

## Textbook Chapters for Exam 3

Chapters 8 (all of it) and Chapter 11 sections 1-3. You're responsible for any material covered in class whether it was on the homework or not. This review sheet covers most everything we have done. Also remember that no equations are given on the exams. Values for equilibrium constants and any standard potentials are given where needed.

## Chapter 8 – Buffers, pH curves, Titrations, and Indicators

- Know the basic premise for making a **buffer solution**. These are “type 2” problems according to Dr. McCord (see acid/base help sheets on our web site)
- Know HOW a good buffer will neutralize both acid and/or base. Yes, this means know the actual reactions that do the neutralizing.
- What is buffer capacity (section 8.4)?
- Be able to use and identify the **Henderson-Hasselbalch equations** for both acids and bases.
- Be able to calculate the pH of any buffer, acidic or basic.
- What is the **common ion effect**?
- Know the 2 ways to prepare buffers:
  1. Mix the two conjugates with proper molar ratios: e.g. HA and NaA
  2. Partial neutralization. : e.g. Neutralize a portion of HA with NaOH to MAKE the  $A^-$  needed. You are essentially doing a titration but stopping somewhere in the middle. After all, that IS where you will have a nice mixture of BOTH acid and conjugate base.
- Be able to calculate the new pH of a buffer AFTER the addition of strong acid or strong base. Remember that you will always be subtracting from one species and adding to the other in this calculation. For example, if my acid/conjugate base ratio is 50 mmol HA and 50 mmol  $A^-$  and I add 15 mmol of  $OH^-$ . After the addition the HA is now  $50 - 15 = 35$  mmol, and the  $A^-$  is now  $50 + 15 = 65$  mmol. That 65/35 ratio is the new ratio that governs the buffer pH.
- Know how to interpret a pH curve and get the stoichiometric point (aka: equivalence point) and the  $pK_a$  (or  $pK_b$ ) for a weak acid (or base).
- In general, what's the pH at the stoichiometric point of a titration of a strong acid with strong base? a weak acid with a strong base? a weak base with a strong acid? Know the answer to this in general first - is the pH equal to, greater than, or less than 7.00 (no calculation necessary). Then know the answer exactly which means you'd have to actually calculate the answer.
- Be able to calculate all the points on a titration curve (pH curve). This really means you now have a full knowledge of

acid/base theory from start to finish. You start with only HA (chapter 7 stuff, Type 1 equations), you titrate a bit and now have a buffer (Chapter 8, buffer stuff, Type 2 equations), you then reach the stoichiometric point (back to Type 1 equations - now the conjugate of what you started with), and finally you keep going and overshoot the end point (governed only by excess titrant).

- Know how indicators work and how to choose the correct indicator for a given titration.
- Know the approximate range of an indicator (in general, when given  $K_a$ ).
- What color will an indicator be at a given pH? (you would know the  $K_a$ ). Is it red? yellow? orange? yellowish orange? bluish green? reddish purple? ... you get the idea.
- Realize that you can have polyprotic acids in the mix for all of the above information. If you make a buffer with a polyprotic acid/base you need to know WHICH  $K_a$  to use. Answer, look at which conjugate pairs are the dominant species. Once you know which pair, you know which  $K_a$  to use.

## MORE Chapter 8 - Solubility Equilibria

Calculations, how to:

- Get molar solubility ( $x$ ) from  $K_{sp}$
- Get  $K_{sp}$  from molar solubility. Do realize that for many problems you must first *convert* the plain ol' solubility (g/L, mg/L, g/100mL, ppm, ppb, etc...) into molar solubility first, then convert that to  $K_{sp}$ .
- Apparent solubility in the presence of a common ion. This is where one of the ions concentrations is already SET in the solubility product expression.
- I already said this above but I'll say it again: be able to get molar solubility ( $x$ ) from “plain” solubility which can be expressed as grams per liter or, in general, mass per unit volume like ppm (mg/L) or even g/100 mL..
- Get all final concentrations in saturated solutions. OK, so you can calculate  $x$  from  $K_{sp}$ . Now tell me what the actual concentration of  $Mg^{2+}$  is, or  $Cl^-$ , or  $OH^-$ , or etc... sometimes it is  $x$ , sometimes it's  $2x$ , or  $3x$ , and so on.

- Predict whether a precipitation will occur. This is just comparing  $Q_{sp}$  to  $K_{sp}$ .
- Know what will precipitate 1st, 2nd, etc.. in solutions containing many different ions that can precipitate.
- Fractional precipitation or selective precipitation. What % of the 1st precipitate is precipitated (or % NOT precipitated) when the 2nd precipitate first starts to precipitate?
- How to get certain insoluble compound to dissolve. Apply Le Chatlier's Principle here.
- Know what a complex ion is and how they dissociate. How to write a  $K_f$  or  $K_d$  expression and how to solve it. Remember that  $K_f$  is a formation constant and  $K_d$  is a dissociation constant and they have an inverse relationship.

## Chapter 11 - Electrochemistry (sections 1-3)

Remember your redox chemistry - Chapter 4. Know the basic concepts that were presented on the homework set called "Redox Practice".

Know how to assign oxidation numbers to all the elements in a given formula.

Know how to balance a redox equation in acid.

What is the difference in oxidation and reduction. KNOW your definitions here!

Know what a redox reaction is. What is being oxidizing and what is being reduced? What is the oxidizing agent and what is the reducing agent?

What is a half-reaction? Why is it so useful? Know how to write half-reactions for both oxidations and reductions.

Know how to combine 2 half-reactions to give an overall cell reaction. (electron balance?) This is essentially the same as what was stated above except that in electrochemical cells we run the 2 half-reactions in 2 different locations - that is we have them physically separated.

Know the difference in voltaic vs electrolytic cells

Know how to write half-reactions for both oxidations and reductions.

Know how to combine 2 half-reactions to give an overall cell reaction. (electron balance?)

Know how to draw a picture of both a voltaic and an electrolytic cell if given the shorthand notation.

**anode | anodic solution || cathodic solution | cathode**

where the "|" are phase changes and "||" is a salt bridge.

What is a salt bridge and what is it used for?

Which electrode is the anode? the cathode?

What's the sign convention used for the cathode and anode?

What's the significance of the SHE?

What's an inert electrode? Used for what? Pt in the SHE, graphite in a dry cell

Know what standard conditions are and how it is symbolized (same as always).

Calculations, how to get:

- $E^0$  for any half-reaction (look it up in a table if it is not given in the question itself).
- $E^0$  for any overall cell reaction.  $E_{cell}^0 = E_{red}^0 + E_{ox}^0$

remember that Zumdahl uses cathode potential minus the anode potential which is the same as above. My oxidizing potential is the "minus the anode potential". Bottom line is that you always leave the reduction reaction as is off the table but you must FLIP the table value for an oxidation and when you FLIP, you must change the sign.

How to convert between  $\Delta G$ ,  $E$ , and  $K$ .

$$\Delta G^0 = -nFE^0 \qquad \Delta G^0 = -RT \ln K$$

$$nFE^0 = RT \ln K$$

"n" here is the # of total  $e^-$  cancelled out in the whole rxn.

## Now your turn

Now you start writing about all this stuff. Read your book. Over and over. Read other books if you need more help and insight. The more you expose yourself to the concepts the more things will make sense.

Remember, I didn't purposely leave anything out here to trick you on the exam. If I talked about it in class it is fair game on the exam. Practice working problems in the book and on the homework.