Early Booklet E.C.:	**+ 2**
Unit 12 Hwk. Pts.:	**/**
Unit 12 Lab Pts.:	**/**
Late, Incomplete, No Work, No Units **Fees**?	Y / N

Unit 12 – Solutions & Acids and Bases

Chapters 14 & 18 of your textbook

Learning Targets for Unit 12

1.1 I can compare the properties of suspension, colloids and solutions.
1.2 I can identify types of colloids and types of solutions.
1.3 I can describe electrostatic forces in colloids.
1.4 I can describe concentration.
1.5 I can determine concentrations and molarity of solutions.
1.6 I can define solubility and the factors that affect it.
1.7 I can identify the physical and chemical properties of acids and bases.
1.8 I can classify solutions as acidic, basic or neutral.
1.9 I can relate the strength of an acid or base to its degree of ionization.
1.10 I can compare the strength of a weak acid to its conjugate base.
1.11 I can explain pH and pOH and relate them to the ion product constant for water.
1.12 I can calculate pH and pOH of aqueous solutions.
1.13 I can write chemical equations for neutralization reactions.
1.14 I can compare the properties of buffered and unbuffered solutions.

Unit Vocabulary for Unit 12

Suspension	Colloid	Tyndall effect	Soluble
Miscible	Insoluble	Immiscible	Concentration
Molarity	Molality	Mole fraction	Solvation
Heat of solution	Unsaturated solution	Saturated solution	Supersaturated solution
Acidic solution	Basic solution	Arrhenius model	Bronsted-Lowry model
Conjugate acid	Conjugate base	Conjugate acid-base pair	Strong acid
Weak acid	Strong base	Weak base	Acid ionization constant
Base ionization constant	pH	pOH	Neutralization reaction
Salt	Titration	Titrant	Equivalence point
Acid-base indicator	Buffer		

Possible 12.1 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2
Final Score: / 4

12.1 Problems – Types of Mixtures
Section 14.1 of your textbook.

1. How can the Tyndall effect be used to distinguish between a colloid and a solution? Why?

2. Explain what is meant by the statement "not all mixtures are solutions."

3. What is the difference between a solute and a solvent?

4. Aerosol sprays are categorized as colloids. Identify the phases of matter of an aerosol spray when it is out of the can..

Possible 12.2 Pts.: 4
Late, Incomplete, No work, No Units Fee: - 1 - 2
Final Score: / 4

12.2 Problems – Solutions and Concentration
Section 14.2 of your textbook.

1. According to lab procedure, you stir 25.0 g of $MgCl_2$ into 550 g of water. What is the percent by mass of $MgCl_2$ in the solution?

2. Calculate the percent by volume created by adding 75 mL of acetic acid to 725 mL of water.

3. How much $CaCl_2$, in grams, is needed to make 2.0 L of a 3.5 M solution?

4. If you dilute 20.0 mL of a 3.5 M solution to make 100.0 mL of solution, what is the molarity of the dilute solution?

Possible 12.3 Pts.: 8
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3
Final Score: / 8

12.3 Problems – Intro to Acids and Bases
Section 18.1 of your textbook.

Classify each compound as an Arrhenius acid or an Arrhenius base.

1. H_2S

2. RbOH

3. $Mg(OH)_2$

4. H_3PO_4

5. **Geology**. When a geologist adds a few drops of HCl to a rock, gas bubbles form. What might the geologist conclude about the nature of the gas and rock?

6. Explain the difference between a monoprotic acid, a diprotic acid, and a triprotic acid. Give an example of each.

7. Why can H^+ and H_3O^+ be written interchangeably in chemical equations?

8. When vinegar reacts with water, it does so according to the following reaction:

$$CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+$$

Make a Bronsted-Lowry acid base pair from the reaction

Possible 12.4 Pts.: 5
Late, Incomplete, No work, No Units Fee: - 1 - 2
Final Score: / 5

12.4 Problems – Strengths of Acids

Section 18.2 of your textbook.

1. Explain the difference between a strong acid and a weak acid.
2. Choose a strong acid, and explain how you would prepare a dilute solution of the acid. Then, select a weak acid, and explain how you would prepare a concentrated solution of the acid.
3. Is sulfuric acid a strong or weak acid?
4. Is aluminum hydroxide a strong or weak base?
5. Is potassium hydroxide a strong or weak base?
6.

Possible 12.5 Pts.: 6
Late, Incomplete, No work, No Units Fee: - 1 - 2
Final Score: / 6

12.5 Problems – pH

Section 18.3 of your textbook.

1. Solution A has a pH of 2.0. Solution B has a pH of 5.0. Which solution is more acidic? Based on the H^+ concentration, how many times more acidic?
2. If 5.00 mL of 6.00 M HCl is added to 95.00 mL of pure water, the final volume is 100.00 mL. What is the pH of the solution? Hint: calculate concentration of diluted acid first.
3. If the concentration of an HCl solution is 0.0045 M, what is the pH?
4. What is the concentration of an HBr solution with a pH of 2.5?
5. What is the pOH of a 0.5 M solution of KOH?
6. Is sodium phosphate an acid salt, basic salt, or neutral salt?

Possible 12.6 Pts.: 7
Late, Incomplete, No work, No Units Fee: -1 -2 -3
Final Score: / 7

12.6 Problems – Neutralization
Section 18.4 of your textbook.

Give the name and formula of the acid and the base from which each salt was formed.

1. NaCl

2. $KClO_3$

3. NH_4NO_3

4. CaS

5. When might a pH meter be better than an indicator to determine the end point of an acid-base titration?

6. When might an indicator be used to determine the end point of an acid-base titration?

7. In an acid/base titration, 46.0 mL of a sulfuric acid solution is titrated to the end point by 74.3 mL of 0.44 M sodium hydroxide solution. What is the molarity of the H_2SO_4 solution?

8. In an acid/base titration, 46.0 mL of a hydrochloric acid solution is titrated to the end point by 114 mL of 1.29 M barium hydroxide solution. What is the molarity of the HCl solution?

Chemistry	Lab 12.1 - Molar Solutions					
Name:						Correction Credit: Half
Lab Points:	E.C.	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
12	1		-1 -2 -3			

Purposes:
1. To familiarize students with the procedure for making chemical solutions.
2. To use colorimetry to estimate the concentration of an unknown solution of copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5\ H_2O$).

Overview/Theory:

Solutions of different concentrations of Cu^{2+} ions will have varying intensities of blue color. Starting with a concentrated stock solution of copper sulfate, you will make several different solutions, thus making a comparative color scale to test unknown solutions against.

To make a stock solution of a particular molarity, use the following equation:

Equation 1. $$\text{Concentration (M)} = \frac{\text{moles solute (mol)}}{\text{liters of solution (L)}}$$

To dilute a stock solution, you can use the equation:

Equation 2. $$M_1 \cdot V_1 = M_2 \cdot V_2$$

M_1 = Molarity of stock solution (M = mol/L)
V_1 = Volume of stock solution (mL or L – it doesn't matter)
M_2 = Molarity of dilute solution (M)
V_2 = Volume of dilute solution (mL or L)

Safety:
1. Wear goggles throughout the lab.
2. Long pants and closed-toed shoes are required.
3. Use only deionized water when preparing any solutions in a lab.

Materials:

Copper (II) sulfate pentahydrate
$CuSO_4 \cdot 5\ H_2O$).
Molar Mass = 249.69 g/mol
Labeling Tape

Graduated Cylinders-100, 10 mL
Small Test Tubes
Test Tube Rack
Graduated Eye Droppers

<u>Procedure</u>: Work in your lab groups, and show calculations.

Part 1:

1. (3 Points) Describe how you would prepare 250 mL of a 1.0 M stock solution of copper (II) sulfate. Use Equation 1 to determine how many moles of solute you need, and then convert that to grams. <u>Show me the mass calculation</u> and I will approve it.
   Approval ___________________________

2. When each group has done this, I will provide a stock solution.

Part 2:

1. Obtain 30 mL of the 1.0 M stock solution and put it in a small beaker.
2. Fill a small test tube with 10 mL of the stock solution and put it into the rack. This is the highest value of your colorimetry scale: label it "1.0 M" with the labeling tape.
3. Prepare four dilute solutions from the stock solution – using your 10.0 mL graduated cylinder. Use Equation 2 to calculate the amount of stock solution you will need to make 10.0 mL each of 0.75 M, 0.50 M, 0.25 M, 0.10 M, and 0.0 M solutions. Save each solution in a labeled test tube.
4. **(5 points)** Show me your colorimetry scale once you have made and <u>labeled</u> five different solutions. **Approval ___________________________**
5. Determine the concentrations of two of the unknowns to within 0.10 M for full credit. They might be a concentration between points of your scale. Hold a white piece of paper behind your test tubes to see shades of color better, then record your estimated concentrations below.
6. For 1 Point Extra Credit, determine the concentration of the E. C. solution within 0.05 M.

(2 Points) Unknown concentration 1 = ________________

(2 Points) Unknown concentration 2 = ________________

(1 Point E. C.) E. C. concentration = ________________

<u>Clean Up:</u>

1. Pour ALL of your copper sulfate solutions into the waste beaker provided.
2. Wash all glassware and leave it at your station, or in your glassware rack.
3. Clean up your lab station so no residue is left on the counter.

Chemistry	Lab 12.2 - Measuring pH With Litmus Paper				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
12		-1 -2 -3			

Purpose:

Experimentally measure and determine the pH of common household items.

Theory:

pH is a calculation of acidity, based on the concentration of hydrogen ions in a solution. While there are several ways of determining pH, the most simple is to use a piece of litmus paper and look at the color that it turns. You can compare this color to a scale on the package of litmus paper to determine what the pH is.

When hydrogen ions (H^+) outnumber hydroxide ions (OH^-), the pH will be less than 7 and the solution will be acidic. When H^+ and OH^- are equal to each other, then the pH will equal 7 and the solution will be neutral (an approximate neutral range of pH is 6 – 8). When the OH^- ions outnumber H^+ ions, then the solution is basic and the pH is greater than 7.

Equipment:

pH paper
Tweezers
Orange
Tomato
Lemon
Ammonia
Battery Acid
Milk
Tap Water
Coca Cola

Procedure:

1. Obtain enough strips of the pH paper to test the pH of each substance. You will have to rip your strips into thirds to maximize resources.
2. Test each of the substances with the pH paper, and record your data in the table on the next page.
3. Clean up your area – all solid materials can be returned to the front of the room, pH paper can be thrown in the trash, and liquids should remain at your station.

Data Table: (8 Points)

Substance:	pH	Acid, Base, or Neutral

Questions:

1. (1 Point) What ion makes a chemical an Arrhenius base? List two examples of Arrhenius bases that are not from this lab.

2. (1 Point) What ion makes a chemical an Arrhenius acid? List two examples of Arrhenius acids that are not from this lab.

3. (2 Points) What other household or laboratory substances you would choose to measure? Why do they interest you? Write this in complete, well-crafted sentences.

Chemistry	Lab 12.3 - Salt Hydrolysis					
Name:						Correction Credit: Half
Lab Points:	E.C.	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
10	1		-1 -2 -3			

Purpose:

Experimentally measure the pH of different salt solutions, and calculate their hydrogen (H^+) ion concentrations.

Theory:

Many salts will hydrolyze water by breaking it into H^+ and OH^- ions.

If a salt is made from a strong acid and a weak base, it will become an acidic salt – triggering the release of more free H^+ ions than OH^- ions. The abundance of hydronium ions leads to acidic conditions and thus a low pH.

If a salt is made from a weak acid and a strong base, it will become a basic salt, meaning that its anion will adhere to a hydrogen ion, leaving the hydroxide ion free in solution. The pH of such a solution will be higher than 7 – meaning that it is basic.

If a salt is made from a strong acid/base, or weak acid/base, it will be nautral.

pH is a calculation based on the molar concentration (M) of the hydrogen ion $[H^+]$, expressed and calculated as follows:

Equation 1: $pH = -\log [H^+]$

In order to calculate hydrogen concentration (in moles/liter) from pH, use the formula:

Equation 2: $[H^+] = 10^{-pH}$

Use the antilog key (10^x)of your calculators, not the exponent key.

Equipment:

pH paper of different ranges
Plastic Test Plate
Deionized Water
Sodium Phosphate – Na_3PO_4
Potassium Nitrate – KNO_3
Zinc Sulfate – $ZnSO_4$

Procedure:

1. Obtain one strip of the pH paper and cut it in thirds to test your solutions.
2. Make a solution of each substance by taking a lentil sized amount of your solute, and dissolving it in 5 drops of water in a plastic test plate. Stir the solution until the crystals dissolve.
3. Measure each solution's pH and record it in the data table on the next page.
4. Clean up your area – all solid materials can be returned to the front of the room, and pH paper can be thrown in the trash.

Data Table (2 Points):

Chemical Formula: (1 Point)	pH (1 Point)	Acid, Base, or Neutral Salt	Hydrogen Ion Concentration $[H^+]$

Questions/Calculations:

1. (3 Points) Based on the pH of your salt's solution, write in your Data Table whether it is an acid salt, basic salt, or neutral salt.

2. (3 Points) Calculate the hydrogen ion concentration of each solution by using Equation 2 from the front of the lab, and write it in the Data Table. Show all three equations here for full credit.

3. (2 Points) Describe in at least two complete sentences how adding a much larger volume of water than five drops would affect the pH of your different solutions. Ask yourself: what does pH depend upon?

E. C. (1 Point): Complete and balance the equation of the reaction of the basic salt sodium phosphate and water. You will have to predict the products of the reaction. Hint: include hydroxide ions to show that the resulting solution will be basic:

$$\_\_\_\_ \ Na_3PO_4 + \_\_\_\_ \ H_2O \rightarrow$$

Chemistry	Lab 12.4 - Neutralization				
Name:					Correction Credit: Half
Lab Points:	Missed:	Late, No Units, No Work Fee:	First Score:	Corrections:	Final Score:
12		-1 -2 -3			

Purpose:

Experimentally determine the concentration of an unknown solution of base by neutralizing it with a known amount and concentration of acid.

Theory:

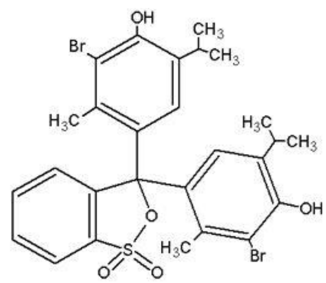
Hydrochloric acid and sodium hydroxide will neutralize each other in a 1:1 ratio according to the reaction:

Equation 1: $HCl + NaOH \rightarrow NaCl + H_2O$

Chemists use neutralization to determine the concentrations of unknown acids or bases through the process of titration. They combine a volume of unknown chemical with a measured amount of a known one until the reaction reaches an end point – often determined by a color change. Using the following equation, they can calculate the concentration of the unknown solution:

Equation 2: $\boxed{\#H^+ \cdot M_A \cdot V_A = \#OH^- \cdot M_B \cdot V_B}$

#H⁺ = Dissociable hydrogen ions from acid's formula
M_A = Acid's molarity
V_A = Acid's volume
#OH⁻ = Dissociable hydroxide ions from base's formula
M_B = Base's molarity
V_B = Base's volume



Bromothymol Blue

The indicator we will use is bromothymol blue, which turns from blue to green to yellow, as the pH of the solution goes from 8 to 7 to 6.

Equipment:

Buret
100 mL Reaction Beaker
Stirring Rod
100 mL Graduated Cylinder
Bromothymol Blue Indicator Solution
Titrant – 0.250 M HCl Solution
Mystery NaOH Solution

Procedure:

1. Using the graduated cylinder, measure 50.0 mL of unknown molarity NaOH into your 100 mL reaction beaker.
2. Add ten drops of bromothymol blue indicator to the NaOH beaker and stir it. Make note of the color in the questions section, put the beaker on white paper to see color more easily.

3. Lower the already-filled buret below the rim of the beaker, then slowly add small aliquots (measured amounts) of the acid while stirring the solution with the glass rod.
4. When you get close to the endpoint, the reaction beaker's color will begin to change. Record this change in your questions section. Stop adding HCl when it just turns green.
5. Determine how many mL of acid you used total, and compute the molar concentration of your NaOH solution using Equations 1 and 2.
6. Clean up your area – pour the contents of your reaction beaker down the drain. Save unused acid in your buret, and leave it at your station.

Data Table (6 Points): Record values to 1/10 mL, and include units!

Volume Chart	
NaOH Volume	
Beginning HCl Volume	
Ending HCl Volume	
Total Volume HCl	
Acid Concentration	

Questions/Calculations: Write in complete sentences.

1. (2 Points) Describe in complete sentences what happened to the reaction solution as you kept adding aliquots of acid, and finally as you got to the end point.

2. (3 Points) Use Equations 1 and 2 to calculate the concentration of your unknown solution of NaOH. Show ALL your group's computations for full credit.

Points Possible:	10
Late/Inc. Fee: -1 -2 - 3	
Final Score:	/ 10

Unit 12 Review – Solutions, Acids, and Bases

This serves as test preparation for the Unit 9 Test. Points earned are based on completion, and we will go over any questions you have during the review.

1. What happens to a thixotropic mixture when it is agitated?
2. Give an example of a suspension.
3. Give an example of a heterogeneous mixture.
4. What is the molar concentration if 0.5 moles KCl are dissolved and made into 2.0 L?
5. How many liters of 2.0 M solution could you make with 12 moles of solute?
6. What is the volume percent of 30 mL alcohol in 140 mL total?
7. What is the percent by mass of a mixture of 15 grams sodium chloride in 140 grams of water?
8. How many grams NaCl would have to be dissolved to make 1.0 L of 0.5 M concentration?
9. Which is more concentrated, a 5.0 M solution of NaCl or a 6.0 M solution of LiCl?
10. List two immiscible liquids.
11. List three ways of speeding solvation.
12. How many mL of a 6.0 M stock solution are needed to make 150 mL of 0.6 M dilute solution?
13. What is the concentration of 100 mL of a dilute solution made from 13 mL of a 4.0 M solution?

14. What do Arrhenius acids contain?

15. What is the pH of a 0.023 M H_2SO_4 solution?

16. What is the pH range of acids?

17. What is the pH and pOH of a 0.053 M HCl solution?

18. How many ionizable hydrogen are there on vinegar?

19. Why is ammonia, NH_3 not an Arrhenius base?

20. What makes an acid strong?

21. Will K_2SO_4 be an acidic, basic, or neutral salt?

22. What is the pOH of a solution with pH of 9.2?

23. How many hydronium ions could carbonic acid produce?

24. What is the pH of a solution with pOH of 2.2?

25. What is the concentration of a HCl solution with pH of 3.2?

26. Will Na_2CO_3 be an acidic, basic, or neutral salt?

27. What can be used to tell when the end point of a titration is reached?

28. What are two products of a neutralization reaction?

29. What kind of salt will a strong base and weak acid make?

30. Write and balance the reaction of HCl and $Ba(OH)_2$.

31. 25 mL of 0.25 M H_2SO_4 neutralizes 50 mL of NaOH. What is the concentration of NaOH?

32. What are the names and formulas of the parent acid and base of lithium chloride?

33. Write and balance the reaction of H_2SO_4 and $Ba(OH)_2$.

34. 15 mL of 1.2 M HCl neutralizes 50 mL of NaOH. What is the concentration of NaOH?