AP Chem Chapter 13 TEST **Name:** **Date:** **Hr:**

MULTIPLE CHOICE

1) Which of the following is true about a system at equilibrium?
   A) The concentration(s) of the reactant(s) is equal to the concentration(s) of the product(s).
   B) No new product molecules are formed.
   C) The concentration(s) of reactant(s) is constant over time.
   D) The rate of the reverse reaction is equal to the rate of the forward reaction and both rates are equal to zero.
   E) None of the above (A-D) is true.

2) Which of the following is true about chemical equilibrium?
   A) It is microscopically and macroscopically static.
   B) It is microscopically and macroscopically dynamic.
   C) It is microscopically static and macroscopically dynamic.
   D) It is microscopically dynamic and macroscopically static.
   E) None of these are true about chemical equilibrium.

3) Equilibrium is reached in chemical reactions when:
   A) The rates of the forward and reverse reactions become equal.
   B) The concentrations of reactants and products become equal.
   C) The temperature shows a sharp rise.
   D) All chemical reactions stop.
   E) The forward reaction stops.

4) For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container.

$$A(g) + 2B(g) \rightleftharpoons C(g)$$

At equilibrium, the concentration of A is 0.246 mol/L. What is the concentration of B at equilibrium?
   A) 0.246 mol/L
   B) 0.325 mol/L
   C) 0.500 mol/L
   D) 0.492 mol/L
   E) none of these

5) If the equilibrium constant for $A + B \rightleftharpoons C$ is 0.208, then the equilibrium constant for $2C \rightleftharpoons 2A + 2B$ is
   A) 0.584
   B) 4.81
   C) 0.416
   D) 23.1
   E) 0.208

6) Apply the law of mass action to determine the equilibrium expression for $2NO_2Cl(aq) \rightleftharpoons 2NO_2(aq) + Cl_2(aq)$.

A) $K = 2[NO_2][Cl_2]/2[NO_2Cl]$
B) $K = 2[NO_2Cl]/2[NO_2][Cl_2]$
C) $K = [NO_2Cl]^2/[NO_2]^2[Cl_2]$
D) $K = [NO_2]^2[Cl_2]/[NO_2Cl]^2$
E) $K = [NO_2Cl]^2[NO_2]^2[Cl_2]$

7) At a given temperature, $K = 0.017$ for the equilibrium:

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

What is K for:

$Cl_2(g) + PCl_3(g) \rightleftharpoons PCl_5(g)$?

A) 0.017
B) 59
C) 0.00029
D) 17
E) 3500

8) Which expression correctly describes the equilibrium constant for the following reaction?

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

A) $K = (4NH_3] + 5[O_2]) / (4[NO] + 6[H_2O])$
B) $K = (4[NO] + 6[H_2O]) / (4NH_3] + 5[O_2])$
C) $K = ([NO][H_2O]) / ([NH_3][O_2])$
D) $K = ([NO]^4[H_2O]^6) / ([[NH_3]^4[O_2]^5)$
E) $K = ([NH_3]^4[O_2]^5) / ([NO]^4[H_2O]^6)$

(Use for #9 and #10) Consider the chemical system $CO + Cl_2 \rightleftharpoons COCl_2$; $K = 4.6 \times 10^9$ L/mol.

9) How do the equilibrium concentrations of the reactants compare to the equilibrium concentration of the product?

A) They are much smaller.
B) They are much bigger.
C) They are about the same.
D) They have to be exactly equal.
E) You can't tell from the information given.

10) If the concentration of the product were to double, what would happen to the equilibrium constant?

A) It would double its value.
B) It would become half its current value.
C) It would quadruple its value.
D) It would not change its value.
E) It would depend on the initial conditions of the product.

11) Determine the equilibrium constant for the system $N_2O_4 \rightleftharpoons 2NO_2$ at 25°C. The concentrations are shown here: $[N_2O_4] = 2.32 \times 10^{-2}$ *M*, $[NO_2] = 1.41 \times 10^{-2}$ *M*.

A) 0.608
B) 1.65
C) 1.17×10^{2}
D) 0.369
E) 8.57×10^{-3}

12) If $K = 0.144$ for $A_2 + 2B \rightleftharpoons 2AB$, then for $4AB \rightleftharpoons 2A_2 + 4B$, K would equal:

A) 0.288
B) 0.144
C) –0.144
D) 3.47
E) 48.2

13) For the reaction $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$, $K_c = 1.22 \times 10^{33}$ at a temperature of 301 K. What is K_p at this temperature?

A) 1.22×10^{33}
B) 3.01×10^{34}
C) 4.93×10^{31}
D) 7.43×10^{35}
E) 2.00×10^{30}

14) Consider the following reaction:

$$2HF(g) \rightleftharpoons H_2(g) + F_2(g) \qquad (K = 1.00 \times 10^{-2})$$

Given 1.00 mole of HF(*g*), 0.362 mole of $H_2(g)$, and 0.750 mole of $F_2(g)$ are mixed in a 5.00 L flask, determine the reaction quotient, *Q*.

A) $Q = 0.0543$
B) $Q = 0.272$
C) $Q = 0.0679$
D) $Q = 2.11$
E) none of these

15) Consider the following equilibrated system: $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$. If the K_p value is 0.604, find the equilibrium pressure of the O_2 gas if the NO_2 gas pressure is 0.520 atm and the P_{NO} is 0.300 atm at equilibrium.

A) 1.05 atm
B) 24.8 atm
C) 0.348 atm
D) 0.201 atm
E) 1.81 atm

16) For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container.

$$A(g) + 2B(g) \rightleftharpoons C(g)$$

At equilibrium, the concentration of A is 0.213 mol/L. What is the value of *K*?

A) 2.18
B) 1.79
C) 0.213
D) 8.40
E) 0.565

17) Initially 2.0 moles of $N_2(g)$ and 4.0 moles of $H_2(g)$ were added to a 1.0-liter container and the following reaction then occurred:

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

The equilibrium concentration of $NH_3(g)$ = 0.55 moles/liter at 700.°C. The value for *K* at 700.°C for the formation of ammonia is:

A) 1.0×10^{-1}
B) 5.5×10^{-2}
C) 5.5×10^{-3}
D) 3.0×10^{-1}
E) none of these

18) The following reaction is investigated (assume an ideal gas mixture):

$$2N_2O(g) + N_2H_4(g) \rightleftharpoons 3N_2(g) + 2H_2O(g)$$

Initially there are 0.10 moles of N_2O and 0.25 moles of N_2H_4, in a 10.0-L container. If there are 0.048 moles of N_2O at equilibrium, how many moles of N_2 are present at equilibrium?

A) 2.6×10^{-2}
B) 5.2×10^{-2}
C) 7.8×10^{-2}
D) 1.6×10^{-1}
E) none of these

(Use for #19-21) Given the equation $2A(g) \rightleftharpoons 2B(g) + C(g)$. At a particular temperature, $K = 1.6 \times 10^4$.

19) If you mixed 5.0 mol B, 0.10 mol C, and 0.0010 mol A in a one-liter container, which direction would the reaction initially proceed?

A) To the left.
B) To the right.
C) The above mixture is the equilibrium mixture.
D) Cannot tell from the information given.
E) None of these (A-D).

20) Addition of chemical B to an equilibrium mixture of the above will
A) cause [A] to increase
B) cause [C] to increase
C) have no effect
D) cannot be determined
E) none of the above

21) Raising the pressure by lowering the volume of the container will
A) cause [A] to increase
B) cause [B] to increase
C) have no effect
D) cannot be determined
E) none of the above

22) Which of the following statements concerning equilibrium is *not* true?
A) A system that is disturbed from an equilibrium condition responds in a manner to restore equilibrium.
B) Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.
C) The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.
D) A system moves spontaneously toward a state of equilibrium.
E) The equilibrium constant is independent of temperature.

23) For a certain reaction at 25.0°C, the value of K is 1.2×10^{-3}. At 50.0°C the value of K is 3.4×10^{-1}. This means that the reaction is
A) exothermic
B) endothermic
C) never favorable
D) more information needed
E) none of these (A-D)

24) Consider the following equilibrium: $2H_2(g) + X_2(g) \rightleftharpoons 2H_2X(g)$ + energy

Addition of X_2 to a system described by the above equilibrium
A) will cause [H_2] to decrease
B) will cause [X_2] to decrease
C) will cause [H_2X] to decrease
D) will have no effect
E) cannot possibly be carried out

25) Consider the following system at equilibrium: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 92.94$ kJ

Which of the following changes will shift the equilibrium to the right?

I. increasing the temperature
II. decreasing the temperature
III. increasing the volume
IV. decreasing the volume
V. removing some NH_3
VI. adding some NH_3
VII. removing some N_2
VIII. adding some N_2

A) I, IV, V, VIII
B) II, III, V, VIII
C) I, VI, VIII
D) I, III, V, VII
E) II, IV, V, VIII

26) Consider the combustion of methane (as represented by the following equation). This is the reaction that occurs for a Bunsen burner, which is a source of heat for chemical reactions in the laboratory.

$CH_4(g) + 2O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(g)$

For the system at chemical equilibrium, which of the following explains what happens if the temperature is raised?

A) The equilibrium position is shifted to the right and the value for *K* increases.
B) The equilibrium position is shifted to the right and the value for *K* decreases.
C) The equilibrium position is shifted to the left and the value for *K* decreases.
D) The equilibrium position is shifted to the left and the value for *K* increases.
E) The equilibrium position is shifted but the value for *K* stays constant.

27) For the gaseous reaction, $2\ H_2 + 2\ NO <=> 2\ H_2O + N_2$, K_p at $120^oC = 2.42$. At a given moment, it is found that the partial pressures of H_2, NO, H_2O and N_2 are 1.1, 1.3, 0.78 and 2.2 atm, respectively. Which of the following statements describes the situation?

A) $Q_p = 1.2$ so the reaction goes to the right
B) $Q_p = 1.2$ so the reaction goes to the left
C) $Q_p = 0.65$ so the reaction goes to the right
D) $Q_p = 0.65$ so the reaction goes to the left
E) The reaction is at equilibrium

28) What effect does a) increasing the total pressure and b) increasing the temperature have on the equilibrium $H_2(g) + CO_2(g) \leftrightarrows H_2O(g) + CO(g)$, $\Delta H^o = 41.2$ kJ/mol.

A) a) equilibrium shifts towards products, b) equilibrium shifts towards products.
B) a) equilibrium shifts towards reactants, b) equilibrium shifts towards products.
C) a) equilibrium shifts towards products, b) equilibrium shifts towards reactants.
D) a) no change in the equilibrium, b) equilibrium shifts towards products.
E) a) no change in the equilibrium, b) equilibrium shifts towards reactants.

29) Consider the reaction, which is exothermic as written, $PCl_5(g) \leftrightarrows PCl_3(g) + Cl_2(g)$. Which of the following changes would result in the production of MORE $Cl_2(g)$?

I. adding $PCl_3(g)$
II. removing $PCl_3(g)$
III. reducing the volume of the container
IV. removing $PCl_5(g)$
V. increasing the temperature
VI. increasing the volume of the container
VII. adding $PCl_5(g)$
VIII. reducing the temperature
IX. adding a suitable catalyst

A) I, IV, V, VI
B) II, VI, VII, VIII
C) II, III, VII, VIII
D) II, V, VI, VII
E) II, VI, VII, VIII, IX

30) Consider a 1 gallon jug of water stored for Y2K emergency use. Assume the water level in the jug has not changed visibly over the 17 years of shelf life. Inside the jug:

I) there is zero evaporation or condensation taking place
II) the evaporation and condensation are taking place at equal rates
III) equilibrium has been reached
IV) evaporation and condensation are occurring but one will always be faster than the other

A) I
B) II, III
C) II, IV
D) I, III
E) I, II, III, IV

Go Vikings!!