Dual Enrollment Chemistry 105/109

Welcome to CMC Dual Enrollment Chemistry 105/109 Basic mathematical/ algebra skills are required to be successful in this course. The focus of the course is to allow you the opportunity of attaining dual enrollment credit through Nicholls State University. This means that you will not only be enrolled at your respective high schools, you will also be enrolled as a Nicholls State University student. Dual enrollment credit provides you with a multitude of opportunities. At the high school level, you will receive an extra quality point if you are dual- enrolled. What this means is that earning a "B" in a dual enrollment course will give you the same quality point value as an "A" in traditional courses (earning a "C" would act as a "B" in other regular courses, etc.) Students enrolled in a dual enrollment curriculum can graduate with a GPA well above a 4.0 upon graduation bettering your chances to receive specific scholarships as you prepare for college. In addition to the extra quality point, you will receive 3 hours of college credit. Chemistry 105 is the first of 3 consecutive chemistry courses typically required by most universities. Even if you don't attend Nicholls State University, the credit that you earn at the CMC is transferrable to most universities. The advantages of earning college credit as a high school student are multifaceted. These courses may allow you the opportunity of graduating a semester (or full year) early. OR…. if you wish to remain on a traditional 4 year college track, you can reduce the number of hours that you take each semester so that you can pursue outside employment to defray the cost of college tuition or to simply enjoy the numerous extra-curricular activities that your prospective universities offer. Regardless of your motive, it is a win-win situation. With dual enrollment you will receive an actual grade earned that will appear on an official NSU transcript, which means you are considered an official college student. ☺

In your senior year, you have the option of completing the remainder of the College Freshmen Chemistry courses by enrolling in Chemistry 106 and Chemistry 110. Chemistry 106 covers more advanced chemistry topics while Chemistry 110 is the laboratory component of Chemistry 105 and 106. Completion of these courses at the CMC will give you a total of 8 credit hours of college chemistry. For many of you, these three courses will be all that you need for the completion of science electives for your college degree. For those going into a science related field, you will be ready to tackle your sophomore level chemistry courses (Organic chemistry).

You must also sign in to Moodle. Go to LPSD homepage. Click on More → Students → Moodle → Career Magnet Center → Chemistry 105 → enrollment key → acole227 → enroll me. If you leave me a message under "post a question or concern", I'll give you 2 bonus points on your first test.

If you have any questions for me over the summer, you can enroll in my summer remind messages. Follow the link: https://www.remind.com/join/ch2018em to enroll. Or text **@ch2018em** to the number 81010. This is only for summer questions. I will have you enroll into another class in August.

You will be provided a workbook for class. Bring in a 1.5 – 2 inch 3-ring binder to hold your workbook and bring your calculator to class everyday. You will also have to pay a $15.00 dollar lab fee to cover the cost of chemicals for lab investigations.

There are two summer assignments for you to complete in order to prepare for this course. You must first print this packet; then read and highlight information that you feel is important in each reading passage. You will then need to answer the questions that follow. The questions will be turned in to me on the first day of school. Also, come to class prepared with loose-leaf paper in a 2-inch 3 ring binder. I look forward to seeing all of you in August and hope to have a fantastic year ahead.

Anna Cole

…. Continuous effort- not strength or intelligence- is the key to unlocking our potential….. Liane Cordes

Read each passage highlighting what you feel is important to study further for test purposes. ***These ARE your notes for the first test.*** *Then answer the corresponding questions that follow each assignment. Be prepared to turn these in to me the first day of class.*

Assignment # 1

Introduction

Probably the most important idea in all scientific knowledge is this: **the properties of matter are determined by the properties of atoms and molecules.** Atoms and molecules determine how matter behaves as we observe it in nature- any change/ rearrangement of atoms would involve a change in the properties of matter that we observe. The understanding of matter at the molecular level gives us unprecedented control over it.

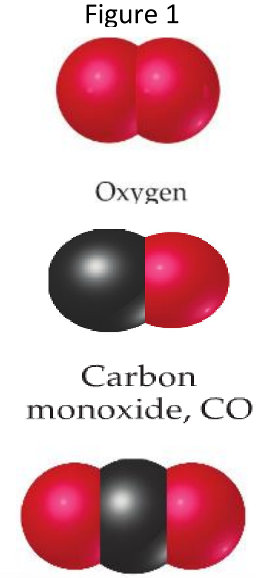
Atoms and Molecules

The air over most U.S. cities contains at least some pollution. A significant component of that pollution is *carbon monoxide*, a colorless gas emitted in the exhaust of cars and trucks. Carbon monoxide gas is composed of carbon monoxide *molecules*, each of which contains a carbon atom and an oxygen atom held together by a chemical bond. **Atoms** are the submicroscopic particles that constitute the fundamental building blocks of matter. Free atoms are not common however in nature; instead they are mostly bonded together in specific geometric arrangements to form **molecules**.

Properties of substances depend on the atoms and molecules that compose them; so the properties of carbon monoxide gas depend on the properties of carbon monoxide *molecules*. Carbon monoxide molecules happen to be just the right size and shape, and happen to have just the right chemical properties to fit neatly into cavities within the hemoglobin molecule - the oxygen-carrying molecule in blood- that normally carries oxygen. Notice the similarities between carbon monoxide and oxygen in Figure 1. Consequently, carbon monoxide diminishes the oxygen carrying capacity of blood. Breathing air containing too much carbon monoxide can lead to unconscientiousness and even death because not enough oxygen reaches the brain. Carbon monoxide deaths have occurred, for example, as a result of running an automobile in a closed garage or using a propane burner in an enclosed space for too long. In smaller amounts, carbon monoxide causes the heart and lungs to work harder and can result in headaches, dizziness, weakness, and confusion.

Cars and trucks emit another closely related molecule, called carbon dioxide, in far greater quantities than carbon monoxide. The only difference between carbon dioxide and carbon monoxide is that carbon dioxide molecules contain two oxygen atoms instead of one. This extra oxygen atom dramatically affects the properties of the gas. Carbon dioxide is found naturally in the atmosphere and is a product of our own respiration. However it does not kill us. Why? Because the presence of the second oxygen atom prevents carbon dioxide from binding to the oxygen-carrying site in hemoglobin, making it far less toxic. Although high levels of carbon dioxide (greater than 10% of air) can be toxic for other reasons, lower levels can enter the bloodstream with no adverse effects. Such is the molecular world. Any change in a molecule- such as the addition of an oxygen atom to carbon monoxide- will likely alter the properties of that substance and change its properties as we observe them in nature. If we want to understand the substances around us, it is imperative that we understand the atoms and molecules that compose them – this is the central goal of chemistry. Consequently, ***chemistry*** can be described as a science that seeks to understand the behavior of matter by studying the behavior of atoms and molecules.

Figure 1



Carbon dioxide

The Classification of Matter

Matter can be defined as anything that occupies space and has mass. We can classify matter according to its state- solid, liquid, or gas- and according to its composition.

Matter can exist in three different **states**. In the solid state, particles are packed close to each other in a fixed location vibrating back and forth. Although the particles are moving, they cannot move past each other. Consequently, solids have a fixed volume and rigid shape. Solids can be **crystalline or amorphous.** Atoms in a ***crystal*** are arranged in a repeating order or pattern, whereas **amorphous** solids do not have any order at all. Examples of crystalline solids include *table salt* and *diamond*. Amorphous solids include *glass* and *plastics*. Another distinction between the two is that crystals have one defined melting point; however amorphous solids tend to occur over a range of temperatures.

In the liquid state, atoms and molecules are a little further apart than in the solid state, but they are free to move relative to each other, giving liquids a fixed volume but not a fixed shape. They will instead take on the shape of its container.

In the gaseous state, particles have very little attraction to each other allowing the particles to exist independently from one another. These particles have a lot of space between them allowing them to be *compressed*. When you squeeze a balloon or sit down on an air mattress, you are forcing the particles in a smaller amount of space, so that they are closer together or compressed. Liquids and solids are not compressible because their molecules are already so close together. Gases always assume the shape and volume of their container.

Classifying Matter According to Its Composition: Elements, Compounds, and Mixtures

In addition to classifying matter according to its state, we can classify matter according to its composition, i.e., the kinds and amounts of particles that compose it. **Pure substances** are composed of one type of atom or molecule whose composition does not vary. Pure substances can be categorized into two types- **elements** and **compounds**- depending on whether they can be broken down into simpler substances. Elements are substances that are made from the same type of **atom** and cannot be broken down into simpler substances. A listing of the elements is located on the periodic table. Very few of these elements are found in their pure state. Elements have a natural tendency to bond to other elements in a fixed ratio to form millions of different compounds. Since compounds are a made of two or more elements chemically bonded, they can be broken down into simpler substances. On earth, compounds are much more common than elements. The composition of both elements and compounds is constant and does not change from one sample to another regardless of how big or small the sample size is. Distilled water is considered a compound because it contains only H_2O molecules regardless amount. In pure water, the ratio of hydrogen to oxygen in the molecule is always 2 hydrogen atoms to 1 oxygen atom. Any other ratio would result in a completely different compound with different observable properties. A water molecule that would have one additional oxygen atom becomes hydrogen peroxide, H_2O_2. All elements and compounds are **homogeneous**, which means that their visible properties are uniform throughout the sample. In other words, we don't see different parts; we only see one distinct set of properties.

In contrast, the composition of something like sweetened tea can vary considerably from one sample to another, depending on the strength of the tea or the amount of sugar that has been added. Sweetened tea is an example of a **mixture**, a substance composed of two or more different types of atoms or molecules *not chemically bonded* that be combined in varying proportions. Mixtures can be categorized into two types – **heterogeneous** or **homogeneous** depending on *how* the substances within them are mixed. Mixtures in which one substance is uniformly distributed throughout another substance are referred to as homogeneous mixtures. As is the case with elements and compounds, when the particles of a mixture are uniformly dispersed on a microscopic level, the properties as we see them on our level (the macroscopic level) are uniform throughout the sample. For example, sweetened tea is an example of a homogeneous mixture. On our level, we see the same properties throughout the sample (assuming there is no ice or sugar on the bottom). This is because the particles on a microscopic level are evenly distributed. Muddy water is an example of a heterogeneous mixture. In heterogeneous matter, we often see different parts to the substance since its particles are not uniformly distributed.

Homogeneous mixtures are called **solutions**. A ***solution*** is formed when one or more substances are dissolved in another substance creating a uniform mixture. Tap water is actually a solution containing many dissolved ions that are uniformly dispersed. As a result, its macroscopic properties are uniform. Some of the most important solutions in chemistry are those dissolved in water. Solutions in which water acts as the *solvent* are known as ***aqueous*** solutions. Water is often referred to as the universal **solvent** since it dissolves so many substances. The substance that is being dissolved *in* the solvent is referred to as the ***solute***. Salt water is just one of many types of aqueous solutions.

It is easy to consider something like salt water as a solution. What is not so easy to fathom is that when you are looking at 10 karat gold or 14 karat gold, you are also looking at a solution. Only 18 karat gold is considered pure gold which consists of a single type of atom. 14 karat or 10 karat gold is a mixture of several metals but yet is homogeneous to the naked eye. Because it is a homogeneous mixture, we can call it a solution. Mixtures of metals are known as alloys. **Alloys** are formed when pure metals such as zinc and copper are melted above their melting point then mixed uniformly. The resulting mixture is then cooled leaving an alloy with slightly different physical properties compared to the metals from which they are made. This alloy (brass) is now a homogeneous mixture as it appears to us. Therefore we consider it to be a solution. All alloys are consequently considered solutions. The atmosphere is also considered a solution since it is a mixture of many gases with uniform properties throughout.

In summary, the properties of matter that are observed macroscopically are determined by the atoms and molecules that compose it. Heterogeneous mixtures are easy to identify due to the different properties exhibited by the mixture. However when viewing homogeneous matter macroscopically, it could actually be one of three things: it could be an element (listed on the periodic table), it could be a compound (which is represented by a chemical formula) or a mixture in which the particles are evenly dispersed (solution).

Physical and chemical changes

Every day we witness changes in matter: ice melts, iron rusts, gasoline burns, fruit ripens, and water evaporates. What happens to the molecules that compose the samples of matter during such changes? The answer depends on the type of change that is occurring. Changes that alter only the state or appearance but not the composition of matter are *physical* changes. The atoms or molecules that compose the substance do not change their identity during a physical change. For example, when water boils, it changes its state from liquid to a gas, but the gas is still composed of water molecules.

In contrast, changes that alter the composition of matter are chemical changes. During a chemical change, atoms rearrange, transforming the original substance into a completely different substance with completely different properties. For example, the rusting of iron is a chemical change. The atoms that compose iron combine with oxygen molecules from air to form iron oxide (Fe_2O_3), the orange substance that we normally call rust.

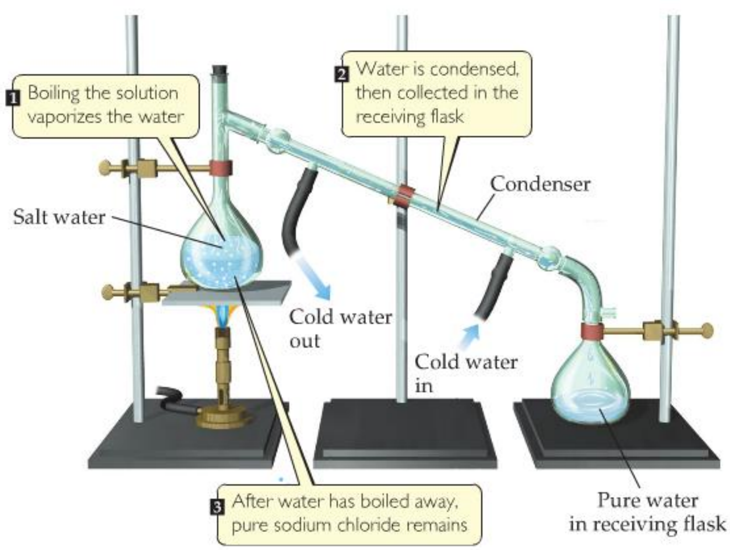
The differences between physical and chemical changes are not always apparent. Only chemical examination can confirm whether any particular change is physical or chemical. In many cases, however, we can identify chemical and physical changes by keeping a few things in mind. Changes in the state of matter, such as melting or boiling, or changes in the physical condition of matter, such as those that result from cutting or crushing, are typically physical changes. Changes involving chemical reactions are often evidenced by heat exchange or color changes.

The properties of matter can also be classified as chemical or physical. A ***physical property*** is one that a substance displays without changing its composition, whereas a ***chemical property*** is one that a substance displays *only* by changing its composition through a chemical change (chemical reaction). For example, the smell of gasoline is a physical property- gasoline does not change its composition when it enters the gaseous state (substances must be in the gaseous state to exhibit odor). The only change that occurs as gasoline vaporizes is in the spacing between the molecules - they are farther apart. The flammability of gasoline, however, is a chemical property – gasoline does change its composition when it burns, turning into completely new substances (primarily carbon dioxide and water). Physical properties include odor, taste, color, appearance, melting point, boiling point, and density. Chemical properties include corrosiveness, flammability, acidity, and toxicity.

Separating mixtures

Compounds can only be separated (broken down) by chemical reactions. However, since a mixture is merely a physical combination of two or more substances each retaining their own properties, they can easily be separated by physical processes. For example, a heterogeneous mixture of iron filings and gold filings could be sorted by color into iron or gold. Or if the filings are very small, we can take advantage of the magnetic properties of iron and simply pass a magnet over the sample. Two other very common methods of separating mixtures in lab are filtration and distillation. When two substances are insoluble in one another (like sand and water), we can use a process of **filtration** to separate the components. Preparing coffee is a very common usage of filtration as the insoluble coffee grinds remain in the coffee filter allowing the aqueous part to pass through. The aqueous component passing through the filter paper is referred to as the *filtrate*. The solid component remaining on the filter paper (coffee) is referred to as the *residue*. However when two substances are soluble in one another such as salt in water, or isopropyl alcohol in water (which is what we refer to as rubbing alcohol) we can separate the components based on differences in their boiling points. This process is called **distillation**. When we boil salt water, water will vaporize leaving the salt behind since salt's boiling point is much higher than is water's. The water vapor is then converted back (condensed) to the liquid state and re-collected. The substance collected is referred to as the ***distillate***. See Figure 2. If we distill rubbing alcohol, the isopropyl alcohol will vaporize first since it has the lowest boiling point and can likewise be condensed and collected. Distilled water is simply distilled tap water. When tap water is distilled, the dissolved ions and any impurities present are left behind while only the pure H_2O molecules are vaporized, condensed and then collected.

Figure 2



The following pages will be turned in the first day of school: ***Name:______________________________***

Use the passages to answer the following questions: (Note: although I have no objection to discussions between classmates, make SURE that this is your work and not copied from another student)

1. According to the reading passage, what is chemistry?____

   ____

2. What is the difference between an atom and a molecule?____

   ____

   ____

3. What is the formulas for carbon monoxide and carbon dioxide? How does the name of these compounds relate to their chemical formulas?

   ____

   ____

   ____

4. Compare and contrast the properties of carbon monoxide and carbon dioxide. Use a Venn Diagram to show similarities and differences.

5. Why is carbon monoxide considered a deadly gas?____

   ____

   ____

6. Why do liquids have no definite shape but a definite volume?____

   ____

   ____

7. What is the meaning of compression? Why are gases compressible whereas solids and liquids are not?

   ____

   ____

   ____

8. What is the difference between a crystalline substance and an amorphous substance. Give examples.

   ____

   ____

   ____

   ____

9. What are the two types of pure substances?____

   What is the difference between homogenous and heterogeneous matter?_______________________________

10. What is a homogeneous mixture commonly referred to as?____

11. What is the difference between the solute in a solution and the solvent?

12. In a salt water solution, what is the solute and what is the solvent?_______________________________________

13. A solution in which water is the solvent is referred to as what type of solution?_____________________________

14. What is an alloy and why is it considered a solution?____

15. Research 3 other common alloys not mentioned in the reading passage along with the metals from which they are made. ____

    Citation of source:____

16. How could we visually ascertain whether a substance is homogeneous or heterogeneous?___________________

17. What products are formed when gasoline burns?____

18. Distinguish between a physical change and a chemical change.____

19. What are examples of physical properties?____

20. What are examples of chemical properties?____

21. Classify each of the following as a pure substance (P) or a mixture (M). If it is a pure substance, classify as an element (E) or compound (C). If a mixture, indicate whether it is homogeneous or heterogeneous.

substance	Pure substance (P) Mixutre (M)	If pure substance, classify as element (E) or compound (C) If mixture, classify as homogeneous or heterogeneous
A. sea water		
B. magnesium		
C. crushed ice		
D. air		
E. tomato juice		
F. iodine crystals		
G. sand		
H. 10 karat gold		
J. bronze		
K. Sweat		
L. aluminum		
M. carbon dioxide		
N. vegetable soup		
O. iron		
P. beef stew		
Q. hydrogen peroxide		
R. apple juice		
S. coffee		
U. carbon		

22. State whether each of the following are chemical (C) or physical (P).
    a. ______Evaporation of rubbing alcohol
    b. ______Burning of lamp oil
    c. ______The bleaching of hair with hydrogen peroxide
    d. ______The formation of frost on a cold night
    e. ______A copper wire is hammered flat
    f. ______A nickel dissolves in acid to form a blue-green solution
    g. ______Dry ice sublimes (changes into a gas) without melting
    h. ______A match ignites when struck on a flint.
23. Rubbing alcohol is a mixture of isopropyl alcohol (boiling point = 82.6°C) and water. Describe a way to separate the alcohol from the water using content specific vocabulary.
    ____
    ____
    ____
24. Suggest a method of separating sugar and sand (I have provided 4 steps. Use as many or as few as you need)
    Step 1: ____
    Step 2: ____
    Step 3: ____
    Step 4:____
25. You need to separate a mixture of sand and water. What would be considered the filtrate and what is considered the residue?
    ____
    ____
    ____
26. According to the passage, how could you define condensation?___________________________
    ____
27. You have a mixture of iron filings, ground chalk ($CaCO_3$) and salt. Devise a plan to separate each component using proper vocabulary as described in the reading passage. Note: I have numbered 6 steps. Use as many or as few as necessary.
    Step 1: ____
    Step 2: ____
    Step 3: ____
    Step 4: ____
    Step 5: ____
    Step 6: ____

28. In the process of attempting to characterize a substance, a chemist makes the following observations: The substance is a silvery white, lustrous metal. It melts at 649°C and boils at 1105°C. Its density at 20°C is 1.738 g/mL. The substance burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into then sheets or drawn into wires. It is a good conductor of electricity. Which of these characteristics are physical properties, and which are chemical properties?
    Chemical: ____
29. Physical: ____

    ____

30. Label each of the following as either a physical process (P) or a chemical (C) process:
    A. ______rusting of a metal can
    B. ______boiling a cup of water
    C. ______pulverizing aspirin
    D. ______digesting a candy bar
    E. ______exploding of nitroglycerin
31. A match is lit and held under a cold piece of metal. The following observations are made:
    A. the match burns
    B. the metal gets warmer
    C. water condenses on the metal
    D. soot (carbon) is deposited on the metal
    Which of these occurrences are due to physical changes and which are chemical?
    Physical: ____
    Chemical: ____

32. Several properties of isopropyl alcohol (rubbing alcohol) are listed. Classify each property as physical or chemical.
    A. colorless
    B. liquid at room temperature
    C. mixes with water (soluble)
    D. flammable
    E. density = 0.79 g/mL
    Physical: ____
    Chemical: ____
33. Several properties of ozone (a pollutant in the lower atmosphere, but part of a protective shield against UV light in the upper atmosphere are listed.) Which properties are physical and which are chemical?
    A. bluish color
    B. pungent odor
    C. very reactive
    D decomposes on exposure to ultraviolet light
    E. gas at room temperature
    Physical: ____
    Chemical: ____

34. Classify each property as physical (P) or chemical (C)

A. ______the tendency of ethyl alcohol to burn

B. ______the shine (luster) of silver

C. ______the odor of paint thinner

D. ______the flammability of propane gas

E. ______the boiling of ethyl alcohol

F. ______the temperature at which dry ice evaporates

G. ______the tendency of iron to rust

H. ______the color of gold

i. ______natural gas burns on a stove

j. ______the liquid propane in a gas grill evaporates because the user left the valve open

k. ______the liquid propane in a gas grill burns in a flame

l. ______a bicycle frame rusts on repeated exposure to air and water

m.______ sugar burns when heated on a skillet

n. ______sugar dissolves in water

o. ______a platinum ring becomes dull because of continued abrasion

p. ______a silver surface becomes tarnished after exposure to air for a long period of time.

Assignment # 2

The Scientific Approach to Knowledge

Scientific knowledge is empirical- that is it is based on *observation* and *experiment*. Scientists observe and perform experiments on the physical world to learn about it. Some observations and experiments are qualitative, but many are quantitative (depend on measurements). Observations often lead a scientist to formulate a **hypothesis**, a tentative explanation of the observation. A good hypothesis is falsifiable, which means that it makes predictions that can be confirmed or refuted by further observations. Hypotheses are tested by **experiments**. Experiments are highly controlled procedures designed to generate observations that can confirm or refute the hypothesis. If the hypothesis is proven wrong, it must be modified or discarded.

In some cases, a series of similar observations can lead to the development of a **scientific law**, a brief statement that summarizes past observations and predicts future ones. Laws describe *how* nature behaves – they are generalizations about what nature does. We often refer to laws are being factual – they describe how matter behaves regardless of the circumstances. However, in some cases, a good hypothesis may form the basis of a scientific **theory**. A theory is a model describing the way nature is and tries to explain *why* nature behaves a certain way (rather than merely telling us how nature behaves). Well established theories are the pinnacle of scientific knowledge, often predicting behavior far beyond the observations or laws from which they were developed. Theories are validated by experiments; however they can never be conclusively proven because some new observations or experiment always has the potential to reveal a flaw. Each new set of observations has the potential to refine the original model. In fact, the more a theory is refined or modified, the more faith that we have in it. The approach described here is called the **scientific method**. Over time, poor theories are eliminated or corrected and good theories that are consistent with experimental results will remain. Established theories with strong experimental support that have stood the test of time and experimentation are the most powerful pieces of scientific knowledge. You may have heard the phrase, "That is just a theory," as if theories are easily dismissible. Such a statement reveals a deep misunderstanding of the nature of a scientific theory. Well established theories are as close to truth as we get in science. The idea that all matter is made of atoms is "just a theory", but it has over 200 years of experimental evidence to support it. It is a powerful piece of scientific knowledge on which many other scientific ideas have been built.

The Units of Measurement

Chemistry is a quantitative science – that is it is based on measurements. All measurements consist of a *number* and a *unit*. In 1999, NASA lost the $125 million dollar Mars Climate Orbiter because of confusion between English and metric units. The chairman of commission that investigated the disaster concluded, "The root cause of the loss of the spacecraft was a failed translation of English units into metric units." As a result, the orbiter- which was supposed to monitor weather on Mars- descended too far into the Martian atmosphere and burned up. In chemistry, as in space exploration, units – standard quantities used to specify measurements- are critical. If you get them wrong, the consequences can be enormous.

The two most common unit systems are the English system, used in the United States, and the metric system, used in most of the rest of the world. The English system consists of units such as inches, yards, and pounds, while the metric system relies on units such as centimeters, meters, and kilograms. In the metric system, there are three basic units of measure; these units describe **mass**, **time**, and **distance**. In science we use an expanded version of the metric system which includes more units than the traditional metric system. This system of measurement is known as the **International System of Units**, also known as the **SI system**. There are 7 standard units of measure in the SI system. (See Table 1)

Table 1

Quantity	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	S
Temperature	Kelvin	K
Amount of substance	mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

Notice in Table 1 that the *kilogram* is a measure of **mass**. Notice also that the kilogram (which is about 2.2 lb – the approximate mass of a brick) is the only base unit described with a prefix. If we divide the mass of a kilogram into a thousand pieces, we get a gram. A small paperclip has a mass approximately equal to a gram. Mass is different from the **weight** of a substance. The mass of an object is a measure of the *quantity* of matter within it, while the weight of an object is a measure of the *gravitational pull* on the matter within it. If you weigh yourself on the moon, for example, the moon's weaker gravity pulls on you with less force than does Earth's gravity, resulting in a lower weight. However, the person's mass- the quantity of matter within his/her body- remains the same. Mass is measured using a balance, while weight (which is a force) is measured with a scale. In chemistry lab, we use BALANCES to measure mass. Although the metric standard is the kilogram, the balances that we use in lab measure mass in grams.

We cannot measure every form of matter by merely using the standard units listed in Table 1 because of the same reasons we need different size units in the English system. Imagine what it would be like if we measured all distances regardless of how long or short using inches. This would be a very impractical approach. With SI units, prefixes are used to indicate sizes of various units. For example, the prefix mill- represents 10^{-3}, one-thousandth of the meter. A milligram (mg) is 10^{-3} gram (g) or 1/1000 of a gram. . Or, alternatively, we can say that it takes 1000 milligrams to make up a gram.

Derived units

Most units describing matter are some combination of the above units. A <u>derived unit</u> is a combination of one or more of the seven base units of measure. For example the SI unit for speed is meters per second (m/s). Notice that this unit is formed from two other SI units- meters and seconds. You are probably more familiar with speed expressed in miles per hour or kilometers per hour – both of which are also derived units. Notice that volume was not listed in the SI base units. The reason for this is because volume is derived from one of the base units. **Volume** is a measure of how much *space an object occupies rather than how much matter is in an object*. Any unit of length, when cubed, becomes a unit of volume. Imagine a distance of 1 foot. If we turn this distance into a three-dimensional cube, now it takes up a certain amount of space . Now, imagine pouring water in this space. The amount of water that would fit into this space would be referred to as 1 ft^3 of water which is describing a volume of water. Thus a m^3, cm^3 (also known as a cc) or dm^3 are all units of volume. Some common equivalencies that are often used in chemistry are: 1 m^3 = 1 kL 1 dm^3 = 1 L and 1 cm^3 = 1 mL. Milliliters (mL) and Liters (L) are non-SI units that are very commonly used in chemistry.

Density

Another very common derived unit that can describe matter is density. Density is defined as the amount of mass in a specific volume of a substance. The densities of solids and liquids are commonly expressed in either grams per cubic centimeter (g/cm^3) or grams per mL (g/mL). Density is an example of an **intensive physical property**, one that is independent of the amount of the substance. If we do a quick search for the density of aluminum, we would find it to be 2.70 g/mL regardless of whether we have 1 gram of aluminum or 1 kg of aluminum. Intensive properties are often used to identify substances because these properties depend only on the **type** of substance rather than the **amount** of the substance. Mass is an example of an **extensive property**, one that depends on amount. You could not use the mass of a substance to try to identify it. Intensive properties are much more useful to us because they do not change with amount.

Questions to complete to be turned in: ***Name:______________________________***

Again…. Be sure this is YOUR work…

1. What is meant by empirical? ____

   ____

2. Describe a hypothesis?____

   ____

3. Distinguish between a theory and a law

Theory	Law

4. What is meant by a quantitative science?____

   ____

   What is the difference between mass and weight? What instrument is used to measure each?

   ____

   ____

   ____

5. What are the three basic units of measure in the traditional metric system?______________________________

6. What is the difference between the metric system and the SI system?__________________________________

   ____

7. Do a search for the prefixes used in the SI system (from 10^{12} to 10^{-12}). Include their numerical equivalency as they relate to the base unit of measure. Cite your source. Use the following example to guide your response.

Example:

prefix	symbol	numerical equivalency
kilo	k	10^{3} or 1000
centi	c	10^{-2} or 1/100

8. What is a derived unit? Give an example?____

____

9. What is the difference between mass and volume?____

____

____

10. What is density, and why is it considered a derived unit?____

____

11. Distinguish between an intensive physical property and an extensive physical property.

Intensive property	Extensive property

12. Label the following as intensive properties (I) or extensive properties (E):

A. _______Color

B. _______Volume

C. _______State of matter

D. _______Density

E. _______Length

13. What non-SI units are the following units of volume equal to?
cm^3 = _____________ dm^3 = _______________ km^3 = ______________

14. Density is calculated by dividing the mass of a substance by its volume. Both mass and volume are extensive properties. Why then is density an intensive property? (Hint: If the mass will increase, what will happen to the volume)

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____

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