1. Calculate the pH and $[OH^-]$ of a 2.2×10^{-3} M HNO_3 solution.

A. pH = 2.66, $[OH^-] = 2.2 \times 10^{-11}$

B. pH = 2.66, $[OH^-] = 4.5 \times 10^{-12}$

C. pH = 11.34, $[OH^-] = 2.2 \times 10^{-11}$

D. pH = 11.34, $[OH^-] = 4.5 \times 10^{-12}$

2. The autoionization of water

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

has $K_w = 2.93 \times 10^{-15}$ at 10 °C and $K_w = 5.48 \times 10^{-14}$ at 50 °C. The autoionization of water

A. proceeds far to the right.

B. has $\Delta H_{rxn} = 0$.

C. is an exothermic reaction.

D. is an endothermic reaction.

3. What is the pH of a 0.42 M formic acid ($HCHO_2$) solution?
K_a ($HCHO_2$) = 1.8×10^{-4}

A. 4.12

B. 3.74

C. 2.06

D. 0.377

4. What is the H_3O^+ concentration of a pH 13.440 solution?

A. 3.631×10^{-14} M

B. 2.304×10^{-10} M

C. 6.026×10^{-4} M

D. 1.136×10^{-1} M

5. Calculate the % ionization of a 0.25 M benzoic acid ($HC_7H_5O_2$) solution.
K_a ($HC_7H_5O_2$) = 6.5×10^{-5}

A. 0.65%
C. 2.3%
B. 1.6 %
D. 100%

6. Determine the pH of a solution that is 0.60 M HClO (hypochlorous acid) and 0.30 M $HClO_4$ (perchloric acid).
K_a (HClO) = 2.9×10^{-8}

A. 1.64
C. 0.52
B. 0.92
D. 0.22

7. What is the **best** method for finding the pH of a 0.100 M chloroacetic acid ($HC_2H_2O_2Cl$) solution?
K_a ($HC_2H_2O_2Cl$) = 1.4×10^{-3}

A. Solve for $[H^+]$ using the "x is small" approximation.
B. Solve for $[H^+]$ using the quadratic equation.
C. Solve for $[H^+]$ by finding x directly since the quadratic equation is not needed.
D. Solve for $[H^+]$ using the method of perfect squares (taking the square root of both sides of the K_a expression).

8. What is the pK_b of the acetate ion?
K_a (acetic acid) = 1.8×10^{-5}

A. 9.26
C. 5.6×10^{-10}
B. 4.74
D. 1.0×10^{-14}

9. Which is the **strongest** of these bases?

A. pyridine (C_5H_5N), $K_b = 1.7 \times 10^{-9}$

B. ammonia (NH_3), $K_b = 1.8 \times 10^{-5}$

C. carbonate ion (CO_3^{2-}), $K_b = 1.8 \times 10^{-4}$

D. methylamine (CH_3NH_2), $K_b = 4.4 \times 10^{-4}$

10. Determine $[H_3O^+]$ of an ethylamine ($C_2H_5NH_2$) solution with pOH = 9.68.
K_b ($C_2H_5NH_2$) = 4.9×10^{-10}

A. 2.1×10^{-3}

B. 4.8×10^{-5}

C. 9.6×10^{-8}

D. 5.8×10^{-10}

11. What is the pH of a 0.61 M cyanide (CN^-) solution?
K_a (HCN) = 4.9×10^{-10}

A. 4.76

B. 9.52

C. 11.55

D. 14.00

12. Which salt solution will have the indicated pH?

A. NH_4Cl, pH = 7

B. KNO_2, pH < 7

C. CH_3NH_3Br, pH > 7

D. $NaC_2H_3O_2$, pH > 7

13. Which statement is **<u>true</u>** about the K_a values of a diprotic acid?

$$H_2A(aq) + H_2O(l) \rightleftharpoons HA^-(aq) + H_3O^+(aq) \qquad K_{a1}$$
$$HA^-(aq) + H_2O(l) \rightleftharpoons A^{2-}(aq) + H_3O^+(aq) \qquad K_{a2}$$

A. For any diprotic acid, $K_{a1} < K_{a2}$.

B. For any diprotic acid, $K_{a1} > K_{a2}$.

C. For any diprotic acid, $K_{a1} = K_{a2}$.

D. The magnitudes of K_{a1} and K_{a2} for a diprotic acid have no necessary relationship to one another.

14. Which ranking of binary acids is in order of **<u>decreasing</u>** acid strength (strongest to weakest)?

A. $H_2S > H_2Te > H_2Se > H_2O$

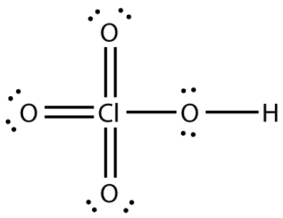
B. $H_2O > H_2S > H_2Se > H_2Te$

C. $H_2Te > H_2Se > H_2S > H_2O$

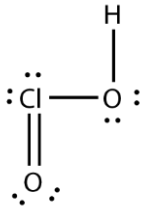
D. $H_2Se > H_2Te > H_2O > H_2S$

15. Which is the **<u>strongest</u>** of these acids?

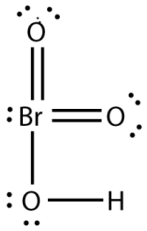
A.



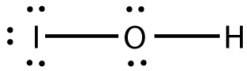
C.



B.



D.



16. Select the **<u>false</u>** statement about the following reaction:

$$HF + BF_3 \rightarrow H^+ + BF_4^-$$

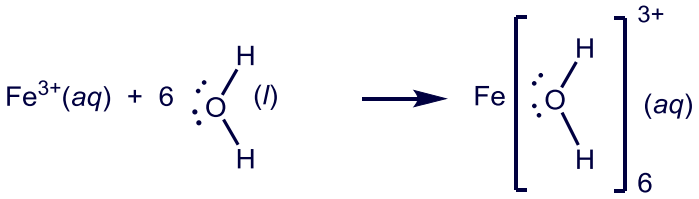
A. BF_4^- is a Lewis acid-base adduct.

B. HF acts as a Lewis acid.

C. BF_3 acts as a Lewis acid.

D. HF acts as a Lewis base.

17. When the ionic compound, $Fe(NO_3)_3$, dissolves in water, the Fe^{3+} ions are hydrated as shown. Select the **true** statement.



A. Fe^{3+} is a Lewis acid because it is an electron pair acceptor.

B. Fe^{3+} is a Lewis acid because it is an electron pair donor.

C. Fe^{3+} is a Lewis base because it is an electron pair acceptor.

D. Fe^{3+} is a Lewis base because it is an electron pair donor.

18. Which of the following is **not** a buffer solution?

A. 0.11 M $HC_2H_3O_2$ (acetic acid) + 0.10 M $KC_2H_3O_2$ (potassium acetate)

B. 0.18 M $HC_7H_5O_2$ (benzoic acid) + 0.21 M $LiC_7H_5O_2$ (lithium benzoate)

C. 0.50 M HF (hydrofluoric acid) + 0.55 M NaF (sodium fluoride)

D. 0.91 M HCl (hydrochloric acid) + 0.87 M CsCl (cesium chloride)

19. What is the pH of a solution that is 0.51 M benzoic acid ($HC_7H_5O_2$) and 0.26 M in potassium benzoate ($KC_7H_5O_2$)?
K_a ($HC_7H_5O_2$) = 6.5×10^{-5}

A. 3.89

B. 4.48

C. 4.69

D. 6.15

20. A 1.0-L buffer is 0.150 M formic acid ($HCHO_2$) and 0.150 M sodium formate ($NaCHO_2$). What is the best estimate of the pH **after** the addition of 10.0 mL 0.0100 M KOH?

pK_a ($HCHO_2$) = 3.74

A. pH = 3.74
B. 2.74 < pH < 3.74
C. 3.74 < pH < 4.74
D. 4.74 < pH < 5.74

21. Calculate at the pH after 10.0 mL of 0.12 M HCl is added to 100.0 mL of a solution that is 0.15 M HNO_2 (nitrous acid) and 0.10 M $NaNO_2$ (sodium nitrite).

K_a (HNO_2) = 4.6×10^{-4}

A. 3.07
B. 3.39
C. 3.71
D. 4.70

22. What base-to-acid ratio is needed to make a pyruvic acid ($HC_3H_3O_3$)/potassium pyruvate ($KC_3H_3O_3$) buffer with a pH of 2.75?

K_a ($HC_3H_3O_3$) = 4.1×10^{-3}

A. $[C_3H_3O_3^-]/[HC_3H_3O_3] = 3.4$
B. $[C_3H_3O_3^-]/[HC_3H_3O_3] = 2.3$
C. $[C_3H_3O_3^-]/[HC_3H_3O_3] = 0.58$
D. $[C_3H_3O_3^-]/[HC_3H_3O_3] = 0.21$

23. Which is the **most** effective buffer for keeping a solution at pH 7.44? All concentrations are 0.25 M.

A. nitrous acid ($pK_a = 3.34$) and sodium nitrite

B. formic acid ($pK_a = 4.19$) and sodium formate

C. hypochlorous acid ($pK_a = 7.56$) and sodium hypochlorite

D. phenol ($pK_a = 9.89$) and sodium phenolate

24. Which statement is **true** about buffer capacity?

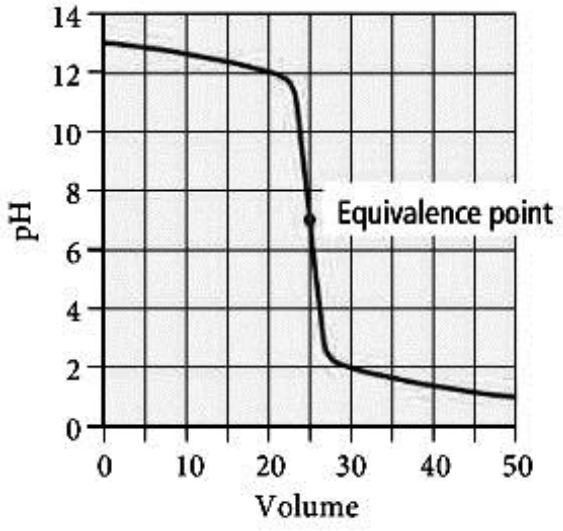
A. The buffer capacity decreases with increasing absolute concentrations of the buffer components.

B. The buffer capacity increases with decreasing absolute concentrations of the buffer components.

C. The buffer capacity is greatest when [acid] >> [base].

D. The buffer capacity is greatest when [acid] and [base] are large and approximately equal.

25. Which statement describes the titration depicted in the graph?



A. A strong acid is added to a flask containing a weak base.

B. A weak acid is added to a flask containing a strong base.

C. A strong acid is added to a flask containing a strong base.

D. A strong base is added to a flask containing a strong acid.

26. What is the pH when 25.0 mL of 0.150 M propanoic acid ($HC_3H_5O_2$) has been titrated with 8.75 mL of 0.200 M KOH?

K_a ($HC_3H_5O_2$) = 4.1×10^{-3}

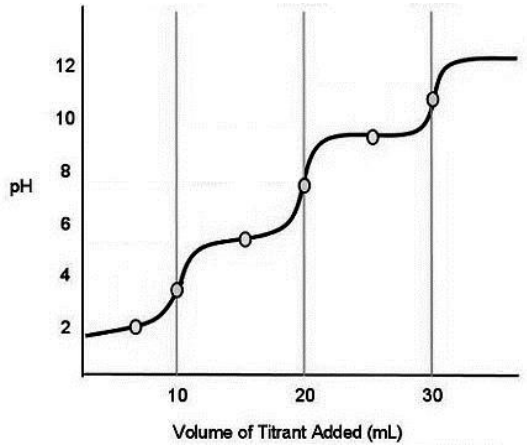
A. 2.33
C. 4.94
B. 3.23
D. 5.09

27. What is the pH of a mixture of 35 mL of 0.25 M HCl and 25 mL of 0.25 M NaF?

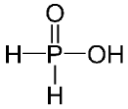
K_a (HF) = 3.5×10^{-4}

A. 1.38
C. 2.20
B. 2.06
D. 2.60

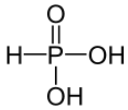
28. The plot for a polyprotic acid is given at right. Which acid is the best match to this plot?



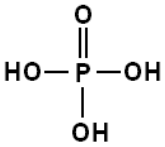
A. hypophosphorous acid, H_3PO_2



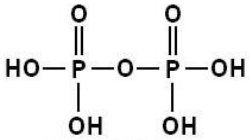
C. phosphorous acid, H_3PO_3



B. phosphoric acid, H_3PO_4



D. pyrophosphoric acid, $H_4P_2O_7$



29. The pK_a = 3.6 for the acid-base indicator bromophenol blue. The acid form of the indictor is yellow and the base form of the indicator is blue. What color is the indicator at a pH of 5.0?

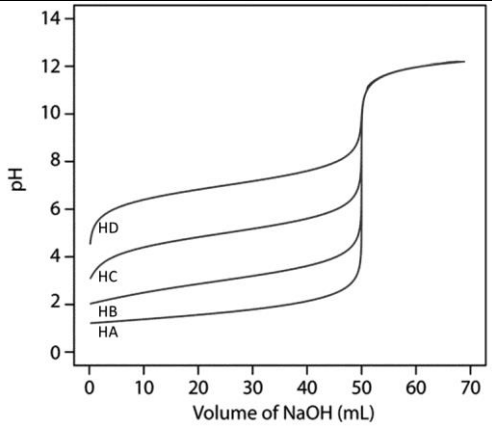
A. yellow

C. blue

B. green

D. colorless

30. The plot to the right shows the results of titrating a series of unidentified acids (HA, HB, HC, and HD) with 0.100 M NaOH. Each flask contains 50.0 mL of 0.100 M acid. Rank the acids by pK_a.



A. pK_a (HD) < pK_a (HC) < pK_a (HB) < pK_a (HA)

B. pK_a (HA) < pK_a (HB) < pK_a (HC) < pK_a (HD)

C. pK_a (HA) = pK_a (HB) = pK_a (HC) = pK_a (HD)

D. More information is needed to rank the acids by pK_a.

CHE 107 Exam 3 Spring 2015 Key

1. B
2. D
3. C
4. A
5. B
6. C
7. B
8. A
9. D
10. B
11. C
12. D
13. B
14. C
15. A
16. B
17. A
18. D
19. A
20. C
21. A
22. B
23. C
24. D
25. C
26. A
27. A
28. B
29. C
30. B