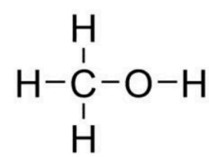
Determining Chemical Formulas Lab; SC2 b,c

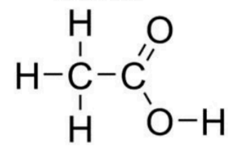
As you have learned previously, when two or more elements combine to create a pure substance, a compound is formed. Chemical formulas are used to provide information about the atoms in a compound. Finding the percent composition of a compound is a method of determining the amount of each element present in a compound. The purpose of this lab is to determine the percent composition of substances and to calculate the empirical and molecular formulas. To calculate the percent composition, the number of atoms of each element in a compound is multiplied by the molar mass of the representative element. The product is then divided by the formula mass. The result is multiplied by 100 to obtain the percentage. This process is then repeated for each element in the compound. Let's pause and do an example on the board. The empirical formula of a substance shows the ratio of moles of each element in the compound. To calculate an empirical formula, determine the number of moles of each element present in the compound. Divide each number of moles by the smallest number of moles. The resulting number is the subscript that follows the symbol for the element in the chemical formula. If the number is not within ±0.1, then multiply the number by the same factor to get the lowest whole number ratio. Let's pause again to make sure everyone understands this process. Next, using the molecular mass of a compound, the molecular formula can be calculated from the empirical formula. Dividing the molecular mass of the compound by the molecular mass of the empirical formula gives a whole number multiple. When the empirical formula is multiplied by this number, the result is the molecular formula. The molecular formula is the actual formula for the compound. Note that there are compounds that have the same empirical and molecular formulas because the ratio of atoms is the same. Finally, let's look at an example of calculating the molecular formula with CH_3.

There are three parts to this lab. Your group may choose to complete parts 2 and 3 before part 1, in any order to maximize efficacy and avoid waiting for stations, materials and chemicals to become available.

Part 1: Modeling Organic Compounds

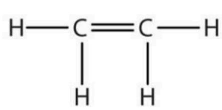


Methanol

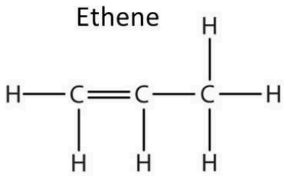


Acetic acid

1). Obtain a bag of molecular models and two Y-plate petri dishes. 2). Place the black carbon atoms in one compartment of the dish and the white hydrogen atoms in another and the red oxygen atoms in the last compartment. 3). In the other Y-petri dish, place the white tubing pieces (covalent bonds) in all three compartments. 4). Use the molecular model pieces to build a molecule of methanol and acetic acid. A double bond requires two pieces of tubing. Every projection on every atom must be used. 5). Write the formulas for each of the molecules using the following format, $C_xH_yO_z$. Let the x, y and z represent the number of atoms present for each element. Transcribe and complete the data table shown below and note that you will also use this table for step 6 on ethene and propene.
6). Use the molecular model pieces to build a molecule of ethene and propene. Record your data.



Ethene



Propene

Chemical Name	Chemical Formula	Percent Carbon (x)	Percent Hydrogen (y)	Percent Oxygen (z)
Methanol				
Acetic acid				
Ethene				
Propene				

Part 2: Experimental Empirical Formula of Glucose

1). Construct a ring stand with a ring and wire gauze. 2). Using a balance, determine the mass of the aluminum weighing dish or a piece of aluminum foil. 3). Add just enough glucose to lightly cover the bottom of the dish/foil. Mass the dish/foil with the glucose. 4). Calculate the mass of glucose and record this information for later use. 5). Light the Bunsen burner and adjust so that the flame is just below, but not touching, the gauze. 6). Heat the glucose until boiling ceases, but do not burn the sugar. Turn off the burner and wait several minutes for the dish to cool. 7). Using a balance, determine the mass of the remaining sample. Dispose of the aluminum dish or aluminum foil.

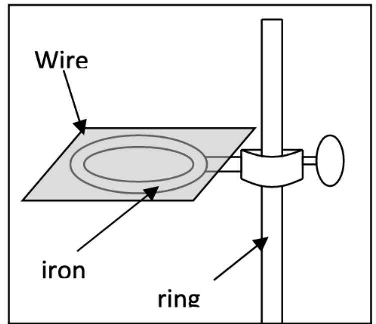


Figure 1

Q1. Glucose consists of carbon, hydrogen and oxygen. Knowing this, what element(s) do you think is/are present in the resulting sample after heating? What do you think was lost from the glucose sample as it was heated?

Q2. Use the mass of the resulting sample, as determined using the balance and the molar mass of the resulting substance to calculate the number of moles present. Show all of your work to receive credit.

Q3. Subtract the mass of the resulting sample from the original mass of the glucose that you placed in the aluminum dish or foil. Use this mass and the molar mass of the substance(s) to calculate the number of moles lost while heating. Show all of your work to receive credit.

Q4. Compare the number of moles in questions 2 and 3. Determine which number is smaller and then divide both numbers by the smaller number. You can now determine the ratio of each substance in the compound's empirical formula. This number is written as a subscript for each element. Write the experimental empirical formula for glucose.

Q5. Calculate the formula mass of the empirical formula by adding the molar masses of the individual elements. Next, determine the expected molecular formula mass of glucose using the periodic table. Divide the molecular formula mass of glucose by the empirical formula mass to obtain a number. Multiply the empirical formula by this number to determine the experimental molecular formula of glucose. Show all of your work to receive credit.

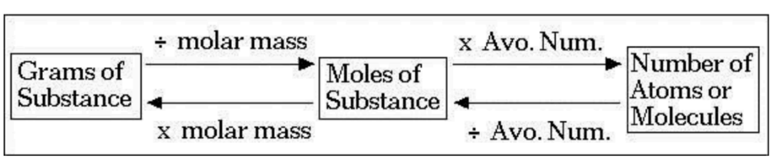
Q6. Determine the percent composition of carbon, hydrogen and oxygen in glucose. Do so by dividing the molar mass of each substance by the mass of the formula mass for glucose, and then multiplying by 100. After you have calculated the percentages, add your answers to check your work. Show all of your work to receive credit.

Q7. Write a balanced chemical equation for the reaction that you observed.

Part 3: Designing Your Own Experiment (using Epsom salt)

1). Design an experiment to determine the percent composition or empirical and molecular formulas of Epsom salt. Epsom salt is a hydrate, which is a substance that contains water. You will need to create as data table to suit your experimental design.

Q8. Show all of your calculations for your designed experiment.

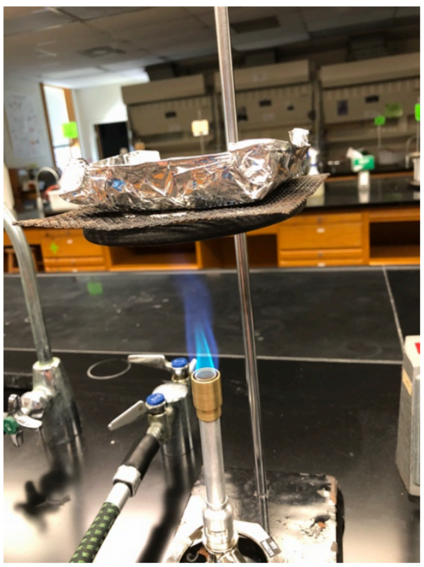
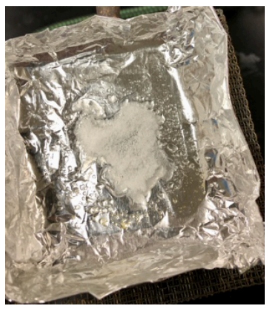
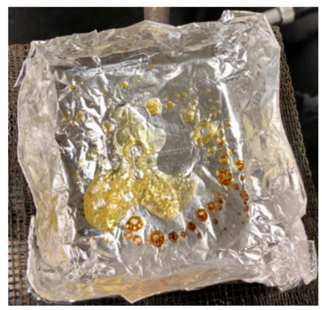
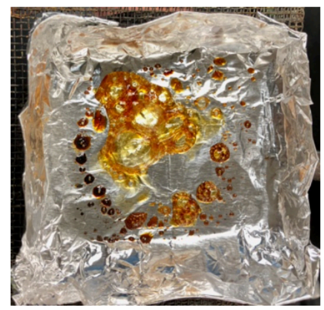
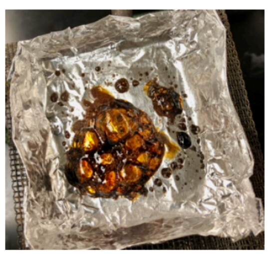


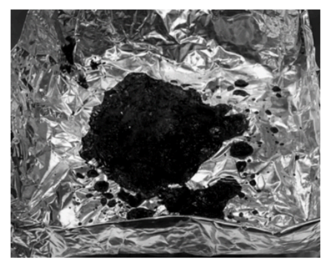
Source:https://www.paulding.k12.ga.us/cms/lib010/GA01903603/Centricity/Domain/541//LabsandActivities/determining%20chemical%20formulas%20lab_2014.pdf?id=478577

Empirical Formula of Glucose

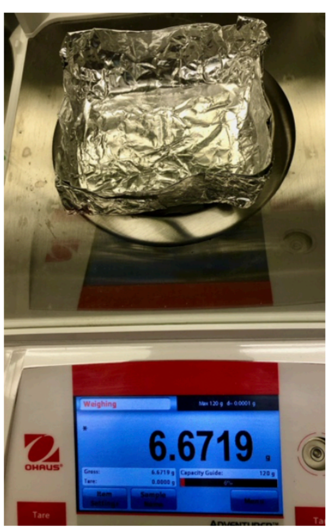
1. A 15 cm x 30 cm piece of aluminum foil was folded in half to form a square. Then each edge was folded over about 1 cm towards the center of the foil. Repeat the 1 cm fold again and pinch the corners together to make the sides of the aluminum tray. Mass the empty tray.
2. Add 1-2 grams of glucose to the tray and re-mass. Set up a ring stand with an iron ring. Place a wire gauze on the ring, then the aluminum tray on top of the gauze. Begin warming gently at first, with the tip of the burner flame slightly below the gauze.
3. Bubbles of water vapor will escape from the solid and the liquid will begin to turn orange in color, then black. Once most of the moisture is gone, adjust the tip of the flame to be touching the gauze and start to heat strongly.
4. When all of the bubbling has stopped and all of the sugar has turned black, remove the aluminum tray from the gauze and allow to cool. Re-mass the tray with the carbon residue.
5. Re-heat the sample strongly for a few minutes, cool, and re-mass. Continue this process until consecutive mass readings are within ± 0.10 grams.

Observations:



Data:

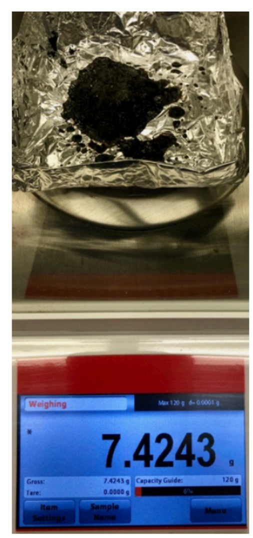


mass of aluminum foil, g

foil & glucose, g

heat until black C, g

2nd heating, g



3rd heating, g