A2 PRACTICAL 1

Finding activation energy (Instructions)

Aim

You are going to carry out an experiment to find the activation energy for the following reaction:

$$2\ MnO_4^-(aq) + 16\ H^+(aq) + 5\ C_2O_4^{2-}(aq) \rightarrow 2\ Mn^{2+}(aq) + 8\ H_2O(l) + 10\ CO_2(g)$$

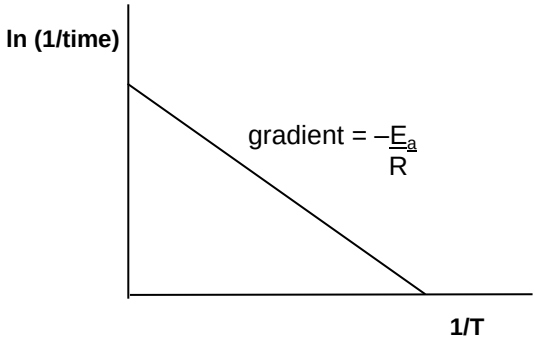
Background

The Arrhenius equation relates activation energy (E_a) to the rate constant (k) and temperature (T).

$$\ln k = -\frac{E_a}{RT} + \ln A$$

The rate of the reaction is proportion to the rate constant k. The rate of reaction is also proportional to 1/time taken to reach a specific point early in the reaction. Therefore the rate constant k is proportional to 1/time.

Therefore a graph of ln (1/time) against 1/T should give a straight line with gradient $-E_a/R$, allowing us to find E_a. Time should be in seconds and T in K giving E_a in J mol^{-1}.



Safety

Potassium manganate(VII) is oxidising and harmful

Ethanedioic acid is harmful

Sulfuric acid is an irritant

Method

1) Place a 250 cm^3 beaker half filled with water on a tripod and gauze and start to warm the water gently.
2) Using a burette, place 10.0 cm^3 of 0.0200 ml dm^{-3} potassium manganate (VII) in a boiling tube.
3) Using a burette, place 10.0 cm^3 of 0.0600 mol dm^{-3} ethanedioic acid (in 0.500 mol dm^{-3} sulfuric acid) in a different boiling tube.
4) Place the two boiling tubes in the water bath and warm to about 30°C.
5) Take the tubes out of the water bath. Add the contents of one tube to the other, start a stopwatch and stir well with a thermometer. Record the temperature at the start of the reaction.
6) Time until the purple colours goes (in the slower reactions, there may be a little pale brown colouring at the end – ignore this as we are timing until the purple has gone). Record the time and temperature at the end of the reaction (use the average of the start and end temperatures as the reaction temperature).
7) Repeat the experiment at around 40, 50, 60 and 70°C (do not go above 70°C), recording the exact temperature each time (the average of the start and end temperature).

Analysis

1) Plot a suitable graph to find the activation energy (E_a) for the reaction.