

• **Chapter 14 Review Problems:**

- Ch. 14 Multiple Choice Review
- **In Textbook:** pg. 621-625 #63, 66, 68(b), 72, 78, 81, 86, 88\* (\*make initial moles  $H_2 = 0.984$  to be equal to initial moles  $I_2$ ), 92(b,c), 98, 103, 107
- **In Study Guide:** pg. 286-288 #6, 7, 12, 14, 18, 19; pg. 296-299 #4 ( $K_P$  only), 11, 13, 16, 17 ( $K_P$  only)  
\*\* Underlined questions should be done b/c these types of questions were not in text book review.

**Topics:**

- 1) Concept of Equilibrium: rate of forward rxn = rate of reverse, understanding plots of concentration vs. time and rate vs. time, writing  $K_C$  and  $K_P$  expressions:

$$K_C = \frac{[C]^c [D]^d}{[A]^a [B]^b}; K_P = \frac{P_C^c P_D^d}{P_A^a P_B^b}$$

- 2) Basic calculations using  $K_C$  and  $K_P$  expressions. (Know that pure solids and liquids are not written in equilibrium constant expressions.)

- 3) Some rules about equilibrium constants:

- Use  $PV = nRT$  to calculate  $P$  or  $M$  from the other to determine  $K_P$  or  $K_C$
- $K$  of a forward reaction is equal to the reciprocal of the  $K$  ( $K^{-1}$ ) of its reverse reaction
- Multiplying a reaction by a factor  $n$  raises  $K$  to the same power ( $K' = K^n$ )
- $K$  of overall rxn (step 1 + step 2 + ... + step  $n$ ) =  $K_1 \times K_2 \times \dots \times K_n$

- 4) Predicting the direction a reaction will proceed by calculating reaction quotient  $Q$ .  $Q$  has the same form as  $K$  but uses initial rather than equilibrium conditions.

$$Q_C = \frac{[C]_0^c [D]_0^d}{[A]_0^a [B]_0^b}; Q_P = \frac{(P_C)_0^c (P_D)_0^d}{(P_A)_0^a (P_B)_0^b}$$

- a) If  $Q = K$  the system is at equilibrium
- b) If  $Q < K$ , [Reactants] is too large and  $\text{rate}_{\text{forward}} > \text{rate}_{\text{reverse}}$  so the system proceeds to the right
- c) If  $Q > K$ , [Products] is too large and  $\text{rate}_{\text{reverse}} > \text{rate}_{\text{forward}}$ , so the system proceeds to the left

- 5) Using "ICE" to calculate initial concentrations, equilibrium concentrations, or equilibrium constants. (There will be no use of the quadratic equation—either you will have an expression that is a perfect square and you can take the root of both sides or you will be able to use the 5% rule.)

- 6) Le Châtelier's Principle: Know how a system will return to equilibrium when a stressor is added (change in a concentration, change in volume or pressure when reaction involves gases, change in temperature, and addition of a catalyst.

- a) Temperature is the only parameter that changes  $K$  (we'll see how in Chapter 18),
  - i) Treating  $\Delta H_{\text{rxn}}$  as a product or reactant we say that increasing  $T$  favors the endothermic direction.
  - ii) Kinetically, increasing temperature increases  $k$  for the endothermic direction of a reversible reaction faster than the exothermic direction (since  $E_a$  for the endothermic reaction is larger), so the equilibrium constant becomes larger for an endothermic reaction and smaller for an exothermic one, which is endothermic in the reverse direction).
- b) Increasing the partial pressure of a gaseous reactant or product favors the direction that produces fewer moles of gas. Changing the partial pressure of a gas not involved in the reaction has no effect unless the volume of the container also changes (assuming constant  $T$ ).