Classic Science

For the Family

PARENT COPY

ADVANCED CHEMISTRY

The lab of MR.Q

Scott McQuerry

Thank you so much for purchasing
this copy of
Classic Science:
Advanced Chemistry

I never would have imagined the "little project" I began a few years ago would have resulted in four elementary textbooks and this new advanced-level curriculum. Thank you. Thank you. Thank you for your emails, suggestions, criticisms, and stories these past few years. They have kept me going and I know I would not have been able to complete these resources without your help! Thank you so much.

Before we get started, I wanted to let you know that the format of this new advanced series is very similar to the elementary curriculum you may have been using. I have only changed a couple of things due to the nature of the material you child will be studying:

Weekly Timeline

This is a 36-week curriculum for children of ages 12-18. The weekly curriculum has been arranged into <u>two-week units</u> (which is different from the elementary curriculum!) Each week has been broken down into three separate days to make it easier for you to set up a schedule:

The first day of each week contains a reading assignment and a series of practice problems for your child.

The second day is designed for your child to review his/her answers on the practice problems from the first day AND to preview the weekly lab activity which may require some preparation.

The third day is set aside for a kitchen-based lab activity that will reinforce the concepts being taught that week.

Quarterly Tests

Four quarterly tests have been created to further assess your child's understanding of the chapter concepts in addition to the unit quizzes. Your child will need time to prepare for both the pre- and post-test sections in each of these tests:

Quarterly Test 1: Week 9 (Chapters 1-8)
Quarterly Test 2: Week 18 (Chapters 9-16)
Quarterly Test 3: Week 27 (Chapters 17-24)
Quarterly Test 4: Week 36 (Chapters 25-32)

Each testing week has been broken down into three separate days to make it easier for you to set up a schedule as well:

The first day of each testing week should be spent reviewing the weekly practice problems and unit quizzes.

The second day is designed for your child to complete a pre-test which will build upon the mechanics of the various chemistry problems that have been studied.

The third day is set aside for a post-test which contains questions that are intended to guide your child towards a deeper understanding of the mechanics within the pre-test.

A sample timeline can be seen below which contains the Unit Quiz and Quarterly Test schedule:

Calendar Week	Weekly Assignment	Assessment
Week 1	Unit 1: Chapter 1	
Week 2	Unit 1: Chapter 2	Unit Quiz
Week 3	Unit 2: Chapter 3	
Week 4	Unit 2: Chapter 4	Unit Quiz
Week 5	Unit 3: Chapter 5	
Week 6	Unit 3: Chapter 6	Unit Quiz
Week 7	Unit 4: Chapter 7	
Week 8	Unit 4: Chapter 8	Unit Quiz
Week 9		Quarterly Test

Weekly Kitchen Labs

I have included one kitchen-based lab activity each week to reinforce the concepts within the weekly readings. The menu has been chosen with the hope that you will spend some quality time preparing meals with your child. The majority of these labs will require your child to do some preliminary calculations from the recipe before the purchase and preparation of the activity.

The cost of running a traditional chemistry lab is astronomically high as compared to the cost of feeding your family. And, the truth of the matter is this:

The preparation of nearly any meal is rooted in the laws of chemistry!

We need to end our traditional belief that a chemistry lab must contain firey explosions and bubbling fluids in weird-shaped glassware! As noted in several articles by the American Chemical Society, the majority of college professors expect their first-year chemistry students to demonstrate basic problem-solving techniques involving measurements, conversions, construction of chemical formulas, and the general understanding of the most fundamental definitions in the field of chemistry. And you have nothing to fear about this, because...

…these are the concepts your child will master by the end of this year!

I built this curriculum to prepare your child for a basic understanding of what a college-level class will expect of them. The labs will help them see the weekly concepts in action, every day, and under their personal control. I know this will help them in their future studies!

Gasp! "There's a lot of math in this book!"

Don't let the name "Advanced" fool you into believing you need a Master's degree in mathematics in order to solve these problems! The majority of the problems in this book use basic math skills that can be easily mastered by any child with experience with pre-algebra.

I recommend that you purchase a simple calculator to help with the calculations. You don't need anything fancy! A basic scientific calculator with an exponent key (EXP) and a log key (LOG) is all you need. At the time of this writing, I found a good-quality calculator with these functions at a local store for $5.

Future books and projects

I am in the process of constructing the second book in the advanced series. Advanced Botany and Anatomy/Physiology is set to be released in the Fall of 2012. This resource will include two (2) 16-week courses on both of these topics. Think of them as "semester courses."

In addition to the ongoing Advanced series, I hope to launch an online learning environment to supplement both the Elementary and Advanced books within the next year. It is my hope to provide this resource to families such as yours to collaborate with each other around the world on the weekly labs and activities within the Classic Science series. Not only will this serve as a collaboration tool, I also hope to provide monthly research-based problems for your family to solve as well.

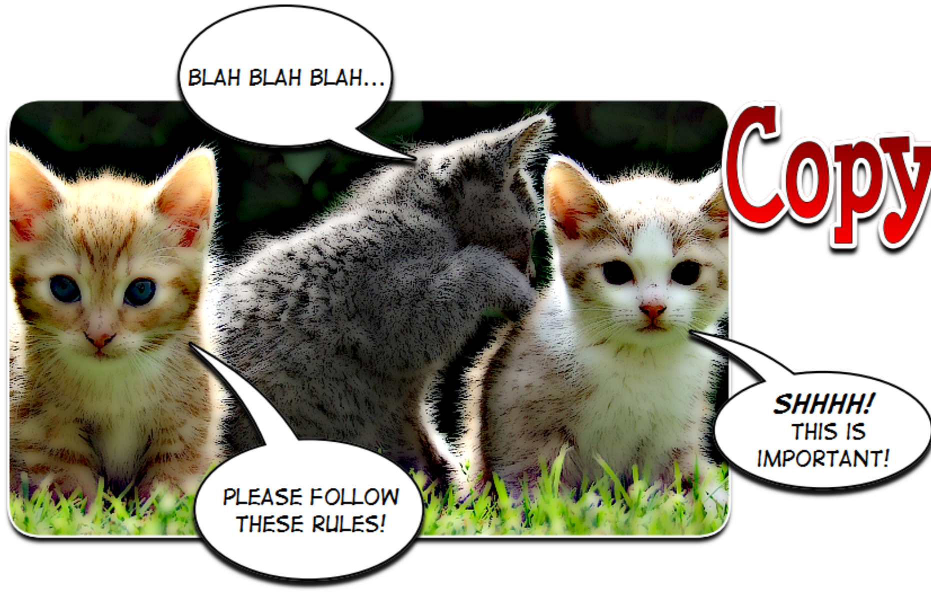
The best way to keep up-to-date on these developments is to sign up for my monthly LabNotes on my website (www.eequalsmcq.com). I'm certain you'll love the free activities I provide each month you can do with your family!

As I've said before, I am honored that you have chosen this curriculum but I am eternally grateful for your time, patience and willingness to educate your child in the sciences. I can only hope that your children will attain the passion I have for this field. Thank you for all you are doing to help shape tomorrow!

Above all else….Keep asking questions and keep searching for the answers! And if you get stuck, I'm only a click away mrq@eequalsmcq.com

Take care,

Scott McQuerry



Copyright Stuff

First of all thank you very much for choosing to use this book with your family. You will not be disappointed! I have been asked by several families the same question, "**Who** are you and **why** are you doing this?" Without going into great detail, E=McQ is owned, operated and stressed over by me. Yep… little o' me. I am an educator by profession and began working with homeschool families several years ago while offering free programs to area families to explore various concepts in science. I guess I can't stop doing what I love!

This product is the fruit of my 13-year labor in science education. Having worked with homeschool families over these years I have gained an appreciation for your needs, struggles and wants. I could not make this curriculum any simpler for your child to master the concepts of science. It is completely reusable, relatively cheap (I tried to keep it under the cost of a tank of gas), adaptable to various needs at home and as fun as humanly possible.

Like I said, I am an "army of one". I have no problem with you using this one copy for your entire family. However, if you give or loan this book out to another family you are putting a lot of pressure on me. If this happens too often, I may not be able to continue producing this curriculum. I am not telling you to keep this curriculum a secret, but I have provided some options for you should another family wish to use this curriculum:

- If your friends are asking to borrow your copy to use throughout the year, please ask them to read this copyright page and go to my website: www.eequalsmcq.com so that they may purchase their own book!

- If you are reselling this curriculum please be aware that its value will diminish if many people are selling it for a lower amount of money. This, too, puts pressure on little o' me. If this is the path you choose, I hope you (or the buyer) will consider providing a small contribution to support my continued work. I know it is impossible to regulate this, but I am certain you will do the right thing!

- If you are part of a CO-OP or other similar group of homeschool families, you may purchase licensing/copying rights for use in your classrooms at a reduced rate. Please contact me at mrq@eequalsmcq.com for details.

Table of Contents

Author: Scott McQuerry

The Complete Menu

Chapter 1: Mr.Q's favorite cookie (thanks Mom!)

Ingredients:

1 box Duncan Hines Yellow Cake Mix with butter
1 package of cream cheese
1 stick of butter
1 egg
2 tsp. vanilla
Powdered sugar (for topping on the finished cookies)
Plastic wrap
Baking sheet
Knife
Ruler

Chapter 2: Chocolate cake....

Ingredients:

1 cup white sugar
1 1/8 cups all-purpose flour
1/2 cup unsweetened cocoa powder
1 teaspoon baking soda
1 teaspoon salt
1/2 cup butter
1 egg
1 teaspoon vanilla extract
1 cup cold, strong, brewed coffee
1 toothpick

Chapter 3: Marinara sauce

Ingredients:

1 can (28 oz. size) pureed Italian plum tomatoes
2 teaspoons extra virgin olive oil
4 medium garlic cloves, minced
1 can (6 ounce size) tomato paste
1 1/4 teaspoon oregano
1/4 teaspoon salt
1/4 teaspoon black pepper
1/3 cup fresh parsley, chopped
Saucepan
Spoon

Chapter 4: Pizza + Quesadillas = Pizza-dillas

Ingredients:

4 whole-wheat tortillas
2/3 cup fresh or frozen spinach, finely chopped
2/3 cup part-skim mozzarella cheese, shredded
1 cup marinara sauce (from last week's lab)
Cooking spray

Chapter 5: M&M Lab

Ingredients:

One small bag each of plain and peanut M&M's
Electric scale (optional)

Chapter 6: Homemade bread

Ingredients:

2 tsp yeast
1 tsp sugar
Water
½ cup whole grain cereal
1 cup wheat flour
3 cups white flour
4 Tbs butter
(cut into ¼ inch cubes)

2 tsp salt
Olive oil
Balsamic vinegar
Various herbs
Cornmeal
Unglazed terra-cotta dish
(the orange-colored material most flowerpots are made out of)

Chapter 7: Nachos

Ingredients:

Block of American cheese (Velveeta) or a Hershey's chocolate bar
Cheese slicer or knife
Microwave oven
Plate
Calculator

Chapter 8: Pizza

Ingredients:

One pizza dough (from the recipe in Chapter 6) or an English muffin
½ cup marinara sauce (from the recipe in Chapter 8) or canned
½ - 1 cup shredded mozzarella cheese
Olive oil
Flour
Rolling pin (optional)

Chapter 9: Organizing the cupboard....

Materials:

Paper and pencils
Something healthy to snack on

Chapter 10: Pancakes

Ingredients:

Bread flour (~3 cups)
Baking powder
Sugar
Salt
Baking soda
Cinnamon, nutmeg, vanilla (optional)
2 eggs
~3 cups whole milk
4 Tbs. vegetable oil or melted butter
Ruler

Chapter 11: Homemade Powerdrink

Ingredients:

1 liter of water
1/2 tsp of baking soda
2 tbsp of agave nectar
1/2 tbsp of sea salt
1 light emitting diode (LED) (Model: 276-021)
1K Ohm resistor (Model: 271-1321)
1 9 V-battery
1 battery connector (Model: 270-325)
1 piece of fibre board or plywood (approximately 4"x6")
1 rubber band
12 inches of copper wire
Tape

*** All items can be purchased cheaply from RadioShack

Chapter 12: Cooking with salt and sugar

Ingredients:

Pinch of salt
Pinch of sugar
Candle
Matches
Aluminum foil (approximately 5" x 10")
Several plates/dishes

Chapter 13: An analysis of food labels

Ingredients:

No special ingredients needed this week

Chapter 14: Carmelizing onions

Ingredients:

Yellow onion
Vegetable or olive oil
Pan
Wooden spoon
Glass of water

Chapter 15: Chocolate Chip Cookies

Ingredients:

You really don't need to make these cookies to complete the activity: but, they are quite tasty!

2 ¼ cup flour
1 tsp baking soda
½ tsp salt
1 cup butter (at room temp)
¾ cup sugar
¾ cup packed brown sugar
2 eggs
2 tsp vanilla
12 oz. Chocolate Chips

Chapter 16: Mixed nuts..

Ingredients:

Two different sized bags of mixed nuts
(If nut allergies exist, you may use various candies like M&M's or Skittles)

Chapter 17: Homemade cupcakes

Ingredients:

2 cups flour
1 ½ cups sugar
3 teaspoons baking powder
1 cup shortening
1/2 teaspoon salt
1 cup milk
1 teaspoon vanilla
3 eggs
Muffin tins
Muffin papers
Whisk (or mixer)
Mixing bowls
Frosting (optional)

Chapter 18: Fruit salad

Ingredients:

5 ripe bananas
5 unripe bananas
5 ripe pears or apples (FYI - You can easily tell when pears are ripe!)
5 unripe pears or apples (The pears will be very firm.)
8 sealable gallon-sized plastic bags

Chapter 19: S'mores

Ingredients:

One bag of large marshmallows (optional)
One Hershey's chocolate candy bar (optional)
One small box of graham crackers (optional)

Chapter 20: Garden salads

Ingredients:

Various fruits and/or vegetables for a homemade salad (you choose!)

Chapter 21: Spinach chromatography

Ingredients:

Fresh spinach leaves (one small bag)
3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

Chapter 22: Sweetened vs Unsweetened tea

Ingredients:

Several tea bags of your favorite tea
One gallon pitcher
6 large cups (~2.5 cups each)
Several small cups for tasting the tea
Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

Chapter 23: Boiling salt water

Ingredients:

Table Salt
Distilled Water
2+ Quart Cooking Pot
Measuring spoons and cups
Thermometer
Stirring spoon
Oven mitt or tongs

Chapter 24: Homemade "pickles" in a day

Ingredients:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)
Zip-Lock freezer bag, quart size
Measuring spoons and cups

Chapter 25: Popcorn

Ingredients:

Popping corn
Vegetable oil, corn oil, or peanut oil
Sealable plastic bags or jars
Skillet or pan with lid
Measuring spoons
Marker
Cookie sheet
Timer

Chapter 26: Homemade ginger ale

Ingredients:

Cold water
1 cup sugar
4-6 tsp freshly grated ginger root
Juice of one lemon
$\frac{1}{4}$ tsp fresh granular baker's yeast
Clean 2 liter plastic soft drink bottle with cap (NOT GLASS!)
Funnel
Grater (preferably with fine "cutting" teeth)
Measuring cup and spoons
Fine mesh strainer or cheese cloth

Chapter 27: Peanuts or corn chips

Ingredients:

Peanuts or corn chips
2 empty aluminum cans
Utility knife or X-Acto knife
10 mL of water (7 drops = 1mL)
Eyedropper
One large paper clip
Matches
Thermometer
Aluminum pie pan or old cookie sheet

Chapter 28: Ice cream

Ingredients:

1 Tbs sugar
½ cup whole milk
½ cup half & half
¼ tsp vanilla
Ice cubes
1/3 cup rock salt
One sandwich sized Ziploc baggie
One gallon sized Ziploc baggie
Thermometer

Chapter 29: Preserving fresh fruit

Ingredients:

1 Banana
1 Apple
1 Vitamin C tablet
Small plastic dishes or bowls
1 cup warm water
1 cup white sugar
½ cup lemon juice
Clear plastic cups and spoons
Fruit-Fresh® (available in spices/canning aisle of your grocery store or you can make your own with 2 Tbs salt + 2 Tbs vinegar + 1 gallon water)
Paring knife

Chapter 30: Creating crystal clear ice cubes

Ingredients:

Distilled water
Regular water
Bottled water
Pan
Ice cube trays (or small plastic cups)

Chapter 31: Blanching vegetables

Ingredients:

3 carrots
3 radishes
Bundle of asparagus
Head of broccoli
Salt
Large pot with lid
Slotted spoon
Ice water
Knife
Paper towels
Marker

Chapter 32: Fried eggs

Ingredients:

One gallon distilled water
One head of red cabbage
One egg
Cooking spray or butter
Large pot and skillet
Strainer
Small bowl
Whisk or fork
Funnel
Knife

Chapter One

Scientific Notation

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

1 box Duncan Hines Yellow Cake Mix (with butter)
1 package of cream cheese
1 stick of butter
1 egg
2 tsp. vanilla

Powdered sugar (for topping on the finished cookies)
Plastic wrap
Baking sheet
Knife
Ruler

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

Definitions

scientific notation	method of writing large and small numbers in shorthand using a system of coefficients (1-9.9) multiplied by exponents by factors of 10. For example, 1224578 would be written as 1.224578×10^6
coefficient	the number used within scientific notation between 1 and 9.9 to be multiplied by an exponent
exponent	a factor of ten. Used within scientific notation to represent large or small numbers.
precision	how close a series of measurements are to each other
accuracy	how close a measured value is to the real value of the object

Sample questions to ask your child after completing the weekly reading.

What is the difference between precision and accuracy?

Precision is how close a series of measurements are to each other.

Accuracy is how close a measured value is to the real value of the object.

What does size have to do with the difficulties of chemistry?

Because of their small size, nobody has ever seen an atom before.

What range of numbers must a coefficient be between in order to write out a number in scientific notation?

The coefficient must always be a number between 1.0 and 9.9

When converting a number between its standard form (i.e. 102,000) and the same number in scientific notation (i.e. 1.02×10^5), what happens to the exponent if the conversion requires the number to get smaller? or larger?

If the coefficient needs to get smaller during a conversion, the exponent will need to get bigger, and vice versa.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 4.57×10^{4}
2) 9×10^{-3}
3) 2.3×10^{1}
4) 9×10^{-1}
5) 2.4212×10^{7}
6) 6.65×10^{-4}
7) 2.19×10^{1}
8) 3.32×10^{-3}
9) 3.21×10^{2}
10) 1.19×10^{-1}
11) 1.492×10^{3}
12) 2.713×10^{-1}
13) 3.14159×10^{5}
14) 6.022×10^{3}
15) 1.2011×10^{-1}
16) 3,825
17) 63,000
18) 0.023
19) 0.00000444
20) 7,121,000,000
21) 0.12
22) 180
23) 0.00081
24) 670,000
25) 34,000,000
26) 3.4×10^{-5}
27) 6.5×10^{4}
28) 3.60×10^{14}
29) 5.49×10^{2}
30) 4.03×10^{7}
31) 8.2×10^{-10}
32) 2.05×10^{-10}
33) 2.18×10^{-3}
34) 9.73×10^{5}
35) 7.0×10^{-6}
36) 3.621471×10^{3}
37) 3.7526×10^{3}
38) 4.5683×10^{2}
39) 2.15×10^{2}
40) 4.28×10^{-2}
41) 5.673×10^{-5}
42) 9.0×10^{-9}
43) 3.9256×10^{-5}
44) 1×10^{-8}
45) 3.7004×10^{-3}
46) 2×10^{-3}
47) 8×10^{-6}
48) 3.6×10^{-6}
49) 1.56×10^{-1}
50) 4.5×10^{-5}

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

1 box Duncan Hines Yellow Cake Mix (with butter)
1 package of cream cheese
1 stick of butter
1 egg
2 tsp. vanilla

Powdered sugar (for topping on the finished cookies)
Plastic wrap
Baking sheet
Knife
Ruler

Mr.Q's favorite cookie (thanks Mom!)

In terms of accuracy, these cookies couldn't be more precise.

The topics of accuracy and precision will be demonstrated in this activity.

Ingredients:

1 box Duncan Hines Yellow Cake Mix with butter
1 package of cream cheese
1 stick of butter
1 egg
2 tsp. vanilla
Powdered sugar (for topping on the finished cookies)

Other materials:
Plastic wrap
Baking sheet
Knife
Ruler

Recipe:

1) Whip the cream cheese and butter together until they are creamy.
2) Add the remaining ingredients and mix together.
3) Roll the dough into the shape of a tube and wrap with plastic wrap.
4) Let it rest overnight in the refrigerator.
5) Before baking, place the ruler next to the dough and accurately cut 1 inch slices.
6) Be certain to remove the plastic wrap and bake for ~12 minutes at 350°F.
7) Top with powdered sugar when done.

The initial measurement of your uncooked dough is very important within this activity. Once you have completed baking your cookies, each should have an identical length. To test this concept, follow this procedure:

1) Measure the length of two cookies chosen at random. Are they the same length?
2) Measure the height of these same two cookies. Are their highest points the same?

If your measurement of the cookie dough as you cut the slices was precise, every cookie should be the same size; however, it is unlikely this will be the case no matter how many times you measure various pairs of cookies.

Explanation:

From your reading, you've learned the definitions of accuracy and precision:

Precision is how close a series of measurements are to each other.
Accuracy is how close a measured value is to the real value of the object.

After comparing the length of your pairs of cookies, you may have discovered that several (if not all) of the pairs were not identical. Despite the fact that you accurately followed the recipe and produced cookies that are (I'm certain) delicious – they are not exactly alike! This means all of your cookies are not precisely like each other.

But what if all of your cookie pairs are nearly the identical length? This would mean that your cooking ability is both accurate and precise!

Is it possible to be neither accurate nor precise during your cooking this week? Yes! What if your oven does not cook properly and burns the cookies on the outside edge of the sheet while leaving several cookies in the center undone? This batch of cookies would not be very precise (since some cookies were properly cooked and others would still be raw) or accurate (since none of the cookies ended up as they were supposed to.)

Accuracy and precision are the two fundamental goals for all chemists in their experiments. However, we are human and we do make mistakes – lots of them! Even the most careful chemist in the world cannot be 100% accurate and 100% precise in her experiments. That is why all of your cookies are a little different from each other. I'm sure you did your best, but that's simply how chemistry works.

(I'm trying hard not to say, "That's the way the cookie crumbles." Yeah... I know it's a bad pun.)

Your goal in the remaining lab activities is to follow the procedures as accurately as you can so that your results will be as precise as possible. I'm certain you can do it! So now it's on to Chapter 2!

Chapter Two

Significant Numbers and Percent Error

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

1 cup white sugar
1 1/8 cups all-purpose flour
1/2 cup unsweetened cocoa powder
1 teaspoon baking soda
1 teaspoon salt

1/2 cup butter
1 egg
1 teaspoon vanilla extract
1 cup cold, strong, brewed coffee
1 toothpick

National Science Education Standards covered this week:

12ASI1.3 Use technology and mathematics to improve investigations and communications. Mathematics plays an essential role in all aspects of an inquiry.

Definitions

significant figures (numbers)	any digits that give us some amount of precision about a set of data
percent error	the accuracy of a measurement as determined by the difference between the accepted measurement and the experimental measurement divided by the accepted measurement and multiplied by 100.

Sample questions to ask your child after completing the weekly reading.

True or false? Zeros to the right of all non-zero numbers are only significant if there's a decimal within the number.
This is correct.

True or false? Zeros to the right of all non-zero numbers are never significant.
False: Zeros to the left of all non-zero numbers are never significant.

True or false? Zeros between non-zero numbers are always significant.
This is correct. These zeros are known as "sandwich" zeros.

True or false? All non-zero numbers in measurements are sometimes significant.
False: All non-zero numbers in measurements are always significant.

What is the purpose of understanding significant numbers in science?
Science depends upon reliable and accurate data collected through experimentation. It is vital that this data be as precise as possible to determine what is happening within the experiment.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 4
2) 2
3) 2
4) 4
5) 5
6) 8
7) 3
8) 2
9) 2
10) 4
11) 2
12) 6
13) 3
14) 1
15) 6
16) 1
17) 3
18) 3
19) 4
20) 2
21) 31
22) 62
23) 3.9
24) 2600
25) 53
26) 400,000
27) 460
28) 330
29) 0.139
30) 0.23
31) 10.7% error
32) 18.2% error

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

1 cup white sugar
1 1/8 cups all-purpose flour
1/2 cup unsweetened cocoa powder
1 teaspoon baking soda
1 teaspoon salt

1/2 cup butter
1 egg
1 teaspoon vanilla extract
1 cup cold, strong, brewed coffee
1 toothpick

Homemade chocolate cake or....

Bake in a 350° oven for 1.2×10^4 seconds

The percent error of a baked cake will be calculated.

Ingredients:

1 cup white sugar
1 1/8 cups all-purpose flour
1/2 cup unsweetened cocoa powder
1 teaspoon baking soda
1 teaspoon salt
1/2 cup butter
1 egg
1 teaspoon vanilla extract
1 cup cold, strong, brewed coffee
1 toothpick

Recipe:

1. Preheat oven to 350°F (175°C). Grease and flour an 8 inch pan. Sift together flour, cocoa, baking soda and salt. Set aside.
2. In a medium bowl, cream butter and sugar until light and fluffy. Add egg and vanilla and beat well. Add flour mixture, alternating with coffee. Beat until just incorporated.
3. Bake at 350°F (175°C) for 35 minutes, or until a toothpick inserted into the cake comes out clean.
4. Be certain to take accurate measurements of any additional or reduced time it takes to bake your cake!

The actual time it takes to bake the cake will undoubtedly be different than what was suggested in the recipe. In order to calculate how accurate this measurement is, use the percent error equation:

$$\text{Percent error} = \frac{(\text{Accepted measurement} - \text{Experimental measurement})}{\text{Accepted measurement}} \times 100\%$$

The "accepted measurement" is the amount of baking time suggested in the recipe and the "experimental measurement" is the actual amount of time it took to bake your cake.

Calculate the percent error of your recipe this week. Do you believe the recipe is very accurate or should it be corrected?

Explanation:

Accurate recipes are necessary to reproduce good food (or to avoid making the same bad choice again in the future!) Much like scientific experiments, the results of cooking are intended to be reproduced many times in the future by several different cooks with very good precision.

If a recipe is not copied down exactly as previously written or if factors like the different cooking abilities of kitchen ovens are not considered within a recipe, the accuracy of its results will be very poor.

Although cooks may not use the percent error equation in their cooking, they do keep very good notes as to what does and does not work within a recipe! In the world of science, the accuracy of our results is expected to be much higher than that of a cook! In the coming weeks, you will learn how accurate and precise chemistry can truly be.

Unit Quiz (Weeks 1-2)

Write the answers to the following problems with the correct number of significant figures.

1) 0.0023 x 0.0121 = _______________

2) 98 / 0.003 = _______________

3) 340 x 0.0005 = _______________

4) 65.90 / 34.001 = ______________

Put these numbers into scientific notation.

5) 10.05×10^{-9} _________________________________

6) 55000000 _________________________________

7) 325×10^{4} _________________________________

8) 5,921,000,000 _________________________________

9) 42.372 _________________________________

10) 362.516×10^{-10} _________________________________

11) 23,000,000,000 _________________________________

12) 0.000080×10^{-7} _________________________________

13) 7,000,631 _________________________________

14) 0.00573 _________________________________

15) 0.507 _________________________________

16) 0.000421×10^{15} _________________________________

17) 0.06723 _________________________________

18) 0.000023 ____________________

19) 0.00000038 ____________________

20) 8000000 ____________________

21) 65000000 ____________________

22) 0.0000200 ____________________

23) 0.000324 ____________________

24) 67000×10^{-4} ____________________

25) 2.68×10^{-15} ____________________

26) 70×10^{-8} ____________________

27) 96,400 ____________________

28) 0.000521×10^{12} ____________________

29) 2.538 ____________________

30) 240.000 ____________________

31) 741,900 ____________________

32) 5.000 ____________________

33) 0.01010 ____________________

34) 0.0005438 ____________________

35) 0.00483×10^{15} ____________________

36) 0.0000054 ____________________

37) 0.75140000 ____________________

38) $0.000000614 \times 10^{-22}$ ____________________

39) 602,200,000,000,000,000,000,000

____

40) For years, many sightings of the legendary monster – Godzilla have been reported along the the coasts of several continents and, most recently, in downtown New York City. Little is known about his physiology as he creatively disguises himself by altering his body and facial structure from citing to citing. Most individuals would agree however, that he must be reaching the twilight of his years and should be at least 50 years old. If Godzilla's actual age is 56 years old, what is the percent error in this estimation?

41) A silver-colored ring has a mass of 23.4 grams and a volume of 1.9 mL. **Is the ring pure silver? If not, what is its percent error?** *(Density = mass/volume; the density of silver is 10.5 g/mL.)*

Unit Quiz Answer Key

1) 0.0000278 rounds to 0.000028
2) 32,667 rounds to 30,000
3) 0.17 rounds to 0.2
4) 1.938189 rounds to 1.938
5) 1.005×10^{-8}
6) 5.5×10^{7}
7) 3.25×10^{6}
8) 5.921×10^{9}
9) 4.2372×10^{1}
10) 3.62516×10^{-8}
11) 2.3×10^{10}
12) 8.0×10^{-12}
13) 7.000631×10^{6}
14) 5.73×10^{-3}
15) 5.07×10^{-1}
16) 4.21×10^{11}
17) 6.723×10^{-2}
18) 2.3×10^{-5}
19) 3.8×10^{-7}
20) 8×10^{6}
21) 6.50×10^{7}
22) 2.00×10^{-5}
23) 3.24×10^{-4}
24) 6.7×10^{0}
25) 2.68×10^{-15}
26) 7×10^{-7}
27) 9.64×10^{4}

28) 5.21×10^{8}
29) 2.538×10^{0}
30) 2.40000×10^{2}
31) 7.419×10^{5}
32) 5.000×10^{0}
33) 1.010×10^{-2}
34) 5.438×10^{-4}
35) 4.83×10^{12}
36) 5.4×10^{-6}
37) 7.5140000×10^{-1}
38) 6.14×10^{-29}
39) 6.022×10^{23}
40) % error = 10.7%
41) 12 g/mL; Percent error = 14%

Chapter Three

Metric System and Conversions

The last words of a chemist:

And now the tasting test.

May that become hot?

And now a little bit of this...

... and please leave that test tube alone!

And now shake it a bit.

Why is there no label on this bottle?

In which glass was my mineral water?

Why does that stuff burn with a green flame?!?

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

28 oz. can pureed Italian plum tomatoes
2 teaspoons extra virgin olive oil
4 medium garlic cloves, minced
1 can (6 ounce size) tomato paste
1 1/4 teaspoon oregano
1/4 teaspoon salt
1/4 teaspoon black pepper
1/3 cup fresh parsley, chopped
Saucepan
Spoon

National Science Education Standards covered this week:

12ASI2.4 Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results

Definitions

base units	basic metric units such as seconds (time), meters (length), kilograms (mass/weight), liters (volume), Pascals (pressure), and Kelvin (temperature)

Sample questions to ask your child after completing the weekly reading.

If you are using the metric stepladder within this weeks' readings and you were attempting to convert 120 kilometers into meters, would you multiply or divide the kilometers? What is the correct conversion for this problem?

You would multiply 120 kilometers by 1000. This is because each step down the ladder requires you to multiply by 10. In this example, it would take three steps to travel from kilometers to meters; therefore 120 kilometers X 10 X 10 X 10 = 120,000 meters.

What are the base units for the following measurements: Time, Distance, Mass or Weight, Volume, Pressure, and Temperature.

Time = Second; Distance = Meter; Mass/Weight = Kilogram; Volume = Liter; Pressure = Pascal; Temperature = Kelvin

During a conversion, if the units go up the stepladder (like from cm to km), what will happen to its number?

Its number will go down in size.

If the units go down the stepladder (like from km to m) during a conversion, will its number become greater or smaller?

Its number will be greater.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 1g
2) 1kg
3) 1L
4) 4.7cm
5) 1.30m
6) 1.200km
7) 3.456m
8) 5.5cm
9) 4.568km
10) centi (c)
11) nano (n)
12) kilo (k)
13) kilo (k)
14) deci (d)
15) micro (μ)
16) milli (m)
17) μg
18) μm
19) km
20) ms
21) dL
22) kcal
23) cL
24) ng
25) meter
26) microsecond
27) milliliter
28) decimeter
29) centiliter
30) kilogram
31) 1.55×10^3 m
32) 4.86×10^1 cg
33) 1.885×10^1 dL
34) 3.88×10^2 mm
35) 1.25×10^0 ms
36) 1.06×10^0 g
37) 1.25×10^{-1} L
38) 1.0×10^{-7} s
39) 9.46×10^4 cal
40) 3.15×10^2 g

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

28 oz.can pureed Italian plum tomatoes
2 teaspoons extra virgin olive oil
4 medium garlic cloves, minced
1 can (6 ounce size) tomato paste
1 1/4 teaspoon oregano
1/4 teaspoon salt
1/4 teaspoon black pepper
1/3 cup fresh parsley, chopped
Saucepan
Spoon

A healthy dipping sauce…

Mama mia! What an easy marinara (aka-red sauce) recipe!

Metric to English conversions will be explored in this simple exercise.

Ingredients:

840mL pureed Italian plum tomatoes
10mL extra virgin olive oil
180mL tomato paste
6.25mL oregano (or more, to taste)
1.25mL salt
1.25mL black pepper
80mL fresh parsley, chopped
4 medium garlic cloves, minced
Saucepan
Spoon

Recipe:

Before you can begin to create this amazing recipe, you are going to need how much of each ingredient you will need to purchase. You will need to use the conversion chart on the following page to help you convert each metric measurement to its English unit.

Once this is completed, <u>check your work</u> within the materials list in the Parent Copy BEFORE you start shopping. You don't want to purchase 10 pounds of parsley when you only need a small amount, right?

After you finish your conversions and obtain the ingredients, you can begin to make your marinara. Here's the recipe:

1) In a medium saucepan, heat oil briefly and add garlic.
2) Sauté (cook) the garlic for 15 seconds, being careful not to let it brown.
3) Add pureed tomatoes, tomato paste, oregano, salt, and pepper.
4) Bring sauce to a boil, reduce heat to low and simmer for 20 minutes.
5) Store in an airtight container once cooled or freeze for future use **(like in next weeks' lab!)**

Explanation:

This introductory exercise is meant to get you prepared to master the skill of converting numbers from one unit to another. The incredibly tiny size of the materials we will be studying in chemistry force chemists to convert these numbers into larger, more manageable units that we can work with. The conversions between the metric and English system of measurements are common within the kitchen and may likely increase in the future!

U.S. to Metric

7 drops = 1 mL

1 teaspoon = 5 mL

1 tablespoon = 15 mL

1/4 cup = 60 mL

1 cup = 240 mL

2 cups (1 pint) = 480 mL

4 cups (1 quart) = 0.95 liter

4 quarts (1 gal.) = 3.8 liters

1 fluid oz. = 30 mL

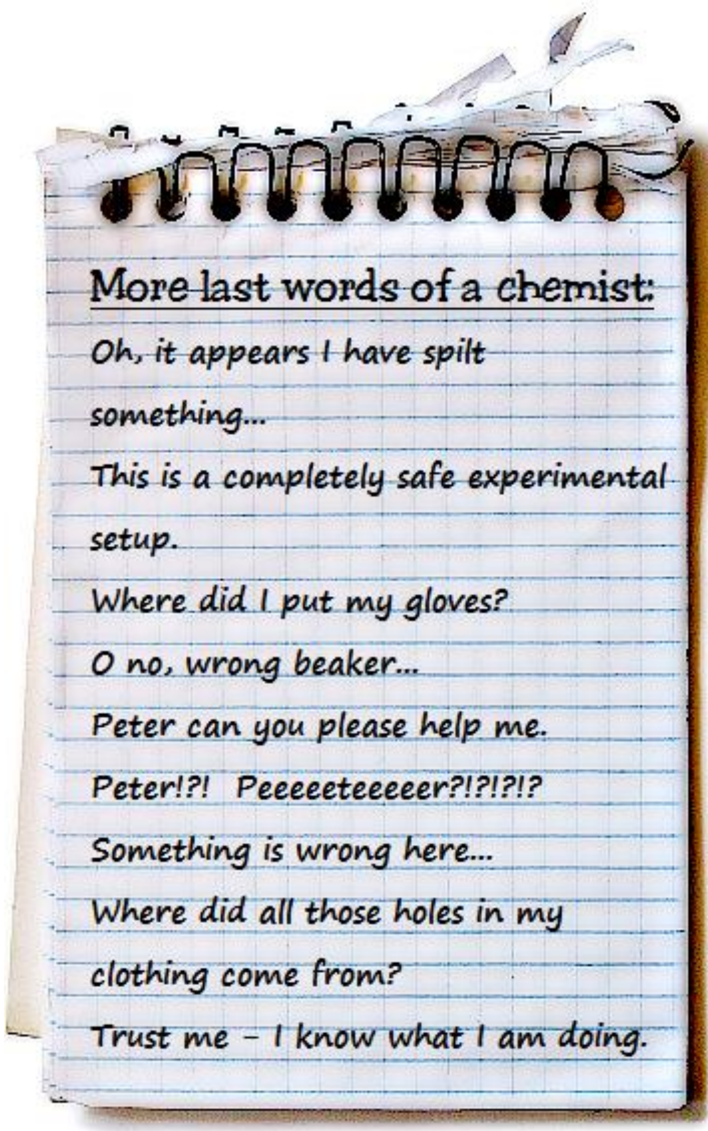
1 oz. = 28 grams

1 pound = 454 grams

1 inch = 2.54 cm

Chapter Four

Dimensional Analysis



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

4 whole-wheat tortillas
2/3 cup fresh or frozen spinach, finely chopped
2/3 cup part-skim mozzarella cheese, shredded
1 cup marinara sauce (from last week's lab)
Cooking spray

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

12ASI1.3 Use technology and mathematics to improve investigations and communications. Mathematics plays an essential role in all aspects of an inquiry.

Definitions

dimensional analysis	a method of converting one unit into another unit through the use of conversion factors
conversion factor	a shortcut that can be used to help with your conversion

Sample questions to ask your child after completing the weekly reading.

Can dimensional analysis be used to convert a number from kilometers to meters?

Yes. Dimensional analysis can be used in nearly every conversion so far as you use some kind of conversion factor within the calculations.

Why is it important to include units with numbers (i.e. 2.3 cm) when using dimensional analysis?

Dimensional analysis is designed to cancel units out during the conversion process. Without units, it may become difficult to set up the correct conversion factors.

What are the steps you should follow when using dimensional analysis to solve a problem?

First, figure out what you are going to convert and what you are going to convert it into.

Second, line up your conversion factor(s) so that our unneeded units will be cancelled out.

Third, multiply the top numbers together and the bottom numbers together and divide the numerator by the denominator.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 894.2 cm = _____ km

894.2 cm	1m	1k	= 0.008942 km
	100cm	1000m	

2) 97 mL = ______ gallons

97 mL	1L	1qt	1gal	= 0.025 gallons
	1000mL	0.95 L	4qt	

3) 133.5 mm = ______ inches

133.5 mm	100cm	1in	= 5.25 inches
	1000mm	2.54cm	

4) 14.5 feet = ______ meters

14.5 feet	12in	2.54cm	1m	= 4.42 meters
	1ft	1in	100cm	

5) 337 milliseconds = ______ kiloseconds

337 ms	1 s	1 ks	= 0.000337 ks
	1000 ms	1000 s	

6) How many centigrams are in 43 kilograms?

$$\frac{43\ \text{kg}}{} \left| \frac{1000\ \text{g}}{1\ \text{kg}} \right| \frac{100\ \text{cg}}{1\ \text{g}} = 4{,}300{,}000\ \text{cg}$$

7) How many miles will a person run during a 10 km race? (1 mile = 1.609km)

$$\frac{10\text{km}}{} \left| \frac{1\ \text{mi}}{1.609\ \text{km}} \right. = 6.21\ \text{mi}$$

8) The moon is 250,000 miles away. How many inches is it from earth? (1 mi = 63,360 inches)

$$\frac{250{,}000\ \text{mi}}{} \left| \frac{63{,}360\ \text{in}}{1\ \text{mi}} \right. = 1.584 \times 10^{10}\ \text{in}$$

9) A family pool holds 10,000 gallons of water. How many liters is this? (1 L = 0.264 gal)

$$\frac{10{,}000\ \text{gal}}{} \left| \frac{1\ \text{L}}{0.264\ \text{gal}} \right. = 37{,}878.8\ \text{L}$$

10) How many seconds are there in 3 months, assuming there are 30 days in a month?

$$\frac{3\ \text{mo}}{} \left| \frac{30\ \text{day}}{1\ \text{mo}} \right| \frac{24\ \text{hr}}{1\ \text{day}} \left| \frac{3600\ \text{s}}{1\ \text{hr}} \right. = 7{,}776{,}000\ \text{s}$$

11) If you have 3.37 oz of a fluid, how many milliliters is this? (1 mL = 0.034 oz)

$$\frac{3.37\text{ oz}}{} \left| \frac{1\text{ mL}}{0.034\text{ oz}} \right. = 99.1\text{ mL}$$

12) A weather station measures 0.8 yards of rain. Express this amount in centimeters (1 cm = 0.01 yards).

$$\frac{0.8\text{ yd}}{} \left| \frac{1\text{ cm}}{0.01\text{ yd}} \right. = 80\text{ cm}$$

13) How many meters are in 750 kilometers?

$$\frac{750\text{ km}}{} \left| \frac{1000\text{ m}}{1\text{ km}} \right. = 750{,}000\text{ m}$$

14) How many liters are in 52.3 milliliters?

$$\frac{52.3\text{ mL}}{} \left| \frac{1\text{ L}}{1000\text{ mL}} \right. = 0.0523\text{ L}$$

15) Determine the number of years in 835,000,000 minutes.

$$\frac{835{,}000{,}000\text{ min}}{} \left| \frac{1\text{ day}}{1440\text{ min}} \right| \frac{1\text{ yr}}{365\text{ day}} = 1588.7\text{ years}$$

16) Light travels through space at 186,000 miles per second. How far will light travel in one year? [This distance is called a light-year (ly)]

$$\frac{186{,}000 \text{ miles}}{1 \text{ second}} \left| \frac{60 \text{ seconds}}{1 \text{ minute}} \right| \frac{60 \text{ minutes}}{1 \text{ hour}} \left| \frac{24 \text{ hours}}{1 \text{ day}} \right| \frac{365 \text{ days}}{1 \text{ year}} = \frac{5.86 \text{ X } 10^{12} \text{ mi}}{\text{year}}$$

17) The sun is 93 million miles or 150 million kilometers away. If you could drive a car at 65 miles per hour to the sun, how many years would it take?

$$\frac{93 \times 10^6 \text{ miles}}{1 \text{ trip}} \left| \frac{1 \text{ hour}}{65 \text{ miles}} \right| \frac{1 \text{ day}}{24 \text{ hours}} \left| \frac{1 \text{ year}}{365 \text{ days}} \right. = \frac{93 \times 10^6 \text{ years}}{5.7 \times 10^5 \text{ trip}} = \frac{163 \text{ years}}{\text{trip}}$$

18) How many blank CDs will Mr. Q need if he wants to digitize eight (8) of his old photo albums?
(1 old album = 450 pictures, 1 picture = 2.2 Mb, 1 CD = 760 Mb)

$$\frac{8 \text{ albums}}{} \left| \frac{450 \text{ pic}}{1 \text{ album}} \right| \frac{2.2 \text{ Mb}}{1 \text{ pic}} \left| \frac{1\text{CD}}{760 \text{ Mb}} \right. = 10.4 = 11 \text{ CDs needed}$$

19) If Mr.Q were to drink 13 cups of coffee during a day, how many gallons would this be?

$$\frac{13 \text{ cups}}{} \left| \frac{1 \text{ pt}}{2 \text{ cups}} \right| \frac{1 \text{ Qt}}{2 \text{ pt}} \left| \frac{1 \text{ gal}}{4 \text{ Qt}} \right. = 0.81 \text{ gallons of coffee}$$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

4 whole-wheat tortillas
2/3 cup fresh or frozen spinach, finely chopped
2/3 cup part-skim mozzarella cheese, shredded
1 cup marinara sauce (from last week's lab)
Cooking spray

Pizza-dillas

Pizza + Quesadilla = Mmmmmm……!

The use of dimensional analysis for unit conversions will be practiced within this activity.

Ingredients:

4 whole-wheat tortillas (20.32cm diameter)
160mL fresh or frozen spinach, finely chopped
160mL part-skim mozzarella cheese, shredded
240mL marinara sauce (from last week's lab)
Cooking spray

Recipe:

To get going on this lab, you will need to first convert the ingredients to English units using the conversion chart at the beginning of this book. This is an excellent opportunity for you to practice your dimensional analysis skills. Be certain to check out the answers in the Parent Copy before you go to the store!

Once you have picked up all of your ingredients, here's how to make your pizza-dillas:

1) Lay 2 tortillas on a flat surface. Spread each with 120mL marinara, 80mL spinach and 80mL cheese.
2) Top both with the remaining 2 tortillas.
3) Place your skillet over medium heat. Lightly coat the pan with cooking spray.
4) Gently slide 1 pizza-dilla into the pan and cook until light golden brown on one side (about 1-2 minutes).
5) Using a spatula, gently flip over the pizza-dilla and cook for 30-60 seconds more or until cheese is fully melted.

6) Remove pizza-dilla and cut into triangles. Repeat with remaining pizza-dillas.
7) Serve with marinara sauce for dipping.
8) Refrigerate leftovers (if there are any) for the next day!

Explanation:

Many situations involve using dimensional analysis, such as cooking or baking. Dimensional analysis is a way of converting measurements into more common units using conversion factors. Your knowledge of dimensional analysis will be vital in future chapters! Keep practicing!

U.S. to Metric

7 drops = 1 mL
1 teaspoon = 5 mL
1 tablespoon = 15 mL
1/4 cup = 60 mL
1 cup = 240 mL
2 cups (1 pint) = 480 mL
4 cups (1 quart) = 0.95 liter
4 quarts (1 gal.) = 3.8 liters
1 fluid oz. = 30 mL
1 oz. = 28 grams
1 pound = 454 grams
1 inch = 2.54 cm

For each of the following problems, use dimensional analysis to calculate your answer.

1. If you had 1.2L of cheese and plenty of the remaining ingredients, how many pizzadillas could you make?

2. Suppose Mr.Q wants to make a little extra money by selling your pizzadillas. Assuming that this snack generally sells for 80 cents per slice and each pizzadilla provides 4 slices, how many pizzadillas would Mr.Q have to sell to make $18.40?

3. Imagine throwing a party for 15 friends. Each friend can eat 8 slices of your "world famous" pizzadillas. If each pizzadilla is evenly cut into four slices, how much would it cost you to feed all of your friends if each pizzadilla costs $2.35 to make? If you only had $30, could you feed all of your friends?

4. If the cost of ingredients to make four pizza-dillas is $2.90 for spinach, $3.20 for cheese, $4.23 for the tortillas, and $2.45 for the marinara sauce. If you have $25 total for groceries, how many pizzadillas could you make?

Answer key:

1. 15 pizza-dillas
2. 5.75 pizza-dillas must be sold
3. $70.50 for everyone (you would need much more money)
4. 4 pizza-dillas

Unit Quiz (Weeks 3-4)

Use dimensional analysis for the following problems. Round to the correct number of significant figures.

1) How many millimeters are there in 0.0045 decimeters?

2) Use dimensional analysis. Convert 881 centuries to days. There are 1461 days in 4 years.

3) You have a sample with a mass of 620 g and a volume of 753 mL. Find its density and round to the correct number of significant figures. (Density=mass/volume)

4) How many grams are there in 23.4 kilograms?

5) How many inches are there in 522 centimeters? There are 2.54 centimeters in an inch.

6) How many inches are there in 4.2×10^{-5} miles? There are 36 inches in a yard and 1760 yards in a mile.

All answers must use significant figures AND you must use scientific notation for numbers larger than 10^{4} and smaller than 10^{-4}.

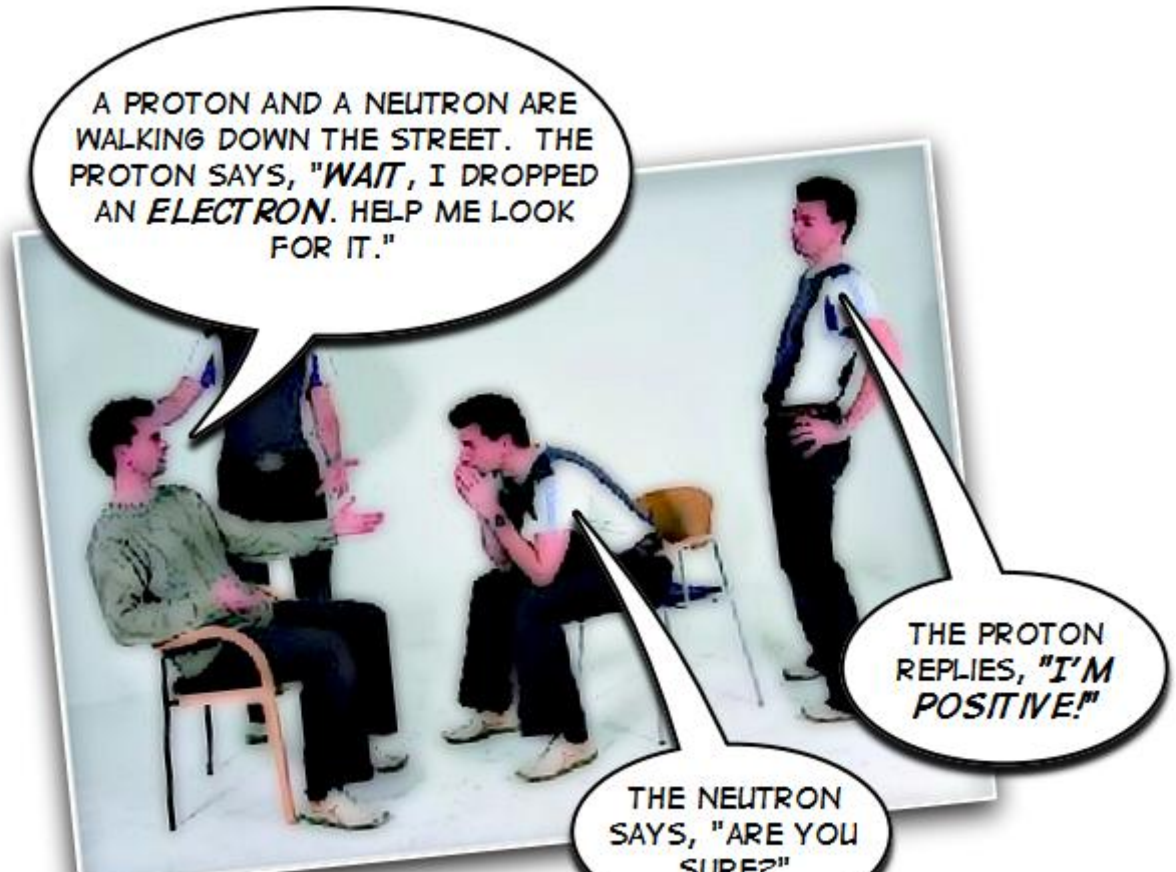
7) 1 mm = ___________ m
8) 1 km = ___________ m
9) 1 m = ___________ cm
10) 1 m = ___________ km
11) 1 cm = ___________ µm
12) 5.0 mm = ___________ m
13) 15 km = ___________ cm
14) 6.00×10^{2} m = ___________ cm
15) 0.45 km = ___________ m
16) 104 km = ___________ µm
17) 1×10^{9} mm = ___________ cm
18) 6×10^{-4} cm = ___________ nm
19) 1µm = ___________ km
20) 4.9×10^{-10} mm = ___________ km
21) 8×10^{-100} mm = ___________ nm

Unit Quiz Answer Key

1) 0.45 mm
2) 3.22 X 10^7 days (32,200,000)
3) 0.82 g/mL
4) 23,400 grams
5) 206 inches
6) 2.7 inches
7) 1 mm = 0.001 m
8) 1 km = 1000 m
9) 1 m = 100 cm
10) 1 m = 0.001 km
11) 1 cm = 10^4 µm or 10,000
12) 5.0 mm = .0050 m
13) 15 km = 1.5×10^6 cm
14) 6.00×10^2 m = 6.00×10^4 cm
15) 0.45 km = 450 m
16) 104 km = 1.04×10^{11} µm
17) 1×10^9 mm = 1×10^8 cm
18) 6×10^{-4} cm = 6000 nm
19) 1µm = 1×10^{-9} km
20) 4.9×10^{-10} mm = 4.9×10^{-16} km
21) 8×10^{-100} mm = 8×10^{-94} nm

Chapter Five

Protons, Neutrons, and Electrons



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

One small bag each of plain and peanut M&M's
Electric scale (optional)

National Science Education Standards covered this week:

12BPS1.1 Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atoms together.

Definitions

atoms	tiny particles that make up the universe
subatomic particles	protons, neutrons, and electrons
atomic mass unit (amu)	the mass of one proton (1.66 x 10^{-27} kg) which are used to determine the overall atomic mass of an element
atomic mass	the average mass of an element and all of its isotopes
elements	close to 120 unique atoms, each of which containing its own physical and chemical characteristics
nucleus	the center of an atom which contains its protons and neutrons
mass number	the sum of the protons and neutrons within an atom
atomic number	the total number of protons in the nucleus of an atom
isotope	an element which contains a different amount of neutrons despite having the same number of protons.
relative abundance	a measured percentage of each element that exists in nature was determined

Sample questions to ask your child after completing the weekly reading.

Which carries a stronger electric charge? A proton or an electron?
Neither. Both carry an equal and opposite charge from each other despite the massive difference in their sizes.

What is the difference between the atomic number and mass number of an element?
The atomic number of an element is simply its number of protons. This measurement is the most precise way of identifying an element.
The mass number of an element is the mass of the protons AND neutrons within an element's nucleus.

Why is the atomic mass of an element not a whole number?
The atomic mass of an element is the average mass of an element and all of its isotopes.

How do you calculate the average atomic mass of an element?

1. *Make a list of each of its isotopes along with the mass numbers and their percent relative abundance.*
2. *Multiply the mass number of each isotope by its relative abundance.*
3. *When you add all of these products together, you have calculated the atomic mass.*

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Carbon
2) mass numbers
3)

atomic symbol	atomic #	mass #	# of protons	# of neutrons	# of electrons
^{12}C	6	12	6	6	6
^{13}C	6	13	6	7	6
^{14}C	6	14	6	8	6

4) (151)(0.4803) + (153)(0.5197)
   Average atomic mass of europium = 152.0 amu
5) (84)(0.005) + (86)(0.099) + (87)(0.07) + (88)(0.826)
   Average atomic mass of strontium = 87.7 amu
6) 85.56 amu
7) 237.98 amu
8) 47.92 amu
9) The masses on the periodic table are the average mass of all isotopes and their abundances found in the universe. Although carbon-12 weighs exactly 12 amu, the periodic table reports that the mass is 12.011 because we are taking into consideration the abundances and masses of the other two carbon isotopes (carbon-13 and carbon-14).

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

One small bag each of plain and peanut M&M's
Electric scale (optional)

Chocolate-flavored isotopes

Wait a minute – Isotopes don't melt in your mouth!

Students will calculate the average weight, relative abundance, and atomic mass of a sample of candy.

Ingredients:

One small bag each of plain and peanut M&M's
Electric scale (optional)

Recipe:

Perform the following calculations for each step and record your data on the data chart on the following page.

Step 1:

Use an electronic scale to determine the mass all of the candies. If this is not a possibility, the average mass of a plain M&M is 0.878 grams and the average mass of a peanut M&M is 1.674 grams.

Step 2:

Count all of the candies of each different kind to find the <u>number of each isotope.</u>

Step 3:

Divide the mass of all isotopes (plain and peanut) by the number of each isotope within your sample to get the <u>average mass</u> of each isotope.

Step 4:

Divide the number of each isotope by the total number of isotopes in your sample and multiply by 100 to get the <u>percentage abundance</u> of each isotope.

Step 5:

Divide the percent abundance from Step 4 by 100 to get the relative abundance of each isotope.

Step 6:

Multiply the relative abundance from Step 5 by the average mass of each isotope (Step 3) to get the relative mass of each isotope.

Step 7:

Add the relative masses to get the average mass of all particles of M&Mium, which is known as the atomic mass.

Explanation:

The extremely small size of atoms makes it impossible to count them or determine their individual masses using direct means. Because of this challenge, chemists must calculate the average atomic masses which depend on the number and masses of the isotopes of an element.

Isotopes are atoms of the same atomic number having different masses due to different numbers of neutrons. The atomic mass of an element is the weighted average of the masses of the isotopes of that element. The weighted average takes account both the mass and relative abundance of each isotope as it occurs in nature.

Data chart:

	Plain	Peanut	Total
Step 1: Mass of all isotopes			
Step 2: Number of each isotope			
Step 3: Average mass of each isotope			
Step 4: Percent of each isotope			
Step 5: Relative abundance of each isotope			
Step 6: Relative mass of each isotope			
Step 7: The atomic mass of your sample (the total from Step 6)			

Chapter Six

Mixtures and Phase Changes

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

2 tsp yeast
1 tsp sugar
Water
½ cup whole grain cereal
1 cup wheat flour
3 cups white flour

4 Tbs butter
(cut into ¼ inch cubes)
2 tsp salt
Olive oil
Balsamic vinegar
Various herbs

Cornmeal
Unglazed terra-cotta dish
(the orange-colored clay material most flowerpots are made out of)

National Science Education Standards covered this week:

12BPS2.5 Solids, liquids, and gases differ in the distances between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.

Definitions

compounds	pure substances that are made up of two or more different atoms (or molecules) that are bonded together
pure substances	mixtures that cannot be physically separated very easily
molecule	combination of two or more atoms that are bonded together
mixture	combination of two or more atoms (not bonded together)
homogenous mixtures (solutions)	combination of two or more different kinds of atoms that are not easy to separate (but they are not bound together)
heterogeneous mixtures	combination of two or more different kinds of atoms that are easy to separate (but they are not bound together)
phases	the three states of matter – solid, liquid, and gas
melting	transition from a solid phase to a liquid phase
boiling	transition from a liquid phase to a gas phase
condensation	transition from a gas phase to a liquid phase
freezing	transition from a liquid phase to a solid phase
pressure	the force of gas molecules hitting the sides of the container in which they are stored
Kelvin scale	temperature scale which sets its zero degree (0°) at the most extreme measurement known as absolute zero
phase change diagram	a graph which depicts the phase change of a pure substance or mixture over time as either pressure or temperature is changed
triple point	single position on a phase change diagram where a substance can be either a solid, liquid, or gas
critical point	position on a phase change diagram where a substance can act like both a gas and a liquid

Sample questions to ask your child after completing the weekly reading.

What is the difference between a compound and a molecule?
A molecule is a combination of two or more atoms that are bonded together. However, a compound is a molecule that contains at least two different elements.

What is one major difference between a pure substance and a mixture?
Pure substances cannot be physically separated (like with your hands) because they tend to be bound together unlike mixtures which are not bound together.

What causes phase changes to occur between/among atoms?
The transfer of energy into/out of atoms causes phase changes to occur. For example, when a solid melts into a liquid it is the solid that absorbs energy which causes its atoms to speed up and move farther away from each other.

Once a phase change is taking place, why doesn't its temperature change?
When a solid begins to melt, it is absorbing enough energy for its atoms to speed up and move away from each other. At this time, energy will continue to be absorbed by the solid until the entire solid is turned into liquid. When this occurs, the liquid begins to absorb more energy and the molecules of water begin to move around more. This causes its temperature to rise.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 50 g, 10 g
2) 132 g
3) 25 °C
4) 68 °C
5) 10 °C
6) 42 g

Material	Pure Substance or Mixture	Element, Compound, Homogeneous, Heterogeneous
concrete	Mixture	Heterogeneous
sugar + pure water ($C_{12}H_{22}O_{11}$ + H_2O)	Mixture	Homogeneous (solution)
iron filings (Fe)	Pure Substance	Element
limestone ($CaCO_3$)	Pure Substance	Compound
orange juice (w/pulp)	Mixture	Heterogeneous
Pacific Ocean	Mixture	Homogeneous (solution)
air inside a balloon	Mixture	Homogeneous
aluminum (Al)	Pure Substance	Element
magnesium (Mg)	Pure Substance	Element
acetylene (C_2H_2)	Pure Substance	Compound
tap water in a glass	Mixture	Homogeneous (H_2O + minerals)
soil	Mixture	Heterogeneous
pure water (H_2O)	Pure Substance	Compound (H_2O)
chromium (Cr)	Pure Substance	Element
Chex mix	Mixture	Heterogeneous
salt + pure water (NaCl + H_2O)	Mixture	Homogeneous (solution)
benzene (C_6H_6)	Pure Substance	Compound
muddy water	Mixture	Heterogeneous (suspension)
Brass (Cu mixed with Zn)	Mixture	Homogeneous (alloy)
baking soda ($NaHCO_3$)	Pure Substance	Compound

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

2 tsp yeast
1 tsp sugar
Water
½ cup whole grain cereal
1 cup wheat flour
3 cups white flour

4 Tbs butter
(cut into ¼ inch cubes)
2 tsp salt
Olive oil
Balsamic vinegar
Various herbs

Cornmeal
Unglazed terra-cotta dish
(the orange-colored clay material most flowerpots are made out of)

A doughy scavenger hunt or…

How to classify matter with bread!

The identification of mixtures and pure substances will be explored during the baking of bread.

Ingredients:

10mL yeast
5mL sugar
Water
120mL whole grain cereal
240mL wheat flour
720mL white flour
60mL butter
(cut into pea-sized cubes)

10mL salt
Olive oil
Balsamic vinegar
Various herbs
Cornmeal
Unglazed terra-cotta dish
(the orange-colored clay material most flowerpots are made out of)

Recipe:

Before you get started on this recipe, you will need to have the Classification of Matter worksheet in front of you which is located at the end of this lesson. In addition, you may want to review the definitions of:

Homogenous mixture
Heterogeneous mixture
Colloid
Suspension

Pure Substance
Compound
Element

As you work through the recipe to make homemade bread, you should be looking for various examples of these classifications of matter. Place an "x" in the appropriate box that identifies which ingredient/mixtures of ingredients correctly identify the definitions above. There may be more than one "x" per ingredient.

Now let's start making some bread:

1) Within 360mL of warm water, add the yeast and sugar.
2) In a separate large bowl, mix together the whole grain cereal, wheat flour, white flour, salt and butter.
3) Create a "volcano" within the dry ingredients so that you may pour the solution from step 1 into its center.
4) Slowly begin to mix in the dry ingredients into the solution with a spoon. Continue this until none of the solution remains and the dough is a wet ball.
5) Place a generous amount of flour onto a clean flat work surface. Place the dough onto the surface and begin pressing and folding the dough. Keep extra flour in a bowl in case the dough begins to stick to you or the counter.
6) Use the heels of your hands to continually press down on the dough.
7) Repeat this process until the dough, upon pinching, feels much like your earlobe. (I'd advise you to test how your earlobe feels BEFORE you become a floury mess!)
8) Cut 1/3 of the dough off and freeze it in a sealable baggie. You are going to need this dough in a couple of weeks!
9) Roll the remaining dough into a ball and place it in a large greased bowl, cover, and place in a warm area for about 45 minutes or until the dough has doubled in size.
10) After this time, place the dough back on the floured countertop once more and fold it in half. Gently press on the dough with the heel of your hands once again for a few minutes and form the bread into the shape of a flattened ball.
11) Sprinkle cornmeal onto a baking sheet and place the dough on top of this surface. (The cornmeal will allow the dough to easily slide off.)
12) Cover the dough with a towel and let it rest for 1 hour. When done, the dough should quickly snap back into place if you lightly push on its side.
13) While the dough is resting, place the terra-cotta dish inside an oven and preheat to 400°F.

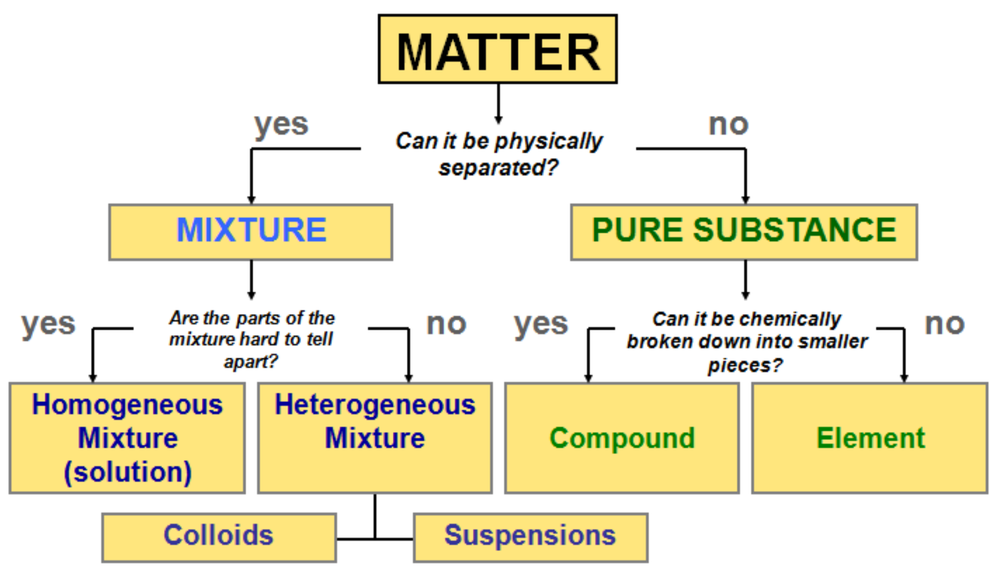
14) Once the dough is ready, slide it onto the dish within the oven and bake for 20-30 minutes.
15) You may use a meat thermometer to check if your bread is done. It should be between 205-210°F. If you don't have a thermometer, simply flick the bread with your finger. If it has a hollow sound, it is likely done!
16) Remove the bread from the oven and allow it to rest for 10-15 minutes before you slice (or tear) it up!

While the dough is baking, mix together your dipping sauces:
Add 45mL of olive oil into a small bowl along with 15mL of balsamic vinegar.

To another small bowl, add 45mL of olive oil and a variety of herbs of your choice. I prefer a simple mixture of basil, oregano, salt, pepper, and red pepper flakes!

Explanation:

The various individual ingredients along with the several mixtures that were created within this recipe will give you plenty of opportunities to look for the various classifications of matter. The following diagram will help you complete the chart on the next page.



Classification of Matter Worksheet

As you work through the recipe to make homemade bread, you should be looking for various examples of these classifications of matter. Place an "x" in the appropriate box that identifies which ingredient/mixtures of ingredients correctly identify the definitions above. There may be more than one "x" per ingredient.

<u>Don't peek at the next page until you are done!</u>

	Homo-mixture	Hetero-mixture	Colloid	Suspension	Pure Substance	Compound	Element
Water							
Sugar							
Water + Sugar							
Water + Sugar + Yeast							
Flour							
Salt							
Flour + Salt							
Dough							
Oil							
Vinegar							
Oil + Vinegar							
Herbs							
Oil + Herbs							

Answer key:

	Homo-mixture	Hetero-mixture	Colloid	Suspension	Pure Substance	Compound	Element
Water					X	x	Possibly
Sugar					x	X	Possibly
Water + Sugar	X						
Water + Sugar + Yeast		x		X			
Flour	X						
Salt					x	x	Possibly
Flour + Salt	X						
Dough		x	x				
Oil	X						
Vinegar	X						
Oil + Vinegar		X		X			
Herbs		X					
Oil + Herbs		x		X			

Unit Quiz (Weeks 5-6)

Classify each of the following substances as element, compound, homogenous mixture, heterogeneous mixture.

1) Ammonia gas (NH_3) ______________________________

2) Vinegar (acetic acid dissolved in water) ______________________________

3) Nitrogen gas (N_2) ______________________________

4) Silver (Ag) ______________________________

5) Smoke ______________________________

6) Pure Ice ______________________________

7) Sugar ($C_6H_{12}O_6$) ______________________________

8) Neon gas (Ne) ______________________________

9) Kids in a pool ______________________________

10) Alcohol dissolved in water ______________________________

11) Draw a phase change diagram for nitrobromomethane using the following pieces of information:

Melting point = 10°C and boiling point = 90°C
Heating begins with the sample at 5°C and continues until 100°C
Melting begins at 3 minutes and finishes at 6.5 minutes
Boiling begins at 12 minutes and finishes at 15 minutes

12) Boris and his friends were looking at tiny crystals of salt with a magnifying glass. The wondered what they would see if they had a magnifying device powerful enough to see the atoms. This is what they thought they might see:

Mike: "The atoms would be packed tightly together. They would look like a solid material without any empty spaces between the atoms."

Shelly: "I think I would see vibrating atoms arranged in an orderly way with spaces between them. There would be nothing in the spaces, not even air."

Chris: " I think I would see atoms not moving and arranged in an orderly way with spaced between them."

Sam: "I think I would see vibrating atoms arranged in an orderly way. There would be space between the atoms. The space would be filled with air."

Daniel: "I think I would see atoms in the shape of small cubes. Each of these small cubes would join together to form a larger cube of salt."

Katy: " I think I would see lots of vibrating atoms connected together by little lines. The lines connecting each atom give them a definite cube shape."

Kathrine: "I think I would see individual atoms moving from place to place. They would be moving all about the inside of the crystal shape."

Which student do you most agree with and why?

13) Suppose that you are the new owner of Mr. Q's Recycling Factory and you looking for business. An official from Kansas City tells you that they have a dump truck full of recyclable materials that must be separated, and they will pay you $5,000 to do it. Unfortunately, the job is made more difficult because someone has ground all of the materials into a fine powder, making it impossible to separate them by hand. Fortunately, you know what the materials are in the truck as well as their densities:

Material	Density (g/mL)
Aluminum soda cans	2.7
Steel cans	5.7
Milk jugs	0.95
Soda bottles	1.4

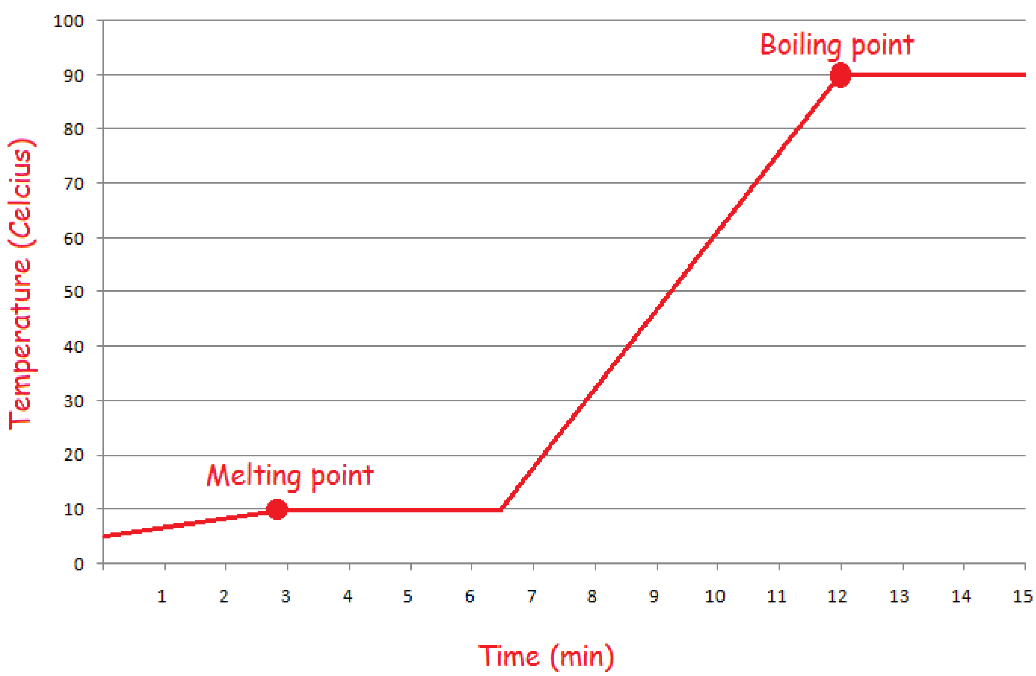
In your factory, you have the following materials at your disposal:

- A long conveyor belt
- A large tank that can be filled with water (Density=1.0 g/mL)
- Another large tank labeled "concentrated sugar water" (Density=1.5 g/mL)
- Several powerful magnets hanging above the conveyor belt
- Several nets for skimming the tanks and scooping material from the bottoms of the tanks.

Your job is to find a way to separate the four recycled materials. You may need to do this in several steps. List your procedure below:

Unit Quiz Answer Key

1) pure substance/compound
2) mixture/homogeneous
3) pure substance/element
4) pure substance/element
5) mixture/homogeneous
6) pure substance/compound
7) pure substance/compound
8) pure substance/element
9) mixture/heterogeneous
10) mixture/homogeneous
11)



Melts at 10 degrees Celcius (3-6.5 minutes)
Boils at 90 degrees Celcius (12-15 minutes)

12) Shelly; Atoms of sodium and chloride will line up in a crystal structure. Since all atoms are always in motion, even those which are solids, they would be vibrating in place. Air cannot possibly exist in between this structure as air is composed of atoms of similar size to those of sodium and chlorine.
13) Answers will vary; one possible solution may include the following procedure:
    - Place the mixture on a conveyor belt that runs under large magnets. The steel cans will be separated from the rest of the mixture.
    - Place the remainder of the mixture in the tank of water. The aluminum and soda bottles will sink, while the milk jugs will float and can be skimmed off the top of the water.
    - Place the aluminum and soda mixture into the tank of sugar water. The sugar water will cause the soda bottle fragments to float, while the aluminum dust will settle to the bottom.

Chapter Seven

Atoms and Energy

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Block of American cheese (Velveeta) or a Hershey's chocolate bar
Cheese slicer or knife
Microwave oven
Plate
Calculator

National Science Education Standards covered this week:

12BPS1.2 The atom's nucleus is composed of protons and neutrons, which are much more massive than electrons. When an element has atoms that differ in the number of neutrons, these atoms are called different isotopes of the element.

12BPS6.1 Waves, including sound and seismic waves, waves on water, and light waves, have energy and can transfer energy when they interact with matter.

Definitions

electromagnetic waves	energy which is released from an oscillating electron
frequency	the rate of oscillations within electromagnetic waves

Sample questions to ask your child after completing the weekly reading.

What role do electrons have with the colors produced by fireworks?
Each element can produce a unique electromagnetic wave pattern (light color) which provides its own unique amount of energy. Therefore, when certain elements are ignited, they produce their own unique color.

Why is the lowest energy level for electrons near the nucleus of the atom?
The farther they are from the nucleus, the more energy electrons have.

Why do electrons jump back to a lower energy level?
Everything in the universe tends to move towards the lowest energy possible.

What is produced by an atom when its electrons are shaken back and forth and side to side really fast?
The oscillation of electrons with an atom produce electromagnetic (EM) waves.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) A continuous spectrum is the line spectra for white light.
2) Line spectra tell you what color(s) of light are being emitted by an individual element.
3) When an atom is excited, its electrons have absorbed some form of energy and have jumped to a higher energy level.
4) When electrons fall back to lower energy levels, light energy is released.
5) All physical systems tend to move towards the lowest possible energy level.

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Block of American cheese (Velveeta) or a Hershey's chocolate bar
Cheese slicer or knife
Microwave oven
Plate
Calculator

Measuring the speed of light with cheese or…

"Not-cho" ordinary lab activity

The speed of light will be calculated using a household microwave.

Ingredients:

Block of American cheese (Velveeta) and cheese grater or a Hershey's chocolate bar
Microwave oven
Plate
Calculator

Recipe:

1) Use your cheese grater and cut one long slice of Velveeta cheese. If you do not have a cheese grater, a large flat bar of chocolate will work just as well.
2) Remove the turntable or any roller mechanism out of the microwave and put the plate of cheese or chocolate inside. You do not want the plate to rotate!
3) Turn the heat to full power for 20 seconds. When you take the plate out, you will see one to three areas where the food has been melted. If no melting has occurred, "zap it" for another few seconds.
4) Measure the distance between these two lines in inches, multiply that number by two and multiply this new number by .00002 to give you the wavelength of radiation (in miles) running through your microwave. Write this number (wavelength) down.
5) Look on the back of the oven to find a label that tells you the frequency the oven operates at. An average frequency on microwaves is around 2450MHz, or 2450 million waves per second. Write this number (frequency) down.

6) Now, simply multiply the first number (wavelength) and the second number (frequency) to receive the speed of light in miles per second.
7) If you have done your math correctly, you should have a number that is close to 186,000.

Explanation:

Your microwave has a component on one side of the oven which sends out energy as a wave - the same sort of wave as a radio wave or a light wave. This wave is perfectly even and regular. Where the wave is at its highest and lowest points, it is reinforced by the waves that are bouncing around inside the oven so that two hot spots are created a half-wavelength apart.

You multiply the distance between the melted cheese by two to identify one complete wavelength. Most microwaves have a stationary emitter and the food is revolved on a turntable to rotate it evenly through the hotspots.

Some microwave ovens have a rotating emitter. The plate in these ovens stands still and the hot spots move. If your microwave doesn't have a turntable, it won't be possible to do this experiment.

The speed of light is 186,000 miles per second. At that speed you could run around the equator of the Earth seven times per second! The use of math to reinforce scientific concepts is essential for every branch of science.

Chapter Eight

Orbitals and Energy Level Diagrams

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

One pizza dough (from the recipe in Chapter 6) or an English muffin
½ cup marinara sauce (from the recipe in Chapter 8) or canned
½ - 1 cup shredded mozzarella cheese
Olive oil
Flour
Rolling pin (optional)

National Science Education Standards covered this week:

12BPS6.2 Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

Definitions

energy levels (orbitals)	layers around a nucleus which contain specific numbers of electrons
quantum mechanics	branch of science in which scientists study the measurable (quantifiable) movements of atoms within orbitals
electron configuration	a method of describing electron orbitals
energy level diagram	visual tool used to identify how to write out the electron configurations of elements
valence electrons	electrons that make up the outermost s and p orbitals

Sample questions to ask your child after completing the weekly reading.

What is the purpose of writing out an element's electron configuration?
An element's electron configuration provides us with its number of orbitals and the number of electrons in its outermost energy levels.

Why is the outermost energy level within an atom not filled up with electrons first?
Since the 1s orbital is closest to the nucleus, it has the lowest possible energy out of all the orbitals. The 1s orbital has to be filled up first, followed by the 2s, then the 2p and so on. This is because everything in the universe tends to move towards the lowest energy possible.

Which electrons are most accessible to other atoms?
Valence electrons are the most accessible to other atoms and are located at the outermost regions of each atom.

What are the names and maximum number of electrons in each of the four orbitals?
s orbitals = 2 electrons
p orbitals = 6 electrons
d orbitals = 10 electrons
f orbitals = 14 electrons

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $1s^2\ 2s^2\ 2p^6\ 3s^1$
2) $1s^2\ 2s^2\ 2p^6\ 3s^2$
3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6$
4) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$
5) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$

Determine what elements are denoted by the following electron configurations:

6) Sulfur
7) Aluminum
8) Neon
9) Chlorine
10) The 3d level should come after the 4s level.
11) The 3s level cannot hold 3 electrons.
12) 3s needs one more electron
13) Switch 2p and 2s
14) phosphorus
15) calcium
16) scandium
17) iodine
18) argon
19) lead
20) $1s^2 2s^2 2p^6$
21) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
22) $1s^2 2s^2 2p^6 3s^2 3p^1$
23) $1s^2\ 2s^1$
24) $1s^2 2s^2 2p^1$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

One pizza dough (from the recipe in Chapter 6) or an English muffin
½ cup marinara sauce (from the recipe in Chapter 8) or canned
½ - 1 cup shredded mozzarella cheese
Olive oil
Flour
Rolling pin (optional)

A pizza's lowest possible energy or…

Pass me a slice of that thermal energy!

All physical systems tend towards the lowest possible energy – even in pizza!

Ingredients:

One pizza dough (from the recipe in Chapter 6) or an English muffin
120 mL marinara sauce (from the recipe in Chapter 8) or canned
120mL-240mL shredded mozzarella cheese
Olive oil
Flour
Rolling pin (optional)

Recipe:

1) If you saved some of your dough and sauce from chapters 6 and 8, take them out and let them sit in the refrigerator overnight.
2) About 2-3 hours before you want to eat, take the dough out of the refrigerator and place it on the counter. It needs to come to room temperature for the next couple of hours.
3) Once it has warmed up, place it on a well-floured surface and flatten it out using a rolling pin or simply with your hands.
4) Cover it with a towel and place it in a warm area for about 30 minutes. When this is done, use a fork to place several holes in the surface of the dough.
5) Place the dough onto a cookie sheet, spread a small amount of oil on its surface, and bake it at 500°F for 1-2 minutes.
6) Remove the dough from the oven and cover it with the marinara sauce and then the mozzarella.
7) Bake for 7-10 minutes more until the cheese is completely melted and the dough crust begins to turn a golden brown.
8) Remove the pizza from the oven and allow it to set for 5-10 minutes.

9) Cut the pizza into slices and CAREFULLY take a bite. Be very observant about what parts of the pizza seem cooler to the touch. And be very careful of the sauce and cheese! They will feel much warmer than the crust!
10) If you happened to have eaten all of your bread and marinara (I wouldn't blame you), you can substitute an English muffin and store-bought pizza sauce.

Explanation:

A very general reason why the crust of your pizza didn't burn you but the cheese may have been a little on the hot side is because of what you studied this week:

Everything in the universe tends to move towards the lowest energy possible.

Every part of that pizza slice was the same temperature when you picked it up. It was inside a 500°F oven, right? However, the thermal energy of the pizza was not conducted into your body evenly, was it? Certain objects in the world have a higher ability to store their heat. This ability is known as **heat capacity** and is very different among the crust and cheese of your pizza. Even though both of these areas on your pizza had the same temperature, the cheese and sauce could transfer its heat much easier than the crust. And where did all of this heat go? You guessed it! Right into your mouth, which, by the way, is much cooler than your 500°F pizza slice.

You see, heat is the transfer of thermal energy from a hotter object to a colder object. And why does heat move from hotter to cooler areas? Because ...

Everything in the universe tends to move towards the lowest energy possible.

There is much less energy in a system which has its thermal energy spread out evenly throughout its surface. Much like with electrons filling up their empty orbitals, the lowest energy areas always get filled first. This can be done either with electron orbitals or with the transfer of heat from hot to cooler areas. Now go get some ice for that tongue and wait a few more minutes before eating the rest of your pizza.

Unit Quiz (Weeks 7-8)

Determine what elements are denoted by the following electron configurations. You may use a periodic table as a reference:

1) $1s^2\ 2s^2 2p^6 3s^1$ ____________________________

2) $1s^2\ 2s^2 2p^6 3s^2 3p^5$ ____________________________

3) $1s^2\ 2s^2 2p^6 3s^2 3p^6 4s^2$ ____________________________

4) $1s^2\ 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$ ____________________________

Explain what is wrong (if anything) with the following electron configurations:

5) $1s^2 2s^2 2p^6 3s^2 3p^2 4s^6 3p$

6) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$

7) $1s^2 2s^2 3s^2 3p^6 4s^2 3d^4$

8) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

Construct the electron configurations for the atoms which contain the following numbers of electrons:

9) 26 ____

10) 22 ____

11) 17 ____

12) How many electrons would an atom need to have before it can begin filling the 3s sublevel?

13) What is the first element that has enough electrons to have one in the 3s sublevel?

14) How many electrons would an atom need to have before it can begin filling the 3d sublevel?

15) What is the first element that has enough electrons to have one in the 3d sublevel?

Fill in the missing numbers and then write the names of the elements from the following electron configurations:

16) $1s^22s^22p^{-}3s^2$ ______________________________

17) $1s^22s^22p^63s^2\_p^64s^2$ ______________________________

18) $1s^22s^22p^63s^2\ \_p^2$ ______________________________

19) $1s^22s^22p^63s^2\_p^6\_s^23d^{10}\_p^1$ ______________________________

Unit Quiz Answer Key

1) Sodium
2) Chlorine
3) Calcium
4) Gallium
5) 3p should have 6 electrons and 4s should have 2 electrons
6) Switch 3d and 4s
7) Missing 2p orbital
8) No errors
9) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
10) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$
11) $1s^2 2s^2 2p^6 3s^2 3p^5$
12) 10; before the 3s can be filled, all of the 1s, 2s, and 2p orbitals must be filled
13) The 11^{th} electron goes into the 3s sublevel. This element is sodium.
14) 20 electrons
15) The 21^{st} electron goes into the 3s sublevel. This element is scandium.
16) 6 – Magnesium
17) 3 – Calcium
18) 3 - Silicon
19) 3, 4, 4 - Gallium

Quarterly Test

Chapters 1-8

This test contains both a pre- and post-test for your child.

Once the pre-test has been completed and reviewed, the post-test may be administered.

The pre-test has been constructed to build upon the mechanics of various chemistry problems, while the post-test is designed for a deeper understanding of these mechanics.

Prior to this exam, it is highly recommended that the weekly practice problems and unit quizzes be reviewed by the child!

Pre-Test (Units 1-4)

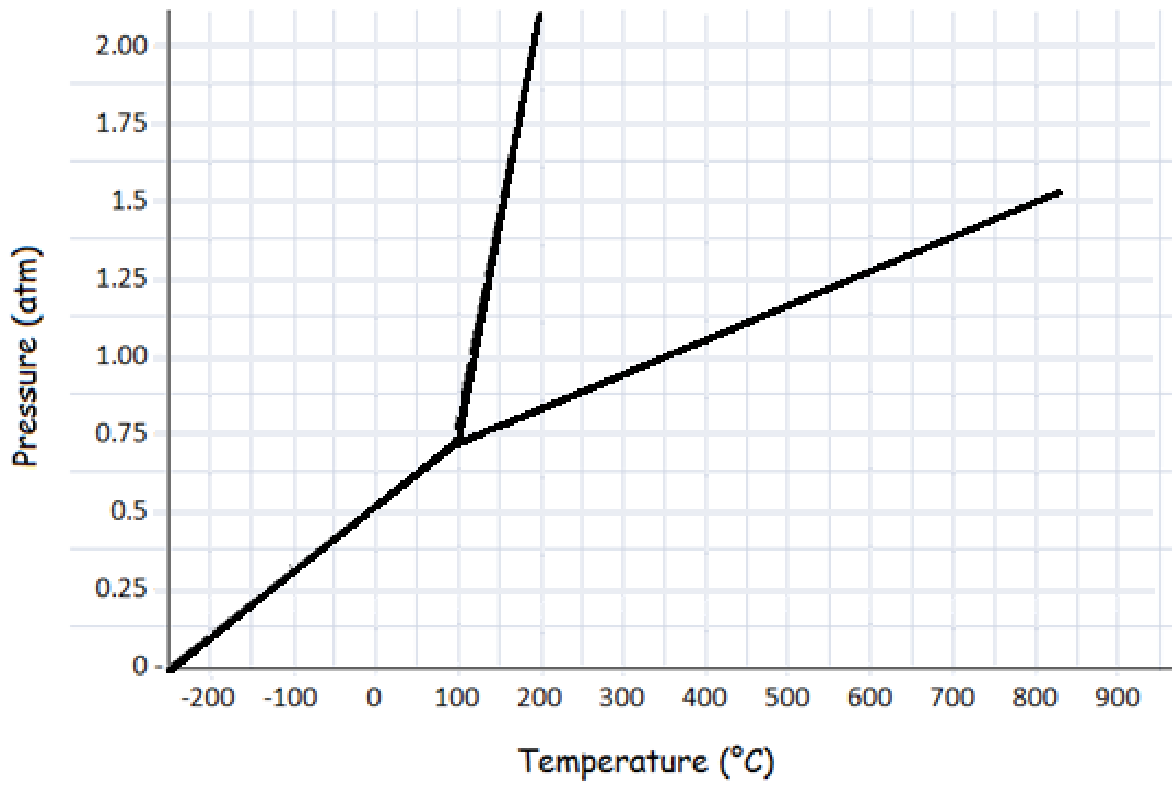
1) Your car's gas tank holds 18.6 gallons and is one quarter full. Your car gets 16 miles/gal. You see a sign saying, "Next gas 73 miles." Should you stop for gas or will you have plenty until you reach this gas station?

2) You're throwing a sushi party for 15 and figure each person might eat 4 pieces. How much is the sushi going to cost you? You call up Uncle Mack's Sushi Barn and learn that each sushi roll will cost you $14.78 and will be cut into 12 pieces. You tell them you'll call back. You have $70. Do you have enough money? <u>Use dimensional analysis to support your answer</u>.

3) One of you experimentally determines the density of Mr. Q's brain to be 4.09 g/mL. This cannot possibly be true as everyone knows Mr. Q's is much denser than that! His actual brain density is 4.18 g/mL. What is your percent error?

4) The mass of sugar in a 2L bottle of soda has an accepted mass of 200.00 grams. You evaporate the fluid and experimentally determine the average mass of the sugar to be 196.5 grams. What is the percent error?

Refer to the phase diagram below when answering the following questions: (remember – normal air pressure is 1atm)



5) Label the following on the phase diagram above: Solid phase, liquid phase, gas phase, triple point, critical point.

6) What is the normal melting point of this substance?

7) What is the normal boiling point of this substance?

8) What is the normal freezing point of this substance?

9) If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of $0^{\circ}C$ and heated it until the temperature was $750^{\circ}C$, what phase transition(s) would occur?

10) At what temperature do the gas and liquid phases become indistinguishable from each other?

11) If I had a quantity of this substance at a pressure of 0.25 atm and a temperature of -100^{0} C, what phase change(s) would occur if I increased the pressure to 1.00 atm? At what pressure would it occur?

12) Fill in the blanks for the elements in this chart. For the purposes of this chart, round all atomic masses to the nearest whole number.

Element Symbol	# of Protons	# of Neutrons	# of Electrons	Atomic Mass	Atomic Number	Electron configuration
	3	4			3	
		6		12		
		18	17	35	17	
	54			131		
	82	125				

Pre-Test Answer Key

1) Your car's gas tank holds 18.6 gallons and is one quarter full. Your car gets 16 miles/gal. You see a sign saying, "Next gas 73 miles." Should you stop for gas or will you have plenty until you reach this gas station?

Do you have enough gas? Technically yes, but I wouldn't take the chance if I were you!

$$\frac{18.6\text{ gallons}}{1\text{ tank}} \;\Big|\; \frac{1\text{ tank}}{4\text{ quarter-tank}} \;\Big|\; \frac{16\text{ miles}}{1\text{ gallon}} = \frac{74.4\text{ miles}}{\text{quarter-tank}}$$

2) You're throwing a sushi party for 15 and figure each person might eat 4 pieces. How much is the sushi going to cost you? You call up Uncle Mack's Sushi Barn and learn that each sushi roll will cost you $14.78 and will be cut into 12 pieces. You tell them you'll call back. You have $70. Do you have enough money? <u>Use dimensional analysis to support your answer</u>.

Will you have enough money? No you will not.

$$\frac{\$14.78}{1\text{ roll}} \;\Big|\; \frac{1\text{ roll}}{12\text{ pieces}} \;\Big|\; \frac{4\text{ pieces}}{1\text{ person}} \;\Big|\; \frac{15\text{ people}}{1\text{ party}} = \frac{\$73.90}{\text{party}}$$

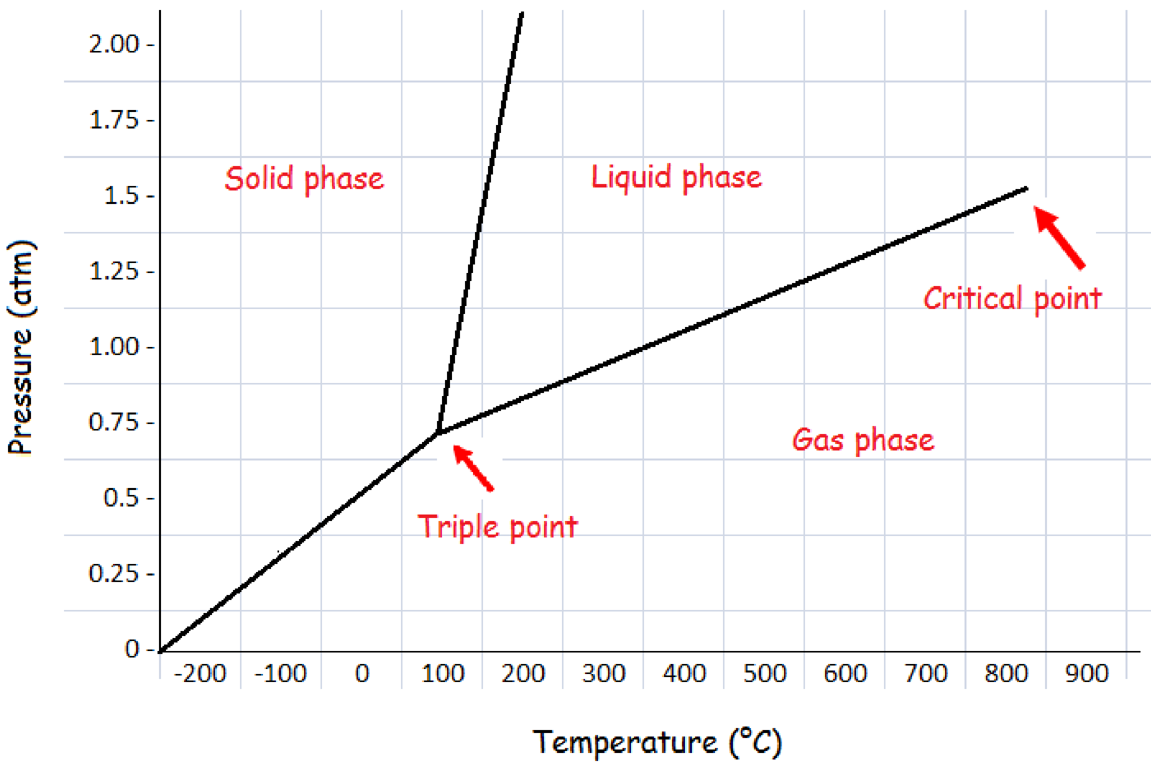
3) One of you experimentally determines the density of Mr. Q's brain to be 4.09 g/mL. This cannot possibly be true as everyone knows Mr. Q's is much more dense than that! His actual brain density is 4.18 g/mL. What is your percent error?

$$\frac{4.18\text{ grams} - 4.09\text{ grams}}{4.18\text{ grams}} \times 100 = 2.15\%$$

4) The mass of sugar in a 2L bottle of soda has an accepted mass of 200.00 grams. You evaporate the fluid and experimentally determine the average mass of the sugar to be 196.5 grams. What is the percent error?

$$\frac{200.00 \text{ grams} - 196.5 \text{ grams}}{200.00 \text{ grams}} \times 100 = 1.75\%$$

5)



6) What is the normal melting point of this substance?

The "normal" atmospheric pressure is at 1atm; therefore, the melting point for this substance would be ~100°C

7) What is the normal boiling point of this substance?

~375°C

8) What is the normal freezing point of this substance?

~100°C

9) If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of 0°C and heated it until the temperature was 750°C, what phase transition(s) would occur?

It would melt at ~140°C and boil/vaporize at ~600°C

10) At what temperature do the gas and liquid phases become indistinguishable from each other?

~820°C (critical point)

11) If I had a quantity of this substance at a pressure of 0.25 atm and a temperature of -100^{0}C, what phase change(s) would occur if I increased the pressure to 1.00 atm? At what pressure would it occur?

Deposition (gas to solid) would occur at ~ 0.35 atm

12)

Element Symbol	# of Protons	# of Neutrons	# of Electrons	Atomic Mass	Atomic Number	Electron configuration
Li	3	4	3	7	3	$1s^2\ 2s^1$
C	6	6	6	12	6	$1s^2\ 2s^2\ 2p^2$
Cl	17	18	17	35	17	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
Xe	54	77	54	131	54	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2 4d^{10}\ 5p^6$
Pb	82	125	82	207	82	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2 4d^{10}\ 5p^6 6s^2 4f^{14}\ 5d^{10}\ 6p^2$

Post-Test (Units 1-4)

Answer the following questions as they pertain to the answer key for Test 1

1) In #3, what would happen to the percent error if the experimental value was greater than the accepted value. Would this new percent error still be valid?

2) Why would the substance in question #9 not condense under the same circumstances?

3) Based upon the phase change diagram in this answer key, what phase changes would occur for this substance at 200° under normal air pressure? What would have to occur for these changes to take place?

4) If you were not provided any reference materials, how could you determine the number of neutrons found within the nucleus of an atom of silver?

5) If you doubled the normal pressure for the substance in questions #6-8, why would it be impossible to determine when vaporization would take place?

6) Describe the steps you took to solve for the missing variables in question #12 for the element carbon.

Post-Test Answer Key

1) Yes. The new percent error would be a negative number; however, the value would still accurately show the percent error generated by the experiment.
2) The substance in question #9 was being heated; therefore, condensation would not occur.
3) Four phase changes could take place at 200°C: vaporization, condensation, freezing, and boiling. In order for vaporization/condensation to take place the, atmospheric pressure must be ~0.80 atm and for freezing/boiling to take place the pressure must be ~2.0 atm.
4) You would not be able to determine these values without the assistance of a periodic table. Without knowing the atomic mass, it would be impossible to determine the number of neutrons for this element.
5) At 2.0 atm, you could not determine the vaporization point for this substance as it falls beyond its critical point.
6) Subtracting the atomic mass from the number of neutrons gives you the number of protons. This value is identical to the atomic number and also the number of electrons as well. Since the number of protons determines the type of element, you must conclude that the element is carbon.

Chapter Nine

Families of the Periodic Table

A chemistry teacher was berating the students for not learning the Periodic Table of the Elements. She said "Why when I was your age I knew both their names and weights." One kid popped up, "Yeah, but teach, there were so few of them back then."

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Paper and pencils
Something healthy to snack on (optional)

National Science Education Standards covered this week:

12BPS2.2 An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number), repeating patterns of physical and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies.

Definitions

non-metals	elements that are typically brittle, poor conductors of heat and electricity, have a very low density, have lower melting and boiling points, and are <u>gases</u> at room temperature
metals	the majority of elements which are typically hard, shiny, malleable, ductile, good conductors of heat and electricity, and have high densities, melting points, and boiling points
malleable	able to be pounded into sheets
ductile	can be drawn into wires
metalloids	elements found between the metals and non-metals on the periodic table which share the properties of both these types of elements
periods	horizontal rows within the periodic table
families (groups)	vertical rows within the periodic table
main block elements	eight families within the periodic table which contain similar chemical characteristics; alkali metals, alkaline earth metals, boron family, carbon family, nitrogen family, oxygen family, halogens, and noble gases
alkali metals	elements within the first family of main block elements that are very reactive with other elements, flammable in air and water, have low melting and boiling points, are soft, have low densities, and contain 1 valence electron
alkaline earth metals	Second main block family of elements which react in air and water (but not as violently as the alkali metals), contain low melting and boiling points (but they are higher than the alkali metals), are soft (but harder than – you guessed it, the alkali metals), and have low densities (but higher than those of the alkali metals); alkaline earth metals all have 2 valence electrons

boron family	third main block family of elements which contain mostly metals with the exception of boron itself, which is a metalloid; boron family elements all have 3 valence electrons
carbon family	fourth main block family of elements which are made up of metals, metalloids, and non-metals (of which carbon is a non-metal); elements in the carbon family have 4 valence electrons
nitrogen family	fifth main block family of elements which are made up of metals, metalloids, and non-metals (nitrogen itself is a non-metal); elements in the nitrogen family have 5 valence electrons
oxygen family	sixth main block family of elements which are made up of metals, metalloids, and non-metals (of which non-metal is a non-metal); this family is quite reactive with other elements (their reactivity is comparable to the alkaline earth metals); elements in the oxygen family have 6 valence electrons
halogens	seventh main block family of elements which are non-metals, are very reactive (much like the alkali metals), and each contain 7 valence electrons
noble gases	eighth main block family of elements which are the least reactive elements on the periodic table and each contain 8 valence electrons

Sample questions to ask your child after completing the weekly reading.

Which of the three main categories of elements within the periodic table contain the most elements?

Of these three categories (Metals, Non-Metals, and Metalloids) the metals contain the majority of the elements.

Elements within each period of the periodic table share few (if any) properties with each other with one small exception. What is this exception?

Elements in the same period have valence electrons in the same energy levels (orbitals) as each other.

Families of elements within each column tend to have very similar physical and chemical properties. What causes this to happen?

Elements within each family have similar electron configurations.

Out of all the elements within the column of alkali metals, which element does not belong to this family?

Hydrogen is found within the same column as the alkali metals but is not a member of this family.

Which families of the period table are the most reactive? Which are the least reactive?

The alkali metals and halogens are the most reactive. The noble gases are the least reactive.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) What was the main property you used to classify the elements into groups? Explain why you chose this property and not another.

   Answers will vary according to the materials.

2) What did the elements in each period have in common with one another? How did his property change as you moved down each period of your periodic table? Explain how you decided which element should go at the top of each column and which should go at the bottom.

   Answers will vary. This portion of the assignment may prove to be the most difficult as finding characteristics of materials that change in small increments may be difficult to locate. Because of this, lining up your materials may have been quite difficult. That's good!

3) How does this exercise give you any insight as to why it may have been difficult to invent the first periodic table? Explain.

   The ability to place your items within this small table may have been difficult; nevertheless, it would be infinitely harder if you were unable to visibly see the items as well! This is one challenge chemists faced when creating the periodic table.

4) Your periodic table contains five blank boxes. Based on the properties and characteristics you used when arranging your periodic table, what objects do you believe would fit well in those blank spaces? Explain your answer.

   Answers will vary. This question may also prove to be rather tricky depending upon the materials you chose. In any case, you should have a greater understanding of the problems associated with organizing any set of items within the similar rules governed by the periodic table!

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Paper and pencils
Something healthy to snack on (optional)

Periodic table of food or…

Will someone please set the table? I'm starving!

The creation of a personalized periodic table from various foods will be explored this week.

Materials:

Paper and pencils
Something healthy to snack on wouldn't be so bad either

Procedure:

1) List 20 of your favorite foods and drinks.
2) Describe basic characteristics of each of your food and drink items. For example, you might describe the primary ingredient, nutritional value, taste, and color of each item. You also could identify the food group of each item such as fruits/vegetables, grains, dairy products, meat, and sweets.
3) Create a data table to organize the information that you collect.
4) Using your data table, construct a periodic table of foods on your paper. Determine which characteristics you will use to group your items. Create families (columns) of food and drink items that share similar characteristics on your table. For example, potato chips, pretzels, and crackers could be combined into a family of salty tasting foods. Create as many groups as you need, and you do not need to have the same number of items in every family.

Explanation:

Many situations involve using dimensional analysis, such as cooking or baking. Dimensional analysis is a way of converting measurements into more common units using conversion factors. Your knowledge of dimensional analysis will be vital in future chapters! Keep practicing!

Chapter Ten

Atomic Radius and Electronegativity

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Bread flour (~3 cups)
Baking powder
Sugar
Salt
Baking soda
Cinnamon, nutmeg, vanilla (optional)
2 eggs
~3 cups whole milk
4 Tbs. vegetable oil or melted butter
Ruler

National Science Education Standards covered this week:

12BPS1.3 The nuclear forces that hold the nucleus of an atom together, at nuclear distances, are usually stronger than the electric forces that would make it fly apart. Nuclear reactions convert a fraction of the mass of interacting particles into energy, and they can release much greater amounts of energy than atomic interactions.

Definitions

atomic radius	a measurement of the relative length of an atom from its nucleus to its outermost orbital
electron affinity	the relative strength of an atom's charge; can be altered when the number of protons in each element is increased/decreased
ion	an atom that has gained or lost one or more electrons
cation	a positively charged ion
anion	a negatively charged ion
electronegativity	a measurement of how much an atom can pull electrons away from other atoms
octet rule	the phenomenon by which all elements move towards the filling their eight possible positions within their outermost s and p orbitals with electrons
shielding effect	the phenomenon by which the inner electrons of an atom act as a shield between the nucleus and the valence electrons which lowers the electronegativity of the atom

Sample questions to ask your child after completing the weekly reading.

Why does the atomic radius decrease as you move from left to right across the periodic table?

As you increase the number of protons in each element, their nuclei becomes more positively charged. This increased charge adds to the electron affinity of each element. Basically, the increased number of positively charged particles pulls the electrons a little closer to the nucleus, causing the overall size of the atom (atomic radius) to decrease a little bit.

Why does the atomic radius increase as you move down the periodic table?

The elements within each family contain the same number of electrons in their outermost orbital. However, as you move from element to element down one family, the number of energy levels increases. Since the number of energy levels increases, so does its size!

What has to happen to an element in order for it to become an ion?

When an atom gains or losses one or more electrons it becomes an ion.

Which has a larger ionic radius – cations or anions?

Cations have a smaller ionic radius than the atoms in which they were created because their fewer numbers of electrons takes up less space. Anions, on the other hand, have gained extra electrons which causes their ionic radius to increase.

The periodic table demonstrate that from left to right, the electronegativity of elements increases; and, from top to bottom it decreases. What exception exists for this rule?

The exception for this rule exists within the noble gases. Since all of their seats are filled in their valence orbitals, they are the most stable and will not pull electrons from other elements. All elements want to be like the noble gases because of their stability.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) a) Ba; b) S^{-2}; c) Cu; d) H^{-1}; e)Na
2) largest radius: S^{2-}, highest electronegativity: S, smallest atom: Be
3) From smallest to largest: oxygen < carbon < aluminum < potassium
4) From smallest to largest: neon < aluminum < sulfur < oxygen
5) Because they have similar electron configurations and the same number of valence electrons. Because valence electrons are responsible for most of the chemistry we observe, this similarity causes the properties of the elements to also be similar.
6) Decreases
7) Increases
8) Smaller
9) Larger
10) a) Na; b) I; c) Cs; d) Ar
11) He, Ne, Ar
12) Increases; The element below has one more energy level than the element above
13) Decreases; Although there are no additional energy levels, there are more charges within the ion allows for more pulling effect
14) As the radius increases, the shielding effect increases too
15) To become an cation, the atom must lose electrons
16) To become a anion, the atom must acquire electrons
17) The radius becomes larger
18) The radius becomes smaller

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Bread flour (~3 cups)
Baking powder
Sugar
Salt
Baking soda
Cinnamon, nutmeg, vanilla (optional)
2 eggs
~3 cups whole milk
4 Tbs. vegetable oil or melted butter
Ruler

Bicarbonate ion pancakes or…

Waiter! There are IONS in my pancakes!

The role of the bicarbonate ion will be demonstrated throughout the cooking of pancakes.

Ingredients:

Bread flour (720mL)
Baking powder
Sugar
Salt
Baking soda
Cinnamon, nutmeg, vanilla (optional)
2 eggs
720mL whole milk
60mL vegetable oil or melted butter

Other items:
Ruler

Recipe #1:

Measure out 480mL of milk and allow it to come to room temperature (about an hour) along with two eggs.

<u>In a mixing bowl, whisk together the following dry ingredients:</u>

300mL cups flour
15mL baking soda
15mL sugar
2.5mL NaCl
Dash of cinnamon, nutmeg, and/or vanilla for taste

<u>In a separate bowl, mix together the following:</u>

1 egg
240mL milk
30mL vegetable oil or melted butter

Mix the wet ingredients into the dry, stirring with a whisk or spoon to combine. Allow the mixture to set for 5 minutes. Cook on a griddle or nonstick frying pan set over medium heat until golden brown, about two minutes per side.

Using your ruler, measure the height of your pancakes (be certain to make several) and record the average height.

Recipe #2:

Repeat the same recipe as before; however, do not use the baking soda. In its place, use an equal amount of baking powder.

Measure the average height of your pancakes from this new recipe.

Explanation:

One of the biggest mysteries in the kitchen has to be the "unknown" difference between baking soda and baking powder. A quick answer would be this:

Both chemicals react with a liquid to form carbon dioxide gas which causes the fluffiness of pancakes; however, baking soda is a base (Sodium bicarbonate) and requires an acidic liquid to form carbon dioxide gas.

Baking powder is a mixture of baking soda and a powdered acid. When baking powder is dissolved in ANY liquid, the sodium bicarbonate and powdered acid react with each other to form carbon dioxide gas.

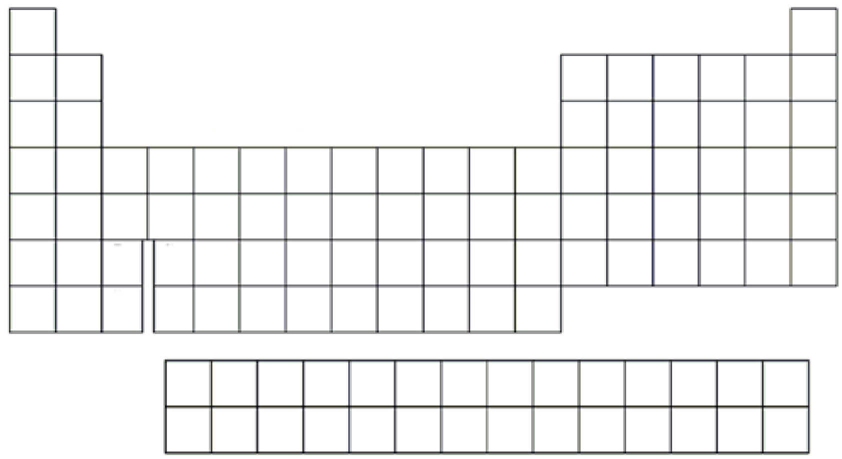
When baking soda dissolves, its molecule breaks apart into two different ions – a sodium ion and a bicarbonate ion. It is the bicarbonate ion which reacts very well with acidic ions to form carbon dioxide gas.

If there are few acidic ions in your pancake batter (much like with Recipe #1), a smaller amount of gas will be produced. Because of the reduced amount of gas, your pancakes from Recipe #1 were probably not as fluffy (tall) as with the second recipe.

Within Recipe #2 there were plenty of acidic ions! These were provided by the powdered acid within the baking powder. When the bicarbonate ions reacted with the acidic ions in the batter, the larger amount of gas should have caused your pancakes to become much fluffier and taller.

Unit Quiz (Weeks 9-10)

1) **Put an "x" in every box that represents the most reactive elements and "0" in every box that represents the least reactive elements we have studied so far.**



2) List the following atoms in order of increasing electronegativity:

O, Ca, Al

3) List the following atoms in order of decreasing electronegativity:

Cl, K, Cu

4) What is the general trend of electronegativity as you go down the periodic table?

5) What is the general trend of electronegativity as you go left to right across the periodic table?

Arrange the following atoms or ions in order of increasing atomic radius:

6) Br^-, Ca^{+2}, K^+, Se^{-2} ______________________________

7) Si, Na^+, Mg^{+2}, O^{-2} ______________________________

8) As^{-3}, Ca^{+2}, Cl^-, K^+ ______________________________

9) What is the element with the greatest electronegativity?

10) In period 2, which element has the smallest atomic radius?

11) In the halogen family, which element has the largest atomic radius?

12) Which element has both metallic and nonmetallic properties?

a) Rb
b) Rn
c) Si
d) Sr

13) Using the 10 clues at the bottom, please place the fictional elements in their correct places in the blank periodic table at the end of this quiz.

	1							18
1	1	2	13	14	15	16	17	2
2	3	4	5	6	7	8	9	10
3	11	12	13	14	15	16	17	18
4	19	20	31	32	33	34	35	36
5	37	38	49	50				

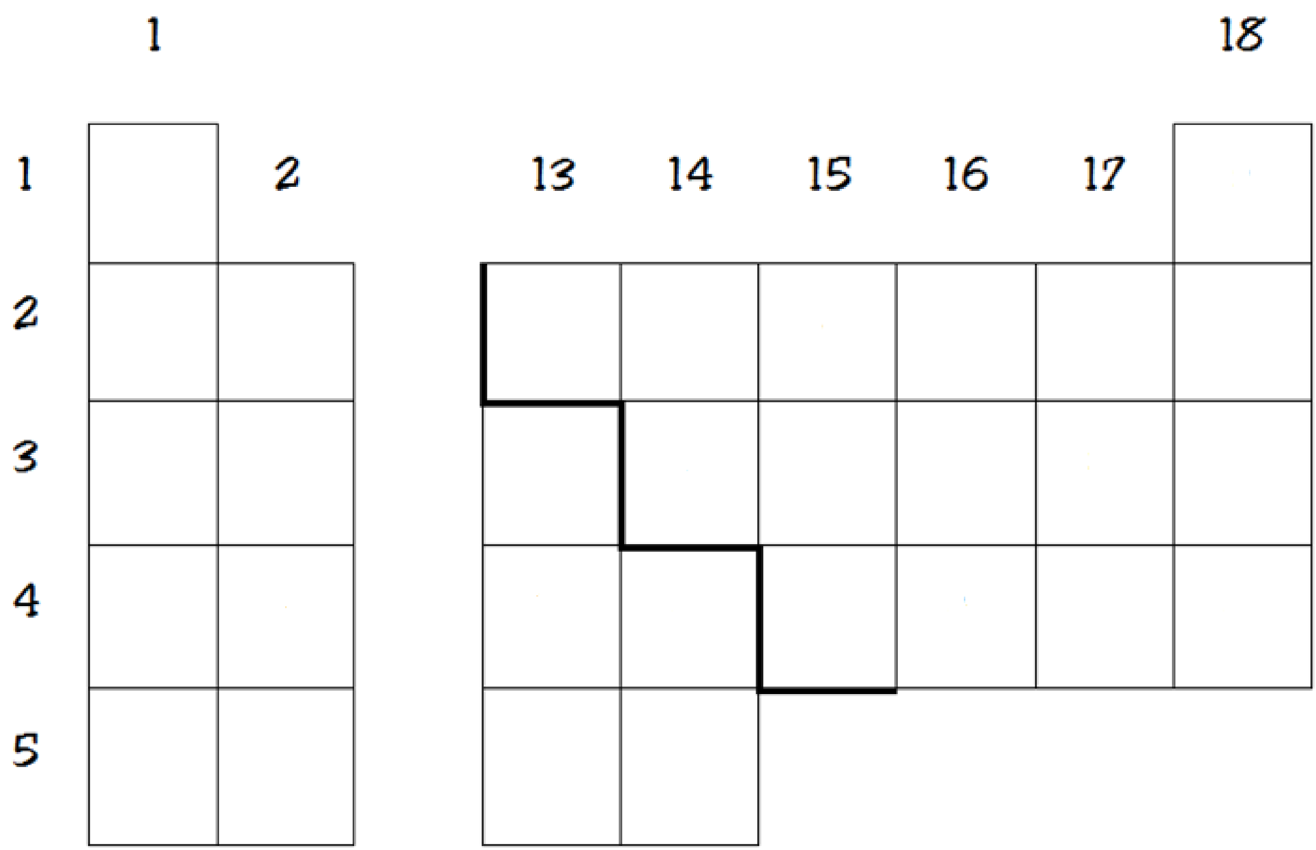
a. The noble gases are bombal (Bo), wobble (Wo), jeptum (J), and logon (L). Among these gases, wobble has the greatest atomic mass and bombal the least. Logon is lighter than jeptum.

b. The most reactive group of metals are xtalt (X), byyou (By), chow (Ch), and quackzil (Q). Of these metals, chow has the lowest atomic mass. Quackzil is in the same period as wobble.

c. Apstrom (A), vulcania (V), and kratt (Kt) are nonmetals whose atoms quickly gain or share one electron. Vulcania is in the same period as quackzil and wobble.

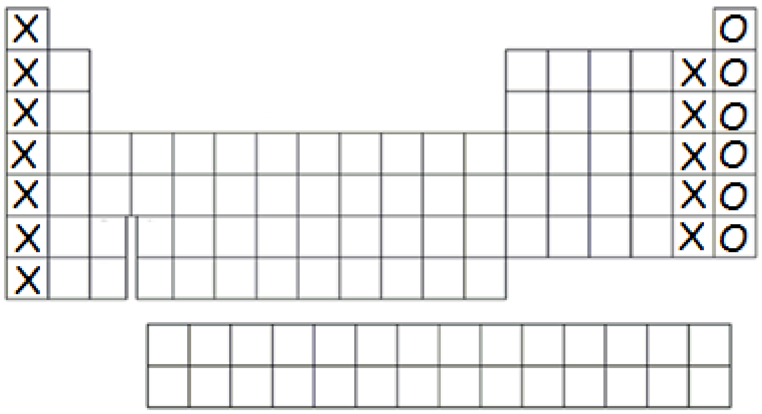
d. The metalloids are Ernst (E), highho (Hi), terriblum (T), and sississ (Ss). Sissis is the metalloid with the greatest atomic mass. Highho and terriblum are in Group 14. Terriblum has more protons than highho. Yazzer (Yz) touches the zigzag line, but it's a metal, not a metalloid.

e. The lightest element of all is pfsst (Pf). The heaviest element in the group of 30 elements is eldorado (El). The most chemically active non-metal is apstrom. Kratt reacts with byyou to form table salt.
f. The element doggone (D) has only four protons in its atom.
g. Floxxit (Fx) is important in the chemistry of life. It forms compounds made of long chains of atoms. Rhaatrap (R) and doadeer (Do) are metals in the fourth period, but rhaatrap is less reactive than doadeer.
h. Magnificon (M), goldy (G) and sississ are all members of group 15. Goldy has fewer total electrons than magnificon.
i. Urrp (Up), oz (Oz), and nuutye (Nu) all gain 2 electrons when they react. Nuutye is found as a diatomic molecule and has the same properties as a gas found in Earth's atmosphere. Oz has a lower atomic number than urrp.
j. The element anatom (An) has atoms with a total of 49 electrons. Zapper (Z) and pie (Pi) lose two electrons when they react. Zapper is used in flashbulbs.



Unit Quiz Answer Key

1)



2) From smallest to largest: Ca → Al → O
3) From largest to smallest: Cl → Cu → K
4) decreases
5) increases
6) From smallest to largest: Br < Se < Ca < K
7) From smallest to largest: O, < Si < Mg < Na
8) From smallest to largest: Cl < As < Ca < K
9) Fluorine (F); Electronegativity increases from left to right across a period and decreases from top to bottom.
10) Neon (Ne); Atomic radius decreases from left to right across a period and increases from top to bottom.
11) Astatine (At); Atomic radius decreases from left to right across a period and increases from top to bottom.
12) c) Si

	1							18
1	Pf	2	13	14	15	16	17	Bo
2	Ch	D	E	Fx	G	Nu	A	L
3	By	Z	Yz	Hi	M	Oz	Kt	J
4	Q	Do	R	T	Ss	Up	V	Wo
5	X	Pi	An	El				

Answers to the fictional periodic table:

Group 1 (vertical) is Pfsst(Pf), Chow(Ch), Byyou(By), Quackzil(Q), Xtalt(X)

Group 2 are Doggone(D), Zapper(Z), Doadeer(Do), and Pie(Pi)

Group 13 are Ernest(E), Yazzer(Yz), Rhaatrap(R), and Anatom(An)

Group 14 are Floxxit(Fx), Highho(Hi), Terriblum(T), Elrado(El)

Group 15 are Goldy(G), Magnifica(M), Sississ(Ss)

Group 16 is Nuutye(Nu), Oz, and Urrp(Up)

Group 17 are Apstom(A), Kratt(Kt), and Vulcania(V)

Group 18 are Bombai(Bo), Logon(L), Jeptum(J), and Wobble(Wo)

Chapter 21

Solutes and Solvents

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Fresh spinach leaves (one small bag)
3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

National Science Education Standards covered this week:

12BPS2.5 Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.

Definitions

solubility	the ability of a solute to be dissolved by a solvent
polar molecule	phenomenon in which one of the atoms within a molecule "pulls" on its electrons a little stronger than the other atom(s) that are bonded together
nonpolar molecule	phenomenon in which the electrons within a molecule are spread evenly throughout its structure; no single atom within the molecules "pulls" on its electrons with a greater force due to their similar electronegativity

Sample questions to ask your child after completing the weekly reading.

Which does all of the dissolving within a solution – the solute or the solvent?

The solvent is responsible for the dissolving of solutes within a solution.

What is one way to determine when a solute will be dissolved by a solvent?

The electronegativity of substances can determine whether or not certain solutes will be dissolved by solvents.

What is mean by the phrase "Like dissolves like"?

When determining the solubility of a substance, this phrase states that polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes.

What are three ways to increase the speed in which a solute is dissolved?

To increase the speed of dissolving a solute, you could grind the solute particles and make them smaller, stir the solute, or increase the temperature of the solution.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Water is more polar; the difference in electronegativities in water is 1.4 and the difference in hydrogen sulfide (H_2S) is 0.4; therefore, water is a more polar molecule than hydrogen sulfide.
2) Nitrogen triiodide (NI_3) is more polar; the difference in electronegativities in nitrogen triiodide is 0.5, while carbon disulfide (CS_2) is 0 (nonpolar).
3) nonpolar
4) nonpolar
5) polar
6) nonpolar
7) nonpolar (ionic)
8) polar
9) polar
10) polar
11) polar
12) polar
13) polar
14) Oxygen dichloride; both oxygen dichloride (OF_2) and methanol are polar, while carbon diselenide (CSe_2) is not.
15) Methanol (CH_3OH); while both compounds are polar, methanol is considerably less polar than lithium chloride (LiCl). Ionic compounds always have a full charge separation, while covalent compounds do not.
16) Ammonia (NH_3); both water and ammonia are polar. Sulfur dibromide (SBr_2) is not.
17) Water; both water and isopropanol are polar. Methane is not.

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

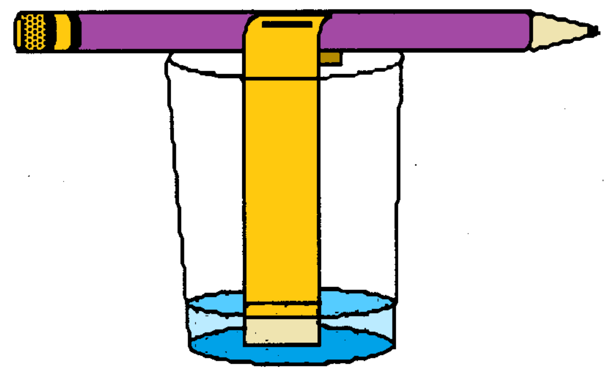
Fresh spinach leaves (one small bag)
3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan

Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

Paper chromatography or…

What is hiding in my salad?

Solutes, solvents, and solutions within vegetables will be reviewed using a simple extraction technique.



Ingredients:

Fresh spinach leaves (one small bag)

Other items:

3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

Recipe:

Okay… It would be WAY too easy to simply have you create a soup or stew as an example of how solutes, solvents, and solutions work in the kitchen. Why not take this opportunity to try something a little different?

1) Cut a strip of coffee filter approximately 5 cm taller than the height of the up and about half its diameter. (See the picture for assistance.)
2) Place a pencil mark across the strip of paper about 1 cm from the bottom. This will be the area where you place the solutes.
3) Place a second pencil mark 6 cm from the first pencil mark. This will be the end attached to the pencil.

4) Place a fresh spinach leaf on the first line of the paper strip. Using the edge of your coin, press down gently until a heavy green mark is visible.
5) Repeat this last step with a blanched spinach leaf.

How to blanch spinach:

a) Fill a large pot with water, bring it to a boil, and add a few spinach leaves.
b) Remove the leaves after approximately 30 seconds or until they turn a brilliant green color.
c) Drain and immediately place the leaves in a bowl of ice water. This stops the cooking process.
d) Squeeze out all of the excess water.

6) Dry the strip with a hair dryer or fan.
7) Wrap the top of the strip (with the second pencil line you drew) over the pencil itself and tape in place.
8) Slowly add enough rubbing alcohol to the cup to submerge the end of the strip <u>without submerging the pencil line!</u>
9) Do not allow the strip to touch the sides of the cup.
10) Cover the top of the cup tightly with plastic wrap.
11) Continue to monitor the strip as the rubbing alcohol moves upwards until it reaches the second pencil line near the pencil.
12) Circle each colored band with a pencil. Draw the colored band on the attached worksheet and compare with the sample drawing within the appendix.

Explanation:

Before we dig into the science behind today's lesson, let's take a brief look at the process of blanching. Cooks use the method of blanching to prepare many different vegetables in their recipes. It tends to soften vegetables, intensify their color, and heightens their flavor. I highly recommend this process for several vegetables you prepare at home! Now, it's time for some science...

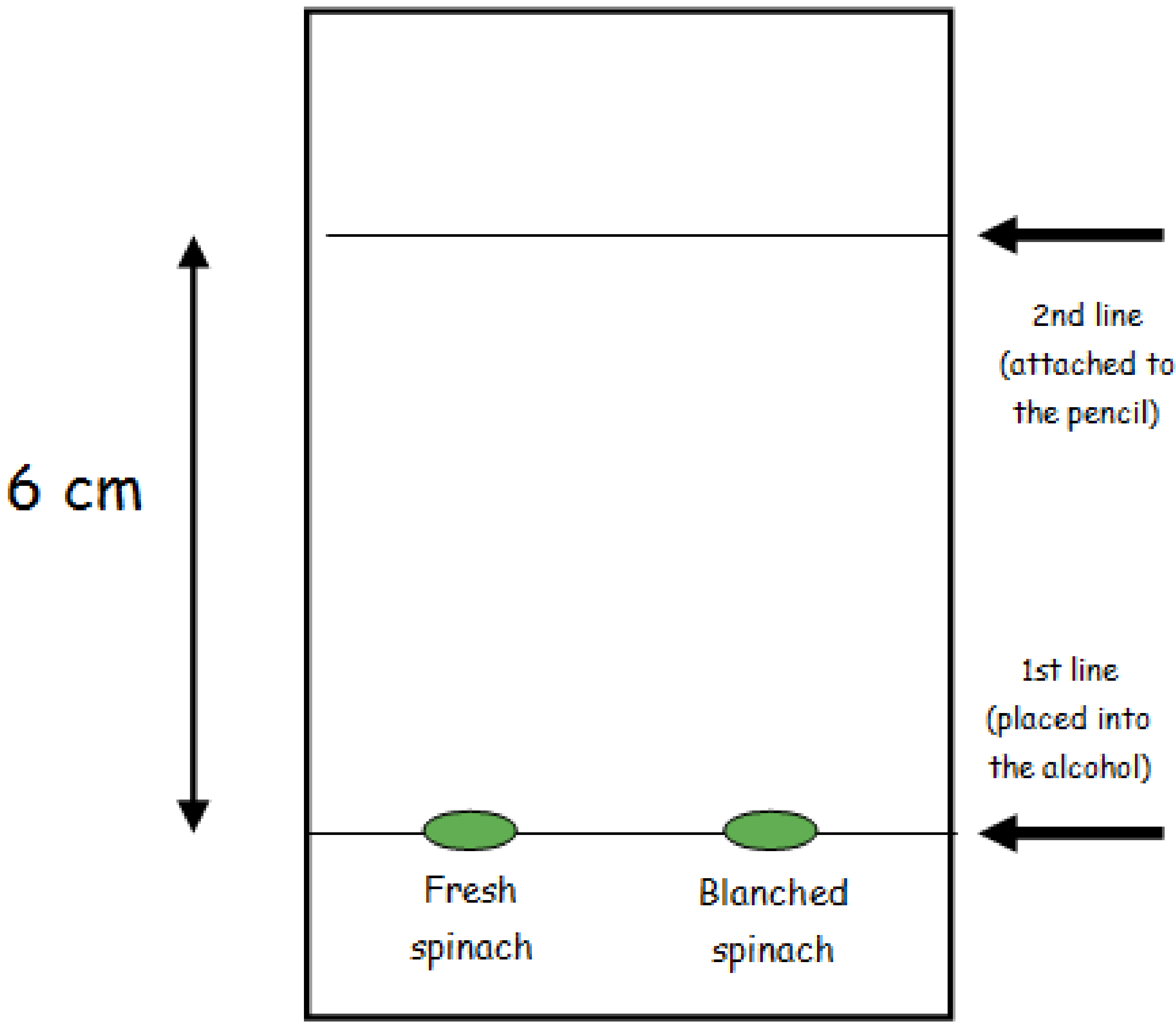
The purpose of this experiment was to separate the pigments (chemicals) within fresh and blanched plant cells. The plant materials that are rubbed onto the filter paper are to be considered solutes and the rubbing alcohol the solvent. When the alcohol slowly moves up the paper strip and mixes with the green pigments, a solution is formed.

The fibers within the paper trap the pigment compounds as the solvent carries them through the paper. Larger molecules get trapped by the fibers first while smaller compounds can travel further up the strip. With this method, the mixture of compounds that exist within the leaf cells can be easily separated.

Fresh spinach contains pigment compounds called chlorophylls and carotene. The colors you should have witnessed with the fresh spinach will be a dark green color. Blanching breaks down these compounds into even smaller pigment compounds called chlorophyllides. These compounds are much lighter in color. You may have noticed this color change within the leaves themselves as you blanched them. If you chose to cook the leaves even longer, these pigments would be broken down into olive-brown colored pigments called pheophytins. However, it is not very easy to detect these final pigments by using this procedure.

This method can be used to separate the mixtures of all kinds of pigments within vegetables at the grocery store. I highly recommend repeating this procedure with every leaf you can find! Some may not provide very interesting results, but others definitely will!

Picture of your chromatography paper (known as a <u>chromatogram</u>)



Chapter 22

Molarity

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Several tea bags of your favorite tea
One gallon pitcher
6 large cups (~2.5 cups each)
Several small cups for tasting the tea
Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

Definitions

concentration	the amount of solute we place into a solution
unsaturated solution	a solution that is able to dissolve more solute
saturated solution	a solution that is not able to dissolve more solute
supersaturated solution	a solution that has dissolved more solute than it naturally should be able to contain
molarity	a measuring scale used to determine the concentration of a solution

Sample questions to ask your child after completing the weekly reading.

Explain three qualitative methods to measure the concentration of a solution:

A solution is said to be unsaturated as it continues to dissolve more solute. Once the solvent can no longer dissolve any more solute, it is said to be saturated. It is possible to add more solute to a solution than should exist. This happens through the heating of the solution during the dissolving process and is known as a supersaturated solution.

How do you determine the molarity of a solution?

To calculate the molarity of a solution, you must divide the moles of solute by the liters of solution.

Why can't you simply measure out the correct amount of solute, then the final amount of solvent, and mix them together to get your desired concentration of a solution?

The volume of the solution will decrease when the solute dissolves.

When calculating how much solvent will be needed to dilute a solution to a desired concentration, what must you be very careful of with the variable V_2?

V_2 is the final volume that will exist after the dilution is completed. It is not simply the amount of solvent that will be added to the original volume.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 12 M
2) 3.52 M
3) 12.5 M
4) 16.15 M
5) 0.036 M
6) 0.38 M
7) 1.15 M
8) 1.07 M
9) 2.12 M
10) Dissolve 219 g HCl, dilute to 2 L
11) Dissolve 360 g NaOH, dilute to 1.5 L
12) Dissolve 92.66 g Na_2SO_4, dilute to 0.75 L
13) Dissolve 2.14 g Na_2CO_3, dilute to 45 mL
14) Dissolve 1.59 g $LiNO_2$, dilute to 250 mL
15) Dissolve 38.04 g $Fe_3(PO_4)_2$, dilute to 56 mL
16) Dissolve 3649.36 g NH_4NO_3, dilute to 6.7 L
17) Dissolve 0.0054 g $MgSO_4$, dilute to 4.5 mL

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Several tea bags of your favorite tea
One gallon pitcher
6 large cups (~2.5 cups each)
Several small cups for tasting the tea

Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

Molarity of sweetened tea or…

I'd like a little tea with my sugar, please.

Calculating the molarity of a solution will be practiced with this sweet little activity.

Ingredients:

Several tea bags of your favorite blend

Other items:

One gallon pitcher
6 large cups (~720mL volume)
Several small cups for tasting the tea
Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

Recipe:

1) Make one gallon of unsweetened tea.
2) Divide the tea equally into 6 different containers (approx 600 mL each).
3) Calculate the molar mass of table sugar (sucrose – $C_{12}H_{11}O_5$) on the attached data sheet.
4) Add the following amounts of sugar into each of the 6 containers:

Container number	Amount of sugar added (tsp)
1	0
2	1
3	2
4	3
5	4
6	5

5) Pour a small amount each tea for your friends to taste. Have them identify which one they prefer.
6) Calculate the molarity of the teas that were preferred.
7) Calculate how many teaspoons of sucrose would be needed in one 240 mL glass of tea to equal the concentration of their preference.

Explanation:

The calculation of molarity is vital in the study of chemistry. Being able to identify how many moles of solute are dissolved into a known amount of solvent is used very frequently.

<u>Another way of defining molarity is this:</u>
Molarity tells you how many atoms of a particular atom/molecule are found within a known volume of fluid. The mathematical way of defining molarity is with the following equation:

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Why is it important to calculate the number of atoms/molecules dissolved in a fluid? Think about all of those reactions you learned about a few chapters ago. Remember! In order for a reaction to take place, two or more molecules have to get close enough to touch each other. If you happen to know how many molecules are "swimming" around in your fluid, you can calculate how fast the reaction will take place, how much reactant will be left over, and a variety of other things as well!

Be certain to check out the last page of this activity to find out the molarities for each of the teas and the answer to your thought question!

Molarity of sweetened tea data sheet

Container number	Amount of sugar added (tsp)	Friend's name	Friend's preference
1	0		
2	1		
3	2		
4	3		
5	4		
6	5		

Molar mass of table sugar ($C_{12}H_{11}O_5$) = ______________________________

Molarities of all the teas: (1 tsp sugar = 4.14 g – use the next page if necessary)

Answer key:

Molar mass of table sugar = 342.3 g/mole

Molarities of all the teas :

1 tsp = 17.25M

2 tsp = 34.5M

3 tsp = 51.75M

4 tsp = 69M

5 tsp = 86.25M

Unit Quiz (Weeks 21-22)

1) If I add 25 mL of water to 125 mL of a 0.15 M NaOH solution, what will the molarity of the diluted solution be?

2) If I add water to 100 mL of a 0.15 M NaOH solution until the final volume is 150 mL, what will the molarity of the diluted solution be?

3) How much 0.05 M HCl solution can be made by diluting 250 mL of 10 M HCl?

4) I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?

5) How much water would I need to add to 500 mL of a 2.4 M KCl solution to make a 1.0 M solution?

6) If I have 340 mL of a 0.5 M NaBr solution, what will the concentration be if I add 560 mL more water to it?

7) If I dilute 250 mL of 0.10 M lithium acetate solution to a volume of 750 mL, what will the concentration of this solution be?

8) If I leave 750 mL of 0.50 M sodium chloride solution uncovered on a windowsill and 150 mL of the solvent evaporates, what will the new concentration of the sodium chloride solution be?

9) What would be the final volume of a solution if you were to dilute the solution in problem #8 to receive a final concentration of 0.25 M?

10) How many grams of ammonia (NH_3) are present in 5.0 L of a 0.050 M solution?

11) What is the molarity of a solution in which 0.45 grams of sodium nitrate are dissolved in 265 mL of solution.

12) What will the volume of a 0.50 M solution be if it contains 25 grams of calcium hydroxide?

13) How many grams of beryllium chloride are needed to make 125 mL of a 0.050 M solution?

14) Explain how you would make 450 mL of a 0.250 M NaOH solution.

15) To what volume will you have to dilute 30.0 mL of a 12 M HCl solution to make a 0.35 M HCl solution?

16) How many grams of calcium chloride will be needed to make 750 mL of a 0.100 M $CaCl_2$ solution?

17) Explain why this experimental procedure is incorrect: To make 1.00 L of a 1.00 M NaCl solution, I will dissolve 58.5 grams of sodium chloride in 1.00 L of water.

Unit Quiz Answer Key

1) $M_1V_1 = M_2V_2$
   (0.15 M)(125 mL) = (M_2)(150 mL)
   M_2 = 0.125 M
2) $M_1V_1 = M_2V_2$
   (0.15 M)(100 mL) = (M_2)(150 mL)
   M_2 = 0.100 M
3) $M_1V_1 = M_2V_2$
   (10 M)(250 mL) = (0.05 M)(V_2)
   V_2 = 50,000 mL
4) $M_1V_1 = M_2V_2$
   (1.5 M)(345 mL) = (M_2)(250 mL)
   M_2 = 2.07 M
5) $M_1V_1 = M_2V_2$
   (2.4 M)(500 mL) = (1.0 M) (V_2)
   V_2 = 1200 mL
   1200 mL will be the final volume of the solution. However, since there's already 500 mL of solution present, you only need to add 700 mL of water to get 1200 mL as your final volume.
   The answer: 700 mL.
6) $M_1V_1 = M_2V_2$
   (0.5M)(340mL) = (M_2)(900mL)
   M_2 = 0.19 M
7) $M_1V_1 = M_2V_2$
   (0.1M)(250mL) = (M_2)(750mL)
   M_2 = 0.033 M

8) $M_1V_1 = M_2V_2$
(0.5M)(750mL) = (M_2)(600mL)
M_2 = 0.63 M

9) $M_1V_1 = M_2V_2$
(0.625M)(600mL) = (0.25M)(V_2)
V_2 =1500 mL

10)
$$0.05M = \frac{X \text{ moles } NH_3}{5\ L} \qquad X = 0.25 \text{ moles } NH_3$$

$$\frac{0.25 \text{ moles } NH_3}{} \left| \frac{17.03g\ NH_3}{1 \text{ mole } NH_3} \right. = 4.26g\ NH_3$$

11) 0.020 M (convert grams of sodium nitrate to moles and follow the molarity equation)

12) 680 mL (as before, convert grams to moles and follow the molarity equation)

13) 0.50 grams (follow the same procedure as seen in #10)

14) Add water to 4.52 grams of sodium hydroxide until the final volume of the solution is 450 mL.

15) $M_1V_1 = M_2V_2$
(12M)(30mL) = (0.35M)(V_2)
V_2 = 1029 mL

16) 8.33 grams (follow the same procedure as seen in #10)

17) If you were to do this, the solution would have a final volume greater than 1.00 L, because sodium chloride itself takes up space. The correct way to do this would be to add water to 58.5 grams of sodium chloride until the final volume of the solution is 1.00 L.

Chapter 23

Colligative Properties I

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Table Salt
Distilled Water
2+ Quart Cooking Pot
Measuring spoons and cups

Thermometer
Stirring spoon
Oven mitt or tongs

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

colligative properties	properties of solutions that depend upon the amount of solute dissolved in a solution; boiling and melting points, osmotic pressure, and electrical conductivity are examples of colligative properties
vapor pressure	pressure which exists between water molecules in a liquid phase
boiling point elevation	colligative property of a solution; as you increase the concentration of a solution (by adding solute into a solvent), the boiling point of the solution increases as well
effective molality	a measurement of the number of moles of solute per kilogram of solvent

Sample questions to ask your child after completing the weekly reading.

What natural force acts to keep water from vaporizing at room temperature?

Air pressure pushes down on liquid water and prevents it from evaporating into the air.

Why does the boiling point of a solution increase when you increase the concentration of a solution?

The greater amount of solute molecules (specifically on the surface of the solution) reduces the amount of solvent molecules that can vaporize out of the solution.

What is the difference between molarity and molality?

Molarity is the number of moles of solute per liter of solution. Molality is a little different in that it is the number of moles of solute per kilogram of solvent.

When calculating the molality of a solution, why is it important to know if the solute is an ionic or covalent compound?

Since the boiling point elevation of a solution depends upon the amount of solute floating around in solution, the type of bond within the solute is important to know because covalent and ionic compounds react differently in a solution. Covalent compounds remain intact, unlike ionic compounds which break apart. Therefore, solutions with ionic compounds will produce greater numbers of solutes.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 100.97 °C
2) 100.68 °C
3) m = 0.91

$$m = \frac{1.37 \text{ moles NaCl}}{1.5\text{kg } H_2O}$$

4) 296.69g MgI_2

$$0.42 \text{ m} = \frac{X \text{ moles } MgI_2}{2.54 \text{ kg } H_2O}$$

5) 116.73g NaCl

$$2.35 \text{ m} = \frac{X \text{ moles NaCl}}{0.85 \text{ kg } H_2O}$$

6)

$$\frac{46.3\text{g}}{} \left| \frac{X \text{ moles } MgSO_4}{120.37 \text{ g } MgSO_4} \right. = 0.38 \text{ moles } MgSO_4$$

$$\frac{0.38 \text{ moles } MgSO_4}{0.299\text{kg } H_2O} = 1.27 \text{ (x2 for the \# of ions)} = 2.54 \text{ m}$$

$$T_{b\ (solution)} - 100 = 0.52(2.54\text{m})$$

$$T_{b\ (solution)} = 101.3\ °C$$

7) T_b(sucrose)= 100.32°C
T_b(salt) = 102.1°C - Higher boiling point

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Table Salt
Distilled Water
2+ Quart Cooking Pot
Measuring spoons and cups

Thermometer
Stirring spoon
Oven mitt or tongs

The effect of table salt on boiling water or…

Did my great aunt really know what she was doing?

This experiment is used to find out how table salt affects the boiling temperature of water.

Ingredients:

Table Salt
Distilled Water

Other items:

1.9L+ Cooking Pot
Measuring spoons and cups
Thermometer
Stirring spoon
Oven mitt or tongs

Recipe:

1) Boil 1000mL of distilled water on a stove.
2) Measure the temperature of the boiling water. Record the highest temperature reading on the attached data sheet. This is the **control** to compare with the remaining trials. Make certain that the thermometer does not touch the sides of the pot. It should only touch the water – you may need the oven mitt or tongs to hold it over the water!
3) Measure out 15mL of table salt using a kitchen measuring spoon. Level the spoonful.
4) Add the measured salt to the boiling water and stir.
5) Measure the temperature of the boiling water with the salt in it. Record the highest temperature reading.
6) Repeat again using an additional tablespoon of salt.
7) Calculate the boiling points of your water after adding 15mL and 30mL of salt.
8) Calculate the percent error of your experimental results.

Explanation:

My great aunt always said that she could get her water to boil faster if she added some salt to her water. But did this experiment actually support her idea?

As you should have observed, the boiling point of the water increased as you increase the salt concentration of the solution. Why? The greater amount of solute molecules (specifically on the surface of the solution) reduces the amount of solvent molecules that can vaporize out of the solution.

Naturally, the boiling point of distilled water should have been 100°C and the two subsequent boiling points should have increased as well. However, the two boiling points you calculated using the equation below may not have been very accurate or precise:

$$T_{b\,(solution)} - T_{b\,(pure\ solvent)} = K_b m$$

To calculate molality (m) within this equation, you will need the following equation:

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solution}}$$

I know you can find the number of moles inside each of the different amounts of sucrose; and, since 1 L = 1000mL = 1kg, you should be able to convert 1000mL to kg rather easy, right?

As for your percent error calculation, remember that the equation for this measurement is:

$$\text{Percent error} = \frac{(\text{Accepted measurement} - \text{Experimental measurement})}{\text{Accepted measurement}} \times 100\%$$

The "accepted measurement" would be the boiling point you calculated; and, the "experimental measurement" is the boiling point you observed during your experiment.

It's hard to determine if my great aunt was correct or not. If she believed a warmer temperature of water would cause her food to cook faster, she might have been right. But we didn't really test if the addition of salt decreased the <u>time</u> needed for boiling to occur.

Hmmm... sounds like a good experiment to run, doesn't it?

Boiling point elevation data sheet

Amount of salt	Temp of boiling water (°C)	Calculated boiling point	% Error
0 Tbs (control)			
1 Tbs NaCl			
2 Tbs NaCl			

Chapter 24

Colligative Properties II

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)
Zip-Lock freezer bag, quart size
Measuring spoons and cups

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

freezing point depression	colligative property of a solution; solutions freeze at lower temperatures than pure solvents because the extra solute molecules "get in the way" of the solvent molecules
osmotic pressure	the pressure which needs to be applied to a solution to keep water from moving across a semipermeable membrane
osmosis	the movement of a fluid across a semipermeable membrane
semipermeable membrane	any "barrier" that will allow solvents (like water) to move through them

Sample questions to ask your child after completing the weekly reading.

How do extra solutes within a solution cause its freezing point to lower?

Solutions freeze at lower temperatures than pure solvents because the extra solute molecules "get in the way" of the solvent molecules. These extra solute particles keep the liquid from freezing at the normal freezing point of solvents.

What is osmotic pressure?

Osmotic pressure is the pressure which needs to be applied to a solution to keep water from moving across a semipermeable membrane (osmosis).

During osmosis, water flows from the solution with the lower solute concentration into the solution with higher solute concentration. When will this movement of fluid stop?

This flow will continue until the concentrations on both sides are equal.

Why is it true that the more concentrated a solution of electrolytes, the better it is at conducting electricity?

Solutions which contain dissolved ionic compounds are able to conduct electricity due to their unbalanced numbers of electrons. The extra amount of ions within the solution increases the ability to move electrons and charges around the solution, thus making it more conductive.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) T_b= 100.8°C
   T_f= -2.8°C

2) T_b = 102.3°C
   T_f = -8.24°C

3) T_f(sucrose) = -2.87°C

4) T_b = 101.47°C
   T_f = -5.27°C

5) –1.76°C

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)
Zip-Lock freezer bag, quart size
Measuring spoons and cups

Homemade "pickles" in a day or…

They're not as good as momma makes, but still tasty.

Osmotic pressure will be demonstrated in this day-long recipe.

Ingredients:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)

Other items:
Zip-Lock freezer bag, quart size
Measuring spoons and cups

Recipe:

1) Measure 250 mL water, 15 mL vinegar, and 7.5 mL salt into a quart size Zip-Lock freezer bag. Mix well to dissolve the salt.
2) Add 5 mL mixed pickling spice, one sprig of fresh dill or a pinch of dried dill, and, if desired, 1 clove of garlic, crushed, to the bag.
3) Obtain one medium size cucumber or two small cucumbers and place in the brine in the quart size Zip-Lock freezer bag. Squeeze out as much air as possible and seal the bag.
4) Allow the bag and its contents to sit upright, so that the cucumber is completely immersed in liquid. If the cucumber is exposed to air, even inside the bag, it will spoil.
5) The cucumber should be kept at room temperature for one day before tasting. If a film appears on the surface of the brine, it needs to be removed. The pickling process will continue as long as the bag and contents remain at room temperature. To halt the pickling process, place the bag and contents in a refrigerator.

Explanation:

The semipermeable membranes in this activity are the cell walls within each of the cucumber's cells. This membrane allows water to move through them, but not the salt. When placed into the brine (the salt/vinegar/water solution), water flows from the inside of the pickle which is the area of lower solute (salt) concentration into the brine itself. This process will continue until the concentrations of salt within the cucumber and the brine are equal.

The large concentration of salt in the brine (as compared to the cells of the cucumbers) increases the osmotic pressure of the solution which keeps water from moving into the cucumbers.

Unit Quiz (Weeks 23-24)

1) Calculate the molality when 75.0 grams of $MgCl_2$ is dissolved in 500.0 g of solvent.

2) 100.0 grams of sucrose ($C_{12}H_{22}O_{11}$) is dissolved in 1.50 L of water. What is the molality?

3) 49.8 grams of KI is dissolved in 1.00 kg of solvent. What is the molality?

For the remaining problems, assume the solvent being used is water.

4) What is the boiling point of a 2.25m solution of sodium chloride?

5) What is the boiling point of a solution with 23.5g calcium chloride dissolved in 150g of water?

6) If a solution boils at 103.5°C, what is the molality of the solution if it is a covalent compound?

7) What will be the freezing point and boiling point of a solution containing 55.0 g of glycerol ($C_3H_5(OH)_3$) and 250 g of water?

8) How many grams of $(NH_4)_3PO_4$ need to be added to 500g of H_2O so that the freezing point of the solution is lowered to –8.3°C? Assume that the ammonium phosphate completely dissolves.

9) What is the boiling point elevation when 11.4 g of ammonia (NH_3) is dissolved in 200g of H_2O?

10) If 1800 g of ethylene glycol ($C_2H_6O_2$) is added to 1900 g of water, what is the elevation in boiling point?

11) Ethylene glycol ($C_2H_6O_2$) is the principal ingredient in antifreeze. How many grams of ethylene glycol will be needed to lower the freezing point of 2100 g of water by 20°C?

12) At what temperature will a magnesium nitrate solution boil if it contains 320 grams of magnesium nitrate in 2547 mL of water?

13) At what temperature will a potassium phosphate solution freeze if it contains 144 grams of potassium phosphate in 487 grams of water?

Unit Quiz Answer Key

1) $\dfrac{75g\ MgCl_2}{} \Big| \dfrac{1\ mole\ MgCl_2}{95.2g\ MgCl_2} = 0.79\ moles\ MgCl_2$

$\dfrac{0.79\ moles\ MgCl_2}{0.5kg\ water} = \mathbf{1.58m}$

2) 0.195m (see method above)

3) 0.300m (see method above)

4) $T_b - 100 = 0.52\ (4.5)$
$T_b = 102.3°C$
(*since NaCl contains 2 ions, you have to multiply the molality by 2 to get 4.5)

5) 102.2°C (first calculate the molality, then use the boiling point equation)

6) 6.83 m

7) -4.45 °C and 101.2 °C

8) 83.5 g (first calculate molality from the freezing point equation; use this answer within the molality equation to find the # of moles of $(NH_4)_3PO_4$; finally, convert these moles to grams)

9) The solution will boil at 101.7°C (follow the steps within #5)

10) 7.95°C (follow the steps within #5)

11) 1.4 kg (follow the steps within #8)

12) 101.3°C (follow the steps within #5)

13) -10.4°C (follow the steps within #5 with the exception of using the freezing point equation)

Quarterly Test

Chapters 17-24

This test contains both a pre- and post-test for your child.
Once the pre-test has been completed and reviewed, the post-test may be administered.
The pre-test has been constructed to build upon the mechanics of various chemistry problems, while the post-test is designed for a deeper understanding of these mechanics.

Prior to this exam, it is highly recommended that the weekly practice problems and unit quizzes be reviewed by the child!

Pre-Test (Units 9-12)

1) Write out the chemical equation when calcium hydroxide reacts with hydrochloric acid to produce calcium chloride and water:

2) What type of chemical reaction is taking place? ____________________

3) How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

4) If I combined 15.0 grams of calcium hydroxide with 75.0 mL of 0.500 M HCl, how many grams of calcium chloride would be formed?

5) What is the limiting reagent from the reaction in problem #3? _______

6) How many grams of the excess reagent will be left over after the reaction in problem 3 is complete?

7) What would be the percent yield if 16.5 grams of excess reagent were left over after running the experiment?

Pre-Test Answer Key

1) Write out the chemical equation when calcium hydroxide reacts with hydrochloric acid to produce calcium chloride and water:

$$Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$$

2) What type of chemical reaction is taking place? **Acid Base Reaction**

3) How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

5grams $Ca(OH)_2$	1 mole $Ca(OH)_2$	2 moles HCl	= **0.135 moles HCl**
	74g $Ca(OH)_2$	1 mole $Ca(OH)_2$	

$$0.1\ M = \frac{0.135\ \text{moles HCl}}{\text{Liters HCl}} = \mathbf{1.35\ Liters\ HCl}$$

4) If I combined 15.0 grams of calcium hydroxide with 75.0 mL of 0.500 M HCl, how many grams of calcium chloride would be formed?

15grams $Ca(OH)_2$	1 mole $Ca(OH)_2$	1 mole $CaCl_2$	111.1grams $CaCl_2$
	74g $Ca(OH)_2$	1 mole $Ca(OH)_2$	1 mole $CaCl_2$

= 22.5 grams $CaCl_2$

$$0.5\ M = \frac{\text{moles HCl}}{0.075\ \text{Liters}} = \mathbf{0.0375\ moles\ HCl}$$

0.0375 moles HCl	1 mole $CaCl_2$	111.1grams $CaCl_2$
	2 moles HCl	1 mole $CaCl_2$

= 2.08 grams $CaCl_2$

5) What is the limiting reagent from the reaction in problem #3? **HCl**

6) How many grams of the excess reagent will be left over after the reaction in problem 3 is complete?

$$15 - 15\left(\frac{2.08}{22.5}\right) = \mathbf{13.6\ grams\ Ca(OH)_2}$$

7) What would be the percent yield if 16.5 grams of excess reagent were left over after running the experiment?

$$\frac{13.6\ \text{grams}\ Ca(OH)_2}{16.5\ \text{grams}\ Ca(OH)_2} \times 100 = 82.4\%$$

Post-Test (Units 9-12)

Answer the following questions as they pertain to the answer key for Test 3

1) Explain how you know the given equation in this worksheet is an acid/base reaction.

2) The fourth step of stoichiometry requires you to use the molar mass of your unknown compound. This step was removed from problem #3. Explain why it was **not** necessary to calculate the molar mass of HCl within the first part of problem #3.

3) Why do you need to use the molarity equation in problem #3?

4) Why are there only 2.08 grams of $CaCl_2$ created within problem #3 and not 22.5 grams?

5) Why is $CaCl_2$ not the limiting reagent in problem #3?

6) The number "15" appears twice within the equation in problem #5. The rules of algebra state that the following portion of the equation has to be completed first:

$$15\left(\frac{2.08}{22.5}\right)$$

a) What does the answer to this portion of the equation tell you about the excess reagent?

b) Why do you need to subtract this answer from "15" to determine the grams of the excess reagent?

Post-Test Answer Key

1) This reaction is technically a double displacement reaction; however, water is being produced which classifies this reaction as an acid/base reaction.

2) The mass of HCl is not needed to calculate the molarity of HCl. Therefore, it was not performed in the first stoichiometry conversion for this problem.

3) The problem asks for the volume of HCl in liters for this reaction. Molarity is calculated as the moles of a substance per liter:

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Since the molarity of HCl was provided and the moles of HCl were calculated, both values were used in the above equation to determine the volume of HCl.

4) You always choose the smaller amount of product that is produced within a limiting reactant problem. Both of the values could be created if there was an excess amount of the opposite reactant.

5) $CaCl_2$ is the product of this reaction, not the reactant.

6a) The answer to this portion of the problem tells you how much of the nonlimiting reactant has been used during the reaction.

6b) You need to subtract the answer from 6a by the total amount of nonlimiting reactant to determine how much nonlimiting reactant was left over after the reaction takes place.

Chapter 13

Naming Ionic Compounds

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

No special ingredients needed this week – just access to the kitchen cabinet

National Science Education Standards covered this week:

12BPS2.1 Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. These outer electrons govern the chemical properties of the element.

Definitions

monatomic ions	ions which contain only one kind of atom
polyatomic ions	molecules which have gained or lost some of their electrons and have turned into ions

Sample questions to ask your child after completing the weekly reading.

How do ions formed from transition metals differ from those of main block elements (the eight families)?

Ions formed from transition metals have the ability to "pitch" different amounts of electrons unlike atoms within the eight families. For example, the transition metal Lead may give away 2 or 4 electrons making it's ion Pb^{+2} or Pb^{+4}.

Is it possible for a molecule to become an ion?

Yes. Multiple atoms which are bonded together may give away or receive extra electrons to form what is known as polyatomic ions.

The chemical name for table salt is sodium chloride. However, if you look on the periodic table, you will not find any element that has the name "chloride." How can you explain this?

When you are writing out ionic compounds and there is only one atom as the anion, you remove the last few letters of the element's name and replace it with "-ide." If the element has a polyatomic anion, you simply add the name of the anion after the cation and you are done.

Some chemical names such as iron (III) chloride contain Roman numerals attached to the cation. What is the importance of these numerals?

The Roman numeral tells you the charge of the cation.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

IONS	nitrate	sulfate	carbonate	phosphate	hydroxide	chromate
sodium	$NaNO_3$	Na_2SO_4	Na_2CO_3	Na_3PO_4	$NaOH$	Na_2CrO_4
silver	$AgNO_3$	Ag_2SO_4	Ag_2CO_3	Ag_3PO_4	$AgOH$	Ag_2CrO_4
ammonium	NH_4NO_3	$(NH_4)_2SO_4$	$(NH_4)_2CO_3$	$(NH_4)_3PO_4$	NH_4OH	$(NH_4)_2CrO_4$
mercury(I)	$Hg_2(NO_3)_2$	Hg_2SO_4	Hg_2CO_3	$(Hg_2)_3(PO_4)_2$	$Hg_2(OH)_2$	Hg_2CrO_4
zinc	$Zn(NO_3)_2$	$ZnSO_4$	$ZnCO_3$	$Zn_3(PO_4)_2$	$Zn(OH)_2$	$ZnCrO_4$
calcium	$Ca(NO_3)_2$	$CaSO_4$	$CaCO_3$	$Ca_3(PO_4)_2$	$Ca(OH)_2$	$CaCrO_4$
magnesium	$Mg(NO_3)_2$	$MgSO_4$	$MgCO_3$	$Mg_3(PO_4)_2$	$Mg(OH)_2$	$MgCrO_4$
copper(I)	$CuNO_3$	Cu_2SO_4	Cu_2CO_3	Cu_3PO_4	$CuOH$	Cu_2CrO_4
lead(II)	$Pb(NO_3)_2$	$PbSO_4$	$PbCO_3$	$Pb_3(PO_4)_2$	$Pb(OH)_2$	$PbCrO_4$
aluminum	$Al(NO_3)_3$	$Al_2(SO_4)_3$	$Al_2(CO_3)_3$	$AlPO_4$	$Al(OH)_3$	$Al_2(CrO_4)_3$
manganese(III)	$Mn(NO_3)_3$	$Mn_2(SO_4)_3$	$Mn_2(CO_3)_3$	$MnPO_4$	$Mn(OH)_3$	$Mn_2(CrO_4)_3$
cobalt(III)	$Co(NO_3)_3$	$Co_2(SO_4)_3$	$Co_2(CO_3)_3$	$CoPO_4$	$Co(OH)_3$	$Co_2(CrO_4)_3$
copper (II)	$Cu(NO_3)_2$	$CuSO_4$	$CuCO_3$	$Cu_3(PO_4)_2$	$Cu(OH)_2$	$CuCrO_4$
iron (III)	$Fe(NO_3)_3$	$Fe_2(SO_4)_3$	$Fe_2(CO_3)_3$	$FePO_4$	$Fe(OH)_3$	$Fe_2(CrO_4)_3$
lead (IV)	$Pb(NO_3)_4$	$Pb(SO_4)_2$	$Pb(CO_3)_2$	$Pb_3(PO_4)_4$	$Pb(OH)_4$	$Pb(CrO_4)_2$
potassium	KNO_3	K_2SO_4	K_2CO_3	K_3PO_4	KOH	K_2CrO_4
barium	$Ba(NO_3)_2$	$BaSO_4$	$BaCO_3$	$Ba_3(PO_4)_2$	$Ba(OH)_2$	$BaCrO_4$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

No special ingredients needed this week – just access to the kitchen cabinet

Common ions in our food or…

Yes, but would you feed it to your cat?

The identification of various ions will be explored through analysis of various food labels.

Ingredients:

Common household items found in the kitchen or grocery store

Recipe:

1) Look at food labels in the grocery store, drugstore, and at home for inorganic compounds (i.e. sodium chloride, magnesium sulfate, etc.)
2) Complete the data table on the following page. The table should have the chemical name as it is written on the label, its chemical formula (i.e. NaCl), and the source it was found in. A list of common ions is provided for you at the end of this lesson.
3) The data table should have at least 20 different compounds, not elements.
4) Compare the inorganic compounds within the items you chose with those found within the cat treats listed below. How are they similar and/or different? Use the internet to discover what some of these similar compounds are used for in both cat and human foods.

Explanation:

Inorganic compounds are found in all processed food (for humans as well as cats), and are generally used for flavoring and preservation. For example, the following are the listed ingredients for a popular shrimp-flavored cat treat:

Flour, liver, dried whole egg, glycerin, pregelatinized wheat flour, shrimp by-products, wheat gluten, torula dried yeast, *calcium sulfate*, **cheese meal, phosphoric acid, animal at (preserved with butylated**

hydroxyanisole, otherwise known as BHA), *potassium chloride*, *salt*, **potassium sorbate (a preservative), wheat middlings, color, choline chloride**, *calcium carbonate, ferrous sulfate*, **vitamin E supplement**, *zinc oxide*, **BHA (again!)**, *cupric oxide*, *cobalt carbonate, manganous oxide*, **vitamin A supplement**, *potassium iodide*, **D-calcium pantothenate, vitamin B-12 supplement, vitamin D-3 supplement, water sufficient for processing.**

Inorganic chemicals found in your items:

Chemical Name	Chemical formula	Found in:
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		
12)		
13)		
14)		
15)		
16)		
17)		
18)		
19)		
20)		

Common Monatomic Ions

+1 Charge		+3 Charge		-3 Charge	
Copper (I) or Cuprous	Cu^{+1}	Aluminum	Al^{+3}	Arsenide	As^{-3}
Lithium	Li^{+1}	Chromium (III)	Cr^{+3}	Nitride	N^{-3}
Potassium	K^{+1}	Cobalt (III)	Co^{+3}	Phosphide	P^{-3}
Rubidium	Rb^{+1}	Iron(III) or Ferric	Fe^{+3}		
Silver	Ag^{+1}	Nickel (III)	Ni^{+3}		
Sodium	Na^{+1}				
		+4 Charge			
+2 Charge		Lead (IV)	Pb^{+4}		
Barium	Ba^{+2}	Tin(IV)	Sn^{+4}		
Calcium	Ca^{+2}				
Chromium (II)	Cr^{+2}	**-1 Charge**			
Cobalt (II)	Co^{+2}	Bromide	Br^{-1}		
Copper (II) Cupric	Cu^{+2}	Chloride	Cl^{-1}		
Iron (II) or Ferrous	Fe^{+2}	Fluoride	F^{-1}		
Lead (II) or Plumbous	Pb^{+2}	Iodide	I^{-1}		
Nickel (II)	Ni^{+2}				
Magnesium	Mg^{+2}	**-2 Charge**			
Radium	Ra^{+2}	Oxide	O^{-2}		
Strontium	Sr^{+2}	Selenide	Se^{-2}		
Tin (II) or Stannous	Sn^{+2}	Sulfide	S^{-2}		
Zinc	Zn^{+2}				

Common Polyatomic Ions

+1 Charge		**-2 Charge**	
Ammonium	NH_4^{+1}	Carbonate	CO_3^{-2}
		Chromate	CrO_4^{-2}
-1 Charge		Dichromate	$Cr_2O_7^{-2}$
Acetate	$C_2H_3O_2^{-1}$	Monohydrogen Phosphate	HPO_4^{-2}
Bicarbonate or hydrogen carbonate	HCO_3^{-1}	Oxalate	$C_2O_4^{-2}$
Bisulfate or hydrogen sulfate	HSO_4^{-1}	Sulfate	SO_4^{-2}
Chlorate	ClO_3^{-1}	Sulfite	SO_3^{-2}
Chlorite	ClO_2^{-1}		
Cyanide	CN^{-1}	**-3 Charge**	
Hydroxide	OH^{-1}	Arsenate	AsO_4^{-3}
Hypochlorite	ClO^{-1}	Arsenite	AsO_3^{-3}
Iodate	IO_3^{-1}	Phosphate	PO_4^{-3}
Nitrate	NO_3^{-1}		
Nitrite	NO_2^{-1}		
Perchlorate	ClO_4^{-1}		
Permanganate	MnO_4^{-1}		
Thiocyanate	SCN^{-1}		

Chapter 14

Naming Covalent and Acidic Compounds

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Yellow onion
Vegetable or olive oil
Pan
Wooden spoon
Glass of water

National Science Education Standards covered this week:

12BPS2.1 Atoms interact with one another by transferring or sharing electrons that are furthest from the nucleus. These outer electrons govern the chemical properties of the element.

Definitions

molecular formulas	formulas which contain how many of each type of atom are present within a compound
empirical formulas	formulas which tell you the ratios of elements to each other within a compound
Lewis structure	very similar to the electron dot structure; however, these drawings depict the valence electrons in lone pairs as dots and contain lines to represent shared pairs in a chemical bond (single, double, triple, etc.)

Sample questions to ask your child after completing the weekly reading.

How is the naming of covalent compounds similar to ionic compounds? How is it different?

Much like ionic compounds, all covalent compounds contain two words. The first word is the same as the name of the first element in the formula. The second is the same as the second element in the formula AND its last few letters are replaced with the suffix "-ide."

The major difference between the naming of these two compounds can be found in the identification of multiple atoms within the formula. Prefixes are used in front of either or both of the words which identify how many of each atom is present within the compound.

How do you name a covalently bonded molecule if it only contains one type of element?

The name of a molecule that contains only one kind of element is the same as the element itself. (i.e. F_2 – Fluorine)

The naming of acids follow two different formats which are determined by the presence of which element within the compound?

The presence of oxygen determines how we name different types of acids.

How are molecular, empirical, and structural formulas different?

Molecular formulas tell you how many of each type of atom are present within the compound. For example, hydrogen peroxide is written as H_2O_2. This compound contains 2 atoms of hydrogen and 2 atoms of oxygen.

Empirical formulas only tell you the ratios of elements to each other. For example, the example of hydrogen peroxide (H_2O_2) above would be written as: HO

Structural formulas are the most specific methods of identifying compounds as they tell you how many of each type of atom are present AND where they are located as well.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) sodium carbonate
2) sodium hydroxide
3) magnesium bromide
4) potassium chloride
5) iron (II) chloride
6) iron (III) chloride
7) zinc hydroxide
8) beryllium sulfate
9) chromium (II) fluoride
10) aluminum sulfide
11) lead (II) oxide
12) lithium phosphate
13) titanium (IV) iodide
14) cobalt (II) nitride
15) magnesium phosphide
16) gallium nitrite
17) silver sulfite
18) ammonium hydroxide
19) aluminum cyanide
20) $SbBr_3$
21) B_6Si
22) ClO_2
23) HI
24) IF_5
25) N_2O_3
26) PI_3
27) tetraphosphorus pentasulfide
28) oxygen
29) selenium hexafluoride
30) disilicon hexafluoride
31) sulfur tetrachloride
32) methane (carbon tetrahydride)
33) diboron silicide
34) nitrogen trifluoride

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Yellow onion
Vegetable or olive oil
Pan
Wooden spoon
Glass of water

Carmelizing onions or…

Sweetening an onion before your very eyes!

Covalently bonded sugars break down creating "sweet onions"

Ingredients:

Yellow onion
Vegetable or olive oil

Other items:

Pan
Wooden spoon
Glass of water

Recipe:

1) Slice the root and top ends off of the onions and peel them.
2) Cut the onions in half. Lay them cut side down and slice the onions lengthwise to about ¼ inch thickness.
3) Remove a couple slices and save them for later.
4) Coat the bottom of the pan with onions.
5) Heat the pan on medium high heat until the oil is shimmering.
6) Add the onions slices and stir to coat the onions with the oil.
7) Spread he onions out evenly over the pan and let cook, stirring occasionally.
8) Let the onions cook for approximately 30 minutes to an hour longer, stirring every few minutes. As soon as the onions start sticking to the pan, let them stick a little before you stir again. Remove them before they begin to burn.
9) Taste the uncooked slices of onion.
10) Wash your mouth out with water.
11) Taste the cooked onion. You should detect a much sweeter flavor.

Explanation:

Before we can figure out how to improve our end results, it's important to understand exactly what's going on when an onion browns.

As the onions slowly heat up, moisture from their interior begins to evaporate, forcing its way out of the onion's cells, and causing them to rupture in a process called **sweating**. This breakdown of the cells is what causes onions to soften during the initial stages of cooking.

As onion cells continue to break down, they release their contents which include our covalently-bonded star for the week – sugar! This is when the onions begin to smell really good.

Once most of the liquid has evaporated and the temperature of the onion starts rising to ~230°F, **caramelization** begins to take place. This reaction involves an important chemical change of sugar, in which dozens of new compounds are formed which causes a massive change in the flavor of the onions.

The most important step begins at this temperature as large sugar molecules like sucrose break down into smaller sugar molecules like glucose and fructose. Glucose and fructose separately are sweeter than a single sucrose molecule, making the overall flavor of caramelized sugars sweeter than the starting sugar.

So what is the moral of the story?

The relatively fast process of caramelizing onions is due to the low melting point of the covalent forces among its sugar molecules.

Unit Quiz (Weeks 13-14)

Name the following compounds:

1) $BaSO_3$ ____________________
2) $(NH_4)_3PO_4$ ____________________
3) PBr_5 ____________________
4) $MgSO_4$ ____________________
5) CaO ____________________
6) H_3PO_4 ____________________
7) $Na_2Cr_2O_7$ ____________________
8) MgO ____________________
9) SO_3 ____________________
10) $Cu(NO_3)_2$ ____________________
11) HI ____________________
12) N_2O ____________________
13) MnO ____________________
14) $AgNO_3$ ____________________
15) As_2O_5 ____________________

Write the chemical formulas for the following compounds:

16) hydrobromic acid ____________
17) chromium(III) carbonate ____________
18) magnesium sulfide ____________

19) iodine trichloride ____________________
20) lithium hydride ____________________
21) ammonium hydroxide ____________________
22) calcium chloride ____________________
23) hydroselenic acid ____________________
24) iron(II) nitride ____________________
25) aluminum hydroxide ____________________
26) tin(II) fluoride ____________________
27) sulfur tetrachloride ____________________
28) mercury(II) iodide ____________________
29) diphosphorus pentoxide ____________________
30) sulfurous acid ____________________

Unit Quiz Answer Key

1) barium sulfite
2) ammonium phosphate
3) phosphorus pentabromide
4) magnesium sulfate
5) calcium oxide
6) phosphoric acid
7) sodium dichromate
8) magnesium oxide
9) sulfur trioxide
10) copper(II) nitrate
11) hydroiodic acid
12) dinitrogen monoxide
13) manganese(II) oxide
14) silver nitrate
15) diarsenic pentoxide
16) HBr
17) $Cr_2(CO_3)_3$
18) MgS
19) ICl_3
20) LiH
21) NH_4OH
22) $CaCl_2$
23) H_2Se
24) Fe_3N_2
25) $Al(OH)_3$
26) SnF_2
27) SCl_4
28) HgI_2
29) P_2O_5
30) H_2SO_3

Chapter 15

The Mole

One day on the Tonight Show, Jay Leno showed a classified add that read: "Do you have mole problems? If so, call Avogadro at 602-1023."

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

You really don't need to make these cookies to complete the activity: but, they are quite tasty!

$2\frac{1}{4}$ cup flour
1 tsp baking soda
$\frac{1}{2}$ tsp salt
1 cup butter (at room temp)
$\frac{3}{4}$ cup sugar
$\frac{3}{4}$ cup packed brown sugar
2 eggs
2 tsp vanilla
12 oz. Chocolate Chips

National Science Education Standards covered this week:

12ASI2.4 Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results

Definitions

mole (Avogadro's number)	a conversion factor for anything in the universe which contains 6.02×10^{23} items
molar mass	the sum of all atomic masses of elements within a compound

Sample questions to ask your child after completing the weekly reading.

Is the conversion factor known as "the mole" something that can only be used within the field of chemistry?

No. Any conversion factor can be utilized in any calculation that may or may not be related to the field of chemistry. The mole simply means 6.02×10^{23} *of some item.*

What information do you need to calculate the number of atoms within a sample if you are to use the mole conversion factor?

You would need to know either the number of moles that exist within your sample or the molar mass of the sample to calculate the number of atoms.

Chemists typically calculate the number of particles of a sample when using Avogadro's number. What type of "particles" are usually being measured?

Atoms or molecules

If you needed to calculate the number of grams per mole of a particular element or molecule and you only had access to a periodic table to help you, what number would you need to find within the table?

The mass number of an element is equal to its molar mass (grams per mole). If a molecule is to be measured, you would calculate the sum of all the atoms within the molecule to determine the molar mass.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 6.02×10^{23} of anything, usually atoms or molecules.
2) "Molar mass" is used to describe the mass of one mole of a chemical compound, while "atomic mass" is used to describe the mass of one mole of an element or the mass of one atom of an element.
3) 0.28 moles
4) 4.07 moles
5) 96.18 grams
6) 393.82 grams
7) 40.3 grams/mole
8) 2.19×10^{23} molecules
9) 9.53×10^{23} molecules
10) 41.2 grams
11) 208.81 grams
12) 52.14 grams
13) 3.43×10^{23} molecules
14) 3.12×10^{-17} grams
15) 3.48×10^{24} molecules
16) 1.69×10^{22} molecules
17) 4.33×10^{-16} grams
18) 1.96×10^{22} molecules
19) 0.39 grams
20) 17.14 grams
21) 2.72×10^{23} molecules
22) 0.7 grams

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

You really don't need to make these cookies to complete the activity: but, they are quite tasty!

2 $\frac{1}{4}$ cup flour
1 tsp baking soda
$\frac{1}{2}$ tsp salt
1 cup butter (at room temp)
$\frac{3}{4}$ cup sugar
$\frac{3}{4}$ cup packed brown sugar
2 eggs
2 tsp vanilla
12 oz. Chocolate Chips

Moley Cookies or…

You don't need to make these cookies, but you'll love them!

The process of molar conversions will be practiced during this activity

Ingredients: You really don't need to make these cookies to complete the activity: but, they are quite tasty!

2.66 moles flour
0.0335 moles baking soda
0.036 moles salt
1.084 moles butter (at room temp)
0.44 moles sugar
0.31 moles packed brown sugar
0.624 moles eggs
0.062 moles vanilla
2.82 moles Chocolate Chips

Recipe:

1) Use the molecular formula chart on the attached page to convert the moles of ingredients to grams and record the grams in the provided data chart.
2) Next, use the unit conversions chart on the attached page to convert grams to standard measurements (English units). Again, record the measurements in the data chart.
3) (optional) Pick up the ingredients from the store and begin to bake your cookies using the following procedure:

Preheat the oven to 350°F (175°C)
Mix together the butter and sugars until smooth.
Beat in the egg(s), then stir in the vanilla.
Add the baking soda and salt.
Stir in flour, chocolate chips.
Drop by large spoonfuls onto ungreased pans.
Bake for 10 minutes or until edges are nicely browned.

Molecular formulas for ingredients:

Baking soda	$NaHCO_3$	Molasses	$C_{12}H_{22}O_{11}$
Baking powder	$NaHCO_3$	Flour	$C_4H_5O_4$
Brown sugar	$C_{12}H_{22}O_{11}$	Salt	$NaCl$
Butter	$C_9H_{14}O_6$	Lemon juice	$C_6H_8O_7$
White sugar	$C_{12}H_{22}O_{11}$	Margarine	$C_9H_{12}O_6$
Chocolate	$C_4H_8O_4$	Milk	(15%) $C_9H_{14}O_6 + H_2O$
Cinnamon	C_9H_8O	Pepper	$C_{17}H_{19}O_3N$
Cloves	$C_{10}H_{12}O_2$	Vanilla	$C_8H_8O_3$
Cream of tartar	$KHC_4H_5O_6$	Egg	$C_6H_{12}O_3N_2$

Unit Conversions:

Use the following conversions to convert grams to standard measurements. NOTE: Most of these substances have extremely complex molecular formulas. I have greatly simplified your project by listing a representative formula only.

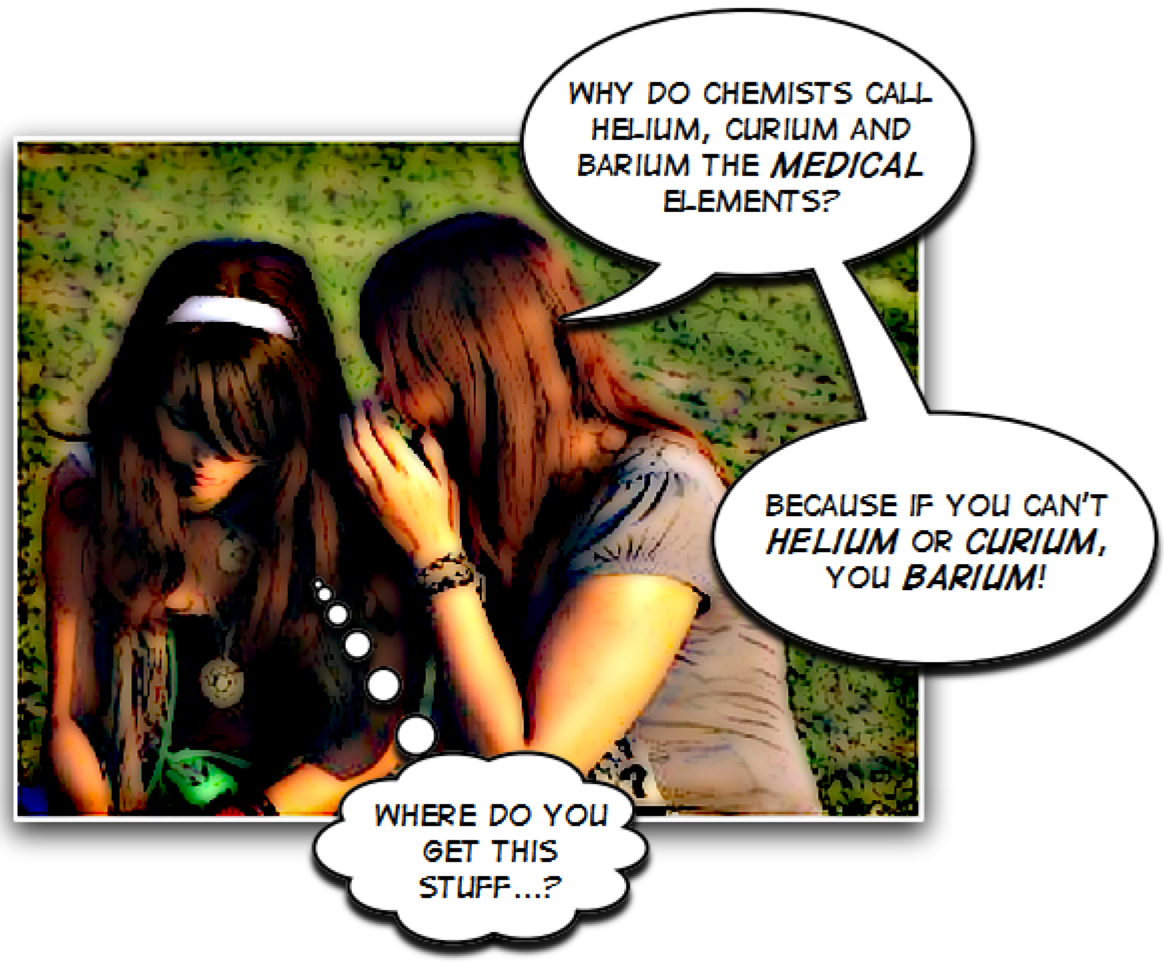
1 teaspoon of baking soda	2.84g	1 cup sugar	198.73 g
1 teaspoon of vanilla extract	4.73g	1 cup brown sugar	141.46 g
1 large egg	50g	1 ounce chocolate chips	28.35 g
1 cup flour	141.95 g	1 tablespoon lemon juice	14.20 g
1 teaspoon salt	4.16 g	1 teaspoon baking powder	2.84 g
1 cup butter	236.59 g	1 teaspoon cream of tartar	2.84 g

Cookie Calculations: Do all of your conversion calculations below. Make sure to record the grams and standard (English) measurements.

Ingredient	Conversions (Mole to Gram, Gram to Standard Measurement)	Standard Measurement

Chapter 16

Percent Composition



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Two different sized bags of mixed nuts
(If nut allergies exist, you may use various candies like M&M's or Skittles)

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

12ASI1.3 Use technology and mathematics to improve investigations and communications. Mathematics plays an essential role in all aspects of an inquiry.

Definitions

percent composition	the total amount (by mass) of each element within a compound

Sample questions to ask your child after completing the weekly reading.

If you needed to know how much of a particular element is present within compound (by percentage), why can't you simply count the number of atoms within a molecule?

To determine a percentage, you will need to take into consideration the size of each atom which will be different for each element.

Explain how you to calculate the percent composition of elements within a molecule:

First, calculate the molar mass of the compound.
Second, multiply the atomic mass of each element within the compound by the number of atoms of that element that is present in the compound.
Finally, divide each of these masses (Step 2) by the molar mass (Step 1) and multiply by 100%.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Cu: 28.4%
   Br: 71.6%
2) Na: 57.5%
   O: 40.0%
   H: 2.5%
3) N: 41.1%
   H: 11.8%
   S: 47.1%
4) N: 30.4%
   S: 69.6%
5) 41.1% C
6) Na: 32.4%
   S: 22.5%
   O:45.1%
7) O:88.79%
   H:11.21%
8) K: 40.3%
   Cr: 26.8%
   O: 33.0%
9) C: 81.8%
   H: 18.2%

10) CH_2O

If you assumed to have a 100g sample of this compound, you would have 40.0g of carbon, 6.7g of hydrogen, and 53.3g of oxygen. After converting each of these masses into moles, you should notice that the carbon and oxygen mole numbers are the same. This mean the ratio of these two elements is 1:1 within the compound. You then need to divide all the mole numbers by the smallest among them, which is 3.33 to get the correct number of moles for all of the elements. This gives you a ratio of 1:2:1 (C:H:O) which is written the chemical formula - CH_2O.

11) c ($C_3H_4O_2$)
12) SO_3

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Two different sized bags of mixed nuts
(If nut allergies exist, you may use various candies like M&M's or Skittles)

Percent composition of mixed nuts or…

I'd like to buy one peanut, please!

The percent composition within bags of mixed nuts will be calculated.

Ingredients:

Two different sized bags of mixed nuts
(If nut allergies exist, you may use various candies like M&M's or Skittles)

Recipe:

1) Record the mass of the nuts from the bag.
2) Open the bag and count the numbers of each of the nuts.
3) Use the following chart to calculate the mass of each group of nuts within your bag:

Nut	Average weight (grams)
Peanut	0.9 g
Almond	0.78 g
Walnut	2.0 g
Brazil nut	0.25 g
Cashew	0.72 g
Pecan	0.67 g

4) Calculate the percent composition of each nut your bag.
5) Repeat this procedure using the different sized bag of nuts.
6) Compare and contrast the percent compositions of each nut within each bag. Are they similar or different? Why do you believe this is so?

Explanation:

The percent composition is used by chemists to determine how much of a particular element is present within a compound. Since all elements contain different amounts of protons and neutrons, their masses are all unique. This is why we use the molar mass when determining the percent composition!

The steps required to calculate the percent composition are pretty easy to follow:

1. Calculate the molar mass of the compound.
2. Multiply the atomic mass of each element within the compound by the number of atoms of that element that is present in the compound.
3. Divide each of these masses (Step 2) by the molar mass (Step 1) and multiply by 100%.

Within this experiment, each of the nuts would be analogous to a specific element. With the knowledge of their unique masses and with the total mass pre-calculated on the bag, you can easily follow these three steps to determine the percent composition for your bag of mixed nuts.

Unit Quiz (Weeks 15-16)

Scene of the Crash

At 6:02 a.m. you and your team of medical examiners are called to the scene of a plane crash. You find evidence of a pre-crash explosion. At the site of the explosion a material has been found. Subsequent chemical analysis shows:

Carbon 37.01% **Nitrogen 18.5%**
Hydrogen 2.22% **Oxygen 42.27%**

The passengers are found in and around the crash. They must be identified by the substances found in their belongings or in their bodies, since they are not recognizable and their dental records are not available. Upon further investigation one passenger was suspected of having been murdered before the crash: the time of death was approximated at one hour prior to the crash.

Table 1:

Passenger	Percent composition (%)				Location
	Carbon	Hydrogen	Nitrogen	Oxygen	
1	67.31	6.98	4.62	21.10	Blood
2	63.15	5.30	---	31.55	Face
	46.66	4.48	31.1	17.76	Stomach
3	72.15	7.08	4.68	16.03	Pockets (2000 tablets)
4	15.87	2.22	18.15	63.41	Blood and pockets
5	75.42	6.63	8.38	9.57	Blood
	37.01	2.22	18.50	42.27	Pockets
6	57.14	6.16	9.52	27.18	Pockets
7	80.48	7.45	9.39	2.68	Pockets
	81.58	8.90	9.52	---	Pockets
8	60.00	4.48	---	35.53	Pockets
	63.56	6.00	9.27	21.17	Pockets

Table 2:

Possible compounds

Compound name	Formula	Notes
Codeine	$C_{18}H_{21}NO_3$	Painkiller, prescription required
Cocaine	$C_{17}H_{21}NO_4$	Narcotic (illegal)
Aspirin	$C_9H_8O_4$	Painkiller
Aspartame	$C_{14}H_{18}N_2O_5$	Artificial sweetener
Vanilla	$C_8H_8O_3$	Flavoring
Trinitrotoluene	$C_7H_5N_3O_6$	Explosive, TNT (dynamite)
Nitroglycerine	$C_3H_5N_3O_9$	Explosive, heart medication
Curare	$C_{40}H_{44}N_4O$	Poison
Thiobromine	$C_7H_8N_4O_2$	Chocolate flavoring
Strychnine	$C_{21}H_{22}N_2O_2$	Rat poison
Dimetacrine	$C_{10}H_{13}N$	Prescription drug, antidepressent
Acetaminophen	$C_8H_9NO_2$	Painkiller (Tylenol)

Table 3:

Passenger information

Passengers and crew	Notes
Amadeo Oldere	Has a heart condition
Connie Majors	Pharmacist
Jim LeClaire	Baker
Archie Starr	Teacher, addicted to sugar-free drinks
Bob (Reno) Henderson	Professional athlete, suspended for drug violations
Lisa Johnson	Environmental engineer, severely depressed
Bill (Cadillac) Jackson	Suspected drug dealer
Norm Anderson	Suspected leader of a terrorist organization

What needs to be done?

Your job is to use the percent composition data in Table 1 to determine formulas for the compounds found with or in the passengers. Match these formulas with the identity of each compound listed Table 2. Be certain to use the number of significant figures in the analysis to determine the number of significant figures you need to use from the periodic table. For example, if four significant figures are given in the data, use four significant figures from the periodic table.

Use the passenger information in Table 3 to make a probable identification of each passenger. Follow the evidence supported by data!

In addition, you must also figure out who was murdered and who is the most probable murderer. Use the worksheet on the following page to write out your answers.

Passenger	Passenger name	Profession	Compound found with/in
1			
2			
3			
4			
5			
6			
7			
8			

Who was murdered? ______________________________

Who is the murderer? ______________________________

Unit Quiz Answer Key

Passenger	Passenger name	Profession	Compound found with/in
1	Bob (Reno) Henderson	Athlete	Cocaine
2	Jim LeClaire	Baker	Vanilla
3	Bill (Cadillac) Jackson	Drug Dealer	Codeine
4	Amadeo Oldere	Heart	Nitroglycerine
5	Norm Anderson	Terrorist	Strychnine TNT
6	Archie Starr	Health	Aspartame
7	Lisa Johnson	Teacher	Curare Dimetacrine
8	Connie Majors	Pharmacist	Aspirin Acetaminophen

Norm Anderson was murdered by Lisa Johnson

Quarterly Test

Chapters 9-16

This test contains both a pre- and post-test for your child.

Once the pre-test has been completed and reviewed, the post-test may be administered.

The pre-test has been constructed to build upon the mechanics of various chemistry problems, while the post-test is designed for a deeper understanding of these mechanics.

Prior to this exam, it is highly recommended that the weekly practice problems and unit quizzes be reviewed by the child!

Pre-Test (Units 5-8)

For each of the following questions, determine whether the compound is ionic or covalent and name it appropriately.

1) Na_2CO_3 ______________________________
2) P_2O_5 ______________________________
3) NH_3 ______________________________
4) $FeSO_4$ ______________________________
5) SiO_2 ______________________________
6) $GaCl_3$ ______________________________
7) $CoBr_2$ ______________________________
8) B_2H_4 ______________________________
9) CO ______________________________
10) P_4 ______________________________

For each of the following questions, determine whether the compound is ionic or covalent and write the appropriate formula for it.

11) dinitrogen trioxide ______________________________
12) nitrogen gas ______________________________
13) methane ______________________________
14) lithium acetate ______________________________
15) phosphorus trifluoride ______________________________
16) vanadium (V) oxide ______________________________
17) aluminum hydroxide ______________________________
18) zinc sulfide ______________________________
19) silicon tetrafluoride ______________________________
20) silver phosphate ______________________________

What family on the periodic table is most associated with each of the following properties?

21) Form +2 ions ______________________________

22) Unreactive ______________________________

23) Highest melting and boiling points ______________________________

24) Why do elements in the same family have similar properties?

25) A 45.9g sample of copper is combined with oxygen which makes a 51.69g sample of copper (I) oxide. What is the percent composition of this compound:

Calculate the percent composition of H and O in each compound:

26) H_2O

27) H_2O_2

28) How many moles of iron are in 50.0 g of iron?

29) How many moles of carbon atoms and oxygen atoms are in 0.250 moles of carbon dioxide?

30) How many moles of copper atoms are in a copper penny weighing 3.10 g? How many copper atoms are in the penny?

31) A chemistry class has 15 men and 17 women in it. How many moles of students are in the class?

Pre-Test Answer Key

For each of the following questions, determine whether the compound is ionic or covalent and name it appropriately.

1) Na_2CO_3 sodium carbonate
2) P_2O_5 diphosphorus pentoxide
3) NH_3 ammonia
4) $FeSO_4$ iron (II) sulfate
5) SiO_2 silicon dioxide
6) $GaCl_3$ gallium chloride
7) $CoBr_2$ cobalt (II) bromide
8) B_2H_4 diboron tetrahydride
9) CO carbon monoxide
10) P_4 phosphorus

For each of the following questions, determine whether the compound is ionic or covalent and write the appropriate formula for it.

11) dinitrogen trioxide N_2O_3
12) nitrogen gas N_2
13) methane CH_4
14) lithium acetate $LiC_2H_3O_2$
15) phosphorus trifluoride PF_3
16) vanadium (V) oxide V_2O_5
17) aluminum hydroxide $Al(OH)_3$
18) zinc sulfide ZnS
19) silicon tetrafluoride SiF_4
20) silver phosphate Ag_3PO_4

What family on the periodic table is most associated with each of the following properties?

21) Form +2 ions — Alkaline earth metals
22) Unreactive — Noble gases
23) Highest melting and boiling points — Transition metals
24) Why do elements in the same family have similar properties?

Elements in the same family have similar properties because they have the same number of valence electrons in their outermost orbitals.

25) A 45.9g sample of copper is combined with oxygen which makes a 51.69g sample of copper (I) oxide. What is the percent composition of this compound: **Answer: Cu_2O is comprised of 88.1% Cu and 11.9% O**

Molar mass of oxygen = 16 grams/mole
Molar mass of copper = 63.5 grams/mole

Cu_2O = (16 gram/mole X 1) + (63.5 grams/mole X 2) = 143 grams/mole

$$Cu_2 = \frac{127 \text{ grams/mole}}{143 \text{ grams/mole}} \times 100 = 88.1\%$$

$$O = \frac{16 \text{ grams/mole}}{143 \text{ grams/mole}} \times 100 = 11.9\%$$

Calculate the percent composition of H and O in each compound:

26) H_2O **Answer: H=11.1% O=88.9%**

Molar mass of oxygen = 16 grams/mole
Molar mass of hydrogen = 1 gram/mole

H_2O = (1 gram/mole X 2) + (16 grams/mole X 1) = 18 grams/mole

$$H_2 = \frac{2 \text{ grams/mole}}{18 \text{ grams/mole}} \times 100 = 11.1\%$$

$$O = \frac{16 \text{ grams/mole}}{18 \text{ grams/mole}} \times 100 = 88.9\%$$

Calculate the percent composition of H and O in each compound:

27) H_2O_2 **Answer: H=5.88% O=94.1%**

Molar mass of oxygen = 16 grams/mole

Molar mass of hydrogen = 1 gram/mole

H_2O = (1 gram/mole X 2) + (16 grams/mole X 2) = 34 grams/mole

$$H_2 = \frac{2 \text{ grams/mole}}{34 \text{ grams/mole}} \times 100 = 5.88\%$$

$$O_2 = \frac{32 \text{ grams/mole}}{34 \text{ grams/mole}} \times 100 = 94.1\%$$

28) How many moles of iron are in 50.0 g of iron?

$$\frac{50.0 \text{ g}}{} \left| \frac{1 \text{ mole}}{55.845 \text{ g}} \right. = 0.895 \text{ moles}$$

29) How many moles of carbon atoms and oxygen atoms are in 0.250 moles of carbon dioxide?

$$\frac{0.250 \text{ moles } CO_2}{} \left| \frac{1 \text{ mole C}}{1 \text{ mole of } CO_2} \right. = 0.250 \text{ moles of C atoms}$$

$$\frac{0.250 \text{ moles } CO_2}{} \left| \frac{2 \text{ moles O}}{1 \text{ mole of } CO_2} \right. = 0.500 \text{ moles of O atoms}$$

30) How many moles of copper atoms are in a copper penny weighing 3.10 g? How many copper atoms are in the penny?

$$\frac{3.10 \text{ g Cu}}{} \left| \frac{1 \text{ mole Cu}}{63.546 \text{ g Cu}} \right. = 0.0488 \text{ moles Cu}$$

$$\frac{0.0488 \text{ moles Cu}}{} \left| \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mole of Cu}} \right. = 2.94 \times 10^{22} \text{ atoms of Cu}$$

31) A chemistry class has 15 men and 17 women in it. How many moles of students are in the class?

$$\frac{32 \text{ students}}{} \left| \frac{1 \text{ mole students}}{6.022 \times 10^{23} \text{ students}} \right. = 5.314 \times 10^{-23} \text{ moles of students}$$

Post-Test (Units 5-8)

Answer the following questions as they pertain to the answer key for Test 2

1) What makes noble gases the most unreactive of all the main block families?

2) The amount of oxygen in the compounds shown in #26 and 27 double however, the percent composition of oxygen does not double as well. Why does this occur?

3) After 1983, copper pennies were created primarily out of zinc with a copper plating on the outside. If the penny mentioned in question #30 were made after 1983, what would need to be done in order to solve the problem?

4) Why were two moles of oxygen used in the conversion factor of question #29?

5) What is the significance of the roman number II in the answers to questions #4 and 7?

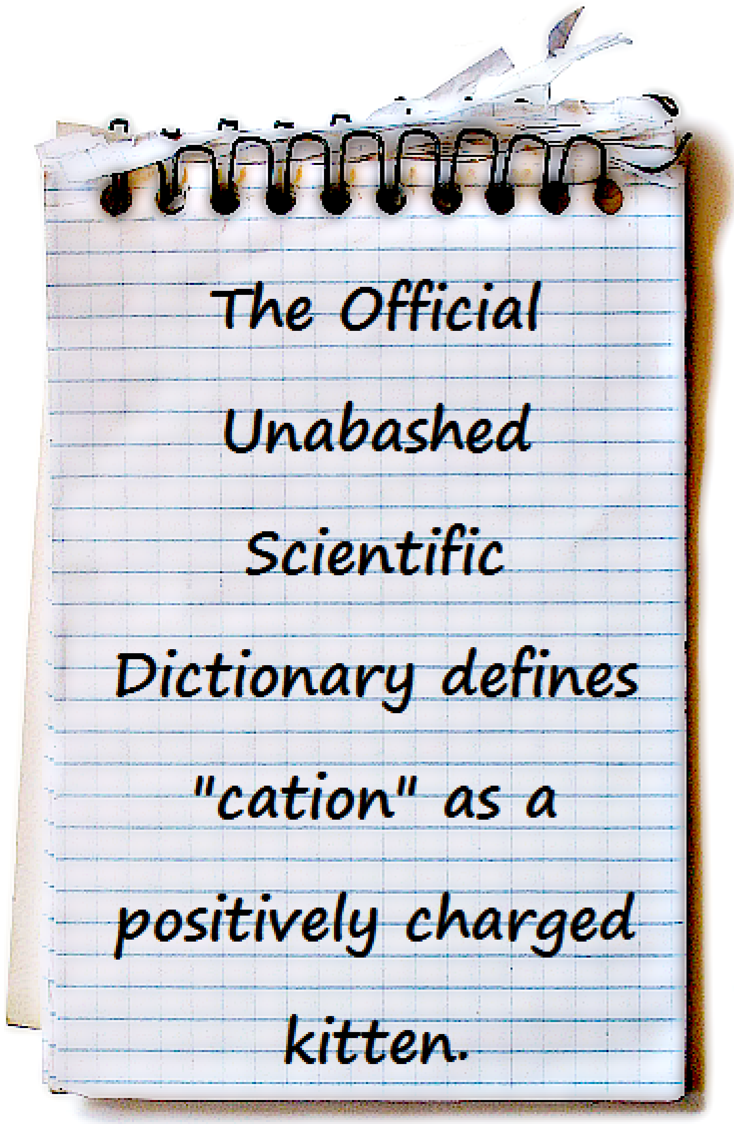
6) Why is the answer to question #19 not simply silicon fluoride?

Post-Test Answer Key

1) Noble gases have eight valence electrons. This is the most stable number of electrons within an element's outermost s and p orbitals. All elements attempt to be more like noble gases as they are the most stable and unreactive.
2) The percent composition of elements is based upon not only the number of atoms that are present within a compound, but also their size! The percent composition of oxygen between water and hydrogen peroxide (H_2O_2) did increase – but so did the molar mass of both compounds. That is why we did the first calculations to determine the mass of the entire compound first.
3) The zinc would need to be removed from the copper penny first. The copper would then need to be weighed so that the problem could be solved.
4) Two moles of oxygen were used due to the chemical formula of carbon dioxide CO_2 – since there are two oxygen atoms for every one carbon atom, you must use two moles of oxygen for every one mole of carbon in your conversion factors.
5) The roman numerals identify the ionic charge of the metals (cations) that are bonding with their negatively charged anions.
6) The bond that forms between silicon and fluorine is covalent; therefore, the prefix "tetra-" must be added to the anion.

Chapter 17

Balancing Chemical Equations



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

2 cups flour
1 ½ cups sugar
3 teaspoons baking powder
1 cup shortening
1/2 teaspoon salt
1 cup milk
1 teaspoon vanilla

3 eggs
Muffin tins
Muffin papers
Whisk (or mixer)
Mixing bowls
Frosting (optional)

National Science Education Standards covered this week:

12BPS3.2 Chemical reactions may release or consume energy. Some reactions such as the burning fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

Definitions

subscripts	the numbers written after individual atoms that identify how many atoms of that element exist within the molecule
coefficients	a number placed in front of a compound to identify how many compounds (as a whole) exist
reactants	compounds which react together to form products
products	compounds that are created from the reaction between reactants
Law of Conservation of Matter	law of chemistry which states that matter cannot be created or destroyed, only rearranged into different positions
MINOH	method used to add coefficients to the type of particles within the equation for it to be balanced; follows a path by which metals are balanced first, followed by ions, non-metals, oxygen, and finally hydrogen
grid method	method of adding coefficients to balance a chemical equation; uses a table for each chemical equation to count the number of atoms within the reactants and the products

Sample questions to ask your child after completing the weekly reading.

How do subscripts help a chemist when writing a chemical formula?
Subscripts identify the number of atoms present within a particular molecule.

When is it necessary to use parentheses when writing a chemical formula?
If more than one polyatomic ion is present within the molecule, the ion must be incorporated within a set of parenthesis before a subscript can be added.

What is the difference between a subscript and a coefficient?
Subscripts identify how many atoms exist within an individual molecule. Coefficients tell you how many molecules are present.

Why is it important to only change coefficients when balancing a chemical equation and not the subscripts?
Changing the coefficients only changes the number of molecules present within the reaction; however, if you change a subscript, you change the type of molecule.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

Answer Key

1) $1\ N_2 + 3\ H_2 \rightarrow 2\ NH_3$

2) $2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$

3) $2\ NaCl + 1\ F_2 \rightarrow 2\ NaF + 1\ Cl_2$

4) $2\ H_2 + 1\ O_2 \rightarrow 2\ H_2O$

5) $1\ Pb(OH)_2 + 2\ HCl \rightarrow 2\ H_2O + 1\ PbCl_2$

6) $2\ AlBr_3 + 3\ K_2SO_4 \rightarrow 6\ KBr + 1\ Al_2(SO_4)_3$

7) $1\ CH_4 + 2\ O_2 \rightarrow 1\ CO_2 + 2\ H_2O$

8) $1\ C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

9) $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

10) $1\ FeCl_3 + 3\ NaOH \rightarrow 1\ Fe(OH)_3 + 3\ NaCl$

11) $4\ P + 5\ O_2 \rightarrow 2\ P_2O_5$

12) $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + 1\ H_2$

13) $2\ Ag_2O \rightarrow 4\ Ag + 1\ O_2$

14) $1\ S_8 + 12\ O_2 \rightarrow 8\ SO_3$

15) $6\ CO_2 + 6\ H_2O \rightarrow 1\ C_6H_{12}O_6 + 6\ O_2$

16) $1\ K + 1\ MgBr \rightarrow 1\ KBr + 1\ Mg$

17) $2\ HCl + 1\ CaCO_3 \rightarrow 1\ CaCl_2 + 1\ H_2O + 1\ CO_2$

18) $1\ HNO_3 + 1\ NaHCO_3 \rightarrow 1\ NaNO_3 + 1\ H_2O + 1\ CO_2$

19) **2** H_2O + **1** O_2 → **2** H_2O_2

20) **2** NaBr + **1** CaF_2 → **2** NaF + **1** $CaBr_2$

21) **1** H_2SO_4 + **2** $NaNO_2$ → **2** HNO_2 + **1** Na_2SO_4

22) **2** C_6H_6 + **15** O_2 → **6** H_2O + **12** CO_2

23) **4** NaI + **1** $Pb(SO_4)_2$ → **1** PbI_4 + **2** Na_2SO_4

24) **2** NH_3 + **2** O_2 → **1** NO + **3** H_2O

25) **2** $Fe(OH)_3$ → **1** Fe_2O_3 + **3** H_2O

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

2 cups flour
1 ½ cups sugar
3 teaspoons baking powder
1 cup shortening
1/2 teaspoon salt
1 cup milk
1 teaspoon vanilla

3 eggs
Muffin tins
Muffin papers
Whisk (or mixer)
Mixing bowls
Frosting (optional)

Chemical equation cupcakes

Uhmmm… You want me to eat THAT?!?!?

The similarities between recipes and balanced equations will be explored.

Ingredients:

480mL flour
360mL sugar
15mL baking powder
240mL shortening
2.5mL salt
240mL milk
5mL vanilla
3 eggs

Other items:
Muffin tins
Muffin papers
Whisk (or mixer)
Mixing bowls
Frosting (optional)

Recipe:

You will be making four separate batches of cupcakes within this recipe	
Batch A	contains all ingredients in their proper amounts
Batch B	contains all ingredients except egg
Batch C	contains all ingredients except baking powder
Batch D	contains all ingredients plus an extra $\frac{1}{2}$ cup shortening

Locate the Cupcake Data Sheet at the end of this lesson. Make your predictions as to what each of the qualitative measurements will be within Batches A through D before you bake.

Once you have completed your predictions, it's time to start cooking!

For Batch A and Batch B:

1) Preheat the oven to 350 degrees Fahrenheit.

2) Mix the following dry ingredients together:

240mL sifted flour
180mL cup sugar
10mL baking powder
1.25mL salt

3) Divide this mixture into two halves. They are to be known as "Dry A" and "Dry B"
4) Measure all of the following liquid ingredients and combine in a separate container:

60mL shortening
120mL milk
2.5mL vanilla

5) Divide this mixture into two halves. They are to be known as "Wet A" and "Wet B"
6) Combine Wet B and Dry B in a large mixing bowl. This is will become Batch B.
7) <u>Add one egg to Wet A</u>, mix well, and add to Dry A. This will become Batch A.
8) Mix well with a wisk or electric mixer for several minutes.
9) Place cupcake papers in muffin tins, and pour the batter into the cups, filling them halfway up to the top.
10) Bake for 20-25 minutes.
11) Cover with favorite frosting after it cools if you wish.

<u>For Batch C and Batch D:</u>

1) Preheat the oven to 350 degrees Fahrenheit.
2) Mix the following dry ingredients together:

240mL flour
180mL sugar
1.25mL salt

3) Divide this mixture into two halves. They are to be known as "Dry C" and "Dry D"
4) Measure all of the following liquid ingredients and combine in a separate container:

60mL shortening
120mL milk
2.5mL vanilla
1 egg

5) Divide this mixture into two halves. They are to be known as "Wet C" and "Wet D"
6) <u>Add 5mL of baking powder to Dry C</u>. Mix together Dry C and Wet C. This (obviously) will become Batch C.
7) <u>Add an additional 120mL shortening to Wet D</u>, mix well, and add to Dry D. This will become Batch D.
8) Mix well with a wisk or electric mixer for several minutes.
9) Place cupcake papers in muffin tins, and pour the batter into the cups, filling them halfway up to the top.
10) Bake for 20-25 minutes.
11) Cover with favorite frosting after it cools if you wish.

After all four batches have cooled, enjoy tasting each one and compare their qualitative measurements to the predictions you made at the beginning of the lesson. Be certain to write down your observations on your Cupcake Data Sheet.

Explanation:

In chemistry, it is very important to add the correct amount of reactant in order for a reaction to occur properly. This is the same with cooking as well! The five properties you were to predict and evaluate are all directly linked to the proper amounts of ingredients added to the batter. It is important to note that the act of baking your cupcakes was actually several reactions at once. Nevertheless, every time you changed the ingredients within your batter, you reduced the accuracy of the final product (the cupcakes).

This activity simulates the balancing of equations very well. The coefficients within chemical equations are the same as the amount of ingredients you have used within your recipe. If you alter any coefficient within a balanced equation, you will not obtain the same product.

Throughout all of these cooking labs, you must realize that you are actually weighing a mass whenever you pull out a measuring spoon or cup. You may only see flour when you measure out one cup for your recipe, but you are actually measuring the mass of a compound. And, if you do not accurately measure the amount needed, your product may not be very desirable.

Cupcake Data Sheet

Property	Prediction (before baking)	Observation (after baking)
Moisture		
Texture (smooth, grainy, etc.)		
Consistency (firmness)		
Height		
Taste		

Chapter 18

Chemical Reactions

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

5 ripe bananas
5 unripe bananas
5 ripe pears or apples (FYI - You can easily tell when pears are ripe!)
5 unripe pears or apples (The pears will be very firm.)
8 sealable gallon-sized plastic bags

National Science Education Standards covered this week:

12BPS3.2 Chemical reactions may release or consume energy. Some reactions such as the burning fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

Definitions

chemical reactions	processes in which the atoms within reactants are rearranged to form new compounds (products)
exothermic	chemical reaction which gives off energy
endothermic	chemical reaction which absorbs energy
precipitate	solid product formed from the chemical reaction between two liquid reactants
synthesis reaction	chemical reaction in which two or more reactants combine to form a more complicated molecule
decomposition reaction	the opposite of a synthesis reaction; a chemical reaction in which one large reactant is broken down into two or more smaller products
single displacement reaction	a chemical reaction in which a single element switches places with another element in a chemical compound.
double displacement reaction	a chemical reaction in which the cations of two compounds exchange places with each other
acid-base reactions	a chemical reaction similar to double displacement reactions; however, unlike double displacement reactions, water is one of the product
combustion reaction	a chemical reaction in which a compound containing carbon and hydrogen combines with oxygen gas; the products formed are heat, water, and carbon dioxide

Sample questions to ask your child after completing the weekly reading.

What are four possible observations that can be made to determine if a chemical reaction has taken place?

Temperature changes, color change, a solid forms, or the formation of a gas all may indicate a chemical reaction has taken place.

What is the difference between the synthesis and decomposition reactions?

Synthesis reactions create a larger molecule from two or more smaller reactants while decomposition reactions break down larger molecules into smaller products.

What is the main difference between double displacement reactions and acid/base reactions?

Double displacement reactions do not produce water, unlike acid/base reactions.

What must the reactants and products include during a combustion reaction?

In order for a combustion reaction to take place, a compound containing carbon and hydrogen must react with oxygen gas to produce heat, water, and carbon dioxide.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $2\ NaBr + 1\ Ca(OH)_2 \rightarrow 1\ CaBr_2 + 2\ NaOH$

Type of reaction: <u>double displacement</u>

2) $2\ NH_3 + 1\ H_2SO_4 \rightarrow 1\ (NH_4)_2SO_4$

Type of reaction: <u>synthesis</u>

3) $4\ C_5H_9O + 27\ O_2 \rightarrow 20\ CO_2 + 18\ H_2O$

Type of reaction: <u>combustion</u>

4) $3\ Pb + 2\ H_3PO_4 \rightarrow 3\ H_2 + 1\ Pb_3(PO_4)_2$

Type of reaction: <u>single displacement</u>

5) $1\ Li_3N + 3\ NH_4NO_3 \rightarrow 3\ LiNO_3 + 1\ (NH_4)_3N$

Type of reaction: <u>double displacement</u>

6) $3\ HBr + 1\ Al(OH)_3 \rightarrow 3\ H_2O + 1\ AlBr_3$

Type of reaction: <u>acid-base</u>

7) Unlike double displacement reactions, acid-base reactions produce water.

8) $Na_3PO_4 + 3\ KOH \rightarrow 3\ NaOH + K_3PO_4$ — <u>Double displacement</u>
9) $MgCl_2 + Li_2CO_3 \rightarrow MgCO_3 + 2\ LiCl$ — <u>Double displacement</u>
10) $C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ — <u>Combustion</u>
11) $Pb + FeSO_4 \rightarrow PbSO_4 + Fe$ — <u>Single displacement</u>
12) $CaCO_3 \rightarrow CaO + CO_2$ — <u>Decomposition</u>
13) $P_4 + 3\ O_2 \rightarrow 2\ P_2O_3$ — <u>Synthesis</u>
14) $2\ RbNO_3 + BeF_2 \rightarrow Be(NO_3)_2 + 2\ RbF$ — <u>Double displacement</u>
15) $2\ AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2\ Ag$ — <u>Single displacement</u>

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

5 ripe bananas
5 unripe bananas
5 ripe pears or apples (FYI - You can easily tell when pears are ripe!)
5 unripe pears or apples (The pears will be very firm.)
8 sealable gallon-sized plastic bags

Fruit salad ala Ethylene or…

One rotten apple spoils the whole bunch!

The chemical reaction involving the ripening of fruit will be explored.

Ingredients:

5 ripe bananas
5 unripe bananas
5 ripe pears or apples (FYI - You can easily tell when pears are ripe!)
5 unripe pears or apples (The pears will be very firm.)

Other items:
8 sealable gallon-sized plastic bags
Marker

Recipe:

1) Label the bags: Bag 1, Bag 2, Bag 3, etc.
2) Place the fruit(s) in the following bags:

Bag number	Fruits	Control or Experimental?
1	Ripe banana	Control group
2	Ripe apple/pear	Control group
3	Unripe banana	Control group
4	Ripe apple/pear	Control group
5	Ripe banana + Ripe apple/pear	Experimental group
6	Unripe banana + Ripe apple/pear	Experimental group
7	Ripe banana + Unripe apple/pear	Experimental group
8	Unripe banana + Unripe apple/pear	Experimental group

3) Place the remaining bananas and apples in different places around your house. You do not want them to be close together!
4) Make one or more predictions about what will happen in this experiment. You are searching for the condition that will contain the fruit which ripens the fastest.
5) Observe and record the changes to the appearance of the fruit each day for five days on the attached data sheet.
6) If the ripening of the fruit was unaffected by storing it with a banana, then both the control and test groups should be the same level of ripeness. Were they? Was the hypothesis accepted or rejected? What is the significance of this result?

Explanation:

You've heard that "one bad apple spoils the whole bushel", right? It's true. Bruised, damaged, or overripe fruit gives off a hormone (ethylene) in the form of a gas that accelerates the ripening of the other fruit. The bags containing ripe fruit should have ripened the fastest within this experiment since the gas cannot escape out of the sealed bag.

Hormones are chemicals that are produced within the cells of plants (and animals for that matter) that have an effect on cells in a different location. Ethylene is produced and released by rapidly-growing plant tissues. The hormone causes several different chemical reactions within fruit - one is fruit ripening. When fruit ripens, the starch in the fleshy part of the fruit is converted to sugar. Ethylene initiates the reaction in which the starch is converted into sugar. The actual reaction is way too complicated to describe here! (Sorry) However...

You use this information in the kitchen all the time!

How? Well, first of all keep a close eye on your fruits and vegetables. If you notice one of them ripening quickly, you may want to separate it from the others. And, if you happen to purchase an unripe bunch of bananas or other fruits/vegetables simply place them in a bag overnight to trap the ethylene gas and induce the ripening process much faster!

Fruit distributors often take advantage of this effect by picking fruit well before ripening and then shipping fruit to grocers while it is still green. Then, just before delivery, the fruit is gassed with ethylene to kick-start the ripening process. This helps make sure none of the fruit will ripen too early, which would be problematic at the grocery store.

Bag number	Fruits	Observations
1	Ripe banana	
2	Ripe apple/pear	
3	Unripe banana	
4	Ripe apple/pear	
5	Ripe banana + Ripe apple/pear	
6	Unripe banana + Ripe apple/pear	
7	Ripe banana + Unripe apple/pear	
8	Unripe banana + Unripe apple/pear	
--	Ripe banana (not in bag)	
--	Unripe banana (not in bag)	
--	Ripe apple/pear (not in bag)	
--	Unripe apple/pear (not in bag)	

Unit Quiz (Weeks 17-18)

Balance the following equations and identify the type of reaction:

1) ____C_3H_6O + ____O_2 → ____CO_2 + ____H_2O

Type of reaction: ________________________________

2) ____C_5H_5 + ____Fe → ____$Fe(C_5H_5)_2$

Type of reaction: ________________________________

3) ____$SeCl_6$ + ____O_2 → ____SeO_2 + ____Cl_2

Type of reaction: ________________________________

4) ____MgI_2 + ____$Mn(SO_3)_2$ → ____$MgSO_3$ + ____MnI_4

Type of reaction: ________________________________

5) ____O_3 → ____$O^{\cdot}$ + ____O_2

Type of reaction: ________________________________

6) ____NO_2 → ____O_2 + ____N_2

Type of reaction: ________________________________

7) _____ HNO_3 + _____ $Mg(OH)_2$ → _____ H_2O + _____ $Mg(NO_3)_2$

Type of reaction: ________________________________

8) _____ H_3PO_4 + _____ NaBr → _____ HBr + _____ Na_3PO_4

Type of reaction: ________________________________

9) _____ C + _____ H_2 → _____ C_3H_8

Type of reaction: ________________________________

10) _____ CaO + _____ MnI_4 → _____ MnO_2 + _____ CaI_2

Type of reaction: ________________________________

11) _____ Fe_2O_3 + _____ H_2O → _____ $Fe(OH)_3$

Type of reaction: ________________________________

12) _____ C_2H_2 + _____ H_2 → _____ C_2H_6

Type of reaction: ________________________________

13) _____ VF_5 + _____ HI → _____ V_2I_{10} + _____ HF

Type of reaction: ________________________________

14) _____ OsO_4 + _____ $PtCl_4$ → _____ PtO_2 + _____ $OsCl_8$

Type of reaction: ________________________________

15) _____ CF_4 + _____ Br_2 → _____ CBr_4 + _____ F_2

Type of reaction: ________________________________

16) _____ Hg_2I_2 + _____ O_2 → _____ Hg_2O + _____ I_2

Type of reaction: ________________________________

17) _____ $Y(NO_3)_2$ + __ $GaPO_4$ → _____ YPO_4 + _____ $Ga(NO_3)_2$

Type of reaction: ________________________________

Unit Quiz Answer Key

1)	$C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$	Combustion
2)	$2\ C_5H_5 + Fe \rightarrow Fe(C_5H_5)_2$	Synthesis
3)	$SeCl_6 + O_2 \rightarrow SeO_2 + 3Cl_2$	Single displacement
4)	$2\ MgI_2 + Mn(SO_3)_2 \rightarrow 2\ MgSO_3 + MnI_4$	Double displacement
5)	$O_3 \rightarrow O^{\cdot} + O_2$	Decomposition
6)	$2\ NO_2 \rightarrow 2\ O_2 + N_2$	Decomposition
7)	$2\ HNO_3 + 1\ Mg(OH)_2 \rightarrow 2\ H_2O + 1\ Mg(NO_3)_2$	Double displacement
8)	$1\ H_3PO_4 + 3\ NaBr \rightarrow 3\ HBr + 1\ Na_3PO_4$	Double displacement
9)	$3\ C + 4\ H_2 \rightarrow 1\ C_3H_8$	Synthesis
10)	$2\ CaO + 1\ MnI_4 \rightarrow 1\ MnO_2 + 2\ CaI_2$	Double displacement
11)	$1\ Fe_2O_3 + 3\ H_2O \rightarrow 2\ Fe(OH)_3$	Synthesis
12)	$1\ C_2H_2 + 2\ H_2 \rightarrow 1\ C_2H_6$	Synthesis
13)	$2\ VF_5 + 10\ HI \rightarrow 1\ V_2I_{10} + 10\ HF$	Double displacement
14)	$1\ OsO_4 + 2\ PtCl_4 \rightarrow 2\ PtO_2 + 1\ OsCl_8$	Double displacement
15)	$1\ CF_4 + 2\ Br_2 \rightarrow 1\ CBr_4 + 2\ F_2$	Single displacement
16)	$2\ Hg_2I_2 + 1\ O_2 \rightarrow 2\ Hg_2O + 2\ I_2$	Single displacement
17)	$1\ Y(NO_3)_2 + 1\ GaPO_4 \rightarrow 1\ YPO_4 + 1\ Ga(NO_3)_2$	Double displacement

Chapter 19

Stoichiometry

A chemistry professor couldn't resist interjecting a little philosophy into a class lecture. He interrupted his discussion on balancing chemical equations, saying, "Remember, if you're not part of the solution, you're part of the precipitate!"

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

One bag of large marshmallows (optional)
One Hershey's chocolate candy bar (optional)
One small box of graham crackers (optional)
* You don't have to purchase these materials to complete the activity, but it will be fun if you do!

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

Definitions

stoichiometry	the process of calculating the amount of reactants we need for a certain amount of product
mole ratio	a conversion factor that exists between the moles of the product and reactants from the chemical equation; can be identified as the coefficients for the known and unknown compounds

Sample questions to ask your child after completing the weekly reading.

What is the practical reason for chemists to use stoichiometry?

The use of stoichiometry is important because the cost of reactants is not always very cheap and it is advantageous to make precise measurements to determine how much reactant is needed to create a precise amount of product.

How do you calculate a mole ratio within a chemical equation?

The mole ratio within a chemical reaction can be identified as the coefficients for the known and unknown compounds you are converting.

Why is dimensional analysis so important when completing a stoichiometry problem?

Dimensional analysis helps the chemist line up the proper conversion factors in order to cancel out any unneeded units.

How are the concepts of molar mass, balanced equations and chemical reactions similar to the use of a recipe?

The ingredients of a recipe are the same as the molar masses of each compound within a reaction. When the correct amounts of each ingredient are written out in the form of a recipe, the recipe itself would be equal to a balanced equation. This recipe tells you how much of each ingredient you need and how it is to be balanced together in order to create a particular product.

Naturally, when you place these separate ingredients together and heat them up, an amazing transformation of flavors takes place. These are the chemical reactions which create a distinct (and hopefully tasty) product.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $LiOH + HBr \rightarrow LiBr + H_2O$
If you start with 6.2 grams of lithium hydroxide, how many grams of lithium bromide will be produced? 22.48 grams

2) $C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$
If you start with 17.6 grams of ethylene (C_2H_4), how many grams of carbon dioxide will be produced? 55.21 grams

3) $2\ HCl + Na_2SO_4 \rightarrow 2\ NaCl + H_2SO_4$
If you start with 62 grams of hydrochloric acid, how many grams of sulfuric acid will be produced? 83.4 grams

4) Given the following equation: $LiOH + KCl \rightarrow LiCl + KOH$
If you start with 1.9 grams of potassium chloride, how many grams of potassium hydroxide will be produced? 1.43 grams

5) Given the following equation: C3H8 + 5O2 → 3CO2 + 4H2O
How much C3H8 would you need to produce 53.3 grams of carbon dioxide from this reaction? 17.8 grams

6) Given the reaction: Be + 2 HCl → BeCl2 + H2
How much hydrochloric acid would you need to produce 12.5 grams of beryllium chloride from this reaction? 11.41 grams

7) Given the reaction: 2NaCl + CaO → CaCl2 + Na2O
How much sodium oxide would you produce if you used 58.3 grams of sodium chloride in this reaction? 30.92 grams

8) Given the reaction: FeBr2 + 2 KCl → FeCl2 + 2 KBr
How much potassium chloride would you need to produce 125 grams of iron (II) chloride from this reaction? 147.04 grams

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

One bag of large marshmallows (optional)
One Hershey's chocolate candy bar (optional)
One small box of graham crackers (optional)
* You don't have to purchase these materials to complete the activity, but it will be fun if you do!

S'more Stoichiometry or…

I know you will want s'more of this lab. (*Sorry…that was horrible*)

The creation of this sticky dessert will help in the practice of stoichiometry.

Ingredients:

One bag of large marshmallows (optional)
One Hershey's chocolate candy bar (optional)
One small box of graham crackers (optional)

Recipe:

You will not have to purchase any ingredients to complete this lab (but it will be a lot tastier if you do!) If you choose not to purchase these items, you may either use the known masses I will provide to you in this lesson OR you can obtain the masses and serving sizes for these ingredients during a trip to the grocery store. Either way will work out just fine!

The problems you are to solve this week are the following:

If you are given one bag of large marshmallows, what is the maximum number of S'mores that can be made?

How many boxes of graham crackers and how many chocolate bars are needed to make this many S'mores?

The S'more Worksheet will provide you an area to show all your calculations. You can check your answers at the end of this chapter.

1) The chemical equation for the creation of a s'more using the following symbols is S_2MmOr_3

2) Calculate the molar mass of the S'more (S_2MmOr_3) by adding all of the ingredients (reactants) together.

Substance	**Symbol**	**Molar Mass**
Graham Cracker	S	7.00 g
Marshmallow	Mm	7.10 g
Chocolate Pieces (3 small pieces within a Hershey's bar)	Or	3.30 g
S'more	S_2MmOr_3	_________ g

3) Write a balanced equation to make one (1) S_2MmOr_3

4) Using the molar mass of one marshmallow from the table above, calculate the number of marshmallows that are available in the bag.

(If you did not purchase a bag of marshmallows for this exercise, assume there are 454 g marshmallows in one bag).

5) With the calculations from the last question, how many graham crackers and chocolate segments would be needed to make the maximum number of s'mores?

6) Convert your number of graham crackers and chocolate segments from the previous question into grams.

(When you go to the store, you cannot quickly determine the exact number of graham crackers or chocolate segments there are in a box or bar. The mass is easy to read, however. Using mass values, you can quickly determine how much you need to buy. Show your work.)

7) Convert the masses of graham crackers and chocolate pieces into the units you will need to purchase at the store – boxes of graham crackers and numbers of chocolate bars.

(If you chose not to purchase these items, you may assume that a box of graham crackers has a mass of 254 g and each chocolate bar has a mass of 49.5 g.)

8) Check your work on the last page of this activity to see how well you did. If you purchased your own materials, you can follow the procedure for working through these stoichiometry problems for your own measurements.

Explanation:

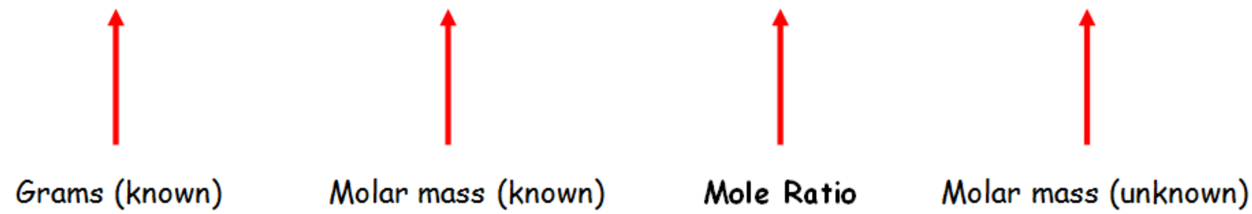
'Stoichio' means element and 'metry' means the process of measuring. The mass and quantity relationships among reactants and products in a reaction are found using the process of stoichiometry.

The use of stoichiometry will be very common throughout the rest of your studies in chemistry this year. You can always think back to this lab to check for understanding! The first thing you needed to do was determine a balanced equation for the reaction of marshmallows, chocolate pieces, and graham crackers. This is the same as the reactants within any chemical equation and it is the first step in learning how to solve nearly any problem in chemistry!

Next, you needed to know how much each of the individual ingredients weighed. This is the same as the molar mass of the reactants and products within a chemical equation.

If you look back in your readings from this week, you should be able to see the similarities in how you solved the problems within this lab exercise with the problem in your readings. Take another look at this diagram in Chapter 19:

$$\frac{45 \text{ grams } C_2H_4}{} \left| \frac{1 \text{ mole } C_2H_4}{28.1 \text{ grams } C_2H_4} \right| \frac{2 \text{ moles } CO_2}{1 \text{ mole } C_2H_4} \left| \frac{44 \text{ grams } CO_2}{1 \text{ mole } CO_2} \right.$$



Look familiar? It should! Within this lab you took your known mass of marshmallows (step 2), converted it into the number of moles using molar mass (step 4), determined the number of graham crackers/chocolate pieces using their molar ratio (step 5), and then converted these amounts in their individual weight (step 6).

Answer key:

2. (2 X 7.0g) + (1 X 7.1g) + (3 X 3.30g) = 31grams
3. 2S + Mm + 3Or → S2MmOr3
4. $\frac{454\text{ g Mm}}{1} \Big| \frac{1\text{ marshmallow (Mm)}}{7.10\text{ g Mm}}$ = **64 marshmallows (in a 454g bag)**

5. $\frac{64\text{ Mm}}{1} \Big| \frac{2\text{ S (graham crackers)}}{1\text{ Mm}}$ = **128 S (graham crackers)**

   $\frac{64\text{ Mm}}{1} \Big| \frac{3\text{ Or (chocolate pieces)}}{1\text{ Mm}}$ = **192 Or (chocolate pieces)**

6. $\frac{128\text{ S}}{1} \Big| \frac{7.0\text{g S}}{1\text{ S}}$ = **896g S**

   $\frac{192\text{ Or}}{1} \Big| \frac{3.3\text{g Or}}{1\text{ Or}}$ = **633.6g Or**

7. $\frac{896\text{g S}}{1} \Big| \frac{1\text{ box S}}{254\text{g S}}$ = **3.5 boxes S**

   $\frac{633.6\text{g Or}}{1} \Big| \frac{1\text{ bar Or}}{198\text{g Or}}$ = **3.2 bars Or**

Chapter 20

Percent Yield

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Various fruits and/or vegetables for a homemade salad (you choose!)

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

12ASI1.3 Use technology and mathematics to improve investigations and communications. Mathematics plays an essential role in all aspects of an inquiry.

Definitions

percent error	a procedure to measure how much error exists within a chemical reaction as compared to a known or calculated amount
limiting reagent (reactant)	the reactant that runs out first within any chemical reaction

Sample questions to ask your child after completing the weekly reading.

What is the main problem with stoichiometry?

The calculations we perform through stoichiometry never equal what we actually create through experimentation. There is always some amount of error.

How do chemists calculate the percent yield of a product?

In order to calculate the percent yield of a product, you must divide the actual amount of product you received through experimentation by the theoretical amount you calculated through stoichiometry. This quotient will then be multiplied by 100 to determine the percent yield of a product.

Why is it good to have a high percent yield from an experiment?

If you can calculate a high percent yield, your experiment was ran very accurately.

What is the purpose of identifying the limiting reactant within a chemical reaction?

The amount of product you can create is limited by the amounts of reactants you have to begin with. Once the limiting reactant is used up, you can no longer create any more product.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $2\ C_6H_{10} + 17\ O_2 \rightarrow 12\ CO_2 + 10\ H_2O$
2) When you do this calculation for 4.6 grams of C_6H_{10}, you find that 14.81 grams of CO_2 will be formed. When you do the calculation with 67 grams of oxygen, you find that 65.03 grams of CO_2 will be formed. Because 14.81 grams is the smaller number, C_6H_{10} is the limiting reagent, forming 14.81 grams of product.
3) C_6H_{10}
4) 51.74 grams of O_2 will be left over
5) 75.96%
6) $CuCl_2 + 2\ NaNO_3 \rightarrow Cu(NO_3)_2 + 2\ NaCl$
7) To solve this problem determine how much sodium chloride can be made from each of the reagents by themselves. When you work out how much sodium chloride can be made with 15 grams of copper (II) chloride, you find that 13.0 grams will be formed. When starting with 20 grams of sodium nitrate, 13.6 grams will be formed. Since 13.0 grams is the smaller number, that's our answer.
8) copper (II) chloride
9) 0.88 grams
10) $11.3/13.0 \times 100\% = 86.9\%$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Various fruits and/or vegetables for a homemade salad (you choose!)

The % yield of salads or…

How much $$$ gets thrown away every time I make a salad?

The creation of a salad will prompt an excellent review of calculating % yield.

Ingredients:

Various fruits and/or vegetables for a homemade salad (you choose!)

Recipe:

You need to answer a brief question before you head out to the grocery store today to work on your lab...

What type of salad would you like to make? Fruit or vegetable?

1) List all of the fruits and vegetables are you going to need for your salad on the attached worksheet along with their amounts (i.e. one cucumber, two tomatoes, etc.)
2) When you get to the grocery store, you will likely need to use the scales in their fruit/vegetable aisle to weigh all of your ingredients. Remember! All of your work needs to be in grams, so if the scales only provide measurements in pounds, write it down on your worksheet and then convert these weights to grams with the following conversion factor: 1 pound = 454 grams
3) Write down the cost of each item, making certain to identify this cost is "per pound" or "per item." This will be important as you do your calculations!
4) When you get home, find the actual yield (%) of each ingredient on the attached chart and write it down on your worksheet. This percentage tells you how much of the fruit/veggie you actually use after it is prepared.
5) Convert the actual yield percentage into grams for each of your ingredients.

6) Calculate the percent yield for each of your ingredients.
7) Take an average of all your percent yields to see the percentage of your money that is spent on consumable ingredients.
8) Subtract this number from 100 to see the percentage of your money that is thrown away.

Explanation:

Chefs study these actual percentages very closely in the preparation of their menus. Since they're job is to make money from their food, it is in their best interest to use as many ingredients as possible which will generate the maximum amount of sellable food with the least amount of waste (in food AND money.)

Chemists are no different than chefs in the preparation of their reactions. The reactants that are necessary to run certain reactions can cost a huge amount of money! It would not be wise to misuse these materials as they could cause serious harm to an individual. From a business perspective, the amount of money lost on a chemical that is carelessly used can be very damaging to the company.

Ingredients and amounts	Cost	Weight in grams (Theoretical yield)	Actual yield (%)	Actual yield (g)	Percent yield
Average all of your percent yields to identify the % of your money that is actually being used for consumable materials. Subtract that % from 100 to find the % that is thrown away.					

Fruit/Vegetable	% Actual yield	Fruit/Vegetable	% Actual yield
Anise	75	Lettuce, leaf	67
Apples	76	Lime	35
Apricots	94	Mustard greens	68
Artichokes	48	Nectarines	86
Asparagus	56	Okra	78
Avocado	75	Onions, green (10-12)	60
Bananas	68	Onions, large	89
Beans, green	88	Orange	70
Beans, lima (in shell)	40	Parsley	76
Beet greens	56	Parsnips	85
Beets, no tops	76	Peaches	76
Beets, with tops	49	Pears	78
Blackberries	92	Peas, green	38
Blueberries	92	Peppers	85
Broccoli	61	Peppers, green	82
Brussels sprouts	74	Persimmons	82
Cabbage, green	79	Pineapple	52
Cantaloupe	50	Plums	85
Cantaloupe	50	Pomegranates	54
Carrots, no tops	82	Potatoes, chef	85
Carrots, with tops	60	Potatoes, red	81
Casaba	50	Potatoes, sweet	80
Cauliflower	45	Radishes, no tops	85
Celery	75	Radishes, with tops	63
Celery root	75	Raspberries	97
Chard	77	Rhubarb, leaves	86
Coconut	53	Rutabagas	85
Cranshaw	50	Shallots	89
Cucumbers	95	Spinach	74
Eggplant	81	Squash, Acorn	78
Endive, chicory, escarole	74	Squash, Butternut	52
Figs	82	Squash, Yellow	95
Garlic bulb	87	Strawberries	87
Grapefruit	45	Watermelon	46
Grapes,seedless	94	Zucchini	95
Honeydew,	60		

Unit Quiz (Weeks 19-20)

1) Titanium (II) sulfide reacts with water to produce hydrogen sulfide and titanium oxide. 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?

2) Sulfur dioxide, sodium chloride, and water can be produced in the laboratory by the reaction of hydrochloric acid with sodium sulfite. What mass of SO_2 can be made from 25.0 g or Na_2SO_3 and 22.0 g of HCl?

3) Write the balanced equation for the reaction of lead (II) nitrate with sodium iodide to form sodium nitrate and lead (II) iodide. <u>You will be using this equation for the next three questions.</u>

4) If I start with 25.0 grams of lead (II) nitrate and 15.0 grams of sodium iodide, how many grams of sodium nitrate can be formed?

5) What is the limiting reagent in the reaction described in these last two problems?

6) How much of the nonlimiting reagent will be left over from the reaction in problem #2?

Unit Quiz Answer Key

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

$$\frac{20g\ TiS}{} \Big| \frac{1\ mole\ TiS}{79.9g\ TiS} \Big| \frac{1\ mole\ TiO}{1\ mole\ TiS} \Big| \frac{63.9g\ TiS}{1\ mole\ TiS} = \mathbf{16\ g\ TiS\ (theoretical\ yield)}$$

$$\frac{22\ g\ TiS\ (actual\ yield)}{16\ g\ TiS\ (theoretical\ yield)} \times 100 = \mathbf{137.5\%}$$

137.5 % is not possible! 100% is the highest yield possible!

2) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$

$$\frac{25g\ Na_2SO_3}{} \Big| \frac{1\ mole\ Na_2SO_3}{126.04g\ Na_2SO_3} \Big| \frac{1\ mole\ SO_2}{1\ mole\ Na_2SO_3} \Big| \frac{64.06g\ SO_2}{1\ mole\ SO_2} = \mathbf{12.7\ g\ SO_2}$$

$$\frac{22g\ HCl}{} \Big| \frac{1\ mole\ HCl}{36.46g\ HCl} \Big| \frac{1\ mole\ SO_2}{2\ moles\ HCl} \Big| \frac{64.06g\ SO_2}{1\ mole\ SO_2} = \mathbf{38.7\ g\ SO_2}$$

Since the smaller of the two answers is 12.7 grams, this is the quantity of sodium oxide that will actually be formed in this reaction.

3) $Pb(NO_3)_2 + 2\ NaI \rightarrow PbI_2 + 2\ NaNO_3$

4)

$$\frac{25g\ Pb(NO_3)_2}{} \Big| \frac{1\ mole\ Pb(NO_3)_2}{331.2g\ Pb(NO_3)_2} \Big| \frac{2\ moles\ NaNO_3}{1\ mole\ Pb(NO_3)_2} \Big| \frac{85g\ NaNO_3}{1\ mole\ NaNO_3} = \mathbf{12.83\ g}\ NaNO_3$$

$$\frac{15g\ NaI}{} \Big| \frac{1\ mole\ NaI}{149.9g\ NaI} \Big| \frac{2\ moles\ NaNO_3}{2\ moles\ NaI} \Big| \frac{85g\ NaNO_3}{1\ mole\ NaNO_3} = \mathbf{8.5\ g}\ NaNO_3$$

Since the smaller of the two answers is 8.51 grams, this is the quantity of sodium nitrate that will actually be formed in this reaction.

5) Sodium iodide

6) There would be 8.4 grams of lead (II) nitrate remaining from this reaction.

$$25g\ Pb(NO_3)_2 - 25g\ Pb(NO_3)_2 \left(\frac{8.5g\ NaNO_3}{12.83\ g\ NaNO_3}\right)$$

$$= 8.4\ g\ NaNO_3 \text{ left over}$$

Chapter 21

Solutes and Solvents

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Fresh spinach leaves (one small bag)
3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

National Science Education Standards covered this week:

12BPS2.5 Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is nearly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.

Definitions

solubility	the ability of a solute to be dissolved by a solvent
polar molecule	phenomenon in which one of the atoms within a molecule "pulls" on its electrons a little stronger than the other atom(s) that are bonded together
nonpolar molecule	phenomenon in which the electrons within a molecule are spread evenly throughout its structure; no single atom within the molecules "pulls" on its electrons with a greater force due to their similar electronegativity

Sample questions to ask your child after completing the weekly reading.

Which does all of the dissolving within a solution – the solute or the solvent?

The solvent is responsible for the dissolving of solutes within a solution.

What is one way to determine when a solute will be dissolved by a solvent?

The electronegativity of substances can determine whether or not certain solutes will be dissolved by solvents.

What is mean by the phrase "Like dissolves like"?

When determining the solubility of a substance, this phrase states that polar solvents dissolve polar solutes and nonpolar solvents dissolve nonpolar solutes.

What are three ways to increase the speed in which a solute is dissolved?

To increase the speed of dissolving a solute, you could grind the solute particles and make them smaller, stir the solute, or increase the temperature of the solution.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Water is more polar; the difference in electronegativities in water is 1.4 and the difference in hydrogen sulfide (H_2S) is 0.4; therefore, water is a more polar molecule than hydrogen sulfide.
2) Nitrogen triiodide (NI_3) is more polar; the difference in electronegativities in nitrogen triiodide is 0.5, while carbon disulfide (CS_2) is 0 (nonpolar).
3) nonpolar
4) nonpolar
5) polar
6) nonpolar
7) nonpolar (ionic)
8) polar
9) polar
10) polar
11) polar
12) polar
13) polar
14) Oxygen dichloride; both oxygen dichloride (OF_2) and methanol are polar, while carbon diselenide (CSe_2) is not.
15) Methanol (CH_3OH); while both compounds are polar, methanol is considerably less polar than lithium chloride (LiCl). Ionic compounds always have a full charge separation, while covalent compounds do not.
16) Ammonia (NH_3); both water and ammonia are polar. Sulfur dibromide (SBr_2) is not.
17) Water; both water and isopropanol are polar. Methane is not.

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

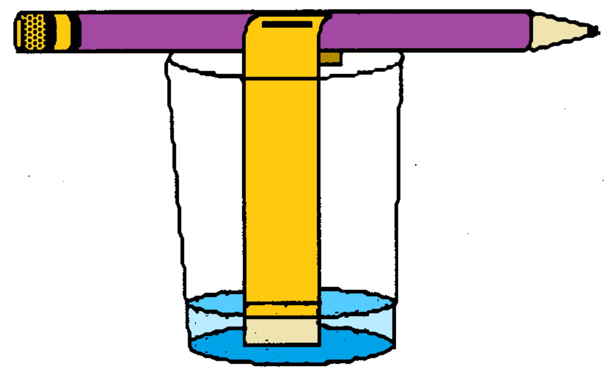
The ingredients for this week's lab are:

Fresh spinach leaves (one small bag)
3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

Paper chromatography or...

What is hiding in my salad?

Solutes, solvents, and solutions within vegetables will be reviewed using a simple extraction technique.



Ingredients:

Fresh spinach leaves (one small bag)

Other items:

3-5 coffee filters
Clear tall plastic or glass cup (not to be used for food)
1 coin
Hair dryer or fan
Pencils
Tape
Clear plastic wrap
Rubbing alcohol
Boiling water
Ice water

Recipe:

Okay… It would be WAY too easy to simply have you create a soup or stew as an example of how solutes, solvents, and solutions work in the kitchen. Why not take this opportunity to try something a little different?

1) Cut a strip of coffee filter approximately 5 cm taller than the height of the up and about half its diameter. (See the picture for assistance.)
2) Place a pencil mark across the strip of paper about 1 cm from the bottom. This will be the area where you place the solutes.
3) Place a second pencil mark 6 cm from the first pencil mark. This will be the end attached to the pencil.

4) Place a fresh spinach leaf on the first line of the paper strip. Using the edge of your coin, press down gently until a heavy green mark is visible.
5) Repeat this last step with a blanched spinach leaf.

How to blanch spinach:

a) Fill a large pot with water, bring it to a boil, and add a few spinach leaves.
b) Remove the leaves after approximately 30 seconds or until they turn a brilliant green color.
c) Drain and immediately place the leaves in a bowl of ice water. This stops the cooking process.
d) Squeeze out all of the excess water.

6) Dry the strip with a hair dryer or fan.
7) Wrap the top of the strip (with the second pencil line you drew) over the pencil itself and tape in place.
8) Slowly add enough rubbing alcohol to the cup to submerge the end of the strip <u>without submerging the pencil line!</u>
9) Do not allow the strip to touch the sides of the cup.
10) Cover the top of the cup tightly with plastic wrap.
11) Continue to monitor the strip as the rubbing alcohol moves upwards until it reaches the second pencil line near the pencil.
12) Circle each colored band with a pencil. Draw the colored band on the attached worksheet and compare with the sample drawing within the appendix.

Explanation:

Before we dig into the science behind today's lesson, let's take a brief look at the process of blanching. Cooks use the method of blanching to prepare many different vegetables in their recipes. It tends to soften vegetables, intensify their color, and heightens their flavor. I highly recommend this process for several vegetables you prepare at home! Now, it's time for some science...

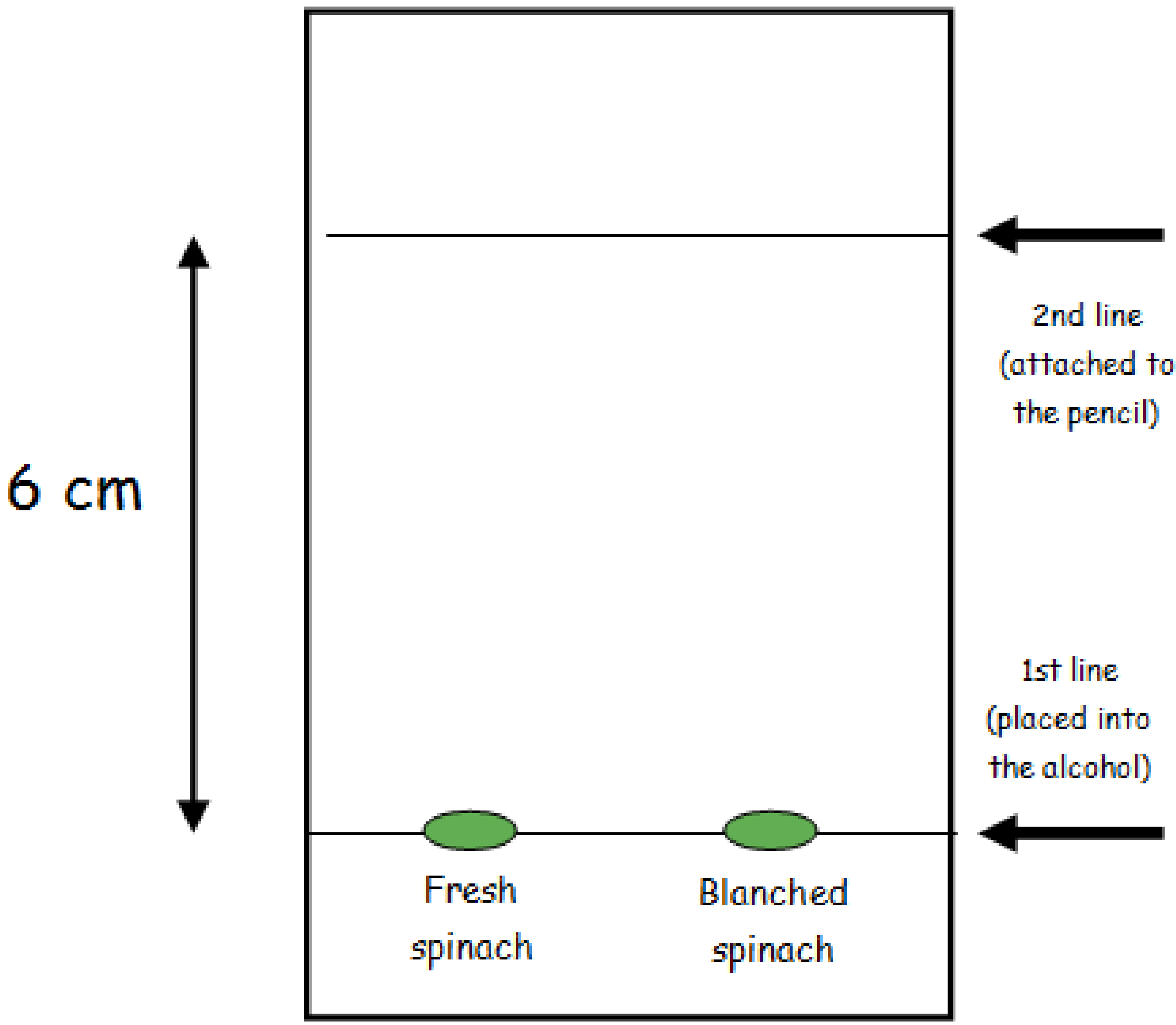
The purpose of this experiment was to separate the pigments (chemicals) within fresh and blanched plant cells. The plant materials that are rubbed onto the filter paper are to be considered solutes and the rubbing alcohol the solvent. When the alcohol slowly moves up the paper strip and mixes with the green pigments, a solution is formed.

The fibers within the paper trap the pigment compounds as the solvent carries them through the paper. Larger molecules get trapped by the fibers first while smaller compounds can travel further up the strip. With this method, the mixture of compounds that exist within the leaf cells can be easily separated.

Fresh spinach contains pigment compounds called chlorophylls and carotene. The colors you should have witnessed with the fresh spinach will be a dark green color. Blanching breaks down these compounds into even smaller pigment compounds called chlorophyllides. These compounds are much lighter in color. You may have noticed this color change within the leaves themselves as you blanched them. If you chose to cook the leaves even longer, these pigments would be broken down into olive-brown colored pigments called pheophytins. However, it is not very easy to detect these final pigments by using this procedure.

This method can be used to separate the mixtures of all kinds of pigments within vegetables at the grocery store. I highly recommend repeating this procedure with every leaf you can find! Some may not provide very interesting results, but others definitely will!

Picture of your chromatography paper (known as a chromatogram)



Chapter 22

Molarity

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Several tea bags of your favorite tea
One gallon pitcher
6 large cups (~2.5 cups each)
Several small cups for tasting the tea

Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

National Science Education Standards covered this week:

12ASI1.4 Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical.

Definitions

concentration	the amount of solute we place into a solution
unsaturated solution	a solution that is able to dissolve more solute
saturated solution	a solution that is not able to dissolve more solute
supersaturated solution	a solution that has dissolved more solute than it naturally should be able to contain
molarity	a measuring scale used to determine the concentration of a solution

Sample questions to ask your child after completing the weekly reading.

Explain three qualitative methods to measure the concentration of a solution:

A solution is said to be unsaturated as it continues to dissolve more solute. Once the solvent can no longer dissolve any more solute, it is said to be saturated. It is possible to add more solute to a solution than should exist. This happens through the heating of the solution during the dissolving process and is known as a supersaturated solution.

How do you determine the molarity of a solution?

To calculate the molarity of a solution, you must divide the moles of solute by the liters of solution.

Why can't you simply measure out the correct amount of solute, then the final amount of solvent, and mix them together to get your desired concentration of a solution?

The volume of the solution will decrease when the solute dissolves.

When calculating how much solvent will be needed to dilute a solution to a desired concentration, what must you be very careful of with the variable V_2?

V_2 is the final volume that will exist after the dilution is completed. It is not simply the amount of solvent that will be added to the original volume.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 12 M
2) 3.52 M
3) 12.5 M
4) 16.15 M
5) 0.036 M
6) 0.38 M
7) 1.15 M
8) 1.07 M
9) 2.12 M
10) Dissolve 219 g HCl, dilute to 2 L
11) Dissolve 360 g NaOH, dilute to 1.5 L
12) Dissolve 92.66 g Na_2SO_4, dilute to 0.75 L
13) Dissolve 2.14 g Na_2CO_3, dilute to 45 mL
14) Dissolve 1.59 g $LiNO_2$, dilute to 250 mL
15) Dissolve 38.04 g $Fe_3(PO_4)_2$, dilute to 56 mL
16) Dissolve 3649.36 g NH_4NO_3, dilute to 6.7 L
17) Dissolve 0.0054 g $MgSO_4$, dilute to 4.5 mL

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Several tea bags of your favorite tea
One gallon pitcher
6 large cups (~2.5 cups each)
Several small cups for tasting the tea
Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

Molarity of sweetened tea or…

I'd like a little tea with my sugar, please.

Calculating the molarity of a solution will be practiced with this sweet little activity.

Ingredients:

Several tea bags of your favorite blend

Other items:

One gallon pitcher
6 large cups (~720mL volume)
Several small cups for tasting the tea
Sugar
Measuring cups/spoons
Ice
4-6 friends/family members

Recipe:

1) Make one gallon of unsweetened tea.
2) Divide the tea equally into 6 different containers (approx 600 mL each).
3) Calculate the molar mass of table sugar (sucrose – $C_{12}H_{11}O_5$) on the attached data sheet.
4) Add the following amounts of sugar into each of the 6 containers:

Container number	Amount of sugar added (tsp)
1	0
2	1
3	2
4	3
5	4
6	5

5) Pour a small amount each tea for your friends to taste. Have them identify which one they prefer.
6) Calculate the molarity of the teas that were preferred.
7) Calculate how many teaspoons of sucrose would be needed in one 240 mL glass of tea to equal the concentration of their preference.

Explanation:

The calculation of molarity is vital in the study of chemistry. Being able to identify how many moles of solute are dissolved into a known amount of solvent is used very frequently.

Another way of defining molarity is this:
Molarity tells you how many atoms of a particular atom/molecule are found within a known volume of fluid. The mathematical way of defining molarity is with the following equation:

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Why is it important to calculate the number of atoms/molecules dissolved in a fluid? Think about all of those reactions you learned about a few chapters ago. Remember! In order for a reaction to take place, two or more molecules have to get close enough to touch each other. If you happen to know how many molecules are "swimming" around in your fluid, you can calculate how fast the reaction will take place, how much reactant will be left over, and a variety of other things as well!

Be certain to check out the last page of this activity to find out the molarities for each of the teas and the answer to your thought question!

Molarity of sweetened tea data sheet

Container number	Amount of sugar added (tsp)	Friend's name	Friend's preference
1	0		
2	1		
3	2		
4	3		
5	4		
6	5		

Molar mass of table sugar ($C_{12}H_{11}O_5$) = ______________________________

Molarities of all the teas: (1 tsp sugar = 4.14 g – use the next page if necessary)

Answer key:

Molar mass of table sugar = 342.3 g/mole

Molarities of all the teas :

1 tsp = 17.25M

2 tsp = 34.5M

3 tsp = 51.75M

4 tsp = 69M

5 tsp = 86.25M

Unit Quiz (Weeks 21-22)

1) If I add 25 mL of water to 125 mL of a 0.15 M NaOH solution, what will the molarity of the diluted solution be?

2) If I add water to 100 mL of a 0.15 M NaOH solution until the final volume is 150 mL, what will the molarity of the diluted solution be?

3) How much 0.05 M HCl solution can be made by diluting 250 mL of 10 M HCl?

4) I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?

5) How much water would I need to add to 500 mL of a 2.4 M KCl solution to make a 1.0 M solution?

6) If I have 340 mL of a 0.5 M NaBr solution, what will the concentration be if I add 560 mL more water to it?

7) If I dilute 250 mL of 0.10 M lithium acetate solution to a volume of 750 mL, what will the concentration of this solution be?

8) If I leave 750 mL of 0.50 M sodium chloride solution uncovered on a windowsill and 150 mL of the solvent evaporates, what will the new concentration of the sodium chloride solution be?

9) What would be the final volume of a solution if you were to dilute the solution in problem #8 to receive a final concentration of 0.25 M?

10) How many grams of ammonia (NH_3) are present in 5.0 L of a 0.050 M solution?

11) What is the molarity of a solution in which 0.45 grams of sodium nitrate are dissolved in 265 mL of solution.

12) What will the volume of a 0.50 M solution be if it contains 25 grams of calcium hydroxide?

13) How many grams of beryllium chloride are needed to make 125 mL of a 0.050 M solution?

14) Explain how you would make 450 mL of a 0.250 M NaOH solution.

15) To what volume will you have to dilute 30.0 mL of a 12 M HCl solution to make a 0.35 M HCl solution?

16) How many grams of calcium chloride will be needed to make 750 mL of a 0.100 M $CaCl_2$ solution?

17) Explain why this experimental procedure is incorrect: To make 1.00 L of a 1.00 M NaCl solution, I will dissolve 58.5 grams of sodium chloride in 1.00 L of water.

Unit Quiz Answer Key

1) $M_1V_1 = M_2V_2$
   (0.15 M)(125 mL) = (M_2)(150 mL)
   M_2 = 0.125 M
2) $M_1V_1 = M_2V_2$
   (0.15 M)(100 mL) = (M_2)(150 mL)
   M_2 = 0.100 M
3) $M_1V_1 = M_2V_2$
   (10 M)(250 mL) = (0.05 M)(V_2)
   V_2 = 50,000 mL
4) $M_1V_1 = M_2V_2$
   (1.5 M)(345 mL) = (M_2)(250 mL)
   M_2 = 2.07 M
5) $M_1V_1 = M_2V_2$
   (2.4 M)(500 mL) = (1.0 M) (V_2)
   V_2 = 1200 mL
   1200 mL will be the final volume of the solution. However, since there's already 500 mL of solution present, you only need to add 700 mL of water to get 1200 mL as your final volume.
   The answer: 700 mL.
6) $M_1V_1 = M_2V_2$
   (0.5M)(340mL) = (M_2)(900mL)
   M_2 = 0.19 M
7) $M_1V_1 = M_2V_2$
   (0.1M)(250mL) = (M_2)(750mL)
   M_2 = 0.033 M

8) $M_1V_1 = M_2V_2$
$(0.5M)(750mL) = (M_2)(600mL)$
$M_2 = 0.63\ M$

9) $M_1V_1 = M_2V_2$
$(0.625M)(600mL) = (0.25M)(V_2)$
$V_2 = 1500\ mL$

10)
$$0.05M = \frac{X \text{ moles } NH_3}{5\ L} \qquad X = 0.25 \text{ moles } NH_3$$

$$\frac{0.25 \text{ moles } NH_3}{} \left| \frac{17.03g\ NH_3}{1 \text{ mole } NH_3} \right. = 4.26g\ NH_3$$

11) 0.020 M (convert grams of sodium nitrate to moles and follow the molarity equation)

12) 680 mL (as before, convert grams to moles and follow the molarity equation)

13) 0.50 grams (follow the same procedure as seen in #10)

14) Add water to 4.52 grams of sodium hydroxide until the final volume of the solution is 450 mL.

15) $M_1V_1 = M_2V_2$
$(12M)(30mL) = (0.35M)(V_2)$
$V_2 = 1029\ mL$

16) 8.33 grams (follow the same procedure as seen in #10)

17) If you were to do this, the solution would have a final volume greater than 1.00 L, because sodium chloride itself takes up space. The correct way to do this would be to add water to 58.5 grams of sodium chloride until the final volume of the solution is 1.00 L.

Chapter 23

Colligative Properties I

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Table Salt
Distilled Water
2+ Quart Cooking Pot
Measuring spoons and cups
Thermometer
Stirring spoon
Oven mitt or tongs

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

colligative properties	properties of solutions that depend upon the amount of solute dissolved in a solution; boiling and melting points, osmotic pressure, and electrical conductivity are examples of colligative properties
vapor pressure	pressure which exists between water molecules in a liquid phase
boiling point elevation	colligative property of a solution; as you increase the concentration of a solution (by adding solute into a solvent), the boiling point of the solution increases as well
effective molality	a measurement of the number of moles of solute per kilogram of solvent

Sample questions to ask your child after completing the weekly reading.

What natural force acts to keep water from vaporizing at room temperature?

Air pressure pushes down on liquid water and prevents it from evaporating into the air.

Why does the boiling point of a solution increase when you increase the concentration of a solution?

The greater amount of solute molecules (specifically on the surface of the solution) reduces the amount of solvent molecules that can vaporize out of the solution.

What is the difference between molarity and molality?

Molarity is the number of moles of solute per liter of solution. Molality is a little different in that it is the number of moles of solute per kilogram of solvent.

When calculating the molality of a solution, why is it important to know if the solute is an ionic or covalent compound?

Since the boiling point elevation of a solution depends upon the amount of solute floating around in solution, the type of bond within the solute is important to know because covalent and ionic compounds react differently in a solution. Covalent compounds remain intact, unlike ionic compounds which break apart. Therefore, solutions with ionic compounds will produce greater numbers of solutes.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) 100.97 °C
2) 100.68 °C
3) m = 0.91

$$m = \frac{1.37 \text{ moles NaCl}}{1.5\text{kg } H_2O}$$

4) 296.69g MgI_2

$$0.42 \text{ m} = \frac{X \text{ moles } MgI_2}{2.54 \text{ kg } H_2O}$$

5) 116.73g NaCl

$$2.35 \text{ m} = \frac{X \text{ moles NaCl}}{0.85 \text{ kg } H_2O}$$

6)

$$\frac{46.3\text{g}}{} \left| \frac{X \text{ moles } MgSO_4}{120.37 \text{ g } MgSO_4} \right. = 0.38 \text{ moles } MgSO_4$$

$$\frac{0.38 \text{ moles } MgSO_4}{0.299\text{kg } H_2O} = 1.27 \text{ (x2 for the \# of ions)} = 2.54 \text{ m}$$

$T_{b \text{ (solution)}} - 100 = 0.52(2.54m)$

$T_{b \text{ (solution)}} = 101.3$ °C

7) T_b(sucrose)= 100.32°C
T_b(salt) = 102.1°C - Higher boiling point

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Table Salt
Distilled Water
2+ Quart Cooking Pot
Measuring spoons and cups

Thermometer
Stirring spoon
Oven mitt or tongs

The effect of table salt on boiling water or…

Did my great aunt really know what she was doing?

This experiment is used to find out how table salt affects the boiling temperature of water.

Ingredients:

Table Salt
Distilled Water

Other items:

1.9L+ Cooking Pot
Measuring spoons and cups
Thermometer
Stirring spoon
Oven mitt or tongs

Recipe:

1) Boil 1000mL of distilled water on a stove.
2) Measure the temperature of the boiling water. Record the highest temperature reading on the attached data sheet. This is the **control** to compare with the remaining trials. Make certain that the thermometer does not touch the sides of the pot. It should only touch the water – you may need the oven mitt or tongs to hold it over the water!
3) Measure out 15mL of table salt using a kitchen measuring spoon. Level the spoonful.
4) Add the measured salt to the boiling water and stir.
5) Measure the temperature of the boiling water with the salt in it. Record the highest temperature reading.
6) Repeat again using an additional tablespoon of salt.
7) Calculate the boiling points of your water after adding 15mL and 30mL of salt.
8) Calculate the percent error of your experimental results.

Explanation:

My great aunt always said that she could get her water to boil faster if she added some salt to her water. But did this experiment actually support her idea?

As you should have observed, the boiling point of the water increased as you increase the salt concentration of the solution. Why? The greater amount of solute molecules (specifically on the surface of the solution) reduces the amount of solvent molecules that can vaporize out of the solution.

Naturally, the boiling point of distilled water should have been 100°C and the two subsequent boiling points should have increased as well. However, the two boiling points you calculated using the equation below may not have been very accurate or precise:

$$T_{b\,(solution)} - T_{b\,(pure\ solvent)} = K_b m$$

To calculate molality (m) within this equation, you will need the following equation:

$$\text{Molality} = \frac{\text{moles of solute}}{\text{kg of solution}}$$

I know you can find the number of moles inside each of the different amounts of sucrose; and, since 1 L = 1000mL = 1kg, you should be able to convert 1000mL to kg rather easy, right?

As for your percent error calculation, remember that the equation for this measurement is:

$$\text{Percent error} = \frac{(\text{Accepted measurement} - \text{Experimental measurement})}{\text{Accepted measurement}} \times 100\%$$

The "accepted measurement" would be the boiling point you calculated; and, the "experimental measurement" is the boiling point you observed during your experiment.

It's hard to determine if my great aunt was correct or not. If she believed a warmer temperature of water would cause her food to cook faster, she might have been right. But we didn't really test if the addition of salt decreased the time needed for boiling to occur.

Hmmm... sounds like a good experiment to run, doesn't it?

Boiling point elevation data sheet

Amount of salt	Temp of boiling water (°C)	Calculated boiling point	% Error
0 Tbs (control)			
1 Tbs NaCl			
2 Tbs NaCl			

Chapter 24

Colligative Properties II

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)
Zip-Lock freezer bag, quart size
Measuring spoons and cups

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

freezing point depression	colligative property of a solution; solutions freeze at lower temperatures than pure solvents because the extra solute molecules "get in the way" of the solvent molecules
osmotic pressure	the pressure which needs to be applied to a solution to keep water from moving across a semipermeable membrane
osmosis	the movement of a fluid across a semipermeable membrane
semipermeable membrane	any "barrier" that will allow solvents (like water) to move through them

Sample questions to ask your child after completing the weekly reading.

How do extra solutes within a solution cause its freezing point to lower?
Solutions freeze at lower temperatures than pure solvents because the extra solute molecules "get in the way" of the solvent molecules. These extra solute particles keep the liquid from freezing at the normal freezing point of solvents.

What is osmotic pressure?
Osmotic pressure is the pressure which needs to be applied to a solution to keep water from moving across a semipermeable membrane (osmosis).

During osmosis, water flows from the solution with the lower solute concentration into the solution with higher solute concentration. When will this movement of fluid stop?
This flow will continue until the concentrations on both sides are equal.

Why is it true that the more concentrated a solution of electrolytes, the better it is at conducting electricity?
Solutions which contain dissolved ionic compounds are able to conduct electricity due to their unbalanced numbers of electrons. The extra amount of ions within the solution increases the ability to move electrons and charges around the solution, thus making it more conductive.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) T_b= 100.8°C
   T_f= -2.8°C

2) T_b = 102.3°C
   T_f = -8.24°C

3) T_f(sucrose) = -2.87°C

4) T_b = 101.47°C
   T_f = -5.27°C

5) –1.76°C

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)
Zip-Lock freezer bag, quart size
Measuring spoons and cups

Homemade "pickles" in a day or…

They're not as good as momma makes, but still tasty.

Osmotic pressure will be demonstrated in this day-long recipe.

Ingredients:

Pickling cucumbers (Kirby cucumbers or equivalent)
Pickling or canning salt
H_2O
Vinegar
Mixed pickling spices such as dill (pinch) and garlic (1 clove)

Other items:
Zip-Lock freezer bag, quart size
Measuring spoons and cups

Recipe:

1) Measure 250 mL water, 15 mL vinegar, and 7.5 mL salt into a quart size Zip-Lock freezer bag. Mix well to dissolve the salt.
2) Add 5 mL mixed pickling spice, one sprig of fresh dill or a pinch of dried dill, and, if desired, 1 clove of garlic, crushed, to the bag.
3) Obtain one medium size cucumber or two small cucumbers and place in the brine in the quart size Zip-Lock freezer bag. Squeeze out as much air as possible and seal the bag.
4) Allow the bag and its contents to sit upright, so that the cucumber is completely immersed in liquid. If the cucumber is exposed to air, even inside the bag, it will spoil.
5) The cucumber should be kept at room temperature for one day before tasting. If a film appears on the surface of the brine, it needs to be removed. The pickling process will continue as long as the bag and contents remain at room temperature. To halt the pickling process, place the bag and contents in a refrigerator.

Explanation:

The semipermeable membranes in this activity are the cell walls within each of the cucumber's cells. This membrane allows water to move through them, but not the salt. When placed into the brine (the salt/vinegar/water solution), water flows from the inside of the pickle which is the area of lower solute (salt) concentration into the brine itself. This process will continue until the concentrations of salt within the cucumber and the brine are equal.

The large concentration of salt in the brine (as compared to the cells of the cucumbers) increases the osmotic pressure of the solution which keeps water from moving into the cucumbers.

Unit Quiz (Weeks 23-24)

1) Calculate the molality when 75.0 grams of $MgCl_2$ is dissolved in 500.0 g of solvent.

2) 100.0 grams of sucrose ($C_{12}H_{22}O_{11}$) is dissolved in 1.50 L of water. What is the molality?

3) 49.8 grams of KI is dissolved in 1.00 kg of solvent. What is the molality?

For the remaining problems, assume the solvent being used is water.

4) What is the boiling point of a 2.25m solution of sodium chloride?

5) What is the boiling point of a solution with 23.5g calcium chloride dissolved in 150g of water?

6) If a solution boils at 103.5°C, what is the molality of the solution if it is a covalent compound?

7) What will be the freezing point and boiling point of a solution containing 55.0 g of glycerol ($C_3H_5(OH)_3$) and 250 g of water?

8) How many grams of $(NH_4)_3PO_4$ need to be added to 500g of H_2O so that the freezing point of the solution is lowered to –8.3°C? Assume that the ammonium phosphate completely dissolves.

9) What is the boiling point elevation when 11.4 g of ammonia (NH_3) is dissolved in 200g of H_2O?

10) If 1800 g of ethylene glycol ($C_2H_6O_2$) is added to 1900 g of water, what is the elevation in boiling point?

11) Ethylene glycol ($C_2H_6O_2$) is the principal ingredient in antifreeze. How many grams of ethylene glycol will be needed to lower the freezing point of 2100 g of water by 20°C?

12) At what temperature will a magnesium nitrate solution boil if it contains 320 grams of magnesium nitrate in 2547 mL of water?

13) At what temperature will a potassium phosphate solution freeze if it contains 144 grams of potassium phosphate in 487 grams of water?

Unit Quiz Answer Key

1) $$\frac{75g\ MgCl_2}{} \Big|\ \frac{1\ mole\ MgCl_2}{95.2g\ MgCl_2} = 0.79\ moles\ MgCl_2$$

$$\frac{0.79\ moles\ MgCl_2}{0.5kg\ water} = \mathbf{1.58m}$$

2) 0.195m (see method above)

3) 0.300m (see method above)

4) T_b – 100 = 0.52 (4.5)
T_b = 102.3°C
(*since NaCl contains 2 ions, you have to multiply the molality by 2 to get 4.5)

5) 102.2°C (first calculate the molality, then use the boiling point equation)

6) 6.83 m

7) -4.45 °C and 101.2 °C

8) 83.5 g (first calculate molality from the freezing point equation; use this answer within the molality equation to find the # of moles of $(NH_4)_3PO_4$; finally, convert these moles to grams)

9) The solution will boil at 101.7°C (follow the steps within #5)

10) 7.95°C (follow the steps within #5)

11) 1.4 kg (follow the steps within #8)

12) 101.3°C (follow the steps within #5)

13) -10.4°C (follow the steps within #5 with the exception of using the freezing point equation)

Quarterly Test

Chapters 17-24

This test contains both a pre- and post-test for your child.
Once the pre-test has been completed and reviewed, the post-test may be administered.
The pre-test has been constructed to build upon the mechanics of various chemistry problems, while the post-test is designed for a deeper understanding of these mechanics.

Prior to this exam, it is highly recommended that the weekly practice problems and unit quizzes be reviewed by the child!

Pre-Test (Units 9-12)

1) Write out the chemical equation when calcium hydroxide reacts with hydrochloric acid to produce calcium chloride and water:

2) What type of chemical reaction is taking place? ___________________

3) How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

4) If I combined 15.0 grams of calcium hydroxide with 75.0 mL of 0.500 M HCl, how many grams of calcium chloride would be formed?

5) What is the limiting reagent from the reaction in problem #3? ______

6) How many grams of the excess reagent will be left over after the reaction in problem 3 is complete?

7) What would be the percent yield if 16.5 grams of excess reagent were left over after running the experiment?

Pre-Test Answer Key

1) Write out the chemical equation when calcium hydroxide reacts with hydrochloric acid to produce calcium chloride and water:

$$Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$$

2) What type of chemical reaction is taking place? **Acid Base Reaction**

3) How many liters of 0.100 M HCl would be required to react completely with 5.00 grams of calcium hydroxide?

$$\frac{5\text{grams } Ca(OH)_2}{} \left| \frac{1 \text{ mole } Ca(OH)_2}{74\text{g } Ca(OH)_2} \right| \frac{2 \text{ moles HCl}}{1 \text{ mole } Ca(OH)_2} = \mathbf{0.135 \text{ moles HCl}}$$

$$0.1\text{ M} = \frac{0.135 \text{ moles HCl}}{\text{Liters HCl}} = \mathbf{1.35 \text{ Liters HCl}}$$

4) If I combined 15.0 grams of calcium hydroxide with 75.0 mL of 0.500 M HCl, how many grams of calcium chloride would be formed?

$$\frac{15\text{grams } Ca(OH)_2}{} \left| \frac{1 \text{ mole } Ca(OH)_2}{74\text{g } Ca(OH)_2} \right| \frac{1 \text{ mole } CaCl_2}{1 \text{ mole } Ca(OH)_2} \left| \frac{111.1\text{grams } CaCl_2}{1 \text{ mole } CaCl_2} \right.$$

$$= 22.5 \text{ grams } CaCl_2$$

$$0.5\text{ M} = \frac{\text{moles HCl}}{0.075 \text{ Liters}} = \frac{0.0375 \text{ moles HCl}}{} \left| \frac{1 \text{ mole } CaCl_2}{2 \text{ moles HCl}} \right| \frac{111.1\text{grams } CaCl_2}{1 \text{ mole } CaCl_2}$$

$$= 2.08 \text{ grams } CaCl_2$$

5) What is the limiting reagent from the reaction in problem #3? **HCl**

6) How many grams of the excess reagent will be left over after the reaction in problem 3 is complete?

$$15 - 15\left(\frac{2.08}{22.5}\right) = \mathbf{13.6 \text{ grams } Ca(OH)_2}$$

7) What would be the percent yield if 16.5 grams of excess reagent were left over after running the experiment?

$$\frac{13.6 \text{ grams } Ca(OH)_2}{16.5 \text{ grams } Ca(OH)_2} \times 100 = 82.4\%$$

Post-Test (Units 9-12)

Answer the following questions as they pertain to the answer key for Test 3

1) Explain how you know the given equation in this worksheet is an acid/base reaction.

2) The fourth step of stoichiometry requires you to use the molar mass of your unknown compound. This step was removed from problem #3. Explain why it was **not** necessary to calculate the molar mass of HCl within the first part of problem #3.

3) Why do you need to use the molarity equation in problem #3?

4) Why are there only 2.08 grams of $CaCl_2$ created within problem #3 and not 22.5 grams?

5) Why is $CaCl_2$ not the limiting reagent in problem #3?

6) The number "15" appears twice within the equation in problem #5. The rules of algebra state that the following portion of the equation has to be completed first:

$$15 \left(\frac{2.08}{22.5} \right)$$

a) What does the answer to this portion of the equation tell you about the excess reagent?

b) Why do you need to subtract this answer from "15" to determine the grams of the excess reagent?

Post-Test Answer Key

1) This reaction is technically a double displacement reaction; however, water is being produced which classifies this reaction as an acid/base reaction.

2) The mass of HCl is not needed to calculate the molarity of HCl. Therefore, it was not performed in the first stoichiometry conversion for this problem.

3) The problem asks for the volume of HCl in liters for this reaction. Molarity is calculated as the moles of a substance per liter:

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Since the molarity of HCl was provided and the moles of HCl were calculated, both values were used in the above equation to determine the volume of HCl.

4) You always choose the smaller amount of product that is produced within a limiting reactant problem. Both of the values could be created if there was an excess amount of the opposite reactant.

5) $CaCl_2$ is the product of this reaction, not the reactant.

6a) The answer to this portion of the problem tells you how much of the nonlimiting reactant has been used during the reaction.

6b) You need to subtract the answer from 6a by the total amount of nonlimiting reactant to determine how much nonlimiting reactant was left over after the reaction takes place.

Chapter 25

Gas Laws I

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Popping corn
Vegetable oil, corn oil, or peanut oil
Sealable plastic bags or jars
Skillet or pan with lid
Measuring spoons
Marker
Cookie sheet
Timer

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

temperature	a measurement of the amount of energy found within molecules
volume	the amount of space in which a fluid is enclosed
STP	"standard temperature and pressure" which is considered to be 273°K (0°C) and 1.00 atm
Boyle's law	gas law which states that as a gas goes through some kind of change, the product of its initial pressure and volume (P_1V_1) will equal the product of its final pressure and volume (P_2V_2)
Charles's law	gas law which states as you increase the temperature of a gas, its volume increases too
Gay-Lussac law	gas law which states that as you increase the temperature of a gas, its pressure goes up too

Sample questions to ask your child after completing the weekly reading.

What is STP?

STP is STP stands for "standard temperature and pressure" which is considered to be 273°K (0°C) and 1.00 atm.

What does increasing the pressure on a gas do to the volume of the gas?

Increasing the pressure on a gas makes its volume decrease; and, decreasing the pressure will increase its volume.

What does increasing the temperature of a gas do to its volume?

Charles's law states that as you increase the temperature of a gas, its volume increases too.

Why must all temperatures within calculations involving gas must be in Kelvin units.

The Kelvin measurements scale contains the most extreme measurement known as absolute zero. This "official zero" helps with our calculations by keeping the ratios of temperature and volume even. For example, if you double the Kelvin temperature of a gas, its volume doubles as well. This doesn't happen when you use the Celsius scale.

What would happen to the pressure of a gas if you increase its temperature?

The Gay-Lussac law states that as you increase the temperature of a gas, its pressure goes up too.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $(1.5atm)(5.6L) = (2.3L)(P_2)$
   $P_2 = 3.7$ atm

2) $(1atm)(18.2L) = (0.85atm)(V_2)$
   $V_2 = 21.4$ L

3) $(1atm)(12000L) = (2.4atm)(V_2)$
   $V_2 = 5000$ L

4) $(29.3L)(328K) = (298K)(V_2)$
   $V_2 = 32.2$ L

5) $(82L)(298K) = (1473K)(V_2)$
   $V_2 = 22.2$ L

6) $(130L)(523K) = (T_2)(49.5L)$
   $T_2 = 1379.5$ K

7) $(1atm)(298K) = (283K)(P_2)$
   $P_2 = 1.05$ atm

8) $(18.2mL)(12.75atm) = (V_2)(1atm)$
   $V_2 = 232.05$ mL

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Popping corn
Vegetable oil, corn oil, or peanut oil
Sealable plastic bags or jars
Skillet or pan with lid
Measuring spoons
Marker
Cookie sheet
Timer

Popcorn and gas laws or…

How to make poppable popcorn unpoppable

The study of gas laws apply to why popcorn pops under increased heat.

Ingredients:

Popping corn
Vegetable oil, corn oil, or peanut oil

Other items:

Sealable plastic bags or jars
Skillet or pan with lid
Measuring spoons
Marker
Cookie sheet
Timer

Recipe:

1) Take 100 kernels of popcorn, place them in a single layer in a small aluminum foil pan or cookie sheet and place it in an oven at 88°C to 93°C for about two hours. Store this popcorn in a sealed plastic bag or a jar labeled "pre-dried." Use within 24 hours.
2) Take 100 kernels of popcorn, place them in a cup, add water to barely cover them, and allow the kernels to soak for about two hours. Dry the kernels with a paper towel and store in a sealed plastic bag or a jar labeled "pre-dried." Use within 24 hours.
3) Add 5mL of cooking oil to the pan. Turn the heat on to high.
4) Place 100 kernels of popcorn onto the oil and place a lid onto the pan.
5) Start your timer.
6) As the popcorn starts to pop, turn the heat to low.
7) Stop the timer after 20-30 seconds pass from the last popped kernel. Be careful not to allow your popcorn to burn. This trial is your control.
8) Clean the pan.
9) Repeat this same procedure using the pre-dried and pre-soaked kernels. Record all times on the attached data sheet. If the times for these experimental trials last longer than 2x of the control, remove the kernels from the heat before they burn!

Explanation:

As the temperature reaches the boiling point of water, the "white fluffy stuff" inside the popcorn (called the **endosperm**) turns into a jelly-like goo. As this happens, the water vaporizes as well and expands rapidly in volume. The hard protein "hull" holds this pressurized goo until the pressure becomes too great, at which point the kernel bursts open and the endosperm expands in volume due to the pressure difference. The water evaporates into the air and the cooked endosperm is dried out quickly making the endosperm light and crisp.

Pre-soaking allows the kernels to absorb more water through their hulls. This increase in volume of water prevents the kernels from popping quickly. This is because it takes more heat to cause the water inside each kernel to boil.

The pre-drying of kernels allows the water within them to slowly evaporate out of the hulls. When heated, these kernels will not contain enough water molecules to generate the pressure needed to burst open the hull.

Since the volume of the kernel stays the same and its internal temperature is increased, its pressure increases as well. This models Gay-Lussac's law beautifully:

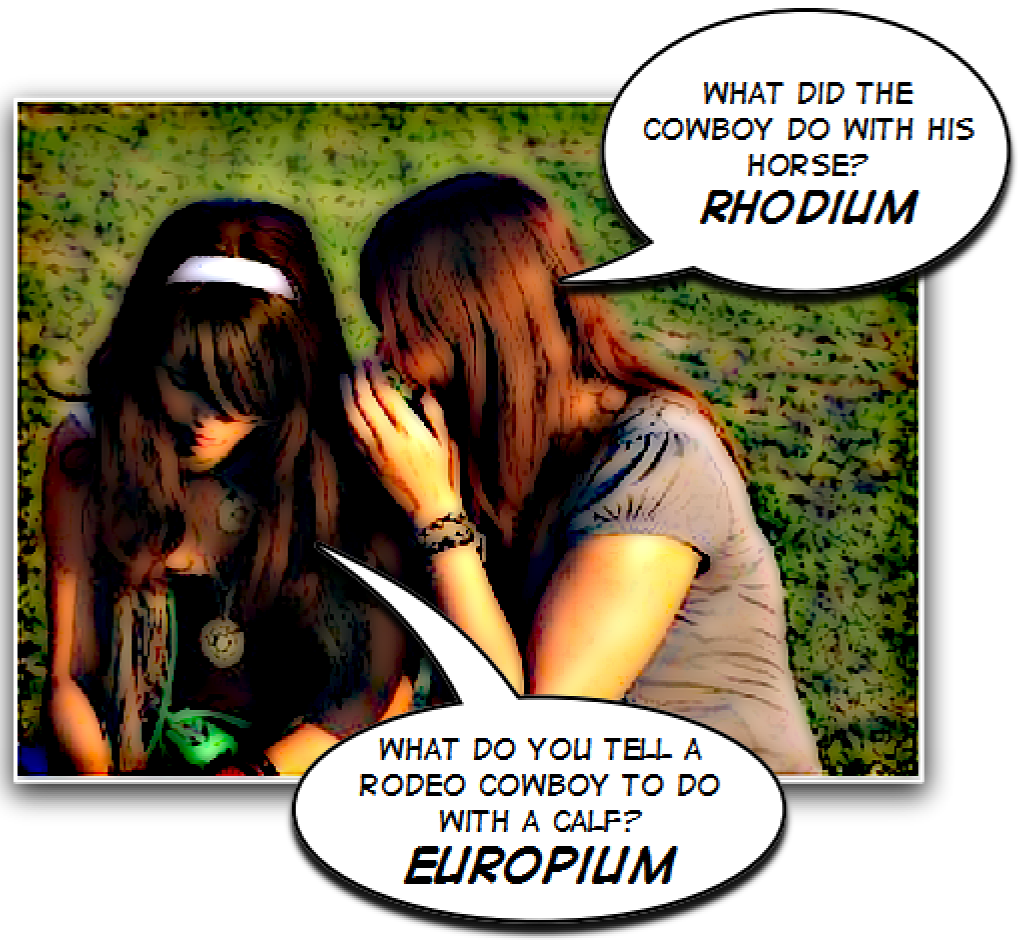
Gay-Lussac's Law $$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Popcorn data sheet

Type of popcorn	Time for all kernels to pop	Number of kernels not popped
Unchanged popcorn (control)		
Pre-soaked		
Pre-dried		

Chapter 26

Gas Laws II



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Cold water
1 cup sugar
4-6 tsp freshly grated ginger root
Juice of one lemon
$\frac{1}{4}$ tsp fresh granular baker's yeast
Clean 2 liter plastic soft drink bottle with cap (NOT GLASS!)

Funnel
Grater (preferably with fine "cutting" teeth)
Measuring cup and spoons
Fine mesh strainer or cheese cloth

National Science Education Standards covered this week:

12BPS2.4 The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.

Definitions

combined gas law	gas law which combines all of the relationships which exist between the Boyle, Charles, and Gay-Lussac gas laws
ideal gas law	gas law which utilizes a fictional "gas" that obeys specific rules when kept at a constant volume, temperature, and/or pressure
Dalton's Law of Partial Pressures	the total pressure of a mixture of gases equals the sum of its individual partial pressures

Sample questions to ask your child after completing the weekly reading.

If you are trying to calculate the change in pressure on an object by altering its temperature, can you use the Combined Gas Law?
The Combined Gas Law can be used even if you do not have one of the tree gas law variables at your disposal – pressure, volume or temperature.

Why is the Ideal Gas Law more accurate than the Combined Gas Law?
Unlike the Combined Gas Law, the Ideal Gas Law takes into consideration the number of gas particles that are in motion within your sample.

If you were to asked to determine the pressure of air on an object within your room and you were provided the volume, temperature, number of moles of air and the gas constant, why couldn't you simply use the Ideal Gas Law to determine the unknown pressure?
Air is a solution of gases, each with its own molar mass. These different masses have the ability to cause different amounts of pressure as they slam into the walls of your room. Therefore, you must first measure the pressure of each gas within the air to determine a final pressure.

Under what circumstances does one mole of fluid equal 22.4 L of fluid?
1 mole = 22.4 L fluid only at STP (273°K and 1.00 atm)

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $\frac{(1.8L)(1atm)}{293K} = \frac{(0.667atm)(V_2)}{263K}$

   $V_2 = 2.42$ L

2) (3.2atm)(120L) =

   n(0.08206)(340K)

   n = 13.76 moles

3) (P)(62.5L) =

   (45)(0.08206)(473K)

   P = 27.94 atm

4) (P)(1.89L) =

   (2)(0.08206)(1673K)

   P = 145.28 atm

5) (200atm)(25L) =

   n(0.08206)(300K)

   n = 203.1 moles

6) (1atm)(100L) = (3)(0.08206)(T)

   T = 406.2 K

7) (P)(35L) = (2)(0.08206)(298K)

   $P_{N2} = 1.39$

   (P)(35L) = (9)(0.08206)(298K)

   $P_{O2} = 6.29$

   $P_{N2} + P_{O2} = 7.68$ atm

8) (0.75atm)(5L) = (P_2)(13L)

   $P_{N2} = 0.288$atm

   (1.25atm)(8L) = (P_2)(13L)

   $P_{O2} = 0.769$atm

   $P_{N2} + P_{O2} = 1.057$ atm

9) (1atm)(4.15L) = n(0.08206)(298K)

   n = 0.17 moles CO_2

   $\frac{0.17 \text{ ~~moles } CO_2\text{~~}}{} \Big| \frac{1 \text{ ~~mole } CaCO_3\text{~~}}{1 \text{ ~~mole } CO_2\text{~~}} \Big| \frac{100g\ CaCO_3}{1 \text{ ~~mole } CaCO_3\text{~~}}$

   = 17 g $CaCO_3$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Cold water
1 cup sugar
4-6 tsp freshly grated ginger root
Juice of one lemon
$\frac{1}{4}$ tsp fresh granular baker's yeast
Clean 2 liter plastic soft drink bottle with cap (NOT GLASS!)
Funnel
Grater (preferably with fine "cutting" teeth)
Measuring cup and spoons
Fine mesh strainer or cheese cloth

Ginger ale under pressure or...

There's a fungus among us...

The combined gas law will be explored within the creation of homemade ginger ale.

Ingredients:

Cold water
240 mL sugar
20-30 mL freshly grated ginger root
Juice of one lemon
1.25 mL fresh granular baker's yeast

Other items:
Clean 2 liter plastic soft drink bottle with cap (NOT GLASS!)
Funnel
Grater (preferably with fine "cutting" teeth)
Measuring cup and spoons
Fine mesh strainer or cheese cloth

Recipe:

1) Add the sugar to the 2 liter bottle with a dry funnel.
2) Add yeast through funnel into the bottle, shake to disperse the yeast grains into the sugar granules.
3) Grate the ginger root on a fine "cutting" grater and place into a measuring cup.
4) Add the juice of a whole lemon to the grated ginger.
5) Stir the lemon juice and grated ginger to form a slurry.
6) Add the slurry of lemon juice and grated ginger to the bottle.
7) Rinse the measuring cup with fresh clean water and pour into the funnel.

8) Cap the bottle and shake to distribute.
9) Fill the bottle to the neck with fresh cool clean water, leaving about an inch of head space. Securely screw cap down to seal. Turn the bottle upside down repeatedly to thoroughly dissolve sugar.
10) Place in a warm location for 24 to 48 hours.
11) Gas will be produced within the bottle throughout this time. Test to see if your ginger ale is done by squeezing the bottle forcefully with your thumb. If you are able to make a dent in the bottle, it is not ready.

Do not leave at room temperature longer than necessary to feel "hard." The excess pressure may cause an eruption when you open it, or even blow up the bottle!

12) Once the bottle feels hard to a forceful squeeze, place in the refrigerator. Before opening, refrigerate at least overnight to thoroughly chill. Crack the lid of the thoroughly chilled ginger ale just a little to release the pressure slowly. You do not want a ginger ale fountain!
13) Filter the ginger ale through a strainer or cheese cloth. You may still have tiny pieces of ginger within your ale. Filter several times if you need to remove most of the sediments.

Explanation:

The combined gas law can easily be witnessed within this activity. First of all, the volume of the container stays the same throughout the experiment. So, that variable can be removed from the equation:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Even though you are not calculating the actual pressure inside the bottle (that would require some equipment that is a little pricey), you are testing the pressure indirectly by squeezing the bottle.

The most important factor in the carbonization of your ginger ale is the temperature of the container! When you place the bottle into a warm area, the increased temperature increases the pressure within the bottle. How?

This increased pressure is caused by the fermentation the yeast within the ginger ale. Fermentation is the process by which yeast (Saccharomyces cerevisiae) breaks down sugar into ethyl alcohol and carbon dioxide. It is this carbon dioxide gas which "carbonates" your drink and makes it fizzy*.

(Yes... I used the word "fizzy." It's a real word – look it up :)

As with any yeast fermentation, there is a small amount of alcohol generated in the beverage. DO NOT PANIC! You'd have to drink nearly two gallons of your ginger ale to equal the same alcohol content (6%) of an average 12 ounce can of beer. I would call this amount of alcohol insignificant, but for persons with who cannot metabolize alcohol very well, or religious prohibition against any alcohol, consumption should be limited or avoided.

Unit Quiz (Weeks 25-26)

<u>Unless stated, assume all of the following problems occur at STP.</u>

Carbon monoxide reacts with oxygen to produce carbon dioxide. If 1.0 L of carbon monoxide reacts with oxygen at STP,

1) How many liters of oxygen are required to react?
2) How many liters of carbon dioxide are produced?

Acetylene gas (C_2H_2) undergoes combustion to produce carbon dioxide and water vapor.

3) How many liters of C_2H_2 are required to produce 75.0 L of CO_2?
4) What volume of H_2O is produced?
5) What volume of O_2 is required?

6) **If liquid carbon disulfide (CS_2) reacts with 450 mL of oxygen to produce the gases carbon dioxide and sulfur dioxide, what volume of each product is produced?**

Assume that 5.60 L of hydrogen gas at STP reacts with copper (II) oxide according to the following balanced equation:

$$CuO + H_2 \rightarrow Cu + H_2O$$

7) How many moles of H_2 react?
8) How many moles of copper are produced?
9) How many grams of copper are produced?

Assume that 8.5 L of iodine gas (I_2) are produced at STP according to the following balanced equation:

$$2\ KI + Cl_2 \rightarrow 2\ KCl + I_2$$

10) How many moles of I_2 are produced?
11) How many moles of KI were used?
12) How many grams of KI were used?

13) **Solid iron reacts with sulfuric acid (H_2SO_4) to produce iron (II) sulfate and hydrogen gas. If 650 mL of hydrogen gas are collected at STP, how many grams of iron (II) sulfate are also produced?**

Ammonium sulfate, an important fertilizer, can be prepared by the reaction of ammonia with sulfuric acid according to the following balanced equation:

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

14) Calculate the volume of NH_3 (in liters) needed at 20°C and 25.0 atm to react with 150 kg of H_2SO_4.

15) **A 3.25 gram sample of solid calcium carbide (CaC_2) reacts with water to produce acetylene gas (C_2H_2) and calcium hydroxide. If the acetylene was collected over water at 17°C and 0.97 atm, how many milliliters of acetylene were produced?**

Unit Quiz Answer Key

1) **$2CO + O_2 \rightarrow 2CO_2$**
   = 0.5 L O_2
2) = 1.0 L CO_2
3) **$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$**
   = 37.5 L C_2H_2
4) = 37.5 L H_2O
5) = 93.75 L O_2
6) **$CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$**
   CO_2 = 150 mL
   SO_2 = 300 mL
7) = 0.25 moles H_2
8) = 0.25 moles Cu
9) = 15.88 Cu
10) = 0.38 moles I_2
11) = 0.76 moles KI
12) = 126.2 g KI
13) **$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$**
    = 4.4 g $FeSO_4$
14)

150kg H_2SO_4	1000g	1 mole H_2SO_4	2 moles NH_3	= 3058 moles NH_3
	1 kg	98.1g H_2SO_4	1 mole H_2SO_4	

25 atm (V) = (3058 moles)(0.08206)(293K)

V = 2941 Liters NH_3

15) $CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

3.25g CaC_2	1 mole CaC_2	1 mole C_2H_2	= 0.051 moles C_2H_2
	64.1g CaC_2	1 mole CaC_2	

0.97 atm (V) = (0.051 moles)(0.08206)(290K)

V = 1.25 Liters C_2H_2 = 1250mL C_2H_2

Chapter 27

1st Law of Thermodynamics

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Peanuts or corn chips
2 empty aluminum cans
Utility knife or X-Acto knife
10 mL of water (7 drops = 1mL)
Eyedropper

One large paper clip
Matches
Thermometer
Aluminum pie pan or old cookie sheet

National Science Education Standards covered this week:

12BPS3.2 Chemical reactions may release or consume energy. Some reactions such as the burning fossil fuels release large amounts of energy by losing heat and by emitting light.

12BPS5.1 The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less organized.

Definitions

thermodynamics	the study of energy; how energy is stored within molecules, how it can be transferred from one substance to another, and how this process is able to produce heat
heat	the movement of energy from one thing to another through the motion of molecules
temperature	the measure of energy found within an object after heat has been transferred
calorie	standard unit of energy
joule	metric unit of energy
exothermic reactions	a reaction in which the amount of energy absorbed by the reactants is less than the energy released by the products
endothermic reactions	chemical reactions that tend to absorb more energy than the energy released by its products
system	name given to chemical reactions and its energy transfer(s)
surroundings	the environment that surrounds "systems"
1st Law of Thermodynamics	also known as "The Law of Conservation of Energy"; states that energy is never lost or gained, it only changes form
enthalpy	the total amount of heat a molecule contains
specific heat (heat capacity)	amount of energy needed to heat a substance by 1°C
heat of reaction (ΔH_{rxn})	measures the change in enthalpy during a chemical reaction
heat of formation (ΔH^0_f)	this is the change in enthalpy when a compound is formed from its elements

Sample questions to ask your child after completing the weekly reading.

What is the difference between heat and temperature?

Heat is the movement of energy from one thing to another through the motion of molecules. Temperature is the measure of energy found within an object after heat has been transferred.

What is the difference between the calories found in our food and the calories measured by scientists to determine the amount of energy in an object?

Both of these "calories" act as a measure of the amount of energy a substance contains; however, food is actually measured in units of 1000 calories (a kilocalorie), which is commonly known as the Calorie (Cal).

Would the act of cooking bacon be considered an endothermic or exothermic reaction?

Cooking bacon is an endothermic reaction. The bacon itself absorbs the energy from the stove and will continue to do so as long as the stove is turned on. However, if the heat source is turned off, the bacon (although still very hot and partially cooking) will no longer be able to absorb any more energy and does not produce more energy than it already contains.

What is the 1st Law of Thermodynamics?

This law is also known as The Law of Conservation of Energy. It states that energy is never lost or gained, it only changes form.

In order to measure the amount of energy a system has, what three things must you know?

First, you need to know the mass of the object.
Second, you need to know the temperature of the object and the temperature you wish the object to finally reach.
And finally, you have to know what exactly how much heat can be absorbed by the object.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $\Delta H = mC_P\Delta T$
   $\Delta H = (127g)(4.18\ J/g \cdot C)(26°C)$
   $\Delta H = 13{,}802.4\ J$

2) $\Delta H = mC_P\Delta T$
   $C_P = \Delta H\ /m \times \Delta T$
   $C_P = 294.75J\ /(15g)(35°C)$
   $C_P = 0.56\ J/g \cdot C$

3) $\Delta H = mC_P\Delta T$
   $m = \Delta H/C_P \times \Delta T$
   $m = 419J/(0.90\ J/g \cdot C)(20°C)$
   $m_{aluminum} = 23.3g$

4) $\Delta H = mC_P\Delta T$
   $\Delta T = \Delta H/m \times C_P$
   $\Delta T = 3240J/(71g)(2.44\ J/g \cdot C)$
   $\Delta T = 18.7°C$
   $T_{final} = 22°C + 18.7°C = 40.7°C$

5) $\Delta H = mC_P\Delta T$
   $\Delta H = (0.257g)(1.8\ J/\ g \cdot K)(354K - 288K)$
   $\Delta H = 30.5\ J$

6) $-\Delta H = mC_P\Delta T$ (ΔH is negative because heat is released by the beaker)
   $-576J = (m)(0.57\ J/g \cdot K)(400K - 413K)$
   $m_{beaker} = 77.7g$

7) $\Delta H = mC_P\Delta T$

$$C_P = \frac{\Delta H}{m\Delta T}$$

$C_P = 959\ J\ /(95.4g)(30.0°C)$

$C_P = 0.34\ J/g \cdot C$

8) $\Delta H = mC_P\Delta T$

$$C_P = \frac{\Delta H}{m\Delta T}$$

$C_P = 435\ J/(6.2g)(64°C)$

$C_P = 1.1\ J/g \cdot C$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Peanuts or corn chips
2 empty aluminum cans
Utility knife or X-Acto knife
10 mL of water (7 drops = 1mL)
Eyedropper

One large paper clip
Matches
Thermometer
Aluminum pie pan or old cookie sheet

Well done peanuts or…

This activity is thermodynamic! *(Geesch! That was worse than the last one…)*

The first law of thermodynamics will be demonstrated in this lab.

Ingredients:

Peanuts

(*Naturally, anyone with a nut allergy should not attempt this activity! An alternative to using peanuts would be any corn chips that have not been processed with any form of nut-based oil.)

Other items:

2 empty aluminum cans
Utility knife or X-Acto knife
10 mL of water
Eyedropper
One large paper clip
Matches
Thermometer
Aluminum pie pan or old cookie sheet

Recipe:

1) Carefully cut out two openings in one of your cans and cut the top off of the second can as shown in the following picture: (Be very careful not to cut yourself!)

2) Bend a large paper clip so that it will rest within the can you cut out in the first step. It must be bent so that a peanut can be attached on one end and will sit upright within the can.
3) Place 10mL of water and the thermometer into the can with its top removed. Let it sit for a few minutes and record the temperature on your data chart.
4) Place this can on top of the can with its sides removed.
5) Rest or attach a peanut to the bend end of the paper clip.
6) Make certain this entire apparatus is located on a nonflammable surface such as an aluminum pan or cookie sheet.
7) Light the peanut, just hold the match under it, the peanut will catch on fire.
8) Notice that the water in the can begins to boil violently.
9) Let the peanut burn out and the test tube cool for 5 minutes or so.
10) Measure the amount of water left in the test tube.
11) Use this information to compute the mass (in grams) of water that boiled away, the amount of calories within the burned peanut used to heat your water, and the percent error from an accepted measurement of 6300 calories. You may use the data sheet attached to this lesson to help you out.

Be certain to read the explanation of this activity before you tackle these calculations!

Explanation:

Various combustion reactions occurred as the peanut burned with allowed heat to flow into the surroundings. This heat flow can be measured if you can measure the amount of work it does on a known sample of water. When you eat a peanut, your body does the same sort of thing: it converts the energy stored in the peanut into the energy it needs to keep running.

The burning peanut should have raised the temperature of water at room temperature (~20 °C) to the boiling point, 100 °C. In order to complete your calculations for this experiment, you need to calculate two enthalpies:

As an example, to raise the temperature of 10 grams of water from 20°C to 100°C you can use the following equation to determine the amount of heat that flowed into the water up to its point of boiling:

$$\Delta H = mC_p\Delta T$$

ΔH = heat flow (enthalpy) in calories
m = the mass of the water in grams
C_p = the specific heat of water which is 1 degree per calorie per gram

ΔT = the temperature change in °C

Therefore...

$$\Delta H = (10)(1)(80) = 800 \text{ calories}$$

Once the water reached its boiling point, it continued to boil until two grams of water evaporated. This requires another equation:

$$\Delta H = Lm$$

L = **latent heat of vaporization** of water.

m = mass of the liquid that changed its state from a liquid to a gas

The latent heat of vaporization is the amount of heat that flows as the liquid water changes it's state into a gas. In this example, the latent heat of vaporization for water is 540 calories per gram.

$$\Delta H = (540)(2) = 1080 \text{ calories}$$

The total energy that was used in this example to boil 2 grams of water is the sum of both ΔH's:

$$\Delta H = 800 \text{ calories} + 1080 \text{ calories} = \underline{1880 \text{ calories}}$$

This means that 1880 calories were used by the peanut to boil our sample of water. However, the most sophisticated devices known to science have determined the true amount of calories within an average sized peanut is actually 6300 calories!

Using this crude device, you should be able to calculate the amount of heat that is used by your peanut. How accurate was your data?

Do not believe that the energy you did not discover simply did not exist in this lab! Even though a small amount of energy you burned within the peanut was used within the <u>system</u> you developed, the remaining energy was released into the <u>surroundings</u>. Remember! According to the 1st Law of Thermodynamics, energy is never lost or gained, it only changes form. The goal of all scientists, however, is to set up experiments where we receive the most accurate data possible. So, how could you modify this experiment to make it more accurate? Hmmm....

Well done peanuts data sheet

Initial temperature of water in can: __________

Amount of water remaining within the can after burning the peanut: __________

Calculate the mass of water remaining in grams using the density formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Density of water is 1.0 grams/mL

Calculate the total amount of heat which was used to heat your sample of water:

Calculate the percent error of your experimental measurement from the accepted measurement of 6300 calories:

$$\text{Percent error} = \frac{(\text{Accepted measurement} - \text{Experimental measurement})}{\text{Accepted measurement}} \times 100\%$$

Chapter 28

2nd and 3rd Laws of Thermodynamics

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

1 Tbs sugar
½ cup whole milk
½ cup half & half
¼ tsp vanilla
Ice cubes

1/3 cup rock salt
One sandwich sized Ziploc baggie
One gallon sized Ziploc baggie
Thermometer

National Science Education Standards covered this week:

12BPS3.2 Chemical reactions may release or consume energy. Some reactions such as the burning fossil fuels release large amounts of energy by losing heat and by emitting light.

12BPS5.4 Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation, or convection and the warming of our surroundings when we burn fuels.

Definitions

entropy (ΔS)	a measure of the amount of energy that spreads throughout the surroundings of a system; used to measure the actions pertaining to the 2nd Law of Thermodynamics
2nd Law of Thermodynamics	states that energy, if concentrated in an area, will spontaneously spread out unless a force keeps it from doing so
spontaneous processes	any naturally occurring actions that exist without the addition of any extra energy
non-spontaneous processes	any process that requires some form of effort to make it occur
free energy (ΔG)	the amount of energy that is available by a system to do some form of work

Sample questions to ask your child after completing the weekly reading.

What is the 2^{nd} Law of Thermodynamics and how is it measured?

The 2^{nd} law of thermodynamics states that energy, if concentrated in an area, will spread out unless a force keeps it from doing so. The amount of energy that is spread out from a system into its surroundings is known as an objects change in entropy.

What is the difference between spontaneous and non-spontaneous processes?

Spontaneous processes are any naturally occurring actions that exist without the addition of any extra energy. These processes are favored in nature and tend to provide the energy required for non-spontaneous processes to occur. The latter process do not occur naturally as they require energy to be set in motion.

Why are exothermic reactions are favored in the natural world?

Since nature favors chemical reactions that result in the lowest energy state possible, systems which undergo exothermic reactions release energy into their surroundings. This reduces the total energy of the system while following both the 1^{st} and 2^{nd} Laws of Thermodynamics.

During a chemical reaction, if a gas is created from non gases, will the amount of entropy increase or decrease and why?

The amount of entropy will increase ($\Delta S+$). More energy is being spread throughout the surroundings along with the energized gas particles.

What two measurements must you have in order to calculate whether or not a reaction will occur spontaneously?

You must have the measurements for both entropy and enthalpy in order to determine the spontaneity of the reaction.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) B; Prediction #2: making a solid from liquid

2) B; Prediction #5: making a gas
C; Prediction #5: making a gas

3) B;The reaction would be spontaneous at lower temperatures but not at higher temperatures. ΔH is negative and Δ**S is negative (because of Prediction #6),** so the reaction is spontaneous at low temperatures according to the table in your readings.

4) Increase; Prediction #5: gases have more freedom of motion

5) Increase; Prediction #6: there are more moles of gas produced in this reaction

6) Increase; Prediction #5: you are forming a gas

7) Decrease; Prediction #6: you are losing gas and you have a decrease in the number of molecules

8) Entropy increases with increasing temperature. An increase in temperature corresponds to an increase in the average kinetic energy of the molecules. This means they are moving around more and have more disorder.

9) $\Delta S° = [2(145.3) + 213.7] - [3(87.4) + 197.5] = 44.6$ J/K

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

1 Tbs sugar
½ cup whole milk
½ cup half & half
¼ tsp vanilla
Ice cubes

1/3 cup rock salt
One sandwich sized Ziploc baggie
One gallon sized Ziploc baggie
Thermometer

Depressed ice cream or…

There there… It's not so bad. Here. Have some ice cream!

The second law of thermodynamics will be explored during the construction of homemade ice cream.

Ingredients:

15 mL sugar
120 mL whole milk
120 mL half & half
1.25 mL vanilla
Ice cubes

Other items:

90 mL rock salt
One (1) 480 mL Ziploc baggie
One (1) 3.8 L Ziploc baggie
Thermometer

Recipe:

1) Place ice cubes in the large baggie and place thermometer among the cubes. Leave 30 seconds.
2) Record temperature of ice in data table provided.
3) Add rock salt into the container with the ice.
4) Place milk, half and half, sugar, and vanilla mixture into the small baggie, seal, and place into a second baggie of similar size. (Yes – we are double bagging!)
5) Seal the second baggie and place into the large baggie.
6) Seal and shake gently for 5 minutes. Check the consistency of your ice cream.
7) Keep shaking back and forth for another 3 to 10 minutes, continually checking until a solid product forms. Record the temperature of the ice once again.
8) Carefully remove the inner bags and place on paper towels. Wipe salty water from around opening. Open baggies and taste your product!

Explanation:

When a substance freezes, the particles arrange themselves into an orderly crystal pattern. When sodium chloride is added to the water, a solution is formed. The forming of the solution interferes with the orderly arranging of the particles in the crystal. Therefore, more kinetic energy (heat) must be removed from the solvent (water) for freezing to occur. This follows the second law of thermodynamics which states that heat energy will always flow from warmer areas to colder areas. The removal of heat from the solution of salt and ice results in a lower freezing point. Furthermore, the more particles of solute (salt) added, the more kinetic energy must be removed. The greater the concentration of solute, the lower the freezing point of the solvent.

Depressed ice cream data sheet

Initial temperature of ice	Final temperature of ice mixture	Change in temperature

Post-Lab Questions

What happened shortly after you added the salt to the ice cubes? Was the temperature above or below the freezing temperature for water?

Heat energy is needed to change phase from a solid to a liquid. List the possible sources of the heat needed for this phase change in your baggie. Which source do you think is the best possibility and why?

In looking at the temperature changes shown on your data table, explain how the energy flow of the baggie system resulted in your tasty treat for an end product. Where is the energy flowing from and where is it going to?

Answer key:

What happened shortly after you added the salt to the ice cubes? Was the temperature above or below the freezing temperature for water?

The ice started to melt as the salt ions broke apart and interfered with the crystal lattice of the water molecules bonds. The ice water that is formed is actually below freezing: super-cooled.

Heat energy is needed to change phase from a solid to a liquid. List the possible sources of the heat needed for this phase change in your baggie. Which source do you think is the best possibility and why?

The ice, milk, salt, air in the baggie and the heat from your hands are all sources of heat for this phase change. The milk is the best source of heat energy for the melting process because it is a liquid and stores more energy for the phase change than the air or salt do. Your hands do not touch enough area to be effective sources of heat.

In looking at the temperature changes shown on your data table, explain how the energy flow of the baggie system resulted in your tasty treat for an end product. Where is the energy flowing from and where is it going to?

The energy flows from the milk to the ice. This removes enough energy to bring about a phase change from liquid to solid.

Unit Quiz (Weeks 27-28)

1) How much heat is required to raise the temperature of 250.0 g of mercury by 52°C? (C_P of mercury = 0.140 J/g · C)

2) How many kilojoules of heat are absorbed when 1.00 kg of water is heated from 18°C to 85°C? (C_P of water = 4.18 J/g · C)

3) A piece of aluminum with a mass of 100.0 g has a temperature of 20.0°C. It absorbs 1100 J of heat energy. What is the final temperature of the metal? (C_P of aluminum = 0.902 J/g · C)

4) An unknown metal has a mass of 18.0 g. If the temperature of the metal sample rises from 15.0°C to 40.0°C as the sample absorbs 89.0 J of heat, what is the specific heat of the sample?

Consider the following reaction:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

5) If ΔH = -92.2kJ and ΔS= -0.1987kJ/K, what is ΔG for the reaction at 748K? Provide the answer in kJ. Is the reaction spontaneous?

6) What would be the ΔG from the previous question for a reaction at 278K? Provide the answer in kJ. Is the reaction spontaneous?

7) The enthalpy and entropy change of a reaction are -3.9 kJ/mole and +56.6 J/mole · K respectively at 25°C. What is the free energy change in kJ/mole? Is this reaction always spontaneous, never spontaneous or does it depend on the temperature?

Would you expect each of the following reactions to be spontaneous (-ΔG) at low temperatures, high temperatures, all temperatures, or not at all?

8) $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$ $\Delta H = -87.9kJ$ ___________________

9) $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ $\Delta H = +92.2kJ$ ___________________

10) $2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$ $\Delta H = -164.1kJ$ ___________________

Unit Quiz Answer Key

1) $\Delta H = (250.0\ g)(0.140\ J/g \cdot C)(52°C)$
$\Delta H = 1820\ J$

2) $\Delta H = mC_P\Delta T$
$\Delta H = (1000g)(4.18\ J/g \cdot C)(67°C) = 280060\ J$
$\Delta H = (0.28J)/(1000) = 280\ kJ$

3) $\Delta H = mC_P\Delta T$
$$\Delta T = \frac{\Delta H}{mC_P}$$
$\Delta T = 1100\ J/(100.0\ g)(0.902\ J/g \cdot C) = 12.2°C$
$T_{final} = 12.2°C + 20°C = 32.2°C$

4) $\Delta H = mC_P\Delta T$
$$C_P = \frac{\Delta H}{m\Delta T}$$
$C_P = 89.0\ J/(18.0\ g)(25°C)$
$C_P = 0.20\ J/g \cdot C$

5) $\Delta G = (-92.2\ kJ) - 748K(-0.1987\ kJ/K)$
$\Delta G = -92.2\ kJ - (-148.6276\ kJ)$
$\Delta G = 56kJ$ (not spontaneous)

6) $\Delta G = (-92.2\ kJ) - 278K(-0.1987\ kJ/K)$
$\Delta G = -92.2\ kJ - (-55.2386\ kJ)$
$\Delta G = -37.0kJ$ (spontaneous)

7) $\Delta G = (-3.9 \text{ kJ/mol}) - 298K(0.0566 \text{kJ/mol} \cdot K)$
$\Delta G = -3.9 \text{ kJ/mol} - 16.8668 \text{ kJ}$
$\Delta G = -20.8 \text{kJ}$; Since ΔS is positive and ΔH is negative, the reaction is always spontaneous.

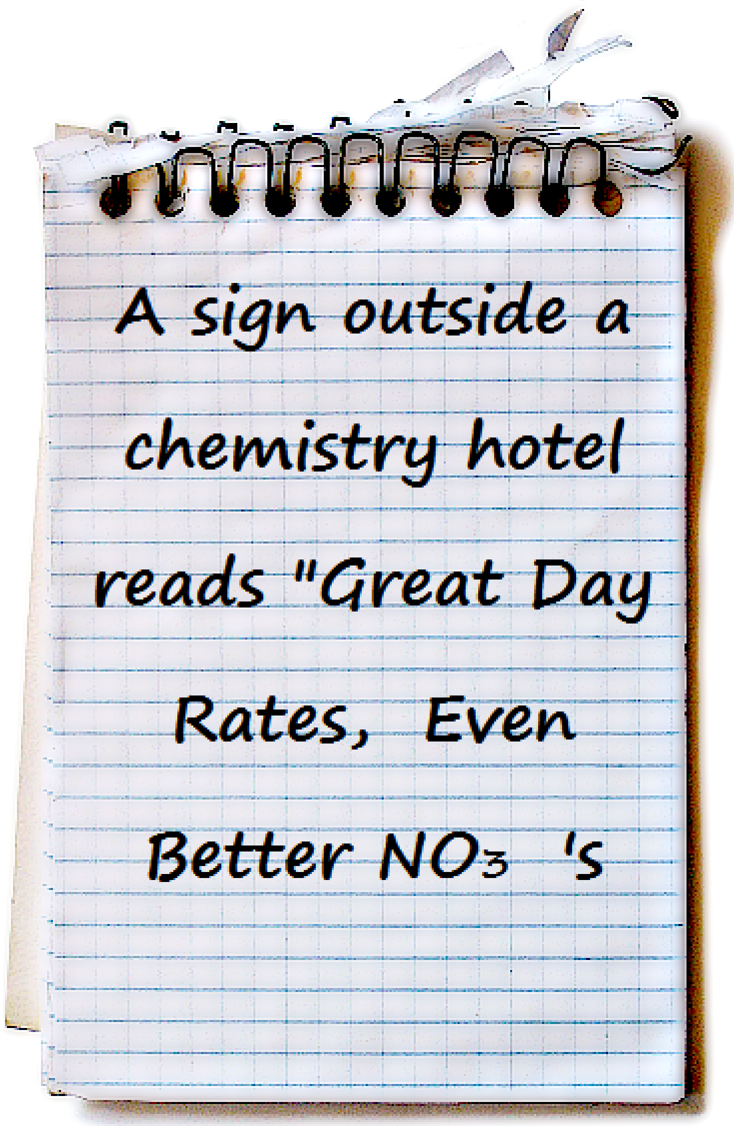
8) ΔS is negative (Prediction #6: losing a mole of gas) and ΔH is negative as well; therefore, if ΔG must be negative, the temperature must be low for the reaction to be spontaneous.

9) ΔS is positive (Prediction #6: gaining a mole of gas) and ΔH is positive; therefore, in order for ΔG to be negative, the temperature must be high.

10) ΔS is positive (Prediction #6: gaining a mole of gas) and ΔH is negative; therefore, ΔG is <u>always</u> negative which means the reaction is spontaneous at all temperatures.

Chapter 29

Kinetics and Rates of Reactions



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

1 Banana
1 Apple
1 Vitamin C tablet
1 cup warm water
1 cup white sugar
Fruit-Fresh® (available in spices/canning aisle of your grocery store or you can make your own with 2 Tbs salt + 2 Tbs vinegar + 1 gallon water)
½ cup lemon juice
Small plastic dishes or bowls
Clear plastic cups and spoons
Paring knife

National Science Education Standards covered this week:

12BPS3.4 Chemical reactions can take place in time periods ranging from the few moments required for an atom to move a fraction of a chemical bond distance to incredibly long time ranges. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature, and on the properties — including shape — of the reacting species.

Definitions

kinetics	the study of the rates of chemical reactions and explains how we can speed them up
collision theory	states that the speed in which a chemical reaction takes place is based solely on how hard the reactants slam into each other and the directions they are traveling when this happens
activation energy	energy required for a reaction to begin making a new product
transition state	the point in which a reaction begins to make a new product
general rate law	used to help to determine how the rate of reaction varies as the reaction progresses; for a chemical reaction that follows a simple formula like $A + B \rightarrow C$ looks like this: $Rate = k[A]^x[B]^y$
reaction orders	exponents (x and y) within a general rate law ($Rate = k[A]^x[B]^y$); used to define how the rate is affected by the reactant concentration

Sample questions to ask your child after completing the weekly reading.

What two measurements must you have in order to calculate the rate of a chemical reaction?

You must know the amount of reactant that is used within a reaction and the amount of time it took for the reaction to happen. Dividing these two pieces of data will give you the reaction rate.

What is "Collision Theory"?

This theory states that the speed in which a chemical reaction takes place is based solely on how hard the reactants slam into each other and the directions they are traveling when this happens.

How and why does increasing the surface area of a reactant increase the rate of reaction?

By grinding a larger reactant into smaller particles, you will increase the amount of surface area that can react within a chemical reaction. This will increase the rate of reaction.

What is the purpose of creating reaction rate laws?

Reaction rate laws help to determine how the rate of reaction varies as the reaction progresses. This is because the rate of reaction changes as the reaction progresses. At first, the rate of reaction is pretty fast; however, after a short burst of rapidly creating a product, the rate of reaction decreases to zero (at which point the reaction is complete).

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) it doubles
2) it remains constant
3) it doubles
4) it quadruples , four times greater
5) it remains constant
6) it quadruples, four times greater
7) Rate = k $[ICl]^1[H_2]^1$
8) Rate = k $[0.10\ mol/L]^1[0.01\ mol/L]^1$
   Initial Rate = 0.002 mol/(L · s)
   0.002 mol/(L · s) = k$[0.10\ mol/L]^1[0.01\ mol/L]^1$

   k = 2
9) b) 2
10) Rate = k$[A]^1[B]^0$
11) d) rate = k$[NO]^2[Cl_2]$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

1 Banana
1 Apple
1 Vitamin C tablet
1 cup warm water
1 cup white sugar

½ cup lemon juice
Small plastic dishes or bowls
Clear plastic cups and spoons
Paring knife

Fruit-Fresh® (available in spices/canning aisle of your grocery store or you can make your own with 2 Tbs salt + 2 Tbs vinegar + 1 gallon water)

Slowing down the rate of reactions or…

How to keep your fresh fruit fresh?

Slowing down the reaction rates is as important as speeding them up, especially with preserving fresh fruits.

Ingredients:

1 Banana	240 mL warm water
1 Apple	240 mL white sugar
1 Vitamin C tablet	120 mL lemon juice

Fruit-Fresh® (available in spices/canning aisle of your grocery store or you can make your own with 30 mL salt + 30 mL vinegar + 3.8 L water)

Other items:

Paring knife	Clear plastic cups and spoons
Small plastic dishes or bowls	

Recipe:

1) Place one vitamin C tablet into 120 mL of warm water and mix until dissolved in a clear plastic cup; label cup as "Vitamin C". (Hint: you may want to crush the tablet first to speed up the dissolving process.)
2) Place 180 mL of sugar into 120 mL of warm water and mix the solution in a separate clear plastic cup; label as "Sugar Dip".
3) Pour lemon juice into a third plastic cup; label as "Lemon Juice".
4) Peel off the apple skin with a paring knife and cut the banana and apple into approximately 1.25 cm slices.
5) Place a few pieces of apple and banana on a dish and label as "Control".
6) Immerse pieces of fruit in each of the dipping solutions for 3 minutes (hold the fruit into the solution; do not allow it to float to the surface).
7) After three minutes, take the fruit out of the solution and place the fruit onto a plate with label to identify the dipping solution used to treat the fruit.

8) While waiting for the fruit in the dipping solutions, add some of the cut fruit to 60 mL of dry granulated sugar in a small dish.
9) Roll the fruit in sugar until totally covered and then place the fruit onto a plate and label it as "Dry Sugar".
10) Roll fruit in a dish of Fruit-Fresh® until covered; place on a third plate and label as "Fruit-Fresh". (The homemade recipe was followed instead of the Fruit-Fresh, allow the fruit to be submerged in the solution for three minutes before removing.)
11) Set aside all of the plates for at least 1 hour so that the degrees of browning can be best observed.
12) After one hour, observe the differences in the degree of browning across treatments and compare them to the controls.
13) Identify which methods were best to prevent browning by recording your observations on the chart provided at the end of this lesson.

Explanation:

You learned how to speed up a reaction in this week's readings; however, good food tends to require more time and patience. Speed is not always the correct pathway towards the perfect dish.

This week's activity shows you the importance of slowing down a reaction rate. The ability to understand how to accomplish this task is as important as learning how to speed up the reaction as well.

The browning of fruits is caused by a chemical reaction among pigments within their cells when they are exposed to the oxygen of the air. These reactions trigger specific **enzymes** in plant tissues to cause the change in color. Enzymes are chemicals within plant and animal cells that function as catalysts.

As you read this week, catalysts speed up chemical reactions; but, they are not changed by the reaction itself. There are two ways to prevent enzymatic browning:

a) Inactivate the enzymes (stop their action); or,
b) Prevent oxygen from coming in contact with the enzyme

All of the experimental trials within this experiment have the ability to prevent the enzymatic browning of fruit:

Plate of fruit	Treatment	Method of preventing enzymatic browning
Sugar Dip	soaked for 1 minute in sugar solution	The sugar syrup coats the fruit and prevents the fruit surface from contacting oxygen.
Lemon Juice	soaked for 1 minute in lemon juice	Lemon juice and other acids lower the pH which keeps the plant enzymes from functioning
Vitamin C	soaked for 1 minute in Vitamin C solution	Vitamin C is a great "antioxidant" which prevents the oxygen from reacting with the plant enzymes
Dry Sugar	rolled in dry sugar until covered	The addition of sugar on the surface of the fruit dehydrates the cells by lowering the osmotic pressure. Without water, reactions slow down due to a lack of "enzyme transportation."
Fruit-Fresh	rolled in Fruit-Fresh® until covered (or soaked in substitute)	Although the ingredients of this product are not entirely known, its food label does suggest it contains vitamin C and other antioxidants as well!

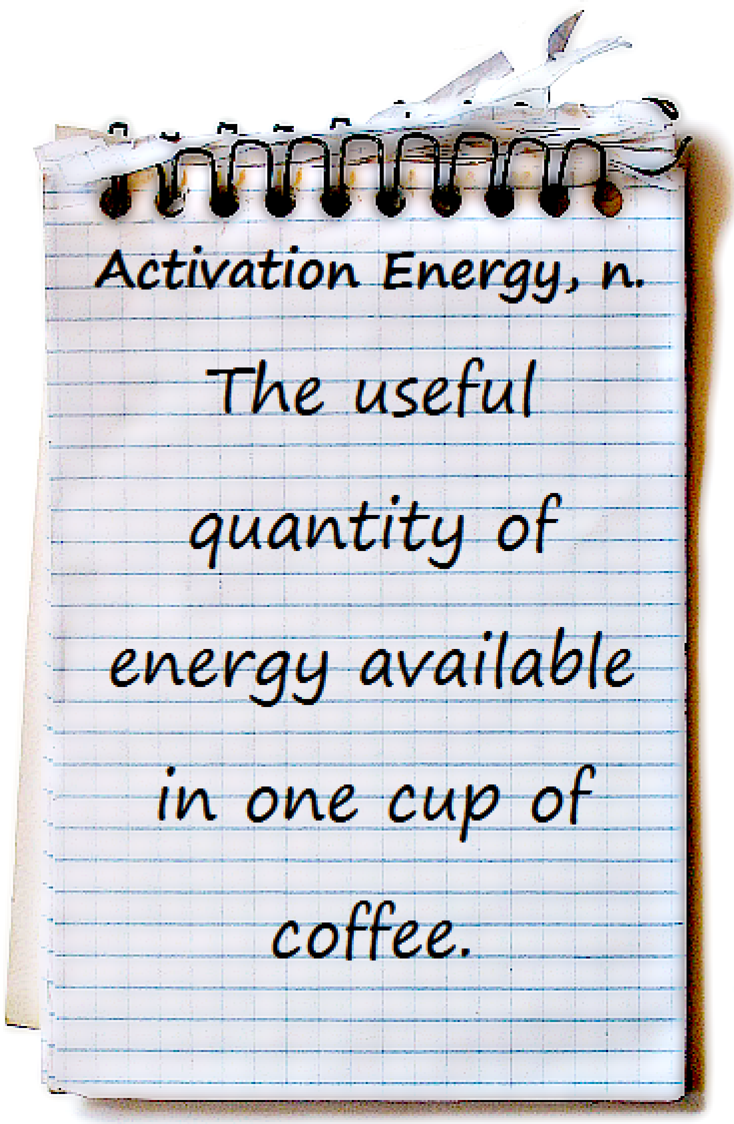
Which of these, when compared to your control group, was able to prevent the enzymatic browning the best. Was this treatment the same for both the apple and the banana?

Observation chart

Plate of fruit	Treatment	Observations after one hour (compare with Control)
Control	fruit not treated and exposed to air	
Sugar Dip	soaked for 1 minute in sugar solution	
Lemon Juice	soaked for 1 minute in lemon juice	
Vitamin C	soaked for 1 minute in Vitamin C solution	
Dry Sugar	rolled in dry sugar until covered	
Fruit-Fresh	rolled in Fruit-Fresh® until covered (or soaked in substitute)	

Chapter 30

Reversible Reactions



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

Distilled water
Regular water
Bottled water
Pan
Ice cube trays (or small plastic cups)

National Science Education Standards covered this week:

12BPS3.4 Chemical reactions can take place in time periods ranging from the few moments required for an atom to move a fraction of a chemical bond distance to incredibly long time ranges. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature, and on the properties — including shape — of the reacting species.

Definitions

equilibrium	time within a reversible reaction (system) where the forward and reverse reactions will take place at the same rate
Le Châtlier's principle	principle which states that whatever changes are done to a reaction in equilibrium, the equilibrium will change to accommodate whatever you did; used to get as much product as possible out of a reaction

Sample questions to ask your child after completing the weekly reading.

What do chemists call the point where the forward and reverse reactions of a system take place at the same rate?
This is known as the point of equilibrium.

During equilibrium, are products and reactants are still being formed?
Yes. Reactants are still reacting together to form new product; however, both reactions are occurring at the same rate.

During equilibrium, do the concentrations of the reactants and products remain the same?
Yes. For every product being made, the same amount of reactant(s) is being made as well.

According to the Le Châtlier's principle, what can be done to increase the amount of products from a chemical reaction in equilibrium?
Adding extra reactants to a reaction in equilibrium or changing the volume of the container in which the reaction is taking place, can increase the amount of products.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Adding something on the product side of the reaction will cause equilibrium to shift to the reactant side. In other words, the reverse reaction will be favored, or you could say that equilibrium shifts to the left.
2) The concentration of I_2 will increase.
3) Reverse reaction is favored to use up the additional ammonia
4) Reverse reaction is favored to replace the lost nitrogen dioxide
5) Forward reaction is favored to replace the lost water vapor
6) Forward reaction is favored to use up the additional hydrogen
7) $2HI(g) \leftrightarrows H_2(g) + I_2(g)$
8) $3H_2(g) + N_2(g) \leftrightarrows 2NH_3(g)$
9) False; at equilibrium, the concentrations will not change, but they are not necessarily the same for all reaction participants.
10) True; this is the definition of equilibrium.
11) False; because the rate of the forward reaction equals the rate of the reverse reaction, the concentrations of the reactants decreases (as the forward reaction occurs) at the same rate that the concentration of the reactants increases (as the reverse reaction occurs). There is no net change in reactant concentrations.

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

Distilled water
Regular water
Bottled water
Pan
Ice cube trays (or small plastic cups)

Crystal clear ice cubes

*That's funny... They don't look like **that** at home!*

Reversible reactions are a breeze when you are dealing with phase changes.

Ingredients:
Distilled water
Regular water
Bottled water

Other items:
Pan
Ice cube trays (or small plastic cups)

Recipe:
1) Fill your pan half-full with distilled water and let it boil. Once it's boiled, let it cool down.
2) After it's cool, boil the water again. And again, let it cool down.
3) Fill your cube trays half-full with the water. If you are using plastic cups, do not allow the water level to rise above 1.25 cm.
4) Put your tray in the freezer and let sit for a few hours.
5) Repeat this procedure with regular tap water and bottled water.

Explanation:
The topic of reversible reactions can easily be seen in the kitchen: dissolved salt or sugar can be crystallized once its solvent is boiled away, the oil/vinegar layers in your shaken salad dressing will reform over time, and the melting and hardening of chocolates and butters can easily be seen as well!

The easiest method of witnessing reversible reactions, however, has to involve phase changes! That is the driving purpose behind your lab this week. The melting of ice into a transparent solid seems like such an easy task, but there are a lot of subtle problems you have to consider.

First of all, distilled water is used in this experiment as it has been purified and all the hard water minerals and deficiencies have been filtered out. As you learned in chapter 21, boiling removes all the bubbles that exist within the water. It is this dissolved gas (along with various amounts of dust and minerals in the water) that cloud up your ice cubes.

The reason why you only fill the trays half-full with water to obtain your clear ice cubes is the same reason why icicles are always clear too. Icicles are created in layers. Water drips down the icicle and freezes in layers rather than freezing all at once. This approach avoids entrapped bubbles. This is how most restaurant ice makers work as well. Cold water runs continuously over a plate where the ice is forming, and the ice cubes/disks grow in layers, much like icicles. If you were to fill up your trays with water, it would freeze more towards the center of the cubes and create a cloudy area within the cube.

Unit Quiz (Weeks 29-30)

1) Calculate the specific rate constant at the temperature at which the data were collected. The rate-law expression is Rate = $k[NO]^2[H_2]$

$$H_2(g) + NO(g) \rightarrow N_2O(g) + H_2O(g)$$

Experiment	Initial [NO]	Initial [H_2]	Rate of reaction
1	0.30 M	0.35 M	2.835×10^{-3} M/s
2	0.60 M	0.35 M	1.134×10^{-2} M/s
3	0.60 M	0.70 M	2.268×10^{-2} M/s

2) Calculate the specific rate constant for this reaction at 800°C. The rate-law expression is: Rate = $k[NO]^2[H_2]$

$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

Experiment	Initial [NO]	Initial [H_2]	Rate of reaction
1	0.0010 M	0.0060 M	7.9×10^{-7} M/s
2	0.0040 M	0.0060 M	1.3×10^{-5} M/s
3	0.0040 M	0.0030 M	6.4×10^{-6} M/s

3) Consider the reaction below:

$$2H_2(g) + 2NO(g) \rightarrow 2H_2O(g) + N_2(g)$$

Initial rate data for this system are given below. Determine the rate law and the rate constant (k).

Experiment	Initial [NO]	Initial $[H_2]$	Rate of reaction
1	6 M	1 M	20 M/s
2	6 M	2 M	40 M/s
3	6 M	3 M	60 M/s
4	1 M	18 M	10 M/s
5	2 M	18 M	40 M/s
6	3 M	18 M	90 M/s

4) Consider the hypothetical reaction:

$$2P + 3Q + R \rightarrow QR + 2PQ$$

Experimental initial rate data for this reaction are given below. From this information, determine the rate law and the rate law constant (k). (Hint: you might want to start with Reactant R)

Experiment	**Initial [P]**	**Initial [Q]**	**Initial [R]**	**Rate of reaction**
1	1 M	1 M	1 M	3 M/min
2	1 M	2 M	2 M	6 M/s
3	1 M	2 M	3 M	6 M/s
4	1 M	3 M	4 M	9 M/s
5	2 M	3 M	5 M	36 M/s

List three ways that the following equilibrium reaction could be forced to shift to the right:

$$2NO_{2\,(g)} \leftrightarrows 2NO_{(g)} + O_{2\,(g)}$$

5) ____

6) ____

7) ____

Given the following equilibrium reaction what will be the effect of the following disturbances to the system:

$$2C_{(s)} + O_{2\,(g)} \leftrightarrows 2CO_{(g)}$$

8) Adding CO (at constant volume and temperature)

9) Addition of O_2 (at constant volume and temperature)

10) Addition of solid carbon (at constant temperature)

11) Decreasing the volume of the container

For the following questions, remember that ΔH = the change in enthalpy (+ΔH is for endothermic and -ΔH is for exothermic)

For each of the following equilibrium, predict whether the system will shift in the forward or reverse directions. Note the energy changes involved and assume that the volume remains constant.

12) Heat is removed from: $A \leftrightarrows B$ $\Delta H^\circ = +40.0$ kJ

13) Heat is removed from: $A + B \leftrightarrows 2C$ $\Delta H^\circ = -25.5$ kJ

14) Heat is added to: $A + 2B \leftrightarrows 3C$ $\Delta H^\circ = -32.0$ kJ

In each of the following equilibria, would you increase or decrease the temperature to force the reaction in the forward direction?

15) $H_2(g) + CO_2(g) \leftrightarrows H_2O(g) + CO(g)$ $\Delta H° = +41.0$ kJ

16) $2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g)$ $\Delta H° = -198$ kJ

Unit Quiz Answer Key

1) $2.835 \times 10^{-3} = x(0.3)^2(0.35) = 9.0 \times 10^{-2}$
2) $7.9\times10^{-7} = x(0.001)^2(0.006) = 1.3 \times 10^2$
3) Rate = $k[H_2][NO]^2$
   k = 0.56
4) Rate = $k[P]^2[Q]^1[R]^0$ or simply $k[P]^2[Q]$
   k = 3.0

5-7) Any three of the following would be correct:

- Add more NO_2
- Remove NO or O_2
- Decrease the pressure
- Increase the volume

8) Reverse reaction is favored. Adding a substance on one side of the equation forces the reaction to the other side of the equation.
9) The forward reaction is favored to use up the additional O_2.
10) No effect. Adding more of a solid does not change its concentration. The reaction may go on *longer,* but equilibrium is not affected.
11) Count moles of GAS on both sides of the equation. There is 1 mole of gas on the reactant side, and 2 moles on the product side. Decreasing volume will favor the side with the fewest moles of gas - the reverse reaction will be favored.
12) Removing heat favors the exothermic direction to replace the lost heat. Thus the reverse direction will be favored.
13) In this case the forward direction is the exothermic direction, so the forward reaction is favored.
14) The reverse reaction is endothermic, so it will be favored to remove the excess heat.
15) Increase temperature; because the forward direction is endothermic and will use up the additional heat.
16) Decrease; because the forward reaction will produce heat removed by making the system cooler.

Chapter 31

Acids and Bases

Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

3 carrots
3 radishes
Bundle of asparagus
Head of broccoli
Salt
Large pot with lid
Slotted spoon
Ice water
Knife
Paper towels
Marker

National Science Education Standards covered this week:

12BPS3.3 A large number of important reactions involve the transfer of hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms.

Definitions

acidic solutions	solutions which contain a high concentration of acidic molecules
basic solutions	solutions which contain a high concentration of basic molecules
Svante Arrhenius	discovered that acids are compounds that give off H^+ ions when dissolved in water and bases are those which give off hydroxide ions OH^- when dissolved in water
Brønsted-Lowry method	enhanced the Arrhenius method of identifying acids and bases; discovered that acids are compounds that give H^+ ions to other compounds while bases are the compounds that accept these H^+ ions
conjugate acids and bases	discovery by Brønsted-Lowry; states that weak acids always form strong conjugate bases and vice versa; and, strong acids always form weak conjugate bases and vice versa
pH/pOH scales	two different scales (between the values 0-14) which were created to calculate the concentrations of H^+ or OH^- ions in solution

Sample questions to ask your child after completing the weekly reading.

What finding about acids and bases did Arrhenius discover?

Arrhenius discovered that acids are compounds that give off H^+ ions when dissolved in water and bases are those which give off hydroxide ions OH^- when dissolved in water.

What discovery by Brønsted-Lowry was used to identify unknown acids and/or bases?

Acids are compounds that give H^+ ions to other compounds; while bases are the compounds that accept these H^+ ions.

According to the Brønsted-Lowry definition, weak acids and strong acids form what types of conjugate compounds?

Weak acids always form strong conjugate bases; and, strong acids always form weak conjugate bases.

A solution cannot be both acid and basic; therefore, they can be measured on a scale with the same range from 0-14. Which side of this range identifies a strong base?

The range closest to 14 denotes a solution that is highly basic.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

BASE ACID C. ACID C. BASE

Whichever product receives the H^+ is the conjugate acid!

2) $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

ACID BASE C. ACID C. BASE

3) NaOH = base

4) HF = acid

5) $[H^+] = 10^{-pH}$ so... pH13

6) $pH = -\log[H^+]$ so... $pH = -\log[1.58 \times 10^{-9}]$ = pH8.8

7) $pOH = -\log[OH^-]$ so... $pOH = -\log[2 \times 10^{-7}] - 14$ = pH7.3

8) $[OH^-] = 10^{-pOH}$ so... pOH7 and... 14 - 7= pH7

9) $pOH = -\log[2.5 \times 10^{-7}] - 14$ = pH7.39 (Basic)

10) $pOH = -\log[3.1 \times 10^{-13}] - 14$ = pH1.49 (Acidic)

11) $pH = -\log[4.21 \times 10^{-5}]$ = pH4.3 (Acidic)

12) $pH = -\log[8.9 \times 10^{-10}]$ = pH9.1 (Basic)

13) $[H^+] = 10^{-pH} = 10^{-3.3} = 5 \times 10^{-4}$

14) $14 - 1.26 = 12.74$; $[H^+] = 10^{-pH} = 10^{-12.74} = 1.82 \times 10^{-13}$

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

3 carrots
3 radishes
Bundle of asparagus
Head of broccoli
Salt
Large pot with lid

Slotted spoon
Ice water
Knife
Paper towels
Marker

A trick in preparing your veggie tray or…

To cover or not to cover? That is the question!

The role of acid solutions while blanching vegetables will be explored this week!

Ingredients:

3 carrots
3 radishes
Bundle of asparagus
Head of broccoli
Salt

Other items:

Large pot with lid
Slotted spoon
Ice water
Knife
Paper towels
Marker

Recipe:

1) Remove three paper towels and label them: Control, With Lid, Without Lid
2) Prepare a bowl of ice water.
3) Place a large amount of water on the stove on high heat.
4) As the water heats up, cut each carrot, radish, and asparagus spear into halves. Remove 3 clusters from the head of broccoli as well.
5) Add a 15 mL of salt to the water after it begins to boil.
6) Place one set of your vegetables as your control group (two halves each of carrot, asparagus, radish and one cluster of broccoli) on the paper towel labeled "Control".
7) Place two of the carrot halves into the boiling water for 3 minutes.
8) Remove with a slotted spoon and immediately place into the ice water for another 3 minutes. Allow the veggies to dry on the paper towel labeled "Without Lid".

9) Repeat steps 7-8 one more time; however, be certain to place the lid on the pan during the cooking this time. Again, remove and submerge in the ice water bath. Place these veggies on the paper towel labeled "With Lid".
10) Repeat steps 7-9 once again using the radishes.
11) If your water has not changed into a orange/red color, repeat steps 7-9 with the asparagus spears next, followed by the broccoli.
12) If the water does appear to have changed color after heating the carrots and radishes, boil fresh water before attempting the asparagus and broccoli trials.
13) Compare the differences in color between the vegetables on the three paper towels.

Explanation:

As you learned when you blanched spinach for your chapter 21 activity, **blanching** is a method used to enhance the color, flavor, and preservation of vegetables prior to storage.

Although the science behind why the colors of your vegetables were enhanced is well beyond the scope of this book, there should be an observable difference between some of the veggies that were blanched with and without the lid. The reason for this discoloration has everything to do with our topic of study this week.

Cooking vegetables releases tiny air pockets within the plant tissues and any dirt that exists within the tissues themselves (not to mention a HUGE list of chemical reactions within the cells of the veggies.) All of these factors enhance the color of the vegetables.

However, if you cook the veggies for too long or if you leave the lid on the pot, the plant's cell walls to shrink and release an acid into the boiling water.

This acid will coat the plant tissues in the water, causing our green vegetables to change into a brown color.

Please take note of the underlined words in the last paragraph. You should have noticed that the green vegetables (asparagus and broccoli) were much more brown when the lid was left on than when no lid was used. Why?

As the veggies hit the boiling water, acids are released into the water and are carried away in the steam through evaporation.

When the pot is covered, the steam and the acids it contains are forced back into the water. Once there, the acids react with the pigments in the vegetables, turning them a shade of brown.

A similar reaction will take place if there's too little water in the pot because of the increased concentration of acids in the water or if you overcook the vegetables which prolong their exposure to the acids.

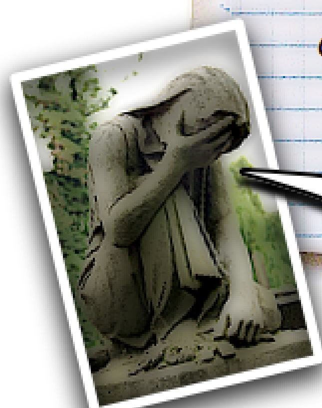
And what about the carrots and radishes? Did they turn colors? Probably not! The red pigments that exist within these vegetables react differently with the acids in the solution. Their colors should have been enhanced by the blanching, but it is unlikely they turned an ugly shade of brown.

Chapter 32

Titrations

Sometimes people can get carried away with a danger that isn't real!

Several years ago, a group reached the media with their campain to ban the "potentially dangerous" chemical – dihydrogen monoxide.



Day One:

Today, your child should complete the readings and practice problems for the week.

Your "grocery list" for this week's lab will be:

One gallon distilled water
One head of red cabbage
One egg
Cooking spray or butter
Large pot and skillet

Strainer
Small bowl
Whisk or fork
Funnel
Knife

National Science Education Standards covered this week:

12BPS3.3 A large number of important reactions involve the transfer of hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms.

Definitions

titration	a method used to neutralize an acid or a base (bring to pH of 7)
indicators	chemical compounds that change color in the presence of acids or bases
litmus paper	pH indicator which turns red in the presence of an acid and blue in a base
phenolphthalein	pH indicator which is a clear liquid while in the presence of an acid but turns pink when mixed with a base.
endpoint	the point in which the color change within a titration begins to appear
equivalence point	the point in which the volume of acid equals the volume of base during a titration

Sample questions to ask your child after completing the weekly reading.

What is the practical use of a titration?

A titration is a method used to neutralize an acid or a base (bring to pH of 7). Once neutralized, the fluid is generally safe to handle or dispose of.

What steps must you follow to calculate the molarity of a neutralized acid or base following a titration?

First, calculate the molarity of the acid or base that was added for the neutralization to occur.

Second, convert the number of moles of the neutralizing substance to the number of moles of the neutralized substance.

Finally, calculate the molarity of the acid or base that was neutralized.

How do you know when the pH level has reached neutrality?

Chemists typically use some form of pH indicator to determine if neutrality has been successfully achieved.

Why is it nearly impossible to reach the equivalence point during a titration?

The equivalence point is the point in which the volume of acid equals the volume of base through titration after an endpoint (the point in which the color changes begins to appear) has been identified.

Day Two:

Your child should check their work on the practice worksheets today with the answer key on the next page.

In addition, your child should read the weekly lab activity and complete all of the necessary conversions before grocery shopping!

Answer Key for Practice Problems

1) Using the equation $M_A V_A = M_B V_B$, gives you the answer 0.021 M HCl
2) Using the equation $M_A V_A = M_B V_B$, gives you the answer 0.009 M NaOH
3) 0.119 M H_2SO_4
   You divided your answer by two because there are two acidic hydrogens that need to be neutralized during the titration. This means it takes twice as much base to neutralize it, making the concentration of the acid appear twice as large as it really is.
4) You cannot do a titration without knowing the molarity of at least one of the substances, because you'd then be solving one equation with two unknowns (the unknowns being M_1 and M_2).
5) $M_1 V_1 = M_2 V_2$
   (2 moles) (1.5M) (45.0 mL) = (3M) (V_2)
   V_2 = 45.0 mL
6) $M_1 V_1 = M_2 V_2$ (2)
   (2M) (37.2 mL) = (M_2) (15.0 mL) (2 moles)
   M_2= 2.48M
7) $M_1 V_1 = M_2 V_2$
   (0.05M)(42 mL)(2 moles) = (0.27M)(V_2)(3 moles)
   V_2 = 5.19 mL
8) | 13.5 mL | 0.45 moles HCl | 1 mole $Al(OH)_3$ | 78 g $Al(OH)_3$ | = 0.158g |
   |---|---|---|---|---|
   | | 1000 mL | 3 moles HCl | 1 mole | |

Day Three: Kitchen Chemistry Lab

Your child should have already read through this weekly lab and made all of the necessary conversions. Before picking up your supplies for the lab, be certain to check the conversions with the main ingredient list below!

The ingredients for this week's lab are:

One gallon distilled water
One head of red cabbage
One egg
Cooking spray or butter
Large pot and skillet

Strainer
Small bowl
Whisk or fork
Funnel
Knife

Green eggs and ~~ham~~ bases or…

These eggs are beyond envious of you finishing the book!

A homemade acid/base indicator will be used to generate a chemical reaction in your breakfast!

Ingredients:

One gallon distilled water
One head of red cabbage
One egg
Cooking spray or butter

Other items:

Large pot and skillet
Strainer
Small bowl
Whisk or fork
Funnel
Knife

Recipe:

Prepare your pH indicator with the following procedure:

1) Quarter a head of red cabbage and insert it into 3.8 L of boiling distilled water.
2) Stir the mixture together every couple of minutes.
3) When the water turns into a dark purple color (approximately 15-20 minutes), strain the cabbage out of the mixture and retain the fluid back into the gallon jug.
4) Allow the solution to cool before use.
5) You may freeze the solution for several months if needed in future experiments.

Frying a green egg

1) Spray a pan with cooking spray.

2) Heat the pan over medium-high heat.
3) Crack an egg and separate the egg white from the yolk. Set the yolk aside.
4) In a small bowl, mix the egg white with a small amount of red cabbage juice (~15+ mL). Be observant of the change in color.
5) Add the egg white mixture to the hot pan.
6) Set the egg yolk in the middle of the egg (if you like "sunny side up" eggs!)
7) Fry it and eat it like you would any other egg.

Explanation:

If you mix the egg white and red cabbage juice thoroughly then the 'white' of the fried egg will be uniformly green. If you only lightly mix the ingredients you will end up with a green egg that has white splotches. Why?

The compounds in red cabbage that change color in response to changes in pH are called anthocyanins. Red cabbage juice is purplish-red under acidic conditions, but changes to a blue-green color under basic conditions. Egg whites are basic (pH ~9) so when you mix the red cabbage juice into the egg white the pigment changes color. The pH does not change as the egg is cooked so the color is stable. It's also edible, so you can eat the fried green egg!

So what are you going to do with all of that leftover cabbage juice? How about you try out these two other activities:

http://eequalsmcq.com/LabNotes1.09momncabbagejuice.gif

http://eequalsmcq.com/LabNotes12.08coolcolorfulhotpack.gif

Unit Quiz (Weeks 31-32)

Find the pH or pOH of the following acidic solutions:

1) The pH of a 0.001 M solution of HCl (hydrochloric acid).

2) The pH of a 1.34×10^{-4} M solution of hydrochloric acid.

3) The pOH of a 7.98×10^{-2} M solution of HNO_3 (nitric acid).

4) The pH of a 735 L of a solution containing 0.34 moles of nitric acid.

5) The pH of a 660 L of a solution containing .0074 moles of hydrochloric acid.

6) The pOH of a 1.2 L of a solution containing 5.0×10^{-4} grams of hydrobromic acid (HBr).

7) The pH of a 792 mL of a solution containing 0.344 grams of hydrochloric acid.

8) The pOH of a 8.7 L of a solution containing 1.1 grams of nitric acid.

9) The pH of a 10.7 L solution containing 0.01 grams of hydrochloric acid.

10) The pH of a 150,000 L solution containing 45 grams of nitric acid and 998 grams of hydrobromic acid.

Determine the [H^+] from the following two pH and pOH values:

11) pH = 7.69 ___________________________

12) pOH = 10.21 ___________________________

13) While titrating an NaOH solution, a student found that 38.46 mL of the base neutralized exactly 32.33 mL of 0.1064 M HCl. Find the concentration (M) of the NaOH.

14) In titrating an H_2SO_4 solution, it was found that 23.66 mL of 0.2137 M NaOH would neutralize 22.04 mL of the acid. Find the concentration of the H_2SO_4.

Unit Quiz Answer Key

1) $-\log(0.001) = 3.00$

2) $-\log(1.34 \times 10^{-4}) = 3.87$

3) $-\log(7.98 \times 10^{-2}) = 1.1$ (pOH)
pH = 14 – 1.1 = 12.9

4) $\frac{0.34 \text{ moles } HNO_3}{735 \text{ L}} = 4.625 \times 10^{-4}$ M
$-\log(4.625 \times 10^{-4}) = 3.3$

5) 4.95 (see method above)

6) 8.72 (Convert grams of HBr to moles; calculate molarity; perform log function; subtract this pOH answer from 14 to obtain the pH value)

7) 1.92 (follow the method from #6 with the exception of subtracting by 14)

8) 11.3 (follow the method from #6)

9) 4.59 (follow the method from #7)

10) 4.06 (follow the method from #7; add both of the mole amounts together before performing the log function)

11) [H+] = 10-pH = 10-7.69 = 2.04×10^{-8}

12) 14 - 10.21 = 3.79; [H+] = $10^{-pH} = 10^{-3.79} = 1.62 \times 10^{-4}$

13) $M_A V_A = M_B V_B$
$(0.1064M)(32.33mL) = (M_B)(38.46mL)$
$M_B = 0.089$

14) $M_A = 0.229M$ (see method above)

Quarterly Test

Chapters 25-32

This test contains both a pre- and post-test for your child.

Once the pre-test has been completed and reviewed, the post-test may be administered.

The pre-test has been constructed to build upon the mechanics of various chemistry problems, while the post-test is designed for a deeper understanding of these mechanics.

Prior to this exam, it is highly recommended that the weekly practice problems and unit quizzes be reviewed by the child!

Pre-Test (Units 13-16)

1) Ethylene (C_2H_4) burns in oxygen to form carbon dioxide and water vapor at a pressure of 1 atm and a temperature of 273K. How many liters of water can be formed if 1.25 liters of ethylene are consumed in this reaction?

2) When chlorine is added to acetylene (C_2H_2), 1,1,2,2-tetrachloroethane ($C_2H_2Cl_4$) is formed at a pressure of 1 atm and a temperature of 298K. How many liters of chlorine will be needed to make 75.0 grams of $C_2H_2Cl_4$?

3) A bag of potato chips is packaged at sea level (1.00 atm) and has a volume of 315 mL. If this bag of chips is transported to Denver (0.775 atm), what will the new volume of the bag be?

4) A Los Angeles class nuclear submarine has an internal volume of eleven million liters at a pressure of 1.250 atm. If a crewman were to open one of the hatches to the outside ocean while it was underwater (pressure = 15.75 atm), what would be the new volume of the air inside the submarine?

5) A piece of stainless steel with a mass of 1.55 g absorbs 141 J of heat when its temperature increases by 178°C. What is the specific heat of the stainless steel?

Please indicate if TRUE or FALSE:

6) _____ The entropy of a gas increases with increasing temperature.

7) _____ Spontaneous processes always increase the entropy of the reacting system.

8) _____ All spontaneous processes release heat to the surroundings.

9) _____ An endothermic reaction is more likely to be spontaneous at high temperatures than at low temperatures.

10) Which of the following choices identifies the correct specific rate constant. The rate-law expression is: Rate = k[NO]^2[H_2]

$$H_2(g) + NO(g) \rightarrow N_2O(g) + H_2O(g)$$

Experiment	Initial [NO]	Initial [H_2]	Rate of reaction
1	0.30 M	0.35 M	2.835×10^{-3} M/s
2	0.60 M	0.35 M	1.134×10^{-2} M/s
3	0.60 M	0.70 M	2.268×10^{-2} M/s

a) 9.4×10^{-3}
b) 2.7×10^{-2}
c) 1.6×10^{-4}
d) 8.1×10^{-3}
e) 9.0×10^{-2}

11) Consider a chemical reaction involving compounds A and B, which is found to be first order in A and second order in B. At what rate will the reaction occur in experiment 2?

Experiment	Initial [A]	Initial [B]	Rate of reaction
1	1.0 M	0.20 M	0.10 M/s
2	2.0 M	0.60 M	? M/s

a) 1.2 M/s
b) 0.20 M/s
c) 0.60 M/s
d) 1.8 M/s
e) 0.36 M/s

The pressure on each of the following systems is increased by decreasing the volume of the container. Explain whether each system would shift in the forward direction, the reverse direction, or stay the same.

12) $2SO_2(g) + O_2(g) \leftrightharpoons 2SO_3(g)$ ____________________________

13) $H_2(g) + I_2(g) \leftrightharpoons 2HI(g)$ ____________________________

14) $CaCO_3(s) \leftrightharpoons CaO(s) + CO_2(g)$ ____________________________

Determine the pOH given the following values:

15) $[H^+] = 2 \times 10^{-8}$ ____________________________

16) $[OH^-] = 5.1 \times 10^{-11}$ ____________________________

Pre-Test Answer Key

1) Ethylene (C_2H_4) burns in oxygen to form carbon dioxide and water vapor at a pressure of 1 atm and a temperature of 273K. How many liters of water can be formed if 1.25 liters of ethylene are consumed in this reaction?

$C_2H_4 + 3\ O_2 \rightarrow 2\ CO_2 + 2\ H_2O$

$$\frac{1.25\ L\ C_2H_4}{} \Bigg| \frac{1\ \text{mole}\ C_2H_4}{22.4\ L\ C_2H_4} \Bigg| \frac{2\ \text{moles}\ H_2O}{1\ \text{mole}\ C_2H_4} \Bigg| \frac{22.4L\ H_2O}{1\ \text{mole}\ H_2O} = \mathbf{2.5\ L\ H_2O}$$

2) When chlorine is added to acetylene (C_2H_2), 1,1,2,2-tetrachloroethane ($C_2H_2Cl_4$) is formed at a pressure of 1 atm and a temperature of 298K. How many liters of chlorine will be needed to make 75.0 grams of $C_2H_2Cl_4$?

$2Cl_2 + C_2H_2 \rightarrow C_2H_2Cl_4$

$$\frac{75g\ C_2H_2Cl_4}{} \Bigg| \frac{1\ \text{mole}\ C_2H_2Cl_4}{168g\ C_2H_2Cl_4} \Bigg| \frac{2\ \text{moles}\ Cl_2}{1\ \text{mole}\ C_2H_2Cl_4} = 0.892\ \text{moles}\ Cl_2$$

(1atm)(V) = (0.892 moles)(0.08206)(298K)

V = 21.8 L Cl_2

3) A bag of potato chips is packaged at sea level (1.00 atm) and has a volume of 315 mL. If this bag of chips is transported to Denver (0.775 atm), what will the new volume of the bag be?

(1atm)(315mL) = (0.775atm)(V_2)

V_2 = 406.5 mL

4) A Los Angeles class nuclear submarine has an internal volume of eleven million liters at a pressure of 1.250 atm. If a crewman were to open one of the hatches to the outside ocean while it was underwater (pressure = 15.75 atm), what would be the new volume of the air inside the submarine?

(1.25atm)(11000000L) = (15.75atm)(V_2)

V_2 = 873015.9 L

5) A piece of stainless steel with a mass of 1.55 g absorbs 141 J of heat when its temperature increases by 178°C. What is the specific heat of the stainless steel?

$\Delta H = mC_P\Delta T$

$$C_P = \frac{\Delta H}{m\Delta T}$$

$C_P = 141\ J/(1.55\ g)(178°C)$

$C_P = 0.511\ J/g \cdot C$

Please indicate if TRUE or FALSE:

6) True The entropy of a gas increases with increasing temperature.

7) False Spontaneous processes always increase the entropy of the reacting system.

8) False All spontaneous processes release heat to the surroundings.

9) True An endothermic reaction is more likely to be spontaneous at high temperatures than at low temperatures.

10) Which of the following choices identifies the correct specific rate constant. The rate-law expression is: Rate = $k[NO]^2[H_2]$

$$H_2(g) + NO(g) \rightarrow N_2O(g) + H_2O(g)$$

Experiment	**Initial [NO]**	**Initial [H_2]**	**Rate of reaction**
1	0.30 M	0.35 M	2.835×10^{-3} M/s
2	0.60 M	0.35 M	1.134×10^{-2} M/s
3	0.60 M	0.70 M	2.268×10^{-2} M/s

a) 9.4×10^{-3}

b) 2.7×10^{-2}

c) 1.6×10^{-4}

d) 8.1×10^{-3}

e) 9.0×10^{-2}

12) Consider a chemical reaction involving compounds A and B, which is found to be first order in A and second order in B. At what rate will the reaction occur in experiment 2?

Experiment	Initial [A]	Initial [B]	Rate of reaction
1	1.0 M	0.20 M	0.10 M/s
2	2.0 M	0.60 M	? M/s

a) 1.2 M/s
b) 0.20 M/s
c) 0.60 M/s
d) 1.8 M/s
e) 0.36 M/s

The pressure on each of the following systems is increased by decreasing the volume of the container. Explain whether each system would shift in the forward direction, the reverse direction, or stay the same.

17) $2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g)$
Forward reaction is favored; there are fewer moles of gas on the product side.

18) $H_2(g) + I_2(g) \leftrightarrows 2HI(g)$
No change - same number of moles on each side.

19) $CaCO_3\ (s) \leftrightarrows CaO(s) + CO_2(g)$
The reverse reaction is favored; there are no moles of gas on the reactants side vs. one mole of gas on the product side.

Determine the pOH given the following values:

19) $[H^+] = 2 \times 10^{-8}$
pH= $-\log[2 \times 10^{-8}] - 14$ = pOH6.3

20) $[OH^-] = 5.1 \times 10^{-11}$
pOH= $-\log[5.1 \times 10^{-11}]$ = pOH10.3

Post-Test (Units 13-16)

Answer the following questions as they pertain to the answer key for Test 4

1) What is the importance of constructing a balanced equation for questions #1 and #2?

2) In question #4, the initial volume of air (11,000,000 L) is reduced to a smaller amount (873,015.9 L). How is this possible? What happened to the molecules of air?

3) Explain why question #7 is false:

4) Explain why question #8 is false:

5) The reactions identified in questions #17 and #18 both contain two moles of products. How is it possible that the increase of pressure within the container causes no change in equilibrium to occur with #18 but favors a forward reaction with #17?

6) What is the significance of subtracting 14 from the pH that was calculated within question #19?

Post-Test Answer Key

1) Without a balanced equation, it is not possible to calculate the molar ratios for the problems.
2) The molecules of air did not disappear; they were only pressed closer together due to the increased pressure. Pressure and volume are inversely related. As pressure increases, volume decreases and vice versa.
3) It is possible for a system to be releasing energy ($-\Delta H$) but not spreading out its energy within the system ($-\Delta S$) because the energy that is being released is being absorbed by its surroundings!
4) For a reaction to be spontaneous, ΔG must be negative. For an endothermic reaction, ΔH is positive, so $T\Delta S$ has to be positive and large enough for ΔG to be negative.

   When ΔS is positive, at high enough T, the value of $T\Delta S$ will be larger than ΔH, meaning the value for ΔG is negative. Therefore, ΔS must be positive and T relatively large for an endothermic reaction to be spontaneous.
   Chemistry is not driven by enthalpy change but by entropy change. Provided there is a large increase in entropy (i.e. gases produced from solids or many molecules from a small number of molecules) then endothermic reactions can be spontaneous.
5) In question #17 the forward reaction is favored because there are fewer moles of gas on the product side. There will be no change in no change in equilibrium within question #18 because there are fewer moles of gas on the product side than on the reactant side.

6) A solution cannot be both acidic and basic. Since both pH and pOH scales have a range of 0-14, either value can be calculated by using the following equation: pH + pOH = 14. Since the question asked for the pOH of the solution and you calculated the pH, it is necessary to subtract this value from 14 to determine the pOH.

1st Law of Thermodynamics	also known as "The Law of Conservation of Energy"; states that energy is never lost or gained, it only changes form
2nd Law of Thermodynamics	states that energy, if concentrated in an area, will spontaneously spread out unless a force keeps it from doing so
accuracy	how close a measured value is to the real value of the object
acid-base reactions	a chemical reaction similar to double displacement reactions; however, unlike double displacement reactions, water is one of the product
acidic solutions	solutions which contain a high concentration of acidic molecules
activation energy	energy required for a reaction to begin making a new product
alkali metals	elements within the first family of main block elements that are very reactive with other elements, flammable in air and water, have low melting and boiling points, are soft, have low densities, and contain 1 valence electron
alkaline earth metals	Second main block family of elements which react in air and water (but not as violently as the alkali metals), contain low melting and boiling points (but they are higher than the alkali metals), are soft (but harder than – you guessed it, the alkali metals), and have low densities (but higher than those of the alkali metals); alkaline earth metals all have 2 valence electrons
anion	a negatively charged ion
atomic mass	the average mass of an element and all of its isotopes

atomic mass unit (amu)	the mass of one proton (1.66 x 10^{-27} kg) which are used to determine the overall atomic mass of an element
atomic number	the total number of protons in the nucleus of an atom
atomic radius	a measurement of the relative length of an atom from its nucleus to its outermost orbital
atoms	tiny particles that make up the universe
base units	basic metric units such as seconds (time), meters (length), kilograms (mass/weight), liters (volume), Pascals (pressure), and Kelvin (temperature)
basic solutions	solutions which contain a high concentration of basic molecules
boiling	transition from a liquid phase to a gas phase
boiling point elevation	colligative property of a solution; as you increase the concentration of a solution (by adding solute into a solvent), the boiling point of the solution increases as well
bonding pair	a shared pair of electrons between covalently bonded atoms
boron family	third main block family of elements which contain mostly metals with the exception of boron itself, which is a metalloid; boron family elements all have 3 valence electrons
Boyle's law	gas law which states that as a gas goes through some kind of change, the product of its initial pressure and volume (P_1V_1) will equal the product of its final pressure and volume (P_2V_2)
Brønsted-Lowry method	method of identifying acids from bases in that acids are compounds that give H^+ ions while bases are the compounds that accept these H^+ ions

calorie	standard unit of energy
carbon family	fourth main block family of elements which are made up of metals, metalloids, and non-metals (of which carbon is a non-metal); elements in the carbon family have 4 valence electrons
cation	a positively charged ion
Charles's law	gas law which states as you increase the temperature of a gas, its volume increases too
chemical reactions	processes in which the atoms within reactants are rearranged to form new compounds (products)
coefficient	the number used within scientific notation between 1 and 9.9 to be multiplied by an exponent
coefficients	a number placed in front of a compound to identify how many compounds (as a whole) exist
colligative properties	properties of solutions that depend upon the amount of solute dissolved in a solution; boiling and melting points, osmotic pressure, and electrical conductivity are examples of colligative properties
collision theory	the speed in which a chemical reaction takes place is based solely on how hard the reactants slam into each other and the directions they are traveling
combined gas law	gas law which combines all of the relationships which exist between the Boyle, Charles, and Gay-Lussac gas laws
combustion reaction	a chemical reaction in which a compound containing carbon and hydrogen combines with oxygen gas; the products formed are heat, water, and carbon dioxide
compounds	pure substances that are made up of 2+ <u>different</u> atoms (or molecules) that are bonded together

concentration	the amount of solute we place into a solution
condensation	transition from a gas phase to a liquid phase
conjugate acids and bases	Additional discovery by Brønsted-Lowry; states that weak acids always form strong conjugate bases and vice versa; and, strong acids always form weak conjugate bases and vice versa
conversion factor	a shortcut that can be used to help with your conversion
covalent bond	a bond between two non-metals in which both atoms share one or more electrons
critical point	position on a phase change diagram where a substance can act like both a gas and a liquid
crystals	ordered arrangements of ions
Dalton's Law of Partial Pressures	the total pressure of a mixture of gases equals the sum of its individual partial pressures
decomposition reaction	the opposite of a synthesis reaction; a chemical reaction in which one large reactant is broken down into two or more smaller products
dimensional analysis	a method of converting one unit into another unit through the use of conversion factors
double bond	two pairs of covalently bonded electrons (4 electrons total)
double displacement reaction	a chemical reaction in which the cations of two compounds exchange places with each other
ductile	can be drawn into wires
effective molality	a measurement of the number of moles of solute per kilogram of solvent
electrolyte	a solution of dissolved ions

electromagnetic waves	energy which is released from an oscillating electron
electron affinity	the relative strength of an atom's charge
electron configuration	a method of describing electron orbitals
electron dot structure	graphical method of describing the number of valence electrons that surround an atom; contains up to eight dots surrounding the chemical symbol of an element
electronegativity	a measurement of how much an atom can pull electrons away from other atoms
elements	close to 120 unique atoms, each of which containing its own physical and chemical characteristics
empirical formulas	formulas which tell you the ratios of elements to each other within a compound
endothermic	chemical reaction which absorbs energy
endothermic reactions	chemical reactions that tend to absorb more energy than the energy released by its products
endpoint	the point in which the color change within a titration begins to appear
energy level diagram	visual tool used to identify how to write out the electron configurations of elements
energy levels (orbitals)	layers around a nucleus which contain specific numbers of electrons
enthalpy	the total amount of heat a molecule contains
entropy (ΔS)	a measure of the amount of energy that spreads throughout the surroundings of a system
equilibrium	time within a reversible reaction (system) where the forward and reverse reactions will take place at the same rate

equivalence point	the point in which the volume of acid equals the volume of base during a titration
exothermic	chemical reaction which gives off energy
exothermic reactions	a reaction in which the amount of energy absorbed by the reactants is less than the energy released by the products
exponent	a factor of ten; used within scientific notation to represent large or small numbers.
families (groups)	vertical rows within the periodic table
free energy (ΔG)	the amount of energy that is available by a system to do some form of work
freezing	transition from a liquid phase to a solid phase
freezing point depression	colligative property of a solution; solutions freeze at lower temperatures than pure solvents because the extra solute molecules "get in the way" of the solvent molecules
frequency	the rate of oscillations within electromagnetic waves
Gay-Lussac law	gas law which states that as you increase the temperature of a gas, its pressure goes up too
general rate law	used to help to determine how the rate of reaction varies as the reaction progresses; for a chemical reaction that follows a simple formula like $A + B \rightarrow C$ looks like this: $\text{Rate} = k[A]^x[B]^y$
grid method	method of adding coefficients to balance a chemical equation; uses a table to count the number of atoms within the reactants and the products in a reaction
halogens	seventh main block family of elements which are non-metals, are very reactive (much like the alkali metals), and each contain 7 valence electrons

heat	the movement of energy from one thing to another through the motion of molecules
heat of formation (ΔH^0_f)	the change in enthalpy when a compound is formed from its elements
heat of reaction (ΔH_{rxn})	the change in enthalpy during a chemical reaction
heterogeneous mixtures	combination of two or more different kinds of atoms that are easy to separate (mixtures are not bound together)
homogenous mixtures (solutions)	combination of two or more different kinds of atoms that are not easy to separate (mixtures are not bound together)
ideal gas law	gas law which utilizes a fictional "gas" that obeys specific rules when kept at a constant volume, temperature, and/or pressure
indicators	chemical compounds that changes color in the presence of acids or bases
ion	an atom that has gained or lost one or more electrons
ionic bond	a bond between a metal cation and a non-metal anion in which one of the ions steals one or more electrons from the other, thus creating a magnetic bond between the two oppositely charged ions
isotope	an element which contains a different amount of neutrons despite having the same number of protons.
joule	metric unit of energy
Kelvin scale	temperature scale which sets its zero degree (0°) at the most extreme measurement known as absolute zero
kinetics	the study of the rates of chemical reactions and

	explains how we can speed them up
Law of Conservation of Matter	law of chemistry which states that matter cannot be created or destroyed, only rearranged into different positions
Le Châtlier's principle	principle which states that whatever changes are done to a reaction in equilibrium, the equilibrium will change to accommodate whatever was altered
Lewis structure	very similar to the electron dot structure; however, these drawings depict the valence electrons in lone pairs as dots and contain lines to represent shared pairs in a chemical bond (single, double, triple, etc.)
limiting reagent (reactant)	the reactant that runs out first within any chemical reaction
litmus paper	pH indicator which turns red in the presence of an acid and blue in a base
main block elements	eight families within the periodic table which contain similar chemical characteristics; alkali metals, alkaline earth metals, boron family, carbon family, nitrogen family, oxygen family, halogens, and noble gases
malleable	able to be pounded into sheets
mass number	the sum of the protons and neutrons within an atom
melting	transition from a solid phase to a liquid phase
metallic bond	the force of attraction between two or more metal nuclei which are surrounded by a sea of electrons
metalloids	elements found between the metals and non-metals on the periodic table which share the properties of both these types of elements
metals	the majority of elements which are typically hard, shiny, malleable, ductile, good conductors of heat and

	electricity, and have high densities, melting points, and boiling points
MINOH	method used to add coefficients to the type of particles within the equation for it to be balanced; follows a path by which metals are balanced first, followed by ions, non-metals, oxygen, and hydrogen
mixture	combination of 2+ atoms that are <u>not</u> bonded together
molar mass	sum of all atomic masses of elements within a compound
molarity	measuring scale used to determine the concentration of a solution
mole (Avogadro's number)	a conversion factor for anything in the universe which contains 6.02×10^{23} items
mole ratio	a conversion factor that exists between the moles of the product and reactants from the chemical equation; can be identified as the coefficients for the known and unknown compounds
molecular formulas	formulas which contain how many of each type of atom are present within a compound
molecule	combination of 2+ atoms that are bonded together
monatomic ions	ions which contain only one kind of atom
nitrogen family	fifth main block family of elements which are made up of metals, metalloids, and non-metals (nitrogen itself is a non-metal); elements in the nitrogen family have 5 valence electrons
noble gases	eighth main block family of elements which are the least reactive elements on the periodic table and each contain 8 valence electrons
non-metals	elements that are typically brittle, poor conductors of

	heat and electricity, have a very low density, have lower melting and boiling points, and are <u>gases</u> at room temperature
nonpolar molecule	phenomenon in which the electrons within a molecule are spread evenly throughout its structure; no single atom within the molecules "pulls" on its electrons with a greater force due to their similar electronegativity
non-spontaneous processes	any process that requires some form of effort to make it occur
nucleus	the center of an atom which contains its protons and neutrons
octet rule	the phenomenon by which all elements move towards the filling their eight possible positions within their outermost s and p orbitals with electrons
osmosis	the movement of a fluid across a semipermeable membrane
osmotic pressure	the pressure which needs to be applied to a solution to keep water from moving across a semipermeable membrane
oxygen family	sixth main block family of elements which are made up of metals, metalloids, and non-metals (of which non-metal is a non-metal); this family is quite reactive with other elements (their reactivity is comparable to the alkaline earth metals); elements in the oxygen family have 6 valence electrons
percent composition	the total amount (by mass) of each element within a compound
percent error	the accuracy of a measurement as determined by the difference between the accepted measurement and the experimental measurement divided by the

	accepted measurement and multiplied by 100.
percent error	procedure used to measure how much error exists within a chemical reaction
periods	horizontal rows within the periodic table
pH/pOH scales	two different scales (between the values 0-14) which were created to calculate the concentrations of H^+ or OH^- ions in solution
phase change diagram	a graph which depicts the phase change of a pure substance or mixture over time as either pressure or temperature is changed
phases	the three states of matter – solid, liquid, and gas
phenolphthalein	pH indicator which is a clear liquid while in the presence of an acid but turns pink when mixed with a base.
polar molecule	phenomenon in which one of the atoms within a molecule "pulls" on its electrons a little stronger than the other atom(s) that are bonded together
polyatomic ions	molecules which have gained or lost some of their electrons and have turned into ions
precipitate	solid product formed from the chemical reaction between two liquid reactants
precision	how close a series of measurements are to each other
pressure	the force of gas molecules hitting the sides of the container in which they are stored
products	compounds that are created from the reaction between reactants
pure substances	mixtures that cannot be physically separated very easily at all
quantum	branch of science in which scientists study the

mechanics	measurable (quantifiable) movements of atoms within orbitals
reactants	compounds which react together to form products
reaction orders	exponents (x and y) within a general rate law (Rate = $k[A]^x[B]^y$); used to define how the rate is affected by the reactant concentration
relative abundance	a measured percentage of each element that exists in nature was determined
salts	products of an ionic bond
saturated solution	a solution that is <u>not</u> able to dissolve more solute
scientific notion	method of writing large and small numbers in shorthand using a system of coefficients (1-9.9) multiplied by exponents by factors of 10. For example, 1224578 would be written as 1.224578×10^6
sea of electrons	a free-flowing collection of electrons surrounding a group of metal ions which act to force these positively charged ions together
semipermeable membrane	any "barrier" that will allow solvents (like water) to move through them
shielding effect	the phenomenon by which the inner electrons of an atom act as a shield between the nucleus and the valence electrons which lowers the electronegativity of the atom
significant figures (numbers)	any digits that give us some amount of precision about a set of data
single bond	a single pair of covalently bonded electrons (2 electrons total)
single displacement	a chemical reaction in which a single element switches places with another element in a chemical compound.

reaction	
solubility	the ability of a solute to be dissolved by a solvent
specific heat (heat capacity)	amount of energy needed to heat a substance by 1°C
spontaneous processes	any naturally occurring actions that exist without the addition of any extra energy
stoichiometry	the process of calculating the amount of reactants we need for a certain amount of product
STP	"standard temperature and pressure" which is considered to be 273°K (0°C) and 1.00 atm
subatomic particles	protons, neutrons, and electrons
subscripts	the numbers written after individual atoms that identify how many atoms of that element exist within the molecule
supersaturated solution	a solution that has dissolved more solute than it naturally should be able to contain
surroundings	the environment that surrounds systems (chemical reactions)
Svante Arrhenius	discovered that acids are compounds that give off H^+ ions when dissolved in water and bases are those which give off hydroxide ions OH^- when dissolved in water
synthesis reaction	chemical reaction in which two or more reactants combine to form a more complicated molecule
system	name given to chemical reactions and its energy transfer(s)
temperature	a measurement of the amount of energy found within molecules
temperature	the measure of energy found within an object after

	heat has been transferred
thermodynamics	the study of energy; more specifically, how energy is stored within molecules, how it can be transferred from one substance to another, and how this process is able to produce heat
titration	a method used to neutralize an acid or a base (bring to pH of 7)
transition state	the point in which a reaction begins to make a new product
triple bond	three pairs of covalently bonded electrons (6 electrons total)
triple point	single position on a phase change diagram where a substance can be either a solid, liquid, or gas
unsaturated solution	a solution that is able to dissolve more solute
valence electrons	electrons that make up the outermost s and p orbitals
Van der Waals	weak forces which hold covalent bonds together
vapor pressure	pressure which exists between water molecules in a liquid phase
volume	the amount of space in which a fluid is enclosed

Credits

Chapter Number/Artist URL

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10	http://www.sxc.hu/browse.phtml?f=view&id=724160
11	http://www.sxc.hu/browse.phtml?f=view&id=1066564
12	http://www.sxc.hu/browse.phtml?f=view&id=1156735
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31	http://www.sxc.hu/browse.phtml?f=view&id=724160
32	http://www.sxc.hu/browse.phtml?f=view&id=182229
Cover	http://www.sxc.hu/browse.phtml?f=view&id=484010