Recitation Worksheet 11: Acid-Base Equilibria (15.1-15.4 and 15.6)

Name: MyID:

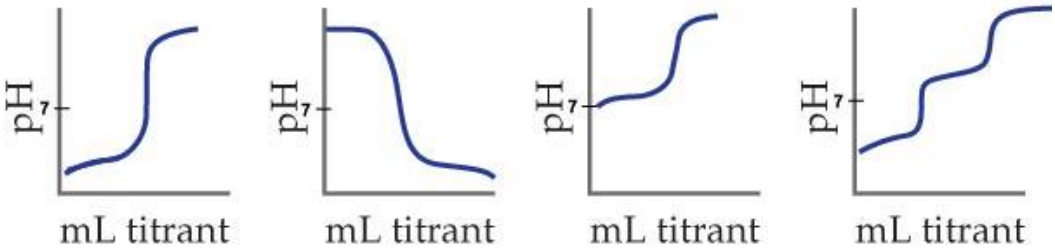
Instructions:

1. Please enter your first and last name as it appears on the eLC classlist (do not use a nickname).
2. Your UGA myID is a combination of letters and numbers (example: Dr. Abdelrahman MyID is ema88805). **Do not use your 81x number.**
   a. If you do not have access to a printer, type your answers in the worksheet PDF and then upload it to **Gradescope** by Friday, April 14th at 11:59 pm. Write your work on separate sheets of paper, convert to a PDF and upload to the "Recitation Worksheet 11 Dropbox" on eLC.
   b. If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
   c. If you have access to a printer, print out the worksheet, write your answer in the answer boxes, and show your work on it when appropriate. Then convert it to a PDF and upload to **Gradescope** by Friday, April 14th at 11:59 pm. You do not need to upload anything to eLC. The pages must be in the correct order and have the same layout as the original, or Gradescope will not be able to read it.
   d. There is a **Gradescope App** available for both iOS and Android devices that allows you to scan and submit your printed work or you can submit your fillable PDF directly. Detailed instructions on how to access and use the app can be found on your CHEM 1212 class eLC page under content ⟶ Welcome module ⟶ Gradescope ⟶ Gradescope new mobile app.
3. Answers must be written in the corresponding answer box, or no credit will be awarded.
4. The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.

1. Which of the aqueous solutions below are buffer solutions? Select all that apply. Insert letters without spaces in the answer box, example **ABCD.**

   A. 0.100 M KBr
   B. 0.200 M NaCl and 0.200 M NH_4Cl
   C. 0.100 M CH_3NH_2 and 0.150 M $CH_3NH_3^+Cl^-$
   D. 0.100 M HCl and 0.050 M $NaNO_2$
   E. 0.100 HCl and 0.200 M $NaCH_3COO$
   F. 0.100 M Na_2HPO_4 and 0.100 M NaH_2PO_4
   G. 0.100 M CH_3COOH and 0.100 M $NaCH_3CH_2COO$

2. Match the titrations curves (i-iv) to the appropriate description (A-D).



A. Titration of a strong base with a strong acid.

B. Titration of a weak acid with a strong base.

C. Titration of a strong acid with a strong base.

D. Titration of a polyprotic acid with a strong base.

3. In the laboratory, you were asked to prepare a buffer solution with pH = 10.50. How many **grams** of NH_4Cl (molar mass = 53.5 g/mol) would you add to 625 mL of 0.258 M NH_3 to prepare a buffer with pH = 10.50? Assume that the solution's volume remains constant. K_b of NH_3 = 1.8 x 10^{-5}. Keep your answer to three significant figures.

[ ] g

4. If 0.100 M of the solutions below were provided to you, which **two solutions** would you use to prepare a buffer with pH = 3.50? Select all that apply. Insert letters without spaces in the answer box, example **AB.**

[ ]

A. Formic acid (HCOOH, pK_a = 3.74)
B. Acetic acid, (CH_3COOH, pK_a = 4.74)
C. Phosphoric acid (H_3PO4, pK_{a1} = 2.15)
D. Sodium acetate ($NaCH_3COOH$)
E. Sodium formate (NaHCOO)
F. Sodium dihydrogen phosphate (NaH_2PO_4)

5. Calculate the final **pH** in each of the titration scenarios below:
   A. The titration of 25.00 mL of 0.160 M HCl with 15.00 mL of 0.242 M NaOH. Keep your answers to two decimal places.

[ ]

B. The titration of 25.00 mL of 0.100 M CH_3COOH (K_a of CH_3COOH = 1.7 x 10^{-5}) with 12.5 mL of 0.200 M NaOH. Keep your answers to two decimal places.

6. What is the pH of a mixture of 0.012 M of C_6H_5COOH (K_a = 6.3 x 10^{-5}) and 0.033 M NaC_6H_5COOH? Keep your answers to two decimal places.

7. A solution is prepared by dissolving 0.23 mol of hypochlorous acid and 0.27 mol of sodium hypochlorite in water sufficient to yield 1.00 L of solution. The addition of 0.05 mol of HCl to this buffer solution causes the pH to drop slightly. The pH does not decrease drastically because the HCl reacts with the _____ present in the buffer solution. The K_a of hypochlorous acid is 1.36 × 10^{-3}.

A. H_2O
B. H_3O^+
C. Hypochlorite ion
D. Hypochlorous acid
E. This is a buffer solution. The pH does not change upon addition of acid or base.

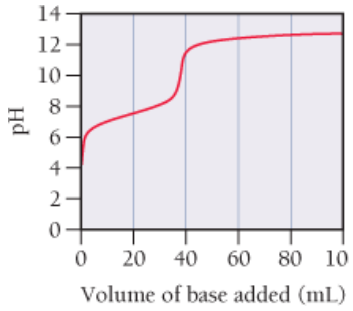
8. To a 0.300 L buffer solution consisting of 0.250 M CH_3COOH and 0.560 M $NaCH_3COO$, 0.0060 mol HCl is added. What are the moles and concentration of CH_3COOH after the addition of HCl? Assume that the volume of the buffer does not change upon the addition of HCl.

A. 0.0060 mol, 0.020 M
B. 0.162 mol, 0.54 M
C. 0.081 mol, 0.27 M
D. 0.075 mol, 0.250 M
E. 0.168 mol, 0.560 M

9. In which of the solutions given below would nitrous acid (HNO_2) ionize *less* than it does in pure water?

A. NaCl
B. KNO_3
C. KNO_2
D. $NaClO_4$

10. You are provided with the titration curves I and II for two weak acids titrated with 0.100 M NaOH. Refer to the titration curves to answer the following questions:



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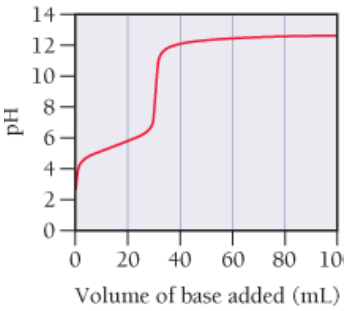


II

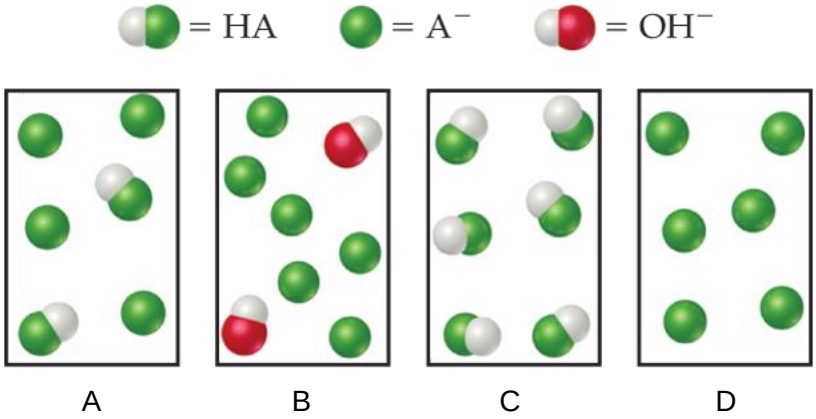
A. Which acid is more concentrated?

B. Which acid has the larger K_a?

11. Which solution has the **greatest** buffering capacity?

A. 0.335M $HC_2H_3O_2$ and 0.497 M $NaC_2H_3O_2$
B. 0.520 M $HC_2H_3O_2$ and 0.116 M $NaC_2H_3O_2$
C. 0.820 M $HC_2H_3O_2$ and 0.715 M $NaC_2H_3O_2$
D. 0.120 M $HC_2H_3O_2$ and 0.115 M $NaC_2H_3O_2$

12. A strong base such as KOH is mixed in a specific proportion with the weak acid HA to make a buffer. Which of the diagrams below is a correct representation of the buffer solution?



13. What change will be caused by addition of a small amount of HCl to a solution containing fluoride ions and hydrogen fluoride?

A. The concentration of hydronium ions will increase significantly.
B. The concentration of fluoride ions will increase as will the concentration of hydronium ions.
C. The concentration of hydrogen fluoride will decrease, and the concentration of fluoride ions will increase.
D. The concentration of fluoride ion will decrease, and the concentration of hydrogen fluoride will increase.
E. The fluoride ions will precipitate out of solution as its acid salt.

14. A 1.00 L buffer solution is 0.150 M in $HC_7H_5O_2$ and 0.250 M in $LiC_7H_5O_2$. Calculate the pH of the solution after the addition of 100.0 mL of 1.00 M HCl. The Ka for $HC_7H_5O_2$ is 6.5×10^{-5}.

A. 4.19
B. 5.03
C. 4.41
D. 3.34
E. 3.97

15. You are working in the lab with three acidic solutions. **Solution 1** is 0.1 M of a **weak monoprotic acid**, **solution 2** is 0.1 M of a **strong monoprotic acid** and **solution 3** is 0.1 M of a **weak diprotic acid**. Each of the former solutions has been titrated with a 0.2 M KOH solution. Which *quantity* is the same for all the three solutions?

A. The volume required to reach the final equivalence point.
B. The volume required to reach the first equivalence point.
C. The pH at the first equivalence point.
D. The pH at one-half the first equivalence point.
E. None of the quantities is the same for the three solutions.

16. Which of the following statements is **<u>accurately</u>** describes the common-ion effect?

A. The extent of ionization of a weak electrolyte is increased by adding to the solution a strong electrolyte that has an ion in common with the weak electrolyte.
B. The solubility of a slightly soluble salt is increased by the presence of a second solute that provides a common ion to the system.
C. The common ion effect occurs when a solubility equilibrium is shifted due to a second compound that contains an ion common with the first.
D. The common ion effect is that common ions precipitate all counter-ions.
E. None of the above statements accurately describe the common-ion effect.