1. What is the hydroxide ion concentration in an aqueous solution with pH = 3.65?
   a) 2.2×10^{-4}
   b) 2.2×10^{-7}
   c) 4.5×10^{-11}
   d) 6.5×10^{-3}
   e) 1.5×10^{-12}

2. What is the pH of 0.020 M hypochlorous acid (HOCl, $K_a = 3.5 \times 10^{-8}$)?

   a) 9.42
   b) 12.00
   c) 1.69
   d) 3.25
   e) 4.58

3. A 0.15 M solution of a certain acid has a pH of 3.72. What is the value of K_a for this acid?
   a) 2.42×10^{-7}
   b) 1.27×10^{-3}
   c) 2.67×10^{-5}
   d) 4.13×10^{-6}
   e) 3.72×10^{-4}

4. The bisulfate ion, HSO_4^-, can act as either an acid or a base in aqueous solution. In which of the following equations does HSO_4^- act as a Brønsted/Lowry acid?

   a) $HSO_4^- + H_2O \rightleftharpoons H_2SO_4 + OH^-$
   b) $HSO_4^- + H_3O^+ \rightleftharpoons SO_3 + 2H_2O$
   c) $HSO_4^- + OH^- \rightleftharpoons H_2SO_4 + O^{2-}$
   d) $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$
   e) Choices c and d.

5. At 0°C, the autoionization constant of water, K_w, is 1.2×10^{-15}. What is the pH of pure water at 0°C?

   a) 6.58
   b) 6.88
   c) 7.00
   d) 7.46
   e) 7.56

6. The concentration of a certain weak acid was diluted from 1.0 M to 0.30 M. What happened to the pH and the percent dissociation of the acid?

   a) The pH increased and the percent dissociation increased.
   b) The pH increased and the percent dissociation decreased.
   c) The pH decreased and the percent dissociation increased.
   d) The pH decreased and the percent dissociation decreased.
   e) The pH increased and the percent dissociation remained the same.

7. What is the pH of a 5.0 M solution of aniline ($C_6H_5NH_2$; $K_b = 3.8 \times 10^{-10}$)?
   a) 4.36
   b) 9.64
   c) -0.070
   d) 9.30
   e) 8.77

8. A 0.10 mol sample of a diprotic acid, H_2A, was dissolved in 250 mL of solution. The K_{a1} for this acid is 1.0×10^{-5} and K_{a2} is 1.0×10^{-10}. What is the concentration of A^{2-} in this solution?

   a) 1.0×10^{-5} M
   b) 2.0×10^{-3} M
   c) 4.0×10^{-6} M
   d) 1.0×10^{-10} M
   e) 0.40 M

9. What is the pH of a 0.75 M solution of NaF? (K_a for HF = 3.5×10^{-4})

   a) 8.67
   b) 7.00
   c) 12.21
   d) 1.79
   e) 5.33

10. Place the following bases in order increasing base strength:

    HS^-, HSe^-, I^-

    a) $I^- < HSe^- < HS^-$
    b) $HSe^- < HS^- < I^-$
    c) $HS^- < HSe^- < I^-$
    d) $I^- < HS^- < HSe^-$
    e) $HS^- < I^- < HSe^-$

11. Which equation below best describes the reaction that occurs when 0.01 mol HCl(g) is added to a 1.0 L solution containing 0.10 M nitrous acid (HNO_2) and 0.10 M sodium nitrite ($NaNO_2$)?

    a) $HNO_2(aq) + H_2O(l) \rightarrow NO_2^-(aq) + H_3O^+(aq)$
    b) $HNO_2(aq) + H_2O(l) \leftrightarrows NO_2^-(aq) + H_3O^+(aq)$
    c) $HNO_2(aq) + OH^-(aq) \rightarrow NO_2^-(aq) + H_2O(l)$
    d) $HCl(aq) + HNO_2(aq) \rightarrow ClNO(aq) + H_2O(l)$
    e) $H_3O^+(aq) + NO_2^-(aq) \rightarrow HNO_2(aq) + H_2O(l)$

12. Which of the following will give a buffer solution when equal volumes of the two solutions are mixed?

I. 0.10 M $HClO_4$ and 0.10 M $NaClO_4$
II. 0.075 M H_3PO_4 and 0.075 M KH_2PO_4
III. 0.10 M HCN and 0.050 M KOH
IV. 0.050 M KOH and 0.10 M NH_3
V. 0.050 M HNO_3 and 0.10 M NaF

a) I only
b) I and II
c) II, III, and V
d) II, III, IV, and V
e) I, II, III, IV and V

13. What is the pH of a solution containing 0.250 M $HONH_2$ and 0.400 M $HONH_3Cl$? (K_b for $HONH_2$ is 1.1×10^{-8}.)

a) 7.75
b) 8.16
c) 5.84
d) 6.25
e) 12.73

14. A 150.0 mL buffer solution containing 0.100 M hydrocyanic acid (HCN, $K_a = 6.2 \times 10^{-10}$) and 0.100 M sodium cyanide (NaCN) has 30.0 mL of 0.120 M KOH added to it. What is the pH of the solution after the KOH has been added?

a) 8.73
b) 9.42
c) 9.00
d) 9.21
e) 9.29

15. How many mL of 0.100 M HNO_3 should be added to 100.0 mL of 0.100 M methylamine (CH_3NH_2, $K_b = 4.4 \times 10^{-4}$) to form a buffer with a pH of 10.64?

a) 127 mL
b) 73.2 mL
c) 100. mL
d) 50.0 mL
e) 10.0 mL

16. Consider the titration of 40.0 mL of 0.12 M HBr (aq) with 0.10 M NaOH (aq). What is the pH after the addition of 30.0 mL of NaOH?

a) 1.35
b) 1.59
c) 1.22
d) 0.92
e) 1.70

17. What is the pH at the equivalence point in the titration of 50.0 mL of 0.100 M benzoic acid ($HC_7H_5O_2$, $K_a = 6.4 \times 10^{-5}$) with 0.200 M KOH?

a) 8.51
b) 9.81
c) 8.60
d) 11.40
e) 5.40

18. Consider the titration of 60.0 mL of 0.100 M propanoic acid ($HC_3H_5O_2$, $K_a = 1.3 \times 10^{-5}$) with 0.100 M KOH. What is the pH after the addition of 50.0 mL of base?

a) 5.59
b) 4.19
c) 4.89
d) 5.63
e) 6.33

19. The molar solubility of MgF_2 is 1.17×10^{-3} M. What is the value of K_{sp} for MgF_2?

a) 6.4×10^{-9}
b) 1.6×10^{-9}
c) 1.4×10^{-6}
d) 3.2×10^{-9}
e) 2.7×10^{-6}

20. What is the molar solubility of $Fe(OH)_3$ in pure water? (K_{sp} for $Fe(OH)_3$ is 4.0×10^{-38}.)

a) 6.5×10^{-7} M
b) 4.5×10^{-10} M
c) 4.0×10^{-17} M
d) 2.0×10^{-10} M
e) 3.4×10^{-13} M

21. K_{sp} for $PbCl_2$ is 1.7×10^{-5}. If 100 mL of 0.20 M $Pb(NO_3)_2$ is added to 100 mL of 0.020 M NaCl, will a precipitate form?

a) Yes, a precipitate will form.
b) No, a precipitate will not form.

Answers:

1. c	6. a	11. e	16. b	21. b
2. e	7. b	12. c	17. a	
3. a	8. d	13. c	18. a	
4. d	9. a	14. b	19. a	
5. d	10. a	15. d	20. c	