

Problem Set 3

(Due: February 10th 5:00 PM)

1. Which of these acids could be used to make a buffer at pH 6.8? You can find a table of pKa values [here](#) or in any general chemistry textbook. Select all that would work.

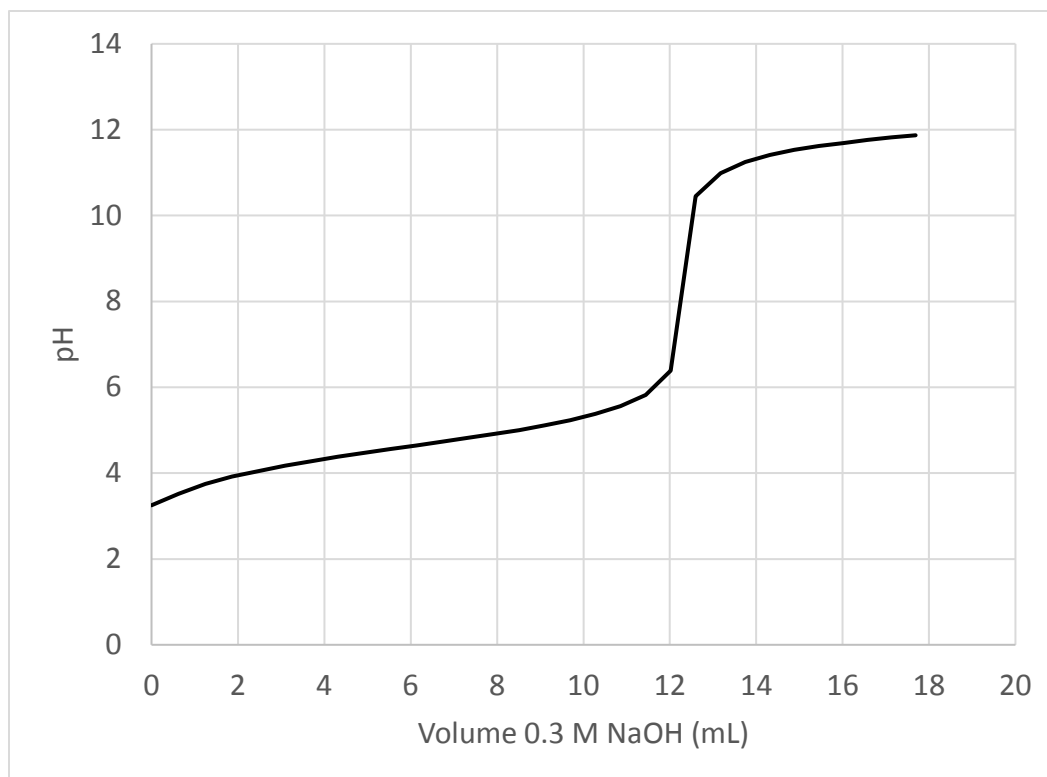
formic acid ammonium carbonic acid acetic acid hydrofluoric acid

2. Rank these solutions by increasing pH. You should not need to do any math to answer this question:

10 mM NaNO₂ 10 mM HNO₂ 10 mM Mg(NO₂)₂ 10 mM NaNO₃ 10 mM HNO₃

3. Clearly explain why hypochlorous acid is a weaker acid than chlorous acid.
4. Consider fluoride and chloride.
- Which of these ions is a weak base? How do you know?
 - Which would make a more acidic solution? How do you know?
 - The chemistry of these two ions is very similar; however, in solution they undergo different chemical reactions. Think very critically about how each of these ions interact with water and propose a reason that one is a weak base and one is not.
5. For each of the following, determine if dissolution in water would make the pH acidic or basic.
- NaF
 - NH₄NO₃
 - NaHSO₄
 - MgHPO₄
6. Consider phosphoric acid:
- Draw 3 sequential acid dissociation reactions that this molecule can be involved in.
 - Determine the 2 species at highest concentration at biological pH (7.4).
 - Calculate the concentration of these two chemical species at biological pH if the total concentration is 17 mM.
7. The condensation of a fatty acid with glycerol is required to build phospholipids and triacylglycerides.
- Show the 3 step process for condensation of 16:0 with glycerol.
 - Is the acid or base form of the fatty acid required for this process?
 - The pKa of 16:0 is approximately 4.5. Under biological conditions (pH = 7.4), which form (HA or A-) of 16:0 is present in the highest concentration?
 - Calculate the fraction of the fatty acid that is present in the form necessary for the condensation reaction.
 - Think critically about what you have just learned. Does this predict that phospholipid synthesis is likely to happen at biological pH? Explain your answer.
8. Calculate the pH after 1 mL of 1 M HCl is added to each of the following solutions"
- 1 L H₂O at pH 7.0
 - 1 L of a 50 mM carbonic acid buffer at pH 7.0.
9. Consider serine:
- Determine the isoelectric point of serine. You can find a table of pKa values [here](#).
 - Does serine carry a net positive or net negative charge at pH 7.4?

10. Sketch a curve for the titration of NaOH into cysteine. Label the y-axis at the 3 pKa values and the 2 intermediate equivalence points.
11. Consider the titration curve below. Based on what you see:
- What is the pKa of this acid?
 - Determine the initial concentration of the acid.
 - Calculate the initial pH.



12. You are doing a titration experiment by adding 500 mM NaOH to 300 mL of 18 mM hypochlorous acid.
- What volume of NaOH is needed to reach the $\frac{1}{2}$ equivalence point?
 - What volume of NaOH is needed to reach the equivalence point?
13. Sketch a curve for the titration of 500 mM NaOH into 300 mL of 18 mM hypochlorous acid. Make sure to label the x and y axis for the three important points we talked about in class. Note that this is the same solution as you saw in problem 12.