Clock reactions and initial rates

OCR A H432 · Full A-level

Show your working where needed.

Name _____ Date _____

1. When should the timer stop?

A student times how long two equal-volume mixtures take to release 5.0 cm^3 of oxygen. Why use the same small gas volume to compare initial rates?

2. Change one concentration

Two 50.0 cm^3 mixtures contain 25.0 cm^3 of other reagents and either 15.0 or 10.0 cm^3 of 0.200 mol dm^{-3} KI. Water makes up the rest. Find the water volume and initial $[I^-]$ in each mixture.

3. An indicator changes colour

An iodine clock starts with 4.00×10^{-5} mol of thiosulfate in 40.0 cm^3. $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$. The starch turns blue-black after 30.0 s.

Explain the delay and calculate the mean rate of iodine production up to the endpoint in mol dm^{-3} s^{-1}. Ignore the iodine needed to colour the starch.

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4. Review four repeat timings

A clock gives 22.5, 23.7, 37.0 and 23.1 s. The student recorded stopping late in the 37.0 s run. Decide how to treat this run. Find 1/t using your mean time.

5. Find both reaction orders

A clock uses the same small endpoint change, total volume and temperature each time. The rows give initial [A], [B] in mol dm^{-3} and time in s.

Run 1: 0.100, 0.0400, 96.0. Run 2: 0.200, 0.0400, 24.0. Run 3: 0.100, 0.0800, 48.0. Deduce the rate equation.

6. Challenge a conclusion

Two iodine clock trials use the same volume, temperature and starting concentrations of the iodine-forming reactants. Run 2 has twice the thiosulfate. Times are 45 s and 91 s, both short relative to the full reaction. Assess the claim that the initial rate halved.

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7. Choose a useful measurement

A reaction consumes a coloured reactant. A student wants its rate at 90 s and can use either a clock endpoint or a colorimeter. Choose a method and explain how to obtain the rate.

8. Calculate a rate constant

In a 50.0 cm^3 mixture an endpoint occurs after 2.50×10^{-5} mol of P has formed in 40.0 s. This small change gives a good initial-rate approximation.

Rate of formation of P = k[X][Y]. Initially [X] = 0.0800 mol dm^{-3} and [Y] = 0.0250 mol dm^{-3}. Calculate k with units.

9. Extra challenge · Correct for two different observing points

Two iodine clock runs each have a final volume of 50.0 cm^3. Run 1 contains 2.00 cm^3 of 0.00500 mol dm^{-3} thiosulfate and takes 24.0 s to change colour. Run 2 contains 3.00 cm^3 of the same thiosulfate and takes 18.0 s.

The initial peroxodisulfate concentration is doubled in run 2. Temperature and initial iodide concentration are unchanged. Use $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ to calculate each average iodine production rate and infer the order in peroxodisulfate. State when this initial-rate comparison is valid.

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