CHAPTER 17 PRACTICE QUIZ Name_____

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

$$HF(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + F^-(aq)$$

1. The dissociation of the weak acid HF in water is represented by the equation above. Which of the following choices shows what would happen to the percent ionization of HF(*aq*) when, in two separate experiments, 1.0 mL of distilled water and 1.0 mL 1.0 *M* KF(*aq*) are added to a 10. mL sample of 1.0 *M* HF(*aq*)?

	Adding 1.0 mL of distilled water to 10. mL 1.0 *M* HF(*aq*)…	Adding 1.0 mL of 1.0 *M* KF(*aq*) to 10. mL 1.0 *M* HF(*aq*)…
(A)	would decrease the % ionization of HF(*aq*)	would decrease the % ionization of HF(*aq*)
(B)	would decrease the % ionization of HF(*aq*)	would increase the % ionization of HF(*aq*)
(C)	would increase the % ionization of HF(*aq*)	would decrease the % ionization of HF(*aq*)
(D)	would increase the % ionization of HF(*aq*)	would increase the % ionization of HF(*aq*)

Name	Formula	K_a	pK_a
lactic acid	$HC_3H_5O_3$	1.4×10^{-4}	3.85

2. The table above lists information for lactic acid. A solution of 0.1 *M* $HC_3H_5O_3$ has a pH of 2.4. Which of the following mixtures would create a buffer solution that has a pH of approximately 4?

   (A) A mixture of 100. mL of 0.1 *M* $HC_3H_5O_3$ and 50. mL of 0.1 *M* NaOH

   (B) A mixture of 100. mL of 0.1 *M* $HC_3H_5O_3$ and 100. mL of 0.1 *M* NaOH

   (C) A mixture of 100. mL of 0.1 *M* $HC_3H_5O_3$ and 50. mL of 0.1 *M* HCl

   (D) A mixture of 100. mL of 0.1 *M* $HC_3H_5O_3$ and 100. mL of 0.1 *M* HCl

3. A solution is prepared by adding 100 mL of 1.0 *M* $HC_2H_3O_2(aq)$ to 100 mL of 1.0 *M* $NaC_2H_3O_2(aq)$. The solution is stirred and its pH is measured to be 4.73. After 3 drops of 1.0 *M* HCl are added to the solution, the pH of the solution is measured and is still 4.73. Which of the following equations represents the chemical reaction that accounts for the fact that acid was added but there was no detectable change in pH?

   (A) $H_3O^+(aq) + OH^-(aq) \rightarrow 2\ H_2O(l)$

   (B) $H_3O^+(aq) + Cl^-(aq) \rightarrow HCl(g) + H_2O(l)$

   (C) $H_3O^+(aq) + C_2H_3O_2^-(aq) \rightarrow HC_2H_3O_2(aq) + H_2O(l)$

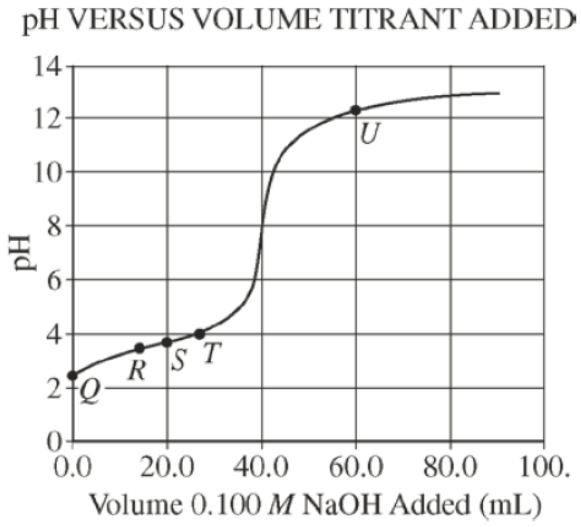
   (D) $H_3O^+(aq) + HC_2H_3O_2(aq) \rightarrow H_2C_2H_3O_2^+(aq) + H_2O(l)$

4. A solution contains equimolar amounts of HOCl(*aq*) and NaOCl(*aq*) and has a pH of 7.5. Five milliliters of concentrated KOH(*aq*) is added to this solution. Which of the following most accurately identifies the species present in greater concentration and the pH of the solution after KOH(*aq*) is added?

	Species present in greater concentration after KOH(*aq*) is added?	pH of the solution after KOH(*aq*) is added?
(A)	HOCl	pH < 7.5
(B)	HOCl	pH > 7.5
(C)	OCl^-	pH < 7.5
(D)	OCl^-	pH > 7.5

Questions 5 – 8 refer to the diagram shown at right.

A 50.0 mL sample of an acid, HA, of unknown molarity is titrated, and the pH of the resulting solution is measured with a pH meter and graphed as a function of the volume of 0.100 *M* NaOH added.



5. At point *R* in the titration, which of the following species has the highest concentration?

   (A) HA

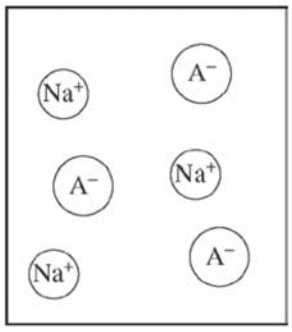
   (B) A^-

   (C) H_3O^+

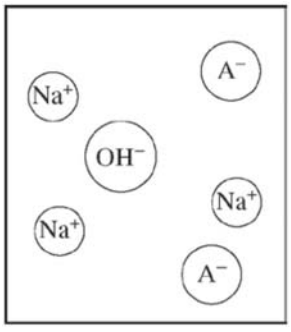
   (D) OH^-

6. Which of the following is the best particulate representation of the species (other than H_2O) that are present in significant concentrations in the solution at point *U* in the titration?

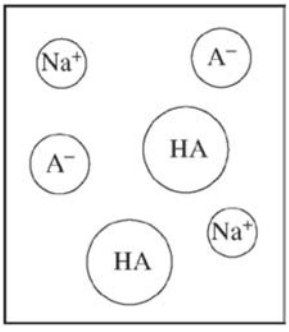
(A)



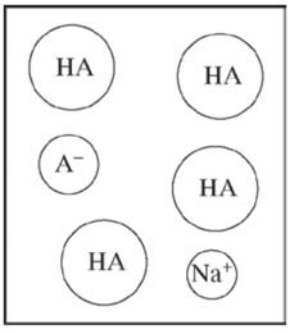
(B)



(C)



(D)



7. At which point on the titration curve is $[A^-]$ closest to twice that of [HA] ?

(A) *R* (B) *S* (C) *T* (D) *U*

8. A student carries out the same titration, but uses an indicator instead of a pH meter. If the indicator changes color slightly past the equivalence point, what will the student obtain for the calculated concentration of the acid?

(A) slightly less than 0.0800 *M*

(B) slightly more than 0.0800 *M*

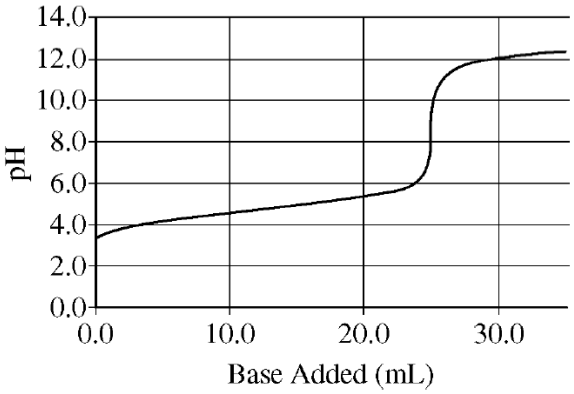
(C) slightly less than 0.125 *M*

(D) slightly more than 0.125 *M*

Questions 9 – 11 refer to the following information.

A sample of Li(*s*) is placed in an Erlenmeyer flask containing 100 mL of water at 25°C. A balloon is placed over the mouth of the flask to collect the hydrogen gas that is generated.

After all of the Li(*s*) has reacted with $H_2O(l)$, the solution in the flask is added to a clean, dry buret and used to titrate an aqueous solution of a monoprotic acid. The pH curve for this titration is shown in the diagram at right.



9. On the basis of the pH curve, the pK_a value of the acid used in the titration is closest to

(A) 4

(B) 5

(C) 8

(D) 12

10. Which of the following indicators would be the best choice for determining the end point in this titration?

	Indicator	pK_a	pH Range	Acid Form	Base Form
(A)	Methyl Orange	4.2	3.1 – 4.4	Red	Yellow
(B)	Methyl Red	5.0	4.2 – 6.2	Red	Yellow
(C)	Thymol Blue	8.9	8.0 – 9.6	Yellow	Blue
(D)	Alizarin Yellow	11.0	10.1 – 12.0	Yellow	Red

11. Which of the following is the balanced net-ionic equation for the reaction between Li(*s*) and water?

(A) $2\ Li(s) + 2\ H^+(aq) \rightarrow 2\ Li^+(aq) + H_2(g)$

(B) $2\ Li(s) + 2\ H_2O(l) \rightarrow 2\ Li^+(aq) + 2\ OH^-(aq) + H_2(g)$

(C) $2\ Li(s) + 2\ H_2O(l) \rightarrow 2\ LiOH(s) + H_2(g)$

(D) $2\ Li(s) + 8\ H_2O(l) \rightarrow 2\ LiH(s) + 8\ OH^-(aq) + 3\ H_2(g)$

Acid Solution	Volume of NaOH Added (mL)
A	40
B	75
C	115
D	200

12. To maximize the yield in a certain manufacturing process, a solution of a weak monoprotic acid that has a concentration between 0.20 *M* and 0.30 *M* is required. Four 100. mL samples of the acid at different concentrations are each titrated with a 0.20 *M* NaOH solution. The volume of NaOH needed to reach the end point for each sample is given in the table above. Which solution is the most suitable to maximize the yield?

(A) Solution A

(B) Solution B

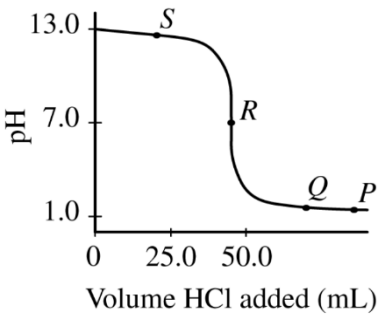
(C) Solution C

(D) Solution D

Questions 13 – 14 refer to the following information.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

To determine the concentration of a NaOH(*aq*) solution, a student titrated a 50. mL sample with 0.10 *M* HCl(*aq*). The reaction is represented by the equation above. The titration is monitored using a pH meter, and the experimental results are plotted in the graph below.



13. At the point labeled R on the pH curve, which of the following ions are present in the reaction mixture at a concentration greater than 0.01 *M* ?

(A) Na^+ and Cl^- only

(B) Na^+ , Cl^-, and H^+ only

(C) Na^+ , Cl^-, and OH^- only

(D) Na^+ , Cl^-, H^+, and OH^-

14. One student titrated the NaOH(*aq*) with 1.0 *M* HCl(*aq*) instead of 0.10 *M* HCl(*aq*). How would the student's titration curve differ from the original curve?

(A) The initial pH would be 11 instead of 13.

(B) The pH at the equivalence point would be 5 instead of 7.

(C) The pH far beyond the equivalence point would be higher than in the original curve.

(D) The pH far beyond the equivalence point would be lower than in the original curve.

$$FeF_2(s) \rightleftharpoons Fe^{2+}(aq) + 2\,F^-(aq) \qquad K_1 = 2 \times 10^{-6}$$

$$F^-(aq) + H^+(aq) \rightleftharpoons HF(aq) \qquad K_2 = 1 \times 10^{3}$$

$$FeF_2(s) + 2\,H^+(aq) \rightleftharpoons Fe^{2+}(aq) + 2\,HF(aq) \qquad K_3 = \ ?$$

15. On the basis of the information above, the dissolution of $FeF_2(s)$ in acidic solution is

(A) favorable, because $K_2 > 1$

(B) favorable, because $K_3 > 1$

(C) not favorable, because $K_1 < 1$

(D) not favorable, because $K_3 < 1$

$$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2\,OH^-(aq) \qquad \Delta H < 0$$

16. The exothermic dissolution of $Mg(OH)_2(s)$ in water is represented by the equation above. The K_{sp} of $Mg(OH)_2$ is 1.8×10^{-11}. Which of the following changes will increase the solubility of $Mg(OH)_2$ in an aqueous solution?

(A) Increasing the temperature of the solution

(B) Decreasing the pH of the solution

(C) Adding NaOH to the solution

(D) Adding $Mg(NO_3)_2$ to the solution

Compound	K_{sp}
$PbCl_2$	1.2×10^{-5}
$CuCl$	1.6×10^{-7}
$AgCl$	1.8×10^{-10}
Hg_2Cl_2	1.4×10^{-18}

17. Based on the K_{sp} values in the table above, a saturated solution of which of the following compounds has the highest $[Cl^-]$?

(A) $PbCl_2$ (B) $CuCl$ (C) $AgCl$ (D) Hg_2Cl_2

Compound	K_{sp}
Ag_2SO_4	1×10^{-5}
$PbSO_4$	1×10^{-8}

18. A 1.0 L solution of $AgNO_3$ and $Pb(NO_3)_2(aq)$ has a Ag^+ concentration of 0.020 *M* and a Pb^{2+} concentration of 0.0010 *M*. A 0.0010 mol sample of $K_2SO_4(s)$ is added to the solution. Based on the information in the table above, which of the following will occur? (Assume that the volume change of the solution is negligible.)

(A) No precipitate will form.

(B) Only $Ag_2SO_4(s)$ will precipitate.

(C) Only $PbSO_4(s)$ will precipitate.

(D) Both $Ag_2SO_4(s)$ and $PbSO_4(s)$ will precipitate.

19. A beaker contains 1.0 L of a saturated solution of $CaF_2(aq)$ that is in equilibrium with undissolved $CaF_2(s)$. A chemist adds 1.0 mL of 10.0 *M* $KF(aq)$ to this beaker. The solution is stirred and the equilibrium is re-established. Which of the following most accurately represents the changes, if any, that have occurred in the system as a result of the addition of 1.0 mL of 10.0 *M* $KF(aq)$?

	The concentration of $Ca^{2+}(aq)$	The mass of $CaF_2(s)$ in the beaker
(A)	has decreased	remains the same
(B)	has decreased	has increased
(C)	has increased	has decreased
(D)	remains the same	remains the same

CHAPTER 17 PRACTICE QUIZ Name_____

FREE RESPONSE – CALCULATOR IS ALLOWED

	Concentration and Identity of Solute
Solution #1	1.0 *M* HF
Solution #2	0.80 *M* NaF

1. Two different aqueous solutions are represented in the table above.

   (a) The K_a value for HF is equal to 6.8×10^{-4}. Calculate the pH of Solution #1. Show the set-up for your calculations in order to receive full credit. Round your answer to two decimal places.

   (b) Calculate the value of K_b for the fluoride ion, F^-. Show the set-up for your calculations in order to receive full credit. Round your answer to two significant figures.

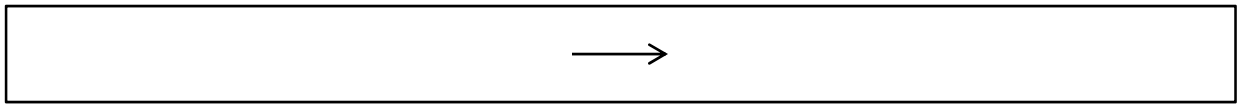
   (c) Calculate the pH of Solution #2. Show the set-up for your calculations in order to receive full credit. Round your answer to two decimal places.

   (d) Solution #3 is prepared by combining 500. mL of Solution #1 with 500. mL of Solution #2. Calculate the value of [HF] and $[F^-]$ in Solution #3. Assume that the volume of this solution is equal to 1.00 L.

   [HF] = _____ $[F^-]$ = _____

(e) Calculate the pH of Solution #3. Show the set-up for your calculations in order to receive full credit. Round your answer to two decimal places.

(f) Write a balanced net-ionic equation for the chemical reaction that would occur if a few drops of concentrated HCl solution were added to Solution #3.



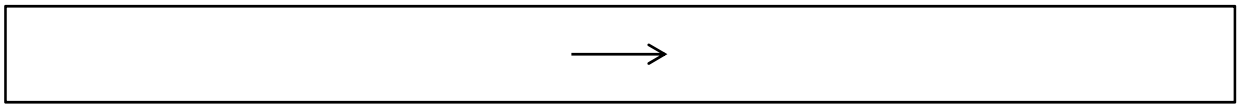
(g) Solution #4 is prepared by adding 4 mL of 10 *M* HCl to 1.00 L of Solution #3. Calculate the value of [HF] and [F^-] in Solution #4. Assume that the volume of this solution is equal to 1.00 L.

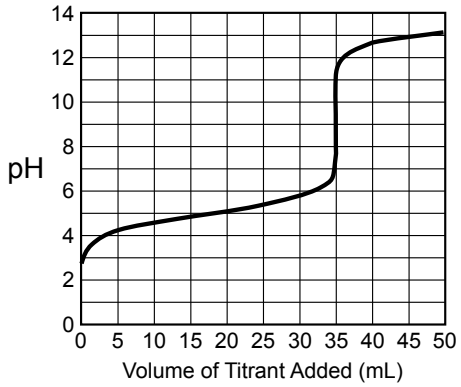
[HF] = _____ [F^-] = _____

(h) Calculate the pH of Solution #4. Show the set-up for your calculations in order to receive full credit. Round your answer to two decimal places.

2. In a certain experiment a propanoic acid ($C_2H_5CO_2H$) solution is titrated with a solution of potassium hydroxide.

(a) Write a balanced net-ionic equation for the chemical reaction between propanoic acid and potassium hydroxide.





(b) In Trial 1 of this experiment, 25.0 mL of propanoic acid was titrated with 0.50 *M* potassium hydroxide. The pH titration curve shown above was generated for Trial 1. The volume of the titrant required to reach the equivalence point in this experiment is _____ mL.

(c) Determine the value of K_a for propanoic acid. Justify your answer.

(d) Calculate each of the following quantities. Show the set-up for your calculations in order to receive full credit.

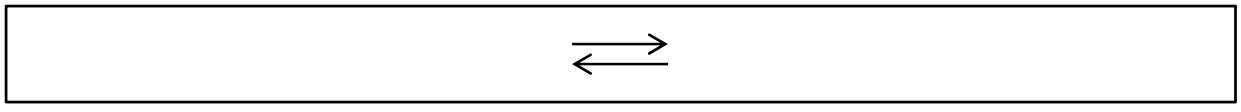
(i) the moles of potassium hydroxide that reacted in this titration experiment

(ii) the concentration of the propanoic acid solution used in this titration experiment

(e) Circle <u>two</u> of the following chemical substances that are present in the highest concentration in the solution at the equivalence point of the titration.

H_3O^+ OH^- K^+ $C_2H_5CO_2H$ $C_2H_5CO_2^-$

(f) Write a balanced net-ionic equation for the chemical reaction between water and one of the substances that you circled in part (e). The equation you write should justify why the pH of the solution at the equivalence point is equal to 9.2.



Indicator	pK_a	pH Range	Acid Form	Base Form
Methyl Red	5.0	4.2 – 6.2	Red	Yellow

(g) A second trial of this experiment is performed using the same conditions as Trial 1, except that an acid-base indicator is used instead of a pH meter. Would methyl red be an appropriate choice for an indicator in this titration? Justify your answer.

3. Answer the following questions concerning magnesium hydroxide, $Mg(OH)_2$.

(a) A saturated solution of $Mg(OH)_2(s)$ is prepared that is in equilibrium with $Mg(OH)_2(s)$. Write the solubility-product expression, K_{sp}, for $Mg(OH)_2$.

(b) The pH of a saturated solution of magnesium hydroxide is equal to 10.52.

(i) Calculate the value of $[OH^-]$ in this saturated solution: _____

(ii) Calculate the value of $[Mg^{2+}]$ in this solution: _____

(c) Use your answers to part (b) to calculate the value of K_{sp} for $Mg(OH)_2$. Show the set-up for your calculations in order to receive full credit.

(d) In a different experiment, 50.0 mL of 4.0×10^{-4} *M* $Mg(NO_3)_2$ was added to 50.0 mL of 3.0×10^{-4} *M* NaOH. Assume that the final volume of this solution is 100.0 mL. Will a precipitate be formed in this experiment? Justify your answer by comparing the value of *Q* to the value of K_{sp} obtained in part (c).