The equilibrium constant of this reaction at 298 K (25°C) is 3.896×10^{-27}, but at 1100 K the constant is 3.112×10^{2}.

a. What do these equilibrium constants tell you about the progress of the reaction at the two temperatures?

b. Suppose the reaction mixture is sampled at 1100 K and found to contain 1.56 M of hydrogen, 3.70×10^{-2} M of methane, and 8.27×10^{-1} M of gaseous H_2O. What concentration of carbon monoxide would you expect to find?

516. Dinitrogen tetroxide, N_2O_4, is soluble in cyclohexane, a common nonpolar solvent. While in solution, N_2O_4 can break down into NO_2 according to the following equation:

$$N_2O_4(cyclohexane) \rightleftarrows NO_2(cyclohexane)$$

At 20°C, the following concentrations were observed for this equilibrium reaction:

$[N_2O_4] = 2.55 \times 10^{-3}$ M

$[NO_2] = 10.4 \times 10^{-3}$ M

What is the value of the equilibrium constant for this reaction? Note: the chemical equation must be balanced first.

517. The reaction given in item 516 also occurs when the dinitrogen tetroxide and nitrogen dioxide are dissolved in carbon tetrachloride, CCl_4, another nonpolar solvent.

$$N_2O_4(CCl_4) \rightleftarrows NO_2(CCl_4)$$

The following experimental data were obtained at 20°C:

$[N_2O_4] = 2.67 \times 10^{-3}$ M

$[NO_2] = 10.2 \times 10^{-3}$ M

Calculate the value of the equilibrium constant for this reaction occurring in carbon tetrachloride.

Equilibrium of Acids and Bases K_a and K_b: Chap. 18, Sec. 3

518. At 25°C, a 0.025 M solution of formic acid, HCOOH, is found to have a hydronium ion concentration of 2.03×10^{-3} M. Calculate the ionization constant of formic acid.

519. The pH of a 0.400 M solution of iodic acid, HIO_3, is 0.726 at 25°C. What is the K_a at this temperature?

520. The pH of a 0.150 M solution of hypochlorous acid, HClO, is found to be 4.55 at 25°C. Calculate the K_a for HClO at this temperature.

521. The compound propylamine, $CH_3CH_2CH_2NH_2$, is a weak base. At equilibrium, a 0.039 M solution of propylamine has an OH^- concentration of 3.74×10^{-3} M. Calculate the pH of this solution and K_b for propylamine.

522. The K_a of nitrous acid is 4.6×10^{-4} at 25°C. Calculate the $[H_3O^+]$ of a 0.0450 M nitrous acid solution.

Mixed Review

523. Hydrazoic acid, HN_3, is a weak acid. The $[H_3O^+]$ of a 0.102 M solution of hydrazoic acid is 1.39×10^{-3} M. Determine the pH of this solution, and calculate K_a at 25°C for HN_3.

524. Bromoacetic acid, $BrCH_2COOH$, is a moderately weak acid. A 0.200 M solution of bromoacetic acid has a H_3O^+ concentration of 0.0192 M. Determine the pH of this solution and the K_a of bromoacetic acid at 25°C.

525. A base, B, dissociates in water according to the following equation:

$$B + H_2O \rightleftarrows BH^+ + OH^-$$

Complete the following table for base solutions with the characteristics given.

Initial [B]	*[B] at Equilibrium*	*$[OH^-]$*	*K_b*	*$[H_3O^+]$*	*pH*
a. 0.400 M	NA	2.70×10^{-4} M	?	? M	?
b. 0.005 50 M	? M	8.45×10^{-4} M	?	NA	?
c. 0.0350 M	? M	? M	?	? M	11.29
d. ? M	0.006 28 M	0.000 92 M	?	NA	?

526. The solubility of benzoic acid, C_6H_5COOH, in water at 25°C is 2.9 g/L. The pH of this saturated solution is 2.92. Determine K_a at 25°C for benzoic acid. (Hint: first calculate the initial concentration of benzoic acid.)

527. A 0.006 50 M solution of ethanolamine, $H_2NCH_2CH_2OH$, has a pH of 10.64 at 25°C. Calculate the K_b of ethanolamine. What concentration of undissociated ethanolamine remains at equilibrium?

528. The weak acid hydrogen selenide, H_2Se, has two hydrogen atoms that can form hydronium ions. The second ionization is so small that the concentration of the resulting H_3O^+ is insignificant. If the $[H_3O^+]$ of a 0.060 M solution of H_2Se is 2.72×10^{-3} M at 25°C, what is the K_a of the first ionization?

529. Pyridine, C_5H_5N, is a very weak base. Its K_b at 25°C is 1.78×10^{-9}. Calculate the $[OH^-]$ and pH of a 0.140 M solution. Assume that the concentration of pyridine at equilibrium is equal to its initial concentration because so little pyridine is dissociated.

530. A solution of a monoprotic acid, HA, at equilibrium is found to have a 0.0208 M concentration of nonionized acid. The pH of the acid solution is 2.17. Calculate the initial acid concentration and K_a for this acid.

531. Pyruvic acid, $CH_3COCOOH$, is an important intermediate in the metabolism of carbohydrates in the cells of the body. A solution made by dissolving 438 mg of pyruvic acid in 10.00 mL of water is found to have a pH of 1.34 at 25°C. Calculate K_a for pyruvic acid.