Edexcel International Chemistry A-level

Practical 10

Finding the Activation Energy of a Reaction

The **Arrhenius** equation shows the relationship between the rate constant and the temperature.

$k = Ae^{\frac{-Ea}{RT}}$

Measuring the value of rate constant (k) at different temperatures (T) allows us to find the value for activation energy (E_a) of a reaction.

Solutions containing bromates, phenol, and an indicator, are prepared at different temperatures. The reaction will be initiated by the addition of sulfuric acid.

Method

1. In a test tube, mix 10 cm^3 of bromide solution with 10 cm^3 of phenol.
2. Add 5 drops of methyl orange indicator.
3. In a separate test tube add 5 cm^3 of sulfuric acid.
4. Place both test tubes in a 65°C water bath and leave them for a few minutes until the contents of the test tubes are at this temperature.
5. Quickly add the sulfuric acid to the other test tube, mix and start a stopwatch.
6. The decolourisation of the indicator is the end of the reaction.
7. Record the time taken for this decolourisation.
8. Repeat steps 1-7 at the following temperatures: 15°C, 25°C, 35°C, 45°C and 55°C.

Data Manipulation

1/*t* is proportional to the rate constant. The rate constant can be thought of as being a **ratio** of *c*, concentration of phenol, to *t*, time taken for the reaction to finish.

Substituting this (k = *c*/*t*) to the Arrhenius equation gives:

$$\ln(t) = \ln c - \ln A + E_a/RT.$$

Therefore, plotting **ln(*t*) against 1/T** should produce a straight graph, with gradient E_a/R. This allows the **activation energy** to be found, as R is a constant (8.31 J K^{-1} mol^{-1})