

Daily Assignments

(check them off as you complete them)

Due Date	Assignment
Fri 3/4	Do <u>WS 10.1</u>
Mon 3/7	Do Nothing
Tue 3/8	Do <u>WS 10.2</u>
	Do Precipitate Lab Skill-Builders #1, 2, 3
Wed 3/9	Do <u>Precipitate Lab ?'s</u>
	• Quiz Today • (packet 10, part 1)
Thur 3/10	Do Nothing ← 😊
Fri 3/11	Do <u>WS 10.3</u>
Mon 3/14	Do <u>WS 10.4</u>
Tue 3/15	Do <u>WS 10.5</u>
Wed 3/16	Do <u>WS 10.6</u>

St. Pat's Day demo

Thur 3/17 Do WS 10.7 #1-4
• toy lab today •

Mon 3/28 Return From Spring Break

Tue 3/29 Finish pH lab

Wed 3/30 Do WS 10.7 #5

Crystals Due: put crystal in small, well-sealed plastic bag, w/ score card, & turn in today!

Thur 3/31 Do WS 10.8 / get ready to titrate!

Fri 4/1 Do Titration Lab ?'s

Mon 4/4 Get Ready For Some Math

Tue 4/5 Do WS 10.9

Wed 4/6 Do WS 10.10 (Mustard Day)

Thur 4/7 Do WS 10.11



• Quiz Today • (WS 10.2 -- WS 10.10)

Come to class with packets **ready to be turned in**, with the above underlined assignments in your folder, with THIS PAGE as the cover page. For **1 point**, be sure your grade-sheet from your last packet is still inside your pocket packet folder & it's in THIS order:

packet order:

- assignment sheet
- WS 10.1 - 10.11
- pH lab
- vinegar titration lab

penalties:

- no name on top (-1/2)
- no folder (-1/2)
- no grade sheet (-1/2)
- turning in old packets (-1/2)

ascorbic acid



pH = 3

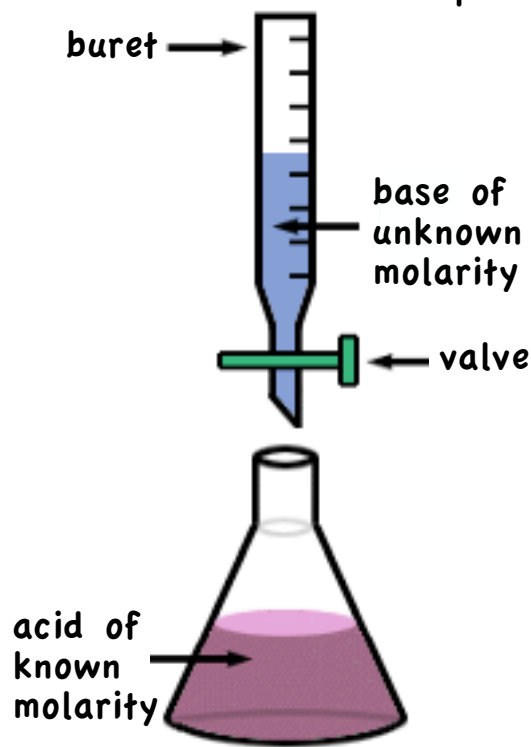
Name: _____ Hour: _____

Packet 10
 acids, bases, & salts



"blue to red; A-C-I-D"
 -Don Showalter

a titration set-up:

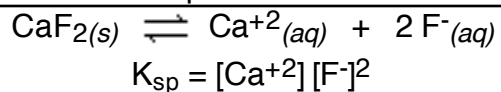


Something to think about...

What does Pepsi have in common with the caves of Missouri?

+ WS 10.1 Solubility Product

K_{sp} is called the solubility product constant. It is the product of the concentrations of a substances' ions in a saturated solution, each raised to the power of the coefficient.



Remember, pure solids and liquids are not included in equilibrium expressions.

The numerical value for K_{sp} can be determined from solubility data (see reference chart).

Calculate the value for K_{sp} for the following:

1. $\text{Mg}(\text{OH})_2$ at $100\text{ }^\circ\text{C}$

2. $\text{AgC}_2\text{H}_3\text{O}_2$ at $0\text{ }^\circ\text{C}$

3. PbCl_2 at $0\text{ }^\circ\text{C}$

4. PbCl_2 at $20\text{ }^\circ\text{C}$

K_{sp} values can be looked up in charts (see reference chart) and be used to determine solubility data.

Calculate the solubility of each salt @ $25\text{ }^\circ\text{C}$, in g/L:

5. BaCO_3

6. ZnS

7. Ag_2S

8. $\text{Fe}(\text{OH})_2$

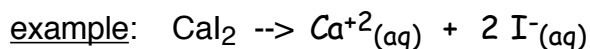
Ans (IRO+2): 0.014, 1.9E-3, 1.9E-4, 5.2E-4, 1.4E-5, 4.6E-5, 5.6E-5, 2.5E-8, 1.3E-9, 8.4E-9, 1.3E-10,
3.2E-10, 6.2E-15

+ WS 10.2 Electrolytes & Solubility

1. Describe the differences between a strong electrolyte, a weak electrolyte, and a nonelectrolyte. Be sure to give an example of each of these electrolytes in the process.

2. According to the demo in class, discuss the process used in the testing for electrolytes. Include diagrams to show what is happening during this testing, like the diagram shown in class:

3. Write a balanced equation for the dissociation (ionization, or "*dissolving*") of the following salts in water:



a) NaNO_3

b) MgCl_2

c) Na_2SO_4

4. Use the solubility rules for ionic compounds ("buff") to determine which of the following solutes would be soluble in water. Give your reasoning for each answer by stating which rule you used.

a) PbCl_2 _____ (insol or sol) rule #: _____

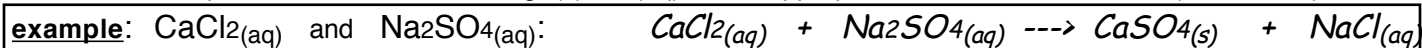
b) Na_2S _____ (insol or sol) rule #: _____

c) K_2O _____ (insol or sol) rule #: _____

d) CaSO_4 _____ (insol or sol) rule #: _____

e) $(\text{NH}_4)_2\text{CO}_3$ _____ (insol or sol) rule #: _____

5. State whether a precipitate would be expected to form if the following solutions were mixed. If a precipitate will form, write a balanced equation for the reaction using "(s)" & "(aq)" when appropriate. If not, write "N.R." (no reaction)...



a) $\text{NaCl}(\text{aq})$ and $\text{Mg}(\text{NO}_3)_2(\text{aq})$

b) $\text{CuCl}_2(\text{aq})$ and $\text{Ca}(\text{NO}_3)_2(\text{aq})$

c) $\text{Ba}(\text{NO}_3)_2(\text{aq})$ and $\text{Na}_2\text{SO}_4(\text{aq})$

d) $\text{HgBr}_2(\text{aq})$ and $\text{Na}_2\text{S}(\text{aq})$

e) $\text{NaOH}(\text{aq})$ and $\text{MgCl}_2(\text{aq})$

(hint- there are 2 "no reactions" for #5)

+ WS 10.3 Acids & Bases

1. List the differences between an acid and a base. Your description should include such things as whether both are electrolytes, which contains a hydronium ion and which includes a hydroxide ion, and you should also include two examples of an acid and two examples of a base that are present in your household.

acid

base

2. List 3 strong acids and explain why these acids are considered strong acids.

3. List 3 weak acids and explain why these acids are considered weak acids.

4. List 2 strong bases and explain why these bases are considered strong bases.

5. List 1 weak base and explain why it is considered a weak base.

6. Listed below are some of the properties of acids and bases. Fill in the blanks with the appropriate word, **acids** or **bases**:

- | | |
|--|---|
| a) _____ produce hydrogen ions (H^+) in solution | e) _____ have a sour taste |
| b) _____ have a bitter taste | f) _____ have a slippery, soapy feel |
| c) _____ produce hydroxide ions (OH^-) ions | g) _____ react with acids to form salts |
| d) _____ react with bases to form salts | h) _____ react with many metals |

7. Write an equation for the dissociation (ionization) of the following **acids** in water: (follow example:)

- | | |
|---------------------------------------|------------|
| a) $HClO_4 \rightarrow H^+ + ClO_4^-$ | d) H_2S |
| b) H_2SO_4 | e) HCl |
| c) $HC_2H_3O_2$ | f) HNO_3 |

8. Write an equation for the dissociation (ionization) of the following **bases** in water: (follow example:)

- | | |
|--|---------------|
| a) $Mg(OH)_2 \rightarrow Mg^{+2} + OH^-$ | d) KOH |
| b) $NaOH$ | e) $Mg(OH)_2$ |
| c) $Ba(OH)_2$ | f) $LiOH$ |

+ WS 10.4 Ionization

1. Describe what occurs when water ionizes (“self-ionization of water”). Include an equation and an explanation.

2. What are the molar concentrations of $[H^+]$ and $[OH^-]$ in pure water at $25^\circ C$? _____

3. What is the ion-product constant, K_w ? _____

4. Find $[H^+]$ for solutions having the following $[OH^-]$ value:

- a) $[OH^-] = 1 \times 10^{-13}$
- b) $[OH^-] = 2.7 \times 10^{-4}$
- c) $[OH^-] = 1 \times 10^{-3}$
- d) $[OH^-] = 6.3 \times 10^{-10}$

5. Calculate $[OH^-]$ of a solution when its $[H^+]$ has the following values:

- a) $[H^+] = 1 \times 10^{-13}$
- b) $[H^+] = 3.6 \times 10^{-5}$
- c) $[H^+] = 1 \times 10^{-2}$
- d) $[H^+] = 7.8 \times 10^{-8}$

6. A solution contains 0.635 g NaOH in 236 mL solution.

a) Write the equation for the dissociation of NaOH:



b) What is the $[OH^-]$?

c) What is the $[H^+]$? (*hint- see #4 above*)

7. A solution contains 0.737 g HNO₃ in 934 mL solution.

a) Write the equation for the dissociation of HNO₃:

b) What is the $[H^+]$?

c) What is the $[OH^-]$? (*hint- see #5 above*)

8. A solution contains 0.0441 g HCl in 560. mL solution.

a) Write the equation for the dissociation of HCl:

b) What is the $[H^+]$?

c) What is the $[OH^-]$?

9. A solution contains 8.93 g KOH in 636 mL solution.

a) Write the equation for the dissociation of KOH:

b) What is the $[OH^-]$?

c) What is the $[H^+]$?

Ans (IRO+1): 1×10^{-14} 4.0×10^{-14} 1.49×10^{-13} 7.98×10^{-13} 1×10^{-12} 4.63×10^{-12} 3.7×10^{-11} 1×10^{-11}
 2.8×10^{-10} 2.3×10^{-8} 1.3×10^{-7} 1×10^{-7} 1.6×10^{-5} 2.16×10^{-3} 1×10^{-1} 1×10^{-1} 0.250 0.0125 0.0673

Units: M (for all)

+ WS 10.5 Brønsted-Lowry Acids and Bases

1. What's the Brønsted definition of an acid? _____ ...of a base? _____

2. In 1923, Johannes Brønsted (Danish) and Thomas Lowry (British) independently expanded _____ definition of Arrhenius acids and bases (which were required to be _____). A Brønsted-Lowry acid is a molecule or ion that is a hydrogen ion (H⁺) donor. The hydrogen ion is also called a proton - we've come across it before while studying nuclear _____ last semester. A Brønsted-_____ base is a _____ or ion that is a proton acceptor. A _____-Lowry acid-base reaction involves the transfer of protons from the _____ to the base. The molecular species that remains after a Brønsted-Lowry acid has given up a _____ is called the conjugate base of that acid. The molecular species that is formed after a Brønsted-Lowry base _____ a proton is called the _____ of that base. The conjugate pair refers to an acid and its conjugate _____ or a base with its conjugate _____. Note that in a conjugate pair, there is no reason why the acid should be _____ while the base is charged.

3. What is the correct name for the H₃O⁺ ion? _____

4. Determine the conjugate base for the following **acids**:

HCl: _____ HNO₃: _____ NH₄⁺: _____ H₂O: _____ H₃PO₄: _____

5. Determine the conjugate acid for the following **bases**:

OH⁻: _____ Br⁻: _____ NH₃: _____ H₂O: _____ CO₃⁻²: _____

6. Identify the conjugate acid/base pairs in the following reactions:



acid: _____ base: _____

conjugate base: _____ conjugate acid: _____



acid: _____ base: _____

conjugate base: _____ conjugate acid: _____

7. Write the equation for the ionization of HNO₃ in water, labeling each acid/base pair:

8. Write the equation for the ionization of CO₃⁻² (a weak base) in water, labeling each acid/base pair:

9. Some acids have a unique property: the ability to donate more than one proton (H⁺) per molecule. A molecule that can donate one proton is called a monoprotic acid. A molecule that donates two protons is a _____protic acid. A molecule that can donate three protons is called a _____ acid.

ANS (IAO): accepts acid acid acid aqueous Arrhenius base biology Brønsted chemistry
conjugate conjugate di Lowry molecule neutral penta proton strong the triprotic weak

+ WS 10.6 pH of Solutions

1. What is the pH scale? _____
2. What exactly do the initials "pH" stand for? _____
3. Why is pure water considered neutral on the pH scale? _____

4. Classify each of the following as **acidic, neutral, or basic**. The pH of each item is also listed.

- | | | | |
|-------------------|-------|-------------------|-------|
| a) tomatoes: 4.2 | _____ | e) soil: 5.5 | _____ |
| b) eggs: 7.8 | _____ | f) milk: 6.4 | _____ |
| c) ammonia: 11.0 | _____ | g) bleach: 12.0 | _____ |
| d) tap water: 7.2 | _____ | h) lye (NaOH): 14 | _____ |

5. Are the following solutions **acidic, neutral, or basic**? (Use the ans. bank below!)

remember. $[H^+] = 1 \times 10^{-7}$ is neutral $[H^+] > 1 \times 10^{-7}$ is acidic $[H^+] < 1 \times 10^{-7}$ is basic

- | | | | |
|-----------------------------------|-------|------------------------------------|-------|
| a) $[H^+] = 1 \times 10^{-8}$ M | _____ | e) $[OH^-] = 1 \times 10^{-3}$ M | _____ |
| b) $[H^+] = 7.3 \times 10^{-1}$ M | _____ | f) $[OH^-] = 1 \times 10^{-7}$ M | _____ |
| c) $[H^+] = 1.0$ M | _____ | g) $[OH^-] = 0.00001$ M | _____ |
| d) $[H^+] = 1 \times 10^{-5}$ M | _____ | h) $[OH^-] = 4.9 \times 10^{-6}$ M | _____ |

6. Name each of the following acids and bases: (first try w/o looking at answer bank!!!)

- | | | | |
|-----------------------------------|-------|--|-------|
| a) HCl | _____ | f) NaOH | _____ |
| b) HNO ₃ | _____ | g) KOH | _____ |
| c) H ₂ SO ₄ | _____ | h) HC ₂ H ₃ O ₂ | _____ |
| d) NH ₃ | _____ | i) H ₃ PO ₄ | _____ |
| e) H ₂ CO ₃ | _____ | j) Mg(OH) ₂ | _____ |

7. a) Which of the above is the acid used in car batteries? _____
b) Which of the above is stomach acid? _____
c) Which of the above "acts upon copper"? _____ (we dissolved a penny in this stuff!)d) Which of the above is commonly known as vinegar? _____
e) Which of the above is the active ingredient in drain opener, a.k.a. 'lye'? _____
f) Which of the above acids are found in soda? _____
g) Which of the above is used as a glass cleaner? _____

Ans (#4, IRO): acidic, acidic, acidic, basic, basic, basic, basic, basic

Ans (#5, IRO): basic, basic, basic, basic, acidic, acidic, acidic, neutral

Ans (#6, IRO): acetic acid, ammonia, carbonic acid, hydrochloric acid, phosphoric acid, potassium hydroxide, magnesium hydroxide, nitric acid, sodium hydroxide, sulfuric acid

+ WS 10.7 pH & pOH

1. What is pH a measure of? _____
2. What is the equation used for finding pH? _____
3. What is the equation that relates to pH and pOH? _____
4. Complete the following table: (first one is done as an example --- partial ans. bank is below, + ans handed out in class)

	[H ⁺]	[OH ⁻]	pH	pOH	acidic, basic, or neutral
a	1.0 x 10 ⁻³	1.0 x 10 ⁻¹¹	3	11	acidic
b		1.0 x 10 ⁻⁵			
c			10.00		
d				6.00	
e	0.010				
f		0.0000010			
g			4.00		
h				7.00	
i	3.2 x 10 ⁻³				
j		1.8 x 10 ⁻¹⁴			
k			10.23		
l				6.78	
m	0.0050				
n		0.000011			
o			10.97		
p				7.01	

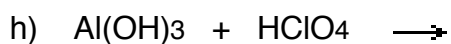
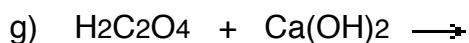
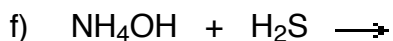
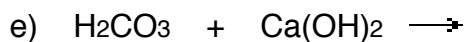
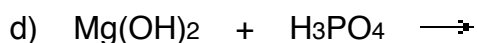
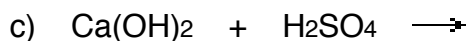
5. What would be the **pH** of each of the following: (**DANGER!** beware of tricks... use the **ANS BANK!**)
 - a) 0.0010 M HCl _____
 - b) 0.0010 M HNO₃ _____
 - c) 0.010 M NaOH _____
 - d) 0.0035 M HCl _____
 - e) 1.0 M HBr _____
 - f) 1.0 M KOH _____
 - g) 0.024 M HCl _____
 - h) 0.075 M KOH _____
 - i) 0.000034 M HCl _____
 - j) 0.00000000000001M HCl _____
 - k) 12 M KOH _____
 - l) 12 M HCl _____

Ans #4 (a-h)(IRO): acid, acid, base, base, base, base, neutral
Ans #4 (i-p)(IRO): acid, acid, acid, barely acid, base, base, base, base
Ans #5 (IRO): -1.1 0 1.6 2.5 3 3 4.5 7 12 13 14 15.1

+ WS 10.8 Acid-Base Neutralization & Titration

1. What type of reaction is a **neutralization** reaction? (from packet 4...) _____
2. Write the generic equation for a neutralization:

3. Write the **balanced** equation for these neutralization reactions: (*remember to balance charges for ionic compounds!*)



-
4. What volume of 2.00 M H_2SO_4 would be required to neutralize 54.1 mL of 1.40 M Ca(OH)_2 ?
 5. What volume of 2.00 M HCl would be required to neutralize 54.1 mL of 1.40 M Ca(OH)_2 ?
 6. It was found that 33.8 mL of a triprotic acid was required to neutralize 43.1 mL of 1.10 M NaOH. What is the molarity of the acid?
 7. 30.0 mL of 0.250 M H_2CO_3 is titrated to the endpoint with 10.4 mL of Al(OH)_3 . How many grams of aluminum hydroxide was in the solution?

+ WS 10.9 K_a / K_b (weak acids & bases)

1. 20.0 g of acetic acid is dissolved into 250. mL of solution.
What is the pH of this solution?

substance	formula	K_a
acetic acid	$\text{HC}_2\text{H}_3\text{O}_2$	1.7×10^{-5}
benzoic acid	$\text{HC}_7\text{H}_5\text{O}_2$	6.3×10^{-5}
boric acid	H_3BO_3	5.9×10^{-10}
cyanic acid	HCNO	3.5×10^{-4}
formic acid	HCHO_2	1.7×10^{-4}
hypochlorous acid	HClO	3.5×10^{-8}
nitrous acid	HNO_2	4.5×10^{-4}
propionic acid	$\text{HC}_3\text{H}_5\text{O}_2$	1.3×10^{-5}
pyruvic acid	$\text{HC}_3\text{H}_3\text{O}_3$	1.4×10^{-4}

2. If 1.5 g of cyanic acid (causes tearing & blistering, and can explode if heated rapidly) is made into 0.50 L of solution, what would be its pH?

substance	formula	K_b
ammonia	NH_3	1.8×10^{-5}
aniline	$\text{C}_6\text{H}_5\text{NH}_2$	4.2×10^{-10}
hydrazine	N_2H_4	1.7×10^{-6}
pyridine	$\text{C}_5\text{H}_5\text{N}$	1.4×10^{-9}
urea	NH_2CONH_2	1.5×10^{-14}

3. Formic acid is responsible for the "sting" from fire ants.
What would be the pH of 0.15 g of this acid in 1.0 L of solution?

4. What is the pH of store-bought ammonia solution? (0.050 M)

5. In 1828, German chemist Fredrick Wöhler synthesized urea in the lab. Normally produced by mammals through protein metabolism, it is now produced in large quantity as a fertilizer due to its high nitrogen content. What is the pH of a 0.75 L solution with 100.0 g of urea?

+ WS 10.10 Salts & Buffers

1. Indicate the acid & base which produced each of the following salts:

a. NaCl	b. KNO₃	c. Ca(C₂H₃O₂)₂	d. Li₃PO₄
acid= <u>HCl</u>	acid= _____	acid= _____	acid= _____
base= <u>NaOH</u>	base= _____	base= _____	base= _____

- A salt from a strong acid & weak base will be acidic.
- A salt from a weak acid & strong base will be basic.
- A salt from a strong acid & strong base will be neutral.
- A salt from a weak acid & a weak base depends on the K_a/K_b of each.

(strong acids= HClO₄, H₂SO₄, HI, HBr, HCl, HNO₃. strong bases= hydroxides of Li, Na, K, Ca, Sr, Ba)

2. Indicate whether the following salts would be **acidic**, **basic**, or **neutral** in water:

- a. Ba(SO₄)₂ _____ b. Li₂SO₄ _____ c. Na₂C₂O₄ _____
d. MgSO₄ _____ e. NH₄ClO₄ _____ f. KI _____

3. Given the **HC₂H₃O₂ / C₂H₃O₂⁻** buffer system...

a. Show how it reacts to the addition of a base:

b. Show how it reacts to the addition of an acid:

4. Given the **NH₄⁺ / NH₃** buffer system...

a. Show how it reacts to the addition of a base:

b. Show how it reacts to the addition of an acid:

5. Given the **H₂PO₄⁻ / HPO₄⁻²** buffer system...

a. Show how it reacts to the addition of a base:

b. Show how it reacts to the addition of an acid:

(Ans, IRO): Ca(OH)₂, HC₂H₃O₂, HNO₃, H₃PO₄, LiOH, KOH, acidic, acidic, basic, neutral, neutral, neutral

+ WS 10.11 Review Worksheet

1. A solution has an $[\text{OH}^-] = 2.6 \times 10^{-3} \text{ M}$. What would be the $[\text{H}^+]$, pH, and pOH?
2. What would be the pH of a 0.0000793 M KOH solution?
3. The pH of a really diluted acid, such as 0.0000000022M HCl, is 7. Why?
4. 2.63 g NaOH are dissolved in 156 mL of solution. Determine the NaOH concentration & the pH.

[NaOH]= _____

pH= _____

5. Complete & balance this reaction:



6. It takes 35.92 mL of 0.165 M $\text{Ba}(\text{OH})_2$ and 23.62 mL of HCl to reach the endpoint of a titration. What is the molarity of the HCl solution?
7. Calculate the pH of a 500. mL solution of containing 0.222 g of hydrazine (liquid rocket propellant)?
[see wkst 10.9 for values]
8. The hydrogen sulfate ion is a Brønsted acid. Show its reaction with water, labeling all acid/base pairs.
9. BaCO_3 is made of what acid _____ and what base _____
Would BaCO_3 be acidic, basic, or neutral in water?
10. With respect to the $\text{HSO}_4^- / \text{SO}_4^{2-}$ buffer system, show how it reacts to the addition of an acid and a base:

Precipitate Lab

Name: _____ partner: _____

Purpose: To determine the identities of five *unknown* solutions based on how they react with four given *known* solutions.

Skill builder #1 (Review): Use your ion sheet to write the correct formulas for each of the following ionic compounds (remember to balance charges, sodium sulfate is done for you as an example).

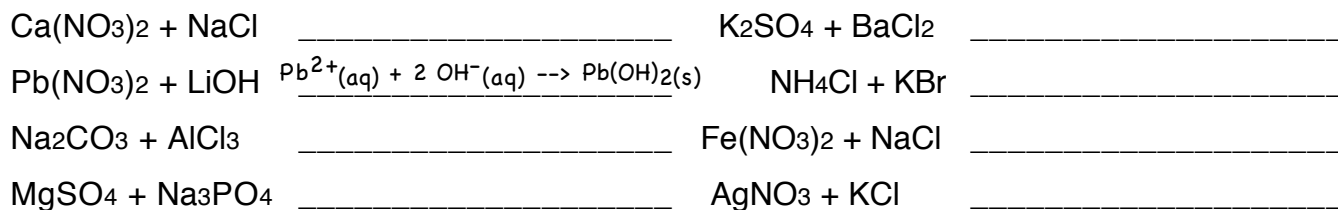
- 1) barium sulfate _____ 2) sodium sulfate Na_2SO_4 3) potassium chloride _____
4) lead(II) iodide _____ 5) calcium nitrate _____ 6) silver phosphate _____
7) ammonium phosphate _____ 8) magnesium bromide _____ 9) aluminum carbonate _____

Skill builder #2: Using your solubility rules, predict whether each of the above ionic compounds will be **soluble** or **insoluble**. Circle all those that would be soluble (Hint: you should end up with **five** of the compounds circled).

Skill builder #3: For the five soluble compounds above, write balanced equations that show their dissolving in water. (sodium sulfate, which should be your first soluble compound, is done for you as an example:

1. $\text{Na}_2\text{SO}_4(\text{s}) \rightarrow 2 \text{Na}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ 2. _____
3. _____ 4. _____
5. _____

Skill builder #4: Using your solubility rules, predict whether each of the following reactions will go (a precipitate forms) or whether it will not (everything remains in solution). For those reactions that **do** go, **write the net ionic equation**, for those that do not go, write "NR" for no reaction. (Hint: one is done for you. You should end up with four more reactions and three NR's).



The lab: In this lab you will be given four different known solutions:

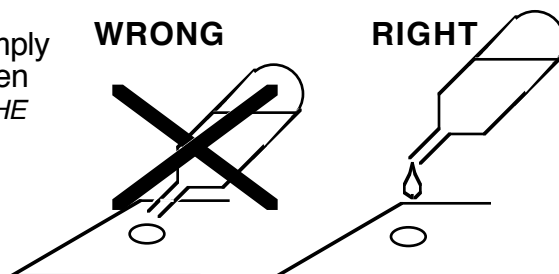
1 = NaOH 2 = Na₂SO₄ 3 = NaI 4 = AgNO₃

and you will use them to try to determine the identity of five different unknown solutions (labelled A, B, C, D and E). These five different unknown solutions correspond with:

Pb(NO₃)₂ CaCl₂ NH₄Cl KNO₃ MgCl₂

but not necessarily in that same order! Your task is to figure out which letter goes with which solution!

If you want to see whether two solutions will react or not, simply place a drop of one of them on the plastic spot plate and then add to a drop of the other solution. **DO NOT CONTAMINATE THE SOLUTIONS BY STICKING THE TIP OF ONE PIPET INTO THE DROP OF ANOTHER. INSTEAD, LET THE DROP FALL AS SHOWN IN THE DIAGRAMS AT RIGHT.**



Data table: Fill in the grid below with the observations. Be as descriptive as possible. Note: some reactions might take a little longer than other; some might be more pronounced than others.

	1- (NaOH)	2- (Na ₂ SO ₄)	3- (NaI)	4- (AgNO ₃)
A				
B				
C				
D				
E				

Based on the data you collected, match up the five unknown solutions to their appropriate identities: Pb(NO₃)₂, CaCl₂, NH₄Cl, KNO₃ & MgCl₂. Consider, for example, how you would expect Pb(NO₃)₂ to react with each of the test solutions (NaOH, Na₂SO₄, NaI & AgNO₃). Now look at your data table and see which solution, A thru E, reacted the way you think Pb(NO₃)₂ would react... When you have figured out the correct match ups, write them in the spaces to the left of the letters in the grid below. Then in each box of the grid, write the net ionic equation that was happening to produce the precipitates you saw. Your net ionic equations should look just like the example given in the skill builder #4: $Pb^{2+}(aq) + 2 OH^{-}(aq) \rightarrow Pb(OH)_2(s)$

	NaOH	Na ₂ SO ₄	NaI	AgNO ₃
_____ = A				
_____ = B				
_____ = C				
_____ = D				
_____ = E				



This is where you write in your results for the lab: what you determined each of the five solutions to be.

Follow-up questions: (Answer on a separate sheet of paper)

- How can two clear solutions mix and produce a cloudy precipitate -- what is going on?
- For the mixtures you considered NR (no reaction). Is it possible a reaction is happening? Explain.
- Look back at the skill builder #4 example in which Pb(NO₃)₂ reacted with LiOH to make Pb(OH)₂. In this reaction, the Li⁺ and the NO₃⁻ are called "spectator ions." Why this name is appropriate?
- Are the precipitates you formed solutions, colloids, suspensions, or some combination? Explain.
- One of your precipitates had a very distinct color. Which one was it, and what was its color?

*6. (bonus) As a follow-up activity, you are given five solution labelled P, Q, R, S and T which you are told correspond with Pb(NO₃)₂, CaI₂, LiNO₃, NaCl and K₃PO₄. You have to figure out which is which, but you can only react them with each other. You collect the data at right. Determine which is which!

* Bonus

	P	Q	R	S	T
P	X	NR	NR	NR	NR
Q	X	X	ppt	yellow ppt	ppt
R	X	X	X	NR	NR
S	X	X	X	X	ppt

pH lab

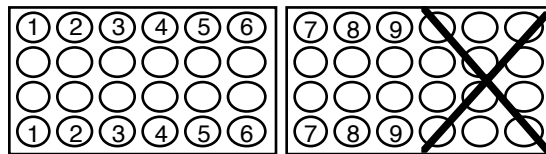
Name: _____

DAY 1 - Indicator Reference Set

Part 1 - Making a serial dilution

You will make your own indicator reference set which will be used to determine the pH of several acids & bases located on top of the lab shelf. --- *pay attention to the details described below* --

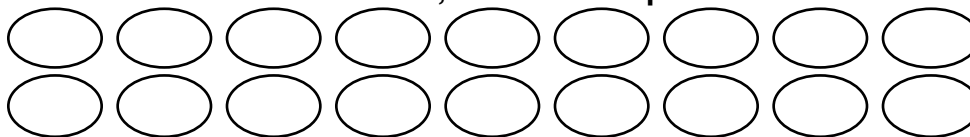
- Place two well plates side by side lengthwise as shown in the figure at right.
- Add 20 drops of 0.1 M HCl solution to the first well (A-1) of the first plate.



- Add 18 drops of water to the remaining 8 wells in that row (A-2 thru A-9).
- Draw up some of the 0.1 M HCl from A-1 into the stem of the pipet and squeeze out two drops of it into the second well (A-2), then put the rest back in the previous well (A-1), then go back to A-2 and mix it well with your pipet.
- Now draw up some of the solution from A-2 (which should be 0.01 M HCl) into the stem of the pipet and squeeze out two drops of it into the third well (A-3), then put the rest back in the previous well (A-2), then go back to A-3 and mix it well with your pipet.
- Continue on with this process all the way down the line. (These solutions represent HCl concentrations from 1×10^{-1} M to 1×10^{-12} M)
- Repeat this exact same procedure across the bottom row (B-1 thru B-9) starting with 0.1 M NaOH instead of 0.1 M HCl.
- To each of the dilutions, add 5 drops of the red cabbage indicator. *very important* ↙

You should realize that the 0.1 M HCl is a strong acid with a pH of 1, and that when it is diluted ten fold (down to 0.01M) it has a pH of 2... but that it obviously cannot be diluted past pH 7. Likewise, the 0.1 M NaOH solution is a strong base (pH 13) and when it is diluted to 0.01 M it has a pH of 12...

In the circles below, indicate the pH of each well:



Part 2 - Using your indicator reference set to test pH

Add about 15 drops of each solution to any empty wells and then add 5 drops of the red cabbage indicator to each well. *Return pipets immediately to proper cups!* Record observations below:

	guess pH	indicator color	acid or base?	indicator pH
baking soda				
aspirin				
Tap Water™				
antacid				
0.1 M HCl				
0.1 M NaOH				
0.1 M NH ₃				
0.1 M HC ₂ H ₃ O ₂				
lemon juice				
bleach				
Sprite®				

DAY 2 - acid / base / pH stations

STATION 1,2,3: CONDUCTIVITY

Use the conductivity meter to determine the conductivity of each of the solutions below. Be sure to **wipe the meter probes clean** with a paper towel after each solution is tested! Record the relative conductivity (N,W,S), and using your knowledge about strong/weak/non electrolytes, write the dissolving reactions for each solution:

	conductivity	dissociation reaction (be sure to use the symbols (s) or (aq) where appropriate!)	
0.1 M HCl		$\text{HCl}_{(aq)} \rightarrow$	
0.1 M HC ₂ H ₃ O ₂			①
0.1 M NaOH			
0.1 M C ₆ H ₁₂ O ₆			②
0.1 M NaCl			
0.1 M NH ₃		$\text{NH}_{3(aq)} + \text{H}_2\text{O}_{(l)} \rightarrow$	
tap water		for the NH ₃ sample (above), identify...	③
		acid _____ conjugate base _____	
distilled water		base _____ conjugate acid _____	

STATION 4: PINK TORNADO

Observe the beaker that contains a magnetic stirrer in a solution. Add **two drops** of the NaOH solution and watch what happens. Be sure to avoid contamination by not letting the tip of the pipet touch the solution.

Observation: _____

What 2 chemicals do you think are inside the beaker?

STATION 5: RAINBOW TUBE

Place a rubber stopper securely in the bottom of a plastic tube, then fill to within 2 cm of the top with green indicator solution. Add 3 drops of 0.1 M HCl. Stopper the top end & invert the tube. Unstopper the end which is now on top and add 3 drops of 0.1 M NaOH. Stopper and invert again. Keep flipping the tube over to allow the bubble to go up and down. Observations:

Explain what's happening, and state how good a mixing technique is this repeated inversion?!?

STATION 6: GOLDENROD PAPER

Use 1 piece of goldenrod paper. Dip cotton swab in NH₃ solution & use it to draw on the goldenrod paper. Next, get a clean cotton swab & dip it in the HC₂H₃O₂ solution. Use it to re-draw on the paper. Record observations: **(THROW AWAY TRASH!)**

STATION 7: COMPUTER SIMULATION SOFTWARE - (do only the problems indicated on the blue card)

STATION 8: COMPUTER SIMULATION SOFTWARE - (do only the problems indicated on the blue card)

STATION 9: Relaxation Station - sit back, take a load off your feet, and soak it all in

+Titration Lab

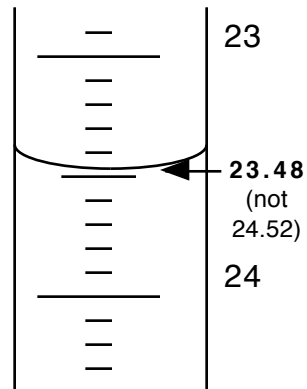
Name: _____

You will be graded on your accuracy, so do a careful job.

Purpose: To determine the molarity of a NaOH solution by performing a titration using 0.100 M HCl.

Procedure:

1. Obtain about 60 mL of 0.100 M **HCl** in the **red** beaker & about 60 mL ? M **NaOH** in the **blue** beaker.
2. Prime each buret with about 2 ~ 3 mL of solution. *Keep the proper solution in the proper buret!*
3. Fill each buret with the proper solution, open the valve just long enough to let out any air bubble. Carefully read the initial amounts & record in the data table.
4. Place the Erlenmeyer flask under the HCl buret, open the valve and allow 10 ~12 mL of the HCl to flow into the flask. Then close the valve.
5. Add 2 drops of the phenolphthalein indicator to the HCl in the flask.



6. **Time to titrate!** Place the Erlenmeyer flask under the NaOH buret and open the valve to allow approximately 5-8 mL of the NaOH to flow into the flask while continuously swirling the flask. Observe the color changes occurring. Continue to add the NaOH slowly while swirling the flask. When a faint pink color appears and *persists for 5 seconds or more* of swirling of the flask, you have reached your endpoint. Note: It is important to realize that if you accidentally pass your endpoint, you can add more HCl to the flask which will cause the solution to become colorless again. You can then add the NaOH slowly to the flask again and attempt once more to carefully reach the endpoint. This is known as “back-titrating.”
7. When you have reached the endpoint, record both of the HCl and NaOH final buret readings in the table below (again to the bottom of the meniscus and again to the hundredth of a mL).
8. Calculate the molarity of the NaOH solution.
9. Pour the solution out of the flask (into the sink) and repeat the titration again-- no need to rinse the flask, only this time using 10-12 mL of the HCl solution. You should estimate how much NaOH you will need for this titration based on the information that you gathered from the first titration.
10. Calculate the molarity of the NaOH solution from the second trial. It should be very close to the molarity you got for the first trial. Then calculate your average. You will be graded on your accuracy, so do a careful job.

TITRATION RESULTS:

	<u>trial 1</u>		<u>trial 2</u>		<u>trial 3</u>	
	HCl	NaOH	HCl	NaOH	HCl	NaOH
Initial buret reading (mL)					?	
Final buret reading (mL)					?	
Total volume used (mL)					?	

Calculations:

Your average is graded for accuracy.
For 1/2 pt, don't forget units!

MOLARITY OF NaOH: Trial #1: _____ Trial #2: _____ Trial #3?: _____ Average:

FOLLOW UP QUESTIONS:

1. Consider each of the following potential error sources. Answer:

- “H” if it would have caused your calculated value for ?M NaOH to come out too high,
- “L” if it would have caused it to come out too low, or
- “N” if it would have had no effect at all on your value.

- _____ There was a little distilled water in the Erlenmeyer flask before you began the titration.
_____ There was a little HCl in the Erlenmeyer flask before you began the titration.
_____ There was a little distilled water in the HCl buret and you forgot to rinse it out with the HCl.
_____ You added 3 drops of phenolphthalein instead of 2 drops.
_____ An air bubble was present in the HCl buret, but it stayed in while you titrated.
_____ An air bubble was present in the HCl buret, and it came out while you titrated.
_____ While you were titrating, some NaOH dripped out onto the table instead of into the flask.
_____ There was a pebble in the bottom of the NaOH buret during the entire titration.
_____ You forget to add the phenolphthalein indicator.

2. What is meant by “priming” the glassware? Why is this done?

3. Why did you use burets instead of graduated cylinders to do this lab?

4. Why did you **not** have to rinse out the flask in between trials?

5. What is the **titration equation**?

ADDITIONAL PROBLEMS: (use titration equation to solve...)

6. You are given a solution of 0.100 M HCl as was used for this lab and are again told to find the unknown molarity of a different NaOH solution. You start with 10.54 mL of HCl and need 13.17 mL of NaOH to reach the endpoint. What is the molarity of this NaOH solution?

Ans: _____

7. You are now given a solution of 0.170 M NaOH and are told to find the molarity of an unknown HBr solution. You start with 11.29 mL of NaOH and need 38.55 mL of HBr to reach the endpoint. What is the molarity of the HBr?

Ans: _____

8. How many mL of 0.340 M HCl would be needed to titrate 14.91 mL of 0.265 M NaOH?

Ans: _____

9. How many mL of 0.340 M HCl would be needed to titrate 14.91 mL of 0.265 M Ca(OH)₂?

Ans: _____

10. How many mL of 0.340 M HCl would be needed to titrate 14.91 mL of 0.265 M Al(OH)₃?

Ans: _____

Complete this statement:

Doing a titration without an indicator is like _____.

Ans (IRO+2): N, N, N, N, L, L, H, H, ?, 0.0498, 0.0800, 1.125, 11.6, 23.2, 28.6, 34.9

Quantitative Analysis of Vinegar Lab

Name: _____

How much acetic acid is in vinegar???

In this lab, you will determine the % by weight of acetic acid in vinegar. This is determined by titrating a measured mass of vinegar with NaOH using phenolphthalein as an indicator.



At the endpoint in the titration, the # of moles of NaOH equals the # of moles of acetic acid. As you can see from the balanced equation, they react in a 1:1 ratio.

Procedure:

1. Obtain ca. 10~15 mL of vinegar (brand #1) in a graduated cylinder. Pour into a clean, 50-mL flask & record the mass of the solution. Add 2 drops phenolphthalein indicator.
2. Set-up a single buret. Prime it & fill it with 0.550 M NaOH solution.
3. Titrate until the endpoint. **Be careful!** You won't be able to back-titrate in this lab. Record initial & final volumes.
4. Repeat with vinegar brand #2.

Data Table:

brand #1: _____	brand #2: _____
mass of vinegar: _____	mass of vinegar: _____
initial volume NaOH: _____	initial volume NaOH: _____
final volume NaOH: _____	final volume NaOH: _____
volume NaOH used: _____	volume NaOH used: _____

Calculations:

The mass of acetic acid titrated in the vinegar is determined this way:

$$\text{Liters OH}^- \times \frac{\text{mol OH}^-}{\text{L}} \times \frac{\text{mol H}^+}{\text{mol OH}^-} \times \frac{\text{g HC}_2\text{H}_3\text{O}_2}{\text{mol}} =$$

Finally, the % acetic acid in the vinegar is calculated:

$$\frac{\text{g HC}_2\text{H}_3\text{O}_2}{\text{g vinegar}} \times 100\%$$

% acetic acid in brand #1:

% acetic acid in brand #2: