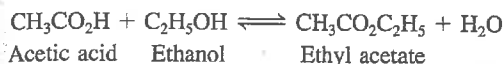


TRY SOME OF THESE PROBLEMS — GOOD PRACTICE FOR
 ESPECIALLY 47, 51, 53 Exercises 04/ THE QUIZ!

38. Ethyl acetate is synthesized in a nonreacting solvent (not ether) according to the following reaction:

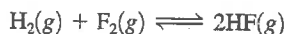


$$K = 2.2$$

For the following mixtures (a–d), will the concentration of H_2O increase, decrease, or remain the same as equilibrium is established?

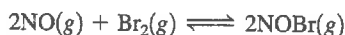
- $[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5] = 0.22 \text{ M}$, $[\text{H}_2\text{O}] = 0.10 \text{ M}$, $[\text{CH}_3\text{CO}_2\text{H}] = 0.010 \text{ M}$, $[\text{C}_2\text{H}_5\text{OH}] = 0.010 \text{ M}$
- $[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5] = 0.22 \text{ M}$, $[\text{H}_2\text{O}] = 0.0020 \text{ M}$, $[\text{CH}_3\text{CO}_2\text{H}] = 0.0020 \text{ M}$, $[\text{C}_2\text{H}_5\text{OH}] = 0.10 \text{ M}$
- $[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5] = 0.88 \text{ M}$, $[\text{H}_2\text{O}] = 0.12 \text{ M}$, $[\text{CH}_3\text{CO}_2\text{H}] = 0.044 \text{ M}$, $[\text{C}_2\text{H}_5\text{OH}] = 6.0 \text{ M}$
- $[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5] = 4.4 \text{ M}$, $[\text{H}_2\text{O}] = 4.4 \text{ M}$, $[\text{CH}_3\text{CO}_2\text{H}] = 0.88 \text{ M}$, $[\text{C}_2\text{H}_5\text{OH}] = 10.0 \text{ M}$
- What must the concentration of water be for a mixture with $[\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5] = 2.0 \text{ M}$, $[\text{CH}_3\text{CO}_2\text{H}] = 0.10 \text{ M}$, $[\text{C}_2\text{H}_5\text{OH}] = 5.0 \text{ M}$ to be at equilibrium?
- Why is water included in the equilibrium expression for this reaction?

39. The equilibrium constant, K , for the reaction



has the value 2.1×10^3 at a particular temperature. When the system is analyzed at equilibrium at this temperature, the concentrations of $\text{H}_2(\text{g})$ and $\text{F}_2(\text{g})$ are both found to be 0.0021 M . What is the concentration of $\text{HF}(\text{g})$ in the equilibrium system under these conditions?

40. The reaction



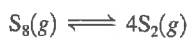
has $K_p = 109$ at 25°C . If the equilibrium partial pressure of Br_2 is 0.0159 atm and the equilibrium partial pressure of NOBr is 0.0768 atm , calculate the partial pressure of NO at equilibrium.

41. A 1.00-L flask was filled with 2.00 mol gaseous SO_2 and 2.00 mol gaseous NO_2 and heated. After equilibrium was reached, it was found that 1.30 mol gaseous NO was present. Assume that the reaction



occurs under these conditions. Calculate the value of the equilibrium constant, K , for this reaction.

42. A sample of $\text{S}_8(\text{g})$ is placed in an otherwise empty rigid container at 1325 K at an initial pressure of 1.00 atm , where it decomposes to $\text{S}_2(\text{g})$ by the reaction



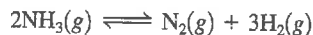
At equilibrium, the partial pressure of S_8 is 0.25 atm . Calculate K_p for this reaction at 1325 K .

43. At a particular temperature, 12.0 mol of SO_3 is placed into a 3.0-L rigid container, and the SO_3 dissociates by the reaction



At equilibrium, 3.0 mol of SO_2 is present. Calculate K for this reaction.

44. At a certain temperature, 4.0 mol NH_3 is introduced into a 2.0-L container, and the NH_3 partially dissociates by the reaction



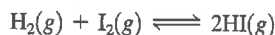
At equilibrium, 2.0 mol NH_3 remains. What is the value of K for this reaction?

45. At a particular temperature, $K = 3.75$ for the reaction



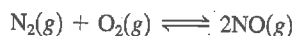
If all four gases had initial concentrations of 0.800 M , calculate the equilibrium concentrations of the gases.

46. At a particular temperature, $K = 1.00 \times 10^2$ for the reaction



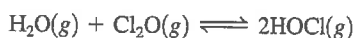
In an experiment, 1.00 mol H_2 , 1.00 mol I_2 , and 1.00 mol HI are introduced into a 1.00-L container. Calculate the concentrations of all species when equilibrium is reached.

47. At 2200°C , $K_p = 0.050$ for the reaction



What is the partial pressure of NO in equilibrium with N_2 and O_2 that were placed in a flask at initial pressures of 0.80 and 0.20 atm , respectively?

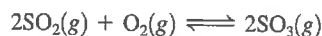
48. At 25°C , $K = 0.090$ for the reaction



Calculate the concentrations of all species at equilibrium for each of the following cases.

- 1.0 g H_2O and 2.0 g Cl_2O are mixed in a 1.0-L flask.
- 1.0 mol pure HOCl is placed in a 2.0-L flask.

49. At 1100 K , $K_p = 0.25$ for the reaction



Calculate the equilibrium partial pressures of SO_2 , O_2 , and SO_3 produced from an initial mixture in which $P_{\text{SO}_2} = P_{\text{O}_2} = 0.50 \text{ atm}$ and $P_{\text{SO}_3} = 0$. (Hint: If you don't have a graphing calculator, then use the method of successive approximations to solve, as discussed in Appendix 1.4.)

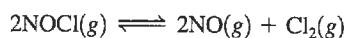
50. At a particular temperature, $K_p = 0.25$ for the reaction



- A flask containing only N_2O_4 at an initial pressure of 4.5 atm is allowed to reach equilibrium. Calculate the equilibrium partial pressures of the gases.

- b. A flask containing only NO_2 at an initial pressure of 9.0 atm is allowed to reach equilibrium. Calculate the equilibrium partial pressures of the gases.
- c. From your answers to parts a and b, does it matter from which direction an equilibrium position is reached?

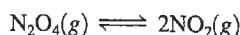
51. At 35°C , $K = 1.6 \times 10^{-5}$ for the reaction



Calculate the concentrations of all species at equilibrium for each of the following original mixtures.

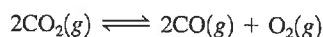
- a. 2.0 mol pure NOCl in a 2.0-L flask
 b. 1.0 mol NOCl and 1.0 mol NO in a 1.0-L flask
 c. 2.0 mol NOCl and 1.0 mol Cl_2 in a 1.0-L flask

52. At a particular temperature, $K = 4.0 \times 10^{-7}$ for the reaction



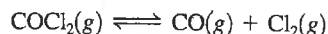
In an experiment, 1.0 mol N_2O_4 is placed in a 10.0-L vessel. Calculate the concentrations of N_2O_4 and NO_2 when this reaction reaches equilibrium.

53. At a particular temperature, $K = 2.0 \times 10^{-6}$ for the reaction



If 2.0 mol CO_2 is initially placed into a 5.0-L vessel, calculate the equilibrium concentrations of all species.

54. Lexan is a plastic used to make compact discs, eyeglass lenses, and bullet-proof glass. One of the compounds used to make Lexan is phosgene (COCl_2), an extremely poisonous gas. Phosgene decomposes by the reaction



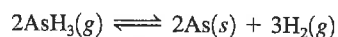
for which $K_p = 6.8 \times 10^{-9}$ at 100°C . If pure phosgene at an initial pressure of 1.0 atm decomposes, calculate the equilibrium pressures of all species.

55. At 25°C , $K_p = 2.9 \times 10^{-3}$ for the reaction



In an experiment carried out at 25°C , a certain amount of $\text{NH}_4\text{OCONH}_2$ is placed in an evacuated rigid container and allowed to come to equilibrium. Calculate the total pressure in the container at equilibrium.

56. The gas arsine, AsH_3 , decomposes as follows:



In an experiment at a certain temperature, pure $\text{AsH}_3(g)$ was placed in an empty, rigid, sealed flask at a pressure of 392.0 torr. After 48 hours the pressure in the flask was observed to be constant at 488.0 torr.

- a. Calculate the equilibrium pressure of $\text{H}_2(g)$
 b. Calculate K_p for this reaction.

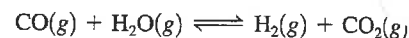
Le Châtelier's Principle

57. Suppose the reaction system



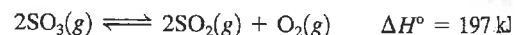
has already reached equilibrium. Predict the effect that each of the following changes has on the equilibrium position: whether the equilibrium will shift to the right, will shift to the left, or will not be affected.

- a. Additional $\text{UO}_2(s)$ is added to the system.
 b. The reaction is performed in a glass reaction vessel; HF attacks and reacts with glass.
 c. Water vapor is removed.
58. Predict the shift in the equilibrium position that will occur for each of the following reactions when the volume of the reaction container is increased.
- a. $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$
 b. $\text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$
 c. $\text{H}_2(g) + \text{F}_2(g) \rightleftharpoons 2\text{HF}(g)$
 d. $\text{COCl}_2(g) \rightleftharpoons \text{CO}(g) + \text{Cl}_2(g)$
 e. $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$
59. An important reaction in the commercial production of hydrogen is



How will this system at equilibrium shift in each of the following cases?

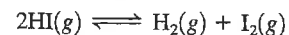
- a. Gaseous carbon dioxide is removed.
 b. Water vapor is added.
 c. The pressure is increased by adding helium gas.
 d. The temperature is increased (the reaction is exothermic).
 e. The pressure is increased by decreasing the volume of the reaction container.
60. What will happen to the number of moles of SO_3 in equilibrium with SO_2 and O_2 in the reaction



in each of the following cases?

- a. Oxygen gas is added.
 b. The pressure is increased by decreasing the volume of the reaction container.
 c. The pressure is increased by adding argon gas.
 d. The temperature is decreased.
 e. Gaseous sulfur dioxide is removed.

61. In which direction will the position of the equilibrium



be shifted for each of the following changes?

- a. $\text{H}_2(g)$ is added.
 b. $\text{I}_2(g)$ is removed.
 c. $\text{HI}(g)$ is removed.

1/3/2010