6B Reaction Kinetics

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考点一：Rate

6.8 illustrate how factors such as heat, concentration, light, and surface area can affect chemical reactions
6.9 state that rate is a change in some quantity over time
6.10 identify ways in which the rate of a particular chemical reaction can be measured, e.g by reference to changes in mass, volume, concentration or pH of a solution
6.11 find the rate of a reaction using the slope of a measured variable (mass, volume, concentration or pH of a solution) against time

1. Factors affect chemical reactions

i.Increasing the **Temperature** makes Reactions Faster. Increasing temperatures, increasing the number of molecules with ENERGY≥ Ea

ii.If you increase the **concentration** of reactants in a solution, there'll be more particles in a given volume of the solution, so particles will collide more frequently.

iii.At higher **pressures**, there are more particles in a given volume of gas, which increases the frequency of successful collisions.

iv.Increasing the **surface area** of solid reactants increases the exposed surface of the reactants. This increases the number of successful collisions

v.A **catalyst** increases the rate of a reaction by providing an alternative reaction pathway with a lower activation energy. The catalyst is chemically unchanged at the end of the reaction.

2. Rate

Reaction rate is the change in amount of reactant or product per unit time (usually seconds).

$$\text{rate of reaction} = \frac{\text{change in concentration}}{\text{time for change to happen}}$$

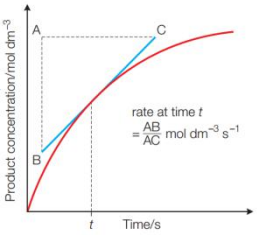
3. Methods to measure rate of reaction

方法	观察	条件	how
volume of gas	气体	gas is given off	Collect it in a gas syringe and measure at regular time intervals.
loss of mass		gas is given off	Measure mass loss at regular intervals with a balance.
colorimetry	看颜色	formation of a coloured product	colorimetry at regular time intervals
titration	H^+	produces or uses up H^+ ions	titrationat regular time intervals
pH		produces or uses up H^+ ions	measure pHat regular time intervals
electrical conductivity	离子	the number of ions changes	measure electrical conductivity at regular time intervals

4. Gradient

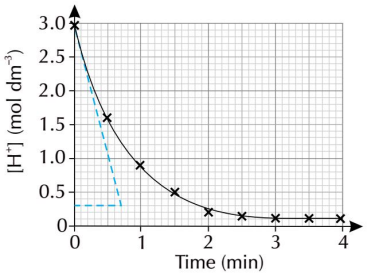
4.1 Reaction rate is the change in amount of reactant or product per unit time (usually seconds).

gradient = change in y ÷ change in x



E.g. if the reactants are in solution, the rate will be change in concentration per second. The units will be mol dm^{-3} s^{-1}.

4.2 Initial Rate(初始速度) --The initial rate of a reaction is the rate at the start of the reaction. You can find this from a concentration-time graph by calculating the gradient of the tangent at time = 0.



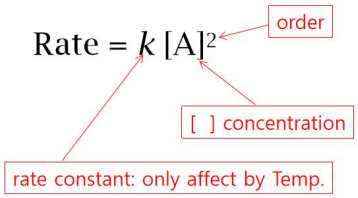
4. 3 The rate of reaction is proportional to **1 ÷ time**, so you can use 1/time as a measure of the **relative rate** of reaction.

考点二：Rate Equation

6.12 identify the order of reaction with respect to a named reagent given the rate equation (rate expression)
6.13 determine the overall order of reaction given the rate equation (rate expression)
6.14 determine the order of reaction with respect to individual reactants from initial rate data

1， Rate equation

the mathematical relationship between the rate of reaction and the concentration of reactants



2, Order

Zero order reactions with respect to [A] Rate = k [A]0

As increase in concentration, the rate stays the same.

First order reactions with respect to [A] Rate = k [A]1

if [A] doubles, the rate will double. If [A] triples, the rate will triple.

Second order reactions with respect to [A] Rate = k [A]2

if [A] doubles, the rate will be 4 times faster. If [X] triples, the rate will be 9 times faster

Overall order of a reaction

3, Rate constant， k

k 只受温度影响； k 越大，rate 越大(正比例)

1), Calculate rate constant **K = rate/[A]^2**

2), Unit of rate constant

ORDER	UNIT
Zero	mol dm^{-3} s^{-1}
First	s^{-1}
Second	dm^3 mol^{-1} s^{-1}
Third	dm^6 mol^{-2} s^{-1}

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

Inserting the units we obtain:

$$\frac{\text{mol dm}^{-3}\,\text{s}^{-1}}{\text{mol dm}^{-3} \times \text{mol dm}^{-3}}$$

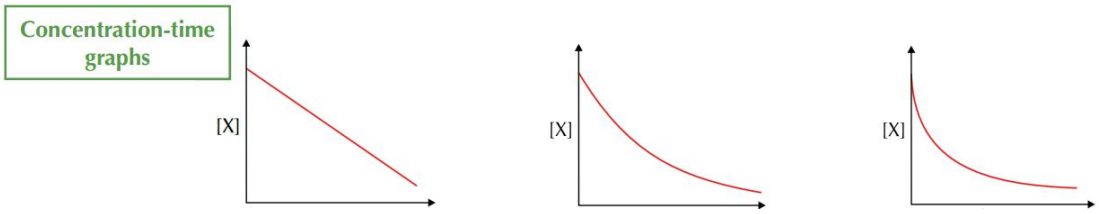
This cancels down to:

$$\frac{\text{s}^{-1}}{\text{mol dm}^{-3}}$$

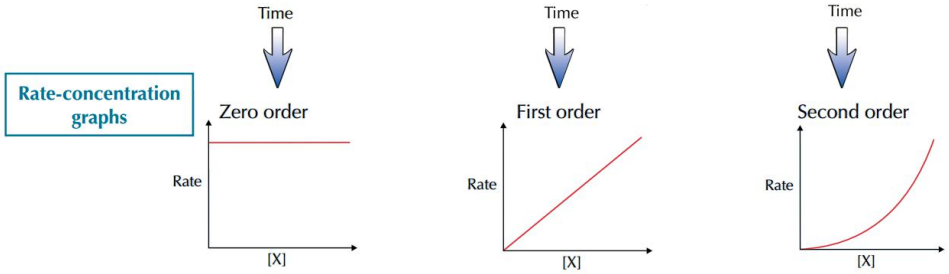
$\frac{M}{s}$, $\frac{0}{s}$, $\frac{M^{-1}}{s}$, $\frac{M^{-2}}{s}$ (M=mol dm^{-3})

4. **Deduce the order (0, 1 or 2)**

i Concentration-time graph (**时间**曲线：想象成一条直线**不断被挤压**。)



ii Rate-concentration graph Rate=k[A]^a （其实就说指数函数）



A horizontal line　　a straight line through the origin　　A curve

iii an initial-rate method

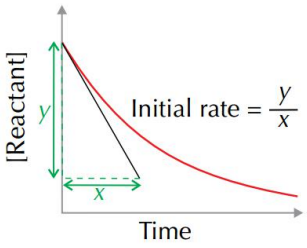
The initial rate of a reaction is the rate at the start of the reaction. You can find this from a concentration-time graph by calculating the gradient of the tangent at time = 0.

a. 获得 initial rate 的方法：

（1）Plot a graph of concentration (of reactant) against time

（2）Draw a tangent at time t = 0

（3）Measure the gradient of the tangent



b. 实验中测 initial rate 需要确保没有被测量的是过量的。

Concentration of methanoic acid does not change significantly during course of reaction So that the rate of reaction would not be affected by the change in concentration of xx.

第一种，初级版(一种物质的浓度是 constant 的)：

答题描述-- *From experiments 1 and 3, as [A] double/triple/quadruple or ✖ 2/3/4, rate increases by a factor of xxx. So xx order.*

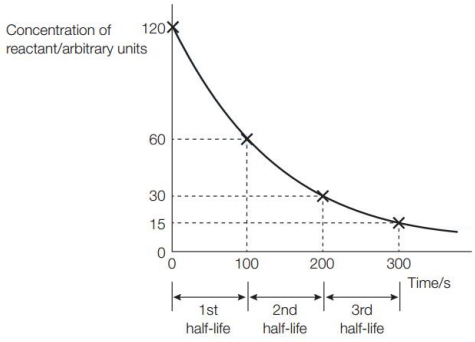
第一种，进阶版(两种物质的浓度都是变化的)：

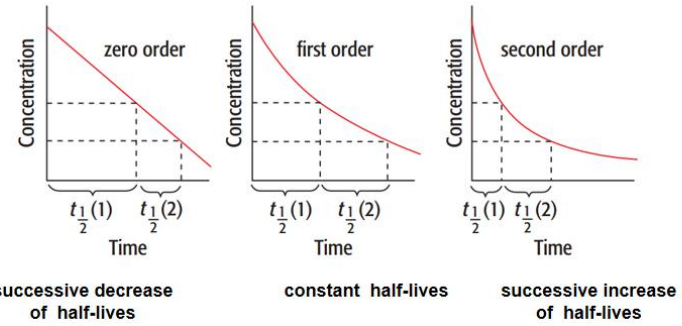
-- *From experiments 1 and 4, as [A] double/triple/quadruple or ✖ 2/3/4, [B] double/triple/quadruple or ✖ 2/3/4, rate increases by a factor of xxx.　So xx order.*

考点三：Half-life

6.15 define the term half-life
6.16 identify a reaction with a constant half-life as being overall first order

1，**Half life**，$t_{1/2}$--the time taken for the concentration of the reactant to fall to one-half of its initial value.





successive decrease of half-lives **constant half-lives** **successive increase of half-lives**