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Effect of concentration on rate of reaction

*UNIT 1 PPA 1*

**Introduction**

This reaction investigates the effect on the rate of reaction between potassium iodide and hydrogen peroxide by changing the concentration of potassium iodide. This reaction is a type of ‘clock’ reaction.

In acidic conditions, hydrogen peroxide reacts with potassium iodide to form water and iodine

H2O2(aq) + 2H+(aq) + 2I-(aq) 🡪 2H2O(l) + I2(aq)

To follow the course of the reaction, small quantities of starch and sodium thiosulphate can be added.

I2(aq) + 2S2O32-(aq) 🡪 2I-(aq) S4O62-(aq)

The starch is used to indicate the presence of iodine.

The thiosulphate ions react with the iodine and change it to iodide ions. Therefore, when the thiosulphate ions have been used up, iodine will be left over which then reacts with the starch turning the mixture from colourless to blue/black.

If you keep the amount of thiosulphate constant, it ensures that the time taken for the colour to change (appear) at each concentration of KI is the time taken to produce the same number of moles of iodine.

If t is the time taken for the blue/black colour to appear, then we can take 1/t as a measurement of the reaction rate.

**Health & Safety**

The solutions involved in this reaction are all dilute enough to be of no significant hazard and thus need no eye protection or other PPE.

(Though the same is not necessarily true for technicians preparing the solutions)

**Each group will need**

|  |  |
| --- | --- |
| Hydrogen peroxide 3 vol (0.25 mol l-1 / 0.83%) | Potassium iodide solution 0.5 mol l-1  |
| Sulphuric acid 0.05 mol l-1  | Sodium thiosulphate solution 0.01 mol l-1  |
| Starch solution (~ 0.4%) | Distilled water |
| Small beakers / flasks | 25 cm3 measuring cylinder |
| Pipettes (3 cm3 pasteur pipettes are suitable but any others able to measure from 1 – 5 cm3 are fine | Timer |

**Procedure**

1. Using pipettes and/or measuring cylinders, add the following reagents to a set of flasks / beakers.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Expt No | Sulphuric acid cm3  | Starch cm3 | Potassium iodide cm3 | Water cm3 | Sodium thiosulphate cm3 |
| 1 | 25 | 1 | 1 | 4 | 1 |
| 2 | 25 | 1 | 2 | 3 | 1 |
| 3 | 25 | 1 | 3 | 2 | 1 |
| 4 | 25 | 1 | 4 | 1 | 1 |
| 5 | 25 | 1 | 5 | 0 | 1 |

Alternatively, you can prepare these one at a time and rinse the flask / beaker between experiments

1. When you are ready to start you should add 1 cm3 of hydrogen peroxide solution to the first beaker and start timing Tum on the water tap and the suction from the pump will ensure that the ﬁlter paper adheres firmly to the perforated bed of the funnel.
2. As soon as the blue/black colour appears, stop the timer and record the time (in seconds).
3. Rinse the flask / beaker if you are only using one and fill it with the next set of reagents.
4. Add 1 cm3 hydrogen peroxide, as before, and time how long it takes to for the colour to appear.
5. Repeat again for the rest of the mixtures

Your results.

1. Calculate the reciprocal of the times (in seconds) 1 / t
2. Plot a graph of concentration of potassium iodide against the reciprocal of the time.

**Notes**

In order to avoid temperature changes confusing the issue, ensure that all the reagents are put out in the laboratory early enough for the temperature to equilibrate – especially is, as is common, the hydrogen peroxide has been kept in the fridge.

**Extensions**

You can use a similar experiment and keep the potassium iodide constant and see the effect of changing the temperature

You could repeat at different pH values

**Technician Guide**

*UNIT 1 PPA 1*

**Each group will need**

Volumes are rounded up to allow for a little extra.

|  |  |
| --- | --- |
| 10 cm3 Hydrogen peroxide 3 vol (0.25 mol l-1 / 0.83%) | 20 cm3 Potassium iodide solution 0.5 mol l-1  |
| 150 cm3 Sulphuric acid 0.05 mol l-1  | 10 cm3 Sodium thiosulphate solution 0.01 mol l-1  |
| 10 cm3 Starch solution (~ 0.4%) | 15 cm3 Distilled water |
| 1 or 5 Small beakers / flasks (100 cm3)  | 25 cm3 measuring cylinder |
| Pipettes (3 cm3 pasteur pipettes are suitable but any others able to measure from 1 – 5 cm3 are fine | Timer |

**Procedure**

1. Using pipettes and/or measuring cylinders, add the following reagents to a set of flasks / beakers.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Expt No | Sulphuric acid cm3  | Starch cm3 | Potassium iodide cm3 | Water cm3 | Sodium thiosulphate cm3 |
| 1 | 25 | 1 | 1 | 4 | 1 |
| 2 | 25 | 1 | 2 | 3 | 1 |
| 3 | 25 | 1 | 3 | 2 | 1 |
| 4 | 25 | 1 | 4 | 1 | 1 |
| 5 | 25 | 1 | 5 | 0 | 1 |

Alternatively, you can prepare these one at a time and rinse the flask / beaker between experiments

1. When you are ready to start you should add 1 cm3 of hydrogen peroxide solution to the first beaker and start timing Tum on the water tap and the suction from the pump will ensure that the ﬁlter paper adheres firmly to the perforated bed of the funnel.
2. As soon as the blue/black colour appears, stop the timer and record the time (in seconds).
3. Rinse the flask / beaker if you are only using one and fill it with the next set of reagents.
4. Add 1 cm3 hydrogen peroxide, as before, and time how long it takes to for the colour to appear.
5. Repeat again for the rest of the mixtures

Your results.

1. Calculate the reciprocal of the times (in seconds) 1 / t
2. Plot a graph of concentration of potassium iodide against the reciprocal of the time.

**Notes**

In order to avoid temperature changes confusing the issue, ensure that all the reagents are put out in the laboratory early enough for the temperature to equilibrate – especially is, as is common, the hydrogen peroxide has been kept in the fridge