Equilibrium

a condition in which a forward chemical reaction and the reverse chemical reaction proceed at equal rates

The Equilibrium Constant, K
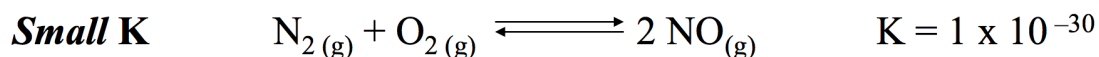
$$K = \frac{\text{products}}{\text{reactants}}$$

> This is a **ratio** of concentrations,
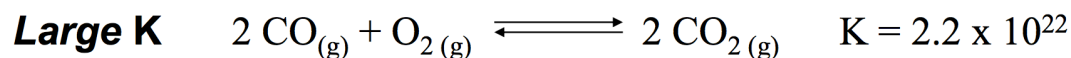> _____
> reported at 25°C

K > 1   mostly or all products
K < 1   mostly reactants
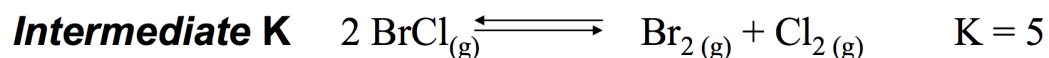
examples:

Equilibrium Constants can have a wide range of values

Small **K** $N_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\,NO_{(g)}$ $K = 1 \times 10^{-30}$

Essentially only reactants at eqbm. (10^{15} x products)

Large **K** $2\,CO_{(g)} + O_{2\,(g)} \rightleftharpoons 2\,CO_{2\,(g)}$ $K = 2.2 \times 10^{22}$

Essentially only products at eqbm.

Intermediate **K** $2\,BrCl_{(g)} \rightleftharpoons Br_{2\,(g)} + Cl_{2\,(g)}$ $K = 5$

Comparable amounts of products and reactants at eqbm.

equilibruim

- forward reaction = reverse reaction
- the amounts of A and B at equilibrium can be the same (K = 1) or different (K<1)

reaction: A → B
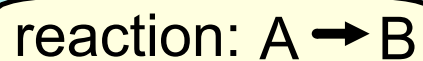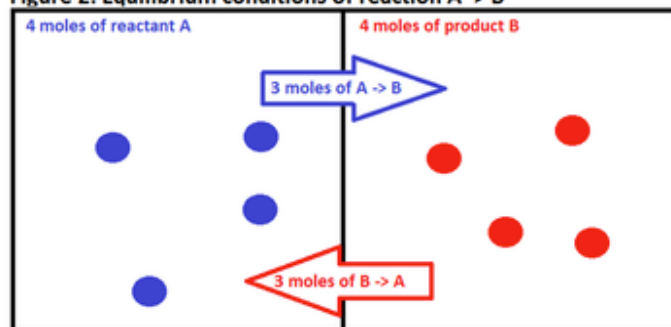
Figure 2: Equilibrium conditions of reaction A -> B

4 moles of reactant A

4 moles of product B

3 moles of A -> B

3 moles of B -> A

http://chemwiki.ucdavis.edu/@api/deki/files/14817/=Figure_2.png

$$K = \frac{products}{reactants} = \frac{[B]}{[A]} = \frac{4}{4} = 1$$

Rate

Forward process

Reverse process

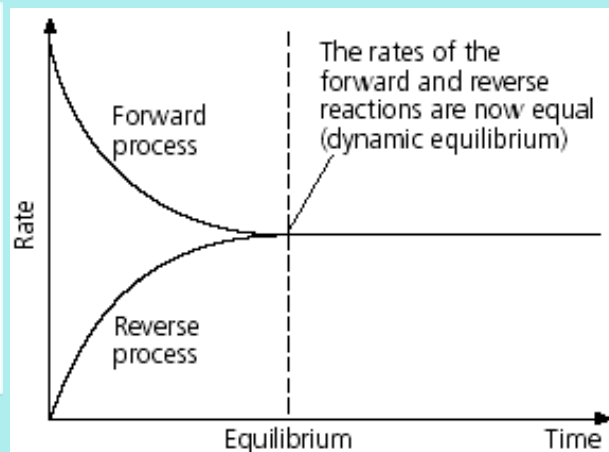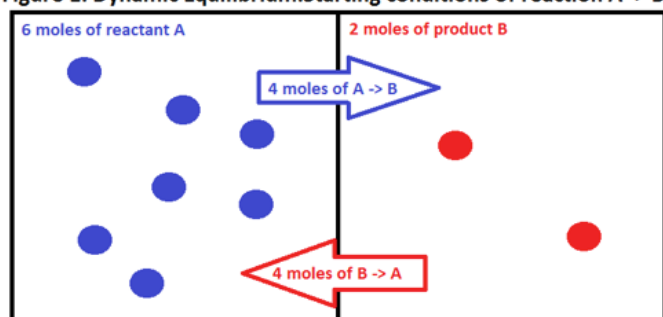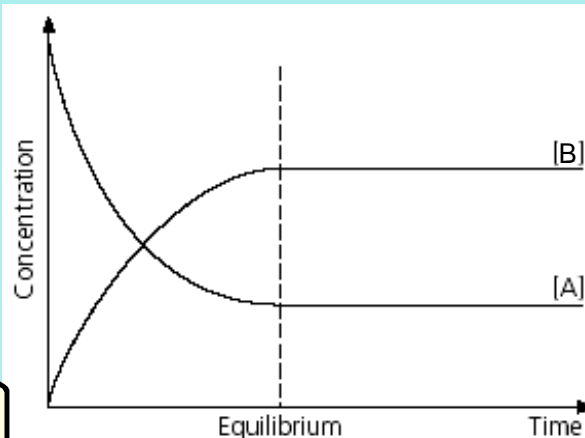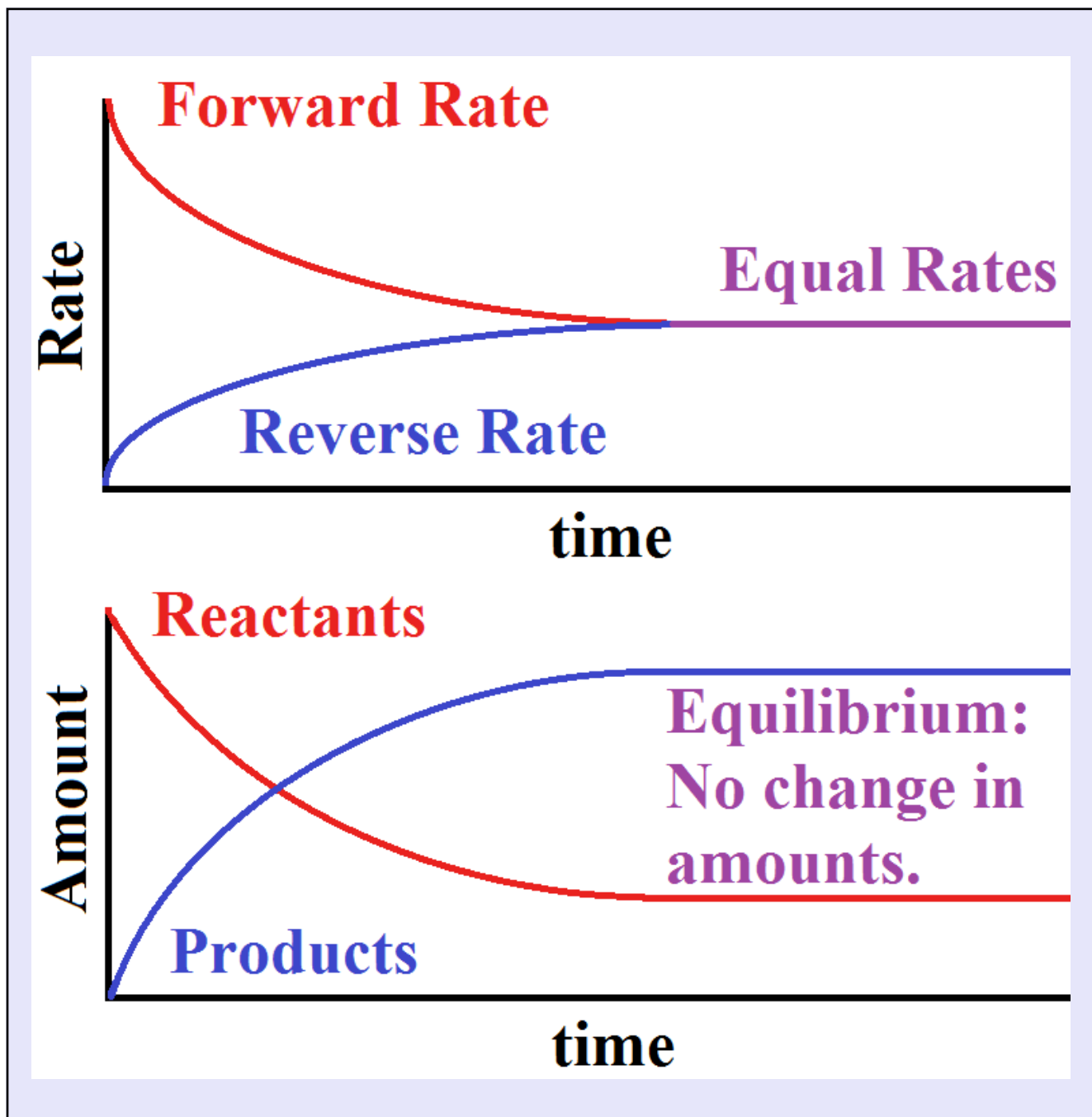The rates of the forward and reverse reactions are now equal (dynamic equilibrium)

Equilibrium   Time

Figure 1: Dynamic Equilibrium:Starting conditions of reaction A -> B

6 moles of reactant A

2 moles of product B

4 moles of A -> B

4 moles of B -> A

$$K = \frac{products}{reactants} = \frac{[B]}{[A]} = \frac{2}{7} = 0.28$$
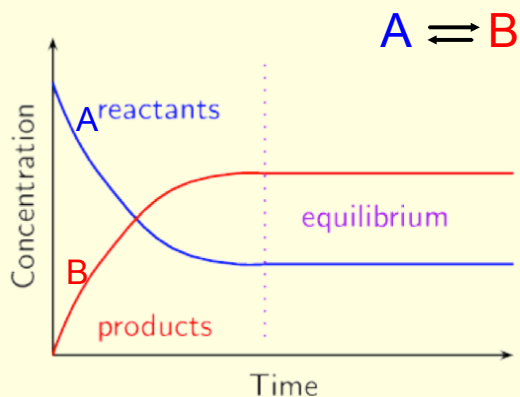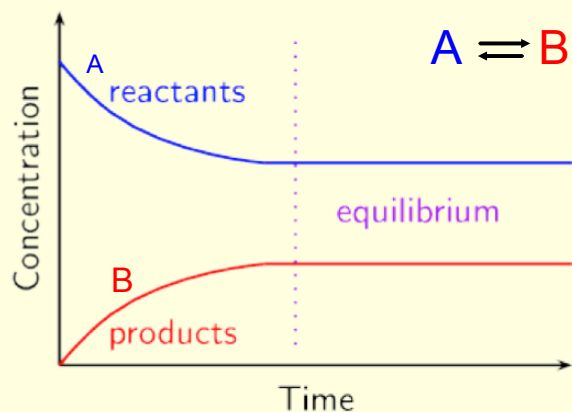
Concentration

[B]

[A]

Equilibrium   Time

Equilibrium

Practice question:
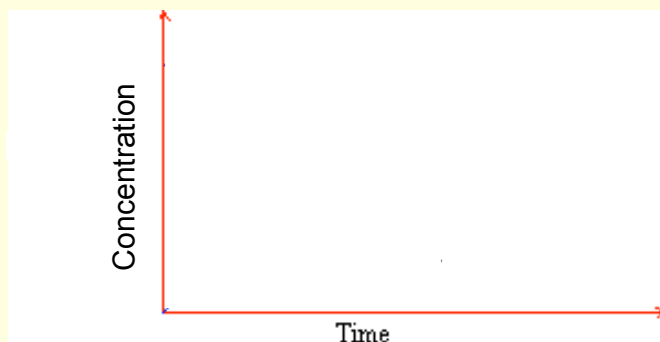
1. What is being favored in the following graph?
2. What is the value of K?
   (greater than, equal to, or less than 1)

$$A \rightleftharpoons B$$

3. What is being favored in the following graph?
4. What is the value of K?
   (greater than, equal to, or less than 1)
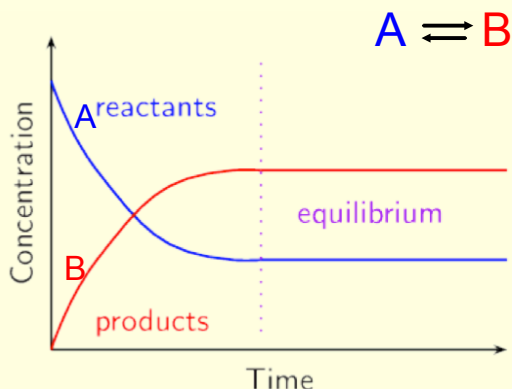
$$A \rightleftharpoons B$$

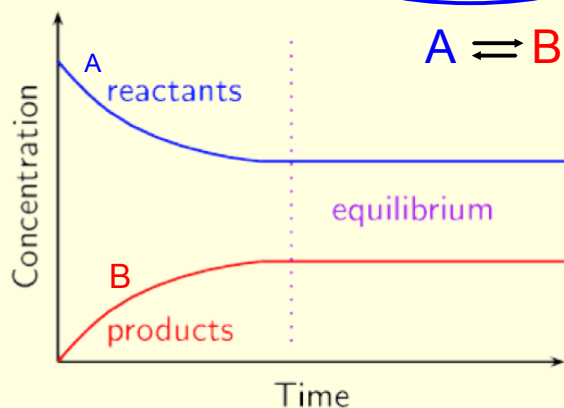5. What would the graph look like if K=1?

Practice question:

1. What is being favored in the following graph? **products**
2. What is the value of K?
   (greater than) equal to, or less than 1)

$$A \rightleftharpoons B$$

3. What is being favored in the following graph? **reactants**
4. What is the value of K?
   (greater than, equal to, or less than 1)

$$A \rightleftharpoons B$$

5. What would the graph look like if K=1?