**AS PRACTICAL 10 – THE EFFECT OF CONCENTRATION ON RATE OF REACTION**

Calcium carbonate reacts with hydrochloric acid as follows:

CaCO3(s) + 2HCl(aq) 🡪 CaCl2(aq) + CO2(g) + H2O(l)

The rate of this reaction can be monitored by measuring the rate of production of carbon dioxide gas. The amount of gas produced can be measured by its volume or by its mass.

**Method 1 – measuring the volume of gas produced**

1. Clamp a gas syringe into a horizontal position so that the bung attached to it can be easily attached to a measuring cylinder.
2. Pour 50 cm3 of 2.0 moldm-3 HCl into a 100 cm3 conical flask.
3. Weigh out 1.00 g of marble chips into a weighing boat.
4. Add the marble chips to the conical flask, attaching the bung and starting the stopclock immediately.
5. Record the volume of gas produced every 30 seconds for five minutes.
6. Repeat steps 1 to 5 using different concentrations of HCl, prepared as follows:

|  |  |  |
| --- | --- | --- |
| Concentration of HCl/moldm-3 | Volume of 2.0 moldm-3 HCl/cm3 | Volume of distilled water/cm3 |
| 2.0 | 50 | 0 |
| 1.6 | 40 | 10 |
| 1.2 | 30 | 20 |
| 0.8 | 20 | 30 |
| 0.4 | 10 | 40 |

**Method 2 – measuring the mass of gas produced**

1. Pour 50 cm3 of 2.0 moldm-3 HCl into a 100 cm3 conical flask
2. Place the conical flask onto a 2 dp mass balance
3. Weigh out 1.00 g of marble chips into a weighing boat.
4. Add the marble chips to the hydrochloric acid, start the stopclock and record the total initial mass of the conical flask and contents
5. Record the mass of the conical flask and contents every 30 seconds for five minutes
6. Repeat steps 1 to 5 using different concentrations of HCl, prepared as follows:

|  |  |  |
| --- | --- | --- |
| Concentration of HCl/moldm-3 | Volume of 2.0 moldm-3 HCl/cm3 | Volume of distilled water/cm3 |
| 2.0 | 50 | 0 |
| 1.6 | 40 | 10 |
| 1.2 | 30 | 20 |
| 0.8 | 20 | 30 |
| 0.4 | 10 | 40 |

**Analysis**

1. On the same axes, plot graphs to show how the volume of gas produced over time for each of the five experiments. Clearly label each line on your graph.
2. On a new set of axes, plot graphs to show the loss in mass (initial mass – mass) over time for each of the five experiments. Clearly label each line on your graph.
3. Suggest how the initial rate of reaction in each experiment could be calculated from your graphs.

**Evaluation**

1. Suggest which of the two methods is a better way of investigating the effect of concentration on reaction rate.