

How fast do reactions go?

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

An effervescent tablet makes carbon dioxide when it meets water, so the fizzing is a clock for the reaction. You time the tablet at four temperatures, convert the times into rates and test whether the rate keeps doubling for every ten degrees. You also judge how reliable the stopwatch results are.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-5

Aim

To investigate how the temperature of the water changes the time an effervescent tablet takes to stop fizzing, and so how it changes the rate of reaction.

Equipment

- Four identical effervescent tablets (citric acid with sodium hydrogencarbonate)
- Four 250 cm³ beakers and a measuring cylinder
- Thermometer, stopwatch, kettle, ice and cold tap water
- Heat-proof mat, paper towel and a marker pen

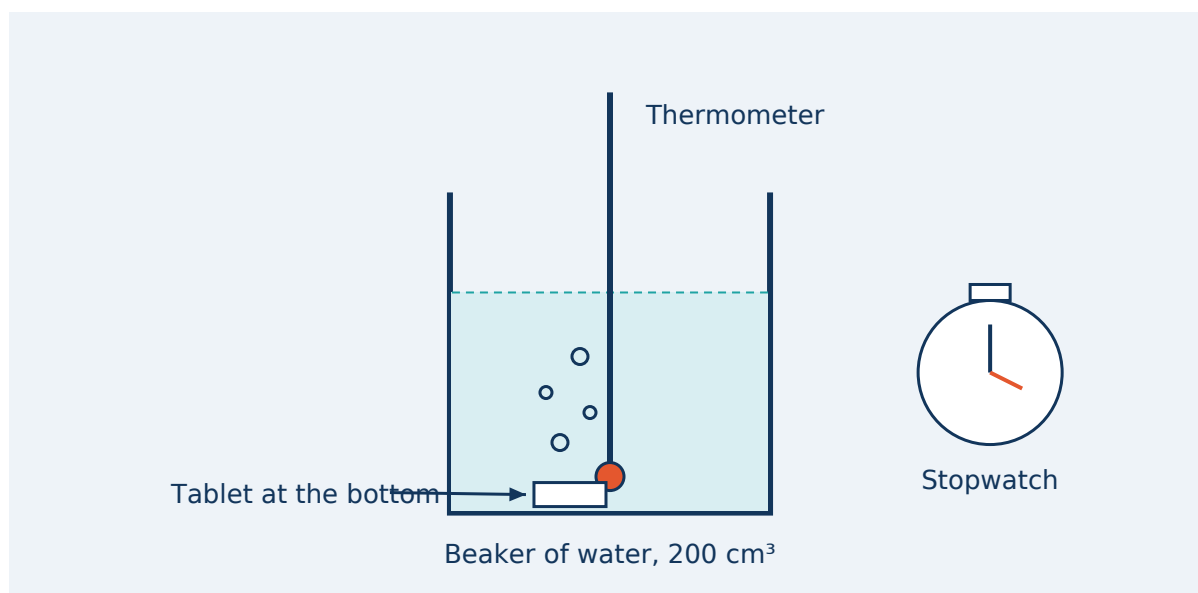
Safety

Safety

Wear safety goggles. Water at 60 °C can scald, so pour it carefully with an adult or teacher present. Do not eat or drink anything in the lab, and mop up spills at once.

Method

1. Measure 200 cm³ of water into a beaker and adjust it with ice or hot water to 5 °C. Check with the thermometer.
2. Drop in one tablet and start the stopwatch at once.
3. Stop the stopwatch when the fizzing stops and record the time to the nearest second.
4. Repeat with fresh water at 20 °C, 40 °C and 60 °C, using a new tablet each time.



Apparatus for timing a tablet in water at different temperatures.

Results

Sample results:

Water temperature / °C	Time to stop fizzing / s
5	190
20	80
40	25
60	9

Analysis questions

Question 1 Calculate the rates

Calculate the rate as $1 \div \text{time}$ for each temperature and express your answers in units of 10^{-3} s^{-1} to three significant figures.

Question 2 Graph and shape

Plot rate (y-axis) against temperature (x-axis) and describe the shape of the line.

Question 3 Factor per ten degrees

Calculate the factor by which the rate increases between 20 °C and 40 °C. Find the average factor per 10 °C and compare it with the rule that the rate doubles.

Question 4 Explain with collisions

Explain the trend using particles and activation energy.

Question 5 Control variables

List three variables that must be kept the same and explain why.

Question 6 Timing uncertainty

The stopwatch time is uncertain by ± 1 s. Calculate the percentage uncertainty for the 9 s and 190 s results and state which is less reliable.

Question 7 Improvements

State the conclusion and suggest two improvements to the method.