Chem 116 Student Notes October 16, 2008 (EC)

Lecture 13: Collision Theory and Reaction Mechanisms

Determining Rate Laws: rate = k [A]^m [B]^n

1) Find m and n
   a) $\frac{rate_2}{rate_1} = \frac{k[A_2]^m[B_2]^n}{k[A_1]^m[B_1]^n}$ or $\frac{rate_2}{rate_1} = \frac{k[A_2]^m[B_2]^n}{k[A_1]^m[B_1]^n}$
   b) $rate_{\frac{2}{1}} = \left[A_{\frac{2}{1}}\right]^m$ or $rate_{\frac{2}{1}} = \left[B_{\frac{2}{1}}\right]^n$
2) Find k
   a) $rate_\# = k\,[A_\#]^m[B_\#]^n$

Clicker Question:

A(g) → 2C(g)

1 unit of A makes 2 units of C, so C is appearing 2x as fast as A is disappearing (or A is disappearing ½ as fast as C is appearing).

½(6.2x10^{-2}) = 3.1x10^{-2}, therefore -3.1x10^{-2} is the answer (negative sign for disappearing)

Half-life: time it takes for ½ of the substance to react

1. time of ½ life only depends on the k value (rest are constants)
   a. [A_t] is going to become ½ [A_o]
      i. $\frac{[A_o]}{[A_t]} = \frac{1}{.5}$=2
   b. ln[A_t]=ln[A_o]-k t
      i. $kt = \ln\left(\frac{[A_o]}{[A_t]}\right)$
      ii. K $t_{half\text{-}life}$ = ln2
   c. $t_{half\text{-}life} = \frac{ln2}{k}$
2. $[A_t] = \frac{1}{2}^{\frac{t}{t_{half-life}}}[A_o]$
   a. $\frac{t}{t_{half-life}}$ = # of half-lives
   b. t = time elapsed
   c. $[A_{end}] = \frac{1}{2}^{\frac{t_{end}}{t_{half-life}}}[A_{start}]$

Causes of Reaction Rates

1. Concentration Rates
    a. [A] and [B]
        i. More collisions → more reactions
2. Temperature
    a. T
        i. More collisions → more reactions
3. Frequency Factor (% of collisions that happen at the right orientations of the reactants to create products)
    a. A
        i. Higher % → more reactions
4. Activation Energy (Energy required to start off the reaction)
    a. E_a
        i. Lower Ea → more reactons

Summed up by:

5. $k = A\,e^{-\left(\frac{E_a}{RT}\right)}$

Can be rewritten by:

6. $(\ln k) \;=\; (\ln A) \;-\; \left(\frac{E_a}{R}\right) * \left(\frac{1}{T}\right)$
7. $(\text{y value}) = (\text{y intercept}) - (\text{slope})\,(\text{x value})$

Therefore:

8. $-\frac{E_a}{R} = \frac{\Delta y}{\Delta x}$