EXPERIMENT NO. 1

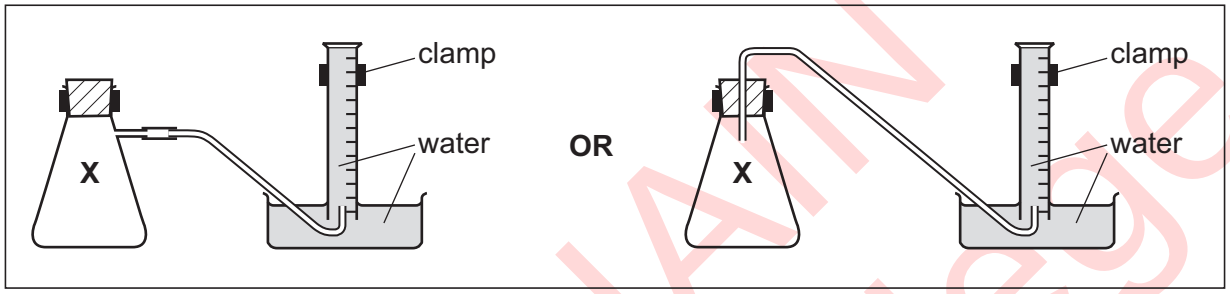
Metal carbonates react with dilute acids to produce carbon dioxide. You will identify the metal, **M**, in a metal carbonate, $\mathbf{M}_2CO_3$, by measuring the volume of carbon dioxide produced during the reaction of $\mathbf{M}_2CO_3$ with excess hydrochloric acid.

$$\mathbf{M}_2CO_3(s) + 2HCl(aq) \rightarrow 2\mathbf{M}Cl(aq) + CO_2(g) + H_2O(l)$$

FA 2 is hydrochloric acid, HC*l*.
FA 4 is $\mathbf{M}_2CO_3$.

(a) Method

Read **all** instructions before starting your practical work.
The diagrams below may help you in setting up your apparatus.



- Fill the tub with water to a depth of about 5 cm.
- Fill the 250 cm^3 measuring cylinder **completely** with water. Hold a piece of paper towel firmly over the top, invert the measuring cylinder and place it in the water in the tub.
- Remove the paper towel and clamp the inverted measuring cylinder so the open end is in the water just above the base of the tub.
- Use the 50 cm^3 measuring cylinder to place 50 cm^3 of **FA 2** into the reaction flask, labelled **X**.
- Check that the bung fits tightly in the neck of flask **X**, clamp flask **X**, and place the end of the delivery tube into the inverted 250 cm^3 measuring cylinder.
- Weigh the container with **FA 4** and record the mass in the space below.
- Remove the bung from the neck of the flask. Tip all the **FA 4** into the acid in the flask and replace the bung **immediately**. Remove the flask from the clamp and swirl it to mix the contents.
- Swirl the flask occasionally until no more gas is evolved. Replace the flask in the clamp.
- Reweigh the container and record the mass, and the mass of **FA 4** used, in the space below.
- When no more gas is collected, measure and record the final volume of gas in the measuring cylinder in the space below.

mass of tube + FA4 /g	21·70
mass of tube + residue /g	20·80
mass of FA4 used /g	0·90
initial volume of measuring cylinder /cm^3	26
final volume of measuring cylinder /cm^3	227
volume of CO_2 collected /cm^3	201

[2]

(b) Calculations

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

(i) Use the volume of gas you collected to calculate the number of moles of gas produced. [Assume that 1 mole of gas occupies 24.0 dm^3 under these conditions.]

$\frac{201\,cm^3}{1000} = 0.201\,dm^3$

$24\,dm^3$ —— 1 mol

$0.201\,dm^3$ —— x

moles of gas = 8.38×10^{-3} mol

(ii) Use your answer to **(i)** to deduce the number of moles of $\mathbf{M}_2CO_3$ used in the reaction.

mole ratio

M_2CO_3 : CO_2

1 : 1

8.38×10^{-3} : 8.38×10^{-3}

moles of $\mathbf{M}_2CO_3$ = 8.38×10^{-3} mol

(iii) Use your answer to **(ii)** and the mass of **FA 4** used to calculate the relative formula mass, M_r, of $\mathbf{M}_2CO_3$.

$mol = \frac{mass}{M_r}$

$8.38 \times 10^{-3} = \frac{0.90}{M_r}$ $= 107.4$

M_r of $\mathbf{M}_2CO_3$ 107.4

(iv) Use your answer to **(iii)** and the Periodic Table to identify metal **M**. Explain your answer.

M_r of $M_2CO_3 = 107.4$

M_r of $CO_3 = 60$

M_r of $M_2 = 107.4 - 60 = 47.4$

A_r of $M = \frac{47.2}{2} = 23.7$

M is Sodium - Na

As it is the nearest.

[4]

(c) (i) A 250 cm^3 measuring cylinder can be read to ±1 cm^3.

Calculate the maximum percentage error in your reading of the volume of gas.

$\frac{1 \times 2}{201} \times 100$

maximum percentage error = 0.995 %

(ii) It is likely that the volume of carbon dioxide that you collected was less than the theoretical volume.

Give **two** reasons why this volume is likely to be less than the theoretical volume.

In each case, suggest and explain a modification to the practical procedure that could help to reduce the difference in volume.

reason gas dissolves in water/solution

modification Use a gas syringe instead of measuring cylinder for gas collection

reason gas escapes before stopper inserted.

modification Use more (excess) volume of a lower concentration of acid

[5]

[Total: 11]