Key tools/skills required for problem set:

- Determine the pH of a buffered system
- Determine the pH of a buffered system after it has been perturbed
- Be able to calculate the pH of a buffered system starting from the corresponding salts and acids that would really be used to make up a buffer.

1. Take the problem we worked in class and determine the pH if 2 mL of 0.05 M NaOH was added to the system.

2. Many aqueous systems are buffered near pH 8 by the presence of carbonic acid (H$_2$CO$_3$) and bicarbonate (HCO$_3^-$). In lab calcium carbonate concentrations normally range between 125 and 250 ppm CaCO$_3$(aq). The dominate species in the marine ecosystem is really HCO$_3^-$ so assume that there are really twice as many moles of HCO$_3^-$ as there are moles of carbonate in the tank water. The dominate acid/base reaction is H$_2$CO$_3$ $\leftrightarrow$ H$^+$ + HCO$_3^-$. Given that the pKa for carbonic acid at 25 °C is 6.37 and that the concentration of H$_2$CO$_3$ in many waters is around $2 \times 10^{-5}$ calculate the expected pH range for the tank.

3. Calculate the change in pH if 100 mL of acid rain with a pH of 2.5 falls into a lake that contains 1000 L of water buffered with the buffer described in problem #2 – pick a specific concentration of HCO$_3^-$ for this problem – don’t try to use a range. What if 1 L of water was added instead (you can neglect dilution in going from 1000 to 1001 L)?

4. Calculate the change in pH if 1 L of acid rain with a pH of 2.5 falls into a lake that contains 1000 L of water that is not buffered and that naturally has a pH of 7. Again you can neglect dilution.

5. The most acidic rain ever measured had a pH of 1.7. How much more acidic is that then “normal” rain with a pH of 5.6? What is the [H$^+$] concentration of this rain? The [OH$^-$]? If you had a bucket full of rain with a pH of 1.7 and then dissolved some acetic acid in it (with a K$_a = 1.76 \times 10^{-5}$) such that the total concentration of acetic acid was 0.1M, what percentage of the acetic acid would dissociate? To do this problem, assume that the pH does not change when the acetic acid is dissolved in it.

6. What would the pH be of a solution containing 0.1 moles carbonic acid and 10 grams KHCO$_3$ in 2 L of water?

7. What would the pH be of a solution containing 20 grams of KHCO$_3$ and 0.1 moles HCl in 2 L of water?
8. What would the pH be of a solution containing 0.2 moles of H$_2$CO$_3$ and 0.07 moles Ca(OH)$_2$ in 2 L of water?

9. What would the pH be if 10 mL of 0.001 M HCl was added to the solution prepared in problem 7?

10. What would the pH be if 10 mL of 0.001 M NaOH was added to the solution prepared in problem 8?

Problems 35-45 in your text (chapter 16) also cover the same material on this problem set if you feel like you would like some extra problems to work.