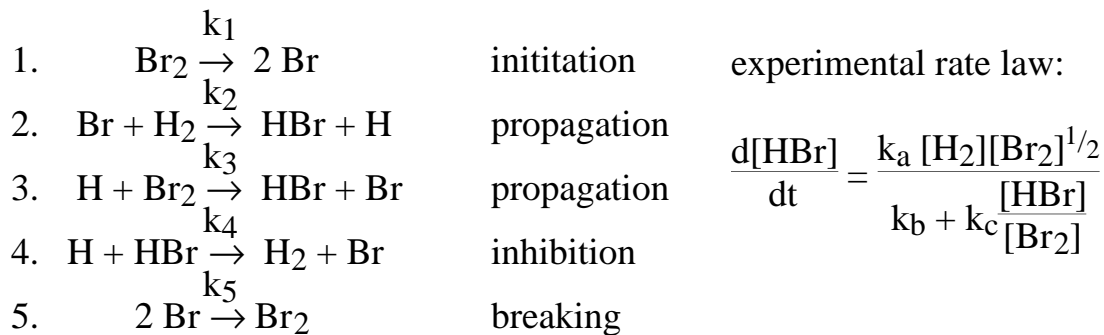


Free Radical Chain Mechanism



I. $\frac{d[\text{HBr}]}{dt} = k_2 [\text{Br}][\text{H}_2] + k_3 [\text{H}][\text{Br}_2] - k_4 [\text{H}][\text{HBr}]$

II. $\frac{d[\text{Br}]}{dt} = 0 = 2 k_1 [\text{Br}_2] - k_2 [\text{Br}][\text{H}_2] + k_3 [\text{H}][\text{Br}_2] + k_4 [\text{H}][\text{HBr}] - 2 k_5 [\text{Br}]^2$

III. $\frac{d[\text{H}]}{dt} = 0 = k_2 [\text{Br}][\text{H}_2] - k_3 [\text{H}][\text{Br}_2] - k_4 [\text{H}][\text{HBr}]$

IV. add II + III: $0 = 2 k_1 [\text{Br}_2] - 2 k_5 [\text{Br}]^2 \Rightarrow [\text{Br}] = \left(\frac{k_1}{k_5} [\text{Br}_2] \right)^{1/2}$

V. solve III for [H]: $[\text{H}] = \frac{k_2 [\text{Br}][\text{H}_2]}{k_3 [\text{Br}_2] + k_4 [\text{HBr}]} = \frac{k_2 \left(\frac{k_1}{k_5} \right)^{1/2} [\text{H}_2][\text{Br}_2]^{1/2}}{k_3 [\text{Br}_2] + k_4 [\text{HBr}]}$

VI. subtract III from I: $\frac{d[\text{HBr}]}{dt} = 2 k_3 [\text{H}][\text{Br}_2]$

substitute V into VI: $\frac{d[\text{HBr}]}{dt} = \frac{2 k_3 k_2 k_1^{1/2} k_5^{-1/2} [\text{H}_2][\text{Br}_2]^{1/2} [\text{Br}_2]}{k_3 [\text{Br}_2] + k_4 [\text{HBr}]}$

$$\frac{d[\text{HBr}]}{dt} = \frac{2 k_3 k_2 k_1^{1/2} k_5^{-1/2} [\text{H}_2][\text{Br}_2]^{1/2}}{k_3 + k_4 \frac{[\text{HBr}]}{[\text{Br}_2]}}$$

Explosions: $2 \text{ H}_2 + \text{O}_2 \rightarrow 2 \text{ H}_2\text{O}$

