A-level Chemistry exemplar for required practical 7 – part a

Measuring the rate of reaction by an initial rate method:

An 'Iodine Clock' experiment: To investigate the reaction of iodide(V) ions with hydrogen peroxide in acidic solution and to determine the order of the reaction with respect to iodide ions.

Student sheet

The 'Iodine Clock' experiment can be used to determine the effect of a change in concentration of iodide ions on the reaction between hydrogen peroxide and iodide ions.

Introduction

Hydrogen peroxide reacts with iodide ions to form iodine and the thiosulfate ion immediately reacts with iodine as shown below.

$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

When the I_2 produced has reacted with all of the limited amount of thiosulfate ions present, excess I_2 remains in solution. Reaction with the starch then forms a dark blue-black colour.

By varying the concentration of I^-, you can determine the order of reaction with respect to I^- ions.

Requirements

You are provided with the following:

- 0.25 mol dm^{-3} dilute sulfuric acid
- 0.10 mol dm^{-3} potassium iodide solution
- 0.05 mol dm^{-3} sodium thiosulfate solution (in a shared burette)
- 0.10 mol dm^{-3} hydrogen peroxide solution (in a shared burette)
- starch solution
- 50 cm^3 burette
- funnel suitable for filling a burette
- stand and clamp
- white tile
- plastic dropping pipette
- 25 cm^3 measuring cylinder
- 50 cm^3 measuring cylinder

- 100 cm^3 beaker
- 250 cm^3 beaker
- stirrer
- stopwatch
- paper towels to dry beakers
- plentiful supply of distilled or deionised water.

Suggested method

Experiment 1

a) Rinse a 50 cm^3 burette with potassium iodide solution. Fill the burette with potassium iodide solution.

b) Transfer 10.0 cm^3 of hydrogen peroxide solution from the shared burette provided to a clean, dry **100 cm^3** beaker. You will use this in step (h).

c) Use a 50 cm^3 measuring cylinder to add 25 cm^3 of sulfuric acid to a clean, dry **250 cm^3** beaker.

d) Use a 25 cm^3 measuring cylinder to add 20 cm^3 of distilled or deionised water into the 250 cm^3 beaker.

e) Use a plastic dropping pipette to add about 1 cm^3 of starch solution to this beaker.

f) Use your burette to add 5.0 cm^3 of potassium iodide solution to the mixture in the 250 cm^3 beaker.

g) Finally, add 5.0 cm^3 of sodium thiosulfate solution from the shared burette provided to the mixture in the 250 cm^3 beaker. Make sure this sodium thiosulfate solution is added last.

h) Stir the mixture in the 250 cm^3 beaker. Pour the hydrogen peroxide solution from the 100 cm^3 beaker into the 250 cm^3 beaker and **immediately** start the timer. Stir the mixture.

i) Stop the timer when the mixture in the 250 cm^3 beaker turns blue-black. Record the time to an appropriate precision in a table of your own design. This experiment could take several minutes.

j) Rinse the 250 cm^3 beaker with distilled or deionised water and dry it with a paper towel.

Experiments 2–5

k) Repeat steps (b) to (j) in four further experiments using the volumes shown in the following table.

Experiment	Volumes of solutions added to 250 cm^3 beaker					Volume in 100 cm^3 beaker
	Sulfuric acid 0.25 M/cm^3	Starch/ cm^3	Water/ cm^3	Potassium iodide 0.10 M/cm^3	Sodium thiosulfate 0.05 M/cm^3	Hydrogen peroxide 0.10 M/ cm^3
1	25	1	20	5.0	5.0	10.0
2	25	1	15	10.0	5.0	10.0
3	25	1	10	15.0	5.0	10.0
4	25	1	5	20.0	5.0	10.0
5	25	1	0	25.0	5.0	10.0

Requirements

In addition to general laboratory apparatus, each student needs the following:

- 125 cm^3 of 0.25 mol dm^{-3} dilute sulfuric acid
- 100 cm^3 of 0.10 mol dm^{-3} potassium iodide solution
- 25 cm^3 of 0.05 mol dm^{-3} sodium thiosulfate solution
- 50 cm^3 of 0.10 mol dm^{-3} hydrogen peroxide solution (freshly prepared)
- 5 cm^3 of 1% starch solution (freshly prepared)
- 50 cm^3 burette
- funnel suitable for filling a burette
- stand and clamp
- white tile
- plastic dropping pipette (or starch solution provided in a dropping bottle)
- 25 cm^3 measuring cylinder
- 50 cm^3 measuring cylinder
- 100 cm^3 beaker
- 250 cm^3 beaker
- stirrer
- stopwatch
- paper towels to dry beakers
- plentiful supply of distilled or deionised water.

The exemplar method provided is based on each student having access to communal burettes (approximately one set for every five students) containing hydrogen peroxide and sodium thiosulfate solutions. Teachers are advised that frequent refilling of these burettes will be required.

The hydrogen peroxide solution must be freshly prepared on the day of the practical from a recently purchased, more concentrated solution.

The 1% starch solution must be freshly prepared on the day of the practical.

The hydrogen peroxide is the reagent controlling the time of the reaction and the concentration stated above can be varied as required.

Spare supplies of all reagents specified in these notes should be available for student use (if needed).

Photographs of an exemplar set-up of this practical can be found in our set-up guide, which is available on our A-level Practicals page.

A-level Chemistry exemplar for required practical 7 – part b

Measuring the rate of reaction by a continuous monitoring method:

The reaction between magnesium and hydrochloric acid.

Student sheet

Requirements

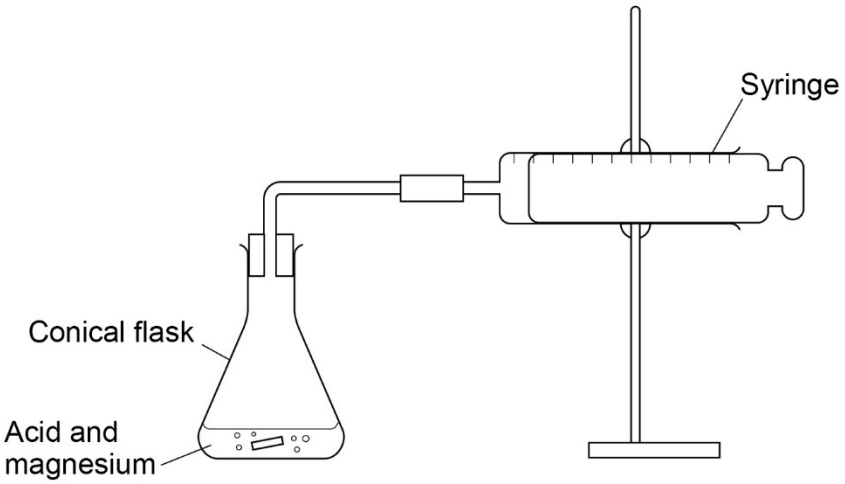
You are provided with the following:

- magnesium ribbon
- 0.8 mol dm^{-3} hydrochloric acid
- 50 cm^3 measuring cylinder
- 100 cm^3 conical flask
- rubber bung and delivery tube to fit conical flask
- 100 cm^3 gas syringe OR trough/plastic container with 100 cm^3 measuring cylinder
- stand, boss and clamp
- stopwatch or timer
- distilled or deionised water.

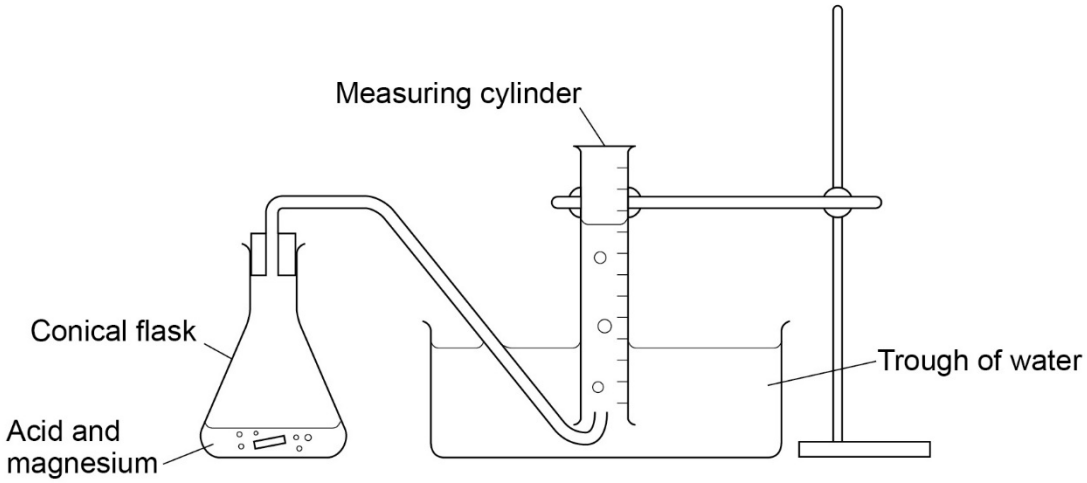
Suggested method

a) Measure 50 cm^3 of the 0.8 mol dm^{-3} hydrochloric acid and add to conical flask.
b) Set up the gas syringe in the stand (or alternative gas collection method as shown by your teacher).

Using a gas syringe



Using a trough



c) Add one 6 cm strip of magnesium ribbon to the conical flask, place the bung firmly into the top of the flask and start the timer.
d) Record the volume of hydrogen gas collected every 15 seconds for 2.5 minutes.

Repeat steps (a) to (d) using 0.4 mol dm^{-3} hydrochloric acid, made by mixing 25 cm^3 of the 0.8 mol dm^{-3} hydrochloric acid with 25 cm^3 of distilled or deionised water.

Analysis

a) Plot a graph of volume of hydrogen produced on the *y*-axis against time in seconds for each hydrochloric acid concentration. Draw a line of best fit.
b) Draw a tangent to each line of best fit at time, t = 0 s
c) Calculate the gradient of each tangent in order to deduce the rate of each reaction.
d) Compare the two rate values obtained.