

233/1  
CHEMISTRY  
PAPER 1

Time: 2 hours

MOMALICHE <sup>2</sup>/<sub>10</sub> CYCLE <sup>10</sup>/<sub>2</sub>

Name M/S. ..... Index Number...../.....

Signature .....

School.....

Date ...../...../.....

**INSTRUCTIONS TO CANDIDATES**

1. Write your name and index no in the spaces provided above.
2. Sign and write the date of exam in the spaces provided above.
3. Answer all the questions in the spaces provided after each.
4. Mathematical tables and silent electronic calculators may be used.
5. All working must be clearly shown where necessary.
6. This paper consists of 12 printed pages. Candidates should check to ensure that all pages are printed as indicated and that no questions are missing.
7. All answers should be written in English.

**For Examiner's Use Only**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

17	18	19	20	21	22	23	24	25	26	27	28	29

Grand  
Total

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1. Metal Q displaces metals T and U from their oxides but does not displace metal R. Metal T displaces U from its oxide. Arrange the metals according to their reactivity starting with the strongest reducing agent. (1 mark)

R - Q - T - U ✓ 01  
 ↑  
 increasing

2. Chlorine gas can be prepared in the laboratory using the following two methods;

Solid substance X and concentrated Hydrochloric acid

Solid substance X, concentrated sulphuric (VI) acid and solid Sodium Chloride.

- a) Name the solid substance X (1 mark)

Manganese (IV) oxide ✓ 01  $KMnO_4$

- b) What is the role of concentrated sulphuric acid in the reaction? (1 mark)

It reacts with sodium chloride to produce hydrogen

chloride which in turn reacts with Manganese (IV) oxide to produce chlorine gas ✓ 2

- c) State how dry chlorine gas is collected. (1 mark)

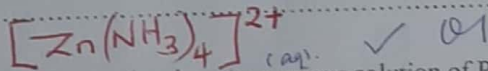
It is collected by downward delivery since it is denser than air ✓ 01

3. A white crystalline solid Q when heated, forms a brown gas, colourless gas that relights a glowing wooden splint and a yellow residue which turns white on cooling. Aqueous solution of Q forms a white ppt. which dissolves in excess aqueous ammonia solution to form a colourless solution P. (2 marks)

- a) Write the name and chemical formulae of complex ion in solution P.

Name: Tetra amine zinc (II) ion ✓ 01

Chemical formula:



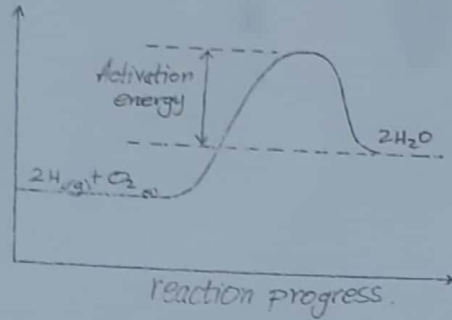
- b) State the observation made when the aqueous solution of P is reacted with few drops of sodium hydroxide. (1 mark)

White precipitate is formed. ✓ 01

- 4(a) Define the term Lattice energy (1 mark)

Energy change when one mole of an ionic compound is formed from its constituent ions in gaseous state ✓ 01

b) The reaction between hydrogen gas and oxygen <sup>exothermic</sup> releases energy. A student drew the reaction profile for the reaction between hydrogen gas and oxygen gas.



State two errors made when drawing the reaction profile.

(2 mks)

- ✓ Products should be at a lower energy than reactants ✓
- ✓ Labelling of the y-axis (Energy in kJ/mol).

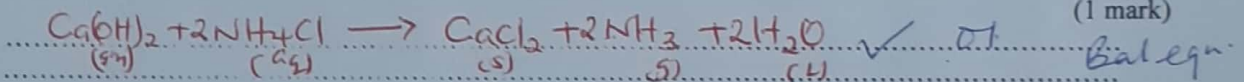
5. Ammonia gas is one of the substances recycled in the Solvay process.

a) Other than water name another substance that is recycled in the process. (1 marks)

Carbon (IV) oxide ✓

b) Write a balanced chemical equation for the reaction that regenerates Ammonia gas in the process.

(1 mark)



\*c) State an industrial use of the only waste product in the Solvay process. (1 mark)

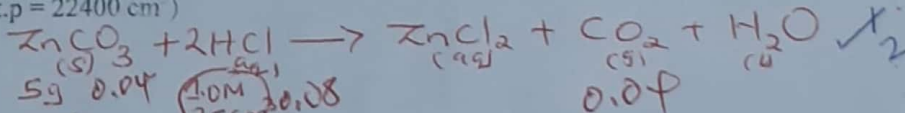
- Used as a drying agent of gases that do not react with it  
 - used to extract sodium metal

6. Lead (II) iodide is a toxic bright yellow solid which was used as a paint pigment known as 'iodine yellow'.

Describe briefly how you would prepare lead (II) iodide in the laboratory starting with lead (II) oxide. (3 marks)

- Add Lead (II) oxide to nitric (V) acid until it is in excess ✓
- Filter to remove unreacted Lead (II) oxide ✓
- To the filtrate add sodium iodide and filter off to remove lead (II) iodide as a residue ✓
- Wash the residue with distilled water ✓
- Dry the residue between the filter papers ✓

7. 5.0g of zinc carbonate were allowed to react with 25cm<sup>3</sup> of 1M hydrochloric acid until there was no further reaction. Calculate the volume of gas that was formed at s.t.p. (Zn = 65.4, O = 16, C = 12, molar gas volume at s.t.p = 22400 cm<sup>3</sup>) (3 marks)



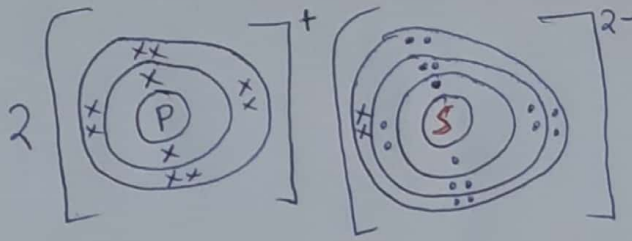
5.0 / 125 = 0.04  
 1.0 mole = 1000 cm<sup>3</sup>  
 ? = 25 cm<sup>3</sup>  
 $\frac{25 \times 1}{1000} = 0.025 \text{ moles}$

HCl : CO<sub>2</sub>  
 2 : 1 ✓  
 2 → 0.025 ✓  
 1 → 0.0125 ✓  
 $\frac{1 \times 0.025}{2} = 0.0125 \text{ moles}$

0.0125 moles → 22400 ✓  
 $0.0125 \times 22400 = 280 \text{ cm}^3$

8. Atoms of element P can be represented as  $^{23}_{11}P$ . Element P reacts with sulphur to form a yellow solid. Using dots (•) and crosses (X) to represent electrons, draw the structure of the yellow solid. (S=16). (2 marks)

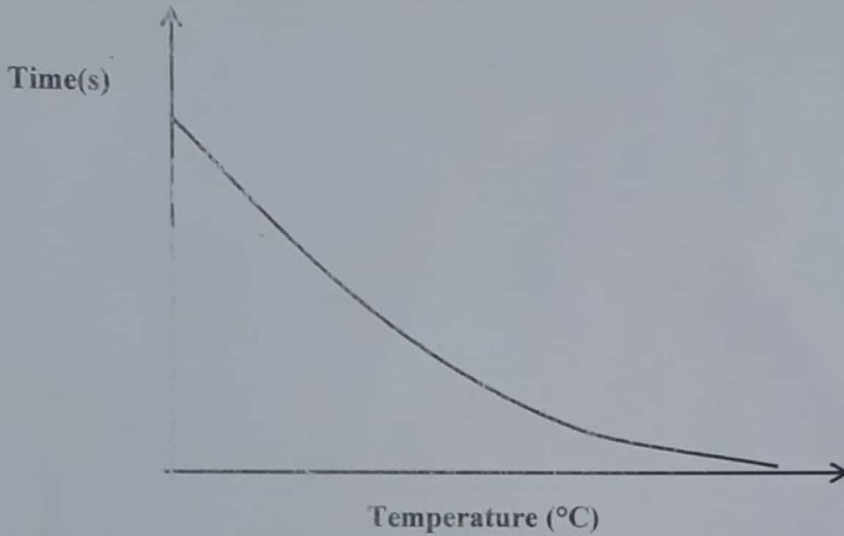
P - 2.8.1  
S - 2.8.6



(2 marks)

✓ 02  
→ All or nothing

9. The curve shown below shows the variation of time against temperature for the reaction between sodium thiosulphate and hydrochloric acid.



(a) Explain the shape of the curve.

Time taken by reaction reduces with increase in temperature. Kinetic energy of reacting particles increases with increasing temperature, frequency of collision increases. (2 marks)

(b) Other than temperature, name one factor that affects the rate of reaction. (1 mark)

- Concentration of reacting substances / surface area
- Presence of a catalyst

10. Magnesium ribbon was added to a solution of hydrogen chloride in methylbenzene. Another piece of Magnesium ribbon was added to distilled water. State and explain observations made. (2 marks)

In methylbenzene there was no effervescence but in water there was effervescence.

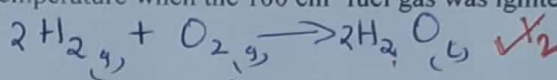
Hydrogen chloride ionises in water. Hydrogen ions react with magnesium producing hydrogen gas.

11 State two differences between luminous and non luminous flame of the Bunsen burner. (2 marks)

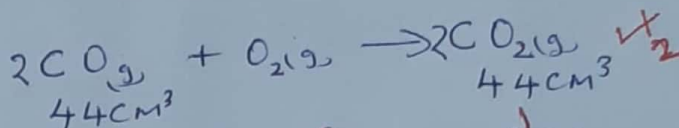
Luminous	Non luminous
- yellow and sooty	blue and non sooty
- fairly hot	very hot
- long and wavy	short and steady

- 12 A fuel gas contains 50% of hydrogen gas and 44% of carbon (II) oxide by volume. The rest of is incombustible. Calculate the volume of gas that remains at room temperature when the 100 cm<sup>3</sup> fuel gas was ignited. (3 marks)

Hydrogen -  $\frac{50}{100} \times 100 = 50 \text{ cm}^3$

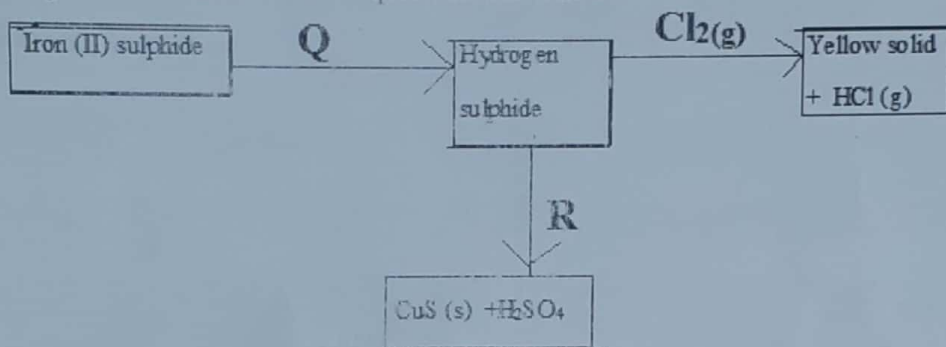


Carbon(II) oxide  $\frac{44}{100} \times 100 = 44 \text{ cm}^3$



Remaining gases  $(100 - 44 \text{ cm}^3) \text{ CO}_2$   
 $6 \text{ cm}^3$  incombustible gas

- 13 Study the diagram below and answer the questions that follow.



- a) Name substances; (1 mark)

Q... dilute hydrochloric acid  
 R... Copper(II) sulphate solution

- b) Write the equation for the reaction that leads to the formation of the yellow solid. (1 mark)



- c) Using a chemical test, describe how you would distinguish between hydrogen sulphide and sulphur (IV) oxide. (1 mark)

Ignite the two gases - Hydrogen sulphide burns while sulphur (IV) oxide does not burn.  
 →  $\text{KMnO}_4$  - colour + yellow sol -  $\text{SO}_2$  - colour  
 →  $\text{K}_2\text{Cr}_2\text{O}_7$  - green + yellow - green

14. A gas occupies a volume of 400 cm<sup>3</sup> at 227°C and 760 mmHg. What will be the temperature of the gas when the volume and pressure of the gas is 100 cm<sup>3</sup> and 380 mmHg respectively. (2 marks)

$227 + 273 = 500 \text{ K}$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$T_2 = \frac{380 \times 100 \times 500}{760 \times 400} = 62.5 \text{ K}$$

- 210.5°C or

15. For each of the following experiments, give the observations, and the type of change that occurs (Physical or chemical)

(3 marks)

Experiment	Observation	Type of change
A few drops of concentrated sulphuric acid added to small amounts of sugar	white/ brown to black solid ✓	Chemical ✓
A few crystals of Iodine are heated gently in a test tube	dark grey to Purple vapour ✓	Physical ✓
A few crystals of copper (II) Nitrate are heated strongly in a test tube.	Blue crystals to black solid, brown gas ✓	Chemical ✓

16. (a) Define solubility of a solute. (1 mark)

Maximum mass of solute required to saturate 100g of the solvent at a particular temperature ✓

b) The solubility of potassium nitrate is 120g/100g of water at 80 °C and 70g/100g of water at 20 °C. What mass of the salt would crystallize if 80g of potassium nitrate solution saturated at 80 °C was cooled to 20 °C

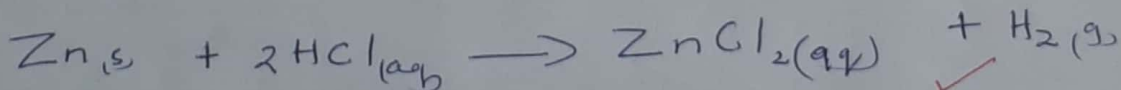
M.S. 100 + 120 = 220g crystals formed  
 $120g \rightarrow 220g$  at 80°C  
 $80g \rightarrow 176g$  at 20°C  
 $220g - 176g = 44g$  crystals formed  
 $\frac{44g}{220} \times 100 = 20g$  crystals formed  
 120 - 70 = 50g KNO<sub>3</sub> (2 marks)  
 $70g \rightarrow 170g$  at 20°C  
 $120 \times \frac{80}{100} = 96g$   
 $96g - 50g = 46g$   
 $\frac{46g}{220} \times 100 = 20.9g$   
 $120 \times \frac{80}{100} = 96g$   
 $96g - 50g = 46g$   
 $\frac{46g}{220} \times 100 = 20.9g$

17. Zinc metal reacted with dilute hydrochloric acid. The gas produced was then passed over heated copper (II) oxide in a combustion tube.

a) State two precautions that must be considered when the gas reacts with copper (II) Oxide in the combustion tube. (2 marks)

- Pass hydrogen through combustion tube before heating copper(II) oxide to drive out all air ✓
- Ignite the excess hydrogen to prevent it from exploding in air ✓

b) Write a balanced chemical equation between zinc and dilute hydrochloric acid. (1 mark)



18. The table below shows ammeter readings recorded when two equimolar solutions were tested separately.

Electrolyte	Current (A)
Dilute Sulphuric (VI) Acid	7.210
Ethanoic Acid	4.011

a) Explain the difference in the ammeter readings. (2 marks)

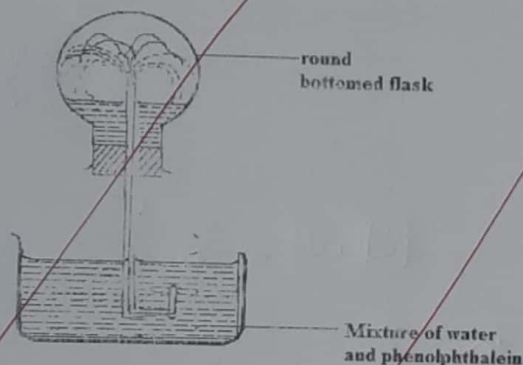
- Sulphuric(VI) acid being a strong acid ionises fully. solution contains many mobile ions hence the high current  
 - Ethanoic acid being a weak acid, ionises partially. solution contains few mobile ions.

b) Compare the reactivity of equal length of magnesium ribbon with each of the electrolytes. (1 mark)

Reaction with  $H_2SO_4$  is higher than with  $CH_3COOH$ .  
 $H_2SO_4$  has more  $H^+$  than  $CH_3COOH$ .

19. The set up below was used to show the solubility of ammonia gas in water.

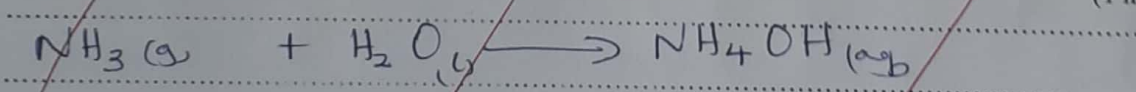
Replaced



\* (a) State and explain the observations made in the flask. (2 marks)

.....  
 .....

(b) Write a balanced equation to show how ammonia gas reacts with water. (1 mark)



20. One of the disadvantages of hard water is wastage of soap.

a) State one other disadvantage (1mk)

Stains white clothes / reduce efficiency in boilers due to deposition of fur  
 ✓ 01 ✓ 01 either

23. The ionization energies of elements A and B are  $495.9 \text{ kJ/mol}$  and  $739.9 \text{ kJ/mol}$  respectively. Both elements are in the same group of the periodic table.

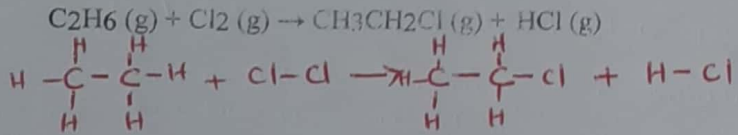
a) What is ionization energy? 24. (1 mark)  
 The minimum amount of energy required to remove an electron in the outermost energy level of an atom in gaseous state ✓ 01

b) Compare the reactivity of elements A and B. Explain your answer. (2 marks)  
 The ionization energy of B is larger/higher than that of A ✓  
 A has weak nuclear forces of attraction due to more occupied energy levels than B. A is more reactive than B ✓ 01; A has smaller ionization energy ( $495.9 \text{ kJ/mol}$ ) than B which is ( $739.9 \text{ kJ/mol}$ ) ✓ 01

25. Study the information given in the table below and answer the questions below.

Bond	Bond energy(kJ/mol)
C-H	413
H-Cl	431
C-Cl	346
Cl-Cl	244
C-C	347

a) Calculate the enthalpy change for the reaction below. (2 marks)



Bond breaking  
 $6 \times \text{C-H} = 6 \times 413 = 2478$   
 $\text{C-C} = 1 \times 347 = 347$   
 $\text{Cl-Cl} = 1 \times 244 = 244$   
 $\underline{3069} \checkmark_2$

Bond formed  
 $\text{C-C} = 1 \times 347 = 347$   
 $\text{C-H} = 5 \times 413 = 2065$   
 $\text{C-Cl} = 1 \times 346 = 346$   
 $\text{H-Cl} = 1 \times 431 = 431$   
 $\underline{3189} \checkmark_2$

$$\Delta H = \text{Bond Breaking} - \text{Bond formation}$$

$$= 3069 - 3189$$

$$= -120 \text{ kJ/mol}$$

b) State a condition required for the reaction in (a) above to take place. (1 mark)  
 u.v light ✓ 01



b) The table below shows tests carried out in a sample of water and the results obtained.

Sample	Results	observations
A	Addition of sodium hydroxide dropwise until excess	Whit precipitate which dissolves in excess
B	Addition of excess ammonia solution	White precipitate
C	Addition of dilute nitric (V) acid followed by barium chloride	White precipitate

Z A P

A P - Present  
Z - Absent

BaSO<sub>4</sub>

(i) Identify the anion present in the water sample (1 Mark)

SO<sub>4</sub><sup>2-</sup> ✓ 01

(ii) Write an ionic equation for the reaction in C (1 Mark)

Ba<sup>2+</sup> + SO<sub>4</sub><sup>2-</sup> → BaSO<sub>4</sub> ✓ 01

21. A piece of sodium was burnt in excess oxygen gas. The product obtained was shaken with water to make a solution.

(a) Write a balanced equation for reaction between the product formed and water. (1 mark)

2Na<sub>2</sub>O<sub>2</sub> + 2H<sub>2</sub>O → 4NaOH + O<sub>2</sub> ✓ 1/2 ✓ 1/2 for state symbol.

(b) State and explain the observation made when red and blue litmus papers are dipped into the solution. (2 marks)

Red litmus paper turns blue while blue litmus paper remains blue because the solution contains OH<sup>-</sup> which are basic in nature.

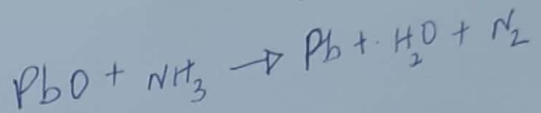
22. Aluminium chloride and sodium chloride are both chlorides of period 3 elements in the periodic table. Use this information to explain the following observations.

a) A solution of Al<sub>2</sub>Cl<sub>6</sub> in water turns blue litmus paper red while that of sodium Chloride does not. (1½ marks)

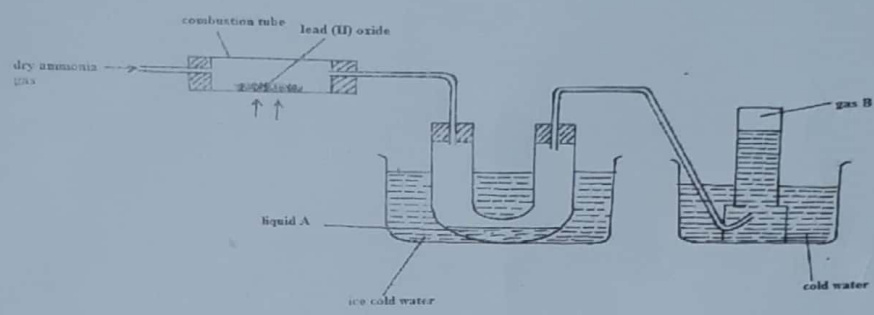
Al<sub>2</sub>Cl<sub>6</sub> hydrolyses/ionises in water to produce hydrogen chloride or (H<sup>+</sup>) which is acid while NaCl does not ionise/hydrolyse

b) Sodium chloride has a melting point 801°C is while Al<sub>2</sub>Cl<sub>6</sub> sublimes 183°C. (1½ marks)

Sodium chloride has a strong giant ionic structure with strong ionic bond which require a lot of energy to break while Al<sub>2</sub>Cl<sub>6</sub> has a molecular covalent structure



26. The diagram below represents a set-up that can be used to obtain nitrogen gas in the laboratory. Use the information on the diagram to answer the questions that follow



- (a) Describe the chemical test for liquid A. (1 mark)
- To liquid A, add anhydrous copper (II) sulphate, white anhydrous copper (II) sulphate turns blue ✓
  - or
  - Add anhydrous cobalt (II) chloride to liquid A, it turns from blue ✓
  - cobalt (II) chloride turns pink. ✓

- (b) What observation is made in the combustion tube during the reaction? (1 mark)
- Orange lead (II) oxide turns to grey ✓
  - Droplets of colourless liquid are formed on the cooler parts of the combustion tube ✓

- (c) State two uses of gas B. (1 mark)
- Manufacture of ammonia in Haber process ✓
  - In light bulb because it is inert ✓
  - As a refrigerant i.e. in storage of semen for artificial insemination ✓
- Any two

27. Analysis of an organic acid isolated from red ants shows that it contains 0.06 g of carbon, 0.01 g of hydrogen and 0.16 g of oxygen. (H=1, O=16, C=12)

a) Calculate the empirical formula for this acid. (1 1/2 marks)

Elements	C	H	O
Mass	0.06	0.01	0.16
Molar mass	12	1	16
Moles	$\frac{0.06}{12} = 0.005$	$\frac{0.01}{1} = 0.01$	$\frac{0.16}{16} = 0.01$
Mole ratio	$\frac{0.005}{0.005} = 1$	$\frac{0.01}{0.005} = 2$	$\frac{0.01}{0.005} = 2$

$$E.F = C_5H_{10}O_4$$

- b) What is the basicity of the acid if the empirical formula of the acid is the same as its molecular formula. (1/2 mark)
- Basicity = 1

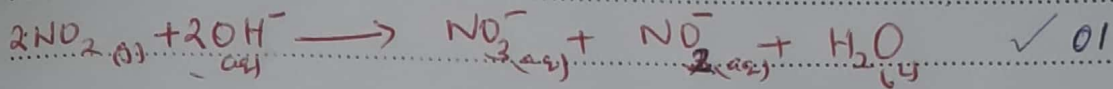
28. Nitrogen (IV) oxide dissolves and reacts with Sodium hydroxide solution to form two salts and water.

- a) What is the nature of Nitrogen (IV) oxide? (1 mark)
- It is acidic ✓ 01

Replaced

Write the Ionic equation for the reaction that takes place.

{1 mark}



29. When powdered brass was reacted with excess dilute sulphuric (VI) acid, a solid residue was left.

(i) Name the residue.

Copper ✓ 1

(1 mark)

(ii) Explain why the residue was left.

Brass is a mixture of zinc and copper. Zinc reacts with the acid but copper does not. Zinc being more reactive displaces hydrogen in the dilute acid faster. ✓ 2

(1 mark)

(iii) State another observation made

Effervescence is produced. Bubbles of a colourless gas. ✓ 1

(1 mark)

30. During manufacture of sulphuric (vi) acid, sulphur (iv) oxide is oxidised to sulphur (vi) oxide in the presence of vanadium oxide catalyst as shown below:



The reaction is carried out at a pressure of 3 atmospheres and a temperature of 450°C. State and explain the effect on the yield of sulphur (vi) oxide if the reaction is:

a) Carried out at 3 atmospheres and 600°C.

The yield decreases at 600°C because the reversed reaction is favoured since it is the reaction that leads to endothermic reaction. i.e.  $\text{SO}_3$  decompose to  $\text{SO}_2$  and  $\text{O}_2$ . ✓ 2

(2mks)

b) In absence of a catalyst.

The yield remains the same. The rate of both reactions slows down. Catalyst has no effect on a reaction at equilibrium. ✓ 1

(2mks)