

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 Calibrated colorimetry for iodine, with suitable wavelength/path length and no interfering colour/turbidity. Mass loss or collected gas volume for escaping CO_2 , limited by leaks or CO_2 remaining dissolved. Timed quenched aliquots followed by titration for acid, requiring justified effective quenching and allowance for sampling delay. Accept another suitable explained technique.

2.2 $n(\text{S}_2\text{O}_3^{2-}) = 0.00500 \times 0.00800 = 4.00 \times 10^{-5} \text{ mol}$. Iodine is half this, $2.00 \times 10^{-5} \text{ mol}$. Original $[\text{I}_2] = 2.00 \times 10^{-5} / 0.00500 = 0.00400 \text{ mol dm}^{-3}$.

2.3 A has twice B's initial rate, since inverse time compares the same endpoint extent. Keep the endpoint amount small and identical and temperature/total volume and other reactant conditions controlled. Only the intentionally varied concentration should differ.

3.1 Initial iodine concentration $0.00500 \text{ mol dm}^{-3}$, final $0.00200 \text{ mol dm}^{-3}$. Disappearance rate $= (0.00500 - 0.00200) / 60 = 5.00 \times 10^{-5} \text{ mol dm}^{-3} \text{ s}^{-1}$. Constant iodine loss in equal time intervals supports zero order in iodine over this measured range, provided the other kinetic factors stay sufficiently constant. Separate controlled variations of propanone and H^+ are needed to determine their individual orders.

3.2 $r = k[\text{propanone}][\text{H}^+]$. Factor $2 \times \frac{1}{2} = 1$, unchanged. Iodine can react after the rate-determining sequence; zero order is not absence from the overall reaction or a unique mechanism proof.

3.3 The fixed small endpoint makes $1/t$ proportional to the initial rate with a comparable proportionality factor across temperatures; reactant concentrations/other conditions are controlled so the change reflects k , with actual mixture temperatures measured in kelvin. $E_a = -R \times \text{gradient} = 8.31 \times 5000 = 41550 \text{ J mol}^{-1}$, or 41.6 kJ mol^{-1} .