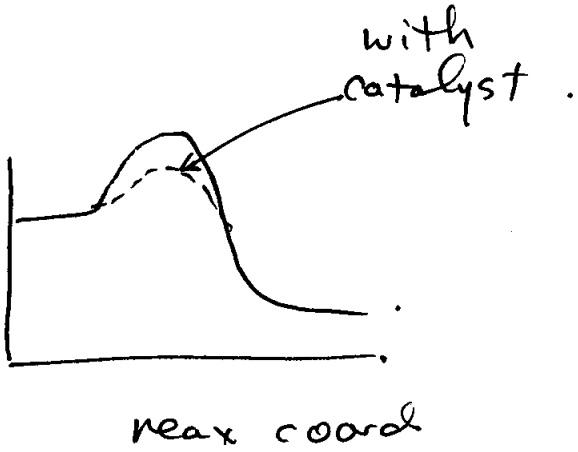
CATALYSTS

- Participate in reax.
- changes mechanism
- no net change in conc or form of catalyst

Homogeneous
Heterogeneous



"Poisons"

Biology.

reactants ⇒ substrates.
catalyst ⇒ enzyme.

Rate constants and multi-step reaction mechanisms

Required:

1- Sum of elementary steps must equal net reaction

2- Rate law must equal that determined experimentally

(Intermediates cannot appear in final rate equation.

$$2NO_2 + F_2 \rightarrow 2NO_2F$$

$$NO_2 + F_2 = NO_2F + F \quad \text{(slow)}$$
$$NO_2 + F = NO_2F \quad \text{(fast)}$$

$$R = -\frac{d[NO_2]}{2\,dt} = \frac{-d[F_2]}{dt} = k[NO_2][F_2]$$

$$H_2 + Br_2 = 2HBr$$

$$Br_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2Br. \quad \overset{\text{equilib}}{\text{(fast.)}}$$

$$Br + H_2 \xrightarrow{k_2} HBr + H \quad \text{(slow)}$$

$$H + Br_2 \xrightarrow{k_3} HBr + Br \quad \text{(fast)}.$$

$$R = k_2[H_2][Br]$$

Need to replace intermediate $[Br]$

reax 1 at equil. so

$$k_1[Br_2] = k_{-1}[Br]^2$$

$$[Br] = \left[\frac{k_1}{k_{-1}}[Br_2]\right]^{1/2}$$

$$R = \underbrace{k_2\sqrt{k_1/k_{-1}}}\ [H_2][Br_2]^{1/2} = k[H_2][Br_2]^{1/2}$$

overall order $= 1 + \frac{1}{2} = \frac{3}{2}$

Note $\frac{k_1}{k_{-1}} = K_1$ (equil. constant)

Try this!

$$Cl_2 + CO = Cl_2O \leftarrow \text{phosgene}$$

① $Cl_2 + M = 2Cl + M$ equil (fast)

② $Cl + CO + M = ClCO + M$ (fast)

③ $ClCO + Cl_2 \xrightarrow{k_3} Cl_2CO + Cl$ (slow)

$$K_1 = \frac{k_1}{k_{-1}} \qquad K_2 = \frac{k_2}{k_{-2}}$$

$$\text{Rate} = k_3 [ClCO][Cl_2]$$

$$K_2 = \frac{[ClCO]}{[Cl][CO]} \Rightarrow [ClCO] = K_2 [Cl][CO]$$

$$K_1 = \frac{[Cl]^2}{[Cl_2]} \Rightarrow [Cl] = \sqrt{K_1 [Cl_2]}$$

$$= k_3 K_2 \sqrt{K_1 [Cl_2]}\,[CO][Cl_2].$$

$$R. = k_3 K_2 \sqrt{K_1}\,[Cl_2]^{3/2}[CO]$$

$$= k [Cl_2]^{3/2} [CO]$$