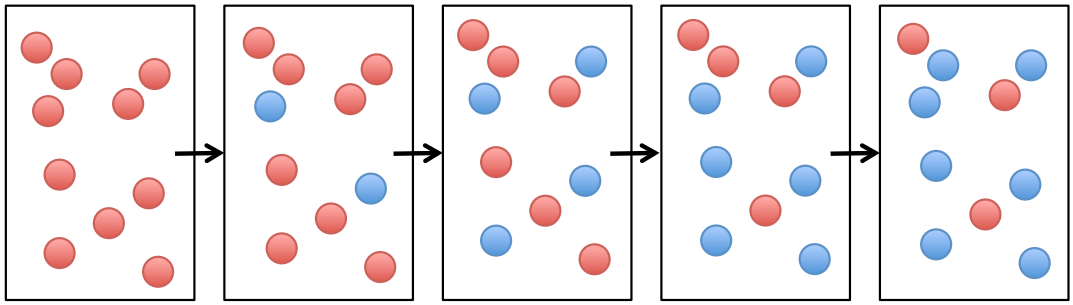
CHE1031 Lecture 11 HW [ABRIDGED]

Note that Word doesn't have symbols for **equilibrium arrows**. My poor substitute is ← →, and means that both forward and reverse reactions occur.

11.1: Concept of equilibrium

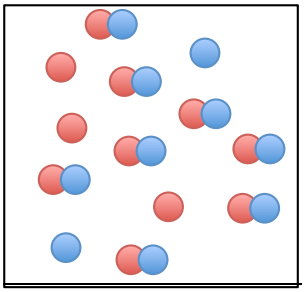
1. These diagrams represent progression of the hypothetical chemical reaction A → B where A is represented by red spheres and B is represented by blue spheres. Does the system reach equilibrium? Explain your answer.



~~11.2: The equilibrium constant~~

~~2. Consider the reaction A + B ←·→ C + D whose equilibrium constant is very large. Which species predominate at equilibrium?~~

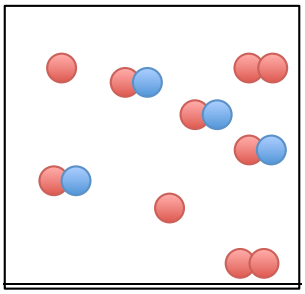
~~3. The diagram seen here represents the equilibrium mixture produced by the reaction A + X ←·→ AX. Is Keq greater than 1, or 1, or less than one?~~



11.3: Working with equilibrium expressions

4. Write the equilibrium expression for these reactions:
   a. $3NO \rightleftharpoons N_2O + NO_2$
   b. $CH_4 + 2H_2S \rightleftharpoons CS_2 + 4H_2$

5. The reaction $A_2 + B \rightleftharpoons A + AB$ has an equilibrium constant of Keq = 2. In the diagram shown here A is red and B is blue. How many atoms of B should be added to the diagram if to reflect equilibrium conditions?



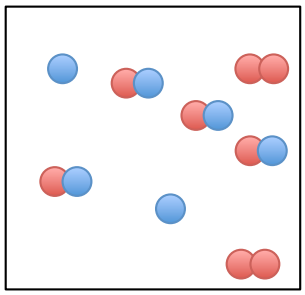
6. When these reactions come to equilibrium, does the equilibrium mixture contain mostly reactants or mostly products?
   a. $N_2 + O_2 \rightleftharpoons 2NO$, Keq = 1.5E-10
   b. $2SO_2 + O_2 \rightleftharpoons 2SO_3$, Keq = 2.5E9

7. Methanol (CH_3OH) is produced commercially by the catalyzed reaction of carbon monoxide and hydrogen gas: $CO + 2H_2 \rightleftharpoons CH_3OH$. An equilibrium mixture in a 2.00 L vessel is found to contain 0.0406 mol of CH_3OH, 0.170 mol CO and 0.302 mol of H_2 at 500°C. Calculate Kc at this temperature.

8. A mixture of 0.10 mol of NO, 0.050 mol of H_2 and 0.10 mol of H_2O is placed in a 1.0 L vessel at 300°K. This equilibrium reaction occurs: $2NO + 2H_2 \rightleftharpoons N_2 + 2H_2O$.
   At equilibrium, [NO] = 0.062 M.
   a. Calculate the equilibrium concentrations of the other reactant and products.
   b. Calculate Kc.

11.4: Le Châtelier's principle

9. This diagram represents the equilibrium state for the reaction $A_2(g) + 2B(g) \leftrightarrows 2AB(g)$. The container's volume is one liter.
   If the container's volume is decreased, will the number of AB molecules increase or decrease? Why?



10. Consider the following equilibrium reaction: $2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g)$ $\Delta H = -25$ kJ.
    How will each change affect the equilibrium mixture of three gases?
    a. O_2 is added to the system.
    b. The mixture is heated.
    c. The volume of the vessel is doubled.
    d. A catalyst is added.
    e. The total pressure is increased by adding a noble gas.
    f. SO_3 is removed from the system.

~~**11.5: Catalysts & equilibrium**~~

~~11. You work at the U.S. Patent Office. You review a patent application that claims that a newly developed catalyst is far superior to the Haber catalyst for producing ammonia because the new catalyst leads to a greater equilibrium conversion of N_2 and H_2 to NH_3 under the same reaction conditions. What would your response be?~~