

Reaction Rate Overview & Rate Expressions (not Rate Laws)

Reaction Rate & Rate Expressions

Fundamentals

- Chemical kinetics is the study of speeds of reactions
 - Reaction rates
- Fundamentally, what factors influence the speed of an particular reaction?
 - Concentration
 - Why?
 - Temperature
 - Why?
 - Physical state
 - Why?
 - Catalyst
 - Catalysts are spectator substances that encourage reactions to take place, while not being included in the reactants or products of the reaction

Reaction Rate & Rate Expressions

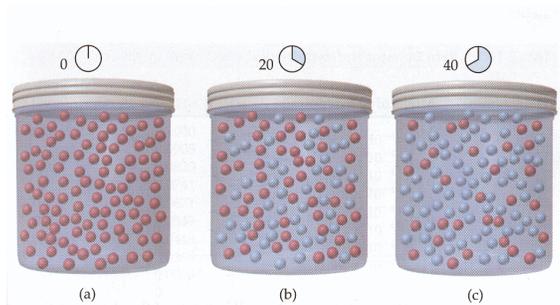
Reaction Rates

- Speed
 - The change that occurs in a given interval of time
 - Example units.....
 - Always in relation to time
- Similarly, we can study the change that take place within a reaction in relation to time
- mol / min

Reaction Rate & Rate Expressions

Reaction Rates

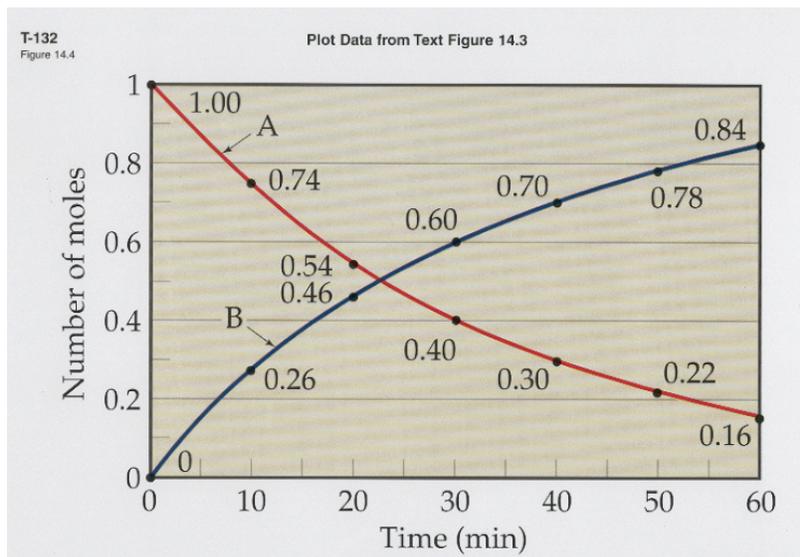
- Consider a hypothetical reaction in which substance A (red spheres) becomes substance B (blue spheres) $A \Rightarrow B$



<u>Time</u>	<u>Amount A</u>	<u>Amount B</u>
0 min	1.0 moles	0 moles
20 min	0.54 moles	0.46 moles
40 min	0.30 moles	0.70 moles

Reaction Rate & Rate Expressions

Reaction Rates



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Reaction Rates

- Mathematically, we can then represent the rate of the reaction as...

$$\text{Average Rate} = \frac{\Delta \text{ moles B}}{\Delta t}$$

$$\Delta \text{ moles B} = \text{moles of B}_{\text{final}} - \text{moles of B}_{\text{initial}}$$

$$\Delta t = \text{time}_{\text{final}} - \text{time}_{\text{initial}}$$

Reaction Rate & Rate Expressions

Reaction Rates

- Up until now, we have studied rates in the units mol/min
- Instead, we will study rates in terms of concentration changes with time.
 - Units are molarity/sec
 - M/s
- Let's consider another reaction, this time studying the rate of the reaction relative to concentration change

Reaction Rate & Rate Expressions

Reaction Rates

- A 0.1000M butyl chloride solution is reacted with water
- $\text{C}_4\text{H}_9\text{Cl} + \text{H}_2\text{O} \Rightarrow \text{C}_4\text{H}_9\text{OH} + \text{HCl}$
- As the reaction proceeds, we track the concentration of the $\text{C}_4\text{H}_9\text{Cl}$

Rate Data for Reaction of $\text{C}_4\text{H}_9\text{Cl}$ with Water

TABLE 14.2 Rate Data for Reaction of $\text{C}_4\text{H}_9\text{Cl}$ with Water

Time, t (s)	$[\text{C}_4\text{H}_9\text{Cl}]$ (M)	Average Rate (M/s)
0.0	0.1000	1.9×10^{-4}
50.0	0.0905	1.7×10^{-4}
100.0	0.0820	1.6×10^{-4}
150.0	0.0741	1.4×10^{-4}
200.0	0.0671	1.22×10^{-4}
300.0	0.0549	1.01×10^{-4}
400.0	0.0448	0.80×10^{-4}
500.0	0.0368	0.560×10^{-4}
800.0	0.0200	
10,000	0	

Reaction Rate & Rate Expressions

Rate Expressions

- Rate Expressions (don't confuse with Rate Laws)
- In the two examples we have studied, the rate of disappearance and the rate of appearance have been equal (1:1)
- What if they aren't 1:1?
- Stoichiometric Relationships



$$M \frac{\quad}{\quad} = \quad \div 2$$

$$\text{Rate} = \frac{-\Delta[A]}{\Delta t} = \frac{\Delta[B]}{2 \Delta t}$$

Reaction Rate & Rate Expressions

Rate Expressions



If H_2 is being created at a rate of 1.0 M/sec, what is the rate of disappearance of HI?

$$\text{Rate} = \frac{-\Delta[\text{HI}]}{2 \Delta t} = \frac{\Delta[\text{H}_2]}{\Delta t} = \frac{\Delta[\text{I}_2]}{\Delta t}$$

Reaction Rate & Rate Expressions

Homework

- 14.1 / 14.2 / 14.3 / 14.4 a&b / 14.17 / 14.18 / 14.19 / 14.23 a&c /
14.24 b&d / 14.25