Name: ____ Date: ____________
Partner(s): ____

Lab: Electrolytes – Acids, Bases, and Salts

Objective: To explore the properties of electrolytes, including acids & bases, and investigate double replacement reactions including precipitation and neutralization.

Safety:

- Wear safety goggles (the splash kind – with the suction and the strap) at all times in the lab, even if you're not using chemicals at that station. Keep the goggles on for clean up too. Wear an apron to protect your clothes.
- Do not perform any procedure until you are sure you understand the directions. Do not perform any procedure other than what you are told to do in the lab directions.
- No fooling around will be tolerated!
- Acids and bases can be extremely harmful to skin and eyes! (i.e. burns, blindness, etc.) Avoid contact, unless the directions explicitly state otherwise.
- Do not taste any substances in the lab, and do not directly smell any of the chemicals (waft the scent towards you with your hand)
- Notify teacher immediately of any spills, and follow teacher directions for clean up. In particular, wipe away any chemicals that spill down the sides of the dispensing containers, since other students will be handling those containers.
- Wash your hands with soap and water after performing the stations.

Sign this statement before proceeding:

I have read the safety guidelines listed above and I agree to abide by them. I know the location of the eyewash and safety shower, and I have been shown how to use them. I understand that my failure to follow proper lab safety procedures will result in my ejection from the lab, receipt of a zero on the lab, and possible ejection from the course.

Student Signature: ________________________________

Date: ____________

Teacher's Initials: _______

Station 1 – Double Replacement & Solubility

$AB + CD \rightarrow AD + CB$

Procedure:

1. In a well plate, you will combine several solutions of ionic compounds and make observations. Look for a color change, formation of a new solid (a precipitate), formation of a new gas (bubbles), or a temperature change to determine if a chemical change occurs. Write your observations in the chart on the right.
2. In the table below, note whether or not a precipitate formed, and write the complete balanced reaction in the space provided.
3. If a precipitate formed, use Table F to decide which product was the precipitate, & CIRCLE IT.

	$CuCl_2$	Silver Nitrate	Potassium Iodide	KOH
$CuCl_2$	X	1	2	3
Silver Nitrate	X	X	4	5
Potassium Iodide	X	X	X	6
KOH	X	X	X	X

Your Observations:

1.

2.

3.

4.

5.

6.

Trial #	Precipitate formed? Y/N	Balanced Equation
1		
2		
3		
4		
5		
6		

Station 2 – Electrolytes

Procedure:

1. For the 6 solutions listed in the table below, identify the substance as an electrolyte or non-electrolyte based on the chemical formula given.
2. If it is an electrolyte, classify it as an acid, base, or salt.
3. Test each solution with a conductivity tester to confirm your predictions, and record your results in the table below.
4. Rinse the prongs of the conductivity tester **between each trial** by gently rinsing them with distilled water (in a squeeze bottle) over the sink.
5. Explain why each solution either conducted electricity or did not.
6. Answer the question.

	Non-Electrolyte? Electrolyte? Acid/Base/Salt?	Result of Conductivity Test?	Explanation
KBr			
HCl			
$C_6H_{12}O_6$			
$MgCl_2$			
$Ca(OH)_2$			
Distilled H_2O			

Rearrange the following list of substances and list them in order from the strongest electrolyte to the weakest, based on their chemical formulas: (HINT: Count *total number* of ions formed)

HBr H_2SO_4 $Ca(OH)_2$ PO_4 LiOH H_3PO_4 NH_4OH

______ ______ ______ ______ ______ ______ ______

STRONGEST → weakest

Station 3 – 2 Cups and a Penny

Procedure:

1. This station uses very dilute chemicals. **YOU WILL TOUCH** these solutions with your fingers, in order to make observations, but **YOU WILL NOT TASTE** them.
2. Follow the directions below and complete the data table with your observations of properties of Solution A and Solution B.
3. Answer the questions.

Procedure	Detailed Observations
1. Pour approximately 30 ml of *solution B* into *Beaker B*. Record observations of *solution B* using 4 of your 5 senses. (NOT TASTE)	
2. Record the year on your penny.	
3. Put your penny into *Beaker B* & record observations.	
4. After 2 minutes, remove your penny (using your hands) and record observations of the penny. Again, look at the year on your penny.	
5. Dip conductivity tester into *solution B* and record results. Rinse the prongs with distilled water when finished.	
6. Dip 1 test strip into *solution B* and record results.	

7. Pour approximately 30 ml of *solution A* into *Beaker A*. Record observations of *solution A* using 4 of your 5 senses. (NOT TASTE)	
8. Record the year on your penny.	
9. Put your penny into *Beaker A* & record observations.	
10. After 2 minutes, remove your penny (using your hands) and record observations of the penny. Again, look at the year on your penny.	
11. Dip conductivity tester into *solution A* and record results. Rinse the prongs with distilled water when finished.	
12. Dip 1 test strip into *solution A* and record results.	

Procedure ctd…	Detailed Observations
13. Combine *solution A* and *solution B* together into *Beaker C* to create a new solution, *solution C*. Record observations of *solution C* using 4 of your 5 senses. (NOT TASTE)	
14. Record the year on your penny.	
15. Put your penny into *Beaker C* & record observations.	
16. After 2 minutes, remove your penny (using your hands) and record observations of the penny. Again, look at the year on your penny.	
17. Dip conductivity tester into *solution C* and record results. Rinse the prongs with distilled water when finished.	
18. Dip 1 test strip into *solution C* and record results.	

Clean Up:

1. Pour solution C into the sink with the faucet running. Then turn faucet off.
2. Rinse Beakers A, B, and C thoroughly with distilled water from the wash bottle.
3. Rinse penny with distilled water from the wash bottle.
4. WASH YOUR HANDS WITH SOAP AND WATER **NOW**!

Questions:

Use the list of acid/base properties in your notes and the properties you just observed to answer the following questions.

1. Which solutions (if any) are bases? _____________ What is their pH range? ________________
2. Support your answer to #1 with at least 3 pieces of evidence from the lab. __________________
   ____
   ____
   ____

3. Which solutions (if any) are acids? ______________ What is their pH range? ________________
4. Support your answer to #3 with at least 3 pieces of evidence from the lab. ___________________
   ____
   ____
   ____

5. Which solutions (if any) are neutral? ______________ What is their pH range? _______________
6. Support your answer to #5 with at least 3 pieces of evidence from the lab. ___________________
   ____
   ____
   ____

Station 4 – 5 Unknowns

Acids & bases have some similar properties and many different properties.
For instance, acids react with metals and bases do not. Strong bases react with oils and show some bubbling when stirred, acids do not. Acids and bases turn indicators different colors – see Table M – and their identity can be determined with the use of an analysis indicator.

UNKNOWN OUR GROUP WILL TEST: _________

Procedure:

1. At this station, there are 5 solutions (A, B, C, D, E) available for you to choose from. One is a STRONG ACID, one is a WEAK ACID, one is NEUTRAL, one is a WEAK BASE, and one is a STRONG BASE.
2. Since you will not know which solution you have, **take all safety precautions** as if you have a concentrated acid or a concentrated base. Do not touch, taste or directly smell any of the chemicals. Avoid contact with the chemicals, and notify teacher of any spills immediately.
3. Choose a solution to test, and decide as a group which 5 tests you will perform on the solution to determine its identity. Materials you will have available include: Mg, oil, and all indicator solutions from Table M.
4. If you have any questions about how to test the unknown solution, ask your teacher BEFORE you start using any chemicals.
5. Once your group has come up with a plan, use the dropper to place a few drops of your chosen unknown into 5 dimples of the well plate. You will be performing one test in each dimple.
6. Perform the 5 tests you have chosen and record your observations.

Describe the Test you Performed	Detailed Observations & Results
1.	
2.	
3.	
4.	
5.	

Conclusion: Identify the unknown you tested as strong acid, weak acid, neutral, weak base, or strong base. Write a paragraph that supports your conclusion using your lab data as evidence.

____

____

____

____

____

Station 5 – pH

This station does not involve lab equipment. If you choose to do this work back at your desk, you may remove your goggles.

Procedure:

1. Follow your teacher's directions and login to the website www.explorelearning.com.
2. Select the "Testing pH" gizmo, and use the online simulation to test the pH of 19 common substances.
3. Label the blank pH scale below with the names of those 19 items in their appropriate location.

1	2	3	4	5	6	7	8	9	10	11	12	13	14

Refer to your notes and observations you've made about properties of acids and bases…

4. Choose 1 acid from the above list and answer *one* of the following questions about it:
   a. What properties of this acid make it well suited for its function?
   b. How do the properties of this acid affect how it is used?

5. Choose 1 base from the above list and answer *one* of the following questions about it:
   a. What properties of this base make it well suited for its function?
   b. How do the properties of this base affect how it is used?

Station 6 – Acid Rain

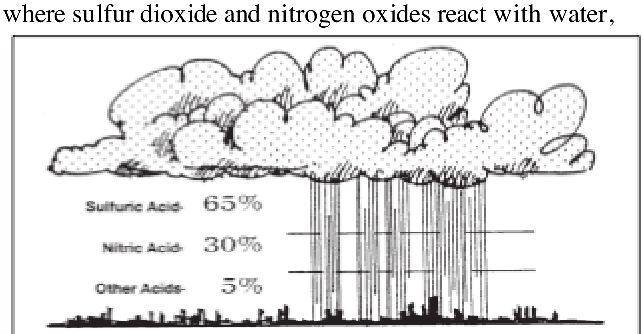
This station does not involve lab equipment. If you choose to do this work back at your desk, you may remove your goggles. Read the passage on acid rain, refer to the diagrams, and answer the questions.

Since the beginning of time, humans have learned to make use of many things in nature such as fire and electricity. From the early times through the Industrial Revolution to the Space Age, humans have produced inventions that use many of the earth's varied energy resources to make living easier. In many cases the energy comes from burning fossil fuels—coal, oil and natural gas.

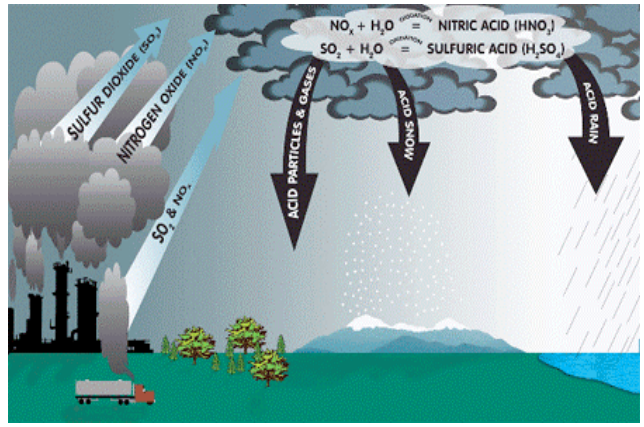
Some of the inventions that make our lives easier are also causing pollution. Pollution is the release of harmful substances into the environment. One form of pollution is acid rain. Acid rain is any form of rain that is more acidic than normal (with a pH lower then 5.6). Pure water has a pH of 7, normal rainfall has a pH of a bit less than 7, but acid rain can have a pH of about 5.0-5.5, and even in the 4 range in the northeastern United States.

Acid rain can damage plants, animals, soil, water, building materials, and people. Scientists have discovered that air pollution from the burning of fossil fuels is the major cause of acid rain. People burn fossil fuels such as coal and oil to make electricity. Electricity heats and lights buildings and runs appliances such as televisions and video recorders. Fossil fuels power our cars, buses, and airplanes. The air pollution created when these fuels burn does not stay in the air forever. It can return to the earth as acid rain. And when it does, it may weaken the plant and animal life it contacts. Acid rain is only one form of pollution that results from burning fossil fuels. It is one of particular interest, however, because it can be transported over long distances. Scientists, engineers, and researchers are learning how to measure the amount and effects of pollution in the air, forests, water, and soil. They are inventing ways to reduce the amount of pollution that enters the environment and prevent new damage in the future.

The smoke and fumes from burning fossil fuels rise into the atmosphere and combine with the moisture in the air to form acid rain. The main chemicals in air pollution that create acid rain are sulfur dioxide (SO_2) and nitrogen oxide (NOx). Acid rain usually forms high in the clouds where sulfur dioxide and nitrogen oxides react with water,



TYPICAL NORTHEASTERN U.S. ACID RAIN COMPONENTS



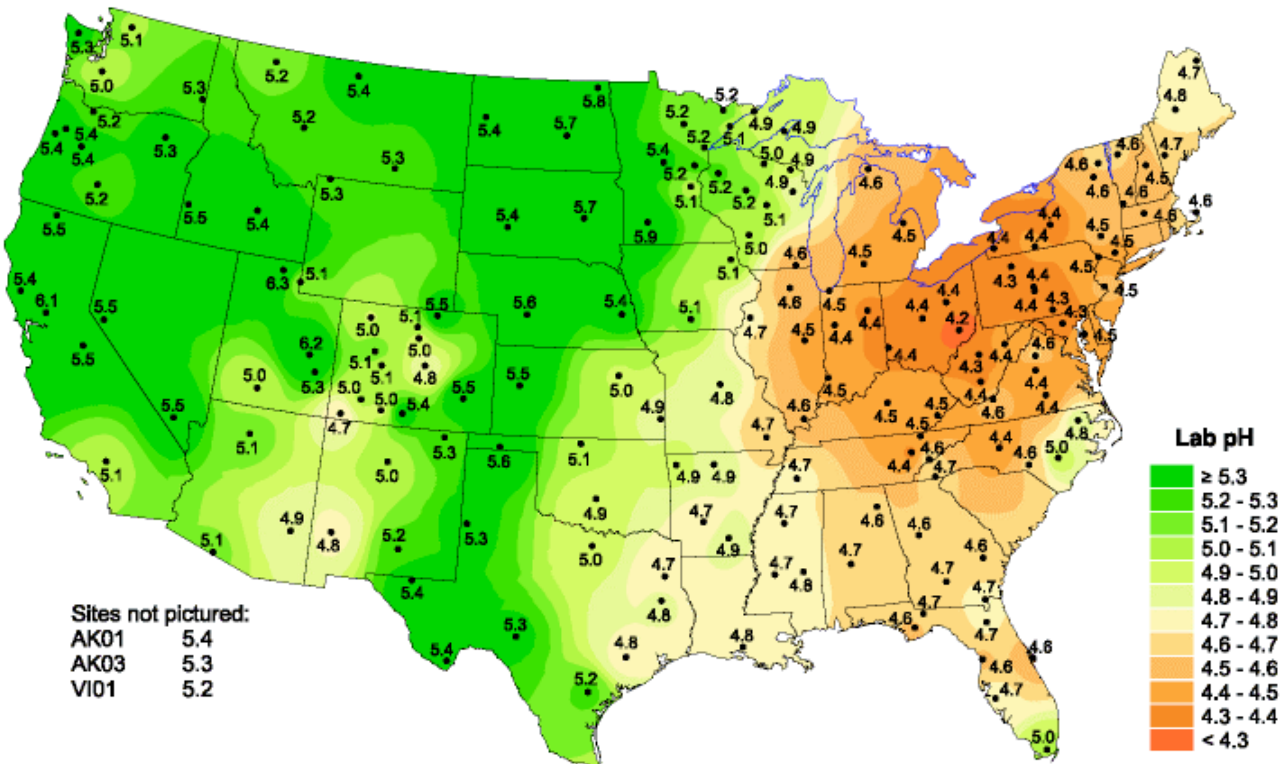
oxygen, and oxidants. This mixture forms a mild solution of sulfuric acid and nitric acid. Sunlight increases the rate of most of these reactions. Rainwater, snow, fog, and other forms of precipitation containing those mild solutions of sulfuric and nitric acids fall to earth as acid rain.

The chemical reactions that change air pollution to acid rain can take from several hours to several days. Years ago, when smokestacks were only a few stories high, pollution from smokestacks usually stayed near the ground and settled on land nearby. This caused unhealthy conditions for plants and animals near the smokestacks. To reduce this pollution, the government passed a law permitting the construction of very tall smokestacks. At that time, people thought that if the pollution were sent high into the air it would no longer be a problem. Scientists now know that this is incorrect. Sending pollution high into the sky increases the time that the pollution stays in the air. The longer the pollution is in the air, the greater are the chances that the pollutants will form acid rain. In addition, the wind can carry these pollutants for hundreds of miles before they become joined with water droplets to form acid rain. For that reason, acid rain can also be a problem in areas far from the polluting smokestacks.

The region of the Continental United States most affected by acid rain is the Northeast, where pH levels of between 4.0 and 4.5 are commonplace. Notably, the most rapid increase in acid precipitation in the U.S. seems to be in the Southeast, an increase paralleling the expansion of Southeastern urban and industrial activities that result in sulfur and nitrogen emissions.

West of the Mississippi, rain is generally neutral or even basic. Colorado, the Los Angeles Basin, the San Francisco Bay Area, Spokane, Tucson, and Portland are the known exceptions. In these locations, as in the Northeast, precipitation ranges from between pH 4.0 to 5.0.

Hydrogen ion concentration as pH from measurements made at the Central Analytical Laboratory, 1999



National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

Questions:

1. What is the major source of air pollution that leads to acid rain? ______________________________
2. Describe the chemical reactions that take place to turn smoke and fumes into acid rain.
   ____
   ____
   ____
3. Does acid rain only fall over the area where sulfur dioxide was formed? Explain your answer.
   ____
   ____
4. Why is acid rain harmful? ____
   ____
5. Where in the United States is the problem of acid rain most severe? __________________________
6. Why is this region most affected? ____
   ____
   ____
7. Why is acid rain considered to be an international problem? _________________________________
   ____
   ____
8. How can the amount of acid rain be reduced? ____
   ____
   ____

Station 7 – Titration Calculations

This station does not involve lab equipment. If you choose to do this work back at your desk, you may remove your goggles. Answer the questions based on the following chart, which shows the data from a titration of a solution of NaOH with 1.2M HCl. Use the titration equation on Table T to help you.

	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Volume of 1.2M HCl	10.0 mL	10.0 mL	10.0 mL	10.0 mL
Initial reading of NaOH	0.0 mL	12.2 mL	23.2 mL	35.2 mL
Final reading of NaOH	12.2 mL	23.2 mL	35.2 mL	47.4 mL
Volume of NaOH used (mL)				
Molarity of NaOH (M)				

1. Calculate the volume of NaOH used to neutralize the acid for each trial. Record in data table. Show one sample calculation.

2. Using the titration equation from table T, calculate the Molarity of the base for each trial. Record in data table. Show one sample calculation.

3. Calculate the average Molarity of the NaOH solution.

4. If I had 500 mL of this HCl solution…
   a. How many liters is that?

   b. How many moles of HCl is that?

   c. How many moles of H^+ ion are in there?

   d. How many moles of $(OH)^-$ ion would be required to neutralize that solution?

Station 8 - Titration

BEFORE YOU BEGIN this station, watch a titration demonstration either by your teacher or on our classroom website. You will be performing a *titration*, which is a controlled neutralization reaction. First, let's review neutralization reactions. Complete the following reactions, and when finished balance each one.
If you get stuck, ask for help.

Remember how to read a meniscus & remember sig figs!

1. ____ HBr + _____ LiOH → ____________ + _____________

2. ____ $Mg(OH)_2$ + _____ HCl → ____________ + ____________

3. ____ $Ca(OH)_2$ + _____ $H_2(SO_4)$ → ____________ + ____________

4. Which type of reation is a neutralization reaction?
   a) synthesis b) decomposition
   c) single replacement d) double replacement

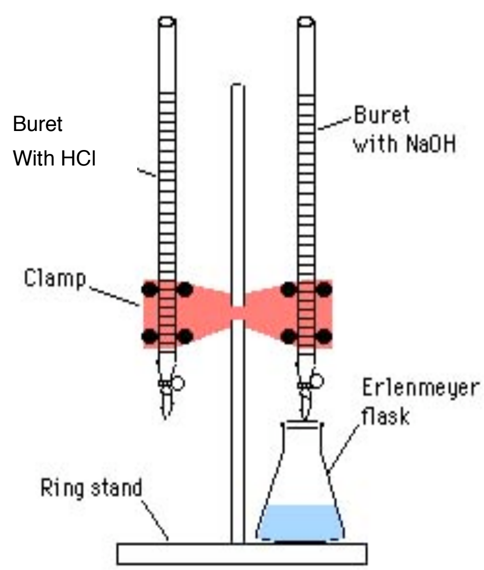
Purpose: A titration is used to determine the concentration, or ***Molarity (M)*** of an unknown acid or base. In this procedure, the unknown solution is added very slowly to the known solution until it is neutralized. We use indicators to tell us when the solutions have exactly reached ***neutral*** (pH = 7). You then use the volume of acid ***(V_A),*** the volume of base ***(V_B),*** and the concentration ***(M)*** of the known solution to calculate the concentration of the unknown. You will use the titration equation from Table T.

$$M_A V_A = M_B V_B$$

Safety: Do not pour liquids while holding the bottles or burets over your head!

Procedure:

1. Make sure 1 buret, 1 funnel, and 1 250ml beaker are labeled acid and the others labeled base. Keep the solutions from being cross contaminated; use the equipment labeled for acid only with acid and the base only with the base. *The graduated cylinder should be only be used with water.*
2. Remove the buret marked ACID from the ring stand to bring it down to your level. Make sure the valve on the tip is closed (perpendicular to the buret). Put a funnel into the top of the buret. Holding the buret vertically, slowly and carefully fill the buret with **0.1M HCl** solution until the level of acid is above the 0ml line.
3. Place the ACID buret back into the ring stand and place a waste beaker beneath the tip. Open the valve to let out extra acid until the meniscus reads 0.0ml. Record your initial volume in your data table.
4. Repeat steps 2 & 3 with the BASE buret and BASE solution.
5. Place the Erlenmeyer flask beneath the tip of the ACID buret and turn the valve to drain approximately 10ml of acid into the flask. Read the buret again, and record the final volume of acid in your data table.



6. Add 10ml of distilled water to the flask, then add 3 drops of phenolphthalein indicator to the mixture. Gently swirl the solution to mix.
7. Place the flask on a white sheet of paper, and position it beneath the tip of the BASE buret. Be sure the tip of the buret is in the flask, but not touching the sides of the flask.
8. Swirling the flask gently, begin the titration by adding the base to the flask slowly, drop by drop. Continue until a **<u>very faint</u>** pink color remains for at least 30 seconds.
9. Read the buret again, and record the final volume of base in your data table.
10. Calculate the concentration (Molarity) of the unknown base using the titration equation.
11. Dispose of waste chemicals into the sink with running water.

Our unknown # _____	**HCl**	**NaOH**
Initial buret reading		
Final buret reading		
Volume used		

Calculate the Molarity of your unknown base here. Show work

<u>Questions:</u>

1. Write the neutralization reaction that you just performed in lab, then balance it:

__________ + __________ → ___________ + _____________

2. How close were your results to the results that your partners got? If they were very close explain why. If they were not very close, explain why not. _______________________________________
____
____
____

3. Why is it important to perform a titration several times in order to get a better result? __________
____
____
____

4. Does repeating a procedure improve the *accuracy* or the *precision* of the results? Or both? Explain your answer *by including definitions of accuracy and precision*. ____________________________
____
____
____

Name: ____

For Teacher Use Only:
Minutes ____________
Approved ____________

Lab: Electrolytes

Lab Credit Sheet

Answer the following questions with thoughtful, detailed answers in complete sentences. Cite specific examples from your observations and results of the lab activity.

1. **Station #1: Double Replacement & Solubility**
   a. Define *solubility*:

   b. Explain how you used Table F to determine which product was the solid precipitate in Trial #1.

2. **Station #2: Electrolytes**
   a. Define *electrolyte*:

   b. What 2 conditions must be present in your solution in order for it to be an electrolyte?

   c. Explain how the # of ions formed affects conductivity of a solution?

3. **Station #3 and #4: Acid/Base Properties**
   a. Compare AND contrast properties of acids and bases.

4. **Station #5: pH**
   a. If solution A has a concentration of H^+ ions equal to $1.0x10^{-9}$M, what is its pH?

   b. If solution B has a pH 100 times more acidic than solution A, what is the pH of solution B?

5. **Station #6: Acid Rain**
    a. In 3-5 sentences, explain what causes acid rain and why it is a significant problem in New York State.

6. **Station #7 and #8: Titration**
    a. Write the balanced neutralization reaction you performed at Station #8:
    b. Show the calculations you used to determine the Molarity of your unknown base.
    c. After a titration, what is the pH of the resulting solution?
    d. After a titration, what can you say about the resulting concentrations of H^+ ion and OH^- ions?