OCR (B) Chemistry A-Level

CI1- Kinetics

Flashcards

What is meant by *rate of reaction*?

What is meant by *rate of reaction*?

The change in concentration of reactants or products over time.

What is a *rate constant*?

What is a *rate constant*?

The constant of proportionality linking the rate of reaction and the concentrations of the reactants raised to their orders in the rate equation.

How do you calculate the units of a rate constant?

How do you calculate the units of a rate constant?

- Rearrange the rate equation to make *k* the subject.
- Substitute units into the equation.
- Cancel the common units to find the units for *k*.

What is an example of finding the units of a rate constant, k?

What is an example of finding the units of a rate constant, k?

$$k = \frac{Rate}{[A][B]^2}$$

$$k = \frac{\cancel{mol\ dm^{-3}}\ s^{-1}}{\cancel{mol\ dm^{-3}} \times (mol\ dm^{-3})^2} = k = \frac{s^{-1}}{mol^2\ dm^{-6}}$$

$$k = dm^6\ mol^{-2}\ s^{-1}$$

What is the *order of reaction*?

What is the *order of reaction*?

- The order with respect to a reactant is the power to which the concentration of the reactant is raised in the rate equation.
- Overall order = sum of all the individual orders of the reactants.

What do the different orders of reaction mean?

What do the different orders of reaction mean?

- Zero order: if rate $\propto [A]^0$ then the rate of reaction is unaffected by changing [A].
- First order: if rate $\propto [A]^1$ then rate of reaction increases at the same rate as [A] increases.
- Second order: if rate $\propto [A]^2$ then rate will increase by the square that [A] increases by.

What does ‘$\propto$’ mean?

What does '$\propto$' mean?

Directly proportional.

I.e. As one amount increases, another amount increases at the same rate.

What is a rate equation?

What is a rate equation?

For a reaction between A and B:

$$\text{Rate} = k[A]^m[B]^n$$

- *m* and *n* represent the orders with respect to each reactant.
- *K* is the rate constant.

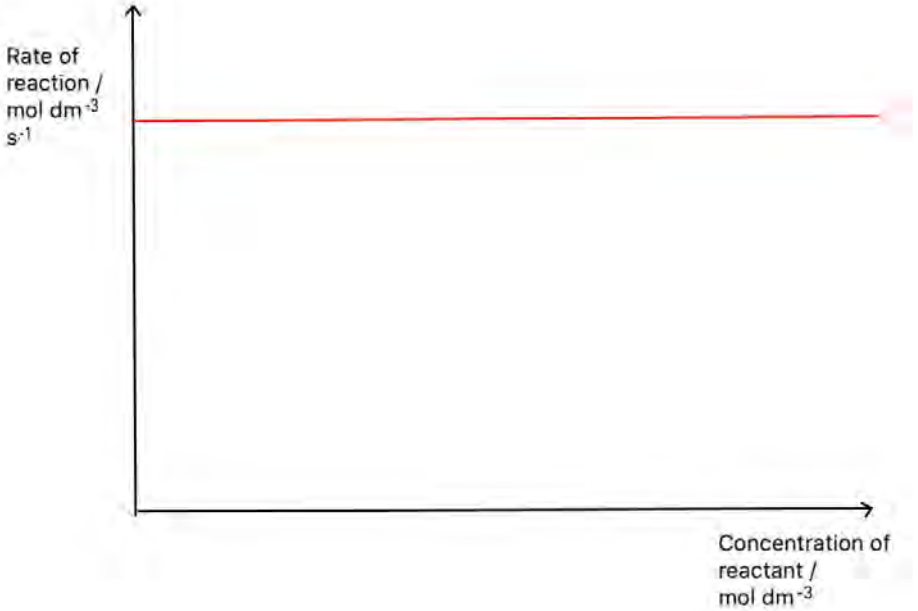
How does the rate constant, *k* vary with increasing temperature?

How does the rate constant, *k* vary with increasing temperature?

- As temperature increases there are more particles with energy > E_a .
- An increase in temperature therefore causes an increase in *k.*

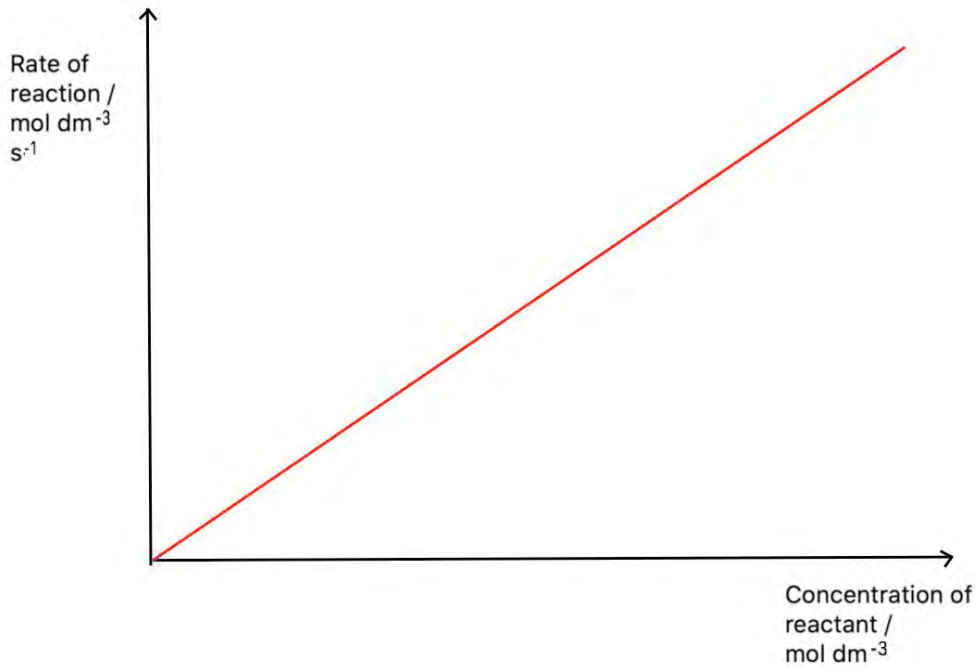
What does a rate-concentration graph look like for a zero order reactant?

What does a rate-concentration graph look like for a zero order reactant?



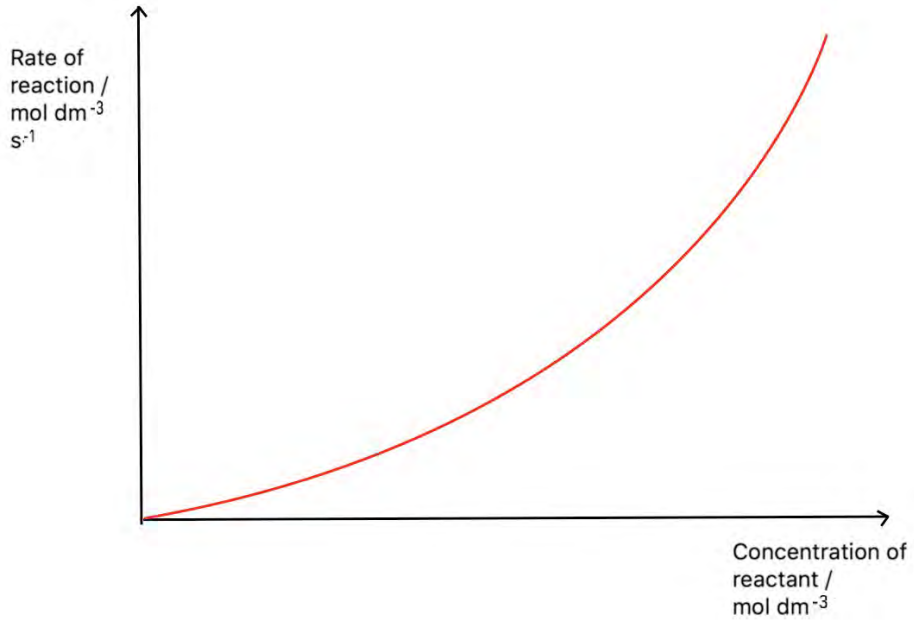
What does a rate-concentration graph look like for a first order reactant?

What does a rate-concentration graph look like for a first order reactant?



What does a rate-concentration graph look like for a second order reactant?

What does a rate-concentration graph look like for a second order reactant?



What is meant by the half-life of a sample?

What is meant by the half-life of a sample?

The average time taken for the concentration of a reactant to decrease by half, $t_{1/2}$

How do you calculate the rate constant, k from half life, $t_{1/2}$?

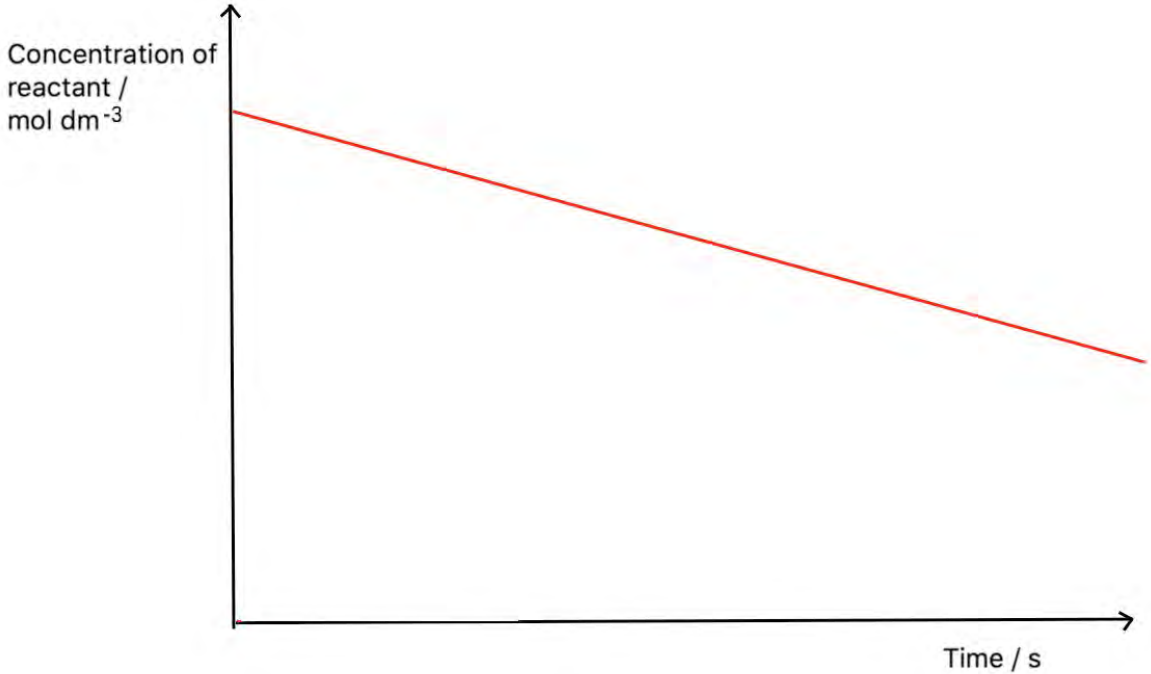
How do you calculate the rate constant, *k* from half life, $t_{1/2}$?

$k = \ln 2 / t_{1/2}$

This equation applies to first-order reactants only.

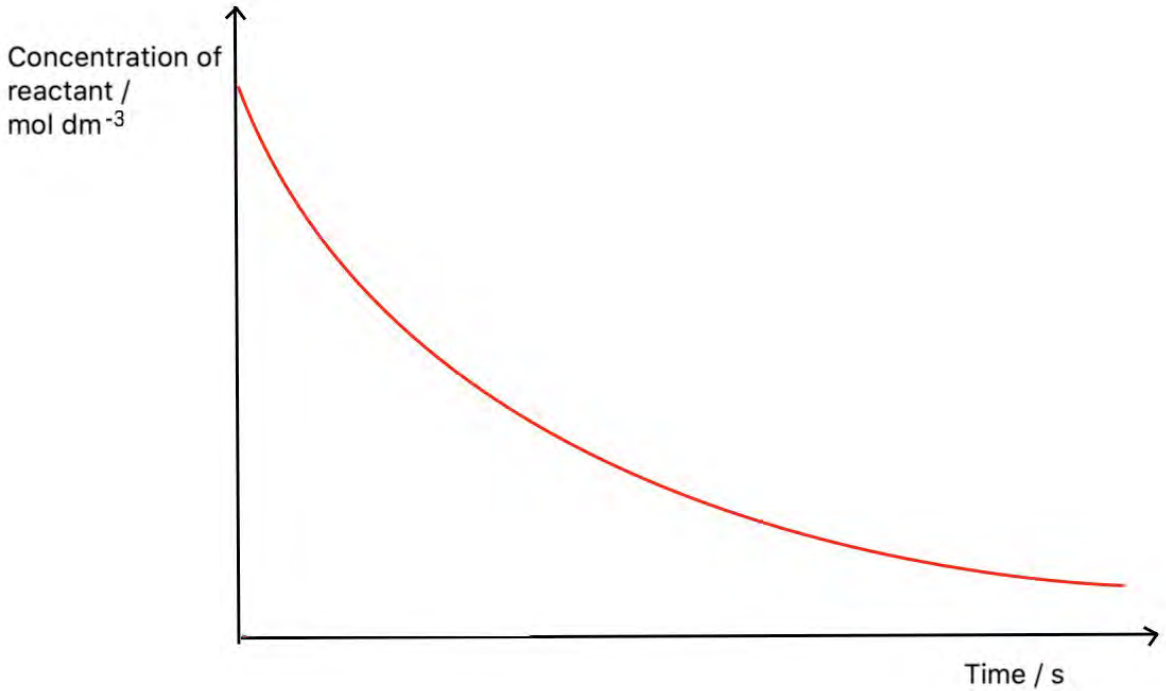
What does a concentration-time graph look like for a zero order reactant?

What does a concentration-time graph look like for a zero order reactant?



What does a concentration-time graph look like for a first order reactant?

What does a concentration-time graph look like for a first order reactant?



How do you calculate half life from a concentration-time graph?

How do you calculate half life from a first order concentration-time graph?

Using the graph, find the time taken for the concentration to halve. Then find the time taken for it to halve again (to increase accuracy). Calculate the average of these values and this will be the half life.

How do you calculate the rate from a first order concentration-time graph?

How do you calculate the rate from a first order concentration-time graph?

- Draw a tangent at the time you want to calculate the rate of reaction for.
- The gradient of this tangent will equal the rate of reaction.

How do you calculate *k* from a first order rate-concentration graph?

How do you calculate *k* from a first order rate-concentration graph?

- Calculate the gradient of the line of best fit.
- The gradient will equal the rate constant, *k*

How do you calculate the gradient of a line/tangent?

How do you calculate the gradient of a line/tangent?

Gradient = The change in y-coordinate / the change in x-coordinate

What is the Arrhenius equation?

What is the Arrhenius equation?

$$k = Ae^{E_a/RT}$$

- k = rate constant
- A = pre-exponential factor
- E_a = activation energy
- R = gas constant
- e = base of the natural logarithm, 2.72 to 3 s.f.
- T = temperature, in kelvin

How do you determine E_a and A for a reaction, using the Arrhenius equation graphically?

How do you determine E_a and A for a reaction, using the Arrhenius equation graphically?

- Take natural logs of the Arrhenius equation:

  $\ln k = \ln A - E_a/R \times 1/T$

- Plot a graph of ln k against 1/T
- The gradient = E_a/R so E_a = gradient x R
- Y-intercept = ln A so $A = e^{\text{y-intercept}}$

What is the rate-determining step?

What is the rate-determining step?

- The slowest step of the reaction.
- Only species that take part in the rate determining step (or steps that take place before it) affect the rate.

What is the relation between the rate-determining step and the orders with respect to the reactants?

What is the relation between the rate-determining step and the orders with respect to the reactants?

- The species present in the rate equation are those that take part in the rate determining step.
- For any reactant in the rate equation, the order attached to it tells you how many molecules of it are involved in the rate determining step.