Recitation 10 (Buffers and Titration)

Name: UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname).
- Your UGA myID is a combination of letters and numbers (example: mine is wpe 28548). **Do not use your 81x number.**
- If you do not have a printer, type your answers in the then upload the worksheet template to Gradescope by Wednesday, April 14 at 11:59 pm. Write your work on separate sheets of paper, convert to a PDF and upload to eLC.
- If you have a printer download the worksheet, convert it to a PDF and upload to Gradescope by Wednesday, April 14 at 11:59 pm. You do not need to upload anything to eLC.

1. For the reaction:

$$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$$

determine the pH of the HF solution and the **change** in the pH (Δ_{pH}) for the addition of 1.75 M NaF salt to a 5.45 M solution of HF, $K_a = 7.2 \times 10^{-4}$?

pH of HF

Δ pH

2. If you start with 80.0 mL of 0.40 M HNO_3, calculate the $[H^+]$ concentration following addition of 40.0 mL of 0.60 M KOH.

M

3. For the reaction:

$$CH_3NH_2(aq) + H_2O(aq) \rightleftharpoons CH_3NH_3^{+}(aq) + OH^{-}$$

Determine the pH of the methylamine solution and the **change** in the pH (Δ_{pH}) for the addition of 6.7 M CH_3NH_3Cl salt to a 4.7 M solution of CH_3NH_2, $K_b=4.38 \times 10^{-4}$.

pH of CH_3NH_2 ☐ Δ pH ☐

4. Which combination of solutions is the best choice for making a buffer solution?

☐

A. equal volumes of 1 M ammonia (NH_3) and 0.001 M ammonium chloride (NH_4Cl)

B. equal volumes of 0.5 M hydrochloric acid (HCl) and 0.5 M sodium hydroxide (NaOH)

C. equal volumes of 0.5 M hydrochloric acid (HCl) and 0.5 M sodium chloride (NaCl)

D. equal volumes of 2 M ammonia (NH_3) and 1 M hydrochloric acid (HCl)

E. equal volumes of 2 M ammonium chloride (NH_4Cl) and 1 M hydrochloric acid (HCl)

5. A chemist poured 10.0 mL of 0.10 M NaCl, 10.0 mL of 0.10 M KOH, and 5.0 mL of 0.20 M HCl solutions together and then he made the total volume to be 100.0 mL. What is $[Cl^-]$in the final solution?

☐ M

6. In a titration of monoprotic acids and bases, there is a large change in pH _____

☐

A. at the point where pH = pK_a of the acid.

B. when the volume of acid is exactly equal to the volume of base.

C. when the concentration of acid is exactly equal to the concentration of base.

D. when the number of moles of acid is exactly equal to the number of moles of base.

E. at the point where pH = pK_b of the base.

7. What volume of 0.50 M HNO_3 is needed to titrate 25.0 mL of 0.050 M $Ca(OH)_2$ solution to the stoichiometric endpoint?

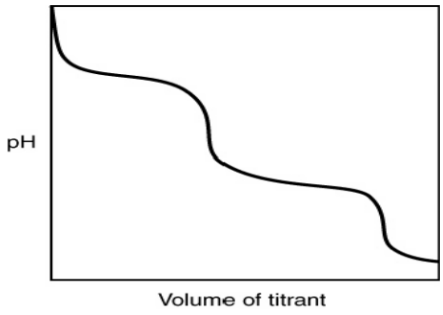
[ ] mL

8. When an acetic acid solution is titrated with sodium hydroxide, the slope of the titration curve (pH vs volume of NaOH added) increases when sodium hydroxide is first added. This change shows that _____.

[ ]

A. nothing is happening during this part of the titration.
B. the reaction is very slow during this part of the titration.
C. a more concentrated solution of NaOH needs to be present to initiate the reaction.
D. acetic acid is being converted to sodium acetate.
E. the pH is not affected until all the acetic acid is consumed.

9. What is indicated by the shape of the titration curve?



[ ]

A. A diprotic acid was titrated with a strong base.
B. A triprotic acid was titrated with a strong base.
C. A diprotic base was titrated with a strong acid.
D. A triprotic base was titrated with a strong acid.
E. A strong acid was titrated with a strong base.

10. What volume of 0.80 M HCl will be required to titrate 36.2 grams of NaBrO to the equivalence point?

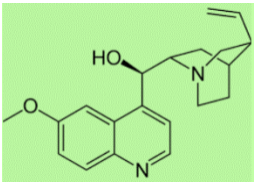
[ ]

A. 150 mL
B. 308 mL
C. 381 mL
D. 258 mL
E. None of the above

11. One brand of extra-strength antacid tablets contains 750 mg of calcium carbonate in each tablet. Stomach acid is essentially a hydrochloric acid solution. Is so much calcium carbonate really needed to neutralize stomach acid? Calculate the volume of stomach acid with a pH of 1.0 that one of these tablets could neutralize, and compare that value with the normal volume of stomach fluid, which usually is about 100 mL. One tablet can neutralize _____ mL of stomach acid at a pH of 1.0.

mL

12. Quinine is a weak base, with $pK_b = 5.10$. What is the pH if a 25.0 mL solution originally containing 0.125 moles of quinine is titrated with 31.0 mL of HCl to the equivalence point?



13. A 25.0 mL sample of a HCl solution is titrated with 0.15 M NaOH solution. The equivalence point is reached with 75.0 mL of base. The concentration of HCl is _____ M.

M

14. 40.0 mL of an acetic acid solution of unknown concentration is titrated with 0.100 M NaOH. After 20.0 mL of the base solution has been added, the measured pH was 5.10. What was the concentration of the initial acetic acid solution? $K_a = 1.8 \times 10^{-5}$.

M

15A. What is the $[H_3O^+]$ in a 0.50 M HF solution? $K_a = 6.8 \times 10^{-4}$.

M

B. What is the $[H_3O^+]$ in a solution containing both 0.50 M HF and 0.10 M NaF? $K_a = 6.8 \times 10^{-4}$.

M

16. A 0.500 g sample of an unknown substance was titrated with a 0.1 M HCl solution. Another 0.500 g sample of it was titrated with a 0.1 M NaOH solution. The resulting titration curves are illustrated here. Given the following possibilities, what is the sample?

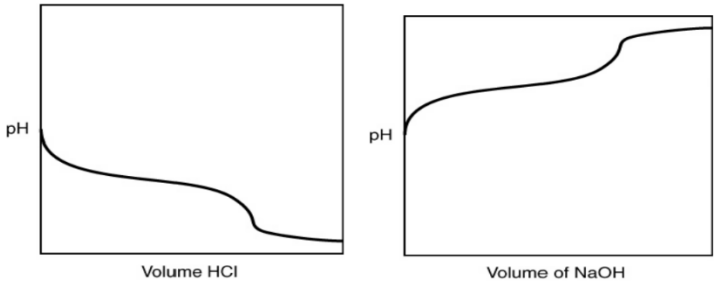
A. Na_2CO_3

B. CO_2

C. $NaHCO_3$

D. H_2CO_3

E. There is no way to tell.



17. Which of the following combinations would give a pH above 7.00 at the equivalence point?

A. HCl + KF

B. HCN + NaOH

C. HF + HCl

D. HCl + KOH

18. Consider 1.00 L of a solution initially containing 0.500 mol ammonia (NH_3) and 0.300 mol of ammonium ion (NH_4^+). What is the pH after addition of 40 mL of 0.800M NaOH to this solution? (NH_4^+ $K_a = 5.6 \times 10^{-10}$)?