

Assignment: Effect of Surface Area

"Things in motion sooner catch the eye than what stirs not"
Troilus and Cressida, III, iii, 183 by William Shakespeare

The rate of reaction for different surface areas was investigated by two students, Dan and Jamie:

20 mL of 2 M HCl, was placed in a conical flask and 1.00 g marble chips, CaCO₃, was weighed on to a watch glass. The two were placed together on a balance and the mass was recorded at time zero. The CaCO₃, was then tipped into the acid and the mass was recorded at 15 second intervals.

The experiment was repeated using 1.00 g CaCO₃, powder instead of the marble chips. The following results were obtained:

Time(s)	0	15	30	45	60	75	90	105	120	135
CaCO ₃ powder (g)	36.21	36.09	36.00	35.96	35.96	← "remains at 35.96 g" - →				
CaCO ₃ chips (g)	36.21	36.16	36.12	36.09	36.04	36.02	36.01	36.00	35.99	35.98

- Write a balanced equation for the reaction of CaCO_{3(s)} with HCl_(aq).
- Which is in excess, the acid or the CaCO₃, ? Show your calculations.
- Why must the same mass of CaCO₃, and the same volume and molarity of acid be used each time?
- CO_{2(g)} is denser than air. Suggest why the mass of the flask and reaction mixture decreases with time rather than increasing as might be expected.
- Acid spray could be lost through the mouth of the conical flask (though this is not the answer to (a)). Why should the flask not be corked? What might be done instead?
- During the experiment what should be done with the watch glass which originally contained the CaCO₃, and why?
- Plot the two sets of results on the same graph with time on the x-axis. Draw smooth curves through your two sets of points.
 - What is the effect of increasing surface of the solid on reaction rate?
 - What would you expect to be the final mass for the experiment with the powder) and why?
 - How long does it take for half the reaction to occur to occur with the marble chips? For the powdered calcium carbonate?
 - By looking at one of your curves (state which) say whether the rate of the reaction stays the same, increases or decreases during the reaction. Suggest an explanation for your findings.
- Sketch and label the comparable graphs you would expect if...
 - the concentration of HCl_(aq) was increased to 4 M
 - if a positive catalyst was used.
 - the effect of warming the HCl, before adding CaCO₃ chips.
- Suggest two ways (other than the above procedure) in which the rate of this reaction may be measured experimentally.
- How many moles of carbon dioxide were evolved in the above experiment?
- Suggest one other method that may be used to measure the rate of this reaction.