Edexcel International Chemistry A-level

Practicals 9a and 9b

Following the rate of the iodine-propanone reaction by a titrimetric method and investigating a 'clock reaction' (Harcourt-Esson, iodine clock)

Practical 9a - Following the rate of the iodine-propanone reaction by a titrimetric method

Equation:

$$I_{2(aq)} + CH_3COCH_{3(aq)} + H^+_{(aq)} \rightarrow CH_3COCH_2I_{(aq)} + 2H^+_{(aq)} + I^-_{(aq)}$$

Sulfuric acid acts as a **catalyst** in this process.

A large **excess** of both propanone and sulphuric acid are used so that their concentrations remain effectively constant during the reaction. This allows us to measure the influence of iodine alone on the rate of reaction.

Method

1. Add 25 cm^3 of sulfuric acid to 25 cm^3 of propanone in a beaker and mix well.
2. Add 50 cm^3 of 0.02 mol dm^{-3} iodine solution to the beaker and immediately start the timer.
3. Using a pipette, remove a 10 cm^3 sample of the mixture to a conical flask. Add a spatula of sodium hydrogencarbonate immediately after removing it from the flask to quench the reaction. Note the time the sodium hydrogencarbonate was added.
4. Withdraw samples every three minutes and repeat this process.
5. Titrate these samples against sodium thiosulphate ($Na_2S_2O_3$), using starch indicator. The indicator will turn from blue-black to colourless as iodine reacts with thiosulphate.
6. Repeat for all samples to find their concentrations.
7. Use these results to plot a graph of concentration against time.

Safety

- Propanone is an **irritant** and **highly flammable**. Keep away from naked flames.
- Sodium thiosulphate releases sulphur dioxide when it reacts. Keep the room well-ventilated.

Practical 9b - Iodine Clock Reaction

In this experiment, rate is measured by timing how long it takes to produce a fixed amount of iodine.

The equation for the reaction between potassium iodide and potassium persulphate:

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

The **total volume** of the solutions used in experiment is the **same**, and the volume of thiosulfate used is also the same. To change the concentrations of persulfate and iodine the remaining volume is topped up with water (if needed).

In the experiment, you will vary the concentration of iodide whilst keeping the concentration of the persulfate constant, and vice versa. Therefore, you will measure the order with respect to each reactant.

Method

1. Add 10 cm^3 of sodium iodide solution to a beaker, followed by 5 cm^3 of sodium thiosulfate solution and 10 drops of starch indicator. The indicator will turn from blue-black to colourless as iodine reacts with thiosulphate.
2. Place the beaker on a white tile so the colour change can easily be seen.
3. Add 10 cm^3 of sodium persulphate to the test tube containing potassium iodide, sodium thiosulfate, and starch indicator.
4. Immediately start a stopwatch.
5. When the solution goes blue-black, the clock is stopped.
6. Repeat the experiment, changing the volume of sodium iodide solution and then sodium thiosulfate solution between experiments. The overall volume must be equal to 25 cm^3.

Conclusions

- The rate of reaction is proportional to **1/time**. Use changes in the rate of reaction and concentrations to deduce the order with respect to each reagent.
- You can **"rewind" the clock** by adding a second amount of thiosulfate and adding the second time to the first.

Errors

- **Inaccurate** timing of the appearance of blue-black colour. Two students could time simultaneously and use an average value.
- Adding starch slightly increases the volume which affects the concentrations of the reactants and thus the amount they change over time.