Teacher's Tools® Chemistry

Chemical Equilibrium: Worksheet

MULTIPLE CHOICE

For questions 1-6, consider the reaction:

$$Fe_2O_{3(s)} + 3H_{2(g)} \leftrightarrow 2Fe_{(s)} + 3H_2O_{(g)} \qquad \Delta H = +15 \text{ kJ}$$

______1. The equilibrium concentrations under certain conditions were found to be

$[H_2O] = 1.0$ M $\qquad [H_2] = 2.5$ M

What is the value for K_c?

(A) 0.40 (B) 0.064 (C) 15.6 (D) Insufficient information to calculate.

______2. K_p is

(A) less than K_c. (B) greater than K_c. (C) equal to K_c. (D) insufficient information to calculate.

Use the following choices for questions # 3 - 6 to indicate the effect of each of the following changes made to the equilibrium system shown above. A choice may be used once, more than once, or not at all.

(A) Systems shifts to the LEFT
(B) Systems shifts to the RIGHT
(C) No change
(D) Cannot be predicted

______3. The volume of the container is decreased.

______4. Some solid Fe_2O_3 is added

______5. Some steam is removed

______6. The temperature is increased

______7. For the reaction:

$$4NH_{3(g)} + 5O_{2(g)} \leftrightarrow 4NO_{(g)} + 6H_2O_{(g)}$$

ΔH is negative. The position of this equilibrium would be shifted to the left by

(A) removing $NO_{(g)}$.
(B) adding $O_{2(g)}$.
(C) increasing the pressure by decreasing the volume of the container.
(D) decreasing the temperature.
(E) None of these

______8. Calculate the equilibrium constant K_p for the following reaction:

$$2A_{(g)} \leftrightarrow B_{(g)} + 3C_{(g)}$$

given that a 1.0 L vessel was initially filled with 5.0 atm of pure A and the partial pressure of gas A was found to be 3.5 atm at equilibrium.

(A) 11.1 (B) 0.70 (C) 3.8 (D) 0.48 (E) None of these

______9. Increasing the volume of the reaction vessel in question 8 would have what effect?

(A) Increasing the value of the equilibrium constant.
(B) Forcing the reaction to proceed to the right.
(C) Forcing the product ratio [C]/[B] to be greater than 3.
(D) Only (A) and (B) are correct.
(E) (A), (B), and (C) are correct.

For questions 10-13, use the following choices to indicate the effect of each of the following stresses on the partial pressure of ammonia. An answer may be used once, more than once, or not at all.

(A) Ammonia partial pressure increases
(B) Ammonia partial pressure decreases
(C) There is no change in the partial pressure of ammonia

$$NH_4HS_{(s)} \leftrightarrow NH_{3(g)} + H_2S_{(g)} \quad \Delta H = +197.8 \text{ kJ}$$

______10. A small quantity of H_2S is added.

______11. The temperature of the system is increased.

______12. A quantity of N_2 is added.

______13. A quantity of NH_3 is added.

PROBLEMS Show work on separate sheets

1. $CO_{2(g)} \leftrightarrow CO_{(g)} + ½ O_{2(g)}$

A 1.00 mole sample of CO_2 is placed in a 1.00 L container and allowed to come to equilibrium at 2500 K. When equilibrium is reached at 2500 K, 17.6% of the original CO_2 has decomposed to CO and O_2. Calculate the value of the equilibrium constant, K_c, for the dissociation reaction at 2500 K.

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2. Ammonium chloride is a crystalline solid that decomposes as follows:

$$NH_4Cl_{(s)} \leftrightarrow NH_{3(g)} + HCl_{(g)}$$

(A) Some solid NH_4Cl is placed in an evacuated vessel at 25°C. After equilibrium is attained, the total pressure inside the vessel is found to be 0.659 atm. Some solid NH_4Cl remains in the vessel at equilibrium. For this decomposition, write the expression for K_p and calculate its numerical value at 25°C.

(B) Some extra NH_3 gas is injected into the vessel containing the sample described in part (A). When equilibrium is reestablished at 25°C, the partial pressure of NH_3 in the vessel is twice the partial pressure of HCl. Calculate the numerical value of the partial pressure of NH_3 and the partial pressure of HCl in the vessel after the NH_3 has been added and equilibrium has been reestablished.

(C) In a different experiment, NH_3 gas and HCl gas are introduced into an empty 1.00 L vessel at 25°C. The initial partial pressure of each gas is 0.500 atm. Calculate the number of moles of solid NH_4C that is present when equilibrium is established.

3. Given the following reaction at equilibrium:

$$N_2O_{4(g)} \leftrightarrow 2NO_{2(g)}$$

Initially, 0.0400 mol $N_2O_{4(g)}$ are placed in a previously evacuated flask and heated to 100°C. When equilibrium is established at 100°C, the equilibrium concentration of $N_2O_{4(g)}$ is found to be 0.0134 M. The volume of the flask is 1.00 L.

(A) Calculate the equilibrium concentration of $NO_{2(g)}$.

(B) Calculate the equilibrium constant, K_c, for the reaction at 100°C.

(C) In another experiment, equilibrium was approached from the other direction by injecting a quantity of $NO_{2(g)}$ into a previously evacuated flask. After equilibrium is established in this system at 100°C, the equilibrium concentration of NO_2 is found to be 0.0243 M. Find the equilibrium concentration of N_2O_4 in the system. (*Hint: No initial/changeequilibrium table is needed.*)

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4. The equilibrium constant, K_c, for the following reaction:

$$N_{2(g)} + O_{2(g)} \leftrightarrow 2NO_{(g)}$$

is 4.00 x 10^{-2} at a very high temperature. The reaction is at equilibrium at this temperature with $[N_2] = [O_2]$ = 0.100 M and [NO] = 0.0200 M in a 2.00 liter flask.

If 0.120 mol of NO is suddenly added to the reaction mixture, what will be the concentrations of all species when equilibrium is reestablished? (*It's an algebra problem.*)

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5. $$H_{2(g)} + CO_{2(g)} \leftrightarrow H_2O_{(g)} + CO_{(g)}$$

For the reaction above, an equilibrium mixture in a 5.0 L container at a certain temperature was analyzed and found to contain

H_2= 0.585 moles, CO_2 = 1.585 moles, H_2O = 0.665 moles, and CO = 0.665 moles.

(A) Calculate the equilibrium constant Kc.

(B) If the volume of the system at equilibrium were increased, how would the new quantity of H_2O (after equilibrium is re-established) compare to the original equilibrium quantity?

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6. The reaction

$$CO_{(g)} + H_2O_{(g)} \leftrightarrow CO_{2(g)} + H_{2(g)}$$

has a K_c value of 4.0 at 500°C. Calculate the concentration of all species at equilibrium starting with:

(A) $[CO] = [H_2O]$ = 0.100 M and $[CO_2] = [H_2]$ = 0.00 M

(B) $[CO] = [H_2O] = [CO_2] = [H_2]$ = 0.040 M