Acid Base Color Chase Lab name: _____ (40/1200 minutes)

Background: Svante Arrhenius explained how certain solutions are acids while some are bases. Scientists then discovered chemicals that will change colors in the presence of an acid or base. These chemicals are called acid base indicators. We need to recognize the indicators listed in Table M, and know how they work.

Pure water is neither acid or base, it is said to be NEUTRAL. Neutral means two different things: that there are no H^{+1} or OH^{-1} ions at all, OR there are EQUAL numbers of H^{+1} and OH^{-1} ions present.

With pH, each whole number change amounts to a 10X change in the hydrogen ion concentration because pH is an exponential scale. Acids with a pH of 2.0 are 10X stronger than acids with a pH of 3.0. Each jump of a whole number of pH is a TEN TIMES change in strength. A solution with a pH of 6.2 is 100X less acidic than one with pH= 4.2 pH

Acid Base Indicators will be different colors in solutions of different pH. They will allow us to make qualitative measures of acid or base strengths. By adding acid we lower the pH, then by adding base, the pH will increase.

This lab is to let you PLAY, but think and learn too. The ALPHABETIZED (A to O) questions next to the trials are for thinking. You should be able to answer all of them, but you don't have to write them out.

PROCDURE:

1. We will only use the deionized water (tap water is a bit acidic) Obtain about 60 mL deionized water in a clean beaker. Put about 10 mL of the water into a second, smaller beaker. (enough to swirl)
2. Observe the water, and in the chart, write what color you see (it's clear silly). Follow the directions in order. For each step, write the color changes you see.
3. You must do each step in order. Each trial has a different order, pay attention!
4. The acid and base we are using are not too strong. Put a drop or two of each on your hand. Feel the difference between them. Weird, right?
5. Goggles at ALL TIMES, and only use 1-2 drops at a time of acid or base.
6. You can do these FIVE TRIALS in any order, each is separate from the other. Rinse out between trials.
7. Use colors from table M, don't imagine you see "fuchsia" or any colors that are funky. Red + Blue = purply. Red + Yellow = orangy. Pink or light pink. Nothing too wacky.

TRIAL 1 - METHYL ORANGE Indicator		
Step	Add to Beaker	color
1	Start with 10 mL deionized water	
2	Add 2 drops of METHYL ORANGE	
3	Add 1-2 drops HCl - ACID	
4	Add 2-3 drops NaOH - BASE	
	repeat acid and base AGAIN	Rinse beaker

A. The water starts clear. Why does the water change color when you put the methyl orange in it without adding acid or base?

B. What is the pH of water?

C. When you add the acid, which way does the pH go (lower or higher)?

D. When you add the base, which way does the pH go (lower or higher)?

TRIAL 2 - PHENOLPTHALEIN Indicator		
Step	Add to Beaker	color
1	Water only	colorless
2	add 2 drops PHENOLPTHALEIN	
3	Add 1-2 drops NaOH - BASE	
4	Add 2-3 drops HCl - ACID	
	repeat acid and base again	rinse

E. Phenolphthalein changes color from colorless to pink at what pH range?

F. If a solution with this indicator present is pink, can it be an acid?

G. If a solution with phenolphthalein is really pale pink, can that solution be a weak base of pH 7.7?

TRIAL 3 - BROMTHYMOL BLUE Indicator		
Step	Add to Beaker	color
1	Water only	colorless
2	add 3 drops BROMTHYMOL BLUE	
3	Add 2 drops NaOH - BASE	
4	Add 2-3 drops HCl - ACID	
	repeat add base then acid again	Rinse, smile

H. We only use colors listed in table M, even if we qualify them with pale, or dark, or even vivid, but we should avoid words like magenta, or fuschia.

I. What color is <u>every</u> base with bromthymol blue?

J. What color are strong acids with this bromthymol blue?

TRIAL 4 - LITMUS Indicator		
Step	Add to Beaker	color
1	Water only	colorless
2	Add 2 drops LITMUS	
3	Add 1- 2 drops HCl - ACID	
4	Add 2-3 drops NaOH - BASE	
	repeat with acid, then base again	Rinse, smile

K. Litmus provides a weak color change, red and blue, but really pale. (oh well)

L. What color is pure water with litmus? Why is it NOT red or blue? (see #8 above)

TRIAL 5 - BROMCRESOL GREEN Indicator		
Step	Add to Beaker	color
1	Water only	colorless
2	Add 2 drops BROMCRESOL GREEN	
3	Add 1- 2 drops HCl acid	
4	Add 2-3 drops NaOH base	
	repeat	Rinse, smile

M. Every time this indicator goes into a base, what color shows?

N. Why?

O. If this indicator shows green, what's the pH range of the solution?

Color Chase Lab Questions

For each of these solution and indicator combinations, tell which color should be, use your Table M and also **page 584** in the big blue text book. No guessing! Questions from here on count for grading.

number	solution	approx. pH	indicator	color
ex	black coffee	~5.0	methyl orange	yellow
1	0.055 M $HCl_{(AQ)}$		methyl orange	
2	ammonia		phenolphthalein	
3	vinegar		phenolphthalein	
4	lemon juice		litmus	
5	$C_2H_5OH_{(L)}$ - ethanol		litmus	
6	black coffee		bromthymol blue	
7	milk		thymol blue	
8	Drano (lye)		thymol blue	
9	pure water		phenolphthalein	
10	pure water		bromthymol blue	
11	orange juice		thymol blue	
12	aqueous aspirin		thymol blue	

14. How does an acid base indicator work? Phenolphthalein is a weak acid. It's dissociation in water as a dynamic equilibrium is below. The molecule of phenolphthalein is COLORLESS. The anion of phenolphthalein is PINK. Show shift arrows the "stress" of adding acid or add base shifts this.

$$HC_{20}H_{13}O_{4(AQ)} \rightleftharpoons H^{+1}_{(AQ)} + C_{20}H_{13}O_4^{-1}{}_{(AQ)}$$

Add ACID

ADD BASE

15. How would you use an acid base indicator in lab? Explain in 2-3 sentences.

16 - 19 Each of these liquids is either acid, base, or neutral. List them in the proper columns. (4 points)

Deionized water	Vegetable oil	$Ca(OH)_{2(AQ)}$
Drano (sodium hydroxide)	Blood	Lemon juice
$NH_{3(AQ)}$	Ocean water	Tums
Coffee	Vinegar	Milk
Gasoline	$NaCl_{(AQ)}$	Very weak NaOH
Sugar water	Rainwater	1.0 M $HCl_{(AQ)}$
Pineapple Juice	$H_2O_{(L)}$	Wegman's Seltzer
$KCl_{(AQ)}$	$Hg_{(L)}$	Coca Cola

<u>There are 9 acids</u>	<u>There are 7 bases</u>	<u>Only 8 are neutral</u>

For each full number change in pH, there is a 10X change in strength because the pH scale is an exponential scale, because it is a logarithmic scale.

An acid with a pH of 2.0 is 10X stronger than an acid with a pH of 3.0.

A base of pH 7.5 is 100X LESS BASIC than a base with pH = 9.5

An acid of pH 1.0 is 1000X more acidic than an acid of pH = 4.0

An acid with a pH = 2.0 has 1 x 10^{-2} moles H^{+1} ions/Liter of acid

An acid with a pH = 4.0 has only 1 x 10^{-4} moles H^{+1} ions/Liter of acid

That difference is a 100X difference because of the exponents.

Fill in the blanks like the first examples. Use ACIDIC or BASIC in the right boxes.

Remember: If both solutions are acids, don't use the base word in the answer.
If both solutions are bases, don't use the acid word in the answer either.

	solution 1 pH	solution 2 pH	#1 is ____ X more ____ than #2
Ex.	3.7	4.7	#1 is *10X more acidic* than solution #2
Ex.	9.3	12.3	#1 is *1000X less basic* *than solution* #2
20	1.0	3.0	#1 is than solution #2
21	1.9	5.9	#1 is than solution #2
22	7.5	12.5	#1 is than solution #2
23	10.8	12.8	#1 is than solution #2
24	7.1	11.1	#1 is than solution #2
25	11.1	9.1	#1 is than solution #2
26	0.5	6.5	#1 is than solution #2
27	4.9	6.9	#1 is than solution #2
28	13.1	9.1	#1 is than solution #2