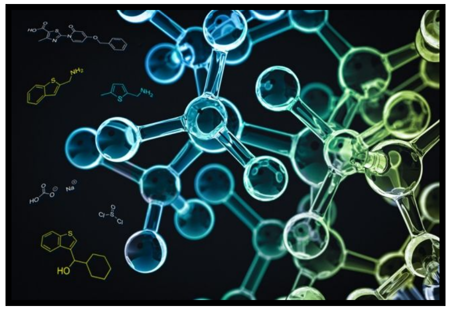
Name: ____ Packet Due Date: ________

Science

Module 3	**Chemical Reactions**
Chapter 3	**Focus Question** *Why did adding a gummy bear cause a chemical explosion?*


Lessons & Objectives

Lesson 1:
- ❑ I can explain what happens to the arrangement of atoms when a substance burns.

Lesson 2:
- ❑ I can observe a simulation and determine how molecules rearrange themselves during a chemical reaction.

Lesson 3:
- ❑ I can determine what properties of the gummy bear caused the explosive reaction.

Packet Completion Rubric

4	3	2	1	0
Nothing in packet is missing. Responses consistently meet ALL of the criteria for high quality work. Exemplary effort is evident throughout the entire packet.	Packet is 75-100% complete/accurate. Work/effort misses the criterion for high quality consistently.	Packet is 50-75% complete/accurate. Work/effort has evidence of quality but not consistently.	More than 50% of the packet is incomplete or incorrect. Work does not meet the expected level of quality.	Packet is entirely incomplete or not turned in.

Grading Breakdown: 0 - 1.9 = F 2 - 2.4 = D 2.5 - 2.9 = C 3 - 3.4 = B 3.5 - 4 = A

"Chemistry itself knows altogether too well that - given the real fear that the scarcity of global resources and energy might threaten the unity of mankind - chemistry is in a position to make a contribution towards securing a true peace on earth."

Kenichi Fukui (Nobel Prize in Chemistry, 1981)

Lesson 1 Objective	I can explain what happens to the arrangement of atoms when a substance burns.

Do Now

$$2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$$

1. What do you notice about the physical states of each molecule?

2. How does this connect to what we saw on stage when Ms. Shikari added heat to the test tube? In other words, explain what we saw with our own eyes vs. on the molecular scale.

Video Notes

1) What happened to the paper when it burned?

2) What do you think happened to the atoms that compose the paper when it burned? Think about the Law of Conservation of Mass.

Article: What Happens When Fuel Burns

Read and Annotate:

When you burn wood in a fireplace, the wood is the fuel that keeps the fire going. Cars are powered by fire inside their engines; gasoline is the fuel that keeps those fires burning.

What Happens When Fuels Burn?

Most people burn fuels every single day. Fuels are substances that release energy when they burn. They are very important to us because we use the energy from burning fuels to do many things, such as run cars and buses, heat homes, and cook food. For example, gasoline is the fuel used in most car engines. When it burns, the energy it releases makes the car move. To prepare for a long trip, you fill your gas tank with gasoline—but after you drive for a while, the tank is empty and you need to fill it up again. What happened to the gasoline? Where did it go?

When we burn something—whether it is a log, a match, or the gasoline in our gas tank—what we are actually doing is causing a chemical reaction. Burning gasoline may not seem like the kinds of chemical reactions that you have seen before. After all, chemical reactions cause substances to change into other substances as the atoms of the reactants rearrange to form the products. When gasoline burns, it doesn't seem to change into a different substance. Instead, it seems to disappear, leaving you with an empty tank. If burning gasoline actually causes a chemical reaction to happen, then why doesn't your tank fill up with a different substance? Can a chemical reaction cause something to change into nothing?

Scientists began to wonder about this question back in the 1700s. Around this time, a French scientist named Antoine Lavoisier (an-TWAN la-VWA-see-ay) began studying what happened to the masses of substances before and after a chemical reaction. Mass is a measure of how much matter makes up an object. First, Lavoisier measured the mass of two reactants before mixing them to cause a chemical reaction. After the reaction had happened, he measured the mass of the products. Every time, Lavoisier found that the reactants and the products had the same mass! Through these experiments, Lavoisier helped come up with the idea we now call the Law of Conservation of Matter: matter cannot be created or destroyed during chemical reactions. This is because the atoms that make up all matter cannot be created or destroyed during chemical reactions. This law tells us that all of the atoms that go into a chemical reaction must come out in the form of one substance or another. Chemical reactions cause atoms to rearrange into new and different groups, but the atoms themselves never stop existing, and new atoms never appear out of nowhere.

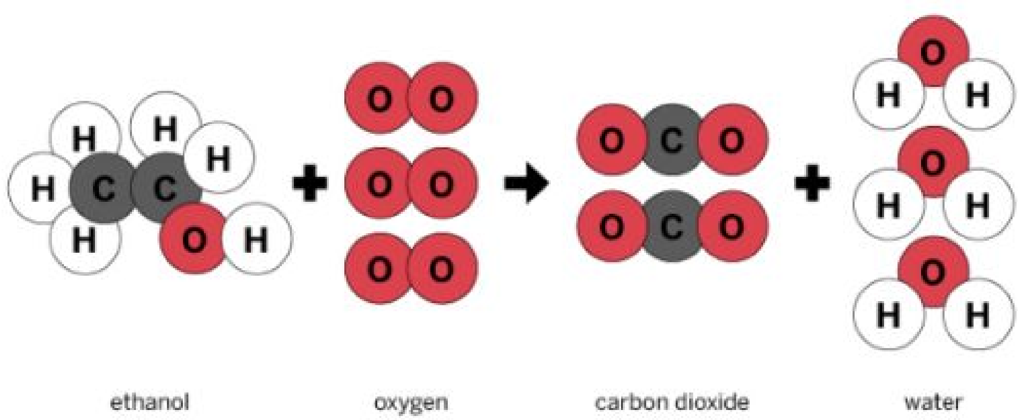
So what does the Law of Conservation of Matter have to do with burning gasoline? It means that even though your gas tank is empty, the atoms that formed the gasoline must still exist somewhere in some form. The only reason that these atoms seem to disappear is because the substances that form when gasoline burns are invisible gases. You can't see them, but they are there, and sometimes that isn't a good thing.

Carbon-Containing fuels

Gasoline is just one of many fuels that contain carbon. One of the most common fuels in use today is ethanol, a substance made up of groups of two carbon atoms, six hydrogen atoms, and one oxygen atom. Ethanol is made from corn and used as a substitute for gasoline. Like gasoline, ethanol is a colorless liquid at room temperature. When you burn anything, including ethanol, you are mixing it with oxygen. However, just having oxygen around isn't enough to make something burn; this reaction only happens at a high temperature. Burning reactions release energy in the forms of heat and light, but these chemical reactions result in more than just energy. See the diagram below to learn more.

The chemical reaction that happens when ethanol and oxygen mix produces two substances: carbon dioxide and water in the gas phase. Since both of these are invisible, colorless gases, it seems like nothing is left of the liquid that was in your gas tank. However, the atoms of the reactants haven't disappeared at all—they've only rearranged to form the products. The carbon dioxide and water produced by this chemical reaction enter the atmosphere whenever we burn ethanol or other carbon-containing fuels. In the recent past, humans have increased the amount of carbon dioxide in Earth's atmosphere by burning such fuels, resulting in widespread changes to Earth's climate. In response to these effects, scientists are working to find fuels that can release energy without producing carbon dioxide.

Burning ethanol at the atomic scale



Hydrogen Fuel

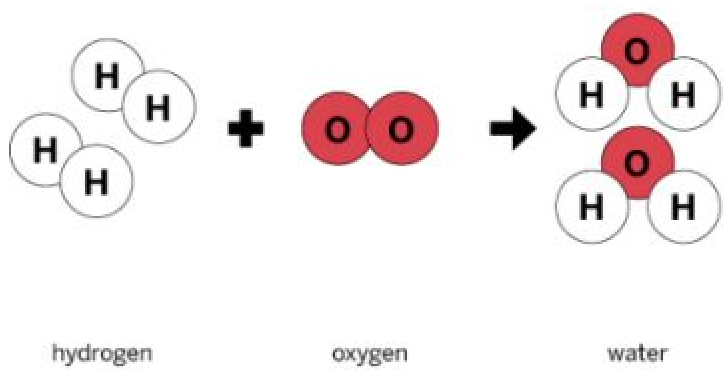
Like gasoline, hydrogen is a fuel that can be burned to power cars and buses. However, unlike gasoline, hydrogen does not contain carbon. It is a substance made up of hydrogen atoms. When you burn anything, including hydrogen fuel, you are mixing it with oxygen. Still, having oxygen around won't cause something to burn on its own; this reaction only happens at a high temperature. Fires are hot and bright because burning reactions release energy, but energy is not the only result of these chemical reactions. See the diagram below to learn more.

The chemical reaction that happens when hydrogen and oxygen mix produces only one substance: water in the gas phase. Since this is an invisible, colorless gas, you can't see it, which makes it seem like nothing is left behind by burning hydrogen fuel. However, the atoms of the reactants haven't disappeared at all—they've only rearranged to form the product.

The water produced by this chemical reaction enters the atmosphere whenever we burn hydrogen. Still, compared to the carbon dioxide that is produced when we burn gasoline, ethanol, and other carbon-containing fuels, the water produced by burning hydrogen has a less harmful effect on Earth's climate.

If we can power our cars with hydrogen without producing carbon dioxide, then why don't more vehicles use hydrogen fuel? Unfortunately, the technology needed to use hydrogen as a fuel is expensive, and storing hydrogen fuel can be difficult. Also, the most common way of getting pure hydrogen is by separating it from substances that contain carbon—so although burning hydrogen fuel does less harm to Earth's climate than burning carbon-containing fuels, the production of hydrogen fuel is still a problem for scientists trying to reduce climate change.

Burning hydrogen fuel at the atomic scale



When hydrogen burns, it mixes with oxygen, and the atoms of these reactants rearrange to form the product: water in the gas phase.

Exit Slip

Think about the annotations you made in the article, concepts you learned from previous lessons, and answer the following question: What happens to the atoms of a substance when it burns?

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Chapter 3

Guiding Question: What role did the gummy bear play during our chemical reaction?

Lesson 2 Objective:

I can observe a simulation and determine how molecules rearrange themselves during a chemical reaction

Do Now

Take a look back at your Lesson 1 exit slip from yesterday. Which of the following claims would you agree with and why?
Question:

What happens to the atoms of a substance when it burns?

Claim 1. All atoms were destroyed.
Claim 2. All of the atoms rearrange to form a different substance or substances.
Claim 3. Some of the atoms are destroyed, and some of the atoms rearrange to form a different substance or different substances.

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Key Concept

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Simulation Video 1

What atoms/elements did we start with?

____

____

What happened to the atoms during the reaction? Be specific with your observations.

What was the resulting molecules at the end of the reaction?

Draw the molecules in the reaction that just occurred!

_______________ + __________________ → _______________________

Simulation Video 2

What atoms/elements did we start with?

____

____

What happened to the atoms during the reaction? Be specific with your observations.

What was the resulting molecules at the end of the reaction?

Draw the molecules in the reaction that just occurred!

_______________ + __________________ → _______________________

When you eat, some of the atoms in your food are rearranged through chemical reactions and become part of your body. Without food, our bodies wouldn't be able to grow.

What Happens to Your Food?

Your body needs food to make it grow. Food gives your body the energy it needs to run properly. Food also provides the matter your body needs to add more cells and get bigger. How does that actually work—how does what you eat become part of your body? Without chemical reactions, your body wouldn't be able to use food at all.

Atoms can't be created or destroyed, only moved around and combined into different types of molecules and complex structures. This is as true in your body as it is anywhere else in the universe. The atoms in the food you eat either stay in your body and are rearranged into new substances there or pass through your body and become your waste.

The food you eat doesn't stay in the delicious form you recognize for long: as soon as it goes into your mouth, your body starts breaking it down. The molecules from the food are rearranged into simpler molecules and extended structures that your body can use to meet its needs. These rearranged molecules can be used by the body to release energy or to support growth.

The molecules your body can use fall into a few different categories, like starches, amino acids, and fats. Starches are molecules your body breaks down and uses to release energy. Releasing energy happens during a chemical reaction called cellular respiration, which is similar to burning. During cellular respiration,

Through chemical reactions in the body, food allows us to grow from babies into children, then teenagers, then adults.

the atoms from the molecules your body has broken down are combined with oxygen and rearranged to form carbon dioxide and water. Amino acids are molecules that make up larger molecules called proteins, which form muscle tissue and perform many other functions in the body. Amino acids become proteins through a chemical reaction. Fat molecules in your food remain fat in the body, which is used to protect your organs and keep you warm. Fat can also be used to release energy through a chemical reaction.

Without chemical reactions, food wouldn't be very helpful to your body. You wouldn't be able to get energy from it, and you certainly wouldn't be able to grow and mature from a baby into a child, a teenager, and then an adult. So next time you notice a growth spurt, thank the chemical reactions that take place in your body!

How does this article connect to the chemical reaction videos we saw earlier?

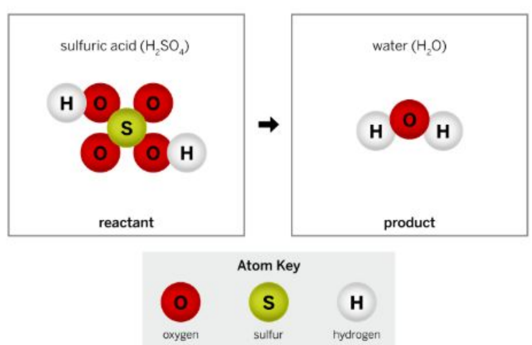
Exit Slip
Mya was investigating a chemical reaction. When she heated up the substance, she found that sulfuric acid changed into water. She made the following atomic-scale model to show what she thinks happened. Do *you* think this is a complete model of what happened during the chemical reaction? Explain your answer. ____ ____ ____ ____

Lesson 3

Objective: I can determine what properties of the gummy bear caused the explosive reaction.

Do Now

Let's take a look at Mya's reaction from yesterday (exit slip). What is the reaction missing (if anything)? Why do you think Mya may have missed a reactant/product?



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Think-Pair-Share
If we look back to Chapter 2, we are familiar with the first reaction that occurs when the potassium chlorate is heated (as seen below):

$$2KClO_{3(s)} \longrightarrow 2KCl_{(s)} + 3O_{2(g)}$$

Check for understanding - Think-Pair-Share:

1. What type of reaction is this again? ____________________________

2. What product do you think is going to be involved in the SECOND reaction when the gummy bear is added? Why do you think that?

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The second reaction
Were you right with the product from the first reaction (oxygen)? What do you think the missing reactant is? Turn and talk with a neighbor to determine the missing reactant! Remember to balance your chemical equation!

$$? + 6O_{2(g)} \longrightarrow 6CO_2(g) + 6H_2O(g)$$

What do you think the missing reactant is? ____________________________________

Key Concept
During a chemical reaction, all of the atoms that make up the ______________________ rearrange to form the ___________________.

This missing reactant

$$\underline{\hspace{4cm}} + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(g)$$

1. What the missing reactant in the chemical equation? ________________________________
2. What is the name of the reactant? ________________________

Modeling Tool Directions & Brainstorming Space
One of the most important skills a chemist can have is the ability to connect what happens on the macroscale to the molecular scale. With a partner, you will recreate the reaction by modeling out both the steps of both reactions on the macroscale and on the molecular scale. Take a moment to review the rubric with your teacher with how you will be graded. One partner will serve as the expert for the molecular scale (the reactions we saw in the auditorium with Ms. Shikari). The other partner will be the expert on the molecular scale. Both people are responsible for the entire model and for making sure both sides are complete and compatible. At the discretion of your teacher, you will present in either small groups or in front of the class next science class. Brainstorm section: 1. Molecular and Macroscale brainstorming section: 2. Writing Caption brainstorming section:

Modeling Tool Rubric:

	4 (Exceeds Standard)	**3** (Meets Standard)	**2** (Approaching Standard)	**1** (Did not meet standard)	**0** (Missing)
Molecular scale depiction	The depiction of the molecular scale ***clearly*** shows both reactions, including all atoms and the correct rearrangement of atoms.	The depiction of the molecular scale shows shows both reactions, including all atoms and the correct rearrangement of atoms.	The depiction of the molecular scale attempts to show both reactions, but may be missing atoms or lacks clarity.	The depiction of the molecular scale is missing one reaction or both reactions are incomplete (missing multiple atoms, etc.).	The depiction of the molecular scale is completely missing.
Macroscale depiction	The depiction of the macroscale ***clearly*** shows both reactions, including all steps, reactants, and products.	The depiction of the macroscale shows both reactions, including all steps, reactants, and products.	The depiction of the macroscale attempts to show both reactions, including all steps, reactants, and products, but may be missing a step or lacks clarity.	The depiction of the macroscale show both reactions, including all steps, reactants, and products, but may be missing a step or lacks clarity.	The depiction of the macroscale is completely missing.
Written descriptions	The written captions ***clearly*** capture the reactions at both the macroscale and molecular scale and use scientific language.	The written captions capture the reactions at both the macroscale and molecular scale and use scientific language.	The written captions attempts to capture the reactions at both the macroscale and molecular scale and use scientific language, but may be missing some key details/scientific language.	The written captions miss much of the key information to accurately and completely describe reactions on the macro and molecular scale.	The written descriptions are missing entirely.
Conventions and aesthetics	Model is aesthetically pleasing and completely encapsulates all steps at the macro and molecular scale. It is clear that a lot of effort was put into the model. No grammatical errors in the written captions.	Model is aesthetically pleasing and completely encapsulates all steps at the macro and molecular scale. There may be a few grammatical errors, but does not take away from meaning. written captions	Model is lacking color and neatness and does not encapsulate all the steps at the macro and molecular scales. There are a lot of grammatical errors in the written caption.	Model is missing either depictions at the molecular and macro scales or is missing the written captions.	No model present.
Total points /16					

Peer Feedback Notes (optional):

Final Model Template

Name: ____ Partner Name:____________________________________

Modeling the reaction of potassium chlorate and a gummy bear.
The reactions on the macroscale:
Writing caption (describing the reactions above on the macroscale): ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Modeling the reaction of potassium chlorate and a gummy bear.
The reactions on the molecular scale:
Writing caption (describing the reactions above on the molecular scale): ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________