AP Chemistry 2003

$$C_6H_5NH_2(aq) + H_2O(l) \rightleftarrows C_6H_5NH_3^+(aq) + OH^-(aq)$$

1. Aniline, a weak base, reacts with water according to the reaction represented above.

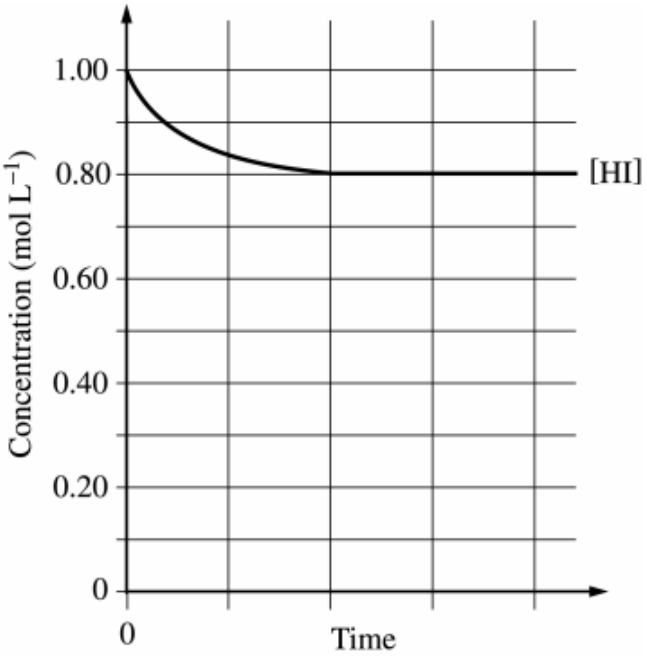
   (a) Write the equilibrium constant expression, K_b, for the reaction represented above.

   (b) A sample of aniline is dissolved in water to produce 25.0 mL of a 0.10 M solution. The pH of the solution is 8.82. Calculate the equilibrium constant, K_b, for this reaction.

AP Chemistry 2003 Form B

$$2\ HI(g) \rightleftarrows H_2(g) + I_2(g)$$

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) Write the expression for the equilibrium constant, K_c, for the reaction.

(b) What is [HI] at equilibrium?

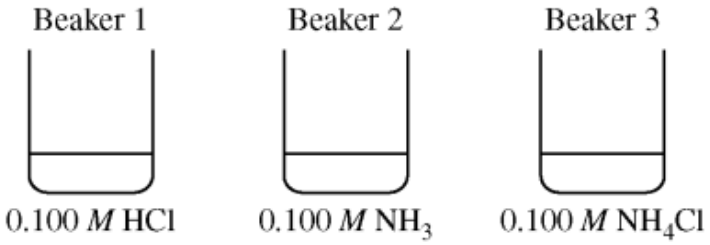
(c) Determine the equilibrium concentrations of $H_2(g)$ and $I_2(g)$.

(d) On the graph above, make a sketch that shows how the concentration of $H_2(g)$ changes as a function of time.

(e) Calculate the value of the following equilibrium constants at 700. K.

   (i) K_c

AP Chemistry 2011



Each of three beakers contains 25.0 mL of a 0.100 *M* solution of HCl, NH_3, or NH_4Cl, as shown above. Each solution is at 25°C.

(a) Determine the pH of the solution in beaker 1. Justify your answer.

(b) In beaker 2, the reaction $NH_3(aq) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$ occurs. The value of K_b for $NH_3(aq)$ is 1.8×10^{-5} at 25°C.

(i) Write the K_b expression for the reaction of $NH_3(aq)$ with $H_2O(l)$.

(ii) Calculate the $[OH^-]$ in the solution in beaker 2.

AP Chemistry 2010

Several reactions are carried out using AgBr, a cream-colored silver salt for which the value of the solubility-product constant, K_{sp}, is 5.0×10^{-13} at 298 K.

(a) Write the expression for the solubility-product constant, K_{sp}, of AgBr.

(b) Calculate the value of $[Ag^+]$ in 50.0 mL of a saturated solution of AgBr at 298 K.

(c) A 50.0 mL sample of distilled water is added to the solution described in part (b), which is in a beaker with some solid AgBr at the bottom. The solution is stirred and equilibrium is reestablished. Some solid AgBr remains in the beaker. Is the value of $[Ag^+]$ greater than, less than, or equal to the value you calculated in part (b) ? Justify your answer.

AP Chemistry 2007

$$HF(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + F^-(aq) \qquad K_a = 7.2 \times 10^{-4}$$

Hydrofluoric acid, HF(*aq*), dissociates in water as represented by the equation above.

(a) Write the equilibrium-constant expression for the dissociation of HF(*aq*) in water.

(b) Calculate the molar concentration of H_3O^+ in a 0.40 *M* HF(*aq*) solution.

AP Chemistry 2003 Solution Guide

$K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$	1 point for correct expression

pH = 8.82 pOH = 14 – 8.82 = 5.18 $[OH^-] = 10^{-5.18} = 6.61 \times 10^{-6}\ M$ $[C_6H_5NH_3^+] = [OH^-] = 6.6 \times 10^{-6}\ M$ $K_b = \frac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]} = \frac{(6.6 \times 10^{-6})^2}{0.10}$ $K_b = 4.4 \times 10^{-10}$	 1 point for calculation of $[OH^-]$ 1 point for $[C_6H_5NH_3^+] = [OH^-]$ 1 point for calculation of K_b

AP Chemistry 2003 Form B Solution Guide

$K_c = \frac{[H_2][I_2]}{[HI]^2}$	1 point for correct expression

From the graph, $[HI]_{eq}$ is 0.80 M	1 point for equilibrium [HI]

$2\ HI(g) \rightarrow H_2(g) + I_2(g)$ I 1.0 M 0 0 C –0.20 M +0.10 M +0.10 M E 0.80 M 0.10 M 0.10 M $[I_2] = [H_2] = 0.10\ M$	1 point for stoichiometric relationship between HI reacting and $H_2(g)$ or $I_2(g)$ forming 1 point for $[H_2]_{eq}$ and $[I_2]_{eq}$

From the graph, $[H_2]_{eq}$ is 0.10 M The curve should have the following characteristics: - start at 0 M; - increase to 0.1 M; - reach equilibrium at the same time [HI] reaches equilibrium	 1 point for any two characteristics 2 points for all three characteristics

$K_c = \frac{[H_2][I_2]}{[HI]^2} = \frac{[0.10][0.10]}{[0.80]^2} = 0.016$	1 point for correct substitution (must agree with parts (b) and (c))

AP Chemistry 2011 Solution Guide

$pH = -\log[H^+] = -\log(0.100) = 1.000$	1 point is earned for the correct pH.

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$	1 point is earned for the correct expression.

Let $[OH^-] = x$, then $K_b = \frac{(x)(x)}{(0.100 - x)}$ Assume that $x << 0.100\ M$, then $1.8 \times 10^{-5} = \frac{x^2}{0.100} \Rightarrow x = [OH^-] = 1.3 \times 10^{-3}\ M$	1 point is earned for the correct setup. 1 point is earned for the correct answer.

AP Chemistry 2010 Solution Guide

$K_{sp} = [Ag^+][Br^-]$	One point is earned for the correct expression (ion charges must be present; parentheses instead of square brackets not accepted).

Let x = equilibrium concentration of Ag^+ (and of Br^-). Then $K_{sp} = 5.0 \times 10^{-13} = x^2 \Rightarrow x = 7.1 \times 10^{-7}\ M$	One point is earned for the correct value with supporting work (units not necessary).

The value of $[Ag^+]$ after addition of distilled water is equal to the value in part (b). The concentration of ions in solution in equilibrium with a solid does <u>not</u> depend on the volume of the solution.	One point is earned for the correct answer with justification.

AP Chemistry 2007 Solution Guide

$K_a = \frac{[H_3O^+][F^-]}{[HF]}$	One point is earned for the correct expression.

$K_a = \frac{[H_3O^+][F^-]}{[HF]} = \frac{(x)(x)}{0.40 - x} = 7.2 \times 10^{-4}$ Assume $x << 0.40$, then $x^2 = (0.40)(7.2 \times 10^{-4})$ $x = [H_3O^+] = 0.017\ M$	One point is earned for the correct setup (or the setup consistent with part (a)). One point is earned for the correct concentration.