Jason Goodwill

Chemistry Coursework Investigation:
The Effect Of Acid Rain On Building Materials

Due to dissolved carbon dioxide rainwater is naturally acidic in the form of the weak carbonic acid. However gases such as sulphur dioxide and nitrogen oxides cause acid rain, which is responsible for the corrosion of buildings and damage to the wildlife. The burning of fossil fuels releases these gases into the atmosphere when the small quantities of sulphur react with the oxygen in the air, forming sulphur dioxide.

The aim of this investigation is to investigate the way in which one factor alters the rate of erosion of building materials such as stonework and metals.

To conduct this experiment I can use marble chips (calcium carbonate) or magnesium ribbon and in place of sulphuric acid dilute hydrochloric acid will be used. This is because sulphuric acid produces an insoluble salt which prevents any further reaction with the acid.

The two possible equations for the experiment are:

1) $Mg + 2HCl \longrightarrow MgCl + H$
2) $CaCO_3 + 2HCl \longrightarrow CaCl + CO + H\,O$

I have decided to conduct my experiment using magnesium ribbon and so equation 1 will be used.

Here is a list of the factors which I could investigate:

- Volume of acid
- Concentration of acid
- Temperature of reaction
- Mass/length of magnesium ribbon
- Particle size (no. of strips of magnesium)

The factor which I have decided to investigate is the volume of hydrochloric acid. The range of volumes I have opted to use are $10cm^3$, $20cm^3$, $30cm^3$, $40cm^3$ and $50cm^3$.

The concentration of acid will remain at 2M throughout the investigation and the investigation will be conducted at room

temperature. Also 1 strip of magnesium ribbon of mass 0.05g will be used throughout the investigation.
For each volume of acid used I will time how long it takes for 50cm³ of hydrogen gas to be produced and collected in a gas syringe.

Apparatus

Conical Flask (with bung)
100cm³ gas syringe
Scales
Measuring cylinder
Stopwatch

Hypothesis

I believe that as the volume of acid increases so will the rate of gas produced. This is because there will be more acid molecules and so there will be more chance of collisions between the magnesium and hydrochloric acid, thus a higher rate of reaction. I believe that the volume of acid will be directly proportional to the rate of reaction and so the following will be true:

Therefore, if the volume of acid is doubled then the rate of gas produced should double.

Diagram

Method

First of all the gas syringe was connected to the conical flask. 0.05g of magnesium ribbon was weighed using the scales and placed inside the conical flask. The first volume of 2M hydrochloric acid, 10cm³, was measured out using a measuring cylinder and then added to the flask. Simultaneously the stopwatch was started and the bung was placed on the conical flask. When 50cm³ hydrogen had been collected the stopwatch was stopped. This was repeated 3 times with each of the volumes of hydrochloric acid, 10, 20, 30, 40 and 50cm³. For each volume an average time was calculated and then using that time the rate of reaction was calculated with the following equation:

$$\text{Rate (cm}^3\text{/s)} = \frac{\text{Volume of gas produced (cm}^3\text{)}}{\text{Time (s)}}$$

Results

Time Taken (s)

Volume of HCl (cm³)	Reading 1	Reading 2	Reading 3	Average Reading	Rate of Reaction (cm³/s)
10	111.41	98.78	101.85	104.01	0.481
20	70.54	61.82	69.39	67.25	0.743
30	48.99	58.48	56.21	54.56	0.916
40	45.39	55.90	44.78	48.69	1.027
50	43.16	26.41	35.69	35.09	1.425