

Rates of reaction

A video featuring these experiments is available at <https://rsc.li/3BMJQR2>, along with teacher notes and worksheets for learners.

1. Initial rate method: the iodine clock

Equipment (per group, for five different concentrations of hydrogen peroxide)

- 1 x volumetric flask, 1 dm³
- 5 x conical flasks, 100 cm³
- 5 x beaker, 100 cm³
- 1 – 5 x white tiles
- 1 x burette, 50 cm³
- 5 x measuring cylinder, 50 cm³
- 1 x pipette, 10 cm³, to measure 20 cm³
- 3 x plastic dropping pipette, 3 cm³
- 1 x beaker, 400 cm³ for waste solutions
- 1 x timer or digital stopwatch
- balance to 1 or 2 decimal places
- marker pen for labelling

Safety equipment: safety spectacles

Preparation

Each group will need the following chemicals for each trial:

- soluble starch, 2% w/v, 20 cm³
- sulfuric acid, 1.0 mol dm⁻³, 50 cm³
- solution X (containing potassium iodide and sodium thiosulfate)*, 100 cm³
- hydrogen peroxide, 20 volume, 100 cm³
- distilled water, 1 dm³
- waste beaker containing sodium carbonate solution, 0.5 mol dm⁻³, 200 cm³

Best results are achieved if the solutions are made up fresh on the day.

***Solution X** should be made up prior to the lesson to save time:

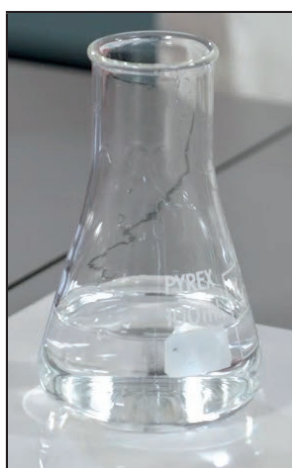
1. Dissolve 6.0 g potassium iodide in 800 cm³ water; add 7.5 g of sodium thiosulfate and stir.
2. Transfer to a volumetric flask and make up to 1 dm³. Label it 'Solution X' (not classified as hazardous).

Preparation of the **starch solution**:

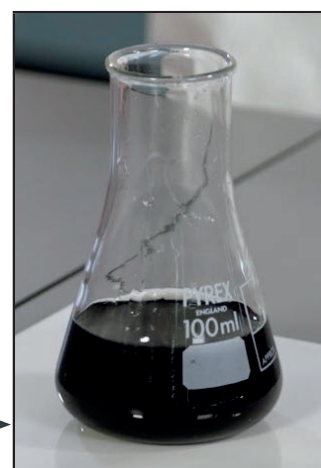
Make a paste with 2.0 g starch in a few drops of water; add 100 cm³ boiling water and stir.

Equipment set-up and tips

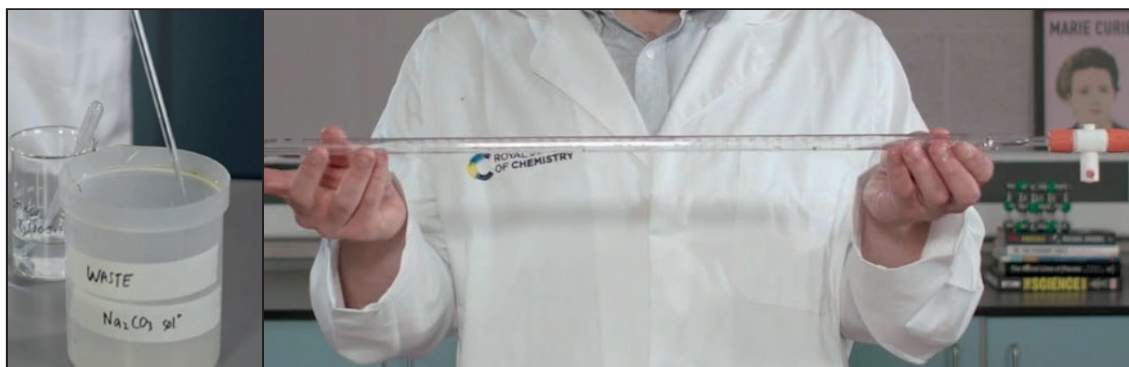
What will be observed and measured?



Add the hydrogen peroxide solution to the potassium iodide, sodium thiosulfate, starch and sulfuric acid solutions in the conical flask. Start the timer.



Stop the timer when the solution turns blue/black. This will show that the thiosulfate has been used up; the iodine will then react with the starch.








Burette and pipettes for measuring reactants, need to be pre-rinsed with the solution they measure, into a waste beaker.

Safety

Read our [standard health & safety guidance](#) and carry out a risk assessment before running any live practical.

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical	Preparation
Starch solution 2% (w/v) Currently not classified as hazardous	See notes above
Sulfuric(vi) acid solution, 1.00 mol dm ⁻³ H ₂ SO ₄ (aq)  DANGER Causes severe skin burns and eye damage	Sulfuric(vi) acid concentrated H ₂ SO ₄ (l) MW= 98.07 g mol ⁻¹  DANGER Cause severe skin burns and eye damage
Potassium iodide, solid KI (s) Not usually classified as hazardous but differs between suppliers.	
Sodium thiosulfate pentahydrate, solid Na ₂ S ₂ O ₃ ·5H ₂ O (s) Currently not classified as hazardous	
Hydrogen peroxide solution, 20 vol H ₂ O ₂ (aq)  WARNING Irritant (eyes)	Hydrogen peroxide solution, 100 vol H ₂ O ₂ (aq)  DANGER Corrosive (eyes)
Sodium carbonate solution, 0.5 mol dm ⁻³ Na ₂ CO ₃ (aq) Currently not classified as hazardous	Sodium carbonate decahydrate solid Na ₂ CO ₃ ·10H ₂ O (s) MW= 286.14 g mol ⁻¹  WARNING Irritant (eyes)

Disposal

Pour the waste solution down a foul-water drain with further dilution.

2. Continuous monitoring method: volume of gas

Equipment (per group)

- 1 x gas syringe, 100 cm³
- 1 x delivery tube
- 1 x side arm boiling tube with bung (or boiling tube and delivery tube attached to bung)
- 1 x pipette and pipette filler, 20 cm³ or measuring cylinder, 25 cm³
- 1 x timer or digital stopwatch
- 1 x clamp and stand
- 1 x syringe holder (to be clamped)
- 1 x thermometer or temperature probe
- 1 x water bath or suitable alternative
- 1 x balance to 1 or 2 decimal places

An alternative to collecting the gas produced is by displacement of water using an inverted burette, a trough and a beehive-shelf (optional).

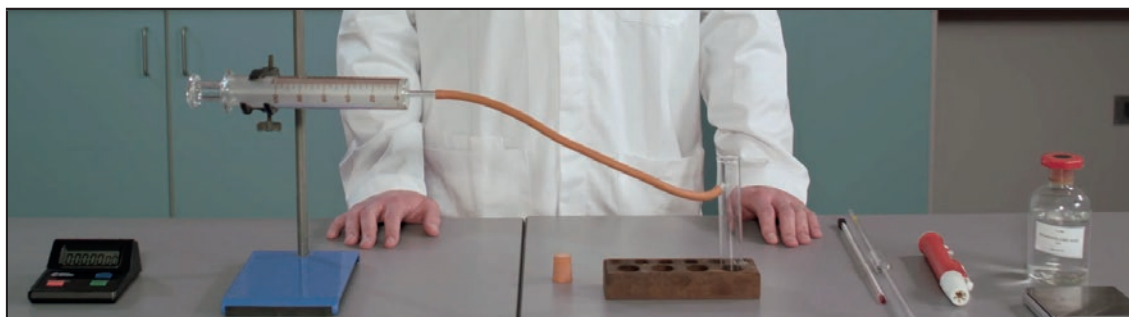
Safety equipment: safety spectacles

Preparation

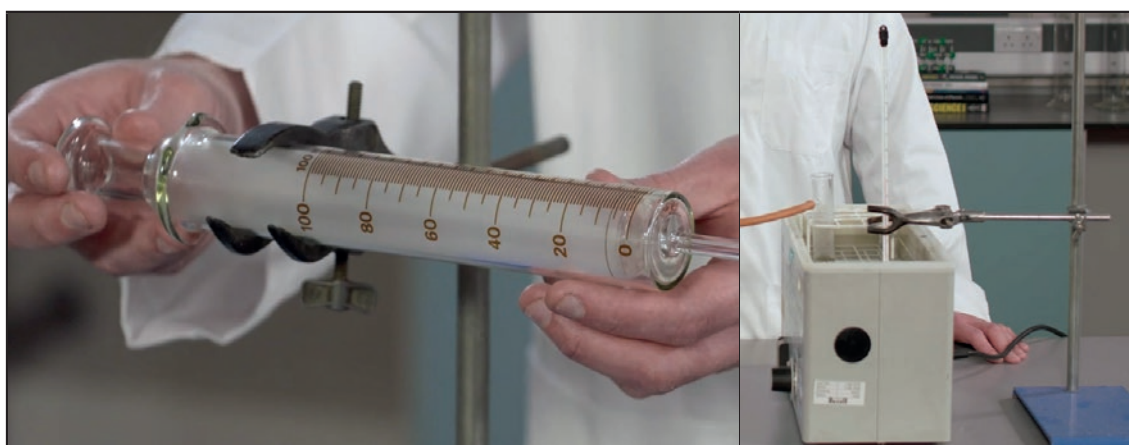
Each group will need the following chemicals:

- magnesium ribbon, 0.09 g (per repeat)
- hydrochloric acid, 1.0 mol dm⁻³, 20 cm³ (per repeat)

Equipment set-up and tips



The side arm boiling tube can be replaced by a boiling tube and bung with one hole, the delivery tube attached to the bung. A measuring cylinder can be used instead of a pipette.



Check that the syringe barrel moves freely in the cylinder. Do not lubricate the syringe barrel as it will stick. If the barrel is a bit sticky due to previous contamination, try cleaning the syringe with a bit of washing up liquid and leave it to dry fully before use.



Take extra care if you are going to use a Bunsen burner to heat up water in a beaker on a tripod and gauze instead of electric water bath.

Safety

Read our [standard health & safety guidance](#) and carry out a risk assessment before running any live practical.

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical	Preparation
Magnesium ribbon Mg (s)  DANGER Classification labelling vary depending on supplier. Some will indicate no hazard and some will give the following hazards: <ul style="list-style-type: none">- flammable solid- self-heating in large quantities; may catch fire- in contact with water releases flammable gases	Hydrochloric acid concentrated HCl (l) MW= 36.46 g mol ⁻¹  DANGER Causes severe skin burns and eye damage May cause respiratory irritation

Disposal

The waste solution should be diluted down to 0.1 mol dm⁻³ and then poured down a foul-water drain.