Chapter 14 Exam Pool Questions

1. Which of the following represents a dynamic equilibrium?
   a) an open pan of boiling water
   b) two people of equal mass balanced on the ends of a seesaw
   c) a coin spinning in mid-air
   d) a stoppered flask half full of water
   e) an object traveling at a constant speed

2. A 20.0-L vessel at 700 K initially contains HI(*g*) at a pressure of 6.20 atm; at equilibrium, it is found that the partial pressure of $H_2(g)$ is 0.600 atm. What is the partial pressure of HI(*g*) at equilibrium?
   $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

   a) 6.20 atm
   b) 5.60 atm
   c) 0.600 atm
   d) 5.00 atm
   e) 6.80 atm

3. Apply the law of mass action to obtain the equilibrium-constant expression for the following reaction:
   $2X(g) + Y(g) \rightleftharpoons 3W(g) + V(g)$

   a) $[X]^2[Y][W]^3[V]$
   b) $\dfrac{[W]^3[V]}{[X]^2[Y]}$
   c) $\dfrac{[3W][V]}{[2X][Y]}$
   d) $\dfrac{[X]^2[Y]}{[W]^3[V]}$

4. Which of the following can we predict from an equilibrium constant for a reaction?
   1. The extent of a reaction
   2. Whether the reaction is fast or slow
   3. Whether the reaction is exothermic or endothermic

   a) 1 only
   b) 2 only
   c) 3 only
   d) 1 and 2 only
   e) 1 and 3 only

5. What is the expression for K_c for the following equilibrium?
$CaSO_3(s) \rightleftharpoons CaO(s) + SO_2(g)$

a) $\dfrac{[CaO][SO_2]}{[CaSO_3]}$

b) $[CaO][SO_2]$

c) $[SO_2]$

d) $\dfrac{1}{[SO_2]}$

e) $\dfrac{[CaSO_3]}{[CaO][SO_2]}$

6. Nitrogen trifluoride decomposes to form nitrogen and fluorine gases according to the following equation:
$2NF_3(g) \rightleftharpoons N_2(g) + 3F_2(g)$

When 2.06 mol of NF_3 is placed in a 2.00-L container and allowed to come to equilibrium at 800 K, the mixture is found to contain 0.0227 mol of N_2. What is the value of K_p at this temperature (R = 0.0821 L · atm/(K · mol))?

a) 1.77×10^{-6}
b) 4.43×10^{-7}
c) 1.91×10^{-3}
d) 1.83×10^{-3}
e) 1.73×10^{-6}

7. At 400 K, an equilibrium mixture of H_2, I_2, and HI consists of 0.054 mol H_2, 0.019 mol I_2, and 0.059 mol HI in a 1.00-L flask. What is the value of K_p for the following equilibrium? (R = 0.0821 L · atm/(K · mol))
$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

a) 3.4
b) 21
c) 0.29
d) 0.017
e) 58

8. For which of the following reactions are the numerical values of K_p and K_c the same?

1. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

2. $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

3. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

a) 1 only
b) 2 only
c) 1 and 2 only
d) 2 and 3 only
e) 1, 2, and 3

9. Consider the following equilibrium:
$\frac{1}{2}N_2O_4(g) \rightleftharpoons NO_2(g)$; $K_c = 3.3$ at 100°C

For which of the following equilibria is K_c less than 3.3 at 100°C?

a) $2N_2O_4(g) \rightleftharpoons 4NO_2(g)$
b) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
c) $4N_2O_4(g) \rightleftharpoons 8NO_2(g)$
d) $3N_2O_4(g) \rightleftharpoons 6NO_2(g)$
e) $\frac{1}{4}N_2O_4(g) \rightleftharpoons \frac{1}{2}NO_2(g)$

10. What is the K_p equilibrium-constant expression for the following equilibrium?
$Ti(s) + 2Cl_2(g) \rightleftharpoons TiCl_4(l)$

a) $\dfrac{1}{P_{Cl_2}^{\ 2}}$

b) $\dfrac{1}{P_{Cl_2}}$

c) $P_{Cl_2}^{\ 2}$

d) P_{Cl_2}

e) $\dfrac{P_{TiCl_4}}{P_{Ti}P_{Cl_2}^{\ 2}}$

11. What is the K_c equilibrium-constant expression for the following equilibrium?
$NiO(s) + H_2(g) \rightleftharpoons Ni(s) + H_2O(g)$

a) $\dfrac{[NiO][H_2]}{[Ni][H_2O]}$

b) $\dfrac{[Ni][H_2O]}{[NiO][H_2]}$

c) $\dfrac{[Ni][H_2O]}{[H_2]}$

d) $\dfrac{[H_2]}{[H_2O]}$

e) $\dfrac{[H_2O]}{[H_2]}$

12. For which of the following reactions will the reactant experience the largest degree of decomposition upon reaching equilibrium at 500 K?

a) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$; $K_p = 1.3 \times 10^{-5}$

b) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$; $K_p = 1.7 \times 10^{-2}$

c) $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$; $K_p = 5.9 \times 10^{-5}$

d) $2NOF(g) \rightleftharpoons 2NO(g) + F_2(g)$; $K_p = 1.2 \times 10^{-26}$

e) $2NO_2F(g) \rightleftharpoons 2NO_2(g) + F_2(g)$; $K_p = 6.6 \times 10^{-22}$

13. Which of the following is always true for a reaction whose value of K_c is 4.4×10^4?

a) The reaction occurs slowly.

b) The reaction occurs quickly.

c) At equilibrium, the reaction mixture is product-favored.

d) At equilibrium, the reaction mixture is reactant-favored.

e) At equilibrium, there are equal moles of reactants and products.

14. Consider the following reaction:

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

Given that 1.00 mol of HF(*g*), 0.360 mol of H_2(*g*), and 0.750 mol of F_2(*g*) are mixed in a 5.00-L flask, determine the reaction quotient, *Q*.

a) $Q = 0.0540$
b) $Q = 0.270$
c) $Q = 0.0675$
d) $Q = 2.11$
e) none of these

15. The reaction quotient for a system is 7.2×10^2. If the equilibrium constant for the system is 36, what will happen as equilibrium is approached?
a) There will be a net gain in product.
b) There will be a net gain in reactant.
c) There will be a net gain in both product and reactant.
d) There will be no net gain in either product or reactant.
e) The equilibrium constant will decrease until it equals the reaction quotient.

16. For the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$, $K_c = 0.290$ at 400 K. If the initial concentrations of HI, H_2, and I_2 are all 1.50×10^{-3} *M* at 400 K, which one of the following statements is correct?
a) The system is at equilibrium.
b) The concentrations of HI and I_2 will increase as the system is approaching equilibrium.
c) The concentrations of H_2 and HI will decrease as the system is approaching equilibrium.
d) The concentration of HI will increase as the system is approaching equilibrium.
e) The concentrations of H_2 and I_2 will increase as the system is approaching equilibrium.

17. For the equilibrium $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, $K_c = 4.0$ at 228°C. If pure PCl_5 is placed in a 1.00-L container and allowed to come to equilibrium, and the equilibrium concentration of PCl_5(*g*) is 0.13 *M*, what is the equilibrium concentration of PCl_3?
a) 0.065 *M*
b) 0.13 *M*
c) 0.44 *M*
d) 0.72 *M*
e) 0.0042 *M*

18. In an experiment, 0.30 mol H_2 and 0.30 mol I_2 are mixed in a 1.00-L container, and the reaction forms HI. If $K_c = 49.$ for this reaction, what is the equilibrium concentration of HI?
$I_2(g) + H_2(g) \rightleftharpoons 2HI(g)$

a) 0.53 *M*
b) 0.58 *M*
c) 0.040 *M*
d) 0.47 *M*
e) 0.075 *M*

19. Drying agents called desiccants can be based on the cobalt complexes shown as

$$Co(H_2O)_6^{2+}(aq) + 4\ Cl^-(aq) \rightleftharpoons CoCl_4^{2-}(aq) + 6H_2O(l)$$

pink clear blue

If this desiccant is moist, then its color will be

a) clear
b) pink
c) blue
d) pinkish blue
e) black

20. Consider the following equilibrium:

$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$; $\Delta H = -92$ kJ

The concentration of PCl_3 at equilibrium may be increased by

a) increasing the pressure.
b) adding Cl_2 to the system.
c) decreasing the temperature.
d) the addition of neon.
e) the addition of PCl_5.

21. Carbon monoxide is toxic because it can successfully compete with oxygen for hemoglobin (Hb) sites according to the following equilibrium:

$Hb(O_2)_4(aq) + 4CO(g) \rightleftharpoons Hb(CO)_4(aq) + 4O_2(g)$

From Le Châtelier's principle, CO poisoning is reversed by

a) increasing the O_2 pressure.
b) increasing the CO pressure.
c) increasing the CO_2 pressure.
d) decreasing the amount of Hb.
e) increasing the amount of Hb.

22. What effect will spraying liquid water into a system have if NH_3 is far more soluble in water than is N_2 or H_2?

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

a) This will not affect the system.
b) More $NH_3(g)$ will form.
c) More $N_2(g)$ will form.
d) Less $NH_3(g)$ will form.
e) More $H_2(g)$ will form.

23. Which of the following equilibria would <u>not</u> be affected by pressure changes at constant temperature?

a) $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$
b) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
c) $2Hg(l) + O_2(g) \rightleftharpoons 2HgO(s)$
d) $CO_2(g) + H_2(g) \rightleftharpoons CO(g) + H_2O(g)$
e) $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(l)$

24. Which of the following equilibria would be affected by volume changes at constant temperature?
1. $2NO(g) + 3F_2(g) \rightleftharpoons 2F_3NO(g)$

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

3. $O_3(g) + NO(g) \rightleftharpoons NO_2(g) + O_2(g)$

a) 1 only
b) 2 only
c) 3 only
d) 1 and 2 only
e) 1, 2, and 3

25. For which of the following systems at equilibrium and at constant temperature will decreasing the volume cause the equilibrium to shift to the right?
a) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
b) $2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$
c) $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$
d) $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$
e) $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$

26. In which of the following reactions does an instantaneous increase in the volume of the reaction vessel favor formation of the products?
a) $MgO(s) + CO_2(g) \rightleftharpoons MgCO_3(s)$
b) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
c) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
d) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
e) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

27. Consider the following equilibrium at 25°C:
$2ICl(g) \rightleftharpoons I_2(g) + Cl_2(g)$; $\Delta H = 27$ kJ; $K_p = 6.2 \times 10^{-6}$

Which of the following would be true if the temperature were increased to 100°C?

1. The value of Kp would increase.

2. The concentration of $ICl(g)$ would increase.

3. The partial pressure of I_2 would increase.

a) 1 only
b) 2 only
c) 3 only
d) 1 and 2 only
e) 1 and 3 only

28. For the following reaction system at equilibrium, which one of the changes below would cause the equilibrium to shift to the right?
$Br_2(g) + 2NO(g) \rightleftharpoons 2NOBr(g)$; $\Delta H° = -30$ kJ

a) Increase the volume of the reaction vessel.
b) Remove some NO.
c) Add some NOBr.
d) Remove some Br_2.
e) Decrease the temperature.

29. 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, VI, VII
b) II, III, V, VIII
c) I, VI, VIII
d) I, III, V, VII
e) II, IV, V, VIII

30. Which of the following statements is <u>incorrect</u> concerning the addition of a catalyst to an equilibrium reaction system?
a) The catalyst increases the rate of both the forward and the reverse reaction.
b) If the reactants are capable of forming many different products, a catalyst may selectively speed up one reaction over another.
c) The catalyst speeds up the attainment of equilibrium.
d) The catalyst increases the yield of the products.
e) The catalyst is not consumed in either the forward or the reverse reaction.

ANSWERS

Question	Answer
1	d
2	d
3	b
4	a
5	c
6	c
7	c
8	d
9	e
10	a
11	e
12	b
13	c
14	b
15	b
16	d
17	d
18	d
19	b
20	e
21	a
22	b
23	d
24	d
25	a
26	b
27	e
28	e
29	e
30	d