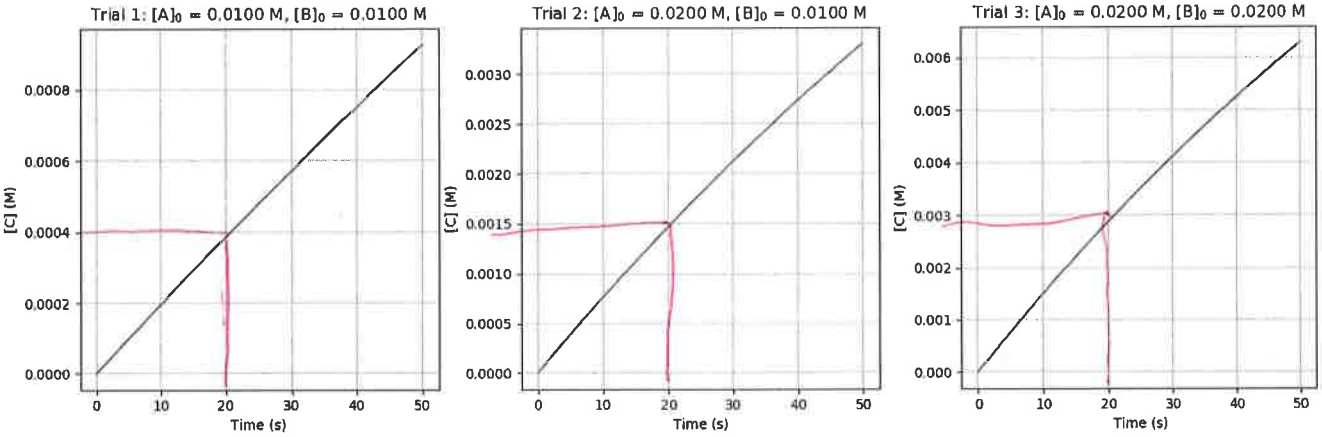
Quiz 17.1 – Rate Laws

Name: Key

Initial Rate Method

Consider the reaction: $A + 2B \longrightarrow 3C$.
Below are graphs of the concentration of C over time under three different initial conditions:



- From the data in the graphs, estimate the average reaction rate over the first 20 *s* for each trial

$\text{rate} = \frac{1}{3}\frac{d[C]}{dt}$

1) $\text{rate} = \frac{1}{3} \cdot \frac{0.0004\ M}{20s} = 6.67 \cdot 10^{-6}\ M/s$

2) $\text{rate} = \frac{1}{3} \cdot \frac{0.0015\ M}{20s} = 2.5 \cdot 10^{-5}\ M/s$

3) $\text{rate} = \frac{1}{3} \cdot \frac{0.0030\ M}{20s} = 5.0 \cdot 10^{-5}\ M/s$

- Find the reaction order for both of the reactants, and the overall reaction order

A: $\ln\left(\frac{r_2}{r_1}\right) = n \ln\left(\frac{[A]_2}{[A]_1}\right) \rightarrow \ln\left(\frac{2.5\cdot10^{-5}\ M/s}{6.67\cdot10^{-6}\ M/s}\right) = n \cdot \ln\left(\frac{0.020\ M}{0.010\ M}\right) \rightarrow n = 1.91 \rightarrow$ 2nd order

B: $\ln\left(\frac{2.5\cdot10^{-5}\ M/s}{5.0\cdot10^{-5}\ M/s}\right) = m \ln\left(\frac{0.010\ M}{0.020\ M}\right) \rightarrow m = 1 \rightarrow$ first order overall: 3rd-order

- Give the value for the rate constant k, with appropriate units

$\text{rate} = k[A]^2[B]$

$2.5\cdot10^{-5}\ M/s = k \cdot (0.0200\ M)^2 \cdot 0.010\ M \rightarrow k = 6.25\ \frac{1}{M^2 \cdot s}$

Half-Lives

$k = \frac{\ln(2)}{t_{1/2}}$

Radioactive decay follows 1st-order kinetics
Give the rate constant or half-life of the following radioactive elements

Element	Half-life	Rate Constant $\left(\frac{1}{s}\right)$
^{14}C	5730 y	$3.83 \cdot 10^{-12}$
^{57}Co	272 d	2.95×10^{-8}
^{99}Tc	6.0 h	$3.2 \cdot 10^{-5}$
^{218}Po	186 s	0.00373
^{3}H	12.3 y	$1.79 \cdot 10^{-9}$

- For each order of reaction, will the half-life increase, decrease, or stay constant over the course of a reaction?

0th order – decrease

1st order – Constant

2nd order – increase

Integrated Rate Laws Method

This quiz comes with a spreadsheet of data for three trials of the reaction:

$A + B \longrightarrow C$

Use the spreadsheet data to determine the complete rate law, including the rate constant with proper units and the reaction order with respect to each reactant

$\text{rate} = 6.0 \frac{1}{M^2 \cdot s} [A][B]^2$ (see Spreadsheet key)