

“HOW THINGS WORK (THINGS NEEDING ATOM-LEVEL DISCRPTIONS)”

PART I. THE CHEM OF SOLUTIONS (e.g., BLOOD, BATH WATER, AND LARGE COKES)

TENTATIVE SCHEDULE (CHAPTERS 13,14,15)

M 8/27

[Pre-class: read Sections 13.1,2 and try problem 13.19]

Organization. It's all on the web! What's the grading plan? Make-up exams? Are students competing?

1. **Kc.** How are chem reactions that don't "go all the way" handled? What's the Kc expression?

The student is to be able to: Explain the situation of a chemical equilibrium.

Give the Kc expression for any given equilibrium, including reactions involving pure liquids, solids, and water.

W 8/29

[Pre-class: read sections 13.2,4,5,6 and try problems 13.23, 31bd, 37a, 45, 53 (set-up only), 77]

2. **Calculating and Reading Kc's.** How (legally) are Kc's obtained? How do you "read" a Kc?
3. **Using Kc.** How are Kc's used to calculate amounts of chemicals in Beaver Lake, blood, or Cokes?

The student is to be able to: Explain the significance of a very large or very small Kc value.

Calculate the value of Kc if given all of the equilibrium concentrations of the chemicals in the reaction.

Calculate the value of Kc given the starting concentrations for all of the chemicals involved and the concentration at equilibrium of one of the chemicals of the reaction.

Given the Kc value and all equilibrium concentrations except one, calculate that one.

Given the Kc value and all starting concentrations, set up an expression to calculate the equilibrium concentrations.

F 8/31

[Pre-class: read sections 13.7,14.1 and try problems 13.59, 61; 14.29.]

4. **LeChatlier.** How do industries use a simple (French) idea to maximize products from an equilibrium reaction?
5. **Bronsted Acid-Base.** What's the most practical way to define aqueous acids and bases? (For this course).

The student is to be able to:

Use the LeChalelier Principle to predict the direction of shift caused by the following disturbances to an equilibrium:

the addition or removal of a chemical,

a change of pressure or a change of volume (for an equilibrium involving gases),

a change of temperature (with DH or exo/endo or heat information given),

the additon of a catalyst.

List what kinds of equilibrium disturbances will cause an equilibrium to shift (to the left or to the right)

Label the Bronsted acid, base, conjugate acid, and conjugate base for a given acid-base reaction.

Be able to give the conjugate acid or conjugate base for a given molecule or ion.

Label molecules or ions as potential Bronsted acids, Bronsted bases, or "could be both".

Write the products for a reaction after the Bronsted acid or base has been specified.

W 9/5

[Pre-class: read sections 14.2,3 and try problems 14.31, 19, 41.]

6. **Strong/weak.** What's the BIG difference between stomach acid and Pepsi acids? Special meaning of strong?
7. **pH idea and pH calcs.** What pH's can you drink? How to convert between pH, $[H_3O^+]$, pOH, and $[OH^-]$.

The student is to be able to: Explain what is meant by "strong acid".

Describe the relative concentrations of all ions and molecules in a weak acid and in a strong acid.

From a list of acids identify which are strong and which are weak.

Qualitatively compare the pH's of weak and strong acids of equal concentrations.

Given any one of $[H^+]$ or $[OH^-]$ or pH, calculate the values for the other two.

F 9/7

[Pre-class: read section 14.4,5 and try problems 14.49, 53, 57, 59, 73, 71]

8. **pH of Strong Acids.** The easiest ones to calculate!
9. **pH of weak acids.** If an acid only gives up some of its H^+ ions, how can you calculate how acidic it will be?

The student is to be able to: Convert between M of a strong acid, $[H^+]$ and pH.

Given any two of: (a) K_a , (b) concentration (M) of a weak acid and (c) $[H^+]$ or pH, calculate the third one.

M 9/10

[Pre-class: read sections 14.6,7 and try problems 14.75, 81a, 87, 134]

12. **pH of strong and weak Bases.** For this course there'll only be one weak base!

13. **Poly H acids.** Carbonic & phosphoric acid are everywhere (blood, lakes, bathwater, Cokes): How handled?

The student is to be able to: List a dozen strong bases and one weak base.

Give the equilibrium expression for a weak base in water. Name the molecules and ions involved.

Describe the relative concentrations of all ions and molecules (and pH) in a weak base and in a strong base.

Convert between the M of a strong base, pOH and pH.

Given any two of: (a) K_b , (b) concentration (M) of a weak base and (c) $[\text{OH}^-]$ or pH, calculate the third one.

Write equations for the step-wise dissociation of phosphoric acid; of carbonic acid; of any given polyprotic acid.

Predict K_{a2} and K_{a3} for a polyprotic acid given K_{a1} , and explain why the numbers change as they do.

Given any two of: (a) K_{a1} for a polyprotic acid, (b) M of the acid and (c) $[\text{H}^+]$ or pH, calculate the third one.

W 9/12

[Pre-class: read sections 14.8,10 and try problems 14.115abdef, 121]

14.-15. **Salts and Oxides.** How can salts such as Na_2CO_3 , or oxides such as CaO , which don't look like acids or bases, give acidic or basic solutions? Which salts or oxides could fix a stomach ache?

The student is to be able to:

Describe the cations and anions of salts that do not cause a change of pH, and explain why they do not.

Write the equilibria for the ammonium ion, high charged metal ions, and anions in water; describe the pH change.

Explain why some salts cannot be labeled acidic, neutral, or basic without extra information.

Classify salts -- which have water solutions that are basic, acidic, neutral, or "can't tell" (without K info).

Prove the K of the equilibrium for the X- ion reacting with water is K_w/K_a where K_a is for the weak acid HX.

Classify the three ions of a triprotic acid as acidic or basic. Rank them in order of basicity, and explain the order.

F 9/14

[Pre-class: read sections 14.9,11 and try problems 14.117abc, 119a, 123ac, 127]

16. **Acid Structures.** A couple of easy lines of reasoning explain why the strong acids are strong.

17. **Lewis Acids and Lewis Bases.** A way to talk acid-base when there are no H ions involved. It can be done.

The student is to be able to: Explain relative acidities of families of acids such as HX (or H_2X).

Explain relative acidities of oxy acids such as HClO_x when X varies from 1 to 2 to 3 to 4.

Explain relative acidities of oxy acids which have the same general formula but different central atoms.

Identify the Lewis acid and the Lewis base in a Lewis acid-base reaction.

M 9/17

[Pre-class: read sections 15.1,2 and try problems 15.21, 23d, 41ac, 53]

18. **Buffer Idea.** How can buffer solutions maintain a pH when acid or base is added to them?

19. **Buffer Calcs.** What pH will a buffer have? What's the recipe for making a buffer of a desired pH?

The student is to be able to:

Describe how to make a buffer solution starting with a given acid, base or salt.

Show how a variety of buffers can be made from the acid and/or ions related to a polyprotic acid like phosphoric acid, and (with K_a values) give the approximate pH of each buffer possible.

For a buffer using weak acid HX, given any 3 of (a) M HX, (b) $[\text{X}^-]$ (c) pH or $[\text{H}^+]$, and (d) K_a , calculate the fourth.

W 9/19

[Pre-class: read section 15.6 and try problems 15.85ab, 91b]

20. **Solubility.** How can you use tables to calculate the solubility of limestone (or any salt) in clean water?

21. **Ksp.** How can you use tables to calculate the solubility of limestone (or any salt) in dirty water?

The student is to be able to:

Using a given K_{sp} , solve for the molar solubility of any salt with the general formula AB, AB_2 , A_2B , A_3B , AB_3 , A_2B_3 or A_3B_2 in pure water. Also the solubility for solutions with extra A or B ions.

F 9/21

[Pre-class: read section 15.4 and try problem 15.56]

22. **Titration.** If we don't want to learn anything new two days before a test, how can we bluff titration curves?

Catch-up; left over stories

The student is to be able to:

Sketch the general shape of the titration curve for the titration of a strong acid (or a weak acid) with a strong base. How is the initial pH and the final pH determined? What is the pH at the equivalence point?

Explain the change of shape of the curve due to the fact the acid is weak.

M 9/24 Exam 1