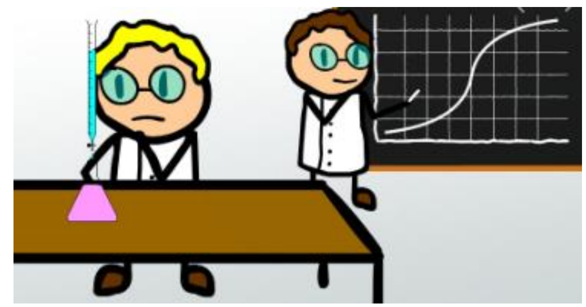
St. Louis Public Schools
Continuous Learning for Students
High School Chemistry

Welcome to Virtual Learning for Chemistry STUDENTS!

Students are encouraged to maintain contact with their home school and classroom teacher(s). If you have not already done so, please visit your child's school website to access individual teacher web pages for specific learning/assignment information. If you cannot reach your teacher and have elected to use these resources, please be mindful that some learning activities may require students to reply online, while others may require students to respond using paper and pencil. In the event online access is not available and the teacher cannot be reached, responses should be recorded on paper and completed work should be dropped off at your child's school. Please contact your child's school for the dates and times to drop off your child's work.
If you need additional resources to support virtual learning, please visit: https://www.slps.org/extendedresources

Overview of Weeks 6 and 7: In week 6, students will continue to learn about stoichiometry and practice stoichiometry problems. In week 7, students will learn key concepts and practices in solution chemistry, particularly acid-based reactions. Students can write their answers in the print packet or type it in the editable pdf files or word documents hyperlinked in this learning plan. **Please keep in mind that daily breakdown of tasks is only a suggestion of pacing and resources.**



To access **all instructional fillable pdf files, also available in print, for Weeks 6-7 go HERE**.

For additional information on Continuous Learning go to https://www.slps.org/keeponlearning

For questions related to this instructional plan, please contact:

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WEEK 6	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material? What needs to be turned in?*
Monday **April 27**	1. Use a model to explain the quantities of substances involved in chemical reactions.	• Complete the S'Mores Lab using s'mores as a model for chemical compounds • Use the video as a resource for direct instruction and visual modeling	Write or type the answers to all parts of S'mores worksheet
Tuesday **April 28**	2. Use models to calculate theoretical and percent yield of a chemical reaction.	• Read step-by-step procedure for % yield calculations (Periodic Table) • Complete Practice problems in this editable pdf or word doc • Use video for support during practice problems	Write or type the answers to practice problems using steps from the reading
Wednesday **April 29**	3. Use models to complete stoichiometric calculations.	• Complete Practice problems in this editable pdf or word doc to review concepts from previous lessons • Use the Stoichiometry video for support and guidance	Write or type the answer to all problems of the worksheet
Thursday **April 30**	4. Construct an explanation that describes acids and bases using patterns in data and textual evidence.	• Follow instructions and complete all parts of the Lab sheet in this editable pdf or word doc • Watch the video to review/support learning	Write or type the answer to all questions and complete all tasks of the worksheet
Friday **May 1**	5. Use chemical symbols to describe the chemical reactions that form and neutralize acids and bases.	• Read Neutralization and Acid-Base Theories, follow steps in examples, and answer practice problems with neutralization reactions in this editable pdf or word doc • Use the instructional video on Acid-Base Theories for support	Write or type the answer to all questions and complete all parts of the worksheet.

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WEEK 7	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material?*
Monday **May 4**	6. To identify strong acids and bases using data and the pH scale.	• Read the lab to analyze data and make predictions. • Complete the lab sheet in this editable pdf or word doc. • Watch the video to review/ reinforce to content	Write or type the answer to all questions and complete all tasks on the worksheet.
Tuesday **May 5**	7. To use models/ and data from an investigation to explain solutions/ concentration.	• Read the lab to analyze data and make predictions. • Complete the lab sheet in this editable pdf or word doc. • Watch the video to review/ reinforce to content	Write or type the answer to all questions and complete all tasks on the worksheet.
Wednesday **May 6**	8. Use mathematical thinking to describe the molarity of substances using proportions.	• Read the lab to analyze data and make predictions. • Complete the lab sheet in this editable pdf or word doc. • Watch the video to review/ reinforce to content	Write or type the answer to all questions and complete all tasks on the worksheet.
Thursday **May 7**	9. Use proportional thinking to analyze the results of a titration experiment to determine the molarity of an acid solution.	• Read to understand the purpose and concept of titration. • Analyze results of the lab using calculations and record answers in this editable pdf or word doc. • Watch videos on Setting a Titration and Titration Calculations to review/reinforce content	Write or type the answer to all questions and complete all tasks on the worksheet.
Friday **May 8**	10. Use models to explain how pH is maintained in human body systems.	• Model analysis and interpretation in the reading • Record answers to analysis questions in this editable pdf or word doc.	Write or type the answer to all questions and complete all tasks on the worksheet.

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PERIODIC TABLE OF ELEMENTS

Atomic #
Symbol
Name
Weight

- C Solid
- Hg Liquid
- H Gas
- Rf Unknown

Metals: Alkali metals; Alkaline earth metals; Lanthanoids (Lanthanides); Actinoids (Actinides); Transition metals; Post-transition metals
Metalloids
Nonmetals: Other nonmetals; Noble gases

Pnictogens | Chalcogens | Halogens

K L M N O P Q

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.008																	2 He Helium 4.0026
2	3 Li Lithium 6.94	4 Be Beryllium 9.0122											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3	11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminium 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
4	19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
5	37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
6	55 Cs Caesium 132.91	56 Ba Barium 137.33	57–71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89–103	104 Rf Rutherfordium (267)	105 Db Dubnium (268)	106 Sg Seaborgium (269)	107 Bh Bohrium (270)	108 Hs Hassium (277)	109 Mt Meitnerium (278)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (286)	114 Fl Flerovium (289)	115 Mc Moscovium (290)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

6	57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97
7	89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (266)

Name: **Date:**
Lab Partner(s):

Lab # 22: Introduction to Reaction Stoichiometry

Chemistry 1

Introduction

Exactly what happens during a chemical reaction? For example, when an Alka-Seltzer tablet is dropped into a glass of water, there's a lot of fizzing and some solid sinks to the bottom of the glass, but there is less solid remaining than before. Was this a chemical reaction? How do you know? Where did the rest of the solid go? When you strike a match, a flame appears to consume the match. Where did the match go? We could ask the same question about the gasoline in a car's gas tank. After a long trip, you will need to fill your tank again. Where did the gas go?

In this unit we will discuss how matter is conserved. The atoms that you begin with at the start of a chemical reaction still exist at the end of the chemical process; the atoms are just connected in a different way to form new compounds. We will also discuss the stoichiometry of chemical processes. "Stoichiometry" comes from the ancient Greek words for "element" and "to measure." Stoichiometry is used to calculate the mass and quantity relationships among reactants and products in a balanced chemical reaction. Because matter is conserved, all chemical reactions must be balanced. The balanced chemical equation can convey the molar relationships between the reactants and the products.

A S'more generally consists of a marshmallow, two graham cracker halves (half on top, half on bottom. Each half is considered 1 piece), and three pieces of chocolate from a standard Hershey chocolate bar. Examine the pictures below. Write potential chemical formulas for the "reactants" – marshallow, graham cracker and chocolate; as well as the "S'more" product.



Marshmallow _______ **Graham Cracker** ______ **Chocolate** _______

halves

Together, these make a **S'more**! __________

Questions:

1. Write a balanced equation using the information given above:

$\rightarrow$

2. What do the **subscripts** represent?

3. What do the **coefficients** represent?

4. What is the ratio of graham crackers to marshmallows? _______________

5. What is the ratio of graham crackers to chocolate? __________________

6. What is the ratio of marshmallows to chocolate? ___________________

You are given a bag of 6 pieces of chocolates, 6 Graham Cracker halves, and 1 Marshmallow.

7. Imagine you are emptying the bag and trying to make as many S'mores as you can. Based on the equation above, how many S'mores can be made? Explain.

8. It's easy to determine the number of S'mores you can make because you can see the number of pieces that are supplied to you. One of the foods ***limited*** the number of S'mores you could make. It is called the ***limiting reactant***. Which food is the limiting reactant? Why?

9. Suppose you now have 10 M (that is, 10 marshmallows), 34 Gc_2, and 72 C_3. How many S'mores can you make? What foods are left over and in what quantity? *Show all work.*

Now you will determine the "molar mass" of the food pieces so that you will be able to convert from grams-to-moles, just as when you do real Stoichiometry calculations. These values are supplied in the table below. *Remember, each piece represents 1 mole of that food.*

Substance	**Molar Mass** (mass of 1 piece or 1 mole)
Mass of 1 piece of Chocolate (C_3)	3.69 g/piece
Mass of a Marshmallow (M)	7.34 g/piece
Mass of a Graham cracker (Gc_2)	7.75 g/piece
Mass of a S'more	______________g

10. If you have 30 grams of C_3, approximately how many pieces do you have?

11. If you have 4 pieces of M, how many grams of M do you have?

12. If you have 33.21 grams of C_3, how many pieces of M and Gc_2 will be necessary to make the maximum number of S'mores possible? How many S'mores can be made?

13. Suppose you have 44.28 g C_3, 58.72 g M and 31.00 g Gc_2. When you make S'mores based upon these values, one of the foods will ***limit*** the number of S'mores you could make. It is called the ***limiting reactant***. Do stoichiometry calculations that will show which food is the limiting reactant.

14. From the previous problem, what foods are left over and in what quantity?

Scientist Name: ________________________________

Percent, Actual, and Theoretical Yield

1) $LiOH + KCl \rightarrow LiCl + KOH$

a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

b) I actually produced 6 grams of lithium chloride. What is my percent yield?

2) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

a) If I start with 5 grams of C_3H_8, what is my theoretical yield of water?

b) I got a percent yield of 75% How many grams of water did I make?

3) $Be + 2\ HCl \rightarrow BeCl_2 + H_2$

My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

4) $2\ NaCl + CaO \rightarrow CaCl_2 + Na_2O$

What is my theoretical yield of sodium oxide if I start with 20 grams of calcium oxide?

5) $FeBr_2 + 2\ KCl \rightarrow FeCl_2 + 2\ KBr$

a) What is my theoretical yield of iron (II) chloride if I start with 34 grams of iron (II) bromide?

b) What is my percent yield of iron (II) chloride if my actual yield is 4 grams?

6) $TiS + H_2O \rightarrow H_2S + TiO$

What is my percent yield of titanium (II) oxide if I start with 20 grams of titanium (II) sulfide and my actual yield of titanium (II) oxide is 22 grams?

7) $U + 3\ Br_2 \rightarrow UBr_6$

What is my actual yield of uranium hexabromide if I start with 100 grams of uranium and get a percent yield of 83% ?

Scientist Name: ________________________________

Stoichiometry Practice

1. Balance the equation for the reaction given below:

$$CuCl_2 + \quad NaNO_3 \rightarrow \quad Cu(NO_3)_2 + \quad NaCl$$

   a) If 15 grams of copper (II) chloride react with 20. grams of sodium nitrate, how much sodium chloride can be formed?

b) What is the name of the limiting reagent? ___________________

c) How much of the excess reagent is left over in this reaction?

d) If 11.3 grams of sodium chloride are formed in the reaction, what is the percent yield of this reaction?

2. Write the equation for the reaction of iron (III) phosphate with sodium sulfate to make iron (III) sulfate and sodium phosphate.

a) If you perform this reaction with 25 grams of iron (III) phosphate and an excess of sodium sulfate, how many grams of iron (III) sulfate can you make?

b) If 18.5 grams of iron (III) sulfate are actually made when you do this reaction, what is your percent yield?

c) Is the answer from problem b) reasonable? Explain.

d) If you do this reaction with 15 grams of sodium sulfate and get a 65.0% yield, how many grams of sodium phosphate will you make?

Introduction to Acids and Bases

Scientist Name: _______________________

Introduction to Acids

1. Answer the BEFORE THE VIDEO question in the box below.
2. View the video “Cheeseburger in Hydrochloric Acid”

   http://www.youtube.com/watch?v=NddZ5ftQb0Q
3. Answer the AFTER THE VIDEO questions the boxes below.

BEFORE THE VIDEO
What do you know about acids?

DISCUSS →

AFTER THE VIDEO	
What do you know about acids?	Explain what part of the video made you think this.

4. Based on what you saw in the video, why do you think we need acids in our stomachs?

Activity: Which are Acids?
Acids are not only in our stomachs, they also are present in our houses and in our classrooms. Brainstorm what common items you may use every day that could be acids. Explain why you think that.

I think that ____ ____ ____may be acids because ________ ____ ____ ____

BLUE LITMUS paper TURNS RED WHEN

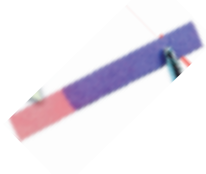
IT IS IN AN A<u>CIDIC</u> ENVIRONMENT.

Therefore, if the liquids you're testing are acids, the **BLUE** litmus will turn **RED**.
If the liquids are not acids, the **BLUE** litmus WILL NOT change color.

Circle the substances below that you think will turn the blue litmus paper RED:

- Orange juice
- Tap water
- Bottled water
- Windex
- Coke
- Bleach

Look at the testing results in the chart below. Fill out the last two columns.

Liquid	Litmus Paper Result	Is it an acid?	Was your hypothesis correct?
Orange juice			
Tap water			
Bottled water			
Windex			
Coke			
Bleach			

Reading: Acids and Bases

Most of the liquids that you see have either acidic of basic properties. We know some information about acids, but what is a base? The following readings tell you more information about **acids and bases**. Read each section aloud, one section at a time.

Read SECTION ONE aloud and complete the Venn Diagram below with quotes and information from the reading about acids and bases.

SECTION ONE:

Define **sour**:

Draw an example:

For thousands of years people have known that vinegar, lemon juice, and many other foods taste **sour**. However, it was not until a few hundred years ago that it was discovered why these things taste sour – because they are all acids**.** The term acid, in fact, comes from the Latin term *acere*, which means “sour”.

In the seventeenth century, the Irish writer and amateur chemist Robert Boyle first labeled substances as either acids or bases (bases are also called alkaline) according to the following characteristics:

Define **corrosive**:

Draw an example:

Acids: taste sour, are **corrosive** to metals, turn litmus (a dye extracted from lichens) red, and become less acidic when mixed with bases.

Bases: feel slippery, turn litmus blue, and become less basic when mixed with acids.

Draw a sketch of **dissolve:**

In the 1800s Swedish scientist Svante Arrhenius proposed that water can **dissolve** many compounds by separating them into their individual ions. Arrhenius suggested that acids are compounds that contain hydrogen and can dissolve in water to release hydrogen ions into solution. For example, hydrochloric acid (HCl) dissolves in water as follows:

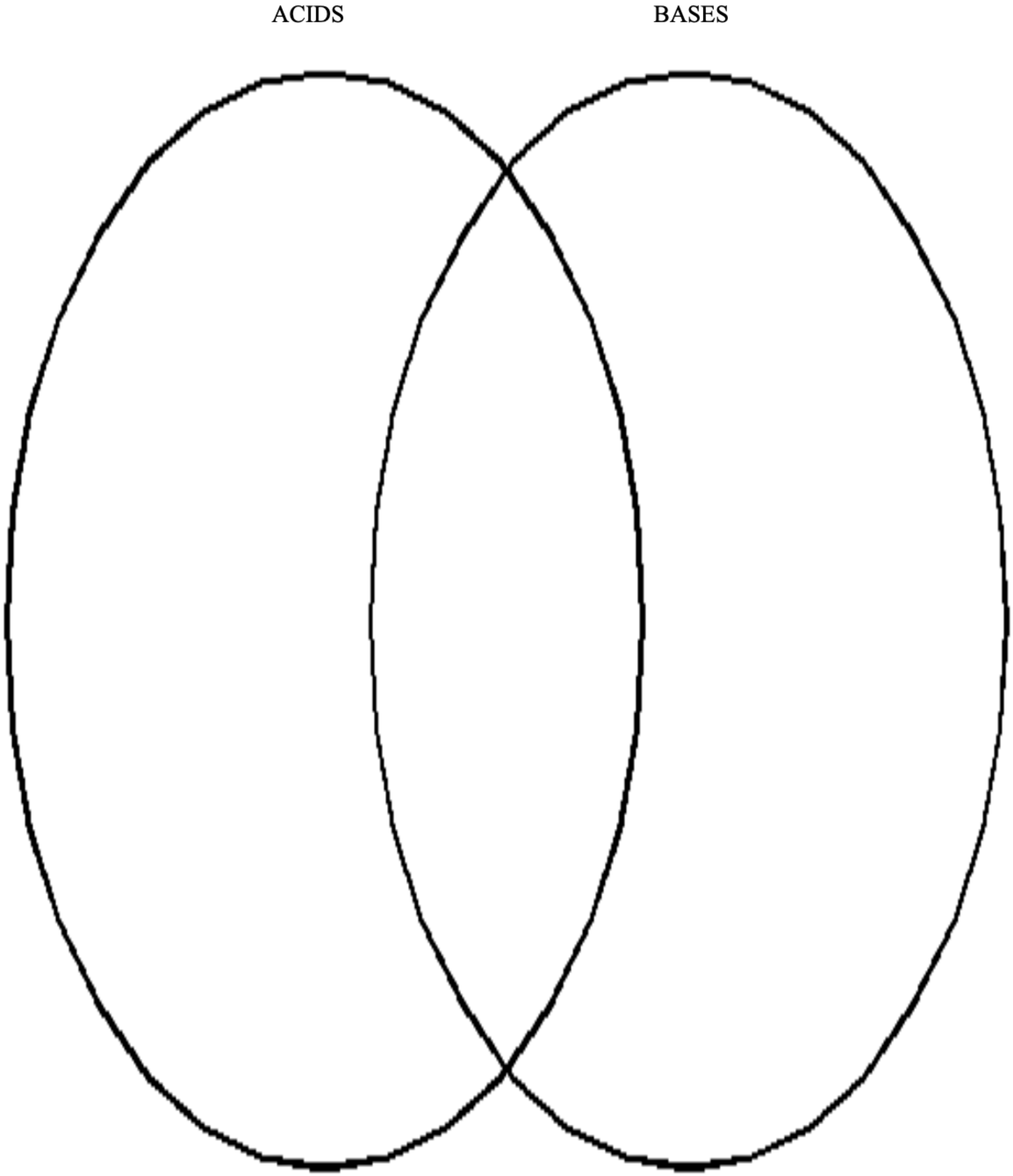
$$HCl \rightarrow H^{+} + Cl^{-}$$

Arrhenius defined bases as substances that dissolve in water to release hydroxide ions (OH-) into solution. For example, a typical base according to the Arrhenius definition is sodium hydroxide (NaOH):

$$NaOH \rightarrow Na^{+} + OH^{-}$$

All acids release H+ ion in solution and all bases release OH- ions in solution.

Complete the Venn Diagram below with quotes and information from SECTION ONE. *If you are completing this digitally, there are text boxes in each section to type into.*



Scientist Name: ___________________________

Neutralization and Theories of Acids & Bases

Read and annotate SECTION TWO, then follow the instructions/model to complete the different stages of what's happening in the neutralization reactions provided. You will be explaining each of the four stages of the neutralization reaction.

SECTION TWO

Neutralization:

As you can see from the equations from the previous lesson, acids release H+ into solution and bases release OH-. If we were to mix an acid and base together, the H+ ion would combine with the OH- ion to make the molecule H_2O.

$$H^+ \quad + \quad OH^- \rightarrow \quad H_2O$$

A neutralization reaction with an acid and a base will always produce water and a salt, as shown below:

Two examples:

	Acid		Base		Water		Salt
First example:	HCl	+	NaOH	→	H_20	+	NaCl
Second example:	HBr	+	KOH	→	H_20	+	KBr

<u>Stage 1:</u> HCl + NaOH	<u>Stage 2:</u> HCl + NaOH ↙ ↘ ↙ ↘ H^+ and Cl^- + Na^+ and OH^-	<u>Stage 3:</u> H^+ and Cl^- + Na^+ and OH^-	<u>Stage 4:</u> H_20 + NaCl
<u>Explanation:</u> *HCl and NaOH are combined together. HCl is an acid and NaOH is a base.*	<u>Explanation:</u> *Since HCl is an acid, it releases H+ ion in solution. Cl- is the other ion that HCl <u>dissociates</u> (or breaks) into.* *Since NaOH is a base, it releases OH- ion in solution. Na+ is the other ion that NaOH <u>dissociates</u> (or breaks) into.*	<u>Explanation:</u> *H+ and OH- combine and Na+ and Cl- combine.*	<u>Explanation:</u> *H+ and OH- form H2O. Na+ and Cl- form NaCl. H20 is water and NaCl is a salt. Therefore, the acid and base combined to form a salt and water.*

Complete the stages for the second example of a neutralization reaction. If you are completing this digitally, there are text boxes for you to type into.

Stage 1:	Stage 2:	Stage 3:	Stage 4:
HBr + KOH	HBr + KOH ↙ ↘ ↙ ↘ and + and	and + and	________________
Explanation: _____ *and* ______ *are combined together.* _____ *is an acid and* _______ *is a base.*	Explanation: *Since* ____ *is an acid, it releases* ____ *in solution.* _____ *is the other ion that* ______ *dissociates (or breaks) into. Since* ______ *is a* *t releases* ____*ion in solution.* ______ *is the other ion that* ________ *dissociates or breaks) into.*	Explanation: ______ *and* _______ *combine and* ______ *and* _______ *combine.*	Explanation: _____ *and* _____*form* _______. ________ *and* ______*form* ________. ______ *is water and* _________ *is salt. Therefore, the acid and base combined to form* _________ *and* _______.

After reading SECTION THREE, write a two sentence summary that explains the difference between Arrhenius' and Bronsted-Lowery's theories of acids and bases.

SECTION THREE:

Though Arrhenius helped explain the fundamentals of acid/base chemistry, unfortunately his theories have limits. For example, the Arrhenius definition does not explain why some substances, such as common baking soda (NaHCO3), can act like a base even though they do not contain OH- ions.

In 1923, the Danish scientist Johannes Bronsted and the Englishman Thomas Lowery published independent yet similar papers that refined Arrhenius' theory. They said that acids release H+ ion in solution and that bases take up H+ ion in solution.

Under the Bronsted-Lowery definition, both acids and bases are related to the concentration of hydrogen ions present. Acids increase the concentration of hydrogen ions, while bases decrease the concentration of hydrogen ions (by accepting them).

Acid		Base				Salt
HCl	+	$NaHCO_3$	→	H_2CO_3	+	$NaCl$

Two sentence explanation of differences in Arrhenius' and Bronsted-Lowery's acid/base theories:

Based on the reading, where did Arrhenius' theory fall short? *If you are completing this digitally, there are text boxes for you to type into.*

Answer		**Quote from reading that let you know this**
	I know this because	

Scientist Name: ___________________________

The pH Scale

Read SECTION FOUR. Think of what this means about the substances that you tested in the beginning activity of this packet. What are the pH values of the substances that we tested in our first activity?

SECTION FOUR:

pH

In 1909 the pH scale was invented. The pH scale measures the concentration of hydrogen ion in the solution. The pH scale ranges from 0 to 14. Substances with a pH between 0 and less than 7 are acids. Substances with a pH greater than 7 and up to 14 are bases. Right in the middle, at pH = 7, are neutral substances, for example, pure water.

Strong acids are measured on the pH scale as having a pH closer to 0. Strong bases are measured on the pH scale as having a pH closer to 14.

ACIDS	BASES

Think back to the substances we testing from Lesson 4 (tap water, bleach, bottled water, orange juice, coke, Windex, bleach). What do you guess was the pH value for each these substances? Explain your choice using evidence from the text above.

Building Vocabulary For each of the words in the table below, draw/insert a picture and write a definition based on readings from this and the previous lessons.

Acid (*noun*)	
Base (*noun*)	
Neutral (*noun*)	
Neutralization Reaction (*noun*)	
pH scale (*noun*)	

Virtual Lab: Classifying Liquids as Acids or Bases

<u>Question:</u> Which is the strongest acid and which is the strongest base from the following items?

Pepsi

Dish soap

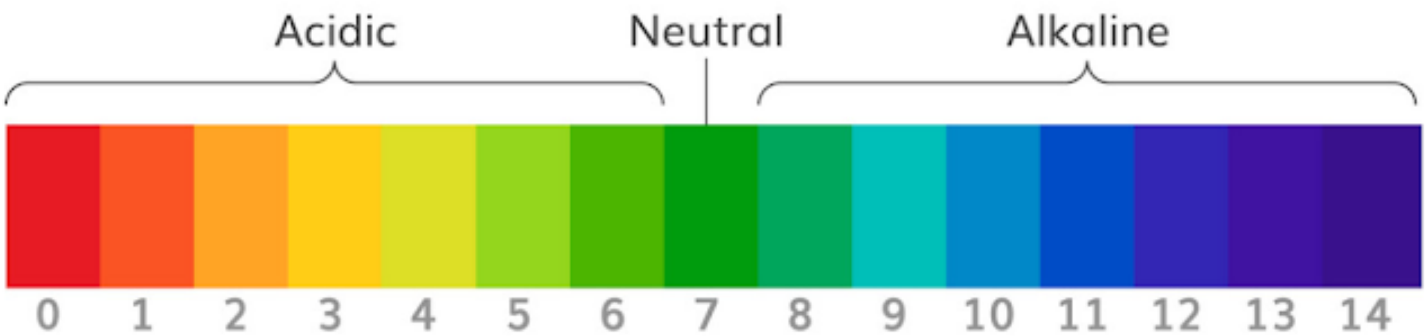
Hand soap

Vinegar

Apple Juice

Orange Juice

Introduction: Various household items that we use and come into contact with everyday are different levels on the pH scale. We use acids and bases every day. As you already know, the pH scale is a way to measure how acidic or alkaline a substance is. In the lab, pH paper tells us the pH of a liquid. All we need to do is hold the pH paper in the liquid for 15 second and it changes color. We use a color code (below) to let us know what pH the liquid is based on the color of the pH paper.



Hypothesis:
Make sure that your hypothesis is written in an "If...then..." format.

For example:

If pH paper is applied to pure water, then the paper will turn green.

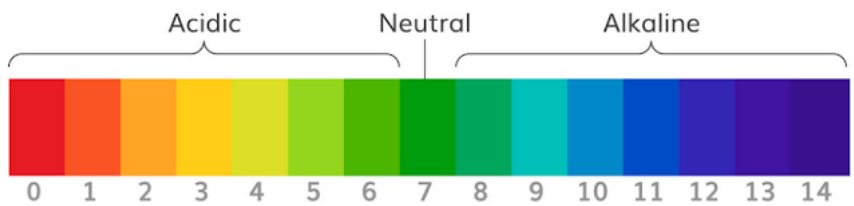
Write two hypotheses: one in which you predict which substance will be the strongest acid, and one in which you predict which will be the strongest base.

Strongest acid hypothesis (remember – "if…then…"!)

Strongest base (most alkaline) hypothesis (remember – "if…then…"!)

Results

Complete the chart on the next page using the color code.



Liquid	pH paper result	pH value (number)
Pepsi		
Dish soap		
Hand soap		
Vinegar		
Apple Juice		
Orange Juice		

<u>Conclusion</u>

Was your hypothesis correct? Explain why or why not.

Create a pH scale below and put the liquids where they belong on the scale *You may type below or add text boxes if you are completing this assignment digitally.*

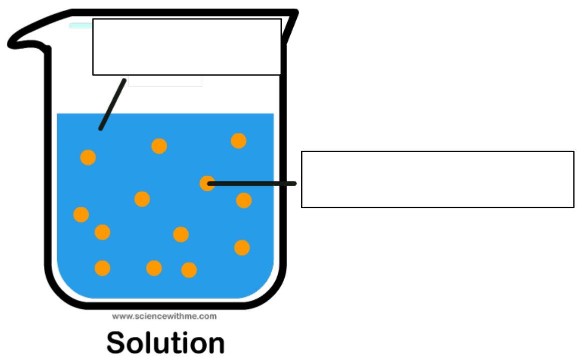
0 7 14

Scientist Name: ______________________________

Solutions and Concentration

Solutions:
Acids and bases are often found in a solution with water. Water is the solvent and the acid or base is the solute. Together, a **solute** and **solvent** make a solution. The **solute** is the substance that is being dissolved and the **solvent** is the liquid that is dissolving the solute.

Use the paragraph above to label the drawing of a solution below with the terms SOLUTE and SOLVENT. *If you are completing this digitally there are text boxes to type into.*



Underline the phrases in the paragraph above that told you the information you need to know about the solute and solvent in solution.

Think:
What **solutions** have you seen at home? Write them below and tell why you think each is a solution. Also tell what you think the solutes and solvents are.

At home, I've seen the following solutions: I believe they are solutions because… I believe that the solvents are….. And that the solutes are….

<u>Understanding Concentration of Solutions</u>

Activity 1

In this activity, you will observe different solutions of **salt water**.

___________ Is the **solute** and _____________ is the **solvent**

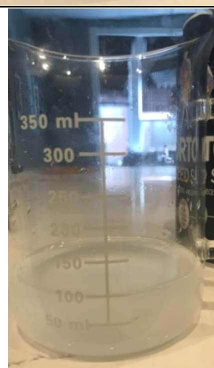
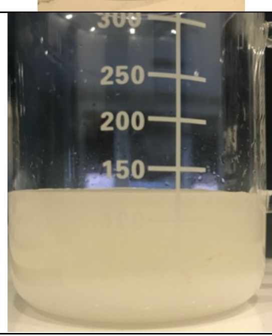
Experiment Question: What will happen to the solution when you double and triple the amount of solute?

In the boxes below, sketch (or describe if typing) what you think the solution will look like after adding the first 10 g of salt, after adding another 10 g of salt, and after adding a third 10 g of salt.

Solution of 100 mL of water and 10 g of salt	**Solution of 100 mL of water and 20 mL of salt**	**Solution of 100 mL of water and 30 mL of salt**
Explanation	**Explanation**	**Explanation**

Observations:

On the chart on the next page, fill out the "qualitative observations" column based on the images for each condition.

Condition	Image	Qualitative Observations (*Describe what you see in the image*)
After 10 g of salt		
After another 10 g of salt (20 g of salt total)		
After another 10 g of salt (30 g of salt total)		

Activity 2

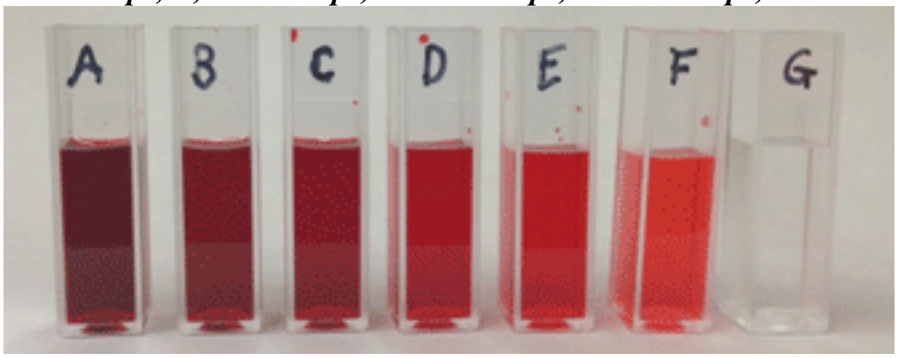
In this activity you will observe how food coloring creates different concentrations of solutions.

__________________ is the **solute** and ______________ is the **solvent**

Think: What do you think will happen as more food coloring is added to the water?

<u>Observations:</u> The below image shows the result of adding a different number of drops of food coloring to the same volume of water:

A has 12 drops, B has 10 drops, C, has 8 drops, D has 6 drops, E has 4 drops, F has 2 drops, G has 0 drops



Describe what you observe in the tubes above, and explain why you think you see these results:

Activities 1& 2 Conclusions

1. Concentration
   a. Define:

   b. Use the word **concentration** to write a sentence explaining what happened in both activities.

2. Which salt solution from activity 1 was the most concentrated? Explain how you know using your qualitative observations.

3. Which of the food coloring solutions was the most **dilute** (least concentrated)? Explain how you know using your qualitative observations.

Scientist Name: ______________________________

Molarity

Concentration of Acids and Bases:
MOLARITY is a measure of concentration used for acids and bases. When scientists talk about concentration of an acid or base, they use the value of MOLARITY.

Molarity tells you the concentration of **solute** in a **solvent**

$$\textbf{Molarity (M)} = \frac{\textbf{moles of solute}}{\textbf{liters of solvent}}$$

Think back to our previous work.
What is a mole? ____

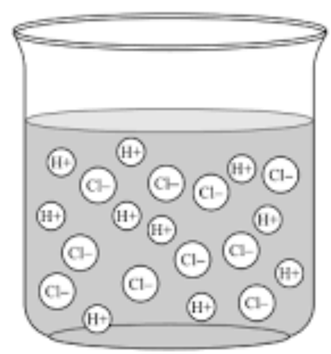
Draw a representation of a mole:

What is a liter? ____

Draw a representation of a liter:

Examples using the value of Molarity:

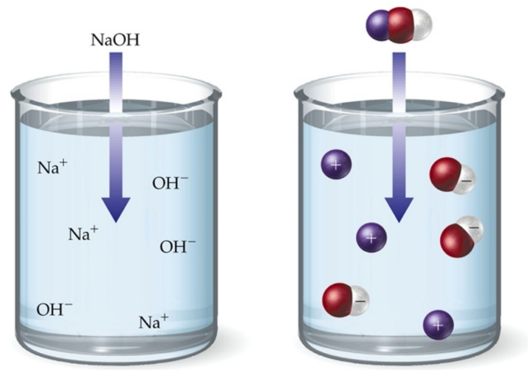
1. There is a solution of HCl (hydrochloric acid)
   a. What is the solute in this example? How do you know that?



   b. What is the solvent in this example? How do you know that?

   c. What is the molarity of the acidic HCl solution if there are 2 moles of HCl and 10 liters of water? (use formula above and show your work)

2. There is a solution of NaOH



   a. What is the solute? How do you know?

   b. What is the solvent? How do you know?

   c. What is the molarity of the basic NaOH solution if there are 4 moles of NaOH dissolved in 25 liters of water? (show your work)

3. What is the molarity of an acidic solution of HF if there are 2 moles of HF dissolved in 50 liters of water? (show your work)

4. How is <u>concentration</u> related to <u>molarity</u>?

Scientist Name: ______________________

Titrations

If you had two salt water solutions and you did not know which one was more concentrated, how could you test it?

If you had an acid or a base solution that you did not know the molarity of, how could you test it? Scientists use a lab procedure called a **TITRATION** to find the molarity of acids and bases that they do not know.

Why may it be important to know the concentration of an acid or a base in a science lab?

Reading: Acid-Base Titrations

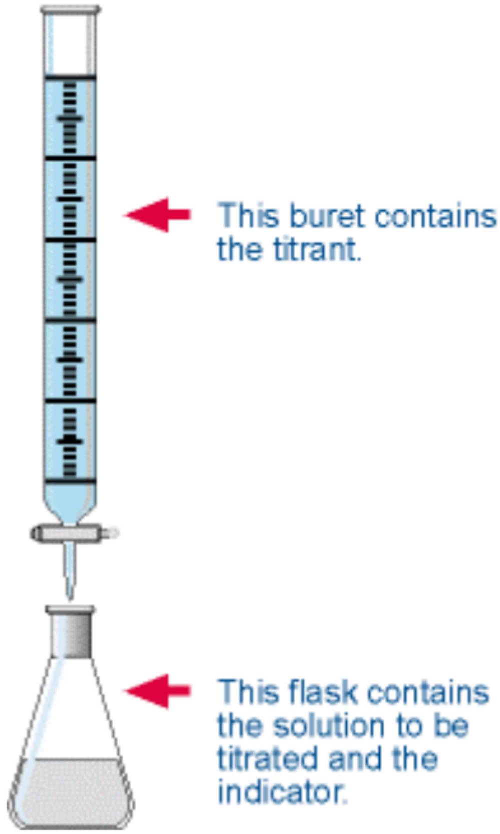
As you read, circle or highlight key words. Only circle the words that you **need** to retell the important information from the reading. You will reconstruct the information from this text after reading it.

Molarities of acidic and basic solutions can be used to convert back and forth between moles of solutes and volumes of their solutions, but how are the molarities of these solutions determined? This section describes a procedure called titration, which can be used to find the molarity of a solution of an acid or a base.

In **titration**, one solution (solution #1) is added to another solution (solution #2) until a chemical reaction between the components in the solutions has run to completion. Solution #1 is called the **titrant**, and we say that it is used to **titrate** solution #2. The completion of reaction is usually shown by a change of color caused by a substance called an **indicator**.

A typical titration proceeds in the following way. A specific volume of the solution to be titrated (solution #2) is poured into an Erlenmeyer flask (see figure below). For example, 25.00 mL of a nitric acid solution of unknown concentration might be added to a 250 mL Erlenmeyer flask.

A solution of a substance that reacts with the solute in solution #2 is added to a buret. (A **buret** is a laboratory instrument used to add measured volumes of solutions to other containers.) This solution in the buret, which has a known concentration, is the titrant. The buret is set up over the Erlenmeyer flask so the titrant can be added in a controlled manner to the solution to be titrated. For example, a 0.115 M NaOH solution might be added to a buret, which is set up over the Erlenmeyer flask containing the nitric acid solution.



Setup for a Typical Titration In a typical titration, the titrant in the buret is added to the solution in the Erlenmeyer flask until the indicator changes color to show that the reaction is complete.

The titrant is slowly added to the solution being titrated until the indicator changes color, showing that the reaction is complete. This stage in the procedure is called the **endpoint**. In our example, the NaOH solution is slowly added from the buret until the mixture in the Erlenmeyer flask changes from colorless to red. The OH- ions in the NaOH solution react with the H_3O^+ ions in the HNO_3 solution.

$$H_3O^+ (aq) \quad + \quad OH^- (aq) \quad \rightarrow \quad 2H_2O(l)$$

Glossary

- ***Titration:*** The addition of one solution (solution #1) to another solution (solution #2) until a chemical reaction between the components in the solutions is complete.
- ***Titrant:*** The solution added in a titration.
- ***Indicator:*** The substance added in a titration to show (by a change of color) when the reaction is complete.
- ***Buret:*** A volume-measuring instrument used to add measured volumes of the titrant in a titration.
- ***Endpoint:*** The stage in a titration where enough of the titrant has been added to react completely with the substance being titrated.

Select twenty of the most important words from the reading that you circled. Reconstruct the meaning of the text above by using only the 20 words that you selected. Draw arrows, symbols, and picture to help explain the information.

Write two of the most important facts that you learned from the article above. Next to each fact, write the quote from the reading that supports the fact. Go back to the reading and underline the quote as well.

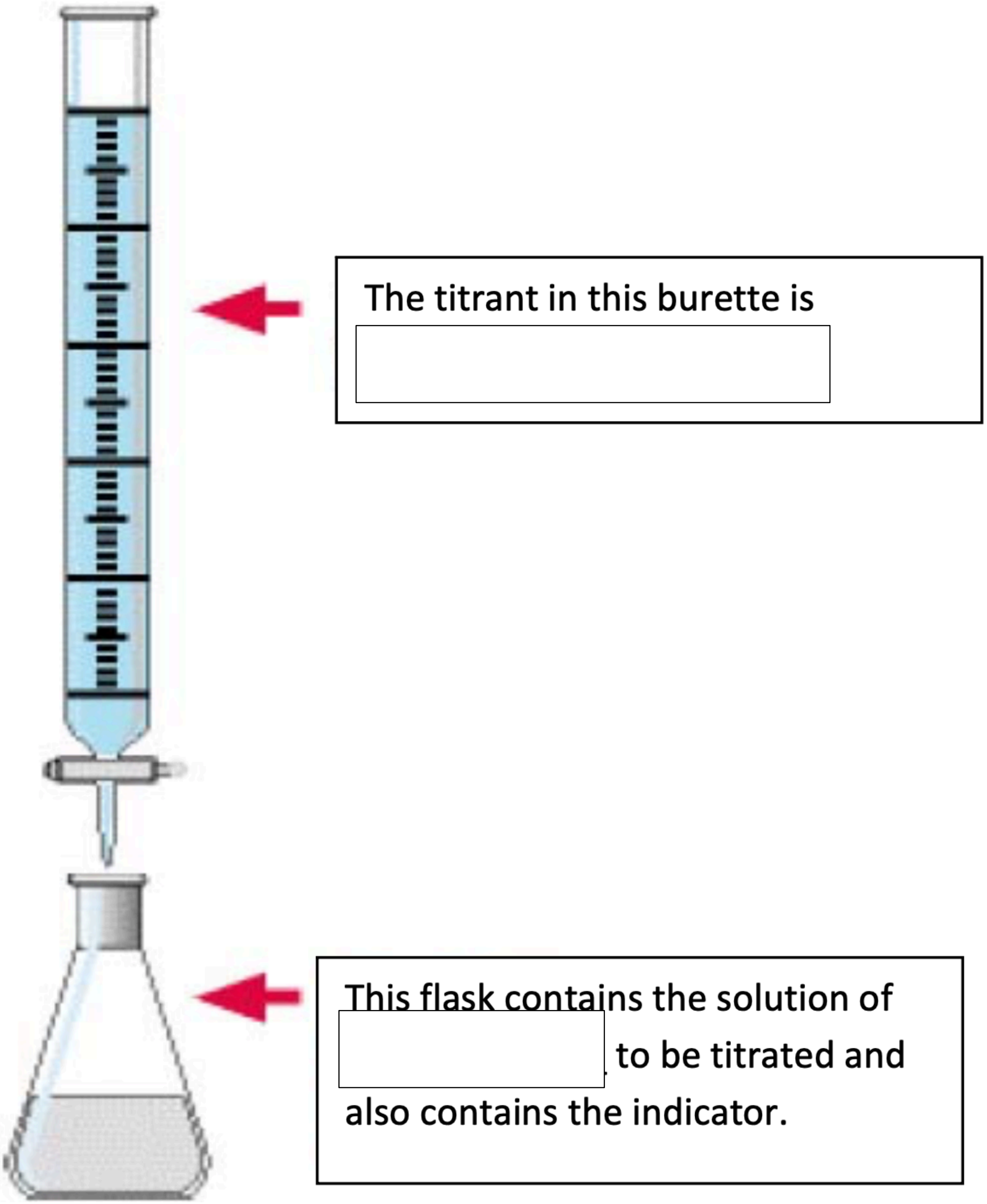
Fact	Quote

Virtual Lab: Acid-Base Titration
In this activity, you will use a TITRATION to find out the molarity of an HCl (hydrochloric acid) solution.

Question for this lab: What is the molarity of the unknown HCl solution?

Introduction:
We will be using NaOH to titrate our HCl solution.

In the diagram below, label where the HCl and NaOH will be. *If you are completing this digitally, there are text boxes for you to type into.*



The indicator that we will use in this lab is phenolphthalein. It will turn pink when the HCl solution in the flask becomes the slightest bit basic. The HCl will become basic because we're adding NaOH slowly from the burette.

Remember that an acid and a base make salt and water when they're added together. That means that the HCl in the flask and the NaOH in the burette make NaCl and H2O when they meet in the flask. As this is happening, the phenolphthalein is still clear in the flask.

However, once you add a drop of base more than the HCl in the flask, the flask becomes basic. Then, the flask turns pink because phenolphthalein turns pink when it's in a basic solution.

Summarize the information from the paragraphs above into two sentences:

You will use the following formula to solve for the Molarity of the unknown HCl solution:

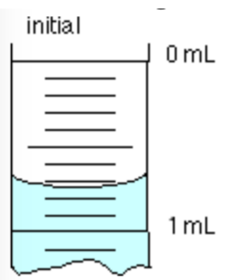
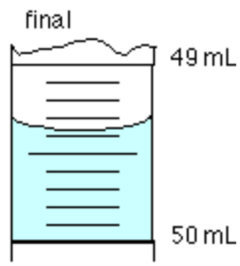
M_A = Unknown Molarity of the acid
V_A = Volume of the acid that was added to the flask
M_B = Known Molarity of the base
V_B = Volume of the base that was added from the burette to the flask

$$M_A \times V_A = M_B \times V_B$$

When solved for the missing quantity it reads:

$$M_A = \frac{M_B \times V_B}{V_A}$$

Data: *Complete the chart below using the images.*

Volume of HCl used	100 mL
Initial NaOH burette reading	 mL
Final NaOH burette reading *(after enough volume was added to turn the HCl solution pink)*	 mL
Volume of NaOH added	*Hint: Final – Initial from above* mL
Molarity of NaOH	0.1 M

Calculations:

Find the Molarity of HCl based on the class average and the formula in your introduction section.

Questions:

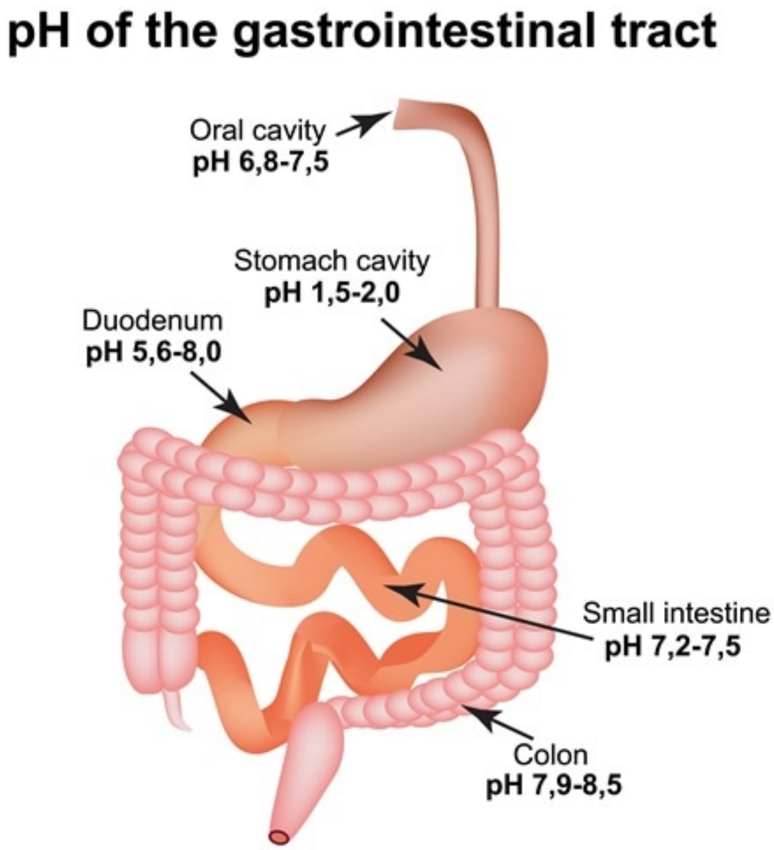
1. What is the **molar mass** of HCl? Explain in words how you know. *(Go back to previous lessons if you need to remind yourself what molar mass is).*

2. How many moles of HCl were in the 20 ml of HCl that we used? Explain in words how you know.

Scientist Name: ______________________________

pH in the Human Body

Fill out the chart below with at least 4 observations/interpretations based on the image.



What I See (low inference observations)	What It Means (What is the meaning of those observations? What can you infer based on the observation?)

Think: What are three things you know or think you know about **heartburn**?

Reading: Heartburn *via Medical News Today https://www.medicalnewstoday.com/articles/9151*

Heartburn is a common problem created by acid reflux, a condition where some of the stomach contents are forced back up into the esophagus. It creates a burning pain in the lower chest.

Persistent acid reflux that happens more than twice a week is called gastroesophageal reflux disease (GERD). Heartburn is felt when stomach acid flows back up into the esophagus, the pipe that carries food from the mouth to the stomach. Heartburn is a symptom of GERD.

According to estimates from the American College of Gastroenterology, at least 15 million Americans experience heartburn every day.

Reading Questions:

1. What does heartburn have to do with pH?
2. What evidence from the text supports your answer to #1?
3. Why would taking an **antacid** tablet be a treatment for this condition?

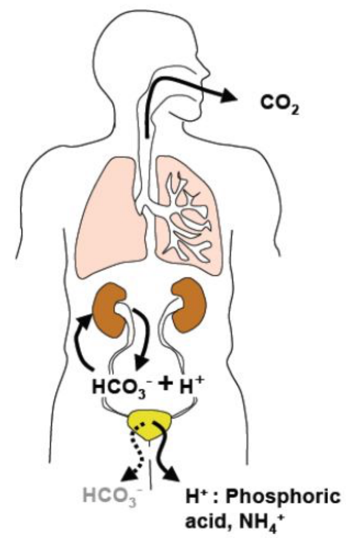
pH in the Body

Think: How do you think the different organs of the body maintain different pH values (as seen in the image on the previous page)?

Reading: Buffers

Proper physiological functioning depends on a very tight balance between the concentrations of acids and bases in the blood and other parts of the body. Acid-balance balance is measured using the pH scale. A variety of buffering systems permits blood and other bodily fluids to maintain a narrow pH range, even in the face of disturbances. A buffer is a chemical system that prevents a radical change in fluid pH by limiting the change in hydrogen ion concentrations in the case of excess acid or base. Most commonly, the substance that absorbs the ions is either a weak acid, which takes up hydroxyl ions (OH^-), or a weak base, which takes up hydrogen ions (H^+).

Buffering Systems in the Body



1. *Based on the above text, what is a* ***buffer****?*

2. *Based on the name, what do you think* ***blood acidosis*** *is?*

3. *What must happen in the blood to prevent blood acidosis? (look at the text above for evidence)*