1.2 - Matter & Energy Unit, Packet 2

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: How does burning change matter & energy?

Anchoring Phenomenon: Ethanol is a clear liquid that looks like water. However, unlike water, ethanol burns easily. Why does ethanol burn but water does not? And how do molecules of ethanol change when it is combusted? We'll explore how atoms and energy are changed by combustion reactions.

Deeper Questions

1. What happens to the atoms in molecules during combustion?
2. What happens to energy in molecules during combustion?
3. How does what we can observe during combustion (e.g., heat & light) relate to the changes happening at the molecular level?

Schedule

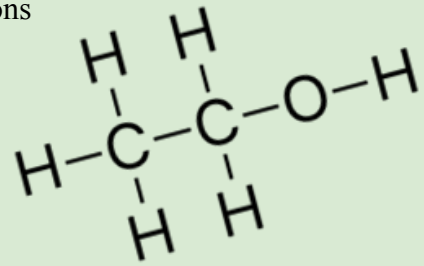
Part 1: Introduction
- Initial Ideas & Data Dive
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

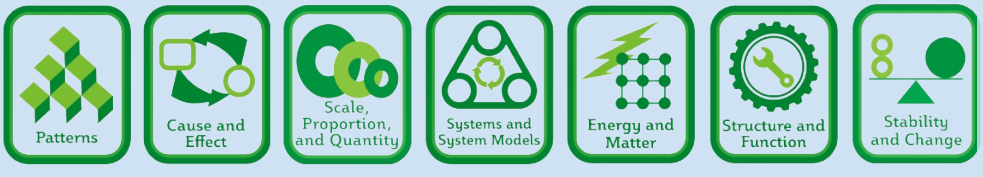
Part 3: Investigation
- Molecular Modeling

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Combustion in Our State



NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do enzymes change molecules?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Part 5 EIA Data; Combustion Basics Poster;

Part 1: Introduction – Changing Molecules (1.2.1)

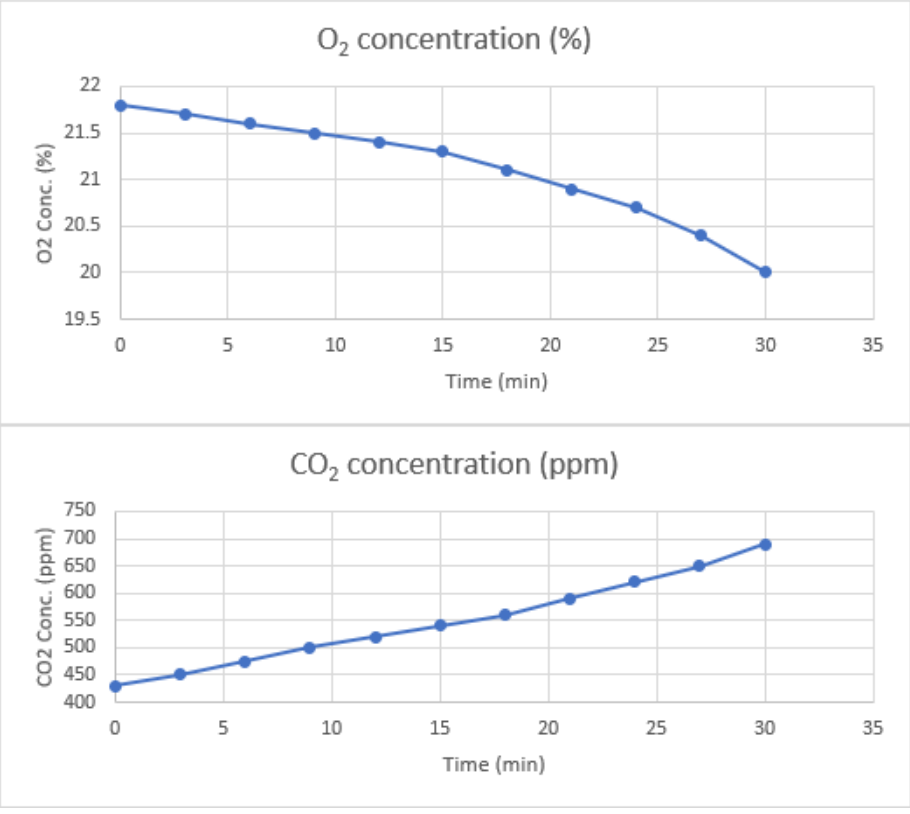
Overview: In this activity, you will begin by discussing your initial ideas about what happens to molecules when something burns. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence

1. A group of students observe ethanol burning in a sealed container. As ethanol burns, the levels of oxygen and carbon dioxide in the air change. Students are asked how & why burning ethanol affected the levels of oxygen and carbon dioxide. **Do you agree or disagree with each student's claim**?
    a. Daryll: "Some oxygen atoms in the air were turned into carbon atoms by the fire to make CO_2."
    b. Nina: "Oxygen from the air was destroyed in the fire; CO_2 molecules came from the ethanol."
    c. Oscar: "The atoms in oxygen and ethanol molecules were rearranged to make CO_2 molecules."
2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

A class is conducting an experiment. They ignited a petri dish of ethanol inside of a sealed box. The box contained sensors that recorded changes in the amount of oxygen (O_2) and carbon dioxide (CO_2) in the air within the box. These changes were recorded in 3-minute intervals. The data is shown below.



***How to read these graphs**: The top graph shows changes in oxygen (O_2). The bottom graph shows changes in carbon dioxide (CO_2).*

The horizontal x-axis for each graph shows the change in time. The vertical y-axis for each graph shows the change in the amount of each gas (% O_2 and ppm of CO_2).

To determine trends in each graph, match each point on each line with where it lines up on the x- and y-axis.

For example, at three minutes, O_2 was at 21.7% and CO_2 was at 450 ppm. At 6 minutes, O_2 levels were lower and CO_2 levels were higher.

Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*

1. **Begin by individually attempting to make sense of this data**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **Based on this data, what is one conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
4. **Based on this data, what is a second conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
5. **Does this data support or refute any of the initial claims on the previous page?** If so, explain.
6. **Both ethanol and water are clear liquids. Why does ethanol burn but water does not?**

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

What happens to the matter and energy in ethanol molecules when it is combusted? Write down an initial explanation in the space below. Don't worry if you aren't completely sure about this. You will come back and revise this explanation as you gain more information during this unit.

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 2: Core Ideas (1.2.2)

Overview: In this activity, you will begin with a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What is a chemical bond? In a picture of a molecule, what represents a chemical bond?
2. How can molecules contain energy if matter and energy are separate things?
3. What is a high energy bond? How do we know if a substance has high energy bonds?
4. What determines if a molecule can be a "fuel"? What determines the amount of energy contained within a molecule?
5. Gasoline, ethanol, and sugar are examples of "high energy" molecules. Why?
6. What must happen to molecules with high energy bonds to transform its chemical energy into other forms of energy (such as light, heat, and motion)?
7. Where does the heat, light, and motion energy of a flame come from?
8. "Combustion reactions are rearrangement reactions." Explain this in your own words.
9. Both ethanol and water are clear liquids. Why does ethanol burn but water does not?
10. True or false: the amount of atoms and the amount of energy that exists after combustion ends is the same as before combustion began. Explain.
11. Explain combustion in a way that specifically addresses our "three rules" of matter & energy: 1) All matter is made of atoms. 2) Atoms last forever. 3) Energy lasts for forever.
12. Why is a spark needed to start a fire?

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

What happens to the matter and energy in molecules when a substance is combusted? Based on this new information, how would you now respond to this question?

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 3: Molecular Modeling (1.2.3)

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. How can molecules contain energy if matter and energy are separate things?
2. What is a high energy bond? What are examples of this? How does it relate to if something burns?
3. Both ethanol and water are clear liquids. Why does ethanol burn but water does not?
4. What happens to the matter and energy in molecules when a substance is combusted?

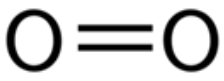
This activity was completed _____ (*instructor signature*)

Overview: In this investigation, you will create molecular models to explore what happens to matter and energy during combustion. In science, *models* are tools that help us clarify our thinking and make more accurate predictions. Models can be pictures, examples, physical objects, or anything that helps us reason more accurately about a concept. Use the following instructions to create each of your molecular models.

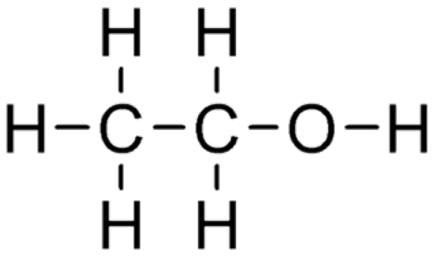
Materials needed for both investigations (per group): modeling clay (such as PlayDoh or Plastilina) with at least three different colors; toothpicks; gold twist-ties or tape; paper towel (to protect tabletops from residue).

Directions - *Carefully read the directions below <u>before</u> beginning. Record info where prompted.*
SEP: Developing & Using Models

1. **Using the modeling clay provided, create <u>three</u> molecules of oxygen gas (O_2).**
   a. You will need six balls of one color to represent oxygen atoms.
   b. Using this image as a guide, connect two oxygen atoms using two toothpicks.
   c. Repeat these instructions until you have three molecules of oxygen (O_2).



2. **Using the modeling clay provided, create <u>one</u> molecule of ethanol (C_2H_5OH).**
   a. Using the same color as you used previously for oxygen, create one ball of that color for the oxygen atom.
   b. Using a different color, create two balls of that color for the carbon atoms.
   c. Using a third color, create six balls of that color for the hydrogen atoms.
   d. Using this image, connect these atoms (one toothpick between each atom).
   e. Mark any high energy bonds (C-C and C-H) with a twist tie, piece of tape, or any other physical marker that your instructor has provided.

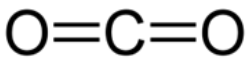


3. **When you think you are finished, raise your hand and show your instructor.**

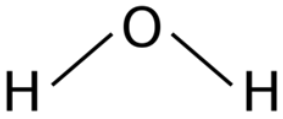
This activity was completed _____ (*instructor signature*)

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

4. **Disassemble your O_2 and ethanol molecules. Using the same clay atoms you used to create the oxygen gas and ethanol molecules, create CO_2 and H_2O using the following instructions.**
5. **Create two molecules of carbon dioxide (CO_2).**
   a. Using this image as a guide, connect a carbon atom to two oxygen atoms using four toothpicks (two toothpicks for each oxygen atom).
   b. Repeat for a second molecule.



6. **Create three molecules of water (H_2O).**
   a. Using this image as a guide, connect a carbon atom to two oxygen atoms using two toothpicks (one toothpick for each hydrogen atom).
   b. Repeat until you have 3 molecules.



7. **Mark any high energy bonds** (C-C and C-H) with a twist tie, piece of tape, or any other physical marker you received.
   a. Make a separate pile for any unused high energy bonds.
8. **Based on the core ideas from this week, explain how each of these molecules relates to what happens when ethanol is combusted.** Also explain what happens to any leftover high energy bonds.
9. When you think you are finished, raise your hand and show your instructor.
   a. While you are waiting for their approval and after they give their approval, complete the post-investigation questions in the next section.
   b. Disassemble your molecules and put away materials only *after* you get approval.

This activity was completed _____ (*instructor signature*)

Post-Investigation Questions - *Record your ideas in the spaces below.*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

1. **How do atoms in ethanol and O_2 relate to the atoms in CO_2 and H_2O? Are they the same atoms?**

_____

_____

2. **Are there any high-energy bonds (C-C or C-H) in ethanol (C_2H_5OH) or oxygen (O_2)?** Yes / No
(circle one)

Are there any high-energy bonds (C-C or C-H) in carbon dioxide (CO_2) or water (H_2O)? Yes / No
(circle one)

How does this relate to the flames we observe during combustion?_____

_____

_____

3. **Based on your results, what happens to the atoms in ethanol & oxygen during combustion?**

4. **Based on your results, where does the energy of the flame (heat, light, motion) come from?**

Be prepared to discuss and defend your ideas in small groups and as a class.

Part 4: Review & Assessment (1.2.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check (link on pg. 1). If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections – Combustion in Our State (1.2.5)

Adopted with permission from Carbon TIME.

Background - *Complete the reading before answering the questions below.*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

Background: *Natural gas is a blend of gases formed from ancient plants and animals. The main component of natural gas is methane (CH_4). When methane molecules are combusted, they are rearranged with oxygen to form carbon dioxide (CO_2) and water (H_2O) molecules: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$.*

Natural gas is a fossil fuel and cannot be replaced as quickly as it is consumed. As such, it is limited in supply. In the US, a significant portion of the electricity is generated by burning fossil fuels. The heat produced during this burning process is used to convert water into steam. This steam powers a turbine to generate electricity. Natural gas is also commonly used for heating homes, to power stoves, and provides heat for dryers and water heaters. You might even notice natural gas outlets in your school labs for Bunsen burners.

Some states rely more on fossil fuels than others. Recently, there has been a growing emphasis on using renewable energy sources like wind and solar power. This shift is driven by both the rising costs of fossil fuels as well as the negative effects of increasing carbon dioxide levels in the atmosphere from combustion.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

What fuels and sources of energy are used in your state? Use the Energy Information Association website (https://www.eia.gov/state/) to complete the questions below.

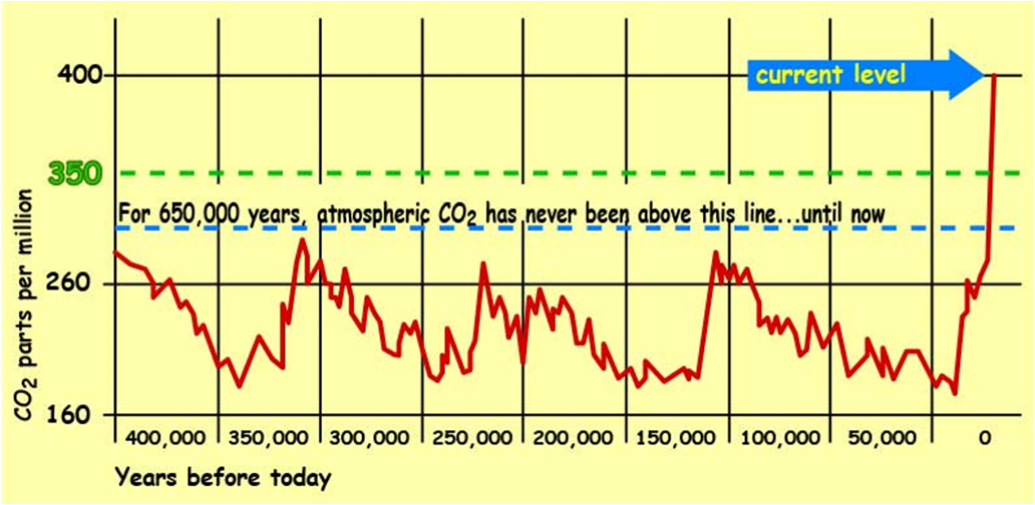
1. Based on this website, what are the top 4 energy sources for your state?

_____ _____

_____ _____

2. Do any of these energy sources involve combustion? Circle any above that do.

This graph is from NASA. It shows how carbon dioxide concentrations have changed over the past 500,000 years (Source: NASA).



3. Based on this data, what are two conclusions that would be supported by this data?

Conclusion 1: _____

Conclusion 2: _____

4. How might the energy sources used in our state relate to recent changes in CO_2 concentrations?

_____

5. What are the advantages & disadvantages of these energy sources? Discuss & record your ideas below.

Advantages	*Disadvantages*

6. If time allows, you can learn more about how electricity is generated from steam produced by combustion at the following web sites: https://www.youtube.com/watch?v=ouWOhk1INjo https://en.wikipedia.org/wiki/Thermal_power_station

Matter & Energy, Packet 2 Formative Assessment (1.2.4)

Name: _____Hour____Date:_____Score:_____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

Background: A class was trying to determine what happens to ethanol when it combusts. The teacher asks, "*What happens to the molecules in the ethanol as it is combusting*?" Three students shared their ideas.

1. Circle "Agree" or "Disagree" for each of the three claims below.

a) Daryll: "The atoms in the molecules of ethanol are being destroyed." Agree / Disagree
b) Nina: "The ethanol and oxygen molecules are being converted into energy." Agree / Disagree
c) Oscar: "The atoms in ethanol & oxygen are reorganized into different kinds of molecules." Agree / Disagree

2. Provide an explanation. Why did you agree or disagree with each student's claim?

a) _____

b) _____

c) _____

The teacher then asks, "*What happens to the energy in the ethanol as it is combusting*?"

3. Circle "Agree" or "Disagree" for each of the three claims below.

a) Daryll: "The chemical energy in the bonds of ethanol is changed to heat and light energy." Agree / Disagree
b) Nina: "The atoms in ethanol and oxygen molecules are being converted into energy." Agree / Disagree
c) Oscar: "Ethanol cannot contain energy because matter and energy are different things." Agree / Disagree

4. Provide an explanation. Why did you agree or disagree with each student's claim?

a) _____

b) _____

c) _____

5. The teacher then asks, "Why does ethanol burn but water does not?" Provide an explanation:

_____

_____

Remember the following "rules" for energy and matter:

- All solids, liquids, and gasses are made of tiny particles called atoms. Atoms can bond together to form molecules (e.g., water molecules consist of 1 oxygen atom & 2 hydrogen atoms).
- In biology, atoms last forever. Atoms cannot be created or destroyed or turned into energy (e.g., a carbon atom is always a carbon atom). If something gains mass, it gains atoms. If it loses mass, it loses atoms. Atoms found in molecules can be rearranged to form new molecules.
- In biology, energy lasts forever. Energy cannot be created or destroyed. Energy can exist as light, heat, motion, or as chemical energy stored in the bonds of molecules. Energy in one form can be transferred into a different form (e.g., light energy can be transformed into heat energy).

This page is intentionally blank. Use for notes or other purposes as needed.