1. Calculating simple buffers (no neutralization)

simply calculation

The only non-neutralization

Acid + conj base
$HA + A^-$
or $B + BH^+$

You are given concentration of the Acid + conj base and will calculate pH (or OH^-, pOH or H^+) from

$H^+ = K_a \frac{C_a}{C_b}$

$OH^- = K_b \frac{C_b}{C_a}$

2. Identifying buffers (after neutralization)

I will give you 5 different solutions of acids + bases (including volume + conc.), calculate the moles of A+B, neutralization if necessary, and see if a buffer remains.

5 solutions, only one is a buffer.

$\boxed{\begin{matrix} B & B \\ BH^+ & BH^+ \end{matrix}}$ or $\boxed{\begin{matrix} HA & HA \\ A^- & A^- \end{matrix}}$ $\Leftarrow$ only ~~o~~one, is a buffer

3. Ranking acidity and basicity based on Ka or Kb values

remember that as Ka gets larger, acidity increases as Kb gets larger basicity gets larger.

I will give you 4 Kas or Kbs, you need to rank them as increasing or decreasing acidity/basicity.

4. Buffer capacity

is the amount of buffer before you run out of buffer.

So a buffer that is 10 ml of 0.1 M acetic acid and 100 ml of 0.2 M sodium acetate is

.001 mole HA ← that is the capacity for base

.02 mole A^- ⇐ that is the capacity for acid

5. Buffer neutralization calculation

classic calculation but don't need to do it.

I give you a buffer with weak/acid + base. Then add a little strong acid or base.

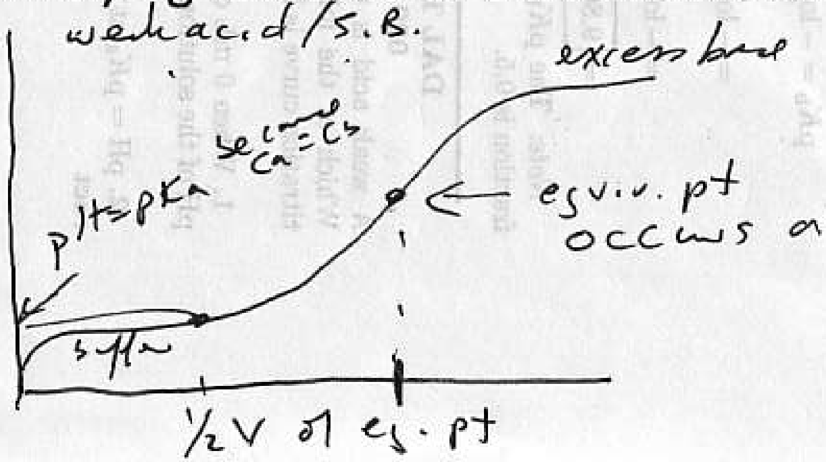
remember, a buffer is usually pH ~ pKa
pOH ~ pKb

so adding a little strong acid makes buffer pH ↓
a little strong base make buffer pH ↑

Hint: you will not need to do the full calculation, you can predict the answer.

6. Identifying features of a titration curve

I will show you a curve. you tell me important parts of it.



be able to do the reverse case as weak base/strong acid

7. Titration calculation—Strong with strong

calculation assumes H^+ & OH^- after speciations are gone

$H^+ + OH^- \rightleftharpoons H_2O$

a classic calc with H^+ and OH^- in moles, then you use limiting reagent to get either H^+ or OH^- left and solve.

This calculation is really easy.

8. Titration calculation—Strong with weak to buffer region

you will get rid of speciations to see one of the following

$H^+ + B \rightleftharpoons BH^+$
$H^+ + A^- \rightleftharpoons HA$
$OH^- + HA \rightleftharpoons A^-$
$OH^- + BH^+ \rightleftharpoons B$

The equation that results after neutralization is a buffer with $H^+ = Ka \frac{Ca}{Cb}$

Hint. I will give a clue that makes the calculation really easy.

9. Titration calculation—Strong with weak to equivalence point

This isn't a calculation, it is an awareness of what happens in a titration at the equiv pt. so think about what happens to pH in these kinds of problem.

stoichiometric point ≡ equiv pt.

10. Ranking solubility based on Ksp values

Hint: know your polyatomics.

I will give you 4 salts with different Ksps. use the estimation in problem 11 to rank the solubilities.

11. Estimating solubility from Ksp

$K_{sp} = x^2$ AB
$K_{sp} = 4x^3$ AB_2
$K_{sp} = 27x^4$ AB_3
$K_{sp} = 108x^5$ A_2B_3

remember that slackers never do the full solubility calcs. They recognize that the # of ions in the salt is = to the exponent of the solubility.

I will give you a Ksp and ask you to estimate a solubility.

12. Calculating molar solubility from Ksp

use the equations in #11 to actually calculate a real value for solubility. This problem requires a pencil + a very modest bit of long division (very short) get the right answer.

$$4\overline{)25}$$
6.25
24
10

13. Common ion calculation

There is a problem with two salts mixed together. One of the ions in the salts is common.

1. remove all spectators. This keeps you from getting confused.
2. write down the equil. + RICE for the insoluble salt.
3. do a crank it out and solve

Example 0.1 M ~~Na~~Cl^- is added to AgCl $K_{sp} = 10^{-10}$

$AgCl \rightleftharpoons Ag^+ + Cl^-$

.1

+x +x

x .1 + x

negligible

so $K_{sp} = 10^{-10} = (.1)x$

$\boxed{x = 10^{-9}}$

14. Selective precipitation

I will give you a bunch of Ksp values.

Some are close, some are far apart. Obviously the ones that are close are hard to selectively ppt.

Example

A 10^{-9} ←

B 10^{-8} ←

C 10^{-4}

D 10^{-15}

which salts can't be selectively ppt?

15. Approximations of acid base equations—competing K values

The circumstances that prompt approximation of Ks

∴ K's must be far apart.

When does this <u>not</u> happen?

1. in polyprotic acids when Ks are close by
2. when a Ka is close to a Kw
3. when a Ka is so large that it isn't weak $(C - x)$ can't get rid of it

16. Approximations of acid base equations—concentration effects on error

As concentration get small they approach OH^- or H^+ from K_w

As K values get small, the concentration also approach H^+ + OH^- from K_w.

So consider the following, which is least error?

$10^{-4} M + K_a = 10^{-10}$

$10^{-1} M + K_a = 10^{-5}$

17. Setting up complex equilibria—number of equations

I will give a compound in H_2O. Write down the following sources of ions.

① H^+

② OH^-

③ cation

④ anion of a salt

⑤ ⑥ ⑦ } any acid or base forms of cation or anion.

18. Setting up complex equilibria— mass and charge balance

Do #17 to start so you have all possible species answers in front of you.

$$\text{mass balance}\left\{\begin{array}{l}\text{write down the stuff}\\ \text{they say to start with}\end{array}\right. = \underbrace{[\quad]+[\quad]+[\quad]}_{\text{all the forms it becomes in \#17}}$$

$$\text{charge balance}\quad \underbrace{\qquad}_{\text{all the +s}} = \underbrace{\qquad}_{\text{all the −s}}$$

19. Equilibria Calculations: dilute solutions case

One time you will see a very dilute concentration like 10^{-6} ~ 10^{-8} or 10^{-10} M.

This is for a strong or weak DILUTE acid or base

$pH \cong 7 \Longleftarrow$ GIANT Hint

20. Polyprotic acid expressions and equations

either di or tri protic. I will give you a species that is H_2A, HA^-, $A^=$ or H_3A, H_2A^-, HA^{-2}, A^{-3}

you will need to know the Ka + equil expression.

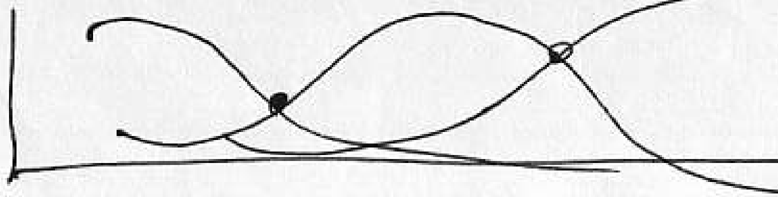
Example $NaK: HPO_4$ $\quad HPO_4^= \rightleftharpoons H^+ + PO_4^{-3}$ $\quad K_{a_3} = \frac{[H^+][PO_4^{-3}]}{[HPO_4^{-2}]}$

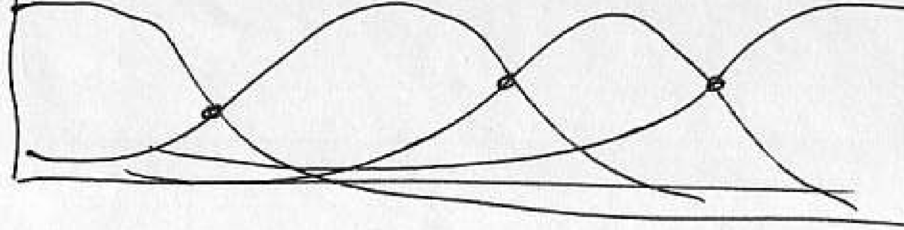
$HPO_4^=$

21. Ranking concentrations in polyprotic acid solutions using alpha diagrams

I will give you a diprot. or triprotic compound and its pK value. I will tell you a pH. you draw the α diagram + see what species is dominant at that pH.

$H_2A \rightleftharpoons HA^- \rightleftharpoons A^=$ $\qquad H_3A \rightleftharpoons H_2A^- \rightleftharpoons HA^{-2} \rightleftharpoons A^{-3}$





22. Polyprotic acid calculation-amphiprotic case

I will give you a species that is either

HA^- $(K_1K_2)^{1/2}$

H_2A^- $(K_1K_2)^{1/2}$

HA^{-2} $(K_2K_3)^{1/2}$

23. Polyprotic acid calculation-weak or buffer case

I will give you a polyprotic acid and ask a pH.

Don't Panic!! It is either

weak acid $\boxed{\begin{matrix} H_2A \\ H_2A \end{matrix}}$ or buffer $\boxed{\begin{matrix} H_2A \\ HA^- \end{matrix}}$ or weak base $\boxed{\begin{matrix} A^= \\ A^= \end{matrix}}$

24. Approximations in polyprotic acid calculations

remember # 15 - the sources of error occur when K values are close? well in polyprotic acid calc. the reason # 23 is easy is if

!!! THE Ks are far Apart!!!

25. Sulfuric acid calculation

I will give an amount of H_2SO_4.

Like, what is pH of 0.1 M H_2SO_4.

!! **BUT** !! you will be asked to set up the RICE equation in terms of x.