# Determining the Activation Energy of a reaction

**Aim**

The purpose of this experiment is to determine the activation energy, $E_a$ , for the reduction of peroxodisulphate(VI) ions, $S_2O_8^{2-}{}_{(aq)}$, by iodide ions, $I^-_{(aq)}$, using a 'clock' reaction.

**Introduction**

The equation for the reduction of peroxodisulphate(VI) ions by iodide ions is:

$$2\ S_2O_8^{2-}{}_{(aq)} + 2\ I^-_{(aq)} \longrightarrow 2SO_4^{2-}{}_{(aq)} + I_{2(aq)}$$

A small, known amount of thiosulphate ions is added to the reaction mixture, which also contains some starch indicator. The thiosulphate reacts with the iodine formed in the above reaction as in the following equation:

$$2\ S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \longrightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$$

At the instant that all the thiosulphate has reacted, free iodine is produced in the solution and its presence is shown by the appearance of the blue-black color of the iodine-starch complex, i.e., the thiosulphate ions act as a 'monitor' indicating the point at which a certain amount of iodine has been formed. For this reason the reaction is often referred to as an iodine 'clock' reaction. In general, for a 'clock' reaction:

$$\text{rate of reaction} \propto \frac{1}{t}$$

where t is the time taken to reach a specified stage.

You carry out the experiment at five difference temperatures between about $20^0$C and $50^0$C. You then find the activation energy for the reaction by plotting a graph of ln (1/t) against 1/T. (T is the absolute temperature.)

**Apparatus & Materials**

safety spectacles, beaker, 400cm$^3$, 2 thermometers, 0-100$^0$C, Bunsen burner, tripod, gauze and mat, 4 burettes and stands, with beakers and funnels for filling, 2 boiling-tubes, clamp and stand, potassium peroxodisulphate(VI) solution, 0.020 M $K_2S_2O_8$, potassium iodide solution, 0.50 M KI, sodium thiosulphate solution, 0.010 M $Na_2S_2O_3$, starch solution, 0.2%, stop-clock or stop-watch

**Procedure**

1. Half-fill the breaker with water and heat it to between 15 $^0$C and 40 $^0$C. This will be used as a water-bath.
2. Using a burette, measure out 5 cm$^3$ of potassium peroxodisulphate(VI) solution into the first boiling-tube. Clamp this in the water-bath and place a thermometer in the solution in the boiling-tube.
3. Using burettes, measure out 2.5 cm$^3$ each of the potassium iodide and sodium thiosulphate solutions and 1.25 cm$^3$ of starch solution into the second boiling-tube.
4. When the temperatures of the two solutions are equal and constant (to within ± 1$^0$C), pour the contents of the second boiling-tube into the first, shake to mix, and start the clock.
5. When the blue color of the starch-iodine complex appears, stop the clock and write down the time in a copy of the Data Collection Table.
6. Repeat the experiment at temperatures close to 15 $^0$C, 20 $^0$C, 25 $^0$C, 30 $^0$C, 35 $^0$C. (The temperatures you use may differ from those by a few degrees but must, of course, be recorded carefully.)

**Data Collection**

| | | | | | |
|---|---|---|---|---|---|
| Temperature ($^0$C) | | | | | |
| Temperature, T (K) | | | | | |
| Time t (s) | | | | | |
| ln 1/t | | | | | |
| 1/T ($K^{-1)}$ or (K/T) | | | | | |

**Calculations**

1. Plot a graph of ln (1/t) (vertical axis) against 1/T (horizontal axis).
2. Use your graph to calculate a value for activation energy.