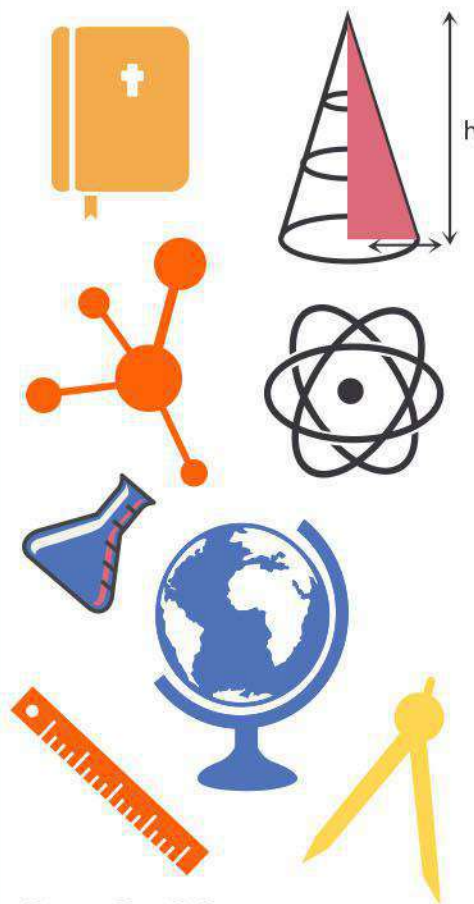


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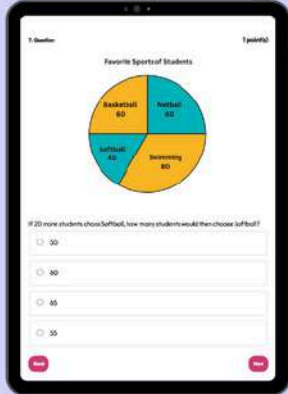


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# CHEMISTRY

PAPER 3  
(80 marks)

Monday **2 JUNE 2025** 12:00 NOON–1:30 P.M.  
(1 hr. 30 mins)

**Additional materials:**  
Graph paper  
Calculator (not graphing)

## MINISTRY OF EDUCATION NATIONAL EXAMINATIONS

BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

### INSTRUCTIONS AND INFORMATION TO CANDIDATES

**Do not open this booklet until you are told to do so.**

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** questions in **Section A** in the spaces provided on this question booklet and any **TWO** questions from **Section B** on the lined paper provided at the back of this question booklet.

Equations and diagrams should be given wherever they are helpful.  
Essential working must be shown.

The intended marks for each question or part question are given in brackets [ ].

Relative atomic masses are given in the Periodic Table printed on page 2.

### ADDITIONAL INFORMATION

s.t.p. ( $t = 0^{\circ}\text{C}$ ,  $p = 1 \text{ atm.}$ )

The volume of one mole of gas at room temperature and pressure (r.t.p.) is  $24\,000 \text{ cm}^3$  ( $24 \text{ dm}^3$ ).

| For Examiner's Use |  |
|--------------------|--|
| Section A          |  |
| 1                  |  |
| 2                  |  |
| 3                  |  |
| 4                  |  |
| Section B          |  |
| 5                  |  |
| 6                  |  |
| 7                  |  |
| TOTAL              |  |

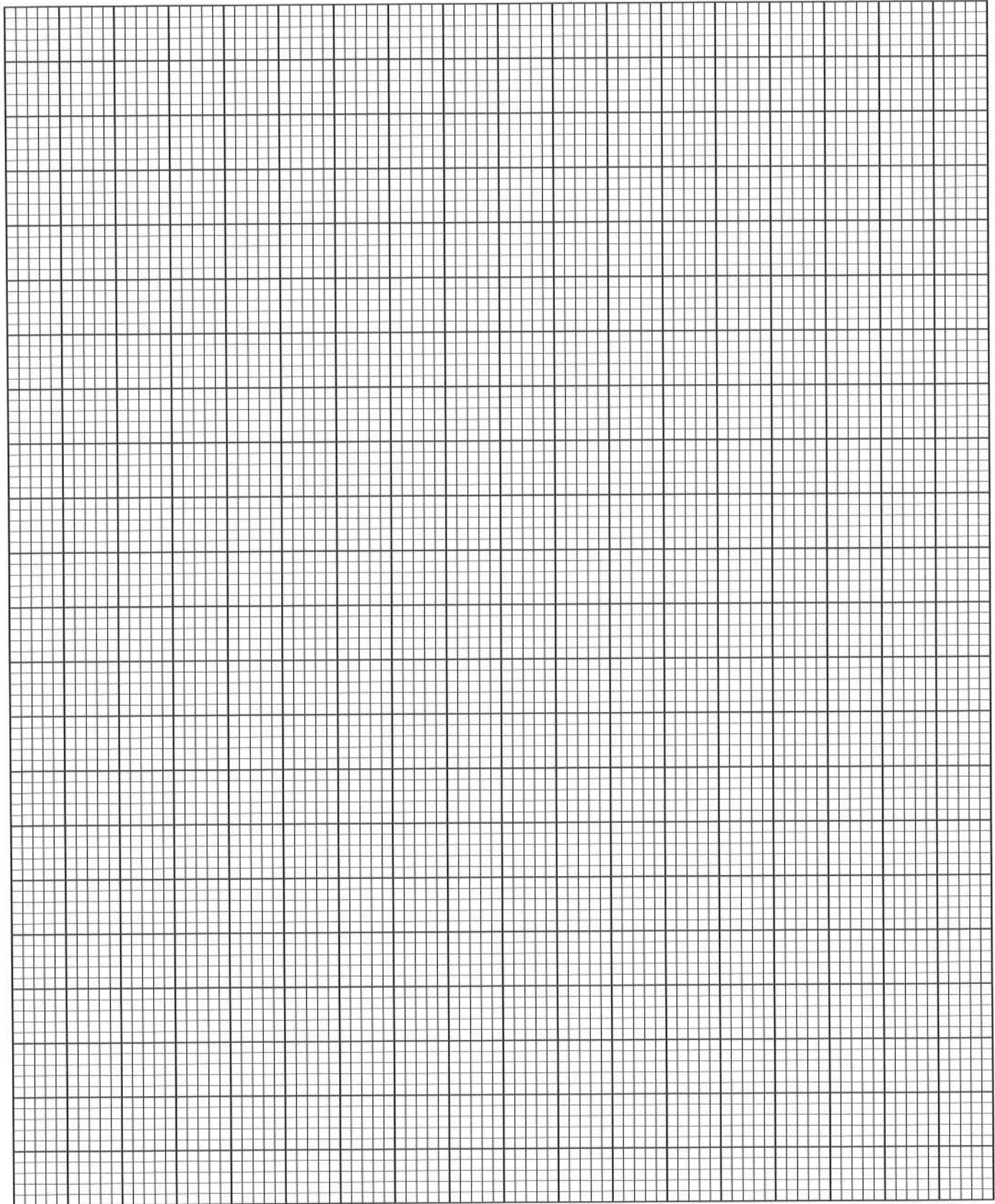
This question paper consists of 16 printed pages and 4 lined pages.

The Periodic Table of the Elements

| Group                                                                                                                                    |                             |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            |                             |                             |                              |                             |                              |                           |  |  |  |
|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|----------------------------|------------------------------|-----------------------------|----------------------------|----------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|---------------------------|--|--|--|
| I                                                                                                                                        | II                          |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            | III                         | IV                          | V                            | VI                          | VII                          | 0                         |  |  |  |
| <div>1<br/>H<br/>Hydrogen<br/>1</div>                                                                                                    |                             |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            |                             |                             |                              |                             |                              |                           |  |  |  |
| 7<br>Li<br>Lithium<br>3                                                                                                                  | 9<br>Be<br>Beryllium<br>4   |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            | 11<br>B<br>Boron<br>5       | 12<br>C<br>Carbon<br>6      | 14<br>N<br>Nitrogen<br>7     | 16<br>O<br>Oxygen<br>8      | 19<br>F<br>Fluorine<br>9     | 20<br>Ne<br>Neon<br>10    |  |  |  |
| 23<br>Na<br>Sodium<br>11                                                                                                                 | 24<br>Mg<br>Magnesium<br>12 |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            | 27<br>Al<br>Aluminium<br>13 | 28<br>Si<br>Silicon<br>14   | 31<br>P<br>Phosphorus<br>15  | 32<br>S<br>Sulphur<br>16    | 35.5<br>Cl<br>Chlorine<br>17 | 40<br>Ar<br>Argon<br>18   |  |  |  |
| 39<br>K<br>Potassium<br>19                                                                                                               | 40<br>Ca<br>Calcium<br>20   | 45<br>Sc<br>Scandium<br>21   | 48<br>Ti<br>Titanium<br>22  | 51<br>V<br>Vanadium<br>23   | 52<br>Cr<br>Chromium<br>24   | 55<br>Mn<br>Manganese<br>25  | 56<br>Fe<br>Iron<br>26     | 59<br>Co<br>Cobalt<br>27     | 59<br>Ni<br>Nickel<br>28    | 64<br>Cu<br>Copper<br>29   | 65<br>Zn<br>Zinc<br>30     | 70<br>Ga<br>Gallium<br>31   | 73<br>Ge<br>Germanium<br>32 | 75<br>As<br>Arsenic<br>33    | 79<br>Se<br>Selenium<br>34  | 80<br>Br<br>Bromine<br>35    | 84<br>Kr<br>Krypton<br>36 |  |  |  |
| 85<br>Rb<br>Rubidium<br>37                                                                                                               | 88<br>Sr<br>Strontium<br>38 | 89<br>Y<br>Yttrium<br>39     | 91<br>Zr<br>Zirconium<br>40 | 93<br>Nb<br>Niobium<br>41   | 96<br>Mo<br>Molybdenum<br>42 | 101<br>Ru<br>Ruthenium<br>44 | 101<br>Rh<br>Rhodium<br>45 | 103<br>Pd<br>Palladium<br>46 | 106<br>Ag<br>Silver<br>47   | 108<br>Cd<br>Cadmium<br>48 | 112<br>In<br>Indium<br>49  | 115<br>Sn<br>Tin<br>50      | 119<br>Sb<br>Antimony<br>51 | 122<br>Te<br>Tellurium<br>52 | 127<br>I<br>Iodine<br>53    | 131<br>Xe<br>Xenon<br>54     |                           |  |  |  |
| 133<br>Cs<br>Caesium<br>55                                                                                                               | 137<br>Ba<br>Barium<br>56   | 139<br>La<br>Lanthanum<br>57 | 178<br>Hf<br>Hafnium<br>72  | 181<br>Ta<br>Tantalum<br>73 | 184<br>W<br>Tungsten<br>74   | 186<br>Re<br>Rhenium<br>75   | 190<br>Os<br>Osmium<br>76  | 192<br>Ir<br>Iridium<br>77   | 195<br>Pt<br>Platinum<br>78 | 197<br>Au<br>Gold<br>79    | 201<br>Hg<br>Mercury<br>80 | 204<br>Tl<br>Thallium<br>81 | 207<br>Pb<br>Lead<br>82     | 209<br>Bi<br>Bismuth<br>83   | 210<br>Po<br>Polonium<br>84 | 210<br>At<br>Astatine<br>85  | 210<br>Rn<br>Radon<br>86  |  |  |  |
| Fr<br>Francium<br>87                                                                                                                     | 226<br>Ra<br>Radium<br>88   | 227<br>Ac<br>Actinium<br>89  |                             |                             |                              |                              |                            |                              |                             |                            |                            |                             |                             |                              |                             |                              |                           |  |  |  |
| *58-71 Lanthanoid series<br>†90-103 Actinoid series                                                                                      |                             |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            |                             |                             |                              |                             |                              |                           |  |  |  |
| <div><div>a</div><div>X</div><div>b</div></div> <div>a = relative atomic mass<br/>X = atomic symbol<br/>b = proton (atomic) number</div> |                             |                              |                             |                             |                              |                              |                            |                              |                             |                            |                            |                             |                             |                              |                             |                              |                           |  |  |  |

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## EXAMINATION

|                         |               |          |                    |
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This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin black lines. There are no margins, text, or other markings on the page.

# SECTION A

Answer **all** questions in this section.

1. Sodium metal is a reactive metal in group I of the Periodic Table. When sodium is exposed to air, it readily reacts with oxygen to form a layer of oxide on its surface.

- (a) Complete the table to determine the mass of oxygen reacted with sodium to form a layer of sodium oxide.

|                                       | Mass amounts |
|---------------------------------------|--------------|
| mass of sodium oxide layer formed (g) | 0.62         |
| mass of sodium reacted (g)            | 0.46         |
| mass of oxygen reacted (g)            |              |

[1]

- (b) (i) Use the data from the table in part (a) to show the empirical formula of sodium oxide is  $\text{Na}_2\text{O}$ .

[2]

- (ii) What does the empirical formula represents?

\_\_\_\_\_

\_\_\_\_\_ [1]

- (c) Using your knowledge of electronic configuration, explain why sodium is more reactive than lithium metal.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [2]

[Turn over



- (d) (i) Use the word equation to write a balanced chemical equation for the reaction.

Sodium + Water  $\rightarrow$  Sodium hydroxide + Hydrogen

\_\_\_\_\_ [2]

- (ii) Use your balanced chemical equation in part (d) (i) to calculate the mass of hydrogen gas produced, if 1.6 moles of sodium is added to excess water.

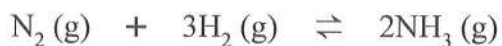
[2]

**TOTAL MARKS [10]**



2. Ammonia is an economically important chemical used to make fertilisers and nitric acid products in industries.

The reactions in the formation of ammonia is:



The reaction to produce ammonia is **reversible** and an **exothermic**.

- (a) (i) Name the process by which ammonia is made in the industry.

\_\_\_\_\_ [1]

- (ii) Write the mathematical expression for Charles' Law.

[1]

- (iii) If  $720 \text{ dm}^3$  of ammonia is produced at  $20^\circ\text{C}$  (RTP), predict the volume of ammonia produced at  $0^\circ\text{C}$  (STP). (Use Charles' Law for your calculation, assuming the pressure is same as at RTP).

[2]

- (b) According to Le Chatelier's Principle explain the effect on the yield of ammonia, produced if:

- (i) temperature increases.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (ii) pressure decreases.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (c) The catalyst used in the industry is finely divided or powdered iron.

What is a catalyst, and explain in terms of particles, why catalysts like iron should have a large surface area.

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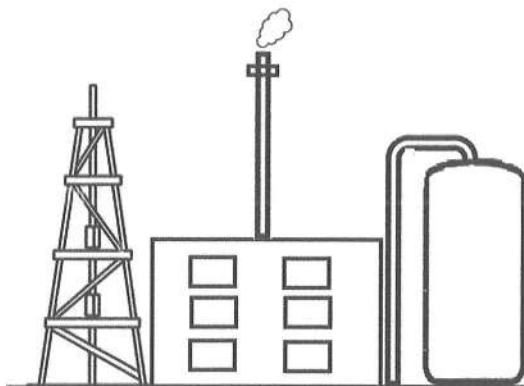
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[2]

**TOTAL MARKS [10]**



3. Below is a diagram of a refinery. Crude oil is broken down into organic compounds. Many of the compounds are not very useful due to their long chains.



- (a) These long chain, less useful, chemicals can be broken down into simpler, more useful organic compounds.

This process occurs in the presence of a zeolite catalyst (chromium oxide or aluminum oxide).

- (i) Name this chemical process. \_\_\_\_\_ [1]

- (ii) State **two** general characteristics of a homologous series of organic compounds.

1. \_\_\_\_\_

2. \_\_\_\_\_

[2]

- (iii) During the chemical process named in a (i), decane is broken down into two organic compounds alkane and alkene.

Complete the equation to show the two products formed.



- (b) The alcohol (ethanol) produced by fermentation is filtered to remove solid waste. The liquor containing 9–12% ethanol is then distilled.

(i) Why is ethanol distilled?

\_\_\_\_\_ [1]

- (c) Ethanol has a variety of uses including the preparation of an organic acid and also making esters.

(i) Name the type of reaction that causes alcohols to form an acid.

\_\_\_\_\_ [1]

(ii) Write a balanced chemical equation for the esterification reaction between propanol and ethanoic acid.

\_\_\_\_\_ [2]

(iii) Give a similarity between the reaction in (c) (ii) and neutralisation.

\_\_\_\_\_ [1]

**TOTAL MARKS [10]**



4. Tin is an element in Group IV.

(a) The position of tin is shown in the reactivity series.

**aluminum**

**zinc**

**iron**

**tin**

**hydrogen**

**copper**

- (i) For each of the reaction shown, use the given reactivity series to determine if a reaction would occur.

If there is a **reaction**, complete the equation.

If there is no reaction, write '**no reaction**'.



- (ii) Explain why aluminum is **not** extracted from its oxide by reaction with carbon.

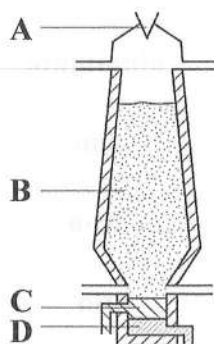
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[1]

- (b) The Blast Furnace diagram is shown below. It is used in the process of extracting iron from its ore.



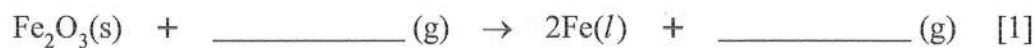
- (i) Name the reducing agent in the initial stages of this extraction process.

\_\_\_\_\_ [1]

- (ii) In terms of electrons, explain the purpose of a reducing agent.

\_\_\_\_\_  
\_\_\_\_\_ [1]

- (iii) Complete the equation for the formation of iron from the iron (III) oxide ore.



- (iv) Calculate the mass of Fe produced from 80 g of  $\text{Fe}_2\text{O}_3$ .

[2]

- (v) Identify which product is tapped off at **C** and **D** on the diagram.

**C** \_\_\_\_\_

**D** \_\_\_\_\_ [1]

**TOTAL MARKS [10]**



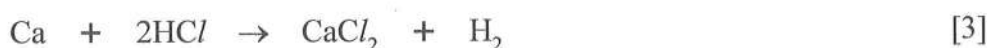
## SECTION B

Answer any **TWO** questions from this Section.

5. Equal masses of calcium were used in **TWO** separate experiments to react with excess dilute hydrochloric acid. One of the experiments was conducted at 20 °C and the other at 30 °C. The volume of hydrogen gas produced was measured at regular intervals. The results of the experiments are given in the table.

| Time/s                                                                         | 0 | 10   | 20   | 30   | 50   | 60   | 80   |
|--------------------------------------------------------------------------------|---|------|------|------|------|------|------|
| <b>Experiment – A</b><br>Volume of H <sub>2</sub> (g)/cm <sup>3</sup> at 20 °C | 0 | 16.5 | 31.0 | 43.0 | 59.5 | 63.0 | 65.0 |
| <b>Experiment – B</b><br>Volume of H <sub>2</sub> (g)/cm <sup>3</sup> at 30 °C | 0 | 19.0 | 44.5 | 49.5 | 64.0 | 65.0 | 65.0 |

- (a) (i) Plot a graph of the volume of hydrogen gas collected in each experiment using the same axes. Label the curves as **A** and **B**. [5]
- (ii) Use your graph to predict the volumes of hydrogen produced in experiment **A** at 40 seconds. [1]
- (iii) Which experiment proceeded at a faster rate and why? Explain in terms of collision theory. [1]
- (iv) Calculate the mass of calcium used to produce 0.3 g of CaCl<sub>2</sub>. Use the equation to calculate.



- (b) Sodium hydroxide solution was used to neutralise hydrochloric acid in a titration reaction. A volume of 50 cm<sup>3</sup> and concentration of 0.2 mol/dm<sup>3</sup> sodium hydroxide solution neutralised 28 cm<sup>3</sup> of hydrochloric acid.

- (i) Write a balanced chemical equation for the reaction. [1]
- (ii) Calculate the number of moles of sodium hydroxide used in the titration experiment. [2]
- (iii) Calculate the number of moles of hydrochloric acid that were neutralised. [1]
- (iv) Determine the concentration of hydrochloric acid. [1]
- (v) Calculate the concentration of sodium hydroxide in g/dm<sup>3</sup>. [2]

- (c) Consider the balanced chemical equation.



Calculate the number of moles of sodium hydroxide used to neutralise 0.15 mol of sulfuric acid. [1]

- (d) Hydrogen gas reacts with chlorine gas to produce hydrogen chloride gas, HCl.

Draw a Bohr model to show the bonding of hydrogen and chlorine in hydrogen chloride gas. [2]

**TOTAL MARKS [20]**



6. (a) Iodised table salt as it is usually sold is not pure NaCl. It contains small amounts of potassium iodide, which provides dietary iodine.

Dilute nitric acid and silver nitrate are added to a sample of chloride ions and a sample of iodine ions. State the observations. [2]

- (b) Magnesium reacts readily with oxygen to produce magnesium oxide.

(i) What is observed when magnesium reacts with oxygen? [1]

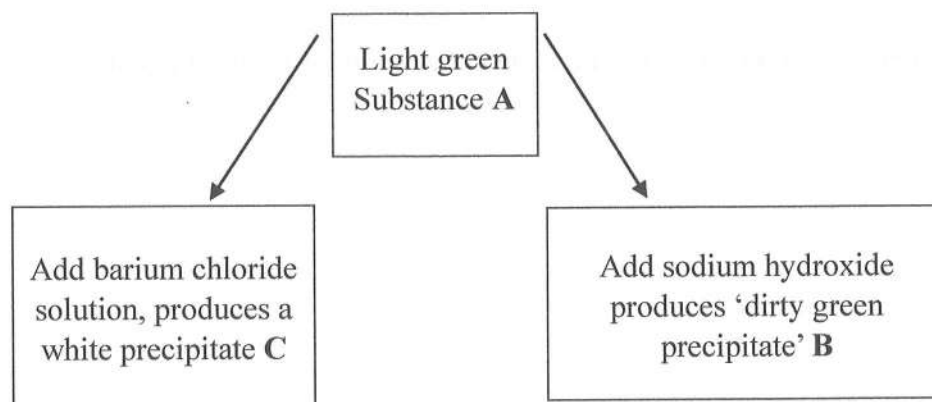
(ii) Neon does not readily react with oxygen compared to magnesium. Using your knowledge of electron configuration, explain what makes magnesium reactive and neon unreactive. [2]

(iii) Write a balanced equation for the reaction between magnesium and oxygen, producing magnesium oxide. [2]

(iv) Calculate the percentage composition of magnesium oxide. [1]

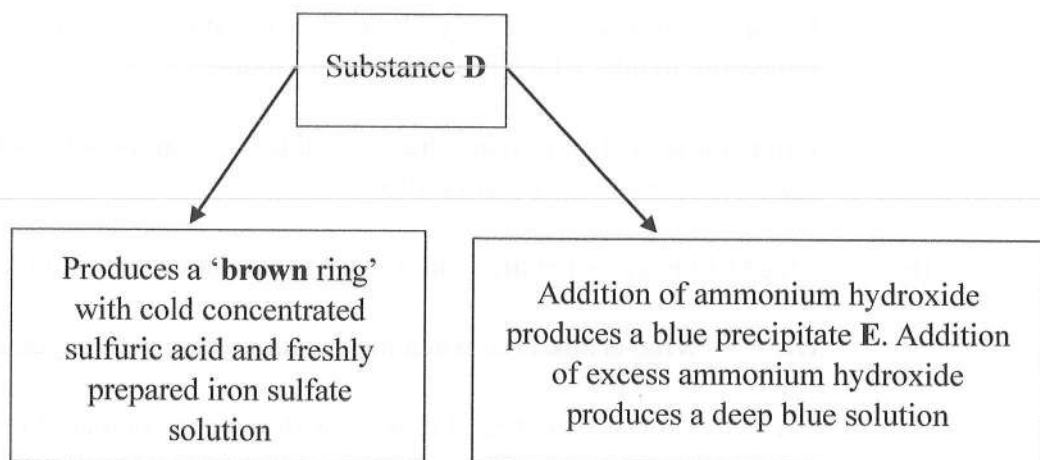
- (c) Identify the compounds in the flowchart below.

(i)



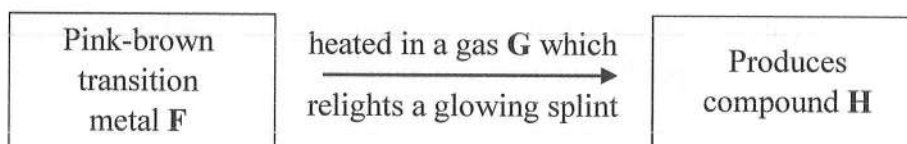
[3]

(ii)



[2]

(iii)



[3]

(d) Other than the pungent smell of ammonia, describe **two** tests which would enable you to identify ammonia gas. [2]

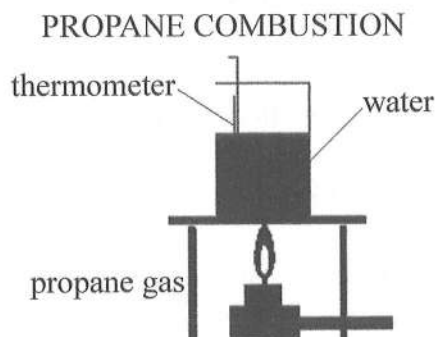
(e) Write a balanced chemical equation for reaction (c) (iii). [2]

**TOTAL MARKS [20]**



7. A student carries out an experiment to determine the heat energy released when cooking gas is burnt.

She used the apparatus shown.



- (a) (i) Calculate the temperature change in this reaction.
- Initial temperature reading **16.7°C**
- Final temperature reading **22.3°C**
- Temperature Change \_\_\_\_\_ [1]
- (ii) Mass of water used in the heating process is 100 g.
- Calculate the heat energy in kilojoules (kJ), in this experiment.  
(*Specific heat capacity of water is 4.2 J/g °C*). [2]
- (iii) The volume of propane gas burnt in this experiment was measured to be **1875 cm<sup>3</sup>**.
- Calculate the **moles of propane gas** burned in this experiment. [2]
- (iv) Calculate the heat of combustion of the propane gas in kJ/mol. [2]
- (v) The heat produced in the experiment is **not** the same as the theoretical value.
- Give **one** reason for this and also a corrective measure. [2]

- (b) (i) Write the chemical equation for the combustion of propane. [2]
- (ii) Sketch an energy profile diagram for the combustion of propane. [3]
- (c) (i) State the name of the pollutant that would be produced if inadequate oxygen burns propane. [1]
- (ii) Explain the negative effect of this pollutant name in part (c) (i). [1]
- (d) Carbon dioxide is also a pollutant.
- (i) State **two** ways the percentage of carbon dioxide is increasing in the environment. [2]
- (ii) State **two** reasons why it is better to use renewable energy resources rather than non-renewable resources. [2]

**TOTAL MARKS [20]**



Question .....  
Write on both sides of the paper

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Question .....  
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Question .....  
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