Name: _____( ) Class: _____ Date: _____

Rate of Reaction

Skills:
MMO: Manipulation, measurement, and observation
PDO: Presentation of data and observations
ACE: Analysis, conclusions and evaluation
P: Planning

Experiment R1: Concentration and Speed of Reaction (Modified from 5074/03/O/N/15)

Aim: To investigate the effect of concentration on the speed of reaction

Apparatus and chemicals

250 cm^3 conical flask
25 cm^3 measuring cylinder
10 cm^3 measuring cylinder
Stop watch
White tile
Burette
Distilled water
P: Aqueous solution of ammonium peroxodisulfate, $(NH_4)_2S_2O_8$
Q: Aqueous solution containing iodide ions, I^-, and another substance

Background

When **P** and **Q** are mixed together, they react to produce iodine.

$$S_2O_8^{2-} + 2I^- \rightarrow 2SO_4^{2-} + I_2$$

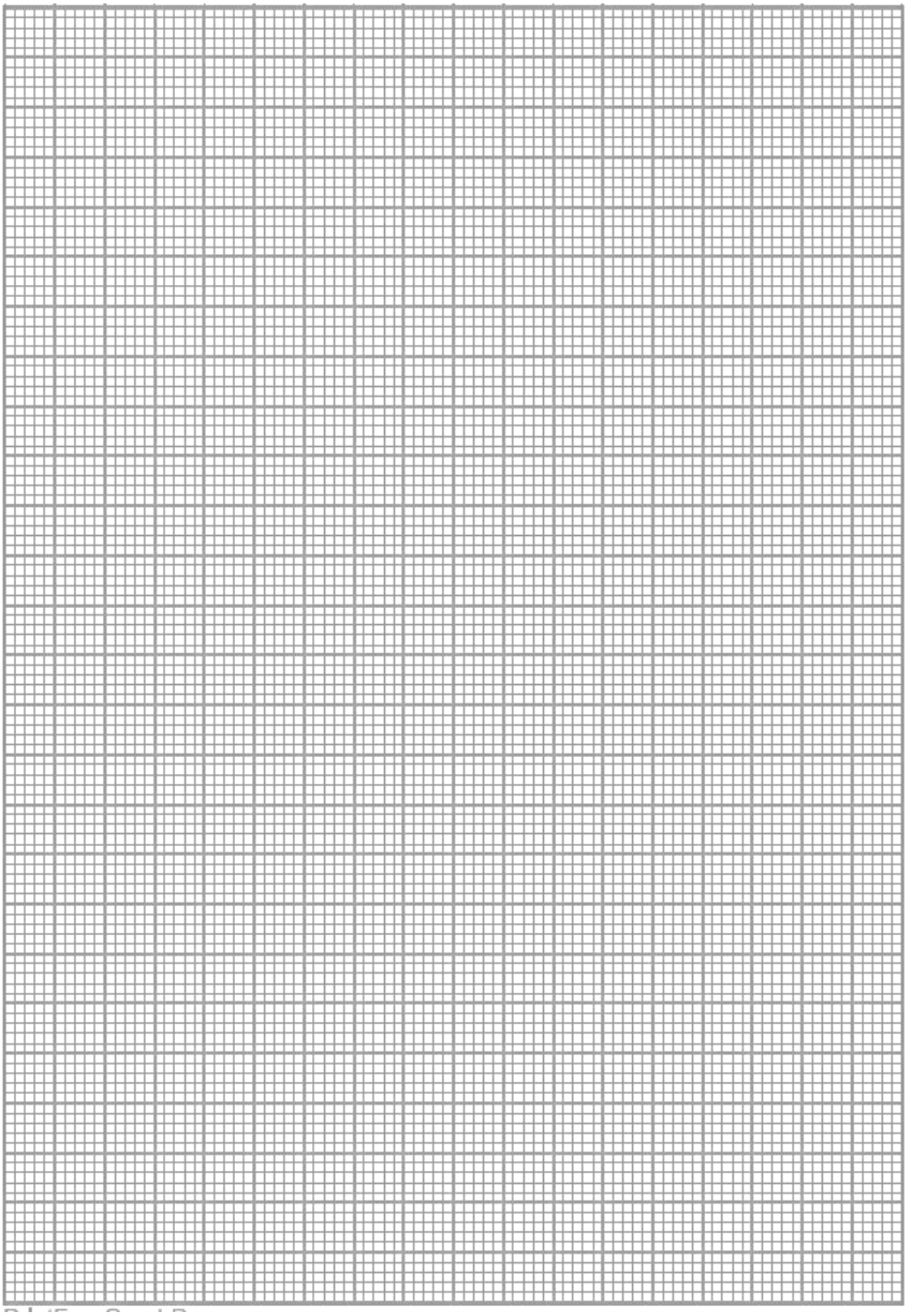
The addition of starch allows the iodine to be detected as the solution turns blue-black.

Procedure

1. Put **Q** into a burette and use it to measure 10 cm^3 of **Q** into a conical flask. To **Q** in the flask, add 2 cm^3 of starch solution using a 10 cm^3 measuring cylinder. Place the flask and its contents on a white tile.
2. Measure 25 cm^3 of **P** as accurately as possible, using a 25 cm^3 measuring cylinder. Pour this volume of **P** rapidly into the mixture of **Q** and starch solution in the flask. Start the stopwatch immediately and swirl the contents of the flask, then leave the mixture to stand. When the mixture first turns blue-black, stop the stopwatch. Record the time to the nearest second in column E of the table.
3. Empty the conical flask and rinse it thoroughly with water.
4. Repeat the procedure described in steps 1 to 3 but in step 2 use the different volumes of P and water given in columns C and D of the table. For example in experiment 2, measure 20 cm^3 of P as accurately as possible, using a measuring cylinder and then add water to P until the total volume of liquid in the measuring cylinder is 25 cm^3.

A	B	C	D	E
Experiment no.	Volume of **Q** / cm^3	Volume of **P** / cm^3	Volume of water / cm^3	Time taken for blue-black colour to appear / s
1	10	25	0	**17**
2	10	20	5	**23**
3	10	15	10	**35**
4	10	10	15	**56**
5	10	5	20	**115**

(a) Plot a graph of time taken for the blue-black colour to appear (column E) against volume of **P** (column C) on the grid below. Draw a line of best fit.



(a) Compare the concentration of ammonium peroxodisulfate in experiment 2 and its concentration in experiment 4.

The concentration of ammonium peroxodisulfate in experiment 2 is doubled / twice the concentration in experiment 4.

(b) Explain, in terms of collisions between reacting particles, why the time taken for the blue-black colour to appear increases as the volume of **P** decreases.

As the volume of P decreases, the concentration of P decreases. The number of particles per unit volume of solution decreases. As such, the particles collide less frequently, and the frequency of effective collisions decreases, causing the time taken to be longer.

(c) Explain **one** disadvantage of using a beaker instead of a conical flask.

A beaker has a wider mouth compared to a conical flask. As such, when the mixture in a beaker is swirled, spillage of the mixture could occur.

(d) Jeremy suggested that for every 10 °C rise in temperature the time taken for the blue-black colour to appear will be halved.

Given the same solutions **P** and **Q**, describe how you would investigate this suggestion.

You can assume that all the apparatus and reagents normally found in a school laboratory are available. You should include the measurements you would take and explain how you would use your results to confirm the suggestion.

Note: Use 10 cm^3 of P with 15 cm^3 of water and 10 cm^3 of Q in all the experiments.

Suggested steps:

1. **Measure 10 cm^3 of the same concentration of Q using a measuring cylinder and pour it into a conical flask.**
2. **Add 2 cm^3 of starch solution to the conical flask and swirl the contents of the flask.**
3. **In a separate measuring cylinder, measure 5 cm^3 of P and 20 cm^3 of water and pour it into a beaker. Measure the temperature of the mixture at room temperature and record this value as x °C.**
4. **Pour the mixture of P and water to the mixture of Q and starch in the conical flask. Start the stopwatch immediately and swirl the contents of the flask, then leave the mixture to stand. When the mixture first turns blue-black, stop the stopwatch and record the time taken to the nearest second.**
5. **Repeat Step 3 by placing the beaker containing the same volume of P and water in a water bath heated to (x + 10 °C). Add this mixture to Q and starch and record the time taken.**
6. **The experiment is repeated with three more temperatures, (x + 20 °C), (x + 30 °C) and (x + 40 °C) and the time for the blue-black to appear was recorded.**
7. **Compare the time taken to see if the timing is halved for every 10 °C rise in temperature to confirm his hypothesis.**