Chemistry foundations measurement worksheet answers

This can also be downloaded as a printable PDF or an interactive PDF. For the interactive PDF, the adobe reader is required for full fonttion. This text is published under Creative License, for reference and adaptation, please click here. Section: Section 1: Chemistry and Matter What is Chemistry? Components of Physical and Chemical Properties and State Mixtures composed in Matthew Section 2: How Scientists Study Chemistry in Scientific Method Section 3: Scientific Video Notation Tu Problems Practice Section 4: Unit Measurement International Systems Units and the Metric Systems derives IF Section 5: Making measurements in Laboratory Accuracy vs. Meaningful Accuracy Figure Exact Numbers in Round calculation Video Tutorial and important figure conversion and the importance of Unit Conversion Factor Chapter Summary Reference Section 1 : Chemistry and Matter What is Chemistry? All around us is made up of chemicals. From the color that makes a rose so melting into the gasoline that fills our cars with the silicone chips that power our computers and cell phones... Chemistry is everywhere! Understanding how chemical molecule forms and communicating to create complex structures allows us to harness the power of chemistry and use it, just like a tool, to create a lot of the modern advance that we see today. This includes advances in medicine, communication, transportation, building infrastructure, food science and agriculture, and nearly every other technical field that you can imagine. Chemistry is a branch of science. Science is the process where we learn about the natural universe by observing, testing, and then generating patterns that explain our observations. It is the process by which we learn about the natural universe of observing, testing, and then generating patterns that explain our observations. Because the physical universe is so vast, there are many different branches of science (Figure 1.1). Thus chemistry is the study of problems, biology is the study of living things, and geology is the study of rock and soil. Mathematics is the language of science, and we will use it to communicate some of the ideas of chemistry. Although we divide science into different fields, there is much overlap among them. For example, some biologists and chemistry work in both many fields that their work is called biochemistry. Similarly, geology and chemistry overlap in the field called geochemistry. Figure 1.1 shows how many of the individual fields of science are related. Figure 1.1: The relationships between some of the major branches of Science. Chemistry lied more or less in the middle, which highlights its importance in many branches of science. Physics vs. Chemical Properties of Understanding Subjects is being able to describe it. One way chemistry describes problems is assigned different types of properties to different categories. The properties that chemistry uses to describe problems falling into the two Category. The physical properties feature describing issues, such as boiling points, melt points and colors. Physical changes, such as melt a solid in a liquid, do not change the chemical structure of that problem. The chemical properties feature describing how chemical structures in change subjects during a chemical reaction. An example of a chemical property is flammabilities - a material of ability to burn - because it is known (known as combination) changing the chemical composition of a material. Components and Compounds any sample of issues with the same physical and chemical properties throughout the sample called a substance. There are two types of substance. A substance that cannot be broken into simple chemical elements is an element. Aluminum, which is used in soda cans, is a component. A substance that can break into simple chemical elements (because it has more than one element) is a compound. Water is a compound of the hydrogen and oxygen components. Today, there are about 118 elements in the universe known as organized on a fundamental chart called the Periodic Table of Elements (Fig. 1.2). In contrast, scientists have identified tens of millions of different compounds to date. The smallest part of an element that holds the identity of this element is called an atom. The atoms are very small; to make a line 1 inch long, you would need 217 million atoms to make! Similarly, the smallest part of a compound that holds the identity of this compound is called a molecule. The molecules consist of atoms attached together and behave as a unit (Fig. 1.2). Scientists usually work with millions of atoms and molecules at a time. When a scientist works Figure 1.2: (Upper Panel) The period table of the Elements is an organized chart containing all the known chemical elements. (Lower Panel) To the left of the arrow shows one of the oxygen atoms and two atoms of hydrogen. Each of these represents single elements. When combined on the right, they form a single molecule of water (H_2O). Note that water is defined as a compound, because each molecule is one made up of more than one type of element, in this case, one of oxygen and two atoms of hydrogen. and with large amounts of atoms or molecules at a time, the scientist is studying the macroscopic view of the universe. However, scientists can also describe chemical events on the level of individual atoms or molecules, which are referred to as the microscopic input. We will see examples of both macroscope and microscopic input throughout this book (Figure 1.3). Figure 1.3: How many molecules are necessary for a period of a sentence? Although we don't notice him from a macroscopic perspective, artifacts consist of microscopic particles so small that billions of them need to make a dry that we can see with the naked eye. X25 and X400,000,000,000 indicate the number of times is terrific. To blend a material consist of two or more substances is a mixture. In a mixture, individual substances maintain their chemical identity. Many mixes are the obvious combination of two or more substances, such as a mixture of sand and water. These mixture is called heterogeneous mixture. In some mixes, the elements are so combined that they act like a single substance even if they don't. Mixture and a consistent composition of all are called homogeneous mixtures that mix homogeneous mixtures that mix so well that neither element can be observed independently of other called solutions. Dissolved cycles of water are an example of a solution. A metal alloy, like steel, is an example of a solid. When, a mixture of mostly nitrogen and oxygen, is a gas solution. Figure 1.4: Eterogeneous vs Homogeneous Mixtures. A mixture has more than one substance. In the upper panel you see an example of a heterogeneous mixture of oil and water. The mixture is heterogeneous because you can be visible seeing two different elements of the mixture. In the below panel, you see an example of a homogeneous mixture, coffee. It is homogeneous because you can't distinguish the many different elements that make up a cup of coffee (water; caffeine; coffee alkaloids and tannin). It looks the same at all. If the mixture is homogeneous and it is also seen in or clear, it is called a solution. In our example, the coffee is a solution; however, an espresso focus can be very opaque and would only blend homogeneous, not a solution. State of Matter Another way to classify subjects is to describe it as a solid, a liquid, or gas, which is made in their example of solution, above. These three descriptions, each preventing that the problem has certain physical properties, represent the three phases of issue. A solid has a definite shape and a definite volume. Fluids have a definite volume, but not a definite form; they take the form of the containers. Gas has neither a definite form nor a definite volume, and they expand to fill the containers. We meet whatever phase of every day. In fact, we regularly encounter water in all three phases: ice (solid), water (liquid), and steam (gas). We know from our experience with water that these substances can change from one phase to another if conditions are right. Typically, the temperature varies in a substance (and, less frequently, the pressure exercised on it) can cause a phase change or a physical process in which a substance goes from one phase to another (Figure 1.5). Phase changes have particular names depending on what phases are involved, as summarized in Table 1.1. Figure 1.5. Analyze Phase Change phases. (Upper Panel) A photo of boiled water demonstrates phase changes in water from the gas phase liquid. Note that phase changes are a physical property of a molecule. The water still produces the same (H_2O) of liquid, or gas state. (Lower panel) Changes in temperature can cause phase changes. The above is the temperature scale for the change phase that occurs in water. If you add heat solid ice, water will melt in 0oC and boil at 100oC. If you remove heat from gas water, it will be condensed in the liquid state of 100oC and freeze at 0oC. In summary, Figure 1.6 Classification of Matter shows the relationship between different ways can be sorted. Figure 1.6 The Classification of Subjects. Matter can be ranked in a variety of ways depending on its properties (back to the top) Section 2: How Does Scientist Chemistry Study Chemistry The Scientific Method How Scientists Work? Generally, they follow a process called the scientific method. The scientific method is an organized procedure for learning answers to questions. To get the answer to a question (for example, why do birds fly to Earth's equator during the cold months?), a scientist goes through these steps, which also illustrates in Figure 1.7. Figure 1.7 The general steps of the scientific method. The steps may not be as clear-cut in real life as described here, but most scientific work follow this general description. Propose a hypothesis. A scientist generates a testable idea, or hypothesis, to try to answer a question or explain how the natural universe is. Some people use the theory to place hypothesis, but the word hypothesis is the appropriate word in science. For scientific applications, the word theory is a general statement that describes a broad range of observations and data. A theory represents the highest level of scientific understanding, and is built into a wide array of real knowledge or data. Test the hypothesis. A scientist assessing the hypothesis by revealing and carrying out his tested experience. If the hypothesis passes the exam, it may be an appropriate answer to the question. If the hypothesis doesn't pass the exam, it may not be a good answer. Refine the hypothesis if necessary. Crashing on the results of experiments, a scientist may want to modify the hypothesis and then test it again. Sometimes the results show the original hypothesis to be completely wrong, in this case a scientist will have to brace a new hypothesis. Not all scientific investigations are simple enough to be separated in these three discreet steps. But the steps represent the general method by which scientists learn about our natural universe. (Back to the top) Section 3: The study's scientific notation of chemistry may involve very large numbers. It can also involve very small numbers. Writing these numbers and using them in long forms are problems, because we'd spend far too much time writing zero, and we'd probably make a lot of mistakes! There is a solution to this problem. It's called scientific notation. Scientific notation allows us to express very large and very numbers using power of 10. Remember that: 100 = 1 101 = 102 = 100 1003 = 1000 1004 = 100000 = 100000 As you can see, the power that 10 is raised is equal to the number of zeros that follow the 1. This will be useful for determining which exhibitors to use when we express numbers using scientific notation. Let's take a large number: 579, 000, 000, 000 and express it using scientific notation. First, we find the coefficient, which is a number between 1 and 10 that will multiply by 10 raised in some power. Our coefficient is: 5.79 This number will be multiplied by 10 which is raised from some power. Now let us know which power is. We can do this by counting the number of positions that stand between the end of the original number and the new position at the decimal point of our coefficient. 5 . 7 9 0 0 0 0 0 0 0 0 0 ↑ ↑ How many positions are there? We can see that there are 11 positions between our decimals and the end of the original number. This means that our coefficient, 5.79%, will be multiplied by 10 raised in the 11th power. Our number expressed in scientific notation is: 5.79x 1011 but what about very small numbers? You may remember that: 10-1 =0.1 10-2=0.01 10-3=0.001 10-4=0.0001 1 0-5 = 0.00001 The number of space on the right decimal point for 1 n is equal to the number of the exponent behind the negative sign. This is useful to keep in mind when we express very little numbers of scientific notation. Here is a very small number: 0.0000642 Let's express this number using scientific notation. Our coefficient will be 6.42 This number will be multiplied by 10 raised in some power, which will be negative. Let us assess the correct power. We can calculate this from count how many positions stand between the decimal point of our undetergged and the decimal point of our original number. 0 . 0 0 0 0 6 4 2 ↑ ↑ How many positions? There are 5 positions between our new decimal points and the decimal point of the original number, so our coefficient will be multiplied by 10% raised to the negative 5th power. The number we write in scientific notation is: 6.42 x 10-5 You can use these methods to express any large or small numbers using scientific notation. VIDEO TUTORIAL FOR IMPORTANT FIGURES: (back to the top) Section 4: Unit measurement International Systems Units and the Metric International System of Units, abbreviated SI from French Systéme Unit Downtime, is the main system of measurement unit used in science. Since the 1960s, the International Systems units have internationally agreed on as the standard metric system. SI base units are based on physical standards. The definitions of the SI base units were and continue to be modified and new base units were added as the advancement of the science is being done. Each SI base unit excluding the kilogram is described by properties that are stable in the universe. There are seven base units, which are listed in Table 1.2. primarily uses five of the base units: the molecular for amount, kilogram in for the meter for length, the second for time, and kelvin's for temperature. The Celsius degree (oC) is also commonly used for temperature. The numeric relationship between kelvins and Celsius degrees is as follows K = oC + 273 The size of each base unit defined by international convention. For example, the kilogram is defined as the amount of mass of a special metal cylinder kept in a vault in France (Figure 1.8). Other base units have similar definitions. The sizes of the base units are not always convenient for all measurements. For example, a master is a rather large unit to describe the width of something as narrow as human hair. Instead of reporting the hair diameter as 0.00012m or even 1.2×10-4m, SI also provides a set of prefixes that can be attached to units, creating units larger or smaller by power of 10, known as the metric system. Figure 1.8K kilograms in. The standard for the kilogram is a platinium-iridium cylinder holding in a special vault in France. Source: Wikimedea (National_prototype_kilogram_K20_replica.jpg) common prefix and multiplication factors are listed in Table 1.3 Prefix used with SI Unit. (Maybe you've already noticed that the base unit's kilogram is a combination of a prefix, kilo-meaning 1,000 ×, and a unit of mars, the gram.) Some prefix creates a multiple of the original unit: 1 kilogram equals 1,000 grams (or 1 kg = 1,000 g), and 1 megamet equals 1,000,000,000 meters (or 1 mm = 1,000.000 m). Other prefix creates a fraction of the original unit. Thus, 1 centimeter equals 1/100 to one meter, 1 millimeter equals 1/1,000 in a meter, 1 microgram equals 1/1,000,000 to 1,000 grams, and so forth. The basic unit mass of mass in the International System of Unit is the kilogram. One kilogram is equal to 1000 grams. A gram is a relatively small number of masses and thus larger masses are often expressed in kilograms. When very small amounts of problems are measured, we often use milligrams that are equal to 0,001 grams. There are many larger, smaller, and intermediate mass units that may be appropriate as well. At the end of the 18th century, a kilogram was the mass of a liter of water. In 1889, a new international prototype of the kilogram was made of an alloy platinum-iridium. Kilograms of equal to the march of this international prototype, which is held in Paris, France. Mass and weight are not the same. Although we often use the terms mes and weights interchangeably, each one has a specific definition with him. Mask an object is a measure of the amount of artifacts in it. The mask (amount of question) of an object remains the same wherever the object is set. For example, moving a brick to the moon does not cause any problems of it to disappear or be removed. The weight of an object is determined by the force of this gravitation on The equal weight to mass object to the local acceleration times of gravity. So on Earth, weight is determined by the force of attraction between the object and the Earth. Since the strength of gravity is not the same at every point on the Earth's surface, the weight of an object is not constant. The pull of gravitation on the object varies depending on where the object is related to the Earth or other gravity-generated objects. For example, a man who weighs 180 pounds on Earth would weigh only 45 pounds if he were in a stationary position, 4,000 miles above Earth's surface. This man would weigh only 30 pounds on the moon because the gravity of the moon is only one-sixth of Earth. The mass of this man, however, would be the same in every situation. For scientific experiments, it's important to measure the mask of a substance rather than the weight to maintain consistency in the results wherever you experience. The length of the SI unit in length is the master. In 1889, the definition of the meter was a low in platinium-iridium alloy stored under conditions specified by the International Office of Standards. In 1960, this definition of the standard master was replaced by a definition based on a wavelength of encryption-86 radiation. In 1983, this definition was replaced by the following: the owner is the length of the path traveled by light in a vacuum during a time interval of a second time. Air temperatures are used in a scientific context, the heat and temperature words don't mean the same thing. Temperature represents the average kinetic energy of the particles that make up a material. Increasing the temperature of a material increases its thermal energy. Thermal energy is the sum of kinetics and energy potential of the particles that make up a material. Objects don't heat up; instead they have thermal energy. Heat is the movement of thermal energy from a warm object to a cool object. When thermal energy moves from one object to another, the temperature of both objects changes. A thermometer is a device that measures temperature. The name is made up of thermals which means heat and meters that are meant to measure up. The temperature of a substance is directly proportional to the average kinetic energy it has. In order for the average kinetic energy and temperature of a substance to be directly proportional, it is necessary that when the temperature is zero, the average kinetic energy must also be zero. It was necessary for the use of calculations in science for a third temperature scale at which zero degrees match zero kinetic energy, that is, the point where molecular stops moving. This scale of temperature was made by Lord Kelvin. Lord Kelvin declares that there are no upper limits to how hot things can get, but there's an extent as to how cold things can get. In 1848, William Lord Kelvin developed the idea of absolute zero, which is the temperature in which molecules stopped moving and has zero energy kinetics. This is known as Kelvin's temperature scale. The Celcius scale is based on the iced dots and boil points of water. Thus, 0oC is the freeze point of water, whereas 100oC is the boiling point of water. Most of us are familiar with temperatures below the freeze point of water. It should be apparent that even if air temperature can be -5oC, the molecules in the air are still moving (i.e. 0oC is not absolute zero). Substances such as oxygen gas and nitrogen gas have already melted and boiled vapor at temperatures below -150oC. The Fahrenheit scale is also defined at the freeze point and boil points of water. However, the scale is different from those of Kelvin and Celsius Scales. At the Fahrenheit scale, the freeze point of water is 32oF and the boil point of water is 212oF. To convert between the Fahrenheit scale and the Celsius scale, The following conversions can be used: [oC]=([oF]-32)× 5/9 or [oF]=[oC]× 9/5+32 Scale Kelvin's temperature has its zero to absolute zero (determined to be -273.15oC), and use the degree scale similar to the Celsius scale. Therefore, the math relationship between the Celsius scale and the Kelvin scale is K=oC+273.15 In the case of the Kelvin scale, the degree sign is not used. Temperatures are expressed simply as 450 K, and are still positive. Unit time if the for time is the second. The second was originally defined as a small fraction of the time needed for the Earth to obey the Sun. It has since been refined several times. The definition of a second (established in 1967 and reaffirmed in 1997) is: The duration of 9.192.631.770 period of radiation corresponding to the transition between the two hyperfine levels in the state was in the sixth-133 room. Chemistry Amount uses mole theme represents a large number of atoms or molecules. Even as a dozen implicate 12 things, a mole (mol) represents 6,022 × 1023 things. The number 6,022 × 1023, called the Avogadro number after chemistry in 19th-century Amedeo Avogadro, is the number we use in chemistry to represent the number of macrocopics in atoms and molecules. So if we have 6,022 × 1023 oxygen atoms, we say we have 1 mol of oxygen atoms. If we have 2 gelaces in Atom Na, we have 2 × (6,022 × 1023) Na atom, or 1.2044 × 1024 atom. Similarly, if we have mol 0.5in benzene (C6H6) molecules, we have 0.5× (6,022 × 1023) C6H6 molecules, or 3,011 × 1023 CH66 molecules. Units derive the combination of SI base units. Units can be multiplied and divided, as the numbers can be multiplied and divided. For example, the area of a square with a side of 2 cm is 2 cm × 2 cm, or 4 cm2 (it as four square centimeters or four square centimeters). Notice that we have square one unit of length, the tape, to get a unit from for the area, the square tape. Volume is a significant number that uses a concrete unit. Volume is the amount of space that a substance handles given to them is defined geometricly as the length × width × height. Each distance can be expressed using the master unit, so volume has the unit out l × l × m, or m3 (it as cubic meter or cubic meter). A cubic meter is a rather large volume, so scientists typically express volumes in terms of 1/1,000 to one cubic meter. This unit has its own name - The Liter (L). A liter is slightly larger than 1 quarter US of volume. (Table 1.4) provides approxim equivalent for some of the units used in chemistry.) As shown in Figure 1.9 The Liter, a liter also is 1,000 cm3. By definition, there is 1,000 mL of 1 L, so 1 milliliter with 1 cubic centimeter represents the same volume. 1 mL = 1 cm3 Figure 1.9: The liter. A liter is defined as a cube which is 10 cm (1/10th of a meter) on one side. A milliliter, 1/1000th of a liter, equals to 1 cubic centimeters (1 cm3). Energy, another significant amount of chemistry, is the ability to make work. Move a box to book from one side of one room to the other side, for example, require energy. It has a unit from kg·m2/s2. (The dot between the kg and m2 units implike the multiplied units together and then the entire theme is divided by s2.) Because this combination is cumbersome, that collection of units is refined as a day (J), which is the SI unit of energy. An older unit of energy, the calories (calories), is also widely used. There: Note that this is different from our common use of the 'large calories' or Cal' listed on food packages in the UNITED States. Big 'Cal' is actually a kilokalorie or kcal (Fig 1.10) Note that all chemical processes or reactions occur with a simultaneous change in energy and that energy can be stored in chemical links. Figure 1.10: Kilocal differences in Scientific and Common Use. Calories represented on food wrapping actually refer to kilocalories in scientific terms. Density is defined as the mask of an object divided by its volume; it describes the amount of questions contained in a given amount of space. density = mass/volume so the units of density are the units of mass divided by the units of volume: g/cm3 or g/mL (for solids and liquids, respectively), g/L (for gas), kg/m3, and so forth. For example, the water density is about 1.00 g/mL, while the density of mercury is 13.6 g/mL. Mercury is more than 13 times as water, meaning it has more than 13 times the amount of question in the same amount of space. The air density at room temperature is about 1.3 g/L. Section 5: Measurement of the Lab It is important to remember the different terminology we use when talking in science. One of these series of terminology is accuracy and accuracy. Although accuracy and accuracy are often used interchangeably in the non-scientific community, the differences between the terms are very important to achieve. Accuracy tells you how close the two measurements are to each other, while accuracy tells you how close a measure is to the known value. A measure can while not being accurate, or accurate, but not accurate; the two terms are not related. You can get a good analogy to a game of arrows (Fig. 1.11). A player who always hit the same spot just on the left side of the board would be accurate but not very accurate. However, an arrow player who is all on the board but hitting the center of the board on average would be accurate, but not exact. A good flower play, just like a good scientist, wants to be both accurate and accurate. Figure 1.11: The Difference between Accuracy and Accuracy. A game of arrows can be used to display the differences between accuracy and accuracy. Adapted from: typically in the lab, accuracy is a measurement of how well your equipment is calibrated. For example, if your balance isn't calibrated correctly, you can make very accurate, repeated measures, but the measures won't represent the true value. Accuracy, on the other hand, is usually determined by how careful the scientist is in concrete measurements. If you are neglect and pass part of your sample along the way, your measurement of repeated experience won't be precise even if your balance is accurate. Its important figure is important to realize that values of scientific measures are never 100% accurate. Our instruments only measure at a certain level of accuracy. Thus, we can choose different instruments to make a measurement based on the level of accuracy we need for the experience. Due to the inheritance accuracy of any measured number we must keep track of the different levels of accuracy each number has with important figures. Significant figures in a measured number are defined as all of the digits known with certainty and precarious at first, or estimated, digit. It makes no sense to report any digits after the first precarious one, so it is the last digit reported in a measure. Zero is used when necessary to place the important figures in the correct positions. So zero cases or may not be important figures. Important figures apply to the real world, as they allow us to quantify the accuracy of any kind of measure. To identify how many numbers in a measure have meaning, you can follow a discreet set of rules, shown below and on the right. Figure 1.12: Measure an object in the correct number of significant figures. How many digits should they show in this measure? The correct answer is 3! The two that you know for sure + the esteemed position... for this reading it would be closed at 1.37 Exact numbers are numbers that are not measured by a scientific instrument. They are either used as definitions to define a concept or terminology, or are made by the total count of something present. An example of an exact number, should be the number of eggs in a cardboard or a defined unit such as winning 100 cm to 1 m. Exact number, such as the number of people in a room, does not affect the number of important figures in calculations made with measured values. in scientific operations, the rules of rounding may be slightly different than the ones you are using. Normal rounding rules suggest that if a number is 4 or below, it should be rounded down to the lower number, whereas if it is 5 or higher, it should be rounded up. However, note that 5 is right in the middle and causes a problem when using these conventional rounding policies. If you have a large data of numbers that you need to round, using this rounding rule will lead to bias of your data (i.e. 4/9th of the time you will rounded down, and 5/9th of the time you will rounded up). In a big data, this bias is unacceptable. In Scientific Rounding, we typically use a rule called the same rounding.' In this rounding system the rules are the same for 4 and below, you round down to the lowest number, and for 6 and above you round up to the highest number. However, if the number you are rounding is 5, then you round to the same number. This helps to relieve the sample bias that can occur when rounding big data. The first thing to achieve before doing any calculations in science is that all numbers measure them only as good as the instrument used to measure them. Even with the best available instrument the measuring number will never be 100% precise. Scientists use good enough the rule of accuracy, meaning that we accept an inheriting amount of impressions from every measure we take as long as the final result is close enough to where we want it to be. This concept becomes dangerous when we start to use these good enough numbers for any calculations, if we are not careful to keep track of our significant digits can quickly lose their good enough status. To protect good enough numbers, the scientific community set certain rules to do any calculations; in this section we need only to concern ourselves with two very important rules: the addition rule / Subtraction, and the Multiplication / Division rules. Find the number with the smallest number of decimals and keep track of the number of decimal places In addition/subtract rounding the final reply to the smallest number of decimal Found in Step 1 Multiplication / Division Rule: Count the number of important figures in each number (keep track of number of important figures) Done The Multiplication/Division Round your final answer to the lowest number of important figures found in step 1 Calculate complicated problems: Use the order of operations, break the issue up in multiple steps To do any addition/subtract steps after the addition rule/Subtraction (not round yet, just keep track of correct decimal hours The number of important figures) Makes multiplication/division using the Multiplication Rule/Round Division final answer to the correct number of significant figures the ability to convert from one unit to another is an important skill. For example, a nurse with 50 mg aspirin pills that must be administered 0.2g of aspirin in a patient, needs to know that 0.2g equals 200 mg, so that 4 tablets are needed. Fortunately, there is a simple way to convert from one unit to another. If you have learned the SI units with prefix described in Section 1.4 Unit Measurements, then you know that 1 cm is 1/100th of a meter or: 100 cm = 1 i Assume we divide both sides of the equation by 1 m (both the number and the unit; Note that it is important to always write out your units! This avoids confusion and error when performing conversions.): As long as we perform the same operation on both sides of the equal sign, the expression remains a equality. Look to the right side of the equation; it now has the same amount of the numerator (the top) as it contains in the denominator (below). Any fraction of the same number in the numerator and the denominator has a value of 1: We know that 100 cm is 100 cm is 1 m, so we have the same amount on the top and the bottom of our fractions, although it is expressed in different units. A fraction that contains the equivalent number of the numerator and the denominator, but is expressed in different units called a Noteworthy conversion factor that conversion factors can be written with either the term of the numerator or denominator, and used as appropriate for the issue that you want to resolve. This is because, both themes are equal to 1 Here is a simple example. How many centimeters are at 3.55m? Maybe you can determine the answer by yourself. If there are 100 cm in each meter, then 3.55 m equals 355 cm. To solve the problem more formally with a conversion factor, we first write down the amount we provide, 3.55m. Then we multiply this amount by a conversion factor, which is the same as multiplying it by 1. We can write 1 as 100cm/1m and multiply: Because I, the abbreviation for meters, occur in both the numerator and the denominator of our expression, are cancelled out. The final step is to perform the calculation that remains once the units have been canceled. Note that it is critical to keep the right units in the final response or it won't make sense. A generalized description of this process is as follows: You may wonder why we use a seemingly complicated procedure for a simple conversion. In later science, the conversion issues you'll encounter won't always be so simple. If you can master the technique of applying conversion factors, you will be able to solve a large variety of issues. In the previous example, we used fractions of 100 cm/1 m as a conversion factor. Is the conversion factor 1 m/100 cm also equals 1? Yes, it does; it has the same number of the numerator as in the same (except that they're flip-flanped). Why didn't we use this conversion factor? If we were to use the second conversion factor, the original unit would not be canceled, and the result would be nonsense. Here is what we would have gotten: INCORRECT USE OF CONVERSION FACTORS!! You can see that none of the units are canceled out. For the response to be sense, we must construct the conversion factor into a form that causes the original unit to be canceled outside. Figure 1.13 A Concept Card for conversion shows a concept card to construct an appropriate conversion. Figure 1.13 A concept card for conversion. This is how you construct a conversion factor converting from one unit to another. (Back to the top) Chapter 1 materials have been adapted and modified to the following common creative resources unless otherwise noted: 1. Anonymous. (2012) Introduction to Chemistry: General, Organic, and Biological (V1.0). Published under Creative Commons by-nc-sa 3.0. Available from: 2. Poulsen, T. (2010) Introduction to Chemistry. Published under Creative Commons by-nc-sa 3.0. Available from: 3. OpenStax (2015) Atom, Isotops, Ions, and Molecules: The Building Blocks. OpenStax CNX. Available at: 12. 12.