Chapter 16 Pool Questions

1. For which of the following equilibria does K_c correspond to an acid-ionization constant, K_a?
   a) $NH_3(aq) + H_3O^+(aq) \rightleftharpoons NH_4^+(aq) + H_2O(l)$
   b) $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$
   c) $NH_4^+(aq) + OH^-(aq) \rightleftharpoons NH_3(aq) + H_2O(l)$
   d) $HF(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + F^-(aq)$
   e) $F^-(aq) + H_2O(l) \rightleftharpoons HF(aq) + OH^-(aq)$

2. Rank acetic acid ($HC_2H_3O_2$), hydrocyanic acid (HOCN), and hydrofluoric acid (HF) in order of increasing strength.

Acid	K_a
$HC_2H_3O_2$	1.8×10^{-5}
HOCN	3.5×10^{-4}
HF	6.8×10^{-4}

   a) $HC_2H_3O_2 < HOCN < HF$
   b) $HOCN < HC_2H_3O_2 < HF$
   c) $HF < HOCN < HC_2H_3O_2$
   d) $HF < HC_2H_3O_2 < HOCN$
   e) $HOCN < HF < HC_2H_3O_2$

3. What is the percent ionization of a 1.3 *M* $HC_2H_3O_2$ solution ($K_a = 1.8 \times 10^{-5}$) at 25°C?
   a) 0.48%
   b) 0.37%
   c) 0.33%
   d) 0.18%
   e) 2.5%

4. A 0.20 *M* solution of a weak monoprotic acid is 0.20% ionized. What is the acid-ionization constant, K_a, for this acid?
   a) 8.0×10^{-7}.
   b) 2.0×10^{-6}.
   c) 1.6×10^{-6}.
   d) 2.0×10^{-5}.
   e) 1.0×10^{-4}.

5. What is K_a for a weak monoprotic acid if a 0.020 *M* solution of the acid has a pH of 3.29 at 25ºC?
   a) 5.1×10^{-2}
   b) 6.9×10^{-2}
   c) 2.6×10^{-4}
   d) 1.3×10^{-5}
   e) 1.0×10^{-6}

6. What is the pH of a 0.035 *M* solution of benzoic acid ($K_a = 6.3 \times 10^{-5}$) at 25ºC?
   a) 6.51
   b) 2.83
   c) 5.66
   d) 5.20
   e) 1.46

7. In a 0.01 *M* solution of 1,4-butanedicarboxylic acid, $HOOCCH_2CH_2COOH$ ($K_{a1} = 2.9 \times 10^{-5}$, $K_{a2} = 5.3 \times 10^{-6}$), which species is present in the highest concentration?
   a) $H_3O^+(aq)$
   b) $HOOCCH_2CH_2COOH(aq)$
   c) $HOOCCH_2CH_2COO^-(aq)$
   d) $^-OOCCH_2CH_2COO^-(aq)$
   e) $OH^-(aq)$

8. For which of the following equilibria does K_c correspond to the base-ionization constant, K_b, of HCO_3^-?
   a) $HCO_3^-(aq) + OH^-(aq) \rightleftharpoons CO_3^{2-}(aq) + H_2O(l)$
   b) $HCO_3^-(aq) + H_2O(l) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$
   c) $HCO_3^-(aq) + H_3O^+(aq) \rightleftharpoons H_2CO_3(aq) + H_2O(l)$
   d) $HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$
   e) $H_2CO_3(aq) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$

9. What is the pOH of a 0.19 *M* solution of pyridine ($K_b = 1.4 \times 10^{-9}$) at 25ºC?
   a) 11.02
   b) 4.79
   c) 8.85
   d) 4.07
   e) 1.44

10. What is the equilibrium concentration of ammonium ion in a 0.26 *M* solution of ammonia (NH_3, $K_b = 1.8 \times 10^{-5}$) at 25°C?
   a) $8.4 \times 10^{-3}\ M$
   b) $3.8 \times 10^{-14}\ M$
   c) $2.6 \times 10^{-1}\ M$
   d) $4.6 \times 10^{-12}\ M$
   e) $2.2 \times 10^{-3}\ M$

11. A 0.0868 *M* solution of a weak base has a pH of 9.04. What is the identity of the weak base?

Weak Base	K_b
Ethylamine ($CH_3CH_2NH_2$)	4.7×10^{-4}
Hydrazine (N_2H_4)	1.7×10^{-6}
Hydroxylamine (NH_2OH)	1.1×10^{-8}
Pyridine (C_5H_5N)	1.4×10^{-9}
Aniline ($C_6H_5NH_2$)	4.2×10^{-10}

a) pyridine
b) ethylamine
c) hydrazine
d) hydroxylamine
e) aniline

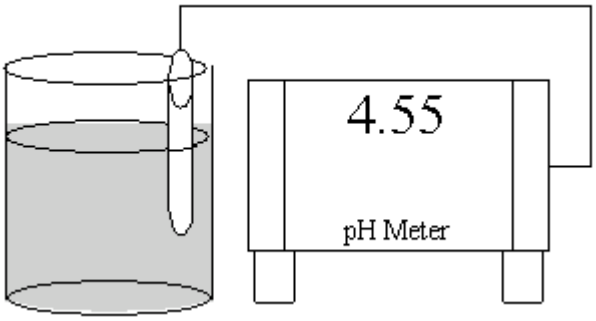
12. Which of the following equilibria best represents the hydrolysis reaction that occurs in an aqueous solution of NH_4Cl?

a) $NH_4^+(aq) + Cl^-(aq) \rightleftharpoons NH_4Cl(s)$
b) $Cl^-(aq) + H_2O(l) \rightleftharpoons HCl(aq) + OH^-(aq)$
c) $NH_4^+(aq) + OH^-(aq) \rightleftharpoons NH_3(aq) + H_2O(l)$
d) $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$
e) $Cl^-(aq) + H_3O^+(aq) \rightleftharpoons HCl(aq) + H_2O(l)$

13. Which of the following solutions has the highest hydroxide-ion concentration?

a) 0.10 *M* NaI
b) 0.10 *M* $NaNO_3$
c) 0.10 *M* NH_4Cl
d) 0.10 *M* NaCN
e) 0.10 *M* NH_4ClO_4

14. Which of the following salts is most likely to form an aqueous solution having the pH shown in the figure below?



a) K_2CO_3
b) $LiNO_3$
c) NaBr
d) NH_4Cl
e) RbCN

15. Consider the reaction $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$. K_b for NH_3 is 1.8×10^{-5} at 25ºC. What is K_a for the NH_4^+ ion at 25ºC?
a) 1.8×10^{-5}
b) 5.6×10^{4}
c) 9.2×10^{-8}
d) 5.6×10^{-10}
e) 7.2×10^{-12}

16. What is K_b for the following equilibrium? K_a for HNO_2 is 5.0×10^{-4}.
$NO_2^-(aq) + H_2O(l) \rightleftharpoons HNO_2(aq) + OH^-(aq)$

a) 5.0×10^{-4}
b) 5.0×10^{10}
c) 2.0×10^{-4}
d) 5.0×10^{18}
e) 2.0×10^{-11}

17. What is the pH of a 0.26 *M* solution of sodium propionate, $NaC_3H_5O_2$, at 25°C? (For propionic acid, $HC_3H_5O_2$, $K_a = 1.3 \times 10^{-5}$ at 25°C.)
a) 4.8
b) 6.3
c) 9.2
d) 7.7
e) 11.1

18. What is the pOH of a solution prepared by adding 0.799 g of ammonium bromide to 175 mL of water? K_b of NH_3 is 1.8×10^{-5}.
    a) 7.00
    b) 8.71
    c) 3.04
    d) 10.96
    e) 5.29

19. What will happen if a small amount of sodium hydroxide is added to a 0.1 *M* solution of ammonia?
    a) K_b for ammonia will increase.
    b) K_b for ammonia will decrease.
    c) The percent ionization of ammonia will increase.
    d) The percent ionization of ammonia will decrease.
    e) The percent ionization of ammonia will remain unchanged.

20. For a solution equimolar in HCN and NaCN, which statement is <u>false</u>?
    a) This is an example of the common-ion effect.
    b) $[H^+]$ is larger than it would be if only the HCN were in solution.
    c) $[H^+]$ is equal to K_a.
    d) Addition of more NaCN will shift the acid-dissociation equilibrium of HCN to the left.
    e) Addition of NaOH will increase $[CN^-]$ and decrease [HCN].

21. Which of the following is the most effective buffer system for a pH value of 4.45?
    a) H_2CO_3/HCO_3^- (K_{a1} for H_2CO_3 is 4.3×10^{-7}.)
    b) HCO_3^-/CO_3^{2-} (K_{a2} for H_2CO_3 is 4.8×10^{-11}.)
    c) H_2S/HS^- (K_{a1} for H_2S is 8.9×10^{-8}.)
    d) $HC_2O_4^-/C_2O_4^{2-}$ (K_{a2} for $H_2C_2O_4$ is 5.1×10^{-5}.)
    e) $H_3PO_4/H_2PO_4^-$ (K_{a1} for H_3PO_4 is 6.9×10^{-3}.)

22. Which of the following mixtures will be a buffer when dissolved in 1 L of water?
    a) 0.1 mol $Ba(OH)_2$ and 0.2 mol HCl
    b) 0.3 mol KCl and 0.3 mol HCl
    c) 0.4 mol NH_3 and 0.4 mol HCl
    d) 0.2 mol $HC_2H_3O_2$ and 0.1 mol NaOH
    e) 0.2 mol HBr and 0.1 mol NaOH

23. A weak acid, HF, is in solution with dissolved sodium fluoride, NaF. If HCl is added, which ion will react with the extra hydrogen ions from the HCl to keep the pH from changing?
    a) OH^-
    b) Na^+
    c) F^-
    d) Na^-
    e) none of these

24. Suppose a buffer solution is made from formic and, $HCHO_2$, and sodium formate, $NaCHO_2$. What is the net ionic equation for the reaction that occurs when a small amount of sodium hydroxide is added to the buffer?
    a) $NaOH(aq) + H_3O^+(aq) \rightarrow Na^+(aq) + 2H_2O(l)$
    b) $H_3O^+(aq) + OH^-(aq) \rightarrow 2H_2O(l)$
    c) $OH^-(aq) + HCHO_2(aq) \rightarrow CHO_2^-(aq) + H_2O(l)$
    d) $NaOH(aq) + HCHO_2(aq) \rightarrow NaCHO_2(aq) + H_2O(l)$
    e) $Na^+(aq) + HCHO_2(aq) \rightarrow NaH(aq) + HCO_2^+(aq)$

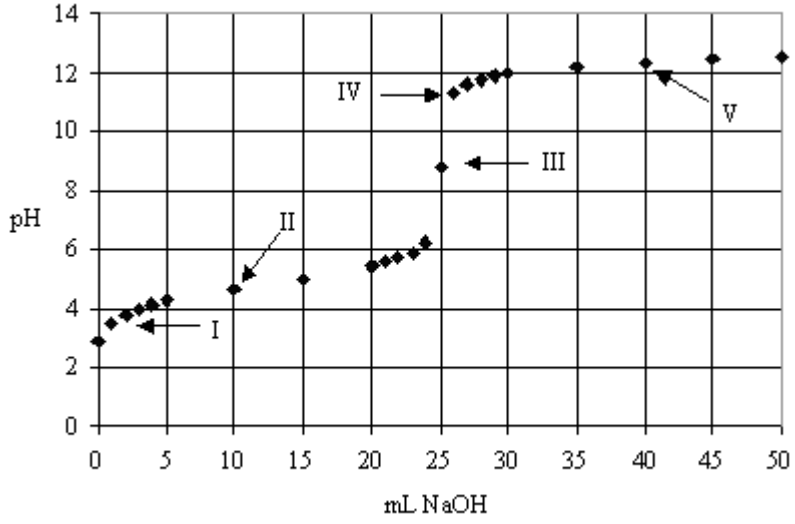
25. What is the hydrogen-ion concentration of a solution that is 0.032 *M* in acetic acid and 0.032 *M* in sodium acetate at 25°C? The acid-ionization constant of acetic acid is 1.8×10^{-5} at 25°C.
    a) 1.8×10^{-7} *M*
    b) 1.8×10^{-6} *M*
    c) 1.8×10^{-5} *M*
    d) 1.8×10^{-4} *M*
    e) 1.8×10^{-3} *M*

26. What is the hydronium-ion concentration of a solution formed by combining 700. mL of 0.18 *M* HCl with 300. mL of 0.51 *M* NaOH at 25ºC?
    $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
    a) 0.33 *M*
    b) 0.18 *M*
    c) 0.027 *M*
    d) 0.13 *M*
    e) 3.7×10^{-13} *M*

27. Which of the following statements is true concerning the titration of a weak monoprotic acid with a strong base?
    a) At the equivalence point, the pH is 7.
    b) At the equivalence point, the solution has excess moles of weak acid.
    c) At the equivalence point, the solution has excess moles of strong base.
    d) At the equivalence point, the solution is composed of the conjugate base of the weak acid.
    e) At the equivalence point, the solution is acidic.

28. Which of the following indicators is most suitable for the titration of a 25.00-mL sample of 0.140 *M* propionic acid, $HC_3H_5O_2$, with strong base?
    a) methyl orange (transition pH range: 3.1–4.4)
    b) methyl red (transition pH range: 4.2–6.3)
    c) bromothymol blue (transition pH range: 6.2–7.6)
    d) thymol blue (transition pH range: 8.0–9.6)
    e) alizarin yellow (transition pH range: 10.0–12.0)

29. The titration curve shown below represents the titration of a weak acid with a strong base. Which point represents the equivalence point?



a) I
b) II
c) III
d) IV
e) V

30. A 25.00-mL sample of propionic acid, $HC_3H_5O_2$, of unknown concentration was titrated with 0.125 *M* KOH. The equivalence point was reached when 41.36 mL of base had been added. What is the approximate concentration of the propionate ion at the equivalence point?
a) 0.125 *M*
b) 0.0779 *M*
c) 0.207 *M*
d) 0.128 *M*
e) 0.147 *M*

ANSWERS

Question	Answer
1	b
2	a
3	b
4	a
5	d
6	b
7	b
8	d
9	b
10	e
11	a
12	d
13	d
14	d
15	d
16	e
17	c
18	b
19	d
20	b
21	d
22	d
23	c
24	c
25	c
26	e
27	d
28	d
29	c
30	b