AP Chemistry Unit 9 - Equilibrium

Unit 9 Review 11

1) How many moles of NaF must be dissolved in 1.00 liter of a saturated solution of PbF_2 at 25 °C to reduce the [Pb2$^+$] to $1x10^{-6}$ molar? (*Ksp* of PbF_2 at 25 °C = $4.0x10^{-8}$)

a) 0.020 mole

b) 0.040 mole

c) 0.20 mole

d) 0.40 mole

2) $\mathbf{2\ SO_{2(g)} + O_{2(g)} \leftrightarrow 2\ SO_{3(g)}}$

When 0.40 mole of SO_2 and 0.60 mole of O_2 are placed in an evacuated 1.00-liter flask, the reaction represented above occurs. After the reactants and the product reach equilibrium and the initial temperature is restored, the flask is found to contain 0.30 mole of SO_3. Based on these results, the expression for the equilibrium constant, *Kc*, of the reaction is

a) $\frac{[0.30]^2}{[0.45][0.10]^2}$

b) $\frac{[0.30]^2}{[0.60][0.40]^2}$

c) $\frac{[0.30]}{[0.45][0.10]}$

d) $\frac{[0.30]}{[0.45][0.10]}$

3) $\mathbf{2\ NO_{(g)} + O_{2(g)} \leftrightarrow 2NO_{2(g)}}$ $\quad \Delta H < 0$

Which of the following changes alone would cause a decrease in the value of *Keq* for the reaction represented above?

a) Decreasing the temperature

b) Increasing the temperature

c) Decreasing the volume of the reaction vessel

d) Adding a catalyst

4) What is the molar solubility in water of Ag_2CrO_4? (The *Ksp* for Ag_2CrO_4 is 8×10^{-12})

a) $8 \times 10^{-12}\ M$

b) $2 \times 10^{-12}\ M$

c) $\sqrt[3]{(4x10^{-12})}M$

d) $\sqrt[3]{(2x10^{-12})}M$

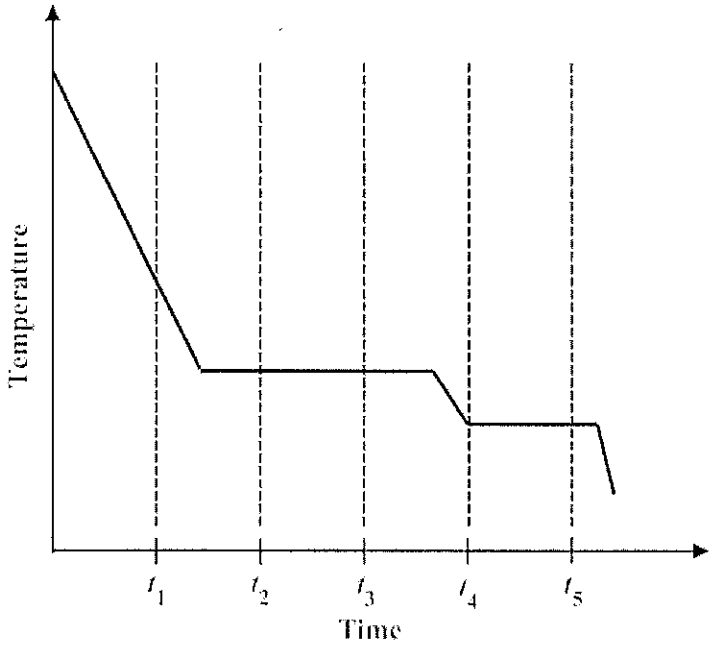
5) In a saturated solution of $Zn(OH)_2$ at 25°C, the value of $[OH^-]$ is $2.0 \times 10^{-6}\ M$. What is the value of the solubility product constant, *Ksp*, for $Zn(OH)_2$ at 25°C ?

a) 4.0×10^{-18}

b) 8.0×10^{-18}

c) 1.6×10^{-17}

d) 4.0×10^{-12}



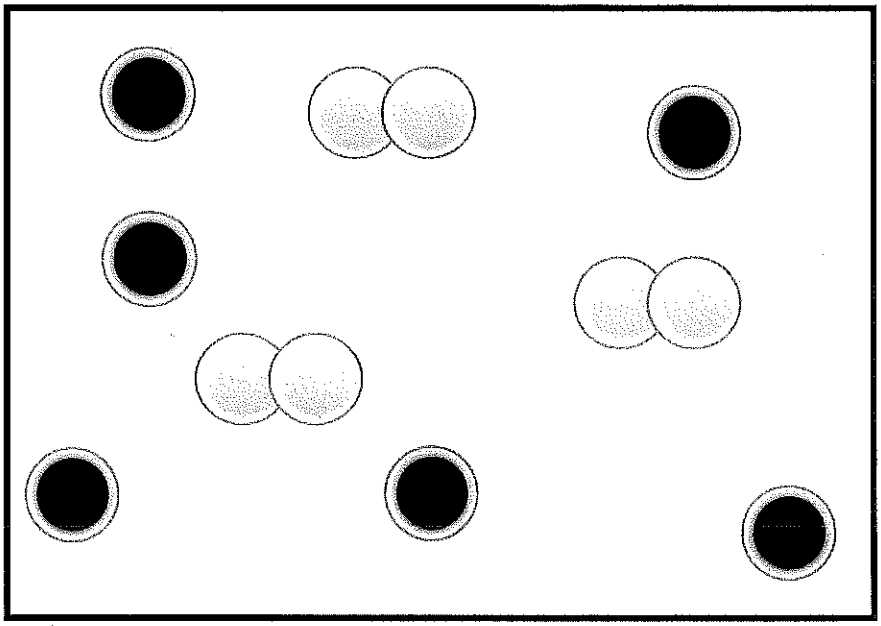
6) The cooling curve above shows how the temperature of a sample varies with time as the sample goes through phase changes. The sample starts as a gas, and heat is removed at a constant rate. At which time does the sample contain the most liquid?

a) t_1

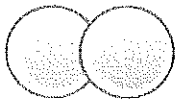
b) t_2

c) t_3

d) t_4



$NO_2 =$ 

$N_2O_4 =$ 

7) The diagram above represents a mixture of $NO_{2(g)}$ and $N_2O_{4(g)}$ in a 1.0 L container at a given temperature. The two gases are in equilibrium according to the equation $2\ NO_{2(g)} \leftrightarrow N_2O_{4(g)}$. Which of the following must be true about the value of the equilibrium constant for the reaction at this temperature?

a) $K = 0$

b) $0 < K < 1$

c) $K = 1$

d) $K > 1$

8) $\mathbf{2A_{(g)} \leftrightarrow 2\ B_{(g)} + C_{(g)} \qquad K = 1.6 \times 10^4}$

Two moles of Gas A are placed into a closed system where the temperature is held constant at 270 K and allowed to reach equilibrium as represented by the chemical reaction shown above. After 15 minutes at equilibrium, additional Gas B is injected into the reaction vessel. Which of the following best describes the behavior of the equilibrium mixture in response to the addition of Gas B?

a) The concentration of Gas A increases.
b) The concentration of Gas C increases.
c) The value of the equilibrium constant increases.
d) There is no observable effect since the equilibrium was already established.

9) Precipitates are insoluble ionic solid products of a reaction, in which certain cations and anions combine in an aqueous solution. The determining factors of the formation of a precipitate can vary. Which of the following leads to the formation of a precipitate?

a) $Q = K_{sp}$
b) $Q < K_{sp}$
c) $Q > K_{sp}$
d) $Q = 1$

10) Which of the following statements concerning equilibrium is TRUE?

a) Catalysts effectively change the position of an equilibrium.
b) The concentration of the products equals the concentration of reactants for a reaction at equilibrium.
c) The equilibrium constant may be expressed in terms of pressure or in terms of concentration for **any** reaction.
d) When two opposing processes proceed at the same rate, the system is at equilibrium.

Wkst: Unit 9 Review II

$$2\,H_2S(g) \rightleftharpoons 2\,H_2(g) + S_2(g)$$

#1) When heated, hydrogen sulfide gas decomposes according to the equation above. A 3.40 g sample of $H_2S(g)$ is introduced into an evacuated rigid 1.25 L container. The sealed container is heated to 483 K, and 3.72×10^{-2} mol of $S_2(g)$ is present at equilibrium.

(a) Write the expression for the equilibrium constant, Kc , for the decomposition reaction represented above. (1pt)

(b) Calculate the equilibrium concentration, in mol L^{-1}, of H_2 and H_2S in the container at 483 K. (3pts)

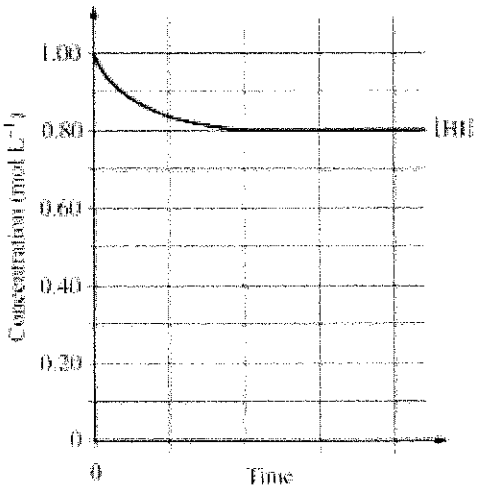
(c) Calculate the value of the equilibrium constant, Kc , for the decomposition reaction at 483 K. (1pt)

(d) Calculate the partial pressure of $S_2(g)$ in the container at equilibrium at 483 K. (1pt)

(e) For the reaction $H_2(g) + \frac{1}{2} S_2(g) \rightleftharpoons H_2S(g)$ at 483 K, calculate the value of the equilibrium constant, Kc (1pt)

$$2\,HI(g) \leftrightharpoons H_2(g) + I_2(g)$$

#2) After a 1.0 mole sample of HI(g) is placed into an evacuated 1.0 L container at 700. K, the reaction represented above occurs. The concentration of HI(g) as a function of time is shown below.



(a) What is [HI] at equilibrium? (1pt)

(b) It is determined that 0.10 mol of $H_2(g)$ is present at equilibrium. On the graph above, make a sketch on your answer pages that shows how the concentration of $H_2(g)$ changes as a function of time. (2pt)

(c) Calculate the value of Kp and Kc equilibrium constants at 700. K. (4pt)

#3) A sample of solid U_3O_8 is placed in a rigid 1.500 L flask. Chlorine gas, $Cl_2(g)$, is added, and the flask is heated to 862°C. The equation for the reaction that takes place and the equilibrium-constant expression for the reaction are given below.

$$U_3O_8(s) + 3\ Cl_2(g) \rightleftharpoons 3\ UO_2Cl_2(g) + O_2(g) \qquad K_p = \frac{(P_{UO_2Cl_2})^3 (P_{O_2})}{(P_{Cl_2})^3}$$

When the system is at equilibrium, the partial pressure of $Cl_2(g)$ is 1.007 atm and the partial pressure of $UO_2Cl_2(g)$ is 9.734×10^{-4} atm.

a) Calculate the partial pressure of $O_2(g)$ at equilibrium at 862°C. (2pt)

b) Calculate the value of the equilibrium constant, Kp, for the system at 862°C. (2pt)

c) After a certain period of time, 1.000 mol of $O_2(g)$ is added to the mixture in the flask. Does the mass of $U_3O_8(s)$ in the flask increase, decrease, or remain the same? Justify your answer. (2pt)

4) Solve the following problem related to the solubility equilbria of some metal hydroxides in aqueous solutions.

a) The solubility of $Cu(OH)_2$ (s) is 1.72×10^{-6} g/100ml of solution at 25°C

i) Write the balanced chemical equation for the dissociation of $Cu(OH)_2$ in aqueous solution

ii) Calculate the value of Ksp for $Cu(OH)_2$ at 25°C

b) The value of Ksp for $Zn(OH)_2$ is 7.7×10^{-17} at 25°C

i) If 50.0 ml of .100M $ZnCl_2$ is mixed with 50.0 ml of 0.300M Na(OH). Will a precipitate form? Assume that the volumes are additive.