Read, Annotate, and Analyze: "Atomic Zoom In"

Directions: Read the following article. As you read, annotate it by adding comments and answer the embedded questions throughout. Try to use **each** of the following annotations with the symbols at least once as you read. You should have at least one annotation per page.

! Main Idea: Underline and add a **"!"** symbol for the sentence you think is the article's main idea

? Question: Choose a word/sentence that you have a question about or is confusing. Add a comment, add the **"?"** symbol to the comment, and explain your question or confusion.

∞ Connection: Choose a word/sentence and add a comment with the '∞' symbol when you make a connection. Explain your connection and remember that there are many types of connections but here are a few possible categories: (Types of connections: A- connection to self, B- connection to the science/content, C- connection to the world)

★ Interesting: Add a comment with a **"★"** symbol when you read something that you think is interesting and explain why you find it interesting.

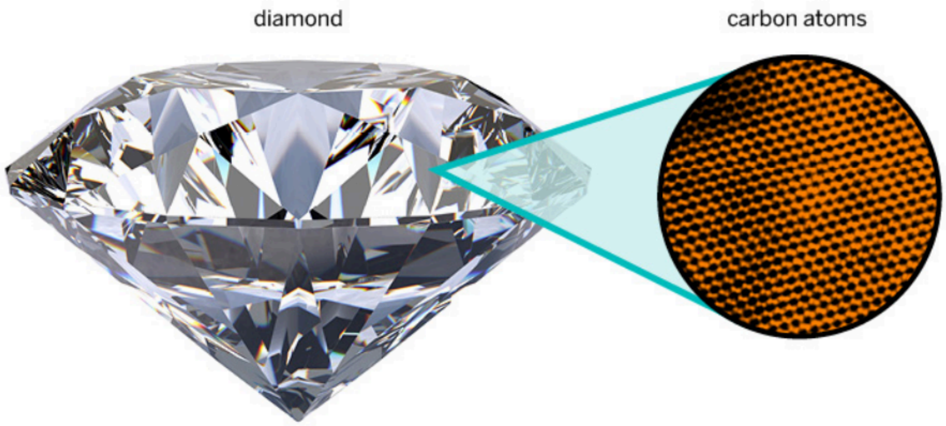
How to add a comment:

1. Highlight a word or sentence and click on the "+" symbol to the right to add a comment
2. Highlight and double/right click until **Comment** option appears and click on it
3. Highlight the word/sentence and then click on "insert" then **Comment**
4. Highlight the word/sentence and then use the shortcut "Ctrl+Alt+M" to insert a comment

****** Add a symbol at the beginning of your comment.**
******* Make sure you save each comment***

→ **Finally**, answer the analysis questions embedded within the article (inside the boxes), **and** at the end as you move through the article.

Atomic Zoom-In: Comparing Substances at a Very Small Scale



Diamonds are made of just one kind of atoms, called carbon atoms.

Imagine you are eating breakfast. The wooden table you're sitting at is hard, your orange juice smells sweet, and the sugar in your sugar bowl is white. The day has just begun, but you've already come into contact with many **substances**, each of which has its own set of **properties**. What is it that gives these substances their different properties? To understand where these differences come from, scientists observe substances at a very small scale—much smaller than we can observe in our daily lives. Let's zoom in and see what we find. What is matter actually made of?

In the 1800's, John Dalton was the first to propose the idea that all matter is made of tiny pieces called atoms. Today we call this "the atomic theory." Since it is a theory it may sound like scientists are not sure about it, but a scientific theory is an idea that has a lot of evidence that many scientists have gathered over a long time. Even today scientists continue to gather evidence that all matter is made of atoms!

Atoms are too small for us to see, but scientists currently know of 118 different types of atoms in the universe, including oxygen, carbon, silver, and gold. Every substance is made of a unique combination of atoms. Substances can be made of just one type of atom or a specific group of atoms that repeats over and over. Chemists represent these groups of atoms using **chemical formulas**: letters and numbers showing the types and numbers of atoms that repeat to make up a substance (example H_2O_2, the chemical formula for hydrogen peroxide). Substances have different properties because they are made of different types and numbers of atoms that repeat.

Connection:
What are the **3 parts** of an atom **and** what are their **charges**?
1) Neutron/neutral
2) Electron/negative
3) Proton/positive

How Atoms Make Your Orange Juice Smell Good and Your Socks Smell Bad

Have you ever noticed how good orange juice smells when you pour yourself a glass? You may be surprised to learn that for many brands of orange juice, the aroma is added. Orange juice is often kept in big tanks for a time before it is packaged and shipped. The juice needs to be processed in order to keep it from spoiling. This processing can cause the pleasant orange scent and flavor to fade. To address this problem, chemists add a substance that makes the packaged juice smell and taste like fresh-squeezed oranges. That substance is called ethyl butyrate (EH-thul BYOO-tuh-rate).

Ethyl butyrate is a naturally occurring substance found in many fruits. If you examine a sample of ethyl butyrate, you might observe that it is a clear liquid with a strong smell of pineapple or orange. It has a chemical formula of $C_6H_{12}O_2$, which means it is always made of groups of 6 carbon atoms, 12 hydrogen atoms, and 2 oxygen atoms. This group of different atoms forms a pattern—it repeats over and over again to make up the substance. The more times the pattern repeats, the more ethyl butyrate you have. Even very small differences at the atomic scale can have important effects on the properties of a substance. One substance that is similar to ethyl butyrate at the atomic scale is called Isovaleric (EYE-so-vuh-LAIR-ick) acid. If you were to observe the properties of Isovaleric acid, you would see that it is also a colorless liquid, but you would never get it confused with ethyl butyrate. Why? Instead of the pleasant smell of citrus, you would smell something similar to sweaty gym socks. Gross!

Why do these two substances have different properties? Looking more closely at the atoms in Isovaleric acid, you can see that it is made of groups of 5 carbon atoms, 10 hydrogen atoms, and 2 oxygen atoms, so its chemical formula is $C_5H_{10}O_2$. Ethyl butyrate and Isovaleric acid have different properties because the atoms that make up each substance are grouped differently. Isovaleric acid has one fewer carbon atom and 2 fewer hydrogen atoms. These atoms are also arranged in a different 2 patterns. At the atomic scale, these seem like small differences, but even small differences are enough to give the two substances very different properties.

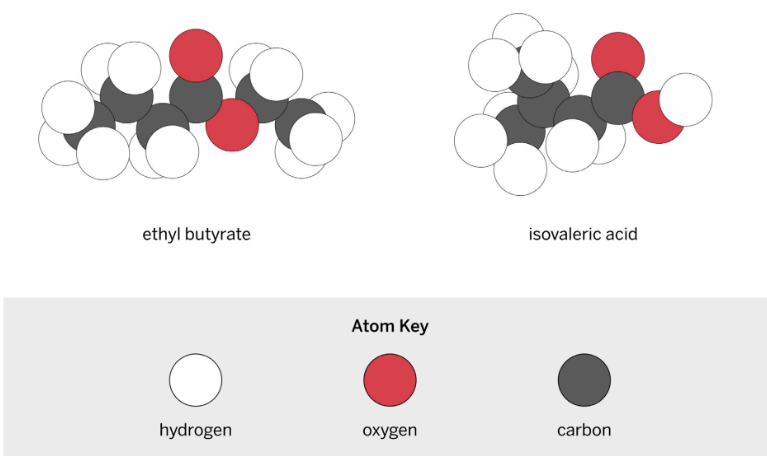
Analysis Question: (Look back the text to answer the questions)

- How are the two molecules- Ethyl butyrate & Isovaleric acid- different at the **molecular** scale?

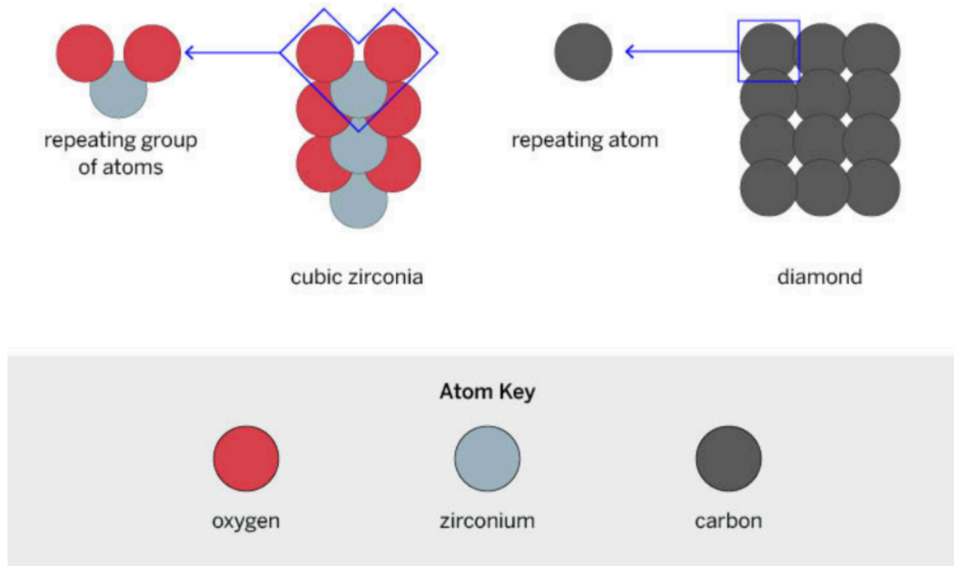
→Isovaleric acid has one less carbon and two less hydrogen.

- How does this difference result in different **physical properties**?

The difference in molecules causes a different smell to be applied.



Ethyl butyrate (left) and Isovaleric acid (right) are both made up of repeating groups of carbon, hydrogen, and oxygen atoms. However, one smells like citrus and the other smells like sweaty gym socks!



Diamonds are made of carbon atoms stuck together in a repeating pattern, while cubic zirconia is made of zirconium and oxygen atoms stuck together in a repeating pattern.

Are These Diamonds Real? Chemistry in Jewel Trading

Diamonds come from deep inside Earth and are often polished and used in jewelry. Because they are very popular, they are also very expensive! Due to the high price of diamonds, jewelry makers sometimes use substances that share some of the same properties as diamonds, but cost less. One of these substances is a human-made material called cubic zirconia. At first glance, cubic zirconia and diamond look very much alike: both are clear, shiny, and solid at room temperature. However, diamonds and cubic zirconia do not share all of the same properties. For one thing, diamonds are the hardest naturally occurring substance that we know of, so they are very hard to scratch. In fact, diamonds are often used in saws to cut very hard things, like stone. Cubic zirconia is not as hard as diamond—it can be scratched easily, and isn't nearly hard enough to cut through stone. Diamond and cubic zirconia are also different in other ways, such as melting point.

Diamond and cubic zirconia have different properties because they are made of different atoms. Diamond is made of carbon atoms packed together tightly, and its chemical formula is a single letter, C, which stands for carbon. Diamond is always made of carbon atoms stuck together in a repeating pattern. Cubic zirconia is made of groups of one zirconium atom and two oxygen atoms. Its chemical formula is ZrO_2. This atom group repeats to make up a cubic zirconia gemstone. If a gemstone is made of atoms other than carbon, chemists can tell that it isn't a real diamond.

Reflection Question:

- Why do you think scientists created a man made material like cubic zirconia, that shares similar properties, but is not made up of the same atoms?

→I believe the reason is that diamonds are very rare, they perfer make really any amount out of common things that can look similar.

Substances are made of atoms or groups of atoms that repeat. The number and type of atoms that repeat are different for different substances. Diamonds are made of *just* carbon atoms repeating. Cubic zirconia is a different substance because it has a different group of atoms that repeat- ZrO_2.

Fresh orange juice smells good because it contains a certain molecule.

All substances are made of groups of repeating atoms, but these groups can take different forms. In some cases, like ethyl butyrate from orange juice and Isovaleric acid from sweaty socks, these repeating atom groups form separate units called molecules. Individual molecules are not connected to the molecules next to them. Many of the substances that you encounter every day, such as air and water, are made of individual molecules. In other cases, like cubic zirconia and diamond, these repeating atom groups link together to form large networks known as extended structures. In extended structures, the atom groups repeat over and over again with all of the atoms connected to their neighbors. Besides diamond and cubic zirconia, there are many other substances made of atoms that form extended structures, such as graphite, metal, and even salt crystals. However, whether they form individual molecules or extended structures, atoms are the basic ingredients that make up every substance and determine its specific properties. Differences at the atomic scale are what make substances look, smell, and feel the way they do.

Analysis Question: (Look back the the text to answer the question)

- What is an extended structure?

→ repeating atom groups linking together to form large networks.

Connection Question:

- Why is it useful for chemists to study substances on both the macroscale and the molecular scale? Explain your answer in 3-5 sentences

It is useful for chemists to study substances on both the macro and molecular scales because it will give you more information. Say a chemist is investigating fire, on the macro scale, he can just say that's orange but with molecular scale too, he can say that he's sure it's orange and that's he's sure that the fire is a plasma too. That can apply to pretty much anything too, to use a different example, I can say that's a white solid, i think but with a microscale too, I can be sure of that.