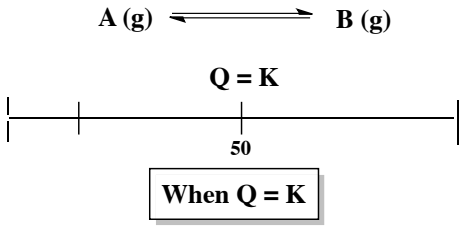
CONCEPT: THE REACTION QUOTIENT, Q

The reaction quotient, Q, is used to determine if our chemical reaction is at equilibrium.

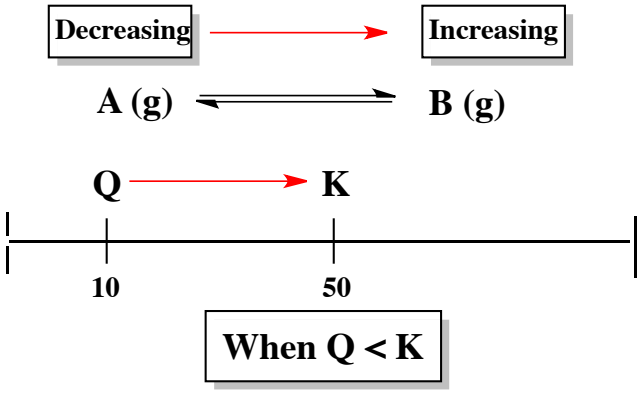
- If the reaction quotient Q is _____ the equilibrium constant K then our reaction is at equilibrium.

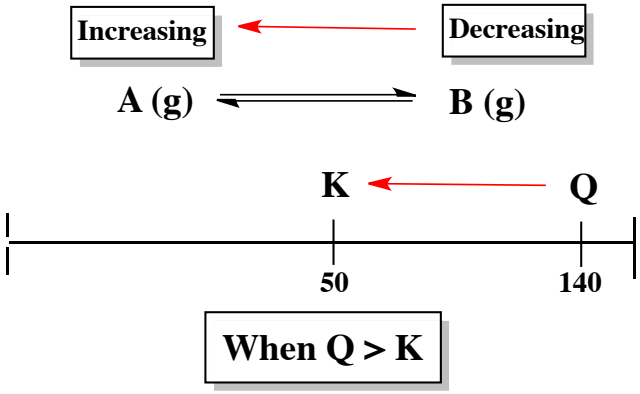
$$Q = \frac{\text{products}}{\text{reactants}}$$



Comparing Q to K determines which direction the reaction shifts in order to reach equilibrium.

- The direction our reaction shifts determines whether our reactants or products are increasing or decreasing.





EXAMPLE 1: Consider the hypothetical reaction below

$3\ A\ (g) + B\ (g) \leftrightarrow 2\ C\ (g) \qquad Kc = 1.5 \times 10^{-3}$

Which of the following statements is correct if the initial concentrations are [A] = 0.85 M, [B] = 0.36 M, and [C] = 0.005 M.

A. At equilibrium, the amount of C will increase.

B. At equilibrium, the amount of A will increase.

C. At equilibrium, the amount of B will increase and C will increase.

D. At equilibrium, the amount of A will increase and B will decrease.

E. The reaction is at equilibrium.

PRACTICE: THE REACTION QUOTIENT, Q

EXAMPLE 1: For the reaction: $2\ CO_2\ (g) \rightleftharpoons 2\ CO\ g) + 2\ O_2\ (g)$, the equilibrium constant is 7.22×10^{-4} at 400 K, while the reaction quotient is 6.63×10^{-2}. If initially we have 0.20 atm CO_2, 0.30 atm CO and 0.15 atm O_2, which of the following statements is **not** true?

a) The pressure of CO_2 will be greater than 0.20 atm.
b) The pressure of CO will be less than 0.30 atm.
c) The pressure of O_2 will be greater than 0.15 atm.
d) The pressure of O_2 will be less than 0.15 atm.
e) The reaction will favor reactants.

EXAMPLE 2: For the following reaction:

$$3\ H_2\ (g) + N_2\ (g) \rightleftharpoons 2\ NH_3\ (g)$$

$K_{eq} = 25$. At a particular time, the following concentrations are measured for the given compounds: $[H_2] = 0.005$ M, $[N_2] = 0.170$ M and $[NH_3] = 3.12 \times 10^2$ M. Which of the following statements is true?

a) The concentration of H_2 will increase.

b) The equilibrium constant will increase.

c) The concentration of NH_3 will increase.

d) The concentration of N_2 will decrease.

e) No change will occur.