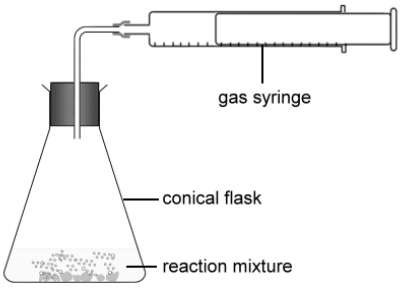
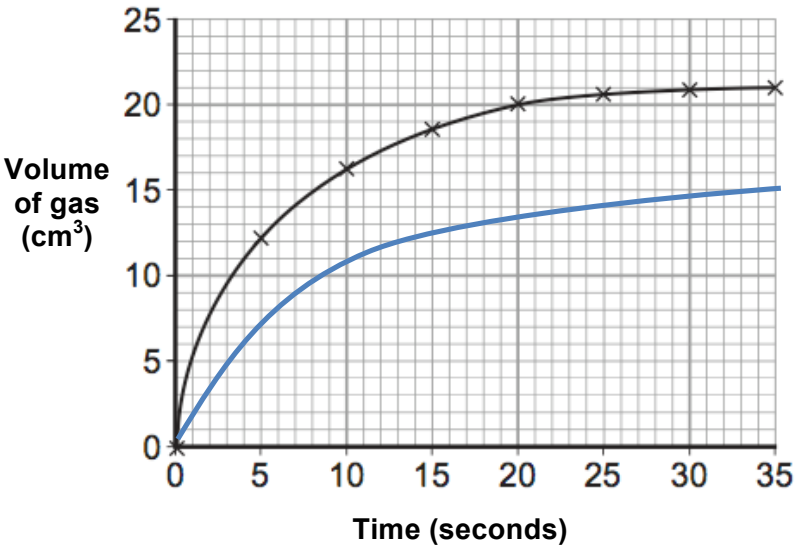
1 The diagram shows the apparatus used to investigate the affect of concentration of hydrochloric acid on the rate of reaction with marble chips. The gas produced is collected in the gas syringe.




The results of the experiment are shown in the graph below.




1 (a) (i) Use the graph to describe the changes in the rate of the reaction over the first 35 seconds.

Rapid increase initially/at first. [1 mark]

Then decrease in rate of gas production or rate of reaction. [1 mark]

Eventually volume of gas production levels off. [1 mark]

Any numbers used to help description. [1 mark]

*(3 marks)*

1 (b) The experiment was repeated using the following conditions.

- The mass and surface area of the marble chips was the same.
- The volume and temperature of the hydrochloric acid was the same.
- The concentration of the hydrochloric acid was reduced.

1 (b) (i) The rate of the reaction decreased. **On the graph**, sketch a line to show the result you would expect for the above conditions.

See graph - a line anywhere below the one on the graph with the same shape

*(1 mark)*

1 (b) Use your knowledge of particles to explain why the rate of the reaction decreased.

Less (reacting) particles in a given volume [1 mark]

Particles less likely to collide [1 mark]

...with enough energy or less successful collisions [1 mark]

*(3 marks)*

1 (b) (i) The purpose of the experiment was to see the affect of concentration on the rate of this reaction. Why was it important to keep the temperature the same for the second experiment?

It (temperature) is a control variable [1 mark]

To ensure only concentration is affecting the rate or so the temperature doesn't affect the rate or changing the changing temperature would change the amount of gas produced/rate of reaction. [1 mark]

*(2 marks)*

It's not usually enough to say fair test' without explaining what it means.

**(Total 9 marks)**

2 Sodium thiosulphate solution reacts with hydrochloric acid to produce insoluble sulfur. The equation for the reaction is:

sodium thiosulfate + hydrochloric acid → sodium chloride + water + sulfur dioxide + sulfur

The rate of reaction between sodium thiosulphate and hydrochloric acid can be increased if the mixture is heated to a higher temperature.

Explain, in terms of particles, why an increase in temperature increases the rate of reaction.

Particles/atoms/ions have more energy [1 mark]

They (the particles) move faster [1 mark]

and collide more often or there are more successful collisions [1 mark]

Collide with more energy or more particles have the activation energy [1 mark]

(3 marks)

2 (a) (i) State one other way in which the rate of reaction between hydrochloric acid and sodium thiosulfate can be increased.

Increase concentration/add catalyst [1 mark]

(1 mark)

**(Total 4 marks)**