

Kinetics = the study of the rate at which a chemical process occurs.

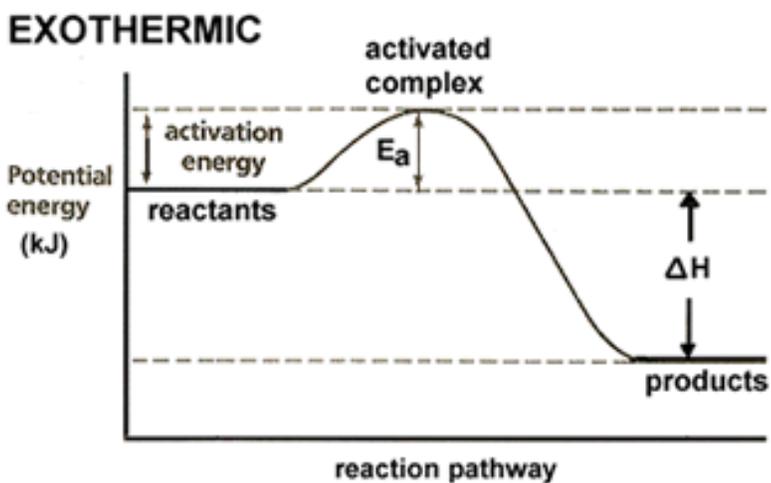
- also sheds light on the reaction mechanism (exactly *how* the reaction occurs).
- Thermodynamics (ΔG , ΔH , ΔS) determines whether a reaction will occur or not; kinetics will determine how fast reaction will occur

Collision Theory

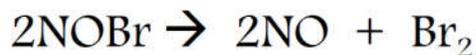
- Used to explain reaction rates.
- States that molecules must collide in order to react
- The _____ there are in a unit of time, _____
- Collisions that result in a reaction are said to be "effective".
- For an effective collision:
 - The molecules must collide with _____
 - The molecules must collide with _____

Energy Diagram

- The _____ is called the **activation energy**.
- On a potential energy diagram, this is the difference in energy between the reactants and the high point on the curve (E_a)
- The arrangement of atoms found at the top of the energy hill is called the activated complex.



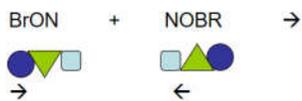
Orientation



● Bromine □ Nitrogen ▲ Oxygen



Reactants collide in proper orientation



No reaction;

Factors that Affect Reaction Rate

1. Temperature: As temperature increases, reaction rate increases.

- Explain why an alka-seltzer tablet will dissolve more quickly in water @ 80°C than in water @ 20°C.

2. Concentration: As concentration increases, reaction rate increases.

- Explain why a sample of magnesium metal will react more quickly in 10 M HCl than it will react in 1 M HCl.

3. Pressure: For a gaseous reaction, as pressure increases, reaction rate increases.

- Ex:

4. Surface Area: If the surface area of a solid is increased (the solid is ground up), the reaction rate will increase.

- Explain why 10 g of powdered zinc will react with hydrochloric acid more quickly than a solid zinc strip that weighs 10 g.

5. Catalyst: speeds up a reaction, but is not used up during the reaction.

- A catalyst speeds up a reaction by _____
- If the activation energy is lowered, _____
_____ (allow for a chemical reaction to occur).
- One way a catalyst can work is by helping to hold the molecules in the correct orientation to react

RATE-LAW EXPRESSIONS WORKSHEET

1) Given the reaction: $2A(g) \rightarrow B(g) + C(g)$

- Express the rate of reaction in terms of the change in concentration of each of the reactants and products.
- When $[C]$ is increasing at $2.0 \text{ mol}\cdot\text{L}^{-1}\cdot\text{s}^{-1}$, how fast is $[A]$ decreasing?

2) Given the reaction: $2D(g) + 3E(g) + F(g) \rightarrow 2G(g) + H(g)$,

When $[E]$ is decreasing at $0.10 \text{ mol}\cdot\text{L}^{-1}\cdot\text{s}^{-1}$, how fast is $[G]$ increasing?

3) Given the reaction: $A(g) + 2B(g) \rightarrow C(g)$,

When $[B]$ is decreasing at $0.50 \text{ mol}\cdot\text{L}^{-1}\cdot\text{s}^{-1}$, how fast is $[A]$ decreasing?

- 4) By what factor does the reaction rate change in each of the following cases, assuming that temperature is held constant?
- A reaction is first order with respect to reactant A, and $[A]$ is doubled.
 - A reaction is second order with respect to reactant B, and $[B]$ is halved.
 - A reaction is second order with respect to reactant C, and $[C]$ is tripled.

5) Given the following reaction and experimental data at 25 °C:

	A	+	B	→	C	
reaction:	$[A]_0$		$[B]_0$			Initial Rate of Formation of C:
1	0.10		0.10			$2.0 \times 10^{-4} \text{ Ms}^{-1}$
2	0.20		0.10			$8.0 \times 10^{-4} \text{ Ms}^{-1}$
3	0.40		0.20			$2.56 \times 10^{-2} \text{ Ms}^{-1}$

- What is the order of this reaction with respect to reactant A?
- What is the order of this reaction with respect to reactant B?
- Write the correct RATE LAW for this reaction

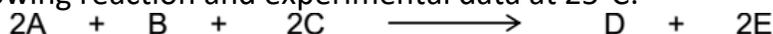
6) Given the following reaction and experimental data at 25 °C:



reaction:	[A] ₀	[B] ₀	[C] ₀	Initial Rate:
1	0.0500 M	0.0500 M	0.0100 M	6.25 × 10 ⁻³ Ms ⁻¹
2	0.1000 M	0.0500 M	0.0100 M	1.25 × 10 ⁻² Ms ⁻¹
3	0.1000 M	0.1000 M	0.0100 M	5.00 × 10 ⁻² Ms ⁻¹
4	0.0500 M	0.0500 M	0.0200 M	6.25 × 10 ⁻³ Ms ⁻¹

- What is the order of this reaction with respect to reactant A?
- What is the order of this reaction with respect to reactant B?
- What is the order of this reaction with respect to reactant C?
- What is the OVERALL reaction order?
- Write the correct RATE LAW for this reaction
- What is the value of the specific rate constant (with UNITS)?

7) Given the following reaction and experimental data at 25°C:



reaction:	[A]	[B]	[C]	Rate:
1	0.10 M	0.20 M	0.10 M	5.0 × 10 ⁻⁴ M/min
2	0.20 M	0.20 M	0.30 M	1.5 × 10 ⁻³ M/min
3	0.30 M	0.20 M	0.10 M	5.0 × 10 ⁻⁴ M/min
4	0.40 M	0.60 M	0.30 M	4.5 × 10 ⁻³ M/min

- What is the order of this reaction with respect to reactant A?
- What is the order of this reaction with respect to reactant B?
- What is the order of this reaction with respect to reactant C?
- What is the OVERALL reaction order?
- Write the correct RATE LAW for this reaction:
- What is the value of the specific rate constant (with UNITS)?
- What would happen to the rate of the reaction if the concentrations of A, B, and C were all DOUBLED?