Name Key Date _____ Class _____

16–2 Review and Reinforcement

The Law of Chemical Equilibrium

On the line at the left, write the letter of the description that best matches each term.

c	1. equilibrium position	a. equilibrium condition for a chemical reaction involving substances in more than one state
d	2. law of chemical equilibrium	b. used to determine if a reaction has reached equilibrium
b	3. reaction quotient	c. depends on the initial concentrations of the substances in a reaction
f	4. homogeneous equilibria	d. states that every reaction proceeds to an equilibrium state with a specific K_{eq}
e	5. law of mass action	e. expresses the relative concentration of reactants and products at equilibrium in terms of an equilibrium constant
a	6. heterogeneous equilibria	f. equilibrium condition for reactions in which products and reactants are in the same state
g	7. equilibrium constant	g. the ratio of product concentration to reactant concentration at equilibrium

Answer each of the following questions in the space provided.

8. What is the equilibrium expression for the equation $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$?

$$K_{eq} = \frac{[HI]^2}{[H_2][I_2]}$$

9. What is the equilibrium expression for the equation $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$?

$$K_{eq} = [NH_3][HCl]$$

10. What is the equilibrium expression for the equation $As_4O_6(s) + 6C(s) \rightleftharpoons As_4(g) + 6CO(g)$?

$$K_{eq} = [As_4][CO]^6$$

11. What is the equilibrium expression for the equation $SnO_2(s) + 2CO(g) \rightleftharpoons Sn(s) + 2CO_2(g)$?

$$K_{eq} = \frac{[CO_2]^2}{[CO]^2}$$

12. What is the equilibrium expression for the equation $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$?

$$K_{eq} = [CO_2]$$

Name _____ Date _____ Class _____

16–2 *Review and Reinforcement (continued)*

13. For the reaction $2CO(g) \rightleftharpoons C(s) + CO_2(g)$, $K_{eq} = 7.7 \times 10^{-15}$. At a particular time, the following concentrations are measured: [CO] = 0.034 *M*, $[CO_2] = 3.6 \times 10^{-17}$ *M*. Is this reaction at equilibrium? If not, in which direction will the reaction proceed?

see attachment

14. For the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $K_{eq} = 0.2$. At a particular time, the following concentrations are measured: $[N_2O_4] = 2.0$ *M*, $[NO_2] = 0.2$ *M*. Is this reaction at equilibrium? If not, in which direction will the reaction proceed?

see attachment

15. For the reaction $2ICl(g) \rightleftharpoons I_2(g) + Cl_2(g)$, $K_{eq} = 0.11$. At a particular time, the following concentrations are measured: [ICl] = 2.5 *M*, $[I_2] = 2.0$ *M*, $[Cl_2] = 1.2$ *M*. Is this reaction at equilibrium? If not, in which direction will the reaction proceed?

see attachment

Match each statement with the appropriate letter. Each letter can be used once, more than once, or not at all.

a 16. The equilibrium concentration of products is much greater than that of reactants.

c 17. The equilibrium concentration of products is much less than that of reactants

b 18. There is a considerable amount of both reactants and products at equilibrium.

a. K_{eq} is much greater than 1.

b. K_{eq} is about equal to 1.

c. K_{eq} is much less than 1.

Answer each of the following questions in the space provided.

19. What effect does changing the initial concentration of substances in a reaction have on the equilibrium constant?

no effect

20. What is meant when chemists say that the equilibrium position of a reaction "lies to the left"?

there are more reactants than products present at equilibrium

21. Why are solids and pure liquids left out of equilibrium expressions?

their concentrations do not change during the reaction

22. How is the reaction quotient (*Q*) related to the equilibrium constant (K_{eq})?

Q can be used to see if a reaction has reached equilibrium and which way it needs to go

(13) $Q = \frac{[CO_2]}{[CO]^2} = \frac{3.6 \times 10^{-17}}{(0.034)^2}$

$Q = 3.11 \times 10^{-14}$

$Q > K_{eq}$ · not at equilibrium
· will move left (reverse)

(14) $Q = \frac{[NO_2]^2}{[N_2O_4]} = \frac{(0.2)^2}{(2)}$

$Q = 0.02$

$Q < K_{eq}$ · not at equilibrium
· will move right (forward)

(15) $Q = \frac{[I_2][Cl_2]}{[ICl]^2} = \frac{(2)(1.2)}{(2.5)^2}$

$Q = 0.384$

$Q > K_{eq}$ · not at equilibrium
· will move left (reverse)