>3</sup> of 0.5M sulphuric (VI) acid.
- (i) Write an equation for the reaction that took place. (1 mark)
  - (ii) Calculate the:
    - I. number of moles of the substance that reacted with sulphuric (VI) acid (2 marks)

II. number of moles of the substances that would react with sulphuric (VI) acid in the one litre of solution.

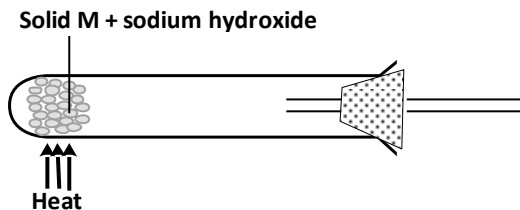
(1 mark)

III. mass of the unreacted substances in one litre of solution

(2 marks)

(H = 1.0 ; Na = 23.0 ; Cl = 35.5; O = 16.0)

(c) The diagram below shows an incomplete set-up used to prepare and collect ammonia gas



(i) Name solid M. (1 mark)

(ii) Complete the diagram to show how a dry sample of ammonia gas can be collected (3 marks)

(d) In an experiment, excess ammonia gas passed over heated copper (II) oxide on a combustion tube.

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

(ii) What property of ammonia is shown in the above reaction? (1 mark)

(iii) Name one use of ammonia (1 mark)

24. The first step in the industrial manufacture of nitric (V) acid is the catalytic oxidation ammonia gas.

(a) What is the name of the catalyst used? (1 mark)

(b) Write the equation for the catalytic oxidation of ammonia gas. (1 mark)

(c) Nitric (V) acid is used to make ammonium nitrate, state two uses of ammonium nitrate. (1 mark)

25. In an experiment, a few drops of concentrated nitric (V) acid were added to aqueous iron (II) sulphate in a test – tube. Excess sodium hydroxide solution was then added to the mixture.

(a) State the observations that were made when:

(i) concentrated nitric (V) acid was added to aqueous iron (II) sulphate (1 mark)

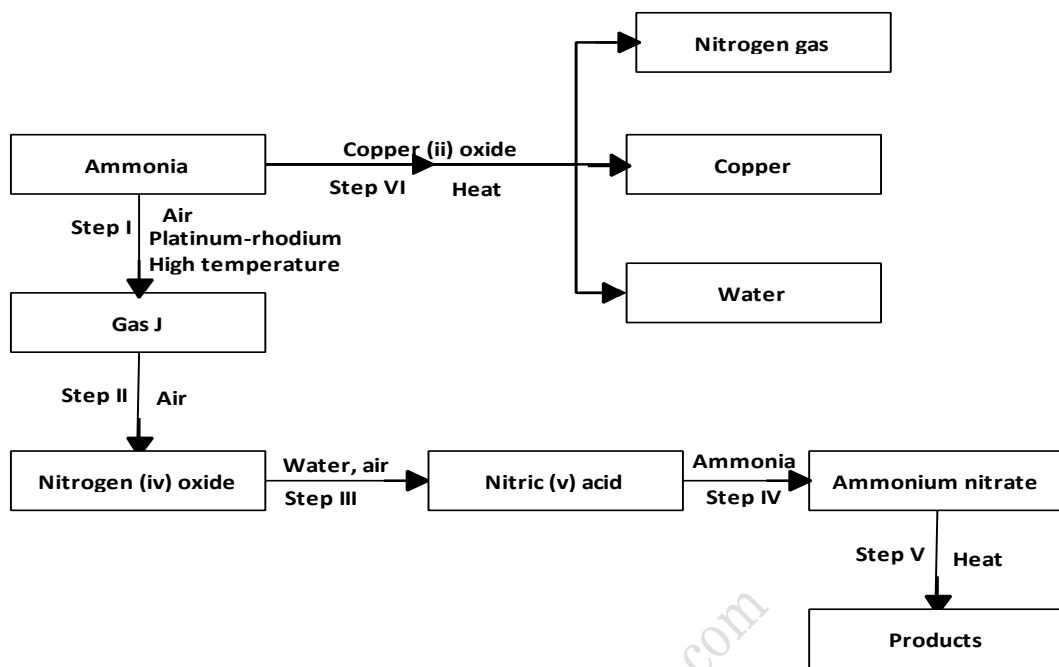
(ii) excess sodium hydroxide was added to the mixture. (1 mark)

(b) Write an ionic equation for the reaction which occurred in (a) (ii) above. (1 mark)

26. When magnesium was burnt in air, a solid mixture was formed. On addition of water the mixture a gas which turned moist red litmus paper blue was evolved. Explain these observations. (2 marks)

27. (a) Describe the process by which Nitrogen is obtained from air on a large scale. (4 marks)

(b) Study the flow chart below and answer the questions that follow.

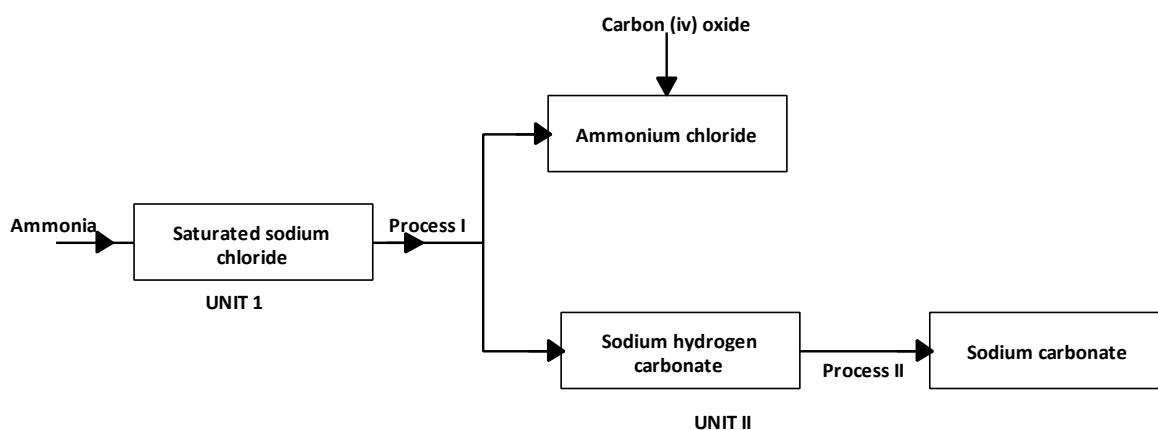


- (i) Identify gas J. (1 mark)
- (ii) Using oxidation numbers, show that ammonia is the reducing agent in step (VI) (2 marks)
- (iii) Write the equation for the reaction that occurs in step (V). (1 mark)
- (iv) Give one use of ammonium nitrate. (1 mark)
- (c) The table below shows the observations made when aqueous ammonia was added to cations on elements E, F and G until in excess.

Cation of	Addition of a few drops of Aqueous ammonia.	Addition of aqueous ammonia.
E	White precipitate	Insoluble
F	No precipitate	No precipitate
G	White precipitate	Dissolves

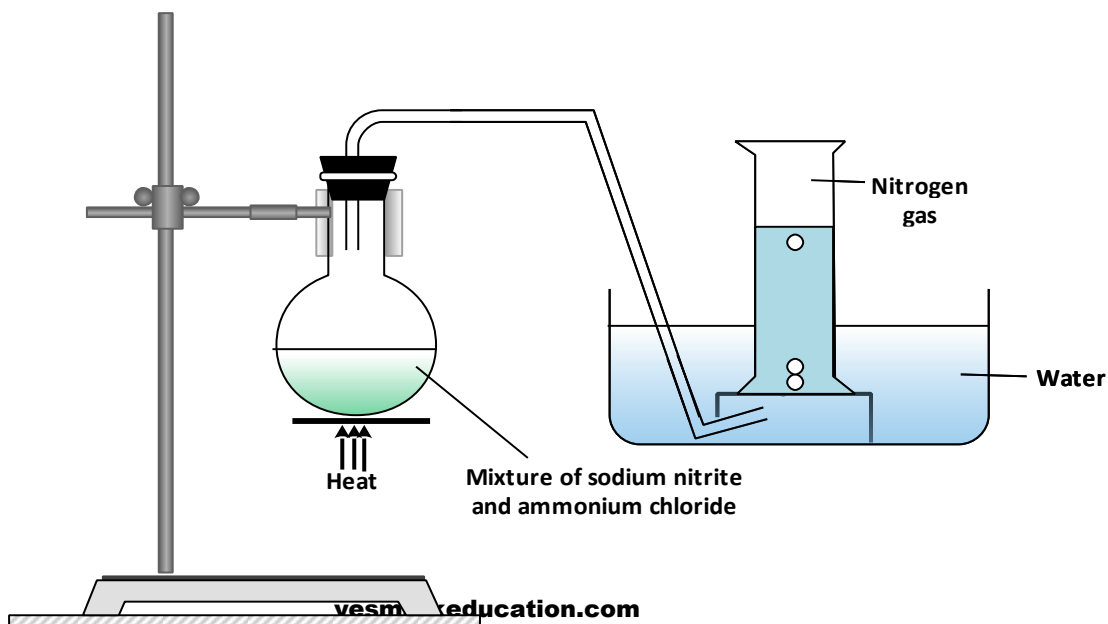
- (i) Select the cation that is likely to be  $Zn^{2+}$  (1 mark)
- (ii) Given that the formula of the cation of element E is  $E^{2+}$ , write the ionic equation for the reaction between  $E^{2+}_{(aq)}$  and aqueous ammonia. (1 mark)

28. The schematic diagram shows part of the Solvay process used for the manufacture of sodium carbonate.



- (i) Explain how the sodium chloride required for this process is obtained from sea water. (2 marks)
- (ii) Two main reactions take place in **UNIT I**. The first one is the formation of ammonium hydrogen carbonate.
- I. Write an equation for this reaction (1 mark)
  - II. Write an equation for the second reaction (1 mark)
- (iii) State how the following are carried out: (2 marks)
- I. **Process I**
  - II. **Process II** (2 marks)
- (iv) In an experiment to determine the percentage purity of the sample of sodium carbonate produced in the Solvay process, 2.15 g of the sample reacted completely with 40.0cm<sup>3</sup> of 0.5 M sulphuric (VI) acid.
- I. Calculate the number of moles of sodium carbonate that reacted. (2 marks)
  - II. Determine the percentage of sodium carbonate in the sample. (2 marks)
- (Na= 23.0, C= 12.0, O = 16.0)
- (b) Name two industrial uses of sodium carbonate. (2 marks)
- In an experiment to prepare nitrogen (I) oxide, ammonium nitrate was gently heated in a flask.
- (a) Write the equation for the reaction that took place in the flask. (1 mark)
  - (b) State and explain how the gas was collected. (1 mark)
  - (c) A sample of the gas was tested with damp blue and red litmus papers. What observations were made? (1 mark)

29. The set up below shows how nitrogen gas is prepared in a laboratory.

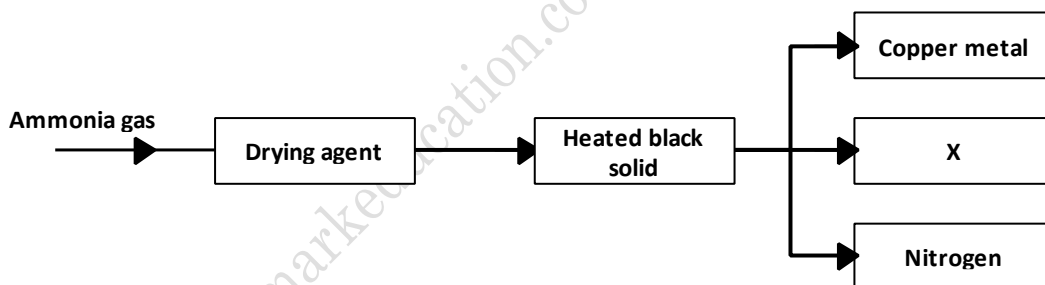


- (a) Describe how nitrogen gas is formed in the flask. (2 mark)  
 (b) Nitrogen is inert, state **one** use of the gas based on this property. (1 mark)

30. (a) When excess calcium metal was added to 50 cm<sup>3</sup> of 2 M aqueous copper (II) nitrate in a beaker, a brown solid and bubbles of gas were observed.

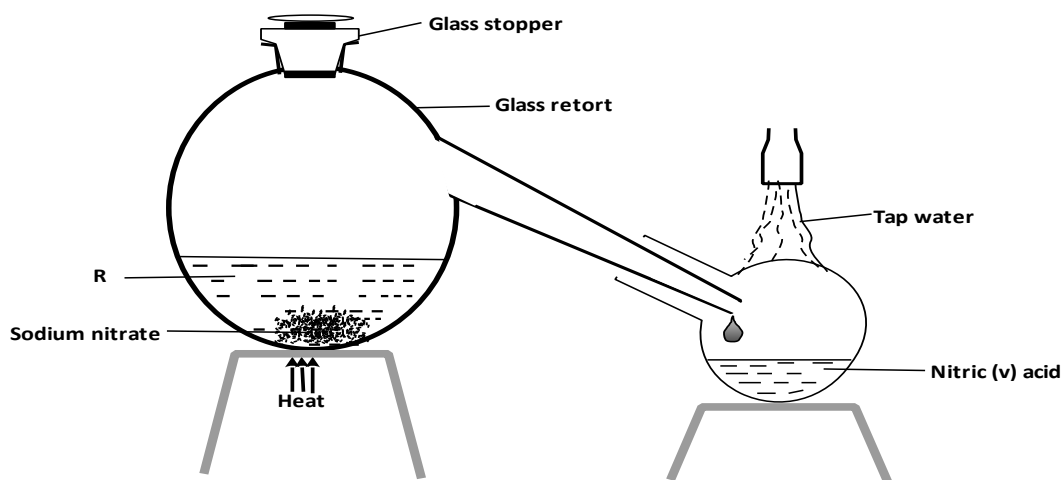
- (i) Write **two** equations for the reactions which occurred in the beaker. (2 marks)  
 (ii) Explain why it is not advisable to use sodium metal for this reaction. (2 marks)  
 (b) Calculate the mass of calcium metal which reacted with copper (II) nitrate solution. (Relative atomic mass of Ca = 40) (2 mark)  
 (c) The resulting mixture in (a) above was filtered and sodium hydroxide added to the filtrate dropwise until in excess. What observations were made? (1 mark)  
 (d) (i) Starting with calcium oxide, describe how a solid sample of calcium carbonate can be prepared. (3 marks)  
 (ii) Name **one** use of calcium carbonate. (1 mark)

31. Study the flow chart below and answer the questions that follow.

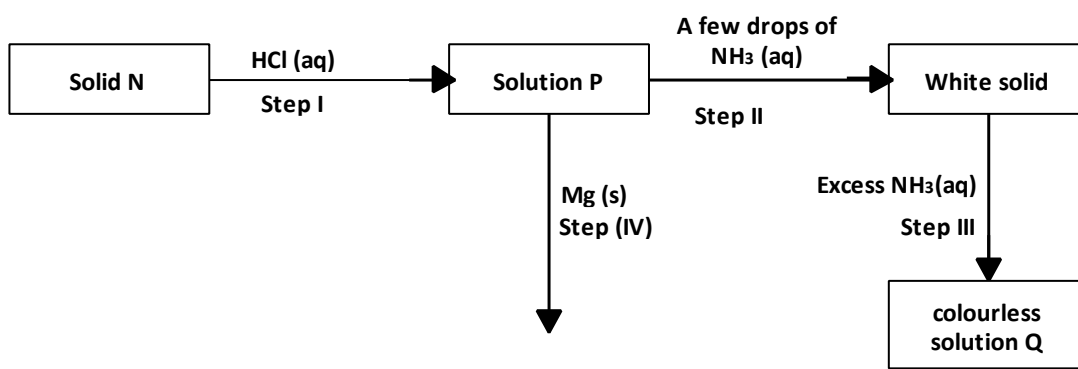


- (a) Name a suitable drying agent for ammonia. (1 mark)  
 (b) Describe one chemical test for ammonia. (1 mark)  
 (c) Name X. (1 mark)

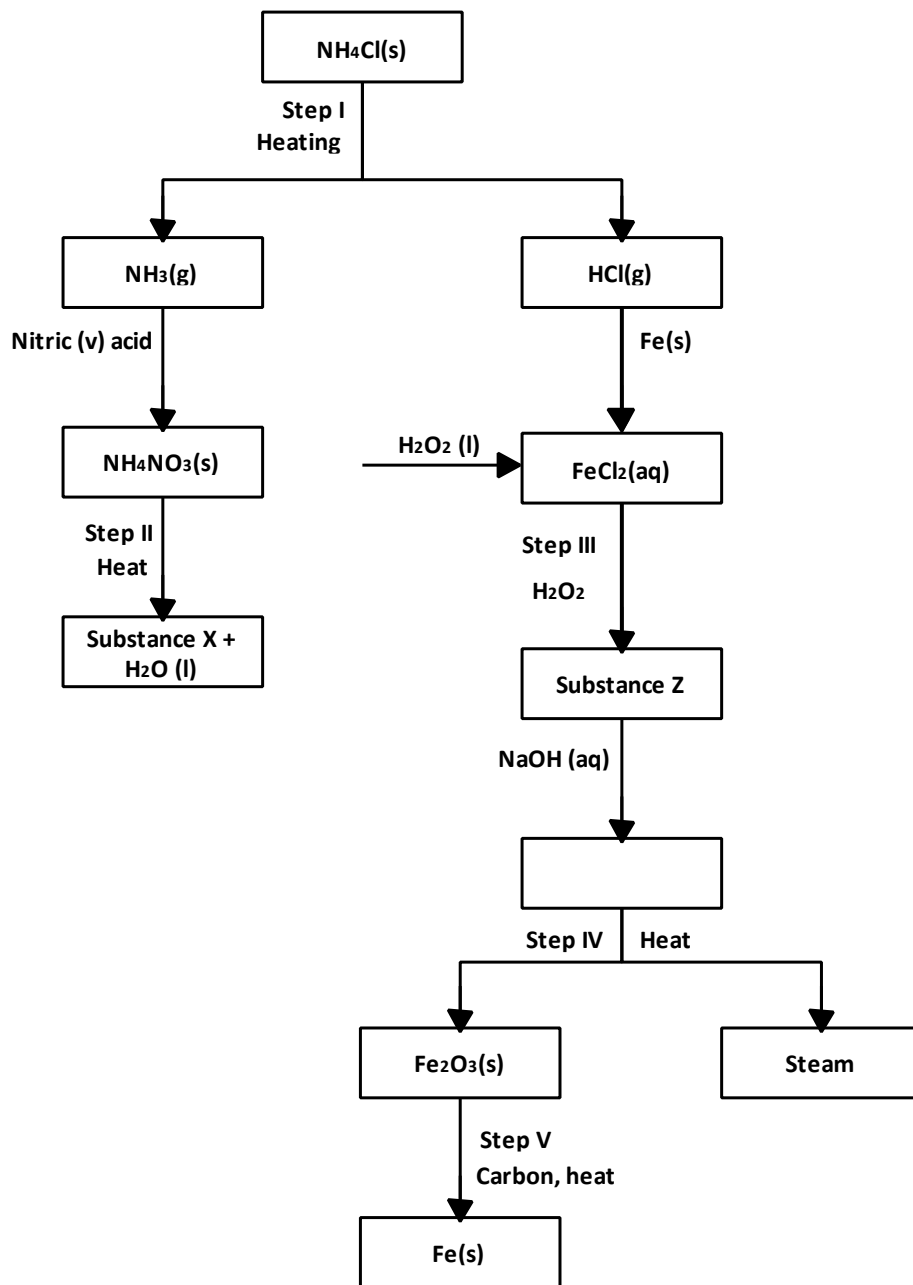
32. In the laboratory, small quantities of nitric (V) acid can be generated using the following set up. Study it and answer the questions that follow.



- (a) (i) Give the name of substance R. (1 mark)  
 (ii) Name one other substance that can be used in place of sodium nitrate. (1 mark)  
 (iii) What is the purpose of using tap water in the set up above? (1 mark)
- (b) Explain the following;  
 (i) It is **not** advisable to use a stopper made of rubber in the set-up (1 mark)  
 (ii) The reaction between copper metal with 50% nitric (V) acid in an open test-tube produces brown fumes. (1 mark)
- (c) (i) Nitrogen is one of the reactants used in the production of ammonia, name two sources of the other reactant. (2 marks)  
 (ii) A factory uses nitric (V) acid and ammonia gas in the preparation of a fertilizer. If the daily production of the fertilizer is 4800kg; calculate the mass of ammonia gas used in kg. (N = 14.0; O = 16.0; H = 1.0) (3 marks)  
 (iii) State **two** other uses of nitric (V) acid other than the production of fertilizers. (2marks)
33. The scheme below shows some reaction sequence starting with Solid N. Study and answer the questions that follow.



- (a) Write the formula of the complex ion in solution Q. (1 mark)  
 (b) Write an equation for the reaction in step IV. (1 mark)
34. When fuels burn in the internal combustion engine at high temperature, one of the products formed is nitrogen (II) oxide.  
 (a) Write the equation for the formation of nitrogen (II) oxide. (1 mark)  
 (b) Give a reason why nitrogen (II) oxide is formed at room temperature. (1 mark)  
 (c) Describe how formation of nitrogen (II) oxide in the internal combustion engine leads to gaseous pollution. (1 mark)
35. On heating a pale green solid K, carbon (IV) oxide gas and a black solid M were formed on reacting K with dilute hydrochloric acid, carbon (IV) oxide gas and a green solution S were formed. When excess aqueous ammonia was added to solution S, a deep blue solution was formed.  
 (a) Identify the cation in solid K. (1 mark)  
 (b) Identify the **two** anions in solution S. (2 marks)
36. Study the flow chart below and answer the questions that follow:



(i) Write an equation for the reaction in:

I. Step II;

II. Step IV

(1 mark)

(1 mark)

(ii) State the observation made in step III. Explain.

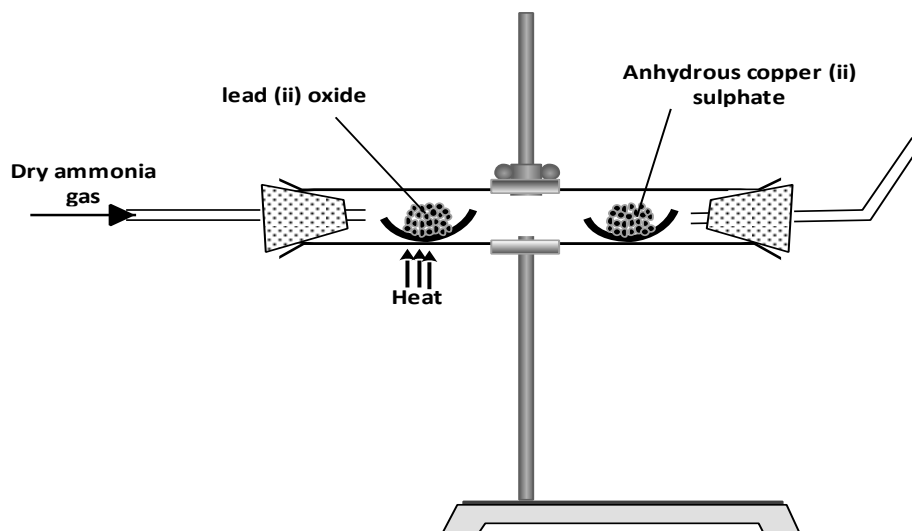
(2 marks)

(iii) Name another substance that can be used in step V.

(1 mark)

37. Dry ammonia gas was passed over heated lead (II) oxide and the products passed (II) sulphate as shown in the diagram below.

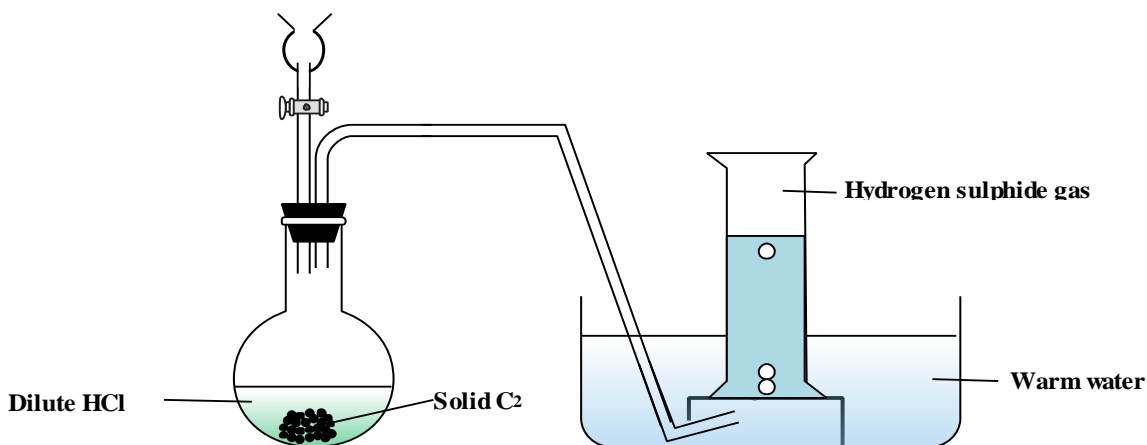
anhydrous copper



State:

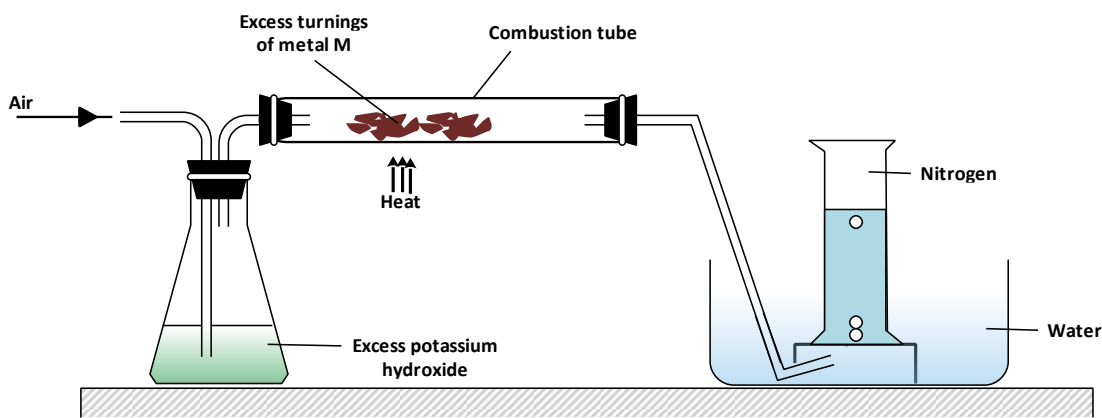
- (a) **two** observations made in the combustion tube. (2 marks)  
 (b) the property of ammonia gas shown in this experiment. (1 mark)

**38.** Study the set-up below and answer the questions that follow.



- (a) Write an equation for the reaction between ammonia and copper (II) oxide. (1 mark)  
 (b) During the experiment, the colour of the contents in the water trough changed. State the colour change observed and give an explanation. (2 marks)

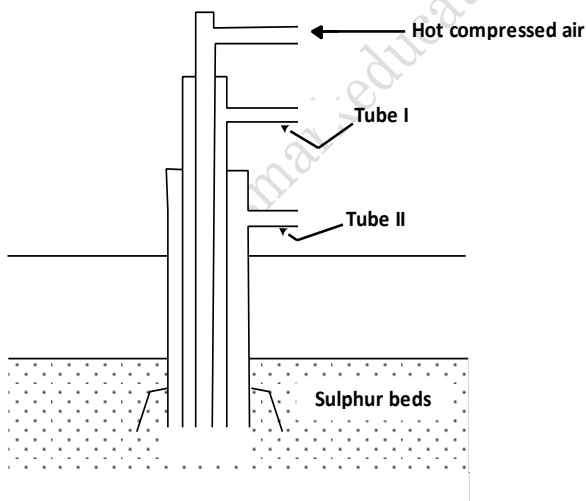
**39.** A student used the set up below to prepare a sample of nitrogen gas.



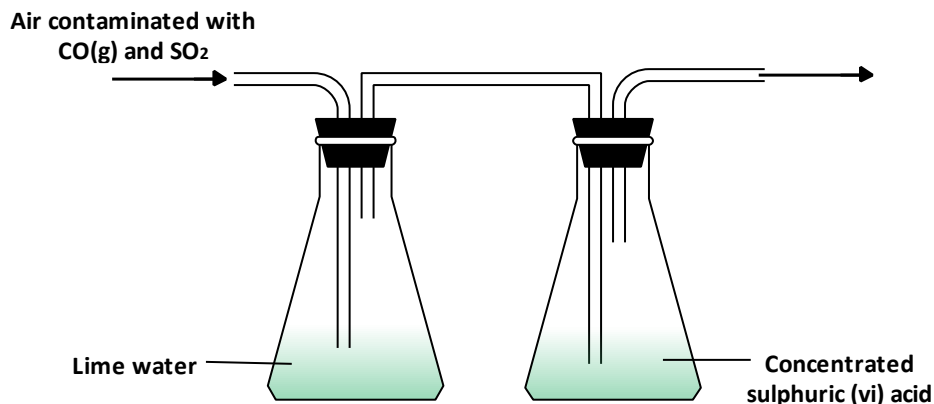
- (a) State the function of potassium hydroxide in the set up. (1 mark)
- (b) Give a suitable metal M for use in the combustion tube. (1 mark)
- (c) Give a reason why the nitrogen gas obtained is not pure. (1 mark)

## 17. SULPHUR AND ITS COMPOUNDS

1. The diagram below represents the extraction of sulphur by Frasch process



- (a) Name the substance that passes through tube;  
 I \_\_\_\_\_ (1 mark)  
 II \_\_\_\_\_ (1 mark)
- (b) What is the purpose of hot compressed air in this process? (1 mark)
2. State what would be observed when dilute hydrochloric acid is added to the products formed when a mixture of iron fillings and sulphur react? (1 mark)
3. A sample of air contaminated with carbon monoxide and sulphur dioxide was passed through the apparatus shown in the diagram below.



Which contaminant was removed by passing the contaminated air through the apparatus?  
Explain.

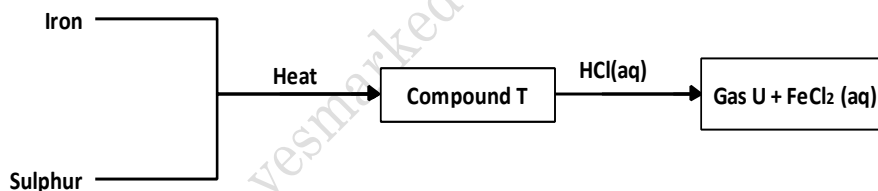
(2 marks)

4. Oxygen reacts with the elements phosphorous, sulphur and chlorine to form oxides in which the element is in its highest oxidation number. The table below gives the oxide of sulphur and its highest oxidation number. Complete the table for phosphorus and chlorine. (Atomic numbers: P=15, S= 16 Cl = 17)

Element	Oxide	Highest oxidation number
P	_____	_____
S	SO <sub>3</sub>	+6
Cl	_____	_____

(2 marks)

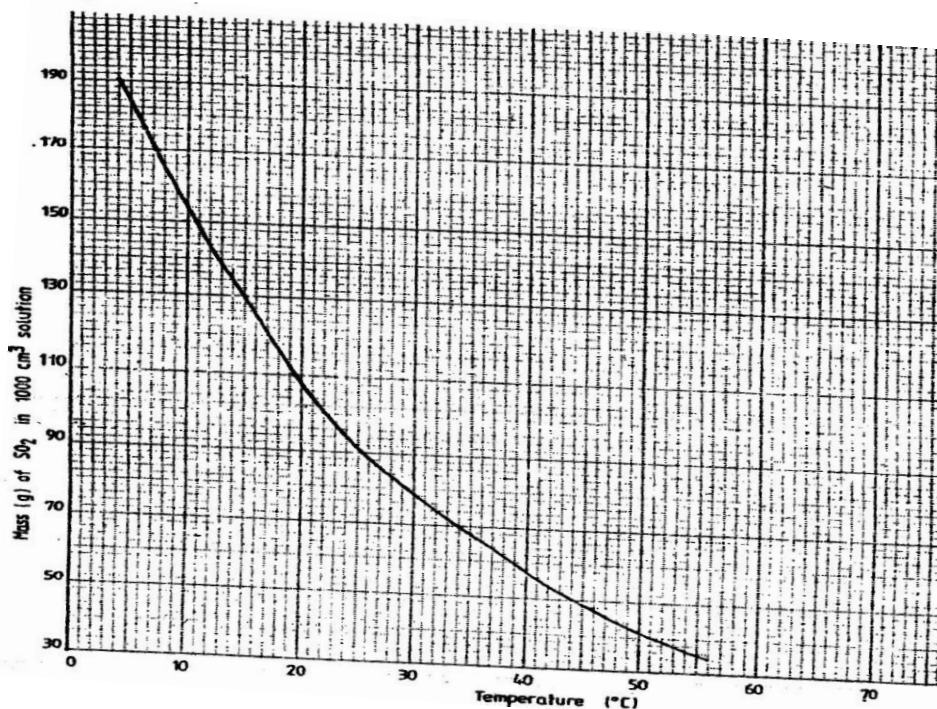
5. Study the flow chart below and answer the questions that follow



- (a) Name (i) Compound T (1 mark)  
(ii) Gas U (1 mark)
- (b) Give a chemical test that you could use to identify gas U (1 mark)

6. (a) The graph below shows the solubility of sulphur dioxide gas at different temperatures. Use the following in it to answer the questions that follow.

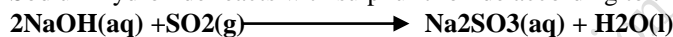
Use the



(i) From the graph determine:

- I. The lowest temperature at which 1,000cm<sup>3</sup> of solution would contain 116g of sulphur (IV) oxide. (1 mark)
- II. The maximum mass of sulphur dioxide that would dissolve in 15 litres of solution at 10<sup>0</sup>C.(2 marks)

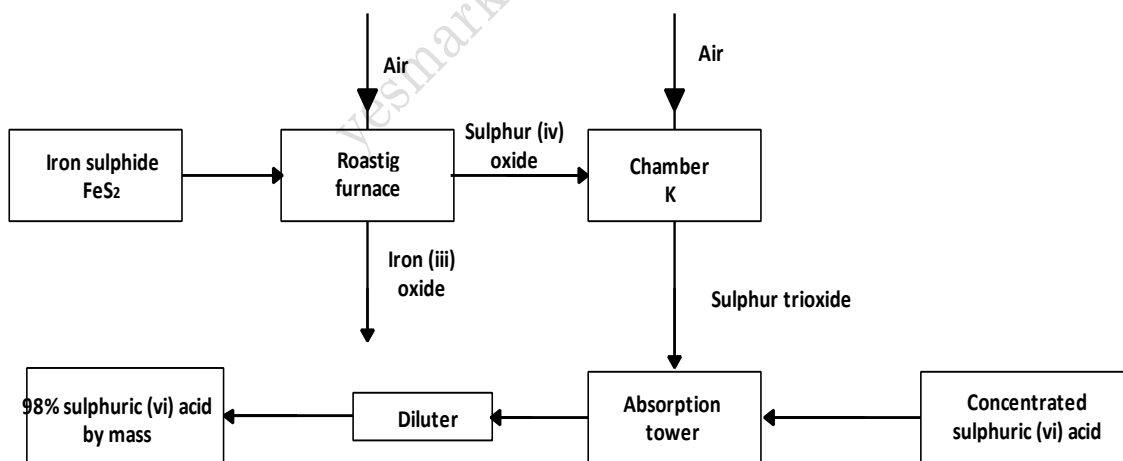
(ii) Sodium hydroxide reacts with sulphur trioxide according to the following equation.



Using the information in the graph determine the volume of 2M sodium hydroxide required to completely neutralize on one litre of saturated sulphur dioxide solution at 23<sup>0</sup>C. (S=32.0; O = 16.0)

(3 marks)

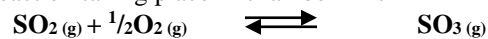
(b) Study the flow chart below and answer the questions that follow.



(i) Write equation for the reaction taking place at:

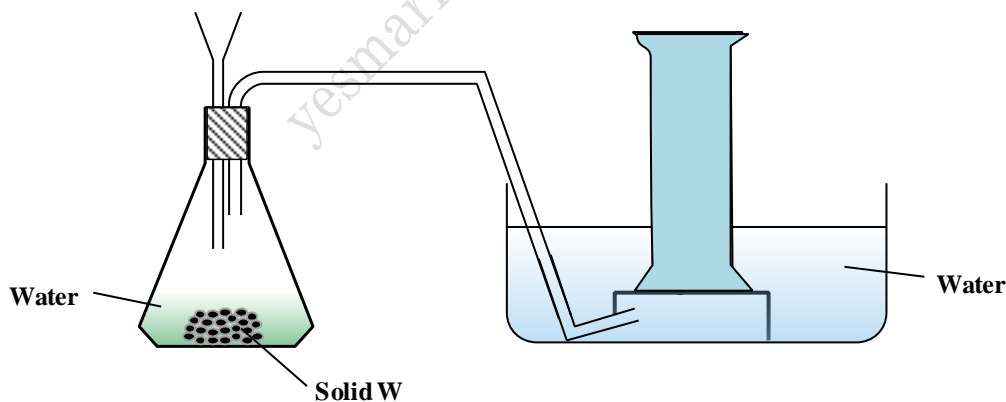
- I. The roasting furnace (1 mark)
- II. The absorption tower (1 mark)
- III. The diluter (1 mark)

(ii) The reaction taking place in chamber K is

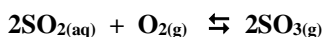


- I. Explain why it is necessary to use excess air in chamber K. (2 marks)
- II. Name another substance used in chamber K. (1 mark)

7. Potassium sulphite solution was prepared and divided into two portions. The first portion gave a white precipitate when reacted with barium nitrate. On addition of dilute hydrochloric acid the white precipitate disappeared.
- Write the formula of the compound which formed as the white precipitate. (1 mark)
  - Write the equation for the reaction between dilute hydrochloric acid and the compound whose formula is written in (a) above. (1 mark)
  - What observation would be made if one drop of potassium dichromate solution was added to the second portion followed by dilute hydrochloric acid? (1 mark)
8. Urea,  $(\text{NH}_2)_2\text{CO}$ , is prepared by the reaction between ammonia and carbon (IV) oxide.
- $$2\text{NH}_3(\text{g}) + \text{CO}_2(\text{g}) \longrightarrow (\text{NH}_2)_2\text{CO}(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- In one process, 680 kg of ammonia were reacted with excess carbon dioxide. Calculate the mass of urea that was formed. (H = 1.0, C = 12.0, N = 14.0, O = 16.0 and relative molecular mass of ammonia = 17) (3 marks)
9. State and explain the observation that would be made when a few drops of concentrated sulphuric acid are added to a small sample of hydrated copper (II) sulphate. (2 marks)
10. Sulphur (IV) oxide and nitrogen (IV) oxide react as shown in the equation below.
- $$\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightarrow \text{SO}_3(\text{g}) + \text{NO}(\text{g})$$
- Using the oxidation numbers of either sulphur or nitrogen, show that this is a redox reaction. (2 marks)
  - Identify the reducing agent. (1 mark)
11. In an attempt to prepare sulphur dioxide gas, dilute sulphuric acid was reacted with barium sulphuric. The yield of sulphur dioxide was found to be negligible. Explain. (2 marks)
12. (a) The diagram below shows a set-up used by a student in an attempt to prepare and collect oxygen gas.



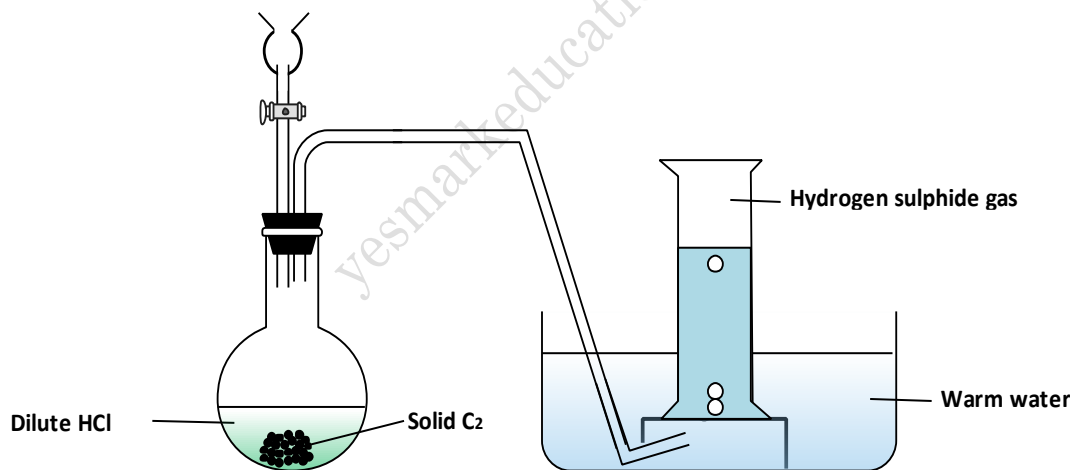
- Complete the diagram correcting the mistakes on it. (2 marks)
  - Identify solid W. (1 mark)
- (b) A piece of phosphorus was burnt in excess and the product obtained was shaken with a small amount of hot water to make a solution.
- Write an equation for the burning of phosphorus in excess air. (1 mark)
  - The solution obtained in (b) above was found to have a  $\text{pH}$  of 2. Give reasons for this observation. (2 marks)
  - Explain why cooking pots made of aluminium do not corrode when exposed to air. (1 mark)
  - The reaction between sulphur (IV) oxide and oxygen to form sulphur (VI) oxide in the contact process is exothermic.



A Factory manufacturing sulphuric acid by contact process produces 350kg of sulphur (VI) oxide per day (conditions) for the reaction catalyst. 2 atmospheres pressure and temperatures between. 400 – 500 °C

- What is meant by an exothermic reaction? (1 mark)
  - How would the yield per day of sulphur trioxide be affected if temperatures lower than 400°C are used? Explain. (3 marks)
  - All the sulphur (VI) oxide produced was absorbed in the concentrated sulphuric (VI) acid to form oleum.  

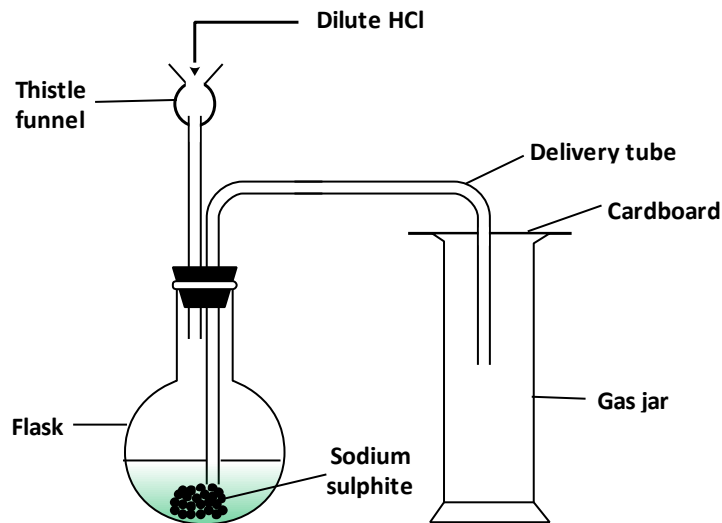
$$\text{H}_2\text{SO}_4(\text{l}) + \text{SO}_3(\text{g}) \rightarrow \text{H}_2\text{S}_2\text{O}_7(\text{l})$$
 Calculate the mass of oleum that was produced per day. (S= 32.0, O= 16.0,=1.0) (3 marks)
- When a solid sample of sulphur is heated in a test tube, it changes into a liquid, which flows easily. On further heating, the liquid darkens and does not flow easily. Explain these observations. (3 marks)
  - A certain matchstick head contains potassium chlorate and sulphur. On striking the two substances react to produce sulphur (IV) oxide and potassium chloride. Explain the environmental effect of using such matches in large numbers. (2 marks)
  - Describe a simple laboratory experiment that can be used to distinguish between sodium sulphide and sodium carbonate. (3 marks)
  - When a sample of concentrated sulphuric acid was left in an open beaker in a room for two days, the volume was found to have increased slightly.
    - What property of concentrated sulphuric (VI) acid is shown by the above reaction? (1 mark)
    - State one use of concentrated sulphuric acid that depends on the property named above. (1 mark)
  - The apparatus shown below was set to prepare and collect hydrogen sulphide



- Name solid C<sub>2</sub>. (1 mark)
  - Give a reason why warm water is used. (1 mark)
  - What observation would be made if hydrogen sulphide gas was bubbled into a solution of lead (II) nitrate? (1 mark)
- In an experiment, sulphur dioxide gas was bubbled into water followed by chlorine gas. The resulting clear solution gave a white precipitate when mixed with an acidified barium chloride solution. Explain these observations. (3 marks)
  - Sulphur exists in two crystalline forms
    - Name one crystalline form of sulphur (1 mark)
    - Give any two uses of sulphur. (2 marks)
  - Oleum (H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>) is an intermediate product in the industrial manufacture of sulphuric acid
    - How is oleum converted into sulphuric acid? (1 mark)

(b) Give one use of sulphuric acid (1 mark)

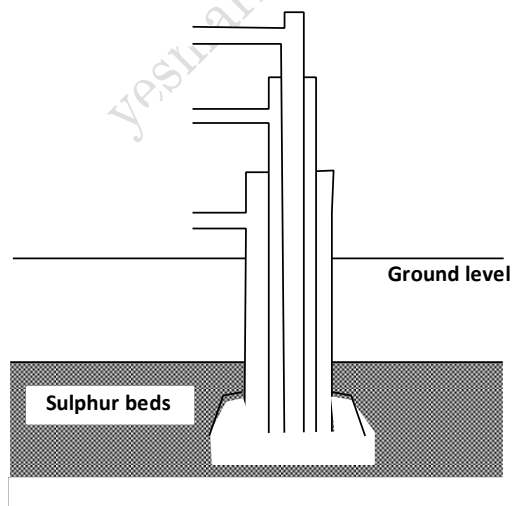
21. Dilute hydrochloric acid and solid sodium sulphite were reacted as shown in the set-up below



(a) Name the gas produced in the flask (2 marks)

(b) Give two reasons why no gas was collected in the gas jar. (2 marks)

22. The diagram below illustrates how sulphur is extracted by the Frasch process.



Label the pipe through which superheated water is pumped in (1 mark)

(b) The equation below shows the oxidation of sulphur dioxide to sulphur (IV) oxide in the contact process.



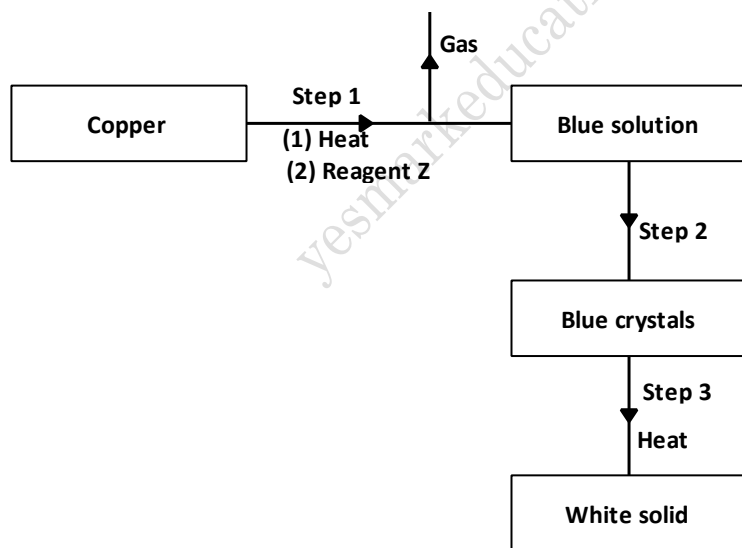
(i) Name one catalyst for this reaction (1 mark)

(ii) State and explain the effect on the yield of sulphur trioxide when:

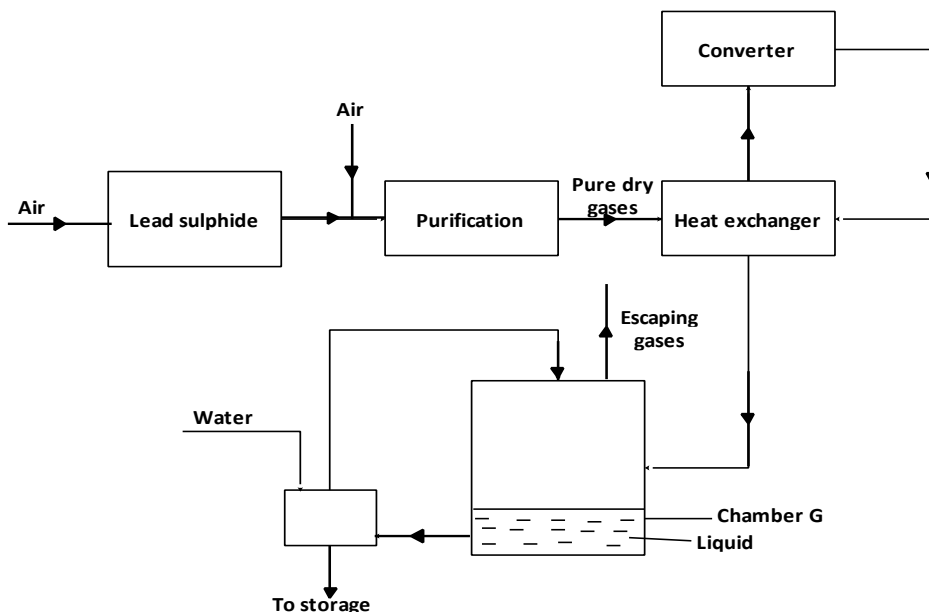
I. the temperature increased (2 marks)

II. the amount of oxygen is increased (2 marks)

- (iii) Describe how sulphur trioxide is converted to sulphuric acid in the contact process. (2 marks)
- (c) State two disadvantages of having sulphur dioxide in the environment. (2 marks)
- (d) Ammonia sulphate is a fertilizer produced by passing ammonia gas into
- Write the equation for the reaction (1 mark)
  - Calculate the mass in Kg of sulphuric acid required to produce 25kg of the fertilizer (S= 32.0; O= 16.0; N = 14.0; H =1.0) (3 marks)
23. Determine the oxidation state of sulphur in the following compounds:
- H<sub>2</sub>S
  - Na<sub>2</sub>SO<sub>3</sub> (2 marks)
24. In an experiment, a gas jar containing most sulphur dioxide was inverted over another gas jar containing hydrogen sulphide gas
- State and explain the observation that was made (2 marks)
  - State the precaution that should be taken when carrying out this experiment. (1 mark)
25. In an experiment to study the properties of concentrated sulphuric acid, a mixture of the acid and wood charcoal was heated in a boiling tube.
- Write the equation of the reaction that took place in the boiling tube. (1 mark)
  - Using oxidation numbers, show that reduction and oxidation reactions took place in the boiling tube. (2 mark)
26. When hydrogen sulphide gas was bubbled into an aqueous solution of iron (III) chloride, a yellow precipitate was deposited.
- State another observation made. (1 mark)
  - Write an equation for the reaction that took place. (1 mark)
  - What type of reaction was undergone by hydrogen sulphide in this reaction? (1 mark)
27. Study the flow chart below and answer the questions that follow.



- Name reagent **Z**. (1 mark)
  - Describe the process which takes place in step 2. (1 mark)
  - Identify the white solid. (1 mark)
28. The diagram below shows some processes that take place during the industrial manufacture of sulphuric acid.

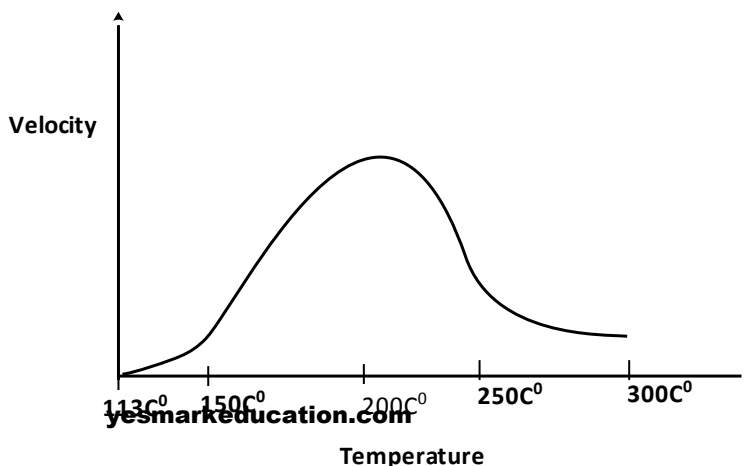


- (i) Write the equation for the reaction in which sulphur dioxide gas is produced. (1 mark)
- (ii) Why is it necessary to keep the gases pure and dry? (1 mark)
- (iii) Describe the process that takes place in chamber G. (1 mark)
- (iv) Name the gases that escape into the environment. (1 mark)
- (v) State and explain the harmful effect on the environment of one of the gases named in (iv) above (1 mark)
- (vi) Give **one** reason why it is necessary to use a pressure of 2-3 atmospheres and not more. (1 mark)
- (b) (i) Complete the table below to show the observations made when concentrated sulphuric (VI) acid is added to the substances shown. (2 marks)

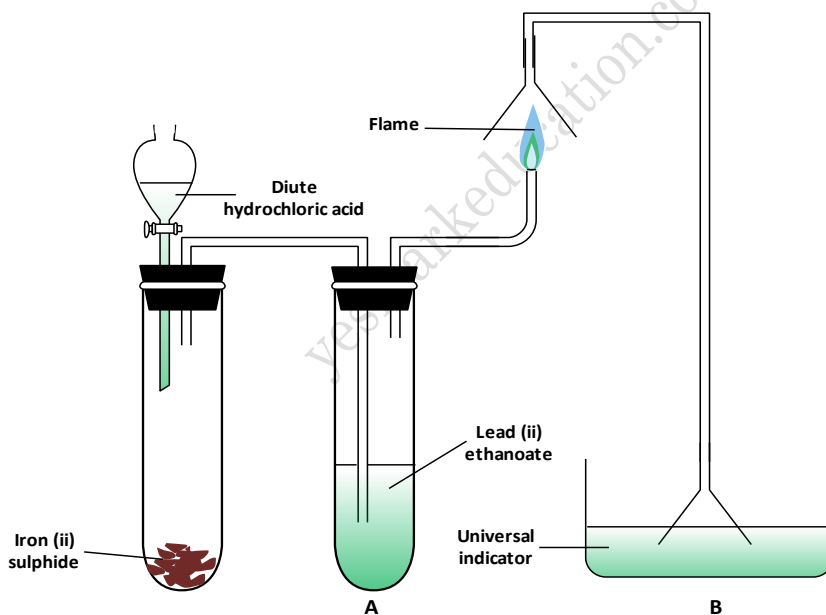
Substance	Observation
Iron fillings	
Crystals of white sugar	

- (ii) Give reasons for the observations made using:
- iron fillings (1 mark)
  - Crystals of white sugar. (1 mark)
- (c) Name one fertilizer made from sulphuric acid. (1 mark)
- (d) Suggest a reason why  $\text{BaSO}_4$  (A pigment made from sulphuric acid) would be suitable in making paint for cars. (1 mark)

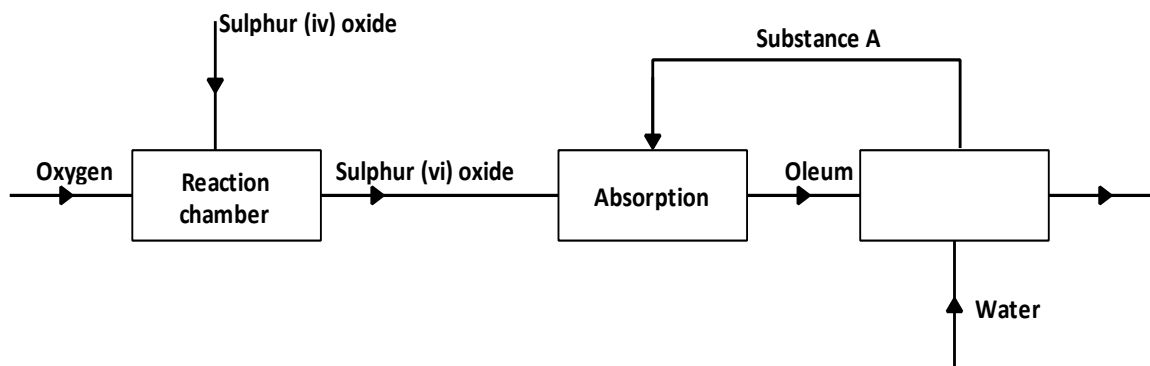
29. Below is a sketch of a graph showing the change in viscosity? (Ease of flow) with temperature when solid sulphur is heated.



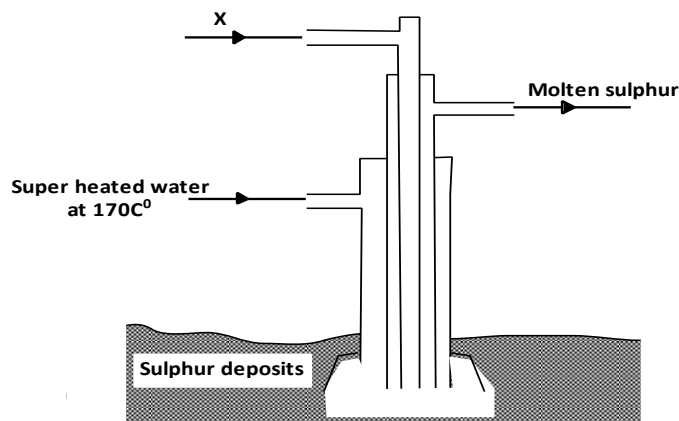
- Describe what happens to the sulphur molecules when sulphur is heated from 150<sup>0</sup>C to about 200<sup>0</sup>C. (2 marks)
30. (a) State the observation made at the end of the experiment when a mixture of iron powder and sulphur is heated in a test tube. (1 mark)
- (b) Write an equation for the reaction the product in (a) above and dilute hydrochloric acid. (1 mark)
- (c) When a mixture of iron powder and sulphur is heated, it glows more brightly than that of iron fillings and sulphur. Explain this observation. (1 mark)
31. Zinc reacts with both concentrated and dilute sulphuric (VI) acid. Write equations for two reactions. (2 mark)
32. Crude oil contains sulphur. What would be the effect to the environment of using fuel containing sulphur? (1 mark)
33. Hydrogen sulphide is a highly toxic and flammable gas. It is normally prepared in a fume chamber.
- (a) Name **two** reagents that can be used to prepare hydrogen sulphide in the laboratory. (1 mark)
- (b) One of the uses of hydrogen sulphide is to produce sulphur as shown in the following equation;
- (c)  $2\text{H}_2\text{S}(\text{g}) + \text{SO}_2(\text{g}) \longrightarrow 3\text{S}(\text{s}) + 2\text{H}_2\text{O}(\text{l})$
- Identify the reducing agent in this reaction and give a reason for your answer. (1 mark)
- (d) Other than production of sulphuric (IV) acid, state **one** commercial use of sulphur. (1 mark)
34. The set up below was used to prepare a gas and study some of its properties. Study it and answer the questions that follow:



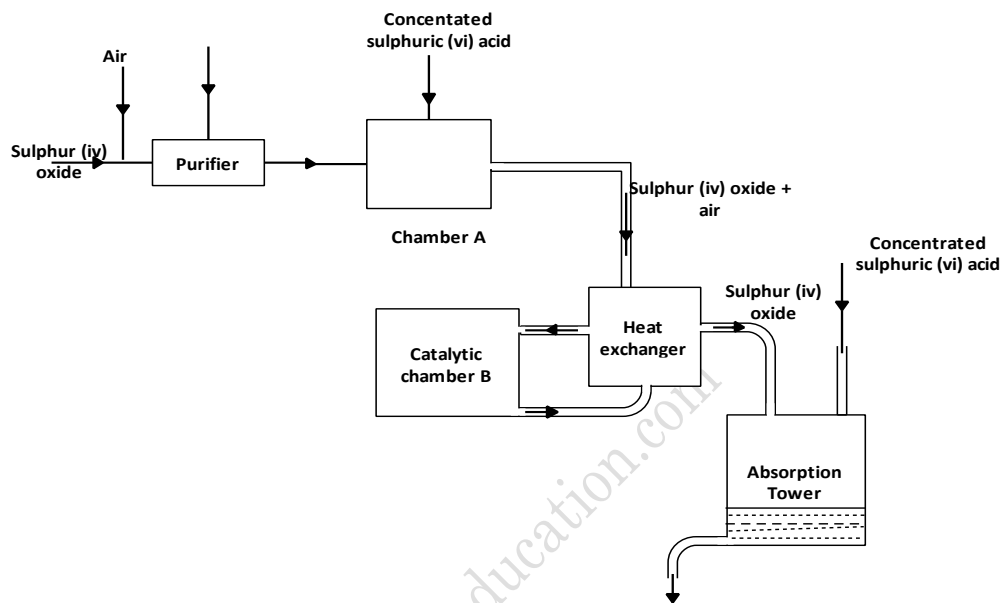
- (a) State and explain the observation made in the:
- (b) (i) tube labelled A; (1 mark)
- (c) (ii) beaker labelled B, (1 mark)
- (d) State **one** precaution that should be taken when carrying out this experiment. (1 mark)
35. The flow chart below shows some of the processes involved in large scale production of sulphuric (VI) acid. Use it to answer the questions that follow.



- (a) Describe how oxygen is obtained from air on a large scale (3 marks)
- (b) (i) Name substance A.  
(ii) Write an equation for the process that takes place in the absorption chamber. (1 mark)
- (c) Vanadium (V) oxide is a commonly used catalyst in the contact process.  
(i) Name another catalyst which can be used for this process. (1 mark)  
(ii) Give two reasons why vanadium (V) oxide is the commonly used catalyst. (2 marks)
- (d) State and explain the observations made when concentrated sulphuric (VI) acid is added to crystals of copper (II) sulphate in a beaker. (2 marks)
- (e) The reaction of concentrated sulphuric (VI) acid with sodium chloride produces hydrogen chloride gas. State the property of concentrated sulphuric (VI) acid illustrated in this reaction. (1 mark)
- (f) Name four uses of sulphuric (VI) acid (2 marks)
36. Acidified potassium manganate (VII) solution is decolourised when sulphur (IV) oxide is bubbled through it. The equation for the reaction is given below. (3 marks)
- $$2\text{H}_2\text{O}_{(l)} + 5\text{SO}_{2(g)} + 2\text{KMnO}_{4(aq)} \rightarrow \text{K}_2\text{SO}_{4(aq)} + 2\text{MnSO}_{4(aq)} + 2\text{H}_2\text{SO}_{4(aq)}$$
- (a) Which reactant is oxidised? Explain. (2 marks)
- (b) Other than the manufacture of sulphuric (VI) acid, state one other use of sulphur (IV) oxide. (1 mark)
37. (a) What would be observed if sulphur (IV) oxide is bubbled through acidified potassium manganate (VII)? (1 mark)
- (b) In an experiment, sulphur (IV) oxide was dissolved in water to form solution L.  
(i) What would be observed if a few drops of barium nitrate solution were **immediately** added to solution L? (1 mark)  
(ii) Write an ionic equation for the reaction that occurred between solution L and aqueous barium nitrate in (b)(i) above. (1 mark)
38. (a) The diagram below shows the Frasch process used for extraction of sulphur. Use it to answer the questions that follow.

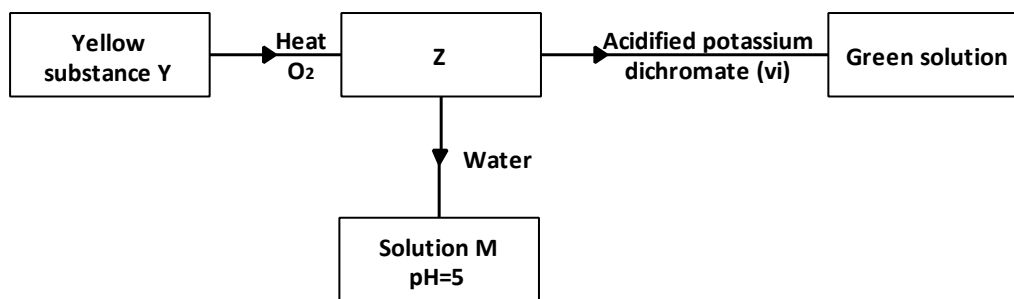


- (i) Identify X. (1 mark)  
 (ii) Why is it necessary to use superheated water in this process? (1 mark)  
 (iii) State **two** physical properties of sulphur that makes it possible for it to be extracted by this method.,(2 marks)
- (b) The diagram below shows part of the process in the manufacture of sulphuric (VI) Acid. Study it and answer the question that follow.



- (i) Write an equation for the formation of sulphur (IV) oxide from sulphur. (1 mark)  
 (ii) What is the role of concentrated sulphuric (VI) acid in chamber A? (1 mark)  
 (iii) Name **two** catalysts that can be used in the catalytic chamber B. (2 marks)  
 (iv) State **two** roles of the exchanger. (2 marks)
- (c) Explain one way in which sulphur (IV) oxide is a pollutant. (1 mark)  
 (d) What observation will be made when a few drops of concentrated sulphuric (VI) acid are added to crystals of sugar? Explain your answer. (1 mark)

39. Study the flow chart below and answer the questions that follow.



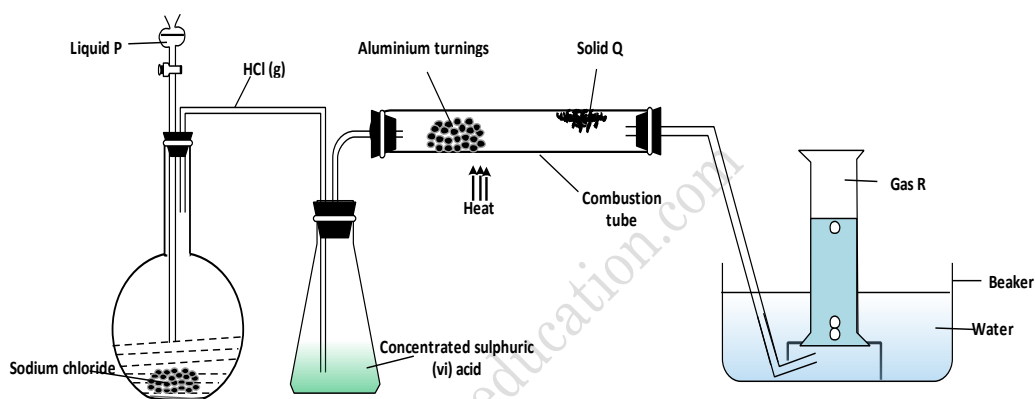
Identify **Z** and **M**.

(2 marks}

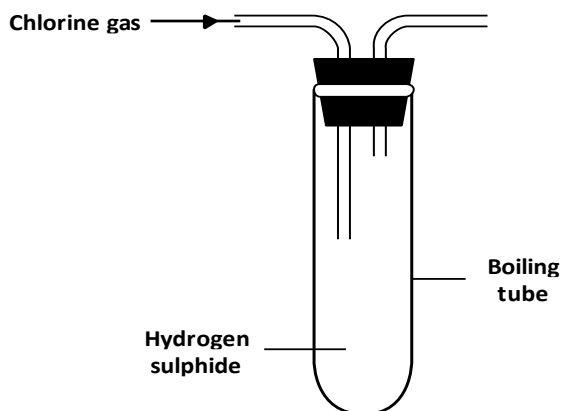
40. In the contact process, during the production of sulphur (VI) oxide, a catalyst is used. Give **two** reasons why vanadium (V) oxide is preferred to platinum. (2 marks)

### 18. CHLORINE AND ITS COMPOUNDS

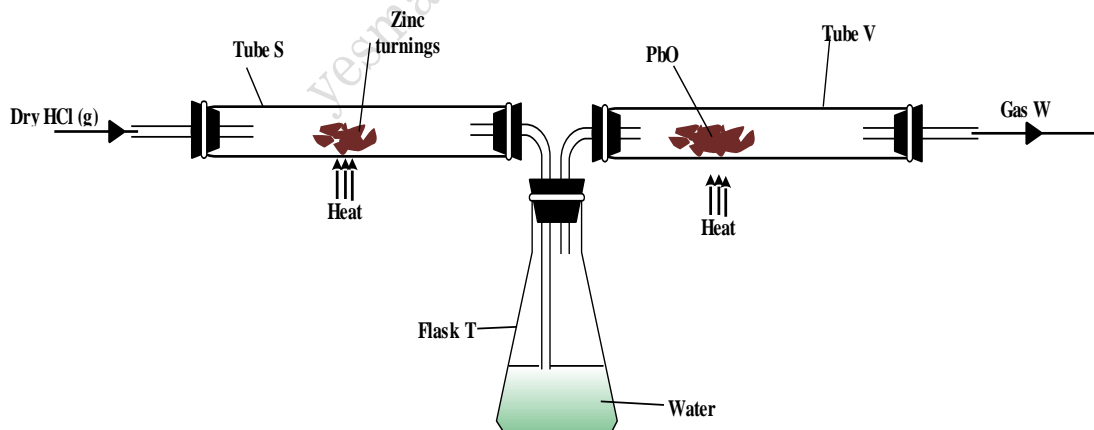
1. (a) In an experiment hydrogen chloride gas was prepared and reacted with aluminium turnings to form a solid Q and gas R as shown in the diagram below.



- (i) Name: Liquid P ..... (1 mark)  
 Solid Q ..... (1 mark)  
 Gas R ..... (1 mark)
- (ii) Name another substance that could serve the same purpose as the concentrated sulphuric (VI) acid (1 mark)
- (iii) Explain the following observation. When blue litmus paper was dipped into the water in the beaker at the end of the experiment it turned red. (2 marks)
- (iv) Explain why solid Q collects farther away from the heated aluminium. (1 mark)
- (b) (i) Write an equation for the reaction that takes place between ammonia gas and hydrogen gas (1 mark)  
 (ii) Calculate the mass of the product that would be formed when 2000cm<sup>3</sup> of hydrogen chloride gas reacts completely with excess ammonia gas (H=1, O= 14.0, Cl = 35.5, one mole of gas occupied 24 litres at room temperature and pressure.) (3 marks)
2. Chlorine and iodine are elements in the same group in the periodic table. Chlorine gas is yellow white aqueous, iodine; I<sub>2</sub>(aq) is brown.
- (a) What observation would be made if chlorine gas is bubbled through aqueous sodium iodide? Explain using and ionic equation. (2 marks)
- (b) Under certain conditions chlorine and iodine react to give iodine chloride, ICl<sub>3</sub>(s). What type of bonding would you expect to exist in iodine trichloride? Explain. (1 mark)
3. In an experiment, chlorine gas was passed into moist hydrogen sulphide contained in a boiling tube as shown in the diagram



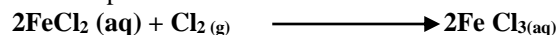
- (a) What observation was made in the boiling tube? (1 mark)
- (b) Write an equation for the above reaction. (1 mark)
- (c) What precaution should be taken in carrying out this experiment? Give a reason. (1 mark)
4. The information below relates to element **L**, **Q**, **R** and **T**. The letters do not represent the actual symbols of the elements. Arrange the elements in order of their increasing reactivity.
- $$\begin{array}{lcl}
 2\mathbf{Q}^{-}(\text{aq}) + \mathbf{R}_2(\text{aq}) & \longrightarrow & \mathbf{Q}_2(\text{g}) + 2\mathbf{R}^{-}(\text{aq}) \\
 2\mathbf{T}^{-}(\text{aq}) + \mathbf{Q}_2(\text{g}) & \longrightarrow & 2\mathbf{Q}^{-}(\text{aq}) + \mathbf{T}_2(\text{g}) \\
 \mathbf{L}^{-}(\text{aq}) + \mathbf{R}_2(\text{g}) & \longrightarrow & \text{no reaction}
 \end{array}$$
- (2 marks)
5. In an experiment, dry hydrogen chloride gas was passed through heated zinc turnings as shown in the diagram below. The gas produced was then passed through heated lead (II) oxide.



- (i) What is the function of water in the flask? (1 mark)
- (ii) Write equations for the reactions that took place in the tubes S and V. (2 marks)
- (iii) How would the total mass of tube V and its contents compare before and after the experiment? Explain. (2 marks)
- (b) Chlorine can be prepared by using the following three agents; solid sodium chloride, concentrated sulphuric (VI) acid and potassium permanganate (VII).
- (i) What is the role of each of the following in the reaction?
- I. concentrated sulphuric (VI) acid (1 mark)

- II. potassium permanganate (VII) (1 mark)
- (ii) Name the bleaching agent formed when chlorine gas is passed through cold dilute sodium hydroxide solution. (1 mark)
- (iii) Name one other use of the compound formed in (ii) above other than bleaching (1 mark)
- (d) 1.9 g of magnesium chloride was dissolved in distilled water. Silver nitrate solution was added until in excess. Calculate the mass of silver nitrate that was used for the complete reaction. (Relative molecular mass of magnesium chloride = 95, N = 14.0, O = 16.0, Ag = 108.0) (3 marks)

6. The equation below represents a redox reaction.



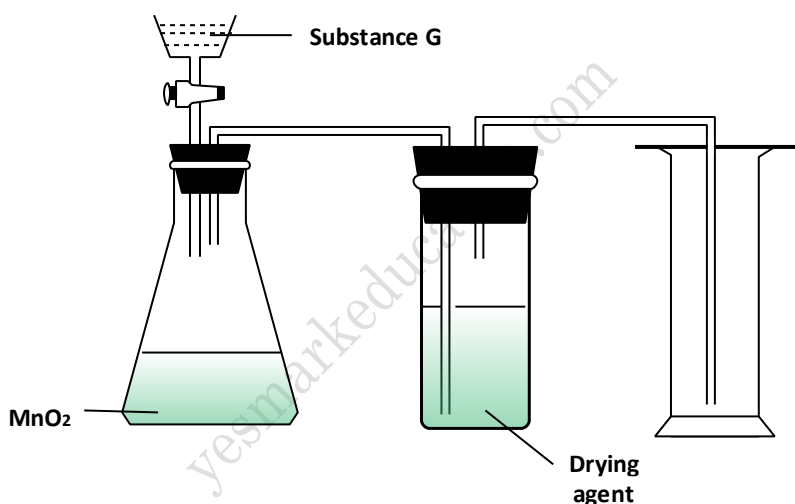
Identify the reducing agent. Give a reason.

(3 marks)

7. What is the oxidation number of chlorine in  $\text{ClO}_4^-$

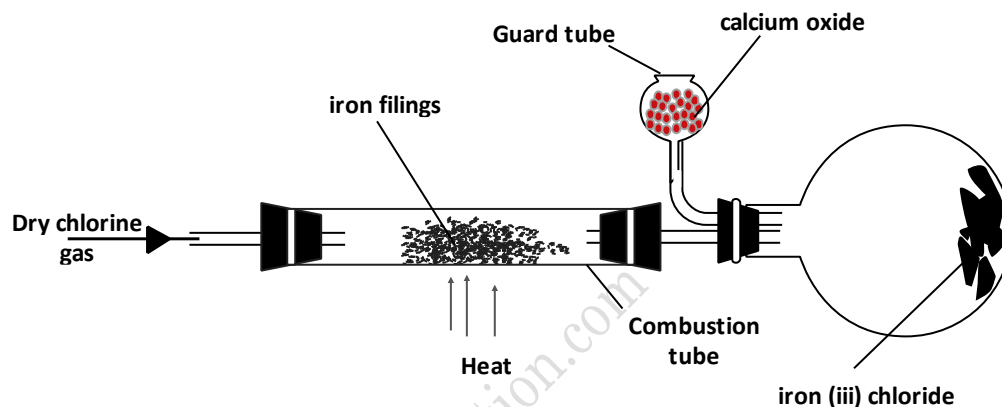
(1 mark)

8. The diagram below shows a set up for the laboratory preparation and collection of dry chlorine gas

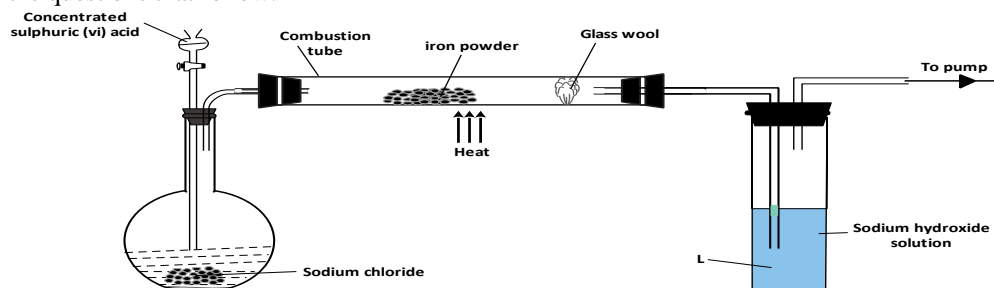


- (a) Name:
- (i) Substance G. (1 mark)
- (ii) A suitable drying agent. (1 mark)
- (b) What property of chlorine makes it possible for it to be collected as shown in the diagram? (1 mark)
9. The equation below represents a redox reaction
- $$\text{Mg}(\text{s}) + 2\text{HCl}(\text{aq}) \longrightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$$
- (a) Write down the equation for the reduction process. (1 mark)
- (b) Which substance is oxidized? (1 mark)
10. (a) (i) In the space provided sketch a labeled diagram to show how hydrogen chloride gas can be prepared and collected in the laboratory using sodium chloride and concentrated sulphuric (VI) acid (the gas need not be dry). (3 marks)
- (ii) Write an equation for the reaction that takes place. (1 mark)
- (iii) Name one drying agent for hydrogen chloride. (1 mark)
- (iv) State and explain the observation that would be made when hydrogen chloride gas is bubbled through a solution of lead (II) nitrate. (2 marks)

- (v) Concentrated hydrochloric acid is used for removing oxide from metal surfaces (pickling). Explain why concentration nitric acid cannot be used for the purpose. (2 marks)
- (b) A sample of hydrogen chloride gas was dissolved in water to make  $250\text{cm}^3$  of solution.  $25\text{cm}^3$  of the solution required  $46\text{cm}^3$  of  $11.0\text{M}$  sodium hydroxide for complete neutralization.
- (i) Calculate the number of moles of hydrochloric acid in  $25\text{cm}^3$  of solution (1 mark)
- (ii) Determine the mass of hydrogen chloride that was dissolve to make  $250\text{cm}^3$  of solution ( $\text{Cl} = 35.5, \text{H} = 1.0$ ) (2 marks)
11. (a) Give the name of reagent which when reacted with concentrated hydrochloric acid produce chlorine gas. (1 mark)
- (b) A student out to prepare iron III chloride using the apparatus shown in the diagram below.



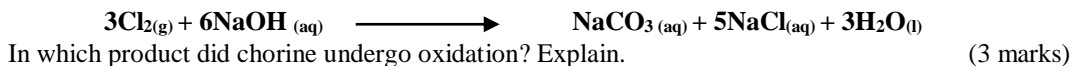
- (i) Explain why:
- I. it is necessary to pass chlorine gas through the apparatus before heating begins. (1 mark)
- II. calcium oxide would be preferred to calcium chloride in the guard tube. (1 mark)
- (ii) What property of iron (III) chloride makes it possible to be collected as shown in the diagram? (1 mark)
- (iii) Write an equation form one chemical reaction that took place in the guard tube. (1 mark)
- (iv) The total mass of iron (III) chloride formed was found to be  $0.5\text{g}$ . Calculate the volume of chlorine gas the reacted with iron. ( $\text{Fe} = 56.0, \text{Cl} = 35.5$  and Molar gas volume at  $298\text{K}$  is  $24,000\text{cm}^3$ ) (3marks)
- (c) When hydrogen sulphide gas was passed through a solution of iron (III) chloride, the following observation were made: the colour of the solution changed from reddish-brown to green and a yellow solid was deposit. Explain these observations. (2 marks)
- (d) State and explain the observations that would be made if a moist blue litmus paper was placed in a gas jar full of chloride gas. (2 marks)
12. The following two tests were carried out on chlorine water contained in two test tubes:
- (a) A piece of blue flower was dropped into the first – tube. Explain why the flower was bleached. (2 marks)
- (b) The second test- tube was corked and exposed to sunlight after a few days, it was found to contain a gas that rekindled a glowing splint. Write an equation for the reaction which produced the gas. (1 mark)
13. The set – up below was used to prepare hydrogen chloride gas and react it with iron powder. Study it and answer the questions that follow.



At the end of the reaction, the iron powder turned into a light green solid.

- (a) Identify the light green solid. (1 mark)  
(b) At the beginning of the experiment, the Ph of the solution in container L was about 14. At the end, the pH was found to be 2. Explain. (2 marks)

14. When excess chlorine gas was bubbled into hot concentrated sodium hydroxide, the following reaction occurred.



15. (a) The table below shows properties of chlorine, bromine and iodine.

Element	Formula	Colour and state room temperature	Solubility in water
Chlorine	Cl <sub>2</sub>	i).....	Soluble
Bromine	Br <sub>2</sub>	Brown liquid	ii).....
Iodine	I <sub>2</sub>	iii).....	Slight soluble

- Complete the table by giving the missing information in (i), (ii) and (iii) (3 marks)
- (b) Chlorine gas is prepared by reacting concentrated hydrochloric acids with manganese (IV) oxide.
- (i) Write the equation for reaction between concentrated hydrochloric acid and manganese (IV) oxide. (1 mark)
- (ii) What is the role of manganese (IV) oxide in this reaction? (1 mark)
- (c) (i) Iron (II) chloride reacts with chlorine gas to form substance E. Identify substance E. (1 mark)
- (ii) During the reaction in c (i) above, 6.30g of iron chloride were converted to 8.06g of substance E. Calculate the volume of chlorine used. (Cl = 35.5, Molar gas volume at room temperature = 24000cm<sup>3</sup>, Fe = 56) (3 marks)
- (d) Draw and name the structure of the compound formed when excess chlorine gas is reacted with ethane gas. (2 marks)
- (e) Give the industrial use of chlorine (1 mark)
16. Calcium oxide can be used to dry ammonia gas. (2 mark)
- (a) Explain why calcium oxide is not used to dry hydrogen chloride gas. (2 mark)
- (b) Name one drying agent for hydrogen chloride gas. (1 mark)

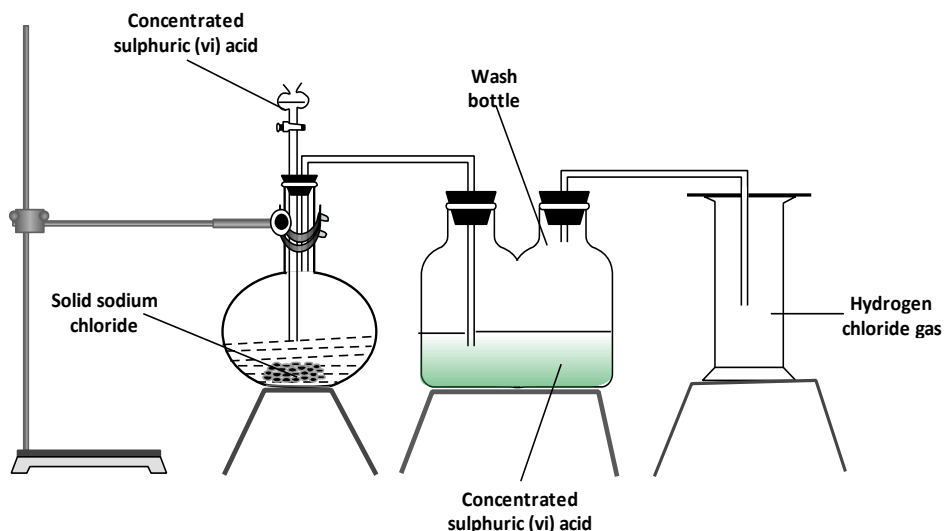
17. The reaction between hot concentrated sodium hydroxide and chlorine produces sodium chlorate (V), sodium chloride and water.

- (a) Write the equation for the reaction. (1 mark)  
(b) Give one use of sodium chlorate (V). (1 mark)

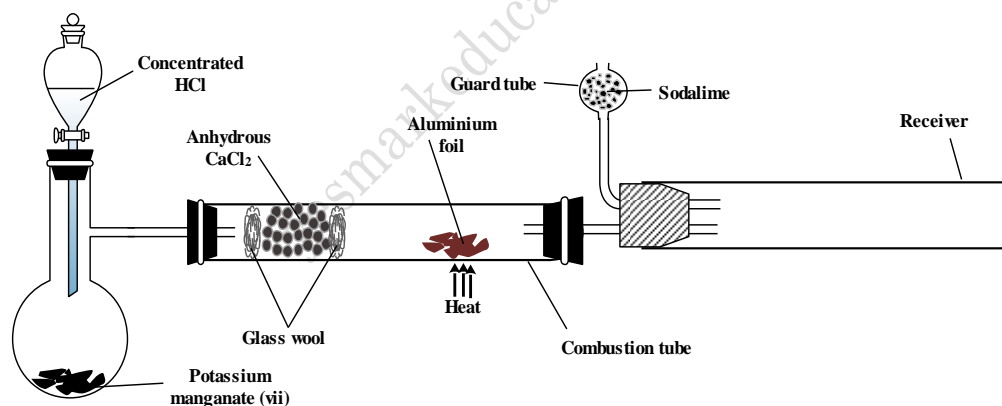
18. Name the process which takes place when:

- (a) Solid carbon (IV) oxide (dry ice) changes directly into gas. (1 mark)  
(b) A red litmus paper turns white when dropped into chlorine water. (1 mark)  
(c) Propane gas molecules are converted into a giant molecule. (1 mark)

19. The diagram below represents the set-up that was used to prepare and collect hydrogen chloride gas in the laboratory.



- (a) State the purpose of concentrated sulphuric acid in the wash bottle. (1 mark)
- (b) Write an equation for the reaction between dry hydrogen chloride gas and heated iron (1 mark)
- (c) Hydrogen chloride gas is dissolved in water to make hydrochloric acid. State one use of hydrochloric acid. (1 mark)
20. State and explain the observations made when excess ammonia gas reacts with chlorine gas (3 marks)
21. The diagram below shows the set up used in an experiment to prepare chlorine gas and react it with aluminium foil. Study it and answer the question that follow.



- (a) In the experiment, concentrated hydrochloric acid and potassium manganate (VII) were used to prepare chlorine gas. State two precautions that should be taken in carrying out this experiment. (2 marks)
- (b) Write the formula of another compound that could be used instead of potassium manganate (VII) (1 mark)
- (c) Explain why it is necessary to allow the acid to drip slowly onto potassium manganate (VII) before the aluminium foil is heated. (2 marks)
- (d) State the property of the product formed in the combustion tube that makes it possible for it to be collected in the receiver. (1 mark)
- (e) When 1.08g of aluminium foil were heated in a stream of chlorine gas, the mass of the product formed was 3.47 g. Calculate the:
- maximum mass of the product formed if chlorine was in excess; (Al= 27; Cl = 35.5) (3 marks)
  - percentage yield of the product formed (1 mark)

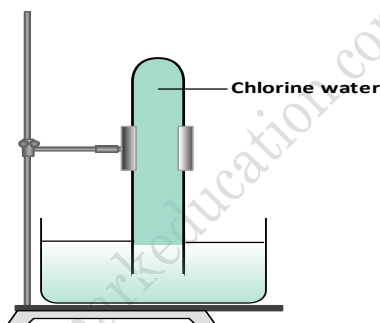
- (f) Phosphorous trichloride is a liquid at room temperature. What modification should be made to set up if it is to be used to prepare phosphorous trichloride? (1 mark)

22. Complete the following table by filling in the missing test and observations

No.	Gas	Test	Observation
I	Chlorine	Put a moist red litmus paper in the gas	
II	Sulphur (IV) oxide		Paper turns green
III	Butene	Add a drop of bromine water	

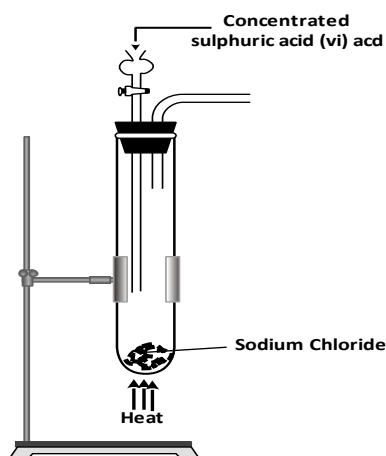
(3 marks)

23. In an experiment, a test-tube full of chlorine water was inverted in chlorine water as shown in the diagram below and the set up left in sunlight for one day.

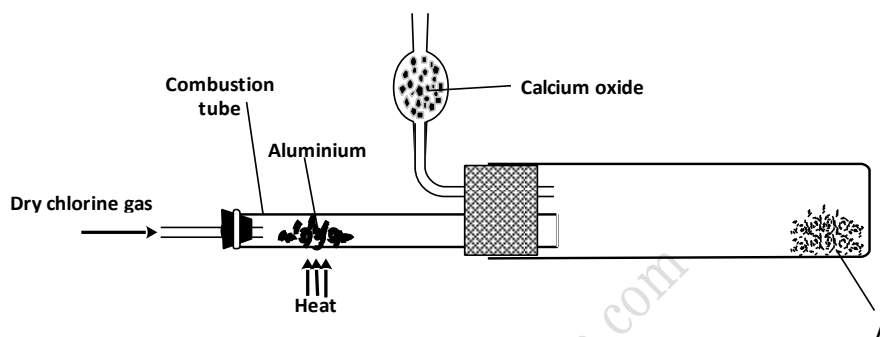


After one day, a gas was found to have collected in the test-tube

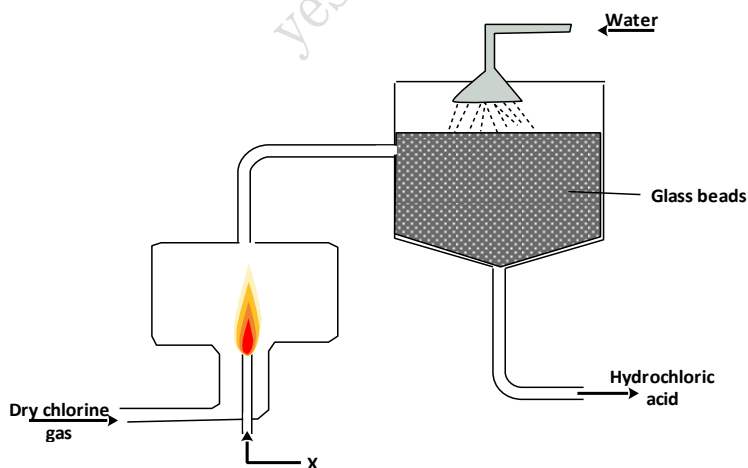
- (a) Identify the gas. (1 mark)  
 (b) What will happen to the PH of the solution in the beaker after one day? Give an explanation. (2 marks)
24. The diagram below is part of a set up used in the laboratory preparation of a gas.



- Complete the diagram to show how a dry sample of the gas can be collected. (3 marks)
25. Two reagents that can be used to prepare chlorine gas are manganese (IV) oxide and concentrated hydrochloric acid.
- Write an equation for the reaction. (1 mark)
  - Give the formula of another reagent that can be reacted with concentrated hydrochloric acid to produce chlorine gas. (1 mark)
  - Describe how the chlorine gas could be dried in the laboratory. (2 marks)
- (b) In an experiment, dry chlorine gas was reacted with aluminium as shown in **Figure 1**.



- Name substance A. (1 mark)
  - Write an equation for the reaction that took place in the combustion tube. (1 mark)
  - 0.84 g of aluminium reacted completely with chlorine gas. Calculate the volume of chlorine gas used. (Molar gas volume is  $24\text{dm}^3$ ,  $\text{Al} = 27$ ). (3 marks)
  - Give two reasons why calcium oxide is used in the set up. (2 marks)
25. The diagram below represents set up for large scale manufacture of hydrochloric acid. Study it and answer the questions that follow.



- Name substance X (1 mark)
- What is the purpose of the glass beads? (1 mark)
- Give two uses of hydrochloric acid. (1 mark)

26. During a class experiment, chlorine gas was bubbled into a solution of potassium iodide.

- (a) State the observations made. (1 mark)  
(b) Using an ionic equation, explain why the reaction is redox. (2 mark)

27. Under certain conditions, chlorine gas reacts with sodium hydroxide to form sodium hypochlorite.

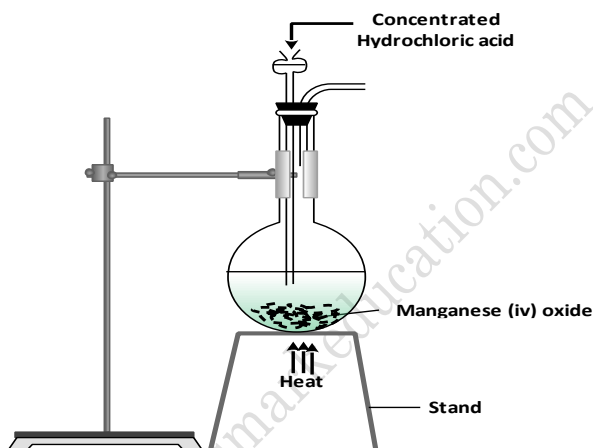
- (a) Name the conditions under which sodium hydroxide reacts with chlorine to form sodium hypochlorite.

28. (a) State and explain what would happen if a dry blue litmus paper was dropped in a gas jar of chlorine

(1 mark)

(b) By using only dilute hydrochloric acid, describe how a student can distinguish between barium sulphite from barium sulphate. (2 marks)

29. (a) The diagram below is part of set up used to prepare and collect dry chlorine gas.



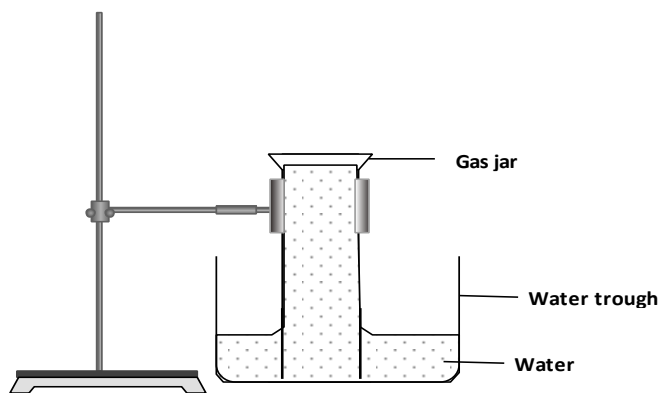
- (i) Complete the diagram to show how a dry sample of chlorine gas can be collected. (3 marks)  
(ii) Name another substance and condition that can be used instead of manganese (VI) oxide. (1 mark)  
(iii) Write an equation for each of the following;  
I. chlorine gas reacting with iron (1 mark)  
II. chlorine gas reacting with hot concentrated sodium hydroxide solution. (1 mark)  
(b) An oxide of chlorine of mass 1.83g was found to contain 1.12g of oxygen. Determine the empirical formula of the oxide (O = 16.0; Cl = 35.5). (3 marks)  
(c) Other than the manufacture of weed killers, name two other uses of chlorine. (2 marks)

30. State and explain what would happen if a dry red litmus paper was dropped in a gas jar of dry chlorine.

(2 marks)

31. A gas jar full of chlorine water was inverted over water and allowed to stand for sometime.

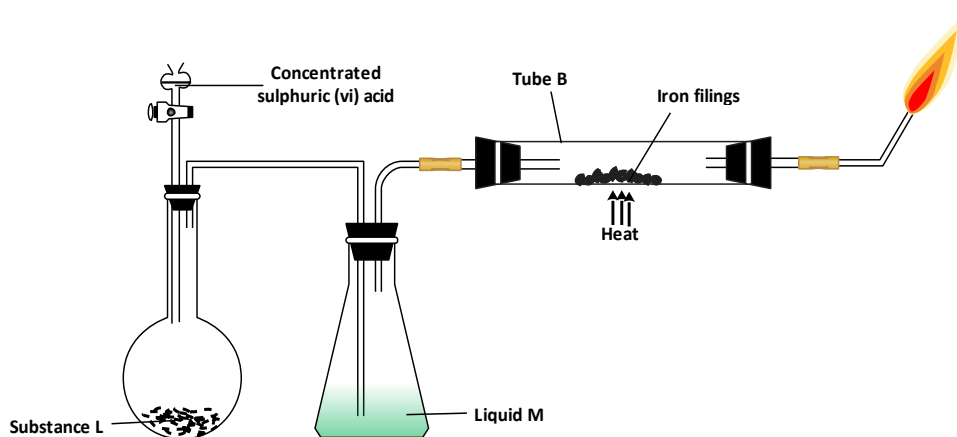
- (a) State and explain **two** observations made in the gas jar after some time. (2 marks)



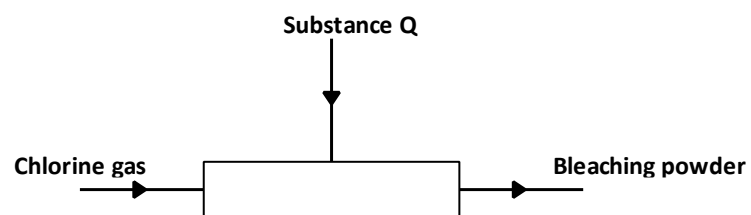
(b) Write the equation for the reaction between chlorine and hot concentrated potassium hydroxide.

(1 mark)

32. The set-up below was used to prepare dry hydrogen chloride gas, and investigate its effect on heated iron filings.



- (i) Name substance **L**. (1 mark)
- (ii) Name liquid **M**. (1 mark)
- (iii) What will be observed in tube **B**? (1 mark)
- (iv) Write an equation for the reaction that occurs in tube **B**. (1 mark)
- (v) Why is the gas from tube **B** burnt? (1 mark)
- (b) (i) Explain the following observations:
- (I) a white precipitate is formed when hydrogen chloride gas is pass through aqueous silver nitrate. (1 mark)
- (II) hydrogen chloride gas fumes in ammonia gas. (1 mark)
- (ii) State **two** uses of hydrogen chloride gas. (1 mark)
- (c) The diagram below is a representation of an industrial process for the manufacture of a bleaching powder.



- (i) Name substance Q. (1 mark)
- (ii) When the bleaching powder is added to water during washing, a lot of soap is used. Explain. (1 mark)

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