Teacher: Pass these back; it’s the direction for the CPR. I am not going to spend too much time talking about the CPR. We are the first group to use these on campus. The web address is different because this is a new server.

Teacher: (Reading from page of notes)

- Exam 3 next week – 18, 19 and 20; next Tuesday
- BOP is due week from Thursday which is rest of 18, all 19 & 20
- CSB due week from Friday; 19 & 20 (parts 1, 2, 3 only)
- CPR starts today
  o Get new ID
  o Do the tour and take initial quiz.
  o Paragraph due by Thursday night 11/20, by 2am (Friday morning); rest due Thursday 12/4, by 2am (Friday morning)
- Use https://; https is the secure server.

If you have any questions, come see me.

Female Student: do the rest?

Teacher: no, that won’t be on the exam, because I am not covering that in class. We are finishing up 19 and summarizing 20 for the exam.

Acid – Base Titrations

- Limiting reagent problems
- Titrating a weak acid with strong base (like lab)

(Example on board.) Curve looks like that. Point 1, 2, 3 and 4. This is similar to what you have been doing. Let’s look at the parts.

Nobh is in the beaker, weak acid down here and your glass electrode in the beaker. Initially it’s a weak acid and the pH is calculated by this. On the exam, you will get one or the either and have to do the 4 parts.
In the first, before the titration, the system is a weak acid. In the second section, that is a buffer system. It is located before the equivalent point. System is weak acid buffer. There is a range for the buffer system, because this is the source for the conjugate base. You would do the limiting reagent using moles and revert back. Then, you do the buffer problem. That is moles weak acid over moles salt. Third, you will do the equivalent point. The system is salt of strong base and weak acid. If you are using, sodium acetate, from lab, what happens is the acetate reacts with the water. In this case, you must know the concentration of salt. So you solve for OH-. (Example on board.) Finally, at the fourth step, you are past the equivalent point. The system is excess strong base. You will find the concentration of OH-: that is moles excess base over total volume.

This is four of your eight systems. Now, lets build the titration curve for adding point 2 molar HCl, pg 16 of my notes… (Example on board.).

I draw pictures to help me think of what is going on in the lab. The initial ph is based on a weak base system. I expect the ph to be greater than 7. (Working problem) so, we can find the poH, by taking the log, changing the sign… And the ph is 11.13. Now, we add some HCl, which will react with the nh3. Once the titration starts, the product is nh4cl.

So, what is the pH when 20 mL of HCl is added?

(Example on board.). NH3=point 01 ml… HCl=point oo4… And nh4cl is plus point oo4. After combining, your system is a weak base buffer. That is moles base over moles salt (like the cation). Your end result 2.7 times 10 to the minus 5 molar. Finding the poH is then 4 point 57. Back on our graph, here is our ph. (Example on board.).

What happens if you are at the equivalence point?

(Example on board.). Each point in a titration is independent of each other. At the equivalence point then we have to add to make the volume of solution. In that case, it’s a salt problem. We have to know the concentration of salt, so we have to know how much we added to get to the equivalence point. One part is given; this we figured out, so what is left is salt to figure out.
Buffers are the only system where you can work with moles. So this number (Example on board.) is important to know where we got it and how much it is. Molarity is moles over Liters… Liters are mol over M… We need to know the concentration of nh4cl, to get to the total volume.

Now, we have a salt problem. Find the pH of a salt solution where we have (Example on board.) point 0667 M. This will be acidic with a pH less than 7. The real reason this is acidic is because this is a weak acid. Here, we are solving for H+. What is the K for that equilibrium? Kw divided by Kb, times that point 0667M.

Here we are at the equivalent point. We had to add 50 mL to get to the equivalent point.

What is the pH when we add 60 mL of HCl?

We are past the equivalent point and at the 4th point. The system is acidic, with a pH less than 7. It is a strong acid. We still have to do the titration, as well as the other steps; limiting. At this point, we have 0 HCl, point 0020 mol of HCl and point 010 mol of the nh4cl. HCl is a strong acid and will overwhelm any effect of the pH; it controls the system.

Remember what I said about buffers and doing the calculations? (Example on board.). Now we do the concentration. Figure the pH by taking the log. The next question is to draw the titration curve. Now I usually get a straight line, but that isn’t what the curve looks like.

Remember what the curve of the weak acid/strong base looked like? Well, what do you think this titration will look like?

If you turn the first graph over, this is what it will look like. (Example on board.). That is the end of chapter 19. Ignore questions on the behavior of indicators. Indicators are weak acids with their own Ka’s. They change color when the pH of the solution is equal to the pKa. I wont include this.

Take a break and then we will start 20.
Okay, here I am adding this solution. This is lead nitrate. It is soluble, because you look at it and it is soluble. It’s a nitrate salt, but you can look at it. Now, I am going to add some potassium iodide. (Example on board.). This potassium solution is also soluble. So, what happens is these are *metapheses* reactions. The balance we need is this (Example on board.).

Look under **solubility products** on the back of your periodic table. Items listed here are relatively insoluble. So I add more potassium iodide.

*What is the yellow stuff?*

Its relatively insoluble, but you can see sometimes it is soluble. *What going on here?* We have an equilibrium going on here. *At this point, of K and Q, which is bigger?* Ksp is used for solubility products; here it is when the solid is breaking into its ion. (Example on board.) You look up lead iodide. Anytime you set this up, you do so like this (Example on board.).

*Where are we, at the equilibria?* Qsp looks like Ksp except you are putting in the real concentrations. *Are the concentrations in that beaker too small or too big?* Too small! In general, they are too small. Lets talk about what we are seeing. It is called precipitation; that is when solid comes out of the solution. This just starts to happen when Qsp is equal to Ksp, or at equilibrium. If Qsp is bigger than Ksp, precipitation occurs until Qsp is equal to Ksp. When Qsp is less than Ksp, no precipitation occurs. In fact, if a solid is present, it will dissolve.

Reactions like this are interesting because it is equilibrium, as it mixes… The Qsp becomes less than the Ksp. I can overwhelm the system and now, the precipitation stays, but the system goes to equilibrium. The solid goes to the bottom if I turn it off. Whenever the solution is saturated, that means in this case, the Ksp is equal to the Qsp. At that point, no more solids will dissolve. If Qsp is less than Ksp it is **undersaturated**. If Qsp is greater than Ksp it is called **supersaturated**. You will see this again.

Ksp is called the **solubility product**; we use if for all slightly soluble compounds. It’s the equilibrium constant for these kinds of solids dissolving into their ions. This is pg 120.
Let's consider silver chloride. It's a compound used in black and white photography. It is a solid, but can dissolve a little bit into its ions. These are temperature sensitive. Everything we do will be at 25 degrees Celsius.

One important thing is to figure out how to calculate or determine Ksp experimentally. We have some barium sulfate, on pg 2. We put solid barium sulfate into the bottom of the beaker and stir with a magnetic stirrer. If we let it go on long enough, we will reach equiliria. That means the solid is dissolving into its ions, just as fast as the ions are forming a solid.

**Molar solubility** is the number of moles that dissolve to form 1 L of saturated solution. **Saturated** means it is full; there can be no more.

(Example on board.). We do this experiment, we find that molar solubility is 1 point 05 times 10 to the minus 5 M. Therefore, Ksp is equal to (1 point 05 times 10 to the minus 5) ^2…

Let's look at this (Example on board.). We have a saturated solution of caF2 at same T; what is the Ksp? Its not very soluble, but it will break down a bit. In terms of molar solubility, the concentration of calcium ions is equal to that conc. The concentration of F must be squared. The concentration of calcium is (Example on board.) this. We can find the Ksp…

We will finish 20 on Thursday.