

Writing an Equilibrium Expression

Chem Worksheet 18-2

Name _____

When a reaction reaches **equilibrium** the reverse reaction forms reactants at the same rate that the forward reaction produces products. A reaction may appear to stop when it reaches equilibrium because the amount of products and reactants does not change. In reality reactant particles are still becoming product particles, but product particles are becoming reactant particles at the same rate. This process is called **dynamic equilibrium**.

A reaction that has reached equilibrium can be described with an equation known as an equilibrium expression. An equilibrium expression relates the concentration of products divided by the concentration of reactants to an equilibrium constant (K_c). When writing an equilibrium expression only aqueous and gaseous substances are included.

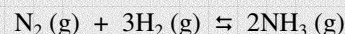
The equilibrium constant (K) is a ratio of products over reactants.

$$K = \frac{\text{products}}{\text{reactants}}$$

In the equation $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ the equilibrium expression would only include CO_2 because the other particles are solids. The equilibrium expression is $K_c = [\text{CO}_2]$. The reason that solids and liquids are not included in equilibrium expressions is that their concentration cannot be measured – they are pure substances.

example

Write the equilibrium expression for K_c for the following reaction:



- Remember to include the constant (K) in your expression

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

Write the equilibrium expressions (for K_c) for the following reactions.

- $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
- $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
- $\text{CaSO}_4(\text{s}) \rightleftharpoons \text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- $\text{Mg}(\text{s}) + 2\text{Ag}^+(\text{aq}) \rightleftharpoons \text{Mg}^{2+}(\text{aq}) + 2\text{Ag}(\text{s})$
- $\text{C}(\text{s}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2(\text{g})$
- $\text{CO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$
- $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})$
- $2\text{POCl}_3(\text{g}) \rightleftharpoons 2\text{PCl}_3(\text{g}) + \text{O}_2(\text{g})$
- $\text{Sn}(\text{s}) + 2\text{CO}_2(\text{g}) \rightleftharpoons \text{SnO}_2(\text{g}) + 2\text{CO}(\text{g})$
- $2\text{HBr}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{Br}_2(\text{l})$
- $\text{O}_2(\text{g}) + \text{NO}_2(\text{g}) \rightleftharpoons \text{O}_3(\text{g}) + \text{NO}(\text{g})$
- $\text{Fe}(\text{s}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{FeO}(\text{s}) + \text{H}_2(\text{g})$

Balance the following equations. Write the equilibrium expressions (for K_c) for each reaction.

- $__ \text{O}_3(\text{g}) \rightleftharpoons __ \text{O}_2(\text{g})$
- $__ \text{NO}(\text{g}) + __ \text{Cl}_2(\text{g}) \rightleftharpoons __ \text{NOCl}(\text{g})$
- $__ \text{CO}(\text{g}) \rightleftharpoons __ \text{C}(\text{s}) + __ \text{O}_2(\text{g})$
- $__ \text{SO}_3(\text{g}) \rightleftharpoons __ \text{SO}_2(\text{g}) + __ \text{O}_2(\text{g})$
- $__ \text{HCl}(\text{g}) + __ \text{O}_2(\text{g}) \rightleftharpoons __ \text{H}_2\text{O}(\text{l}) + __ \text{Cl}_2(\text{g})$
- $__ \text{Sb}_2\text{S}_3(\text{s}) + __ \text{H}_2(\text{g}) \rightleftharpoons __ \text{Sb}(\text{s}) + __ \text{H}_2\text{S}(\text{g})$