Name: _____ Period: _____ Assigned on Monday, March 09, 2026

10.1 Finding Equilibrium Concentrations **Due Tuesday, March 10, 2026**

1. K_{eq}= 4.65 x 10^{-12} for the reaction: $2CH_4\,(g) \rightleftharpoons H_2C_2\,(g) + 3H_2\,(g)$
   If the initial concentration of CH_4 is 0.00300 M:

   a) Is this a reactant favored or product favored equilibrium? _____

   b) Calculate the equilibrium concentration of all species.

2. For the reaction shown below, initially a mixture contains 0.850 mol each of N_2 and O_2 in an 8.00 L vessel. Find the concentrations of each gas in the mixture when equilibrium is reached. K_c = 0.0123 at the reaction temperature. (Note: You must calculate the initial concentrations of each substance using the moles and volumes you are given! The "c" in K_c means concentration!)

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

3. HCl(g) can react with methanol vapor, $CH_3OH(g)$, to produce $CH_3Cl(g)$, as represented by the following equation:

   $CH_3OH(g) + HCl(g) \rightleftharpoons CH_3Cl(g) + H_2O(g)$ $K_P = 4.7x10^3$ at 400 K

   $CH_3OH(g)$ and HCl(g) are combined in a 10.0 L sealed reaction vessel and allowed to reach equilibrium at 400 K. The initial partial pressure of $CH_3OH(g)$ in the vessel is 0.250 atm and that of HCl(g) is 0.600 atm.

   a) Identify all the types of intermolecular forces that exist among molecules of $CH_3OH(g)$ and among molecules of HCl(g).

   b) In terms of intermolecular forces, explain which substance in part (a) you would expect to have the higher boiling point.

   c) Does the total pressure in the vessel increase, decrease, or remain the same as equilibrium is approached? Justify your answer in terms of the reaction stoichiometry.

   d) Considering the value of K_P, calculate the final partial pressure of each species present after the system inside the vessel reaches equilibrium at 400 K.

   e) How many moles of HCl(g) were placed initially in the reaction vessel? (Must use the ideal gas law for this if you have studied it already on your own...if not skip this.)

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

   At 450°C, 2.0 moles each of $H_2(g)$, $I_2(g)$, and HI(g) are combined in a 1.0 L rigid container. The value of K_C at 450°C is 50. Which of the following will occur as the system moves toward equilibrium?

   A) More $H_2(g)$ and $I_2(g)$ will form.
   B) More HI(g) will form.
   C) The total pressure will decrease.
   D) No net reaction will occur, because the number of molecules is the same on both sides of the equation.

Answers on last page of digital copy on website.

Answers

1a) reactant
b) $[H_2C_2] = 3.53x10^{-5}M$; $[H_2] = 1.06x10^{-4}$ M; $[CH_4] = 0.00300$ M

2) (remember, this was changed from the original assignment…make sure you did the current version of this problem)
$[N_2]_{eq} = 0.100$ M; $[O_2]_{eq} = 0.100$ M; $[NO]_{eq} = 0.0112$ M

3a) CH_3OH has hydrogen bonds, dipole-dipole forces, and dispersion forces; HCl has dipole-dipole forces and dispersion forces
b) CH_3OH will have the higher boiling point as its molecules are held together with stronger hydrogen bonds than HCl's dipole-dipole forces
c) Stays the same as the moles of gas are equal on both sides of the equation. As one mole of reactant is lost, one mole of product is produced.
d) $P_{CH3OH} = 0$ atm; $P_{HCl} = 0.35$ atm; $P_{CH3Cl} = 0.25$ atm; $P_{H2O} = 0.25$ atm
e) (Use ideal gas law) n = 0.183 mol

4) B