

Rate laws, orders and half-lives

AP Chemistry · Lab answers

The model answers use the sample table. The $1/t$ values rise in proportion to thiosulfate concentration, so the order is one. Percentage uncertainty is largest for fast runs, which affects which points you trust most in the graph. Remember to give each calculated value to a sensible number of significant figures.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 5

Question 1 Fair test

Rate depends on the concentration of every reactant. If total volume or acid volume changed, the acid concentration would change too, so the effect of thiosulfate would be mixed with the effect of acid. Keeping them fixed means thiosulfate is the **only variable**.

Question 2 Mixed concentration

$[S_2O_3^{2-}] = V \times 0.100/55$. 50 cm³: **0.0909 M**; 40: **0.0727 M**; 30: **0.0545 M**; 20: **0.0364 M**; 10: **0.0182 M**.

Question 3 Relative rate

$1/t = 0.0417, 0.0333, 0.0244, 0.0161, 0.00800 \text{ s}^{-1}$. Each run forms the same small amount of sulfur (the same cloudiness hides the cross), so $\text{rate} \propto \text{amount/time} \propto 1/t$. **$1/t \propto \text{initial rate}$** .

Question 4 Graph

Plot $1/t$ on the y-axis and concentration on the x-axis. For first order the points lie on a **straight line through the origin**, because $\text{rate} \propto [S_2O_3^{2-}]$. A curve bending upwards would suggest order 2.

Question 5 Order from two points

Concentration ratio $0.0727/0.0364 = 2.0$. Rate ratio $(1/30)/(1/62) = 62/30 = 2.07$. $\text{Rate} \propto []^n$: $2.0^n = 2.07$, so $n \approx 1$ (first order).

Question 6 Uncertainty

24 s: $1/24 = 4 \%$. 125 s: $1/125 = 0.8 \%$. The slow runs are measured with a smaller relative error; the 50 cm³ point has the largest uncertainty.

Question 7 Improvement

Use a light sensor or a standard viewing distance so the end-point does not depend on the observer; use a burette for volumes; repeat each run and average. At 10 °C higher the times would be about **half**, since the rate typically doubles for a 10 °C rise.