

iClicker Question

Answer C

$$\text{Rate} = k[\text{CO}_2]^2 [\text{O}_2]$$

Key points about kinetics so far

Collision Theory= For chemicals to react they must collide. The collisions also have to occur at correct orientation

Depends on: Temperature, activation energy, and fraction of collisions that occur at the right orientations of the molecules

Reaction Pathway

Transition state (Activated complex)- Intermediate state between reactants and products where the energy is the highest

Relating energy profiles, activation energies, and speeds of reactions

Activation energy determines the speed of reactions - if the activation energy is higher, the speed is slower

Fastest reaction- Lowest E_a

Slowest reaction- Highest E_a

Ranking the reactions in order from fastest to slowest, if the reactions occur at the same temperature and have the same value for A (related to the fraction of collisions at the right orientation)

1, $E_a = 15 \text{ kJ/mol}$ (fastest)

3, $E_a = 20 \text{ kJ/mol}$

2 $E_a = 24 \text{ kJ/mol}$ (slowest)

Reversing Energy Profile

Rxn 3 is the fastest because it has the lowest E_a

Elementary Reactions

Molecularity- How many particles are involved in the elementary step occurring
How many particles involved in elementary step

$A \rightarrow B$ rate = $k [A]$ – Unimolecular

$2A \rightarrow C$ = rate $[A]^2$ - Bimolecular 2 A colliding

$A + B \rightarrow D$ = rate $[A] [B]$ – Bimolecular A+ B Colliding

Rate Determining Step – Determines how fast reaction goes, reaction only goes as fast as the slowest step

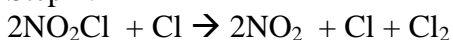
Slow step – Rate determining step

Intermediates – Chemicals that show up on reactant and product side - they get created in one step of the mechanism and then used up again in another step

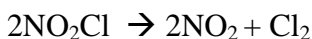
Fast Equilibrium – Forward and reverse reaction happen at the same rate, and equilibrium gets established faster than the rate determining step

Sample Exercise 14.15 p 606

Step 1:



Intermediates – Cl



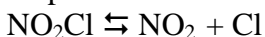
Condition 1 adds up to overall reaction

Condition 2- Doesn't add up

$$\text{Rate} = k_2 [\text{NO}_2\text{Cl}] [\text{Cl}]$$

Fast reversible has forward rate = reverse rate of that step

Step 2



Forward rate = Reverse rate

$$k_f [\text{NO}_2\text{Cl}] = k_r [\text{NO}_2] [\text{Cl}]$$

- Want to solve for Cl, substitute into overall reaction rate & see if it makes overall reaction rate the same as the experimentally observed rate law

$$[\text{Cl}] = k_f [\text{NO}_2\text{Cl}] / k_r [\text{NO}_2]$$

$$\text{Rate} = k_2 [\text{NO}_2\text{Cl}] [\text{Cl}]$$

$$k_2 [\text{NO}_2\text{Cl}] (k_f [\text{NO}_2\text{Cl}] / k_r [\text{NO}_2])$$

Combined ($k_2 k_f / k_r$) :

$$[\text{NO}_2\text{Cl}]^2 / [\text{NO}_2]$$

-Now it is the same as the experimentally determined rate law