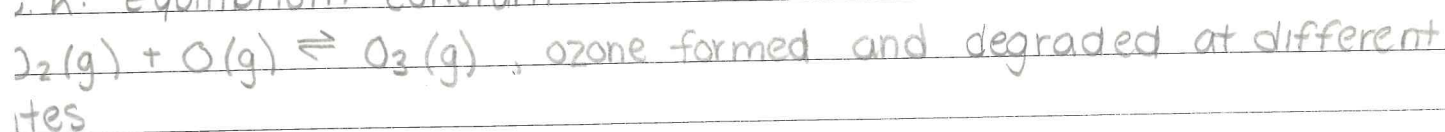


↳ Double arrow because it is not so favored $\rightarrow$ 15% goes to products

1. Widely used for fertilizer (& explosives)

Whether a process is reactant or product favored depends on the driving forces

↳ K : equilibrium constant



↳ At equilibrium, the rate of formation equals the rate of destruction

1. rate formation = rate destruction

↳ To predict whether reaction is reactant-favored or product-favored, look at K

1. If $K > 1$, products favored

2. If $K < 1$, reactants favored

↳ $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$, initial concentrations don't effect K , same equilibrium concentrations are found $\rightarrow$ same K

deriving an expression for K

↳ For the forward rxn, $\text{rate}_f = k_f[\text{N}_2\text{O}_4]$

↳ For the reverse rxn, $\text{rate}_r = k_r[\text{NO}_2]^2$ ← coefficient

At equilibrium, $\text{rate}_f = \text{rate}_r$, so $k_f[\text{N}_2\text{O}_4] = k_r[\text{NO}_2]^2$

$$K = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{\text{products}}{\text{reactants}}$$

1. K = equilibrium constant (this is uppercase!)

2. k = rate constant

↳ for a general reaction, $a\text{A} + b\text{B} \rightleftharpoons d\text{D} + e\text{E}$

$$K = \frac{[\text{D}]^d [\text{E}]^e}{[\text{A}]^a [\text{B}]^b} = \frac{\text{products}}{\text{reactants}}$$

K is unitless and concentrations are molar at EQUILIBRIUM

D What is K for $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$?

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

1. K depends on the temperature, which may be a driving force

III. Gases

u. K_p : the equilibrium constant in terms of pressures

1. Can be done because pressure is proportional to concentration

$$K_p = \frac{(P_D)^d (P_E)^e}{(P_A)^a (P_B)^b}$$

How do K_c and K_p Relate?

$$u. P = \frac{nRT}{V}, \quad \frac{n}{V} \text{ is concentration}$$

1. So, $K_p = K_c(RT)^{\Delta n}$, where Δn is moles products - moles reactants

u. K_c and K_p may or may not be the same

What does K mean?

u. $K \gg 1$, product favored, equilibrium lies to the right

u. $K \ll 1$, reactant favored, equilibrium lies to the left

u. $10^{-3} \leq K \leq 10^3$, significant amounts of products and reactants

Manipulating Expressions for K

3. If you flip a reaction then its K is $1/K$

u. If you multiply a reaction by a constant, then its K is K^2

u. If you add reactions together, then multiply the K 's