

## Answers to More Chapters 15 &amp; 16 Study Questions

- $$1. \frac{K_a}{[H^+]} = \frac{[C_3H_5O_2^-]}{[HC_3H_5O_2]} = \frac{1.3 \times 10^{-5}}{1.0 \times 10^{-5}} = 1.3$$
- $$2. pH = pK_a + \log \frac{[H_2BO_3^-]}{[H_3BO_3]}; \quad pK_a = -\log(5.8 \times 10^{-10}) = 9.24; \quad pH = 9.24 + \log \frac{1.5}{1}$$

$$= 9.24 + 0.18 = 9.42$$
- $$3. Na_2SO_4(aq) + Sr(NO_3)_2(aq) \rightarrow 2 NaNO_3(aq) + SrSO_4(s)$$

$$SrSO_4(s) \rightleftharpoons Sr^{2+}(aq) + SO_4^{2-}(aq) \quad K_{sp} = [Sr^{2+}] \times [SO_4^{2-}] \quad K_{sp} = 3.2 \times 10^{-7}$$

$$x = [Na_2SO_4] = [SO_4^{2-}]; [Sr^{2+}] = 0.10 \text{ M}$$

$$3.2 \times 10^{-7} = (0.10 \text{ M})(x); \quad x = (3.2 \times 10^{-7})/0.10 \text{ M} = 3.2 \times 10^{-6} \text{ M}$$
- $$4. Pb(IO_3)_2(s) \rightleftharpoons Pb^{2+}(aq) + 2 IO_3^-(aq); \quad K_{sp} = [Pb^{2+}] \times [IO_3^-]^2$$

$$[Pb^{2+}] = [Pb(IO_3)_2] = 2.6 \times 10^{-11} \text{ M}; \quad [IO_3^-] = [KIO_3] + [Pb(IO_3)_2] \approx [KIO_3] = 0.10 \text{ M}$$

$$K_{sp} = [Pb^{2+}] \times [IO_3^-]^2 = (2.6 \times 10^{-11} \text{ M})(0.10 \text{ M})^2 = 2.6 \times 10^{-13}$$
- $$5. PbI_2(s) \rightleftharpoons Pb^{2+}(aq) + 2 I^-(aq); \quad K_{sp} = [Pb^{2+}] \times [I^-]^2; \quad K_{sp} = 1.4 \times 10^{-8}$$

$$x = [PbI_2] = [Pb^{2+}]; \quad [I^-] = 0.010 \text{ M} + 2 [Pb^{2+}] \approx 0.010 \text{ M}$$

$$K_{sp} = [Pb^{2+}] \times [I^-]^2; \quad 1.4 \times 10^{-8} = x [0.010 \text{ M}]^2; \quad x = (1.4 \times 10^{-8})/(1 \times 10^{-4}) = 1.4 \times 10^{-4} \text{ M}$$
- $$6. PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2 Cl^-(aq); \quad K_{sp} = [Pb^{2+}] \times [Cl^-]^2; \quad K_{sp} = 1.7 \times 10^{-5}$$

$$x = [PbCl_2] = [Pb^{2+}]; \quad [Cl^-] = 2x; \quad 1.7 \times 10^{-5} = x (2x)^2 = 4x^3$$

$$x^3 = (1.7 \times 10^{-5})/4 = 4.2 \times 10^{-6}; \quad x = (4.2 \times 10^{-6})^{1/3} = 0.016 \text{ M}$$
- $$7. Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow 2 NaNO_3(aq) + PbCl_2(s)$$

$$PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2 Cl^-(aq); \quad K_{sp} = [Pb^{2+}] \times [Cl^-]^2; \quad K_{sp} = 1.7 \times 10^{-5}$$

$$x = [Pb(NO_3)_2] = [Pb^{2+}]; \quad [Cl^-] = [NaCl] = 0.010 \text{ M}$$

$$K_{sp} = [Pb^{2+}] \times [Cl^-]^2; \quad 1.7 \times 10^{-5} = x (0.010)^2; \quad x = (1.7 \times 10^{-5})/(1 \times 10^{-4}) = 0.17 \text{ M}$$
- 0.10 M NaOH; pH = 13 → yellow
  - 0.10 M NaOH; pH = 13 → purple
  - cresol red is orange when pH = pK<sub>a</sub>; pH = 1
  - yellow in methyl yellow: pH > 4; yellow in cresol purple: pH < 7; so, 4 < pH < 7

9. a) moles base = moles acid =  $28.0 \text{ mL} \times \frac{0.150 \text{ moles HCl}}{1000 \text{ mL}} = 0.00420 \text{ moles}$

b) molar mass =  $\frac{\text{mass}}{\text{moles}} = \frac{0.290 \text{ g}}{0.00420 \text{ moles}} = 69.0 \text{ g/mole}$

10. a) moles base = moles acid:  $V_B \times M_B = V_A \times M_A$

$2.50 \text{ mL} \times 3.00 \text{ M} = 750 \text{ mL} \times M_A$ ;  $M_A = \frac{2.50 \times 3.00}{750} = 0.0100 \text{ M HCl}$

b)  $\text{pH} = -\log[\text{H}^+] = -\log(1.00 \times 10^{-2} \text{ M})$ ;  $\text{pH} = 2.0$