

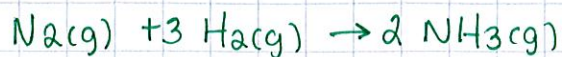
Chemical Equilibrium

(1)

- Some reactions are reversible

reactants \rightarrow products

forward
reaction



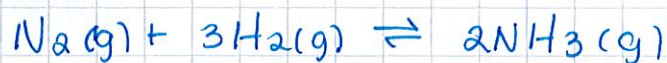
reactants \leftarrow products

reverse
reaction



You show the reaction is reversible by using DOUBLE ARROWS.

reactants \rightleftharpoons products



- Dynamic Equilibrium occurs when...

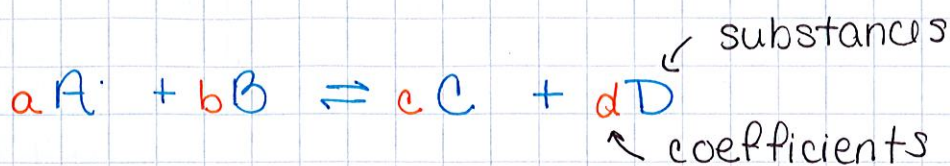
the rate of the forward reaction = the rate of the reverse reaction

@ equilibrium...

- the concentrations of the reactants and products WILL NOT CHANGE!
- the concentrations of the reactants and products DO NOT HAVE TO BE EQUAL!

The Equilibrium Expression (it's an equation)

general format



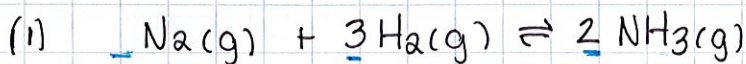
$$K_{eq} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

concentration (molarity)

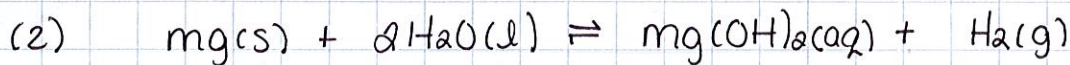
equilibrium constant

Solids & Liquids are NEVER written in the expression!

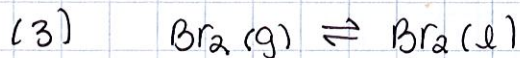
Examples - write the equilibrium expression for these reversible reactions:



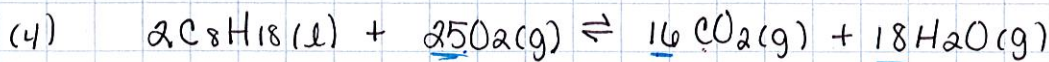
$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3}$$



$$K_{eq} = \frac{[Mg(OH)_2][H_2]}{1}$$



$$K_{eq} = \frac{1}{[Br_2]}$$



$$K_{eq} = \frac{[CO_2]^{16} [H_2O]^{18}}{[O_2]^{25}}$$

Calculating K_{eq}

(1) $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$
 calculate K_{eq} when the equilibrium mixture contains .0203M CH_3OH , .151M H_2 , and .0850M CO .

$$K_{eq} = \frac{[CH_3OH]}{[CO][H_2]^2} = \frac{[.0203M]}{[.0850M][.151M]^2}$$

$$K_{eq} = 10.5 \text{ } \frac{1}{M}$$

(2) The equilibrium constant for the reaction
 $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$
 is .849. Find the concentration of I_2 when $[H_2]$ is $4.479 \times 10^{-4} M$ and $[HI]$ is $3.240 \times 10^{-4} M$.

$$K_{eq} = \frac{[H_2][I_2]}{[HI]^2} \quad .849 = \frac{[4.479 \times 10^{-4} M][I_2]}{[3.240 \times 10^{-4} M]^2} \quad \frac{M}{M^2}$$

$$1 \cdot \frac{M}{1} = \frac{1}{M}$$

$$.849 = \frac{4266.689529 \frac{1}{M} [I_2]}{4266.689529 \frac{1}{M}}$$

$$.000199 M = [I_2]$$

(3) For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, K_{eq} is .393 M^{-2} . What is the concentration of H_2 if $[N_2]$ is .25M and the $[NH_3]$ is .86M.

$$K_{eq} = \frac{[NH_3]^2}{[N_2][H_2]^3} \quad .393 \text{ } \frac{1}{M^2} = \frac{[.86M]^2}{[.25M][H_2]^3}$$

$$[H_2]^3 \cdot .393 \text{ } \frac{1}{M^2} = \frac{2.9584M}{[H_2]^3} \cdot [H_2]^3$$

$$[H_2]^3 \cdot .393 \text{ } \frac{1}{M^2} = \frac{2.9584M}{.393 \text{ } \frac{1}{M^2}}$$

$$[H_2]^3 = 7.527735369 M^3$$

$$\sqrt[3]{[H_2]^3} = \sqrt[3]{7.527735369 M^3}$$

$$[H_2] = 2.0 M$$