Last-minute Checklist for Exam 3 (not necessarily complete)

Chapter 14 Sections 11, 13, and 14.

Chapter 14. I am comfortable with writing equilibrium expressions for weak acids, strong acids and calculating the pH of any solution (given the concentration) of a weak acid or weak base. I can calculate the pH for solutions of strong acids and strong bases, given the concentration. I can convert pH, pOH, $[H_3O^+]$ and $[OH^-]$.

Section 14.11. Polyprotics

- ❑ I know how to write the equilibrium expressions for any polyprotic acid.
- ❑ I know how to determine if a species is a better weak acid or weak base.
- ❑ Given the molarity and the pK_a values, I can calculate the pH of the solution of any member in a series H_3A, H_2A^-, HA^{-2}, and A^{-3}.

Section 14.13. Relationship between K_a and K_b.

- ❑ I can use $K_a \times K_b = K_w$ and $pK_a + pK_b = 14$.

Section 14.14. Acid-base properties of salts.

- ❑ I can inspect the formula of a salt and determine if it is acidic, basic, or neutral. In order to perform this feat, I have memorized the list of pH neutral cations and anions. I also know that I start by separating the salt into its two ions and considering each one separately.
- ❑ I can determine the pH of any salt, given the concentration and access to K_a or K_b data. This requires me to be familiar with Sections 14.8, 14.9, 14.10, and 14.12.

Chapter 15 Sections 1 – 6.

- ❑ I know how to write equilibrium expressions for weak acids, weak bases and water as we learned in Chapter 14.

Section 15.1 Neutralization reactions.

- ❑ I know how to write net ionic equilibrium expressions and how to calculate numerical values for K_n for the following. I know that pH neutral ions are not shown in the net ionic equations.
  - ❑ Strong acids reacting with strong bases
  - ❑ Weak acids reacting with strong bases
  - ❑ Strong acids reacting with weak bases
  - ❑ Weak acids reacting with weak bases (here the net ionic is often the same as the overall reaction.)

Sections 15.2 – 15.4 Buffers.

- ❑ I know the two recipes for making a buffer. (We also did this in lab!)
  - ❑ Recipe 1. Mix a weak acid with its conjugate weak base. They do not react, only mix.
  - ❑ Recipe 2-a. React a weak acid with a limiting reagent amount of strong base.
  - ❑ Recipe 2-b. React a weak base with a limiting reagent amount of strong acid.

- I know how to determine the pH of any buffer given the concentrations or the moles of acid and base. I will use the Henderson-Hasselbalch *buffer* equation expressed in terms of concentrations (Recipe 1 only) OR moles (Recipe 1 or 2) of weak base and weak acid.
- I know how to use the Henderson-Hasselbalch Buffer Equation to determine what the pH does when small amounts of strong acid or strong base are added to a buffer. I know to do this, I must work in moles. The "Buffer Wheel" is a convenient way to handle these sorts of problems.
- I know how to determine the buffer capacity towards strong acid or strong base.
- I know how to calculate the ratio of weak base to weak acid in order to prepare a buffer of desired pH.

Sections 15.5 and 15.6 Titration of a strong acid with a strong base.

- I can "read" a titration graph and determine if is the titration of sa + sb or wa + sb.
- Regarding sa + sb, I can calculate the pH anywhere along the way using a ***mole*** ICE table and the reaction: $H_3O^+ + OH^- \rightarrow 2\ H_2O$. To calculate the pH, I must first determine the concentration of excess H_3O^+ or OH^- and to do that, I must use M=n/V and that V is the total volume.
- I know that at the equivalence point, $n_{acid} = n_{base}$, and the pH = 7.
- I know that I can use n = MV anytime I want (for example, $n_{acid} = M_{acid} \times V_{acid}$, $n_{base} = M_{base} \times V_{base}$), but only at the equivalence point is the following expression true: $n_{acid} = M_{acid} \times V_{acid} = n_{base} = M_{base} \times V_{base}$

Sections 15.7 Titration of a weak acid with a strong base.

- I can "read" a titration graph and determine the pKa which is equal to the pH half-way to the equivalence point (when $n_{HA} = n_{A^-}$).
- Regarding wa + sb (OH^-), I can calculate the pH anywhere along the way. There are 4 regions, each with a separate calculation:
    - Region I. Before any OH^- has been added: The pH of the weak acid is determined as you did in Chapter 14, using a MICE table and the 400 Rule.
    - Region II. The buffer region (between V = 0 mL and the equivalence point): This is a Recipe 2(a) buffer calculation (Reaction a weak acid with a limiting reagent amount of strong base). Use the mole version of the Henderson-Hasselbalch and use the buffer wheel! Note that the initial number of moles of weak base = 0.
    - Region III. Equivalence point: Here you have completely converted all of your weak acid into weak base, so you need to do a Chapter 14 weak base K_b calculation. At the equivalence point, n_{A^-} (now present) = n_{HA} (originally present) = $M_{HA} \times V_{HA} = n_{OH^-}$ (added, but now all gone) = $M_{OH^-} \times V_{OH^-}$. Use a MICE table, and total volume.
    - Region IV. After the equivalence point, there is excess OH^-. Simply determine the moles of excess hydroxide, divide by the total volume in liters

and you have [OH^-] using a nice table. Then you can determine pOH and finally pH.

- I know that at the equivalence point, $n_{acid} = n_{base}$, and the pH > 7.
- I know that I can use n = MV anytime I want (for example, $n_{HA} = M_{HA} \times V_{HA}$, $n_{OH^-} = M_{OH^-} \times V_{OH^-}$), but only at the equivalence point is the following expression true: n_{HA} (originally present) = $M_{HA} \times V_{HA} = n_{OH^-}$ (added, but now all gone) = $M_{OH^-} \times V_{OH^-}$

Sections 15.8 Titration of a weak base with a strong acid.

- I can "read" a titration graph and determine the pKa which is equal to the pH half-way to the equivalence point (when $n_{HA} = n_{A^-}$).
- Regarding wb + sa (H_3O^+), I can calculate the pH anywhere along the way. There are 4 regions, each with a separate calculation:
    - Region I. Before any H_3O^+ has been added: The pH of the weak base is determined as you did in Chapter 14, using K_b and a MICE table.
    - Region II. The buffer region (between V = 0 mL and the equivalence point): This is a Recipe 2-b buffer calculation (Reaction a weak base with a limiting reagent amount of strong acid). Use the mole version of the Henderson-Hasselbalch and use the buffer wheel! Note that the initial number of moles of weak acid = 0.
    - Region III. Equivalence point: Here you have completely converted all of your weak base into weak acid, so you need to do a Chapter 14 weak acid K_a calculation. At the equivalence point, n_{HA} (now present) = n_{A^-} (originally present) = $M_{A^-} \times V_{A^-} = n_{H_3O^+} = M_{H_3O^+} \times V_{H_3O^+}$ (added, but now all gone). Use a MICE table, and total volume.
    - Region IV. After the equivalence point, there is excess H_3O^+. Simply determine the moles of excess hydroxide using a nice table, divide by the total volume in liters and you have [H_3O^+]. Then you can determine pH.
- I know that at the equivalence point, $n_{acid} = n_{base}$, and the pH < 7.

Section 15.9. Titration of polyprotic acids with strong base.

- I know what the titration curve looks like for a polyprotic acid with OH^-.
- I can "read" the titration curve in order to determine all of the K_a values.
- I know when I can use $M_{H_3O^+} \times V_{H_3O^+} = M_{OH^-}V_{OH^-}$ and how the first equivalence point is related to the second (and third.)
- I know what buffer systems exist along the titration curve (what the wa and wb base are that constitute a buffer).
- I can list all of the major acid and base species present at various points along the titration curve.
- I can pick a reasonable indictor (given K_a values for the indicator and the color changes they undergo) for each equivalence point