CONCEPT: REACTION QUOTIENT

Calculating the Reaction Quotient

- The **Reaction Quotient** (__) is a _____ of product to reactant concentrations at a particular time.
  - □ Like the equilibrium constant it can be calculated by setting up an expression and ignoring ____ and ____.

EXAMPLE: The formation of gaseous ammonia is displayed by the equation given below:

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

What is the reaction quotient if the following amounts (in moles) of each component is placed in a 10.0 L vessel.

N_2 = 0.650 moles H_2 = 0.330 moles NH_3 = 0.529 moles

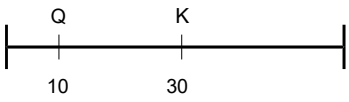
Comparing Q to K

- Once you've determined Q compare it to K to determine which direction the chemical reaction will shift.
  - □ ____ will always shift towards ____ in order to maintain equilibrium.
    - The balanced chemical equation will shift in the _____ direction as Q.
    - Shifting towards a side causes all molecules on that side to ___ in amount.

Q to K Comparison

Q < K

□ The reaction will shift ____ to maintain equilibrium.

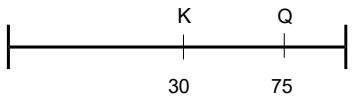


$2\,NO\,(g) + Br_2\,(l) \rightleftharpoons 2\,NOBr\,(g)$

□ Reactants ____ and products ____.

Q > K

□ The reaction will shift ____ to maintain equilibrium.

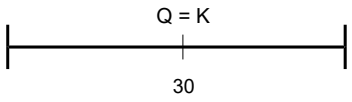


$2\,NO\,(g) + Br_2\,(l) \rightleftharpoons 2\,NOBr\,(g)$

□ Reactants ____ and products ____.

Q = K

□ The reaction is ____ equilibrium.



$2\,NO\,(g) + Br_2\,(l) \rightleftharpoons 2\,NOBr\,(g)$

□ Reactants and products amounts are _____.

EXAMPLE: For the reaction: $4\,HBr\,(g) + O_2\,(g) \rightleftharpoons 2\,Br_2\,(g) + 2\,H_2O\,(l)$, the equilibrium constant is 0.063 at 400 K. If the reaction quotient is 0.100, which of the following statements is true?

a) [HBr] will decrease b) [O_2] will increase c) [Br_2] will increase d) [H_2O] will increase

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PRACTICE: For the reaction: 2 CO_2 (g) $\rightleftharpoons$ 2 CO g) + 2 O_2 (g), the equilibrium constant is 3.12 x 10^{-4} at 400 K, while the reaction quotient is 4.18 x 10^{-4}. 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.

PRACTICE: The equilibrium constant for the following gas phase reaction is 0.75 at 750 K. After a short time, analysis of a small amount of the reaction mixture shows the concentrations to be [NOBr] = 1.25 M, [NO] = 0.80 M and [Br_2] = 0.50 M. Which of the following statements is/are true?

$$2\ NOBr\ (g) \rightleftharpoons NO\ (g) + Br_2\ (g)$$

a) The reaction mixture is at equilibrium.

b) No further reaction will occur.

c) The partial pressure of NOBr will increase.

d) The partial pressure of NO will increase.

e) The reaction will shift to the left, the reactant side.