



Rates of Reaction

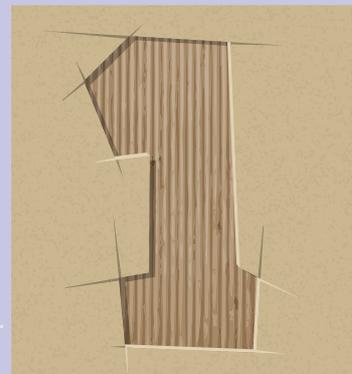


Before you start these experiments, be sure to read and follow the **General Safety Notes and Practical Tips** on page 2. Then answer the questions in your workbook.

Experiment One: Effect of Concentration

Equipment:

- 4 test tubes
- 1 test tube rack
- 4 small equal sized pieces of magnesium ribbon
- 1 stopwatch
- paper
- 4 mL of 0.5 mol L⁻¹ hydrochloric acid
- 4 mL of 1.0 mol L⁻¹ hydrochloric acid
- 4 mL of 2.0 mol L⁻¹ hydrochloric acid
- 4 mL of 3.0 mol L⁻¹ hydrochloric acid



Method:

- Step 1:** Place 4 mL of each of the concentrations of acid into the 4 test tubes; Label the test tubes with a piece of paper.
- Step 2:** Put each test tube into the test tube holder.
- Step 3:** Put 1 piece of magnesium into each test tube and start the stopwatch.
- Step 4:** Watch **VERY** carefully. As each piece reacts away **COMPLETELY** write down the time.
- Step 5:** When they have all reacted wash out the test tubes and put the equipment away.

Results:

	0.5 mol L ⁻¹	1.0 mol L ⁻¹	2.0 mol L ⁻¹	3.0 mol L ⁻¹
Time to React (sec)				

Conclusion:

- The acid that reacted the fastest was . It took .
- The acid that reacted the slowest was . It took .
- The more concentrated the acid, the **FASTER / SLOWER** it reacts with the magnesium. (Circle your answer.)
- Label each of the following diagrams as either 0.5 mol L⁻¹, 1.0 mol L⁻¹, 2.0 mol L⁻¹ or 3.0 mol L⁻¹.

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- If something is concentrated, it means that there is a **LOT / LITTLE** of the substance. (Circle your answer.)
- The more concentrated the substance is, the **FASTER / SLOWER** the reaction goes. (Circle your answer.)
- The opposite of concentrated is **DILUTE / WATERY / MINIMUM**. (Circle your answer.)
- In this experiment, the amount of products made would have been the same in each reaction because while the concentration of the acid differed, the amount of magnesium didn't. Is this statement **TRUE or FALSE** ?

Experiment Two: Effect of Temperature

Equipment:

- Bunsen burner
- tripod
- gauze mat
- heatproof mat
- thermometer
- 100 mL tap water
- 2 test tubes
- beaker
- test tube rack
- 4 mL of 2.0 mol L⁻¹ hydrochloric acid
- stopwatch
- 2 small pieces of calcium carbonate

Method:

Part One: Step 1: Set up the Bunsen burner and light it. Put the 100 mL of water into the beaker and put it on the tripod.

Step 2: Heat the water to 80°C. When it reaches 80°C, put 4 mL of 2.0 mol L⁻¹ hydrochloric acid **into the test tube** and **place the test tube into the beaker** of water. Leave it for 1 minute.

Step 3: Turn off the Bunsen burner.

Step 4: Add 1 piece of calcium carbonate to the test tube (leaving it in the beaker on top of the tripod). Start the stop watch.

Step 5: Watch it carefully and when it has fully reacted, stop the stopwatch and record the time.

Step 6: When the gear has cooled down, wash it and put it away.

Part Two: Step 1: Put 4 mL of 2.0 mol L⁻¹ hydrochloric acid into the test tube.

Step 2: Add 1 piece of calcium carbonate and start the stopwatch.

Step 3: Watch it very carefully and when it has fully reacted, stop the stopwatch and record the time.

Step 4: Wash and clean up the gear.

Results:

Time taken to react in heated acid:

Time taken to react in cool acid:

Conclusion:

- a. HOT / COLD acid reacted with the calcium carbonate fastest.
- b. HOT / COLD acid particles move around the quickest in the solutions.
- c. HOT / COLD acid particles crashed into the calcium carbonate with more force.
- d. Tilly was making homemade lemonade. She used 1 cup of boiling water to dissolve 2 cups of sugar before adding the lemon juice, cold water and ice. Explain why she added boiling water to start with.

- e. Why do you think we keep products like meat, cheese and milk in a cold place like the fridge?



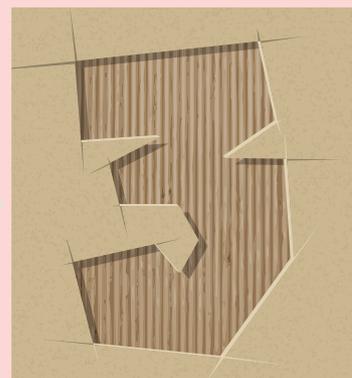
Experiment Three: Effect of Particle Size

Equipment:

- 2 test tubes
- test tube rack
- 2 calcium carbonate crystals (of the same mass)
- stopwatch
- pestle and mortar
- 2 x 4 mL of 2.0 mol L⁻¹ hydrochloric acid

Method:

- Step 1:** Place the two test tubes in the test tube rack.
- Step 2:** Put 4 mL of 2.0 mol L⁻¹ hydrochloric acid into each test tube.
- Step 3:** Add one crystal of calcium carbonate to one test tube and start the stop watch.
- Step 4:** Watch it carefully until it has fully reacted, then stop the stop watch and record the time.
- Step 5:** Take the other crystal and grind it to a powder using the pestle and mortar.
- Step 6:** Now repeat steps 3-4 with the powdered calcium carbonate.
- Step 7:** When you are finished, wash and put away the gear.



Results:

Time taken for calcium carbonate **crystal** to react:

Time taken for calcium carbonate **powder** to react:

Conclusion:

a. Label the following diagrams as either calcium carbonate crystal or calcium carbonate powder.



- b. Which type of calcium carbonate reacted the fastest? and it took .
- c. The **LARGER / SMALLER** particles reacted fastest.
- d. The **LARGER / SMALLER** particles had greater total surface area.
- e. The **LARGER / SMALLER** particles have more area for the acid to react on so it reacts faster.
- f. When you light a fire, it is best to use small pieces of wood **NOT** a large log. Explain why.

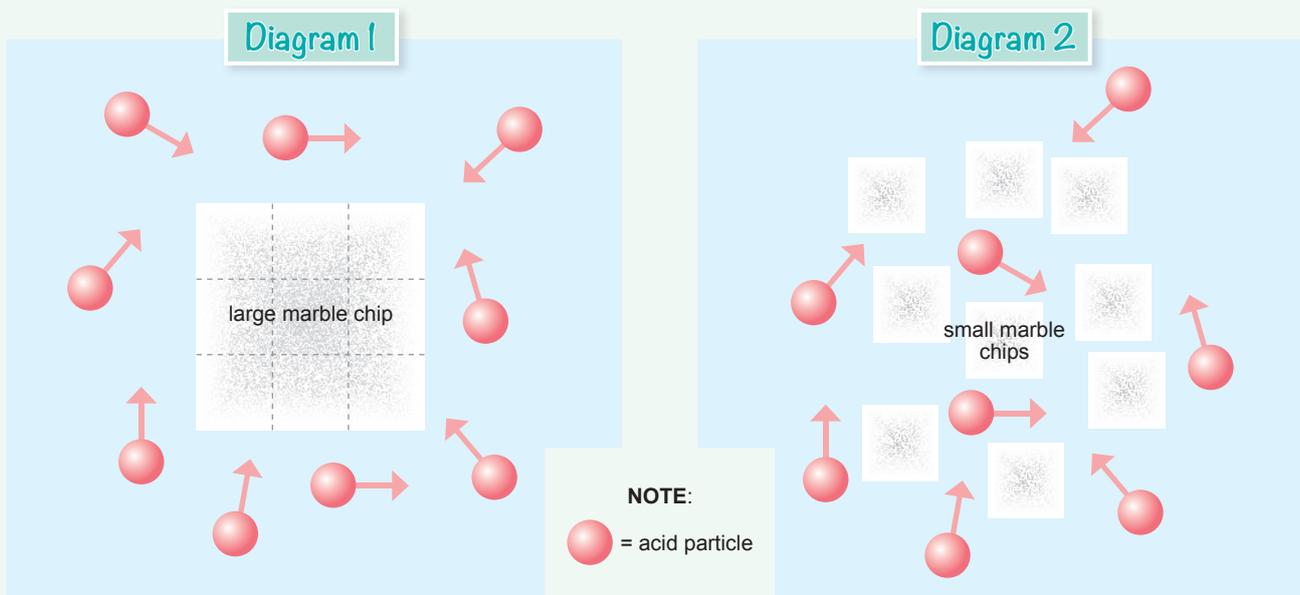
g. When you make a stir-fry, it is best to cut all the vegetables the same small size. Explain why.

Summary Questions

1. Write **true** or **false** beside each of the following statements:

- a. Smaller particles react **faster** than larger particles.
- b. Dilute acid reacts **faster** than concentrated acid.
- c. Hotter acid will react **slower** than colder acid.
- d. If you add concentrated acid to water, it makes it dilute.
- e. If you crush up calcium carbonate, it will react **slower** than a whole piece.
- f. 60°C acid will react **slower** than 98°C acid.
- g. Stirring or swirling salt as it is added to water will make it dissolve **faster**.
- h. 4 mol L^{-1} nitric acid will react **faster** than 0.1 mol L^{-1} nitric acid.

2. Use the diagrams below to answer the following questions.



- a.
 - i. In Diagram 1, the CaCO_3 has a perimeter of 3 units / 9 units / 12 units . (Circle your answer.)
 - ii. In Diagram 1, the acid particles CAN / CAN'T get to the middle easily to react. (Circle your answer.)
- b.
 - i. In Diagram 2, the CaCO_3 has a perimeter of 4 units / 9 units / 36 units . (Circle your answer.)
 - ii. This is a BIGGER / SMALLER surface area than in the first diagram. (Circle your answer.)
 - iii. So, the reaction in the second diagram would be FASTER / SLOWER than Diagram 1. (Circle your answer.)
- c. Overall, when there is more a for c to occur on, the reaction can occur f.