Rates of Reaction II

1 Molly studied the reaction between calcium carbonate and hydrochloric acid. She carried out three experiments to study the effect of surface area of the calcium carbonate. She used calcium carbonate in the form of small lumps, medium lumps or large lumps. In each experiment she used 0.35 g of calcium carbonate and excess hydrochloric acid. She measured the volume of gas collected in a gas syringe at intervals.

(a) (i) Complete and balance the equation for the reaction: [2]

$CaCO_3(s) + HCl(aq) \rightarrow CaCl_2(aq) +$ …….. + ……..

(ii) What do the symbols (s) and (aq) mean? [2]

(s) ……

(aq) ……

(iii) Explain what the word *excess* means in this experiment. [2]

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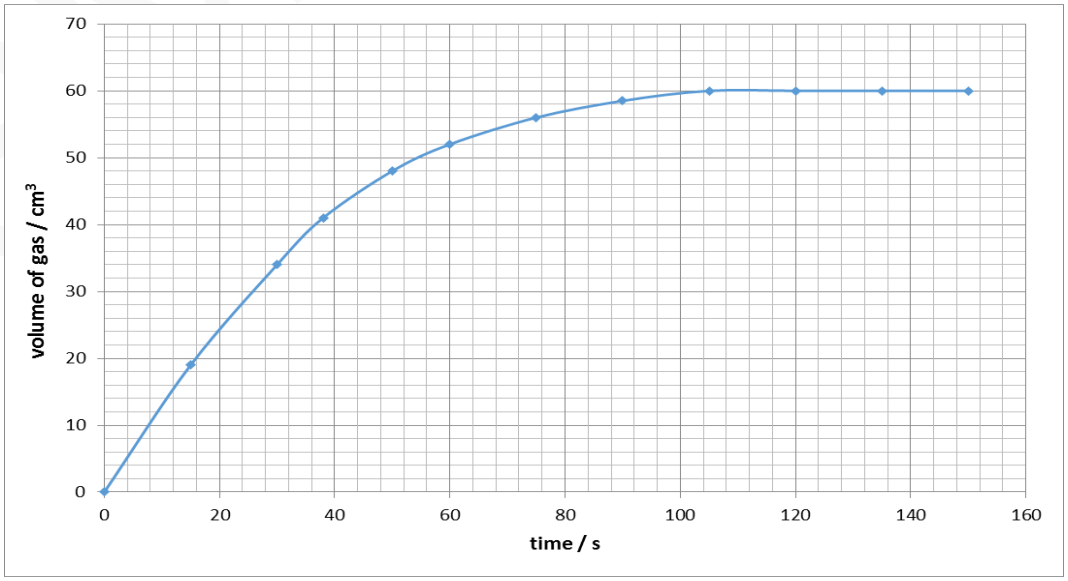
(b) In each experiment she used the same mass of calcium carbonate. Write down **three** other things she should keep the same in each experiment. [3]

1 ……

2 ……

3 ……

(c) In each experiment all the calcium carbonate had reacted within 150 s. Molly's graph for medium lumps is shown on the grid. Sketch graph lines for small lumps and large lumps on the axes below. Label your lines **S** for small lumps and **L** for large lumps. [3]



(d) Molly's teacher calculated that 84 cm^3 of gas should have been produced in these experiments. Explain why less than this amount was collected. [1]

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(e) Molly's friend repeats her experiment with medium marble chips but makes a mistake and uses a larger volume of hydrochloric acid. Explain how this will affect the volume of gas produced and the rate of reaction. [3]

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(f) Molly was asked by her teacher to work out the average rate at which gas was produced for the experiment with medium marble chips. The calculation that Molly did was

$$\frac{60}{150} = 0.40 \text{ cm}^3/\text{s}$$

Explain why her teacher said that this calculation was not correct. [2]

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(g) Molly repeated the experiment with medium marble chips but using the same volume of a more concentrated solution of hydrochloric acid. Sketch the graph that she would get on the axes below. [2]