

Station #1

A Wellesley student's nutritious breakfast...

The United States Recommended Daily Allowance of iron is 18mg. Iron-fortified cereals often contain large amounts of iron to help people meet this dietary need (the demonstration in front of you is the extracted iron from a box of cereal). Suppose you eat 2 servings of one of the cereals in front of you for breakfast (choose one and write down which one you chose). How many iron atoms have you just ingested?

Now suppose you had to eat each iron atom one at a time, at a rate of one atom per second. How long would it take to ingest the above number of iron atoms? (For comparison, the age of the universe is 13.7 billion years, according to the NASA Wilkinson Microwave Anisotropy Probe.)

People generally have approximately 3g of iron in their whole body. Most of the iron in the body is used to transport oxygen (O_2) through the bloodstream so oxygen can reach every cell in the body. One iron binds to one oxygen molecule (this process is mediated by a protein called hemoglobin, which you may have heard of). Assume that about 80% of the iron in your body is involved in transporting oxygen at any given time. How many *grams* of oxygen are being transported in your bloodstream at this moment?

Station #2:

A contest of sorts...

In front of you are 5.0 g of each of the following substances:

water (H_2O)

ethanol ($\text{C}_2\text{H}_5\text{OH}$)

sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)

caffeine ($\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$)

- A) Without referring to your calculator, determine which vial contains the largest number of molecules.
- B) Which vial contains the largest number of *atoms*? This time you will need your calculator.
- C) By looking at the two substances, which liquid - ethanol or water - is denser?

Please do not write on this sheet. It will be used by other students.

Station #3:

Cost per atom of aluminum in foil

Approximately how much does each atom cost in your roll of aluminum foil? Report your answer in cents. Use the price given on the box. Please do not use the entire roll of foil.

Context question (if time permits): Go online and look up the price of aluminum in the commodities markets in the recent past (search "aluminum prices"). In light of this information, does your answer make sense?

Station #4:

What's so special about 6.022×10^{23} ?

A mole is defined as the number of carbon atoms in exactly 12g of carbon-12. Avogadro's number (N_A) is the number of items in a mole, 6.022×10^{23} . But *why* does it have the value 6.022×10^{23} ? Why isn't it something easier to work with, like 1.00×10^{23} ?

Try to answer the following questions from what you know. Ask your instructor if you get stuck:

- A) What are the units of Avogadro's number?
- B) Is Avogadro's number an integer, or would you expect it to have a decimal component?
- C) An atomic mass unit (amu) is defined as exactly 1/12 the mass of a single carbon-12 atom. What is the mass of carbon-12 in g/mol? In amu/atom? What is the relationship between g/mol and amu?
- D) Let's say you had an atom that weighed 1 amu/atom (1 g/mol). How many grams does one atom weigh (g/atom)? Since our atom weighs 1 amu, g/atom is the same as g/amu. How many amu's are there in 1 gram (amu/g)? What is the relationship between grams, amu and N_A ?

Station #5:

Take-home question

(Answer this question before next week, and put your answer in your Results worksheet.)

A Nobel-Prize-worthy compound...

A long, long time ago (1951) in a land far, far away (Pennsylvania), you and fellow scientists uncover a strange, orange powder, and you want to know what it is...

You know that this compound contains only C, H, and Fe. By using various methods. You find that the percentages, by weight, of C and H are 64.56 and 5.42, respectively.

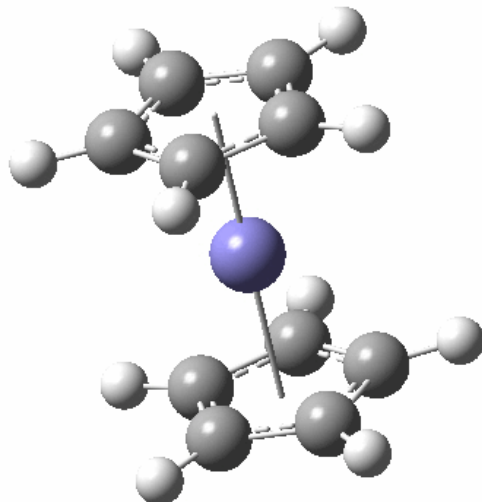
1. What must the weight percentage of Fe be in the compound?
2. Consider 100g of the substance. What is the mass of each element, in grams, in that 100g sample?
3. How many moles of C, H, and Fe are there in this arbitrary 100g sample?
4. You now have the number of moles of each element in your unknown compound. Can you use these numbers directly to write the formula? For example, if the number of moles of C, H, and Fe were x , y , z , could you say the formula is $C_xH_yFe_z$? If not, why not?
5. Chemical formulas give you the number of moles of each element in one mole of a compound. We want to have the ratio of the moles of the various atoms in a mole of the molecule to be whole numbers. In order to do this, divide the moles of each atom by the smallest

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number of moles of the various atoms. For example, if you have fewer moles of C than any other atom in this molecule, divide each of the moles by the moles of C (including the moles of C itself). If all of your ratios are integers, you have found the so-called simplest, or empirical, formula for the molecule. What is that formula for this molecule?

6. The true molecular formula is some integral multiple of the empirical formula, and the integer may be 1. In order to obtain the molecular formula it is useful to have an independent measure of the molecular weight (more correctly the molecular mass) of the compound. In the case of this molecule, mass spectroscopy shows the molecular mass to be 186.04 g/mol. What is the mass in g/mol of your empirical formula? What is the actual molecular formula of your compound?
7. Reconcile your answer with the diagram below (also see the online lab manual for an interactive image). Does your molecular formula agree with the diagram?



8. What is the name now given to this compound, whose structure determination led to the 1973 Nobel Prize in Chemistry? (Hint: Try plugging the molecular formula into Wikipedia)