1 Ethene gas reacts with steam to form gaseous ethanol.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g)$$

The reaction can reach a position of equilibrium. The forward reaction is exothermic.

(a) State and explain the effect of increasing the pressure on the **position of equilibrium**. All other conditions are unchanged.

.....

.....

..... [2]

(b) Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the reaction. All other conditions are unchanged.

.....

.....

..... [2]

(c) State and explain the effect of increasing the temperature on the position of equilibrium. All other conditions are unchanged.

.....

.....

..... [2]

[Total: 6]

2 Sulfur dioxide is a pollutant in the air.

(a) State **one** source of sulfur dioxide in the air.

..... [1]

(b) Sulfur dioxide is oxidised to sulfur trioxide in the air.
Oxides of nitrogen act as catalysts for this reaction.

What is meant by the term *catalyst*?

.....

..... [1]

(c) Sulfur trioxide dissolves in rainwater to form acid rain.

Which **one** of the following pH values could be the pH of acid rain?
Draw a circle around the correct answer.

pH 4 pH 7 pH 9 pH 13 [1]

(d) State **one** adverse effect of acid rain on buildings.

..... [1]

[Total: 4]

3 A student does experiments to show that hydrochloric acid is a strong acid and ethanoic acid is a weak acid. The student adds an excess of hydrochloric acid and an excess of ethanoic acid to separate samples of lumps of calcium carbonate.

Only the identity of the acid is changed between the experiments. All other conditions are kept the same.

(a) State **two** observations which would show that hydrochloric acid is a stronger acid than ethanoic acid.

1 .....

2 ..... [2]

(b) The student uses the same size container and checks that the pressure is the same for each experiment.

State **three** other conditions which must be kept the same to ensure fair testing.

1 .....

2 .....

3 ..... [3]

[Total: 5]

4 The first step in the preparation of hydrated copper(II) sulfate is to add powdered copper(II) carbonate to dilute sulfuric acid.

When the reaction in is done using lumps of copper(II) carbonate instead of powder, the rate of reaction decreases. All other conditions are kept the same.

Give a reason for this. Explain your answer in terms of particles.

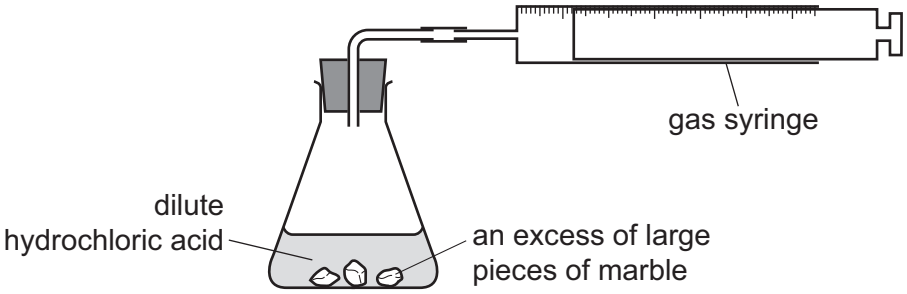
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.....

..... [2]

[Total: 2]

5 A student investigated the progress of the reaction between dilute hydrochloric acid, HC*l*, and an excess of large pieces of marble, $CaCO_3$, using the apparatus shown.



The experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

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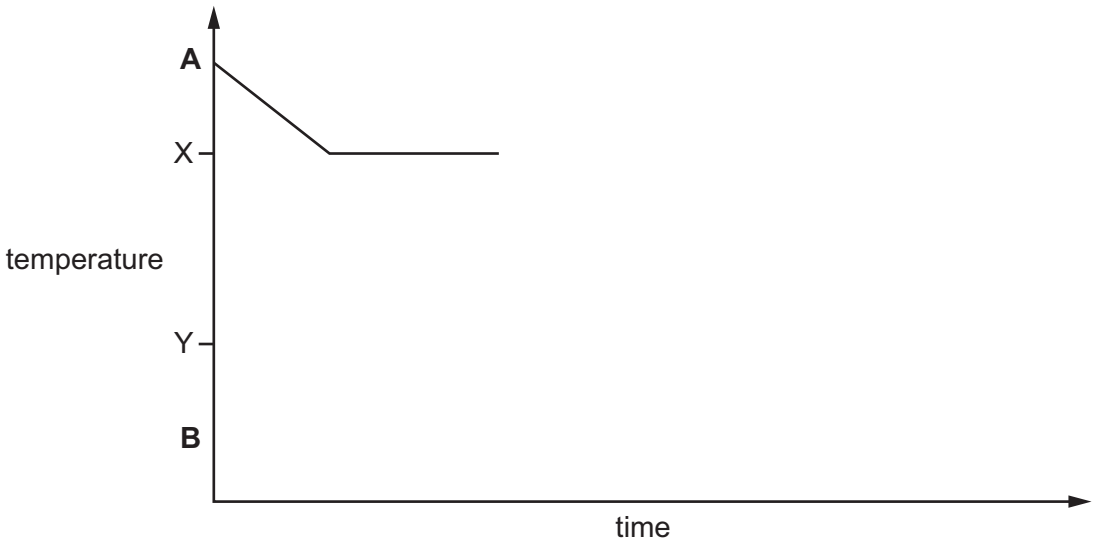
.....

..... [5]

[Total: 5]

6 A substance boils at temperature X and melts at temperature Y.

Complete the graph to show the change in temperature over time as the substance cools from temperature **A** to temperature **B**.



[2]

[Total: 2]

7 Ammonia is manufactured from nitrogen and hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) Give the meaning of the symbol $\rightleftharpoons$.

..... [1]

(b) The nitrogen for this process is obtained from the air.

State the percentage of nitrogen in clean, dry air.

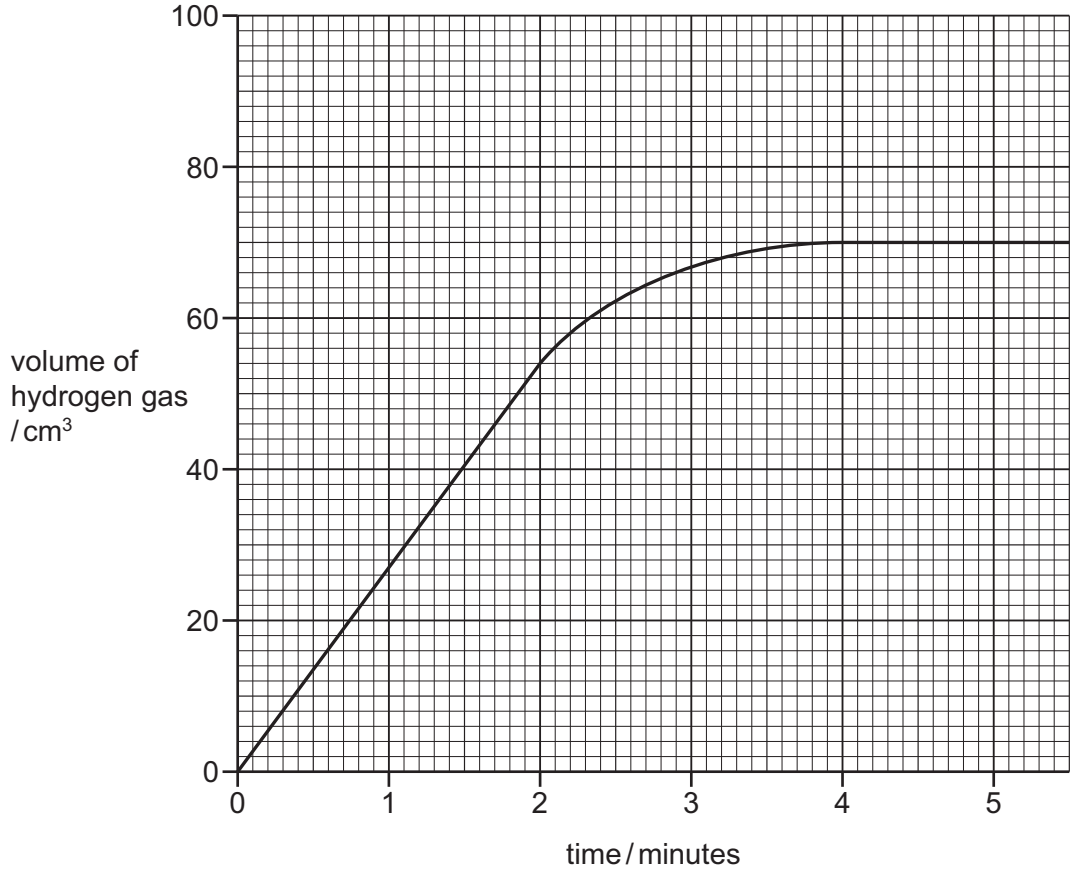
..... [1]

[Total: 2]

8 A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

The graph shows the results using small pieces of zinc and dilute hydrochloric acid.



(a) Deduce the volume of hydrogen gas produced in the first two minutes of the reaction.

..... cm^3 [1]

(b) Draw a letter **S on the graph** to show where the reaction is slowing down but has **not** stopped completely. [1]

(c) Draw a line **on the grid** to show how the volume of hydrogen gas changes with time when the reaction is repeated with a catalyst.
All other conditions are kept the same.

[1]

(d) State the effect on the rate of this reaction of decreasing the temperature at which the reaction is done.
All other conditions are kept the same.

..... [1]

(e) State the effect on the rate of this reaction of using zinc powder instead of small pieces of zinc. All other conditions are kept the same.

..... [1]

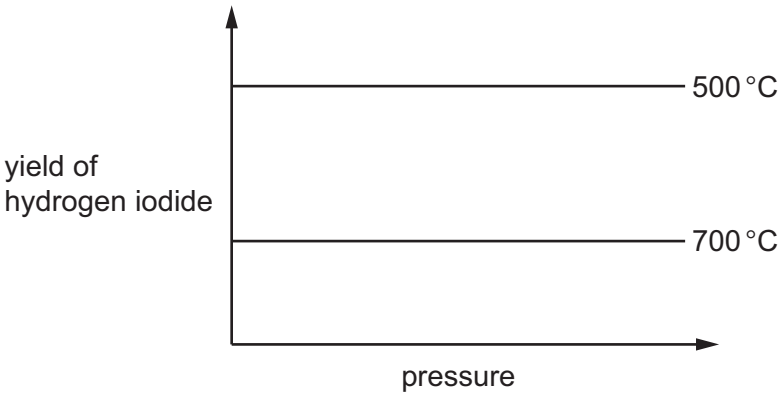
[Total: 5]

9 Hydrogen gas reacts with iodine gas. The equation is shown.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

The reaction is reversible and can reach equilibrium.

The graphs show how pressure affects the yield of hydrogen iodide, HI, at two different temperatures.



(a) Explain why the yield at 500 °C does **not** change as the pressure is increased.

.....

..... [1]

(b) What can you conclude from the difference in the yield of hydrogen iodide at the **two** temperatures shown?
Explain your answer.

.....

.....

..... [2]

[Total: 3]

10 Hydrogen gas reacts with iodine gas. The equation is shown.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

The reaction is reversible and can reach equilibrium.

What is meant by the term *equilibrium*?

.....

.....

..... [2]

[Total: 2]