**1. Identifying acid and base strength** 97%

you need to know the 7 strong acids and the strong bases. This is absolutely straight ahead.

$HCl$
$HBr$
$HI$
$H_2SO_4$
$HClO_4$
$HClO_3$
$HNO_3$

all the alkali metal and alkali earth hydroxides.

$Ba(OH)_2$
$LiOH$ etc

**2. Calculating simple buffers** 74%

This is a straight ahead calculation of simple equilibria

Buffer: weak acid / conjugate base (two cmpds separated by a H+)

$HC_2H_3O_2 + C_2H_3O_2^-$

Hint: make sure you can work with pK values

use either

$H^+ = K_a \frac{C_a}{C_b}$ or $OH^- = K_b \frac{C_b}{C_a}$

**3. Identifying buffers (after neutralization)** 63%

You will be given a list of cmpds that might be buffers after neutralization.

Example 1 mole of NaOH + 2 mole HCOOH ⇒ 1 mole HCOOH / 1 mole $HCOO^-$ (after neutr.) — buffer!! yeah

Hint: This one has a bunch of numbers and letters in it. Those of you who can reduce this to HA/$A^-$ or B/$BH^+$ in structure will not be confused.

**4. Ranking acidity and basicity based on equilibrium constants** 88%

Given a list of acids or base w/ K values (or pK)

in general, as K ↑ strength ↑

| example | K | |
|---|---|---|
| weaker conj. base ← Acid 1 | $10^{-2}$ | ← stronger acid |
| stronger conj. base ← Acid 2 | $10^{-4}$ | ← weaker acid |

Hint: you may need to be able to convert between Ka + Kb on this. And remember, the stronger the acid, the weaker the base. The weaker the acid the stronger the base.

93%

**5. Buffer capacity** Just like the quiz. If you are give amounts of a buffer (in moles) that tells you how much $H^+$ or $OH^-$ is accommodated.

Example 1 mole of HA + 2 mole of $A^-$

so $OH^-$ capacity is 1 mole } note it is
$H^+$ capacity is 2 mole } backward from the buffer

94%

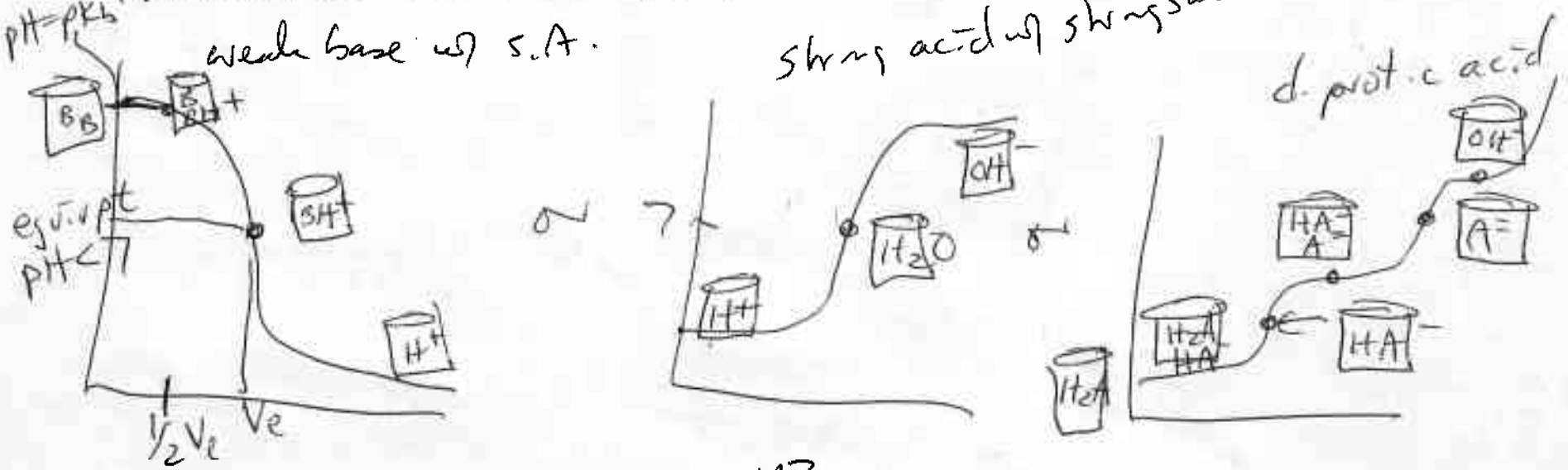
**6. Buffer neutralization calculation** How many times do I have to give you this problem.

Buffer neutralization is the only problem of 3 things added to solution.

you can work the 6 steps including neutralization or hope that you can <u>eyeball</u> this one.

**7. Identifying features of a titration curve** 92%

titration curves look like this




43%

**8. Identifying features of a titration curve**

Things you should be able to say about these curves.

- The species present along the curve
- What the shape looks like for titrating A w/ B vs B w/ A or mono vs di vs tri etc
- When the endpoint happens
- pH is related to Ka or Kb

Problems 9, 10, 11, 12 are the same problem.

**9. Titration of strong acid and strong base** 78%

Very simply, approximations hold so perform the 6 steps for solving pH of Acids + bases.

- each will require neutralization
- one will have an answer of pH = 7 (#10)
- every one of these 4 problems starts off ~~same~~ an acid and a base.
- 6 steps
  1. get rid of spectators → $Cl^-$, $Br^-$, $I^-$, $NO_3^-$, $SO_4^-$, $ClO_4^-$, $ClO_4^-$ / $Na^+$, $Li^+$, $Rb^+$, $Sr^{++}$, $Ca^{++}$ etc

**10. Titration of strong acid and strong base (equivalence point)**

  2. you will have either $H^+$ or $OH^-$ left as one of the species (because this is a titration)
  3. The other species will be either $OH^-$, $H^+$, B, HA
  4. so you have to neutralize - fast, so know your neutralization reaction.

$$H^+ + A^- \rightleftharpoons HA$$
$$H^+ + B \rightleftharpoons BH^+$$
$$H^+ + OH^- \rightleftharpoons H_2O$$
$$OH^- + HA \rightleftharpoons A^- + H_2O$$
$$OH^- + BH^+ \rightleftharpoons B + H_2O$$

} know these

Continuation of explanation of problems 9-12

**11. Titration of weak acid/base with strong base/acid (buffer region)** 87%

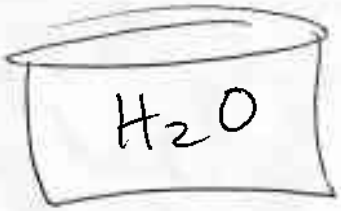
5. to neutralize
   1. convert everything to moles
   2. write down the neutralization reaction
   3. put the moles of each under rxn
   4. find the limiting reagent
   5. set it to zero &
   6. add that # of moles to product
      subtract that amount from reactant

Hint: In one of these problems you will be looking at compounds with 2 OH's

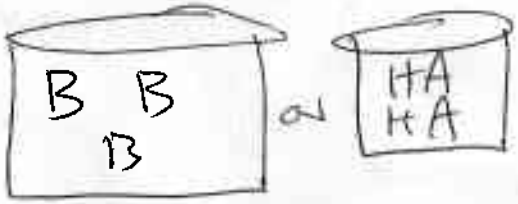
63%

**12. Titration of weak acid/base with strong base/acid (equivalence point**

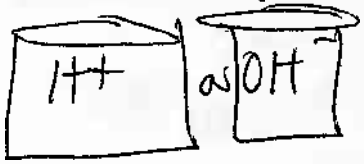
6. you should have one of the following beakers




#10
pH=7




#12
$H^+ = (K_a C_a)^{1/2}$ $OH^- = (K_b C_b)^{1/2}$




#9
$H^+ = C_a$
$OH^- = C_b$


#11
$H^+ = K_a \frac{C_a}{C_b}$

**13. Estimating solubility from Ksp** 91% eyeball

Just like the g.z, I will give ym a collection of Ksp values. Ball Park the answers by using a root equal to # of ions in soln.

$AB \rightarrow A^+, B^- \sim \sqrt{Ksp}$

$AB_2 \rightarrow A^{++}, 2B^- \sim \sqrt[3]{Ksp}$

etc.

use this to rank solubilities knowing that the larger the # the more soluble.

Example AB $10^{-10} \rightsquigarrow [10^{-5}]$

$AB_2$ $10^{-12} \rightsquigarrow [10^{-4}]$ ← more soluble

**14. Calculating molar solubility from Ksp** 87%

say idea as above but ym need to be exact

AB $\sqrt{Ksp}$

$AB_2$ $\frac{\sqrt[3]{Ksp}}{4}$

$AB_3$ $\frac{\sqrt[4]{Ksp}}{27}$

have to do this with a calculator

**15. Common ion calculation** 63% I never got to this in class before spring break. So I taught it on one of the days after the break.

What is $[Ag^+]$ in a satd $AgBr$ soln w/ (0.1)M $NaBr$. $K_{sp} = 1 \times 10^{-9}$

$AgBr \rightleftharpoons Ag^+ + Br^-$

| | | |
|---|---|---|
| | ∅ | 0.1M |
| | +x | +x |
| | x | .1+x |

$K_{sp} = [Ag^+][Br^-] = (x)(.1+x)$ (.1+x: negligible)

$K_{sp} = 10^{-9} = x(.1)$ $x = 10^{-8}$

**16. Approximations: deriving acid base equations from equilibrium theory** 72%

Know how it is that complicated cubics and quadratics reduce to simple equil. like $H^+ = Ca$ or $OH^- = (K_b C_b)^{1/2}$

Hint As an example, I'll asked you to turn a cubic into a simple first order for a weak acid soln.

- large C
- $K_w$ is negligible ($10^{-14}$)
- $K_a$ values are far apart.

**17. Approximations: simplifying polyprotic acid calculations**

All the polyprotic acid calculations will be solved with approximation solutions. 17b just like #23. I will give you a problem with an answer that is a calculation of form

$[H^+] = (K_a C_a)^{1/2}$ or $[H^+] = (K_1 K_2)^{1/2}$ or $[H^+] = K_a \frac{C_a}{C_b}$

for $H_2A$, a diprotic, in one case #17 and a $H_3A$, triprotic, in the other, #23.

**18. Setting up complex equilibrium problems**

This is a real w.s. problem.

For a given system, how many unknowns?

Example How many unknowns in a $NaHCO_3$ solu?

$Na^+$, $HCO_3^-$, $H^+$, $OH^-$, $H_2CO_3$, $CO_3^{=}$ ← 6 of them

Steps 1. always have $H^+ + OH^-$ 2. include dissociated acid $Na^+$, $HCO_3^-$ 3. look for further A/B reaction $H_2CO_3$, $CO_3^{=}$

## 19. Mass and charge balance

I will ask you to solve a simple mass or charge balance for a acid/base system. This one is <u>way</u> easier than any of Neal's worksheet.

What is mass balance for adding NaA + HA in terms of $A^-$?

$$C_{NaA} = [A^-] + [HA]$$

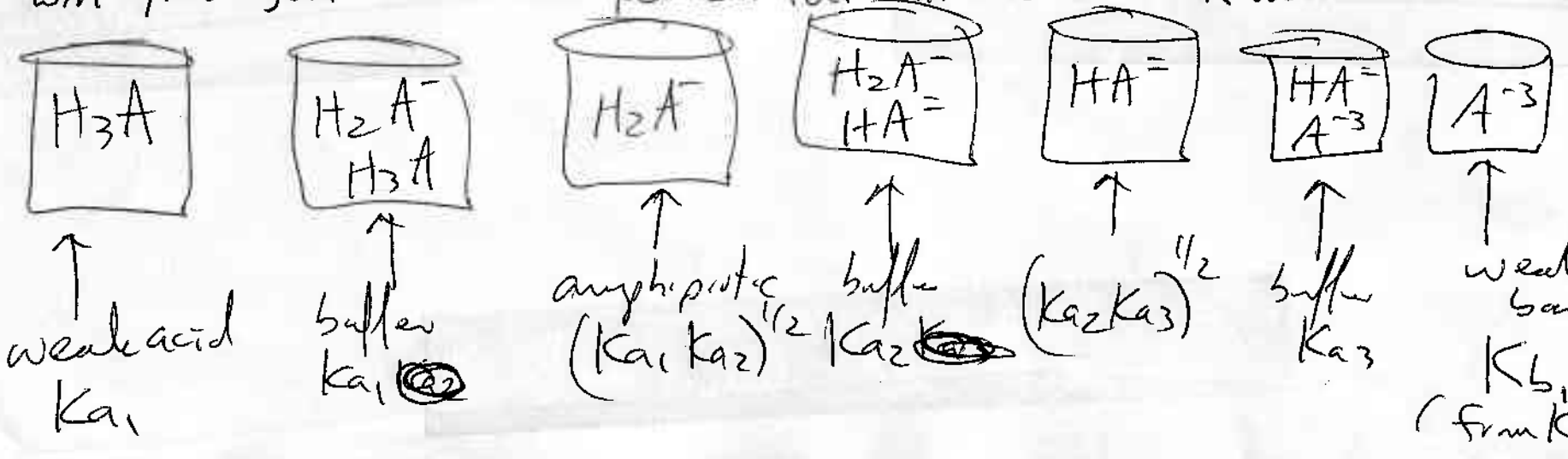
charge balance: put all the ⊕ on one side, ⊖ on other.

So above

$$[Na^+] + [H^+] = [OH^-] + [A^-]$$

## 20. Equilibrium expressions for a polyprotic acid

I will give you some compounds. You tell me which K values to solve. Then



25% on quiz 3, 96% on quiz 4, 100% on Exam 2?

**21. Equilibria Calculations: dilute solutions** Just how many times do you have to do a

$10^{-8}$ M HCl calc?

Eyeball it.

**22. Equilibrium Calculations: sulfuric acid case**

This is the famous $H_2SO_4$ case. What is the pH or $SO_4^=$ etc, of a 0.1 M $H_2SO_4$ solution.

step 1 $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$

| | | |
|---|---|---|
| .1 | 0 | 0 |
| -.1 | +.1 | +.1 |
| 0 | .1 | .1 |

step 2 $HSO_4^- \rightleftharpoons H^+ + SO_4^=$

| | | |
|---|---|---|
| .1 | .1 | 0 |
| -x | +x | +x |
| .1-x | .1+x | x |

$K_{a2} = \frac{(.1+x)(x)}{(.1+x)}$

You don't need a calculator.

**23. Equilibrium Calculations: weak polyprotic acids**

Using this information from question #20, be able to solve a triprotic acid problem simply with approximations.

$[H^+] = (K_a C_a)^{1/2}$ $H_3A$ $[H^+] = (K_1 K_2)^{1/2}$ amphiprotic

$[OH^-] = (K_b C_b)^{1/2}$ $A^{-3}$ $[H^+] = K_{a_1} \frac{C_a}{C_b}$ if buffer

You will also do this for problem #17

**24. Balancing redox reactions (simple)**

I will give you two ½ rxns. You will balance them. No H or O involved, so a snicker. Use the method I taught

$2Fe^{+2} + 1Cu^{+2} \rightleftharpoons 2Fe^{+3} + 1Cu^{0}$

2 e⁻ x 1

1 e⁻ x 2

Hint. I will ask for one of the coeff. units

Example $Fe^{++} = 2$

**25. Balancing redox reactions (in acid or base)**

Just like #24, but after assigning the # of $e^-$ transferred for ½ rxns, you will figure out $H^+/H_2O$ or $OH^-/H_2O$ to balance.

in acid = add $H_2O$ equal to ~~smallest~~ O difference and $2H^+$ per O to other side

Hint: I don't feel like writing down $OH^-$ case.

Hint: have you ever noticed that the problems w/ multiple atoms in molecule are harder? $As_2O_3$ is harder than $MnO_4^-$

**26. Assigning Oxidation/Reduction Strength**

I expect you to know this nomenclature cold

E is large + when a ½ reaction is easily reduced and is therefore a strong oxidizing agent

E is small (or even −) when a reaction is difficult to reduce and is therefore a weak oxidizing agent

The same concept holds for strong + weak reducing agents but for the reverse reactions that require you to reverse the sign of $E^\circ_{½}$

continues from #26

## 27. Assigning Oxidation/Reduction Strength

You will be given rankings of ½ rxns as reduction potentials. Be able to identify strong + weak versions of oxidizing + reducing agents

Example

| | $E^\circ$ |
|---|---|
| $Li^+ + e^- \rightarrow Li$ | -3 |
| $H^+ + e^- \rightarrow \frac{1}{2} H_2$ | 0 |
| $F_2 + 2e^- \rightarrow 2F^-$ | +3 |

strong reducing agent

strong oxidizing agent

So $F_2$ is strong oxidizing agent

$Li^+$ is weak oxidizing agent

$Li$ is strong reducing agent

$F^-$ is weak reducing agent

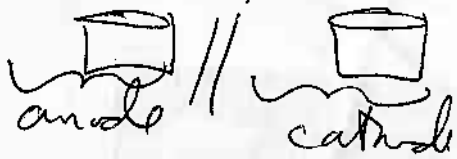
## 28. Assigning EC cell nomenclature

First, be able to know if rxn is $E^+$ or $E^-$

Then either in the ½ reaction, the reduced species is the cathode + oxidized is anode

or

I'll show you a picture or shorthand




anode // cathode

**29. Assigning EC cell nomenclature**

What might I ask in 28 + 29

- sign of electrode
- direction of $e^-$ (to cathode)
- which is cathode or anode
- which is ox or reduction

So first know if $E^+$ or $E^-$ and which $\frac{1}{2}$ rxn is which

**30. Calculating Ecell at standard conditions**

Once again, know if $E^+$ or $E^-$

$E^+$ battery
spontaneous
voltaic
galvanic

$E^-$ electrolysis
electrolytic

In both cases $E^\circ_{cell} = E^\circ_{cath} - E^\circ_{anode}$