Equilibrium constant expression review

1. Products over reactants
2. Stoichiometric coefficient = exponent
3. Don't include solvent or solids

When you....	The new K_{eq} is...
Reverse a reaction	$K_2 = \frac{1}{K_1}$
Multiply by a constant	$K_2 = K_1^x$ where x= the constant
Add two or more reactions	$K_3 = K_1 \times K_2$

The value of the equilibrium constant can be determined from concentration data

Example:
A solution of ethanol and acetic acid each have an initial concentration of 0.810 M. After heating, it is found that the acetic acid concentration has dropped to 0.748 M. What is K for the reaction?

$$\underset{\text{ethanol}}{C_2H_5OH(aq)} + \underset{\text{acetic acid}}{CH_3CO_2H(aq)} \rightleftharpoons \underset{\text{ethyl acetate}}{CH_3CO_2C_2H_5(aq)} + H_2O(\ell)$$

Initial

Change

Equilibrium

K =

General idea: plug actual concentrations into equilibrium expression. This is the reaction quotient, Q.

If Q = K, system is at equilibrium
If Q < K, there are too few products
reaction proceeds in forward direction
If Q > K there are too many products
reaction proceeds in reverse direction

Example (using reaction above): A solution contains:

$[C_2H_5OH]$ = 0.422 M
$[CH_3CO_2H]$ = 0.215 M
$[CH_3CO_2C_2H_5]$ = 0.658 M

Is it at equilibrium, and if not, in which direction will it react?

Clicker question

$Cu(NH_3)_4^{2+}(aq) \Leftrightarrow Cu^{2+}(aq) + 4\ NH_3(aq)$ K = 8.5×10^{-13}

If $[Cu^{2+}] = 1.0 \times 10^{-6}$, $[NH_3] = 1.0 \times 10^{-3}$, $[Cu(NH_3)_4^{2+}] = 1 \times 10^{-2}$, then …

1. It is at equilibrium
2. Reaction goes forwards
3. Reaction goes backwards

How to solve equilibrium problems

1. Write the equilibrium expression
2. Determine Q
   - if Q = K, it's at equilibrium
   - if Q < K, reactants go to form products
   - if Q > K, products go to form reactants
3. Call the amount reacting "x"
4. Solve for x in the equilibrium expression
5. Use x to determine equilibrium concentrations