Unit 7 Multiple Choice Practice

1. Nitrous acid, HNO_2, has a pK_a value of 3.3. If a solution of nitrous acid is found to have a pH of 4.2, what can be said about the concentration of the conjugate acid/base pair found in solution?

   a. $[HNO_2] > [NO_2^-]$
   c. $[H_2NO_2^+] > [HNO_2]$
   (b.) $[NO_2^-] > [HNO_2]$
   d. $[HNO_2] > [H_2NO_2^+]$

   $pH > pK_a$
   $\Rightarrow \downarrow [H^+]$
   $\Rightarrow \downarrow [HNO_2], \uparrow [NO_2^-]$

2. A buffer solution can be formed by dissolving equal moles of:

   a. HF and NaOH
   c. CH_3COOH and NaCl
   b. KBr and Na_3PO_4
   (d.) HF and NaF

3. How many liters of distilled water must be added to 10. mL of an aqueous solution of HNO_3 with a pH of 2 to create a solution with a pH of 3? pH 2→3 ⇒ $[H^+]$ dilute by factor of 10!

   a. 10. mL
   b. 20. mL
   c. 40. mL
   (d.) 90. ml

4. Which of the following changes would affect the pH of a buffer solution?

   ✗ I. Doubling the amount of acid and conjugate base used.
   ✗ II. Doubling the amount of water in the solution.
   ✓ III. Adding a small amount of strong acid or strong base.

   ] Same HA:A⁻ ratio

   (a.) III only
   b. I and II only
   c. II and III only
   d. I, II, and III

5. The $[OH^-]$ in a solution with a pH of 3.00 is

   (a.) 1.0×10^{-11} M
   b. 1.0×10^{-9} M
   c. 1.0×10^{-6} M
   d. 1.0×10^{-3} M

   $pH = 3 \Rightarrow pOH = 14 - 3 = 11$
   $\Rightarrow pOH = 10^{-11}$

6. Consider the following:

I. H_2SO_4
II. HSO_4^-
III. SO_4^{2-}

Which of the chemical species above are present in a reagent bottle labeled 1.0 M $H_2SO_4(aq)$?

a. I only b. I and II only (c.) II and III only d. I, II, and III

dilute by factor of 10!

7. The pH of a 1.0 mL solution of 0.30 M NaOH if 9.0 mL of distilled water is added to the solution is closest to:

a. 3 b. 11 (c) 12 d. 13

$$[OH^-] = \frac{0.3\,M}{10} = 0.03\,M \approx 0.01 = 1E{-}2 \Rightarrow pOH = 2 \Rightarrow pH = 12$$

8. A 0.25 M solution of a weak monoprotic acid has a pH of 6. What is the value of K_a for the acid?

(a.) 4×10^{-12} b. 4×10^{-11} c. 2.5×10^{-6} d. 2.5×10^{-5}

$$[H^+] = x = 10^{-6}\,M \qquad K_a = \frac{x^2}{[HA]} = \frac{(10^{-6})^2}{0.25} = \frac{10^{-12}}{1/4} = 4 \times 10^{-12}$$

9. Consider the following equilibrium: $2\,H_2O(l) + \text{energy} \leftrightarrow H_3O^+(aq) + OH^-(aq)$

Which of the following describes the result of decreasing the temperature?

	$[H_3O^+]$	$[OH^-]$	K_w
a.	increases	increases	increases
b.	decreases	increases	decreases
c.	increases	decreases	no change
(d.)	decreases	decreases	decreases

10. The pH of a solution changes from 3.00 to 6.00. By what factor does the $[H_3O^+]$ change?

a. 3 b. 30 c. 100 (d.) 1000

fav = weaker!

A B 67 CB CA

$HClO_2(aq) + C_2H_3O_2^-(aq) \leftrightarrow ClO_2^-(aq) + HC_2H_3O_2(aq)$

11. The equilibrium constant for the reaction represented by the equation above is greater than 1.0. Which of the following gives the correct relative strength of the acids and bases in the reaction? prod-favored

	Acids	Bases
a.	$HC_2H_3O_2 > HClO_2$	$ClO_2^- > C_2H_3O_2^-$
(b.)	$HClO_2 > HC_2H_3O_2$	$C_2H_3O_2^- > ClO_2^-$
c.	$HClO_2 > HC_2H_3O_2$	$ClO_2^- > C_2H_3O_2^-$
d.	$HC_2H_3O_2 > HClO_2$	$C_2H_3O_2^- > ClO_2^-$

dilute by factor of 2!

12. When 10.0 mL of 0.10 M HCl is added to 10.0 mL of water, the concentration of H_3O^+ in the final solution is:

a. 0.010 M (b.) 0.050 M c. 0.10 M d. 0.20 M

13. A 0.50 M solution of a weak monoprotic acid has a pH of 4. Calculate the ionization constant, K_a, for the acid.

a. 5×10^{-9} (b.) 2×10^{-8} c. 2×10^{-4} d. 5×10^{-5}

$[H^+] = 10^{-pH}$

$= 10^{-4}$

$K_a = \frac{x^2}{[HA]} = \frac{(10^{-4})^2}{0.5} = \frac{10^{-8}}{1/2} = 2E\text{-}8$

14. A bottle of water is placed in an ice bath to chill. What happens to the pH of the water as it cools?

(a.) It will increase because the auto-ionization of water is an endothermic process. ↑ pH = ↓ [H+]

b. Nothing; the volume would have to change in order for any ion concentration to change.

c. Nothing; pure water always has a pH of 7.00.

d. It will decrease because the concentration of H^+ is decreasing.

⇒ basic

15. Which of the following 1.0 M solutions would have a pH greater than 7.00?

a. HCN b. KNO_3 c. NH_4Cl (d.) $NaC_2H_3O_2$

Na^+ → NaOH = SB

$C_2H_3O_2^-$ → $HC_2H_3O_2$ = WA

16. In order to change the pH of a solution from 2.0 to 4.0 the $[H_3O^+]$ must

a. increase by a factor of 2
b. decrease by a factor of 2
c. increase by a factor of 100
(d.) decrease by a factor of 100

17. A buffer solution may contain equal moles of

(a.) a weak acid with its conjugate base
b. a strong acid with its conjugate base
c. a weak acid and a strong base
d. a strong acid and a strong base

18. What is the conjugate acid and the conjugate base of HPO_4^{2-}?

	Conjugate Acid	**Conjugate Base**
a.	PO_4^{3-}	$H_2PO_4^-$
(b.)	$H_2PO_4^-$	PO_4^{3-}
c.	$H_2PO_4^-$	H_3PO_4
d.	H_3PO_4	PO_4^{3-}

19. When comparing 1.0 M solutions of bases, the base with the lowest $[OH^-]$ is the

a. weakest base and it has the largest K_b value.
b. strongest base and it has the largest K_b value.
(c.) weakest base and it has the smallest K_b value.
d. strongest base and it has the smallest K_b value.

20. What is the concentration of $Sr(OH)_2$ in a solution with a pH = 11.00?

a. 2.0×10^{-11} M b. 1.0×10^{-11} M (c.) 5.0×10^{-4} M d. 1.0×10^{-3} M

$pOH = 14 - 11 = 3 \Rightarrow [OH^-] = 10^{-3}$ M $OH^- \times \frac{1\ Sr(OH)_2}{2\ OH^-} = 0.5 \times 10^{-3}$

$= 5E\text{-}4$

21. Which of the following pairs of substances would make a good buffer solution?

a. H_2SO_4 and LiOH
b. HCl and KCl
(c.) $HC_2H_3O_2$ and $NaC_2H_3O_2$
d. HF and NaH_3

22. Consider the neutralization reactions between the following acid-base pairs in dilute aqueous solutions:

WA + SB		(1) $CH_3COOH + NaOH \rightarrow$
SA + SB	✓	(2) $HNO_3 + KOH \rightarrow$
WA + SB		(3) $H_3PO_4 + Ba(OH)_2 \rightarrow$
SA + SB	✓	(4) $HCl + KOH \rightarrow$
SA + WB		(5) $H_2SO_4 + NH_3 \rightarrow$

For which of the reactions above is the **net ionic** equation $H^+ + OH^- \rightarrow H_2O$?

a. 1, 3 b. 2, 4, 5 (c.) 2, 4 d. 3, 5