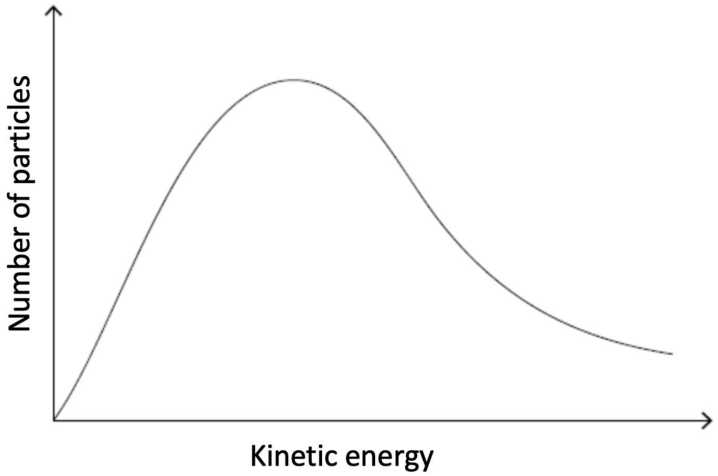
KINETICS Core (SL & HL)

1. The diagram below shows a Maxwell-Boltzmann distribution of a sample of gas at a given temperature, T.



(a) Sketch on the graph a distribution of the same sample of gas at a higher temperature, T_2.

[2]

(b) Explain how and why increasing temperature affects the rate of a chemical reaction.

[3]

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(c) A catalyst increases the rate of a reaction. Explain, in words, how a catalyst functions and indicate this by appropriate annotations on the Maxwell-Boltzmann graph.

[3]

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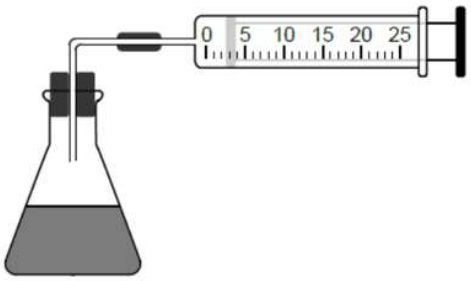
2. A reaction was carried out in a laboratory to measure the volume of gas produced when excess calcium carbonate chips react with hydrochloric acid using a gas syringe.

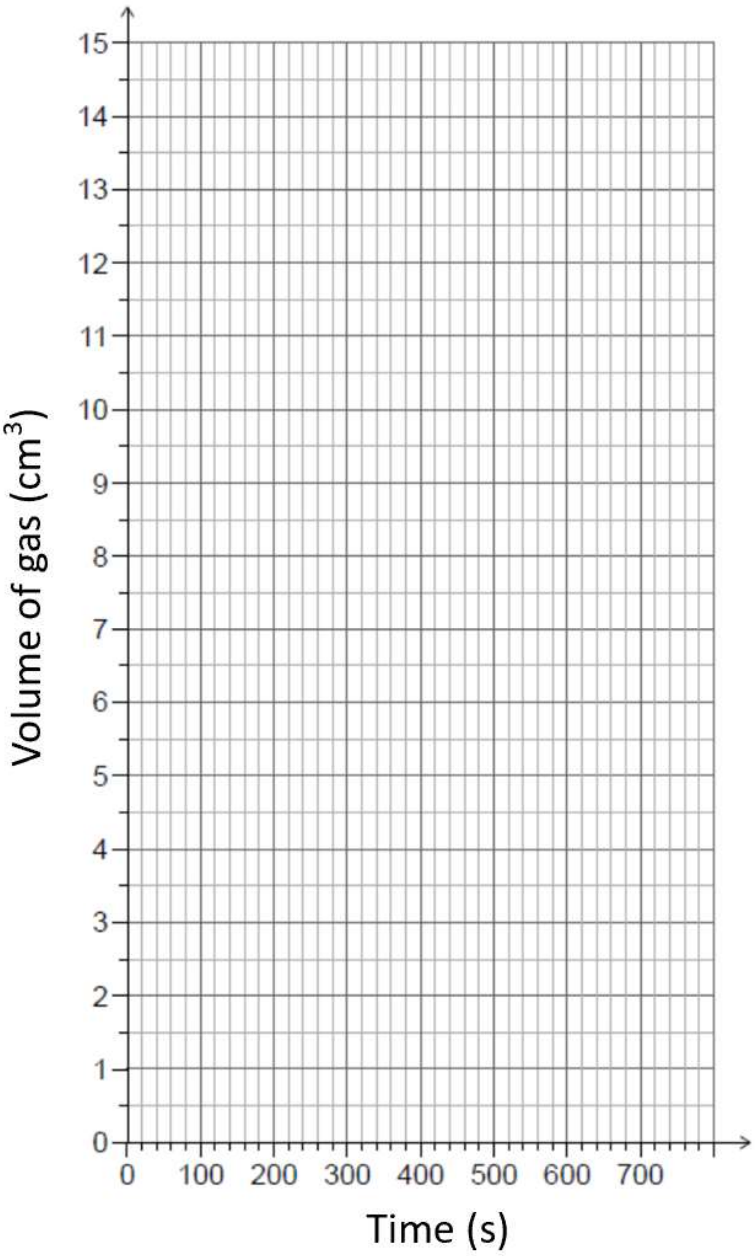
$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) Plot a graph of the data on the axes below. Draw a line of best fit on the graph.

[3]

Time (secs)	Volume of gas (cm^3)
0	0.0
100	4.0
200	6.8
300	8.8
400	10.2
500	11.2
600	11.6
700	11.6





(b) Calculate the **initial** rate of reaction. Show your working on the graph.

[2]

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(c) Calculate the rate of reaction at 400 seconds.

[2]

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(d) State and explain what happens to the rate of reaction over time.

[2]

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(e) A second reaction was carried out under exactly the same conditions as the first experiment, except that the calcium carbonate was crushed into smaller pieces. Sketch on the graph above a line to predict the results of this reaction. Label the line 'Exp2'.

[2]

3. (a) Zinc reacts with sulfuric acid. The reaction is exothermic.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

(i) Sketch a potential energy profile for this reaction; label the activation energy.

[2]

(ii) Copper catalyses the zinc and sulfuric acid reaction. Annotate your potential energy profile above with a dotted line to show the effect of a catalyst.

[1]

(b) Zinc also reacts with copper sulfate solution:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

(i) State one way in which the rate of reaction might be monitored. No practical details are required.

[1]

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(ii) Explain why increasing the concentration of the copper sulfate solution would increase the rate of reaction.

[2]

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(iii) Two experiments were carried out by reacting powdered zinc and then zinc shavings with copper sulfate solution (all other conditions were the same).
Reaction **A** took 92 seconds to go to completion, reaction **B** took 156 seconds to complete.
Calculate the relative average rates of these two reactions.

[1]

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(iv) Explain the effect of using powdered zinc rather than zinc shavings on the rate of reaction.

[2]

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Total Marks 28 (42 minutes)