Name: _____ ( ) Class: _____ Group: _____ Date: _____

☞ Reference in textbook:
Book 5, Part XIII
Ch.52, p.14

Experiment 52.1

Determining the activation energy of the reaction between peroxodisulphate ions and iodide ions

Objective

To determine the activation energy of the reaction between peroxodisulphate ions, $S_2O_8^{2-}(aq)$ and iodide ions, $I^-(aq)$.

Apparatus and Chemicals

Each group will need:

- Safety spectacles
- Beaker (250 cm^3)
- 4 measuring cylinders (10 cm^3)
- 2 thermometers (–10°C to 110°C) (with a reinforced bulb)
- 10 boiling tubes
- Magnetic stirrer-hotplate
- 2 stands and clamps
- Glass rod
- Stopwatch
- Ammonium peroxodisulphate solution (0.020 M, 50 cm^3)
- Potassium iodide solution (0.50 M, 25 cm^3)
- Sodium thiosulphate solution (0.010 M, 25 cm^3)
- 0.2% starch solution (12.5 cm^3)
- Distilled water
- Ice

Chemical disposal:

- Dispose of the wastes into labelled waste bottles for different kinds of chemicals.

Time required:

2 periods

Procedure

Safety precautions

EYE PROTECTION
MUST BE WORN
必須戴上安全眼鏡

Ammonium peroxodisulphate solution

Ammonium peroxodisulphate solution

1. (a) Prepare a water bath by adding 200 cm^3 of water to a 250 cm^3 beaker and heat it to about 55°C.
   (b) Using a measuring cylinder, add 10 cm^3 of ammonium peroxodisulphate solution to a boiling tube (tube *A*).
   (c) Clamp tube *A* in the water bath and put a thermometer into tube *A* (Figure 52.1).

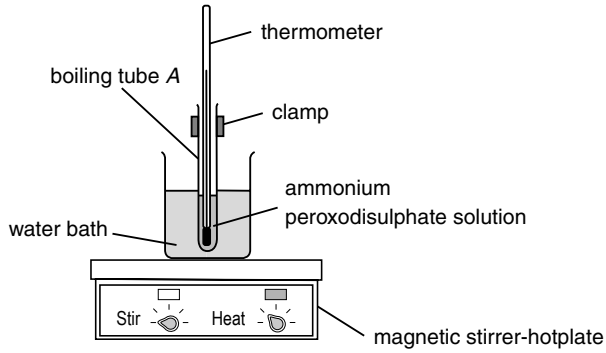

Figure 52.1

2. (a) Using measuring cylinders, add 5 cm^3 potassium iodide solution, 5 cm^3 sodium thiosulphate solution and 2.5 cm^3 starch solution, in another boiling tube (tube *B*) (Figure 52.2a).
   (b) Clamp tube *B* in the water bath and put another thermometer into tube *B* (Figure 52.2b).

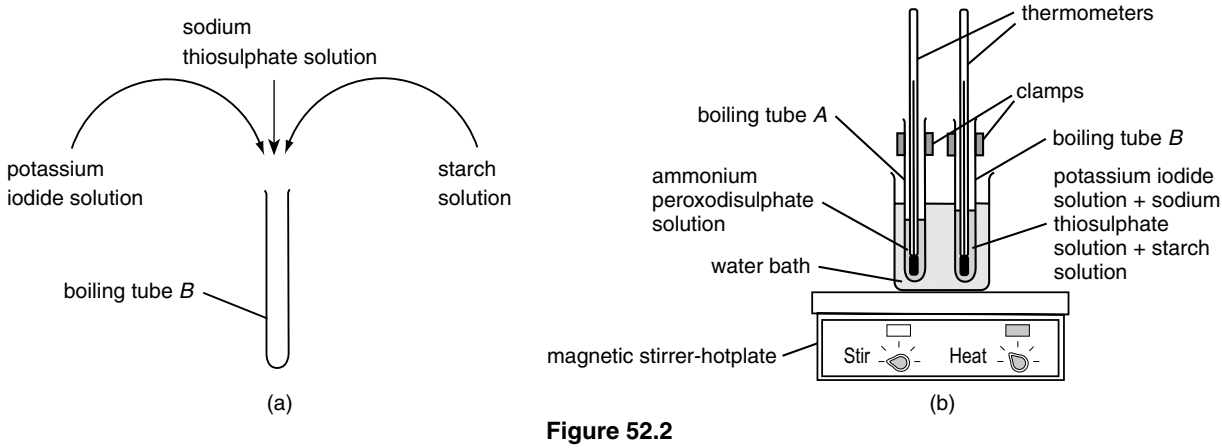

Figure 52.2

3. (a) When the temperatures of the two solutions become steady and are approximately equal (e.g. 55°C), remove the thermometers in tubes *A* and *B*, and pour the contents of tube *B* into tube *A*.
   (b) Stir the mixture in tube *A* gently with a glass rod and start the stopwatch immediately. Put the thermometer into tube *A* after stirring.

4. When the dark blue colour of the starch-iodine complex appears in the solution and completely masks the thermometer, stop the stopwatch. Record the time in **Table 52.1**.

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SBA note

The temperature of the water bath can be lowered by adding ice to it, until the desired temperature is reached. However, it is not necessary for the temperatures to be exactly the same as listed (i.e. 15°C , 25°C, 35°C and 45°C).

5. Record the temperature of the mixture in **Table 52.1**.
6. Repeat steps 1 to 5 at temperatures close to 45°C, 35°C, 25°C and 15°C.

Results

7. Record the results in **Table 52.1**.

Temperature of reaction mixture (°C)					
Time for the appearance of dark blue colour (s)					

Table 52.1

8. (a) According to the Arrhenius equation, $k = Ae^{-\frac{E_a}{RT}}$

where k is the _____ ,

A is the Arrhenius constant,

E_a is the _____ (in J mol^{-1}),

R is the _____ (i.e. 8.31 J K^{-1} mol^{-1}),

T is the _____ (in K).

Taking logarithm of the Arrhenius equation gives

$$\log k = \log A - \frac{E_a}{2.3RT} \quad \text{..... (1)}$$

Substitute k by $\frac{1}{\text{time}}$ in Equation (1) gives

$\log\left(\frac{1}{\text{time}}\right) = \log A' - \frac{E_a}{2.3RT}$ where A' is a constant

A plot of $\log\left(\frac{1}{\text{time}}\right)$ against $\left(\frac{1}{T}\right)$ gives a straight line. Its slope is equal to _____ .

(b) Before plotting the graph using the results in **Table 52.1**, complete **Table 52.2** below.

$\log\left(\frac{1}{\text{time}}\right)$					
$\frac{1}{T}$ ($\times 10^{-3}$ K^{-1})					

Table 52.2

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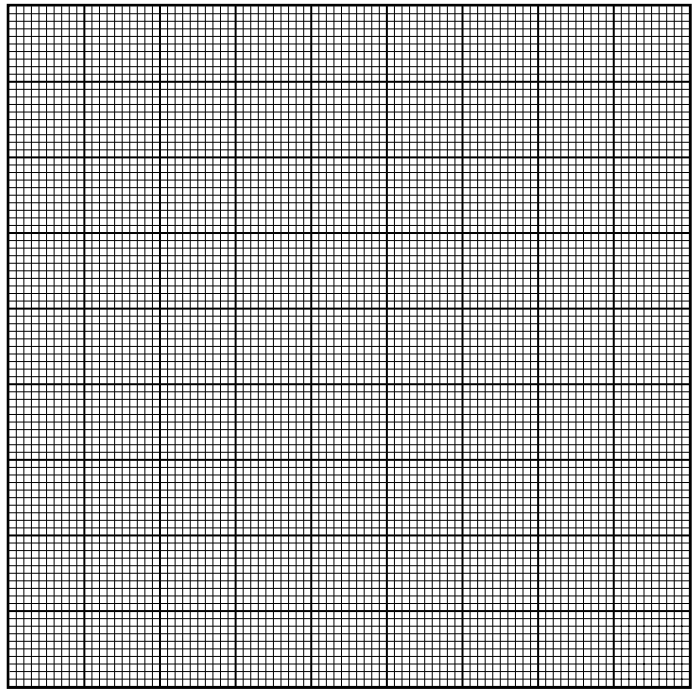
(c) In **Graph 52.1** below, plot $\log\left(\frac{1}{\text{time}}\right)$ against $\left(\frac{1}{T}\right)$.



Graph 52.1

SBA note

Calculate the slope either from any 2 points on the best straight line or by using the Graph Wizard of the Excel application.

(d) From the graph, the slope is _____ .

(e) Calculate the activation energy of the reaction (in kJ mol^{-1}).

Summary

9. Since the rate is directly proportional to $\frac{1}{\text{time}}$, a plot of $\log\left(\frac{1}{\text{time}}\right)$ against $\frac{1}{T}$ should give a _____ . The activation energy of the reaction can be found from the _____ of the line.

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Questions

10. Write an ionic equation for the reaction between peroxodisulphate ions and iodide ions.

_____

11. What is the purpose of using sodium thiosulphate solution in this experiment?

_____

_____

_____

12. What does the appearance of the dark blue starch-iodine complex indicate in this experiment?

_____

_____

_____

_____

_____

13. State TWO sources of error in this experiment.

_____

_____

_____

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_____

_____

_____

_____

Related exercise in textbook

Book 5

Chapter 52 exercise p.23 Q27