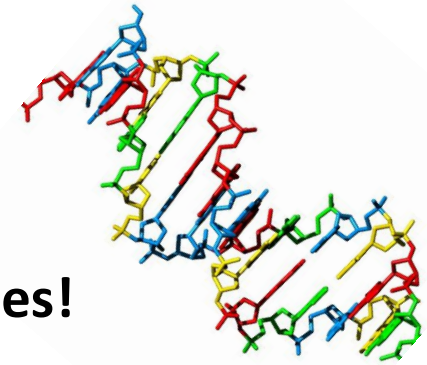


Mr. Severino

S.T.E.M. Mathematics Link: Chemistry

Content Standards Covered: CC.8.EE.4; A.CED.2-3; A.REI.5-6

Mathematical Practices: 1, 2, and 4.

Those Amazing Molecules!

The watermark (and graphic) for this page shows the molecule that contains all of the genetic information necessary for life—**DNA**. This molecule is shared by every living thing ever to grace our planet. Dinosaurs had DNA, for example. Insects, trees, dolphins, plants, and any other form of life all have DNA. And yes, people do as well. When you get to high school, you will learn about DNA, RNA, and a lot more about the molecular world. And should you decide to go into medicine someday (doctor, nurse, scientists, etc.), you will discover how the simplicity of atoms makes up the incredibly beautiful, complex world.

(For additional clarity, all living organisms have **nucleic acid** but it could be **RNA** instead of DNA, as in the case of some viruses. RNA is the actual genetic material rather than DNA.)

When I studied chemistry years ago, I was fascinated at how atoms actually come together to form the building blocks of life. I am, for example, a collection of mostly hydrogen, oxygen, and carbon atoms called Gregory Severino. You, and every other person on the planet, are a nearly identical collection of such atoms with a different name label. All life on Earth is carbon based—meaning, carbon is the most important element of life. Carbon possesses those unique properties that tie all of the elements in DNA together.

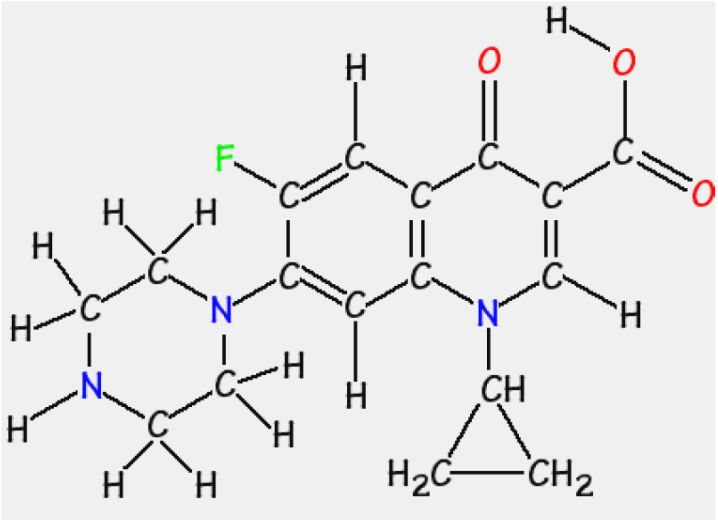
For this project, you will explore the molecular world and see how **systems of equations** are related to those amazing molecules that make up everything. The skills that I have taught you will enable you to complete all of the problems. Feel free to use your graphing calculator as well.

Part I: What Atoms Make Up Living Things?

1) Using the Internet, discover the main elements that make up the human body. I have given you three. Find five more. Arrange the percentages of each element from greatest to least.

2) A typical 150 pound human has about 7×10^{27} atoms. That's a 7 followed by 27 zeros. Using a proportion, find the number of atoms that make you up.

Part II: An Atom Counting Exercise



This is a figure showing the locations of hydrogen (H), oxygen (O), carbon (C), nitrogen (N) and fluorine (F) atoms in one molecule of ciprofloxacin. This man-made compound kills bacteria such as anthrax by interfering with the enzymes that cause DNA in the anthrax bacterium to rewind after being copied, which stops DNA and protein synthesis.

Problem 1 - How many atoms of each element are present in one molecule of ciprofloxacin? (Note H_2 means 2 atoms of H)

Problem 2 - Write the molecular formula of this molecule by filling-in the blanks with the number of counted atoms in the following:

$$C\_\_\ H\_\_\ FN_3O\_\_$$

Problem 3 – The mass of each element is given in terms of Atomic Mass Units (AMUs). If the masses of the atoms in ciprofloxacin are H = 1 AMU, C=12 AMU, O=16 AMU, N = 14 AMU and F = 19 AMU, what is the total mass of the ciprofloxacin molecule in units of AMUs?

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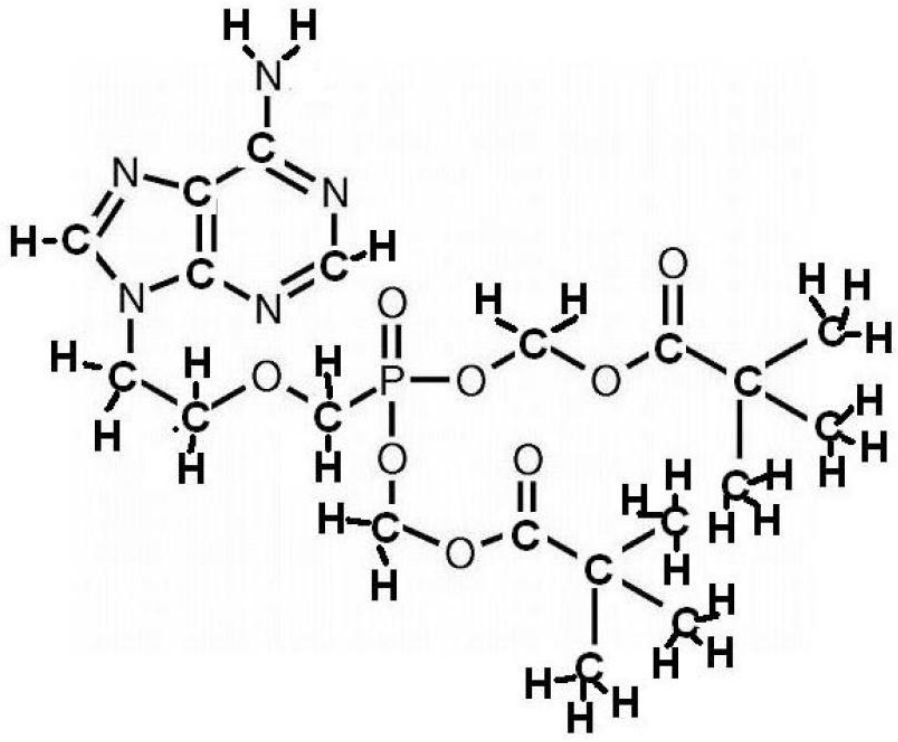
Part III: Another Atom Counting Exercise



This is a figure showing the locations of hydrogen (H), oxygen (O), carbon (C) , nitrogen (N) and phosphorus (P) atoms in one molecule of adefovir dipivoxil, which is a drug designed to treat hepatitis B.

Problem 1 - How many atoms of each element are present in one molecule of adefovir dipivoxil?

Problem 2 - Write the molecular formula of this molecule by filling-in the blanks with the number of counted atoms in the following:

$$C_{20}\ H\_\_\ N\_\_O\_\_P\_\_$$

Problem 3 – The mass of each element is given in terms of Atomic Mass Units (AMUs). If the masses of the atoms in adefovir dipivoxil are H = 1 AMU, C=12 AMU, N= 14 AMU, O=16 AMU, and P = 31 AMU, what is the total mass of a single molecule in AMUs?

In the next section, you are going to see how molecular formulas can form a <u>system of equations.</u>

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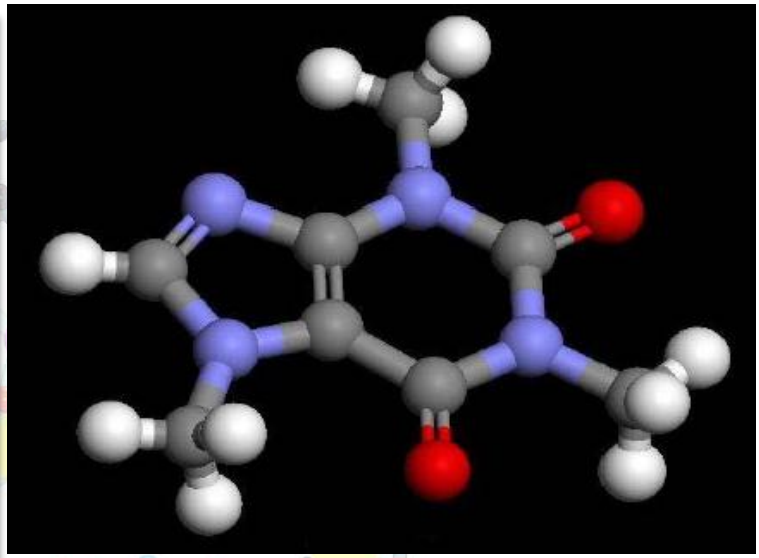
Part IV: Solving Systems of Equations Algebraically

Given the total mass of molecules in AMUs and the number of mystery atoms X, Y, and Z that are involved, determine the identity of the atoms that comprise the molecules by setting up a system of equations.



Problem 1 - Acetic acid consists of 4 X atoms, 2 Y atoms and 2 Z atoms. Methyltriacetylene consists of 4 X atoms, 7 Y atoms, but doesn't have any Z atoms. Propanol consists of 6 X atoms, 3 Y atoms and 1 Z atom. The total atomic mass of the molecules are 60 AMU for acetic acid, 88 AMU for methyltriacetylene, and 58 AMU for propanol. What are the atomic masses of the atoms X, Y and Z? Use the table below to identify them.

I will help you get started. **Let z= 16**. This equation represents acetic acid:

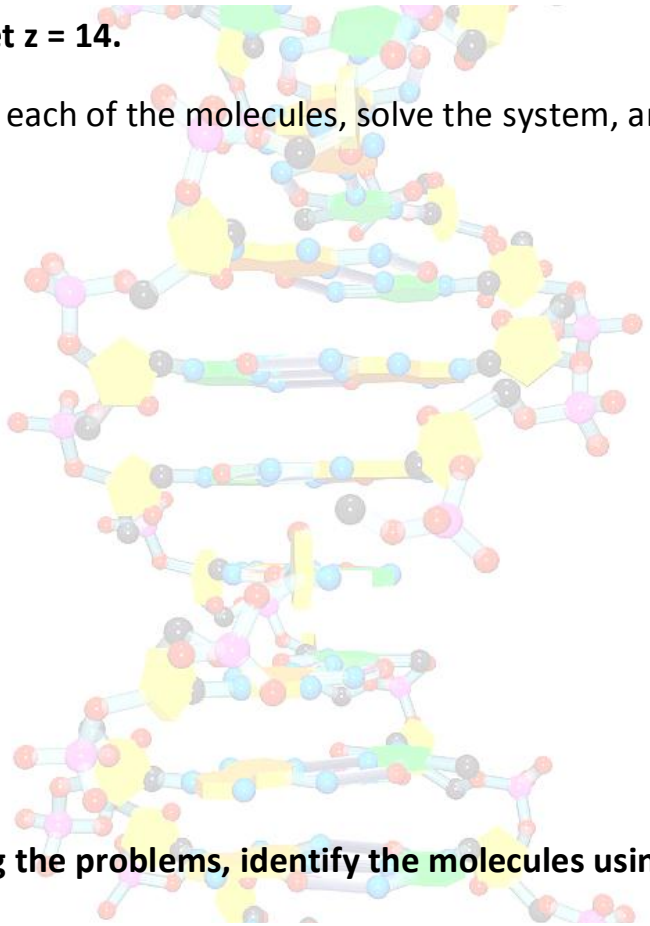
$$4x + 2y + 2(\mathbf{16}) = 60$$

Now, write equations for the other molecules, letting z =16. Set up a system of equations and solve for the variables.

Problem 2: Cyanotetra-acetylene consists of 1 X atoms, 9 Y atoms and 1 Z atoms. Aminoacetonitrile consists of 4 X atoms, 2Y atoms, and 2 Z atoms. Cyanodecapentayne consists of 1 X atoms, 11 Y atoms and 1 Z atom. The total atomic mass of the molecules are 123 AMU for cyanotetra-acetylene, 56 AMU for aminoacetonitrile, and 147 AMU for cyanodecapentayne. What are the atomic masses of the atoms X, Y and Z? Use the table below to identify them.

For this problem, let z = 14.

Write equations for each of the molecules, solve the system, and then identify the molecules.



After solving the problems, identify the molecules using this chart.

Hydrogen	1	Sodium	23	Scandium	45
Helium	4	Magnesium	24	Titanium	48
Lithium	7	Aluminum	27	Vanadium	51
Beryllium	9	Silicon	28	Chromium	52
Boron	11	Phosphorus	31	Manganese	55
Carbon	12	Sulfur	32	Iron	56
Nitrogen	14	Chlorine	35	Cobalt	59
Oxygen	16	Argon	40	Nickel	59
Fluorine	19	Potassium	39	Copper	64
Neon	20	Calcium	40	Zinc	65

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S.T.E.M. Mathematics Link: Chemistry

Scoring Rubric

Part I: What Atoms Make Up Living Things?

Problem 1: Correct answer _____/5 points

Problem 2: Correct answer _____/5 points

Part II: An Atom Counting Exercise

Problem 1: Correct answer _____/5 points

Problem 2: Correct answer _____/5 points

Problem 3: Correct answer _____/5 points

Part III: Another Atom Counting Exercise

Problem 1: Correct answer _____/5 points

Problem 2: Correct answer _____/5 points

Problem 3: Correct answer _____/5 points

Part IV: Solving Systems of Equations Algebraically

Problem 1:

Correct system of equations _____/ 10 points

Correct answers _____/ 10 points

Accurate identification _____ /10 points

Problem 2:

Correct system of equations _____/ 10 points

Correct answers _____/10 points

Accurate identification of Molecules _____ /10 points

Name_____ _____ / 100 points