**Formative Assessment Exemplar - 8.1.6**

**Introduction:**

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS A LESSON FOR STUDENTS.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

**General Format:**

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

**Accommodation Considerations**:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

**References:**

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

**Teacher Facing Information**

**Standard:** 8.1.6

**Assessment Format:** Online Only (Requires students to have online access)

| **Phenomenon** | |
|---|---|
| A few students were building a campfire with one of their parents. One of the students noticed that after the fire died down, the wood was much smaller than it had been from the start. Curious, they wondered where the wood had gone. | Proficient Student Explanation of Phenomenon:<br><br>Students need to show that matter is conserved by explaining that there needs to be the same number of oxygen, hydrogen, and carbon molecules on each side of the equation. |
| **Cluster Task Statement** | |
| (Represents the ultimate way the phenomenon will be explained or the design problem will be addressed)<br>In the following questions, you will be using a model of wood in a campfire to explain whether or not matter is conserved. | |
| **Supporting Information** | |
| https://www.youtube.com/watch?v=EqqpcFj8G-s&t=22s<br><br>A group of students are at summer camp. To start a fire, they need wood ($C_6H_{10}O_5$), oxygen ($O_2$) and energy. As the fire burns, it produces carbon dioxide ($CO_2$) and water ($H_2O$). Carbon dioxide and water are invisible, so the students cannot see them come off the fire. | |

**Figure 1: Campfire**

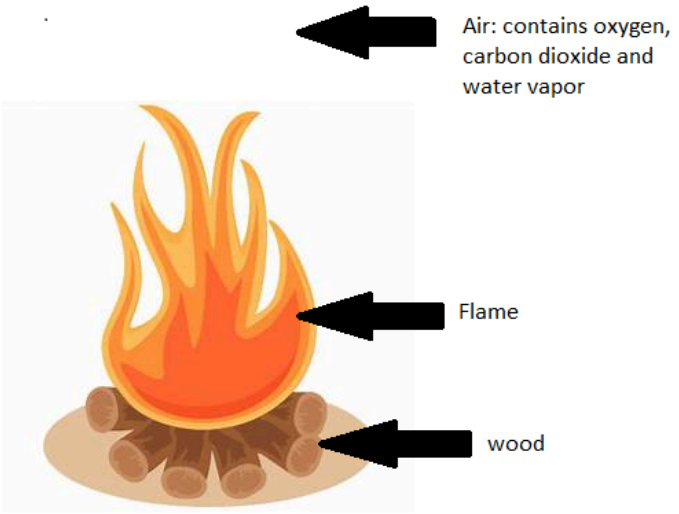



Figure 1 shows the parts of a campfire.

**Table 1: Mass of each material in a campfire**

| Material | Wood | Oxygen | Carbon Dioxide | Water Vapor |
|---|---|---|---|---|
| Mass (kg) | 2.32 Kg | 2.75 Kg | 3.78 Kg | 1.29 Kg |

Table 1 shows the mass of each material in a campfire.

**Chemical reaction of burning wood:**

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

Relaxing Campfire Video

**Cluster Questions**

Gather:
Cluster Question # __1__
Question Type: **Table Match**
Addresses:
_X_DCI (PS1.B)
X_SEP (Obtaining info)
__CCC
Answer:

Question 1:
The students remember learning about reactions in science class. a student asks, "When we light a fire, what are the **products** and what are the **reactants**?"

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

Using the chemical equation above, help this student identify each.

| Name of molecules in **products** | Name of molecules in **reactants** |
|---|---|

| Products | Reactants |
|---|---|
| Carbon dioxide, water vapor | Wood, oxygen |

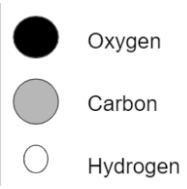
| | |
|---|---|
| | |

Gather:
Cluster Question #__2____
Question Type: **Multiple Choice**
Addresses:
__X__ DCI (PS1.B)
__X__ SEP (Modeling)
__X__ CCC (Matter)
Answer:
B. Jorge

Question 2:

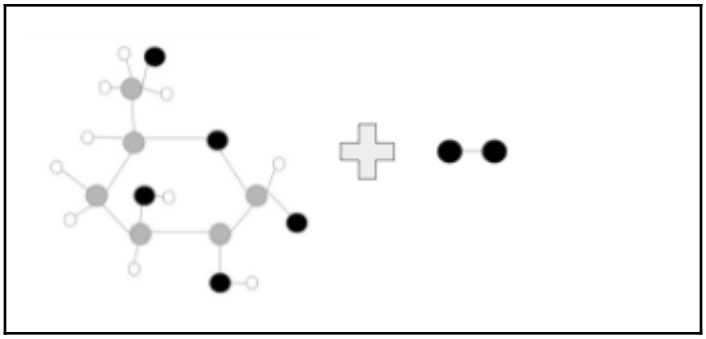
Reaction:
$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT → $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

Key:

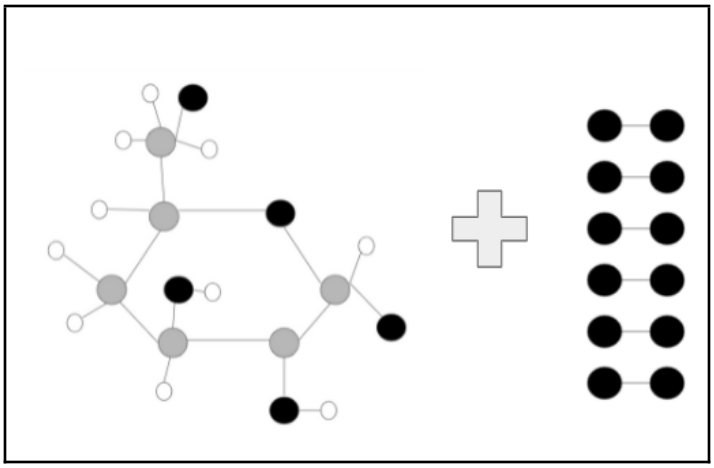



Before the students light the fire, they draw models of the molecules. Which model do you agree with?

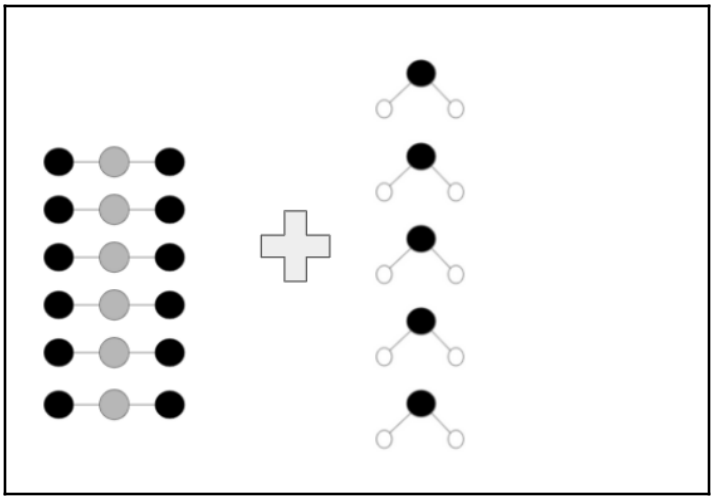
A. Student A



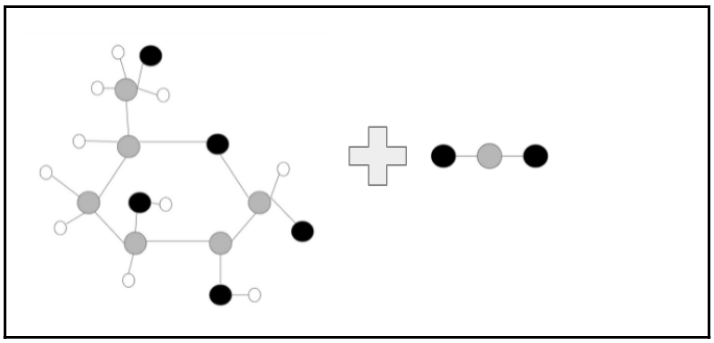
B. Student B



C. Student C



D. Student D



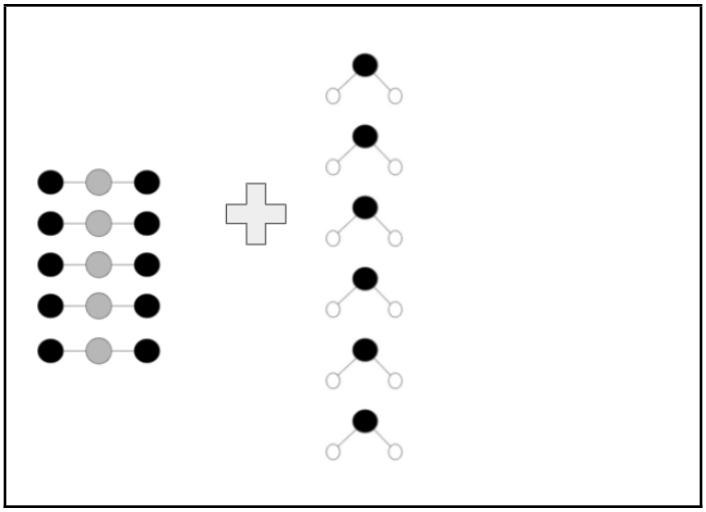
Gather:
Cluster Question # _3__
Question Type: Multiple Choice
Addresses:
_X_DCI (PS1.B)
X__SEP (Models)
_X_CCC (Matter)
Answer:
C. Carissa

Question 3:

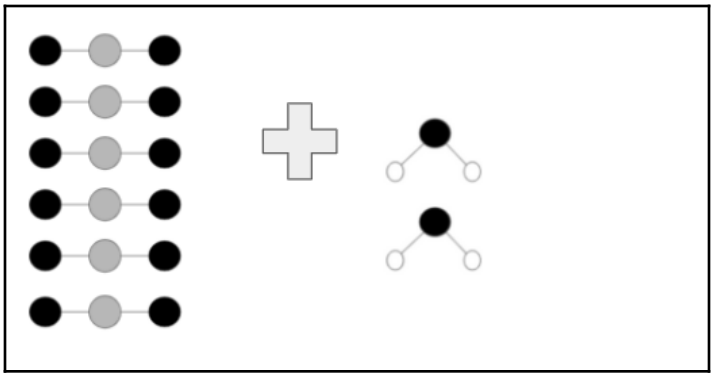
$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT → $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

After the fire is lit, the students observe what they see and draw models of the molecules. Which model do you agree with?

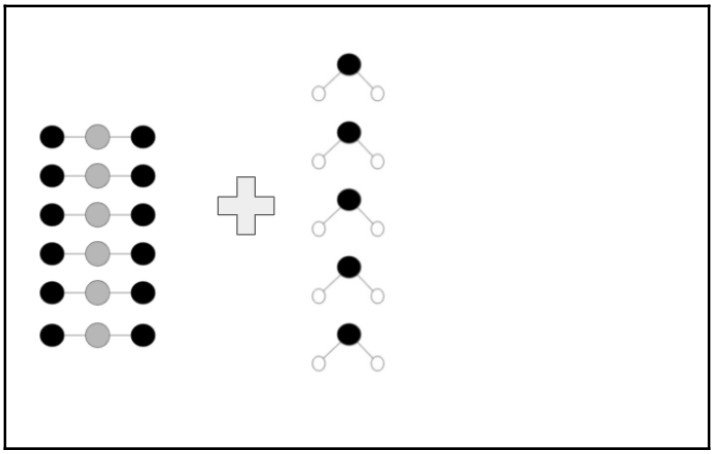
A. Student A



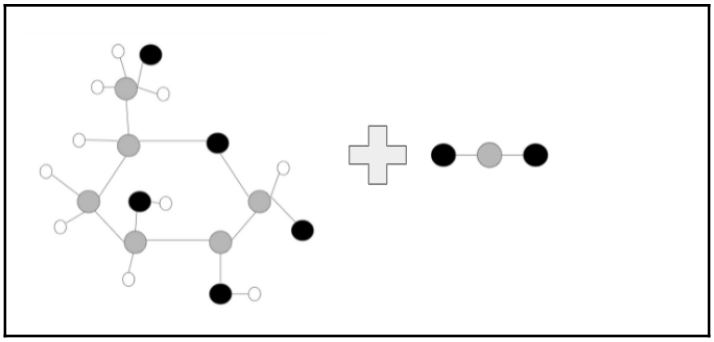
B. Student B



C. Student C



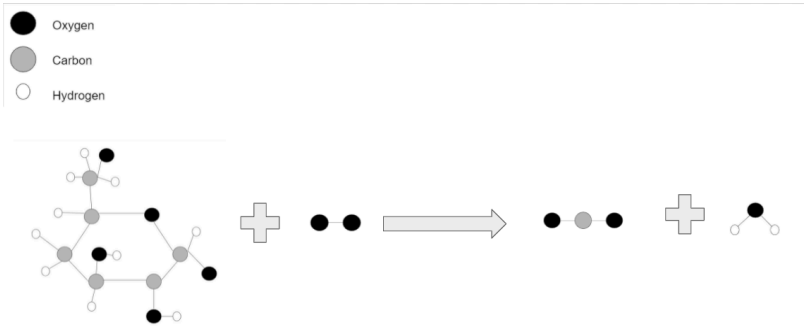
D. Student D



Gather:
Cluster Question #__4___
Question Type: Long Answer
Addresses:
__X__ DCI (PS1.B)
____ SEP
__X__ CCC (Matter)
Answer:
The total mass of the products will be the same as the total

Question 4:
Compare the total mass of the products to the total mass of the reactants. Be sure to explain your reasoning.

| Material | Wood | Oxygen | Carbon Dioxide | Water Vapor |
|---|---|---|---|---|
| Mass (kg) | 2.32 Kg | 2.75 Kg | 3.78 Kg | 1.29 Kg |

| | |
|---|---|
| mass of the reactants. This is because during a chemical reaction, atoms rearrange to form new substances. Matter is neither created nor lost. | |
| Reason:<br>Cluster Question #___5___<br>Question Type: Short Answer<br>Addresses:<br>__X__ DCI: PS1.B<br>_____ SEP:<br>__X__ CCC: Matter<br>Answer:<br>The carbon in the wood becomes the carbon in the carbon dioxide. The hydrogen in the wood becomes the hydrogen in the water vapor. | Question 5:<br>identify what reactants become what products.<br>The carbon in the _____ becomes the carbon in the _____.<br>The hydrogen in the _____ becomes the hydrogen in _____.<br>$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT → $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor) |
| Reason:<br>Cluster Question #___6___<br>Question Type: **Long Answer**<br>Addresses: Chemical reactions<br>__X__ DCI: (PS1.B)<br>_____ SEP:<br>__X__ CCC: Matter<br>Answer:<br>This was an example of a chemical change because the atoms rearranged to form new substances with new properties. | Question 6:<br>Was the change a chemical change or a physical change? How do you know? |
| Communicate:<br>Cluster Question #___67__<br>Question Type:<br>Addresses:<br>__X__ DCI (PS1.B)<br>__X__ SEP (Modeling)<br>__X__ CCC (Matter)<br>Answer:<br><br>I disagree because the model shows only 1 of each type of | Question 6:<br>  <br><br>A student created the following model to show what happens to |

| | |
|---|---|
| molecule. This means that there are more oxygens, hydrogens and carbons in the reactants than there are in the products. Matter in this instance would not be conserved. To make sure that they show matter is conserved, they should have 6 o2 molecules, 6co2 molecules, and 5 h2O molecules. | wood when it is burned. Using the chemical equation below, do you think this model accurately portrays the reaction? Why or why not? $C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor) |

**Proficiency Scale**

**Proficient Student Explanation:**
In their explanations, students need to show that matter is conserved by explaining that there needs to be the same number of oxygen, hydrogen, and carbon molecules on each side of the equation.

| Level 1 - Emerging | Level 2 - Partially Proficient | Level 3 - Proficient | Level 4 - Extending |
|---|---|---|---|
| **SEP:**<br>Does not meet the minimum standard to receive a 2. | **SEP:**<br>Develop and/or use models to describe and/or predict phenomena. | **SEP:**<br>Develop and/or use a model to predict and/or describe phenomena.<br>Develop a model to describe unobservable mechanisms. | **SEP:**<br>Extends beyond proficient in any way. |
| **CCC:**<br>Does not meet the minimum standard to receive a 2. | **CCC:**<br>Matter is made of particles.<br>Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems. | **CCC:**<br>Matter is conserved because atoms are conserved in physical and chemical processes. | **CCC:**<br>Extends beyond proficient in any way. |
| **DCI:** | **DCI:**<br>When two or more | **DCI:**<br>Substances react | **DCI:** |

| | | | |
|---|---|---|---|
| Does not meet the minimum standard to receive a 2. | different substances are mixed, a new substance with different properties may be formed.<br>No matter what reaction or change in properties occurs, the total weight of the substances does not change | chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.<br><br>The total number of each type of atom is conserved, and thus the mass does not change. | Extends beyond proficient in any way. |

**(Student Facing Format on following page)**

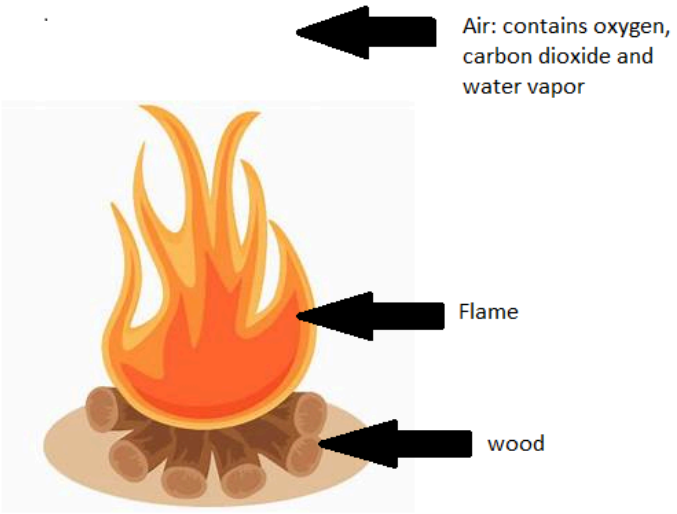
Name: _____ Date: _____

**Stimulus**

A few students were building a campfire with one of their parents. One of the students noticed that after the fire died down, the wood was much smaller than it had been from the start. Curious, they wondered where the wood had gone.

https://www.youtube.com/watch?v=EqgpcFj8G-s&t=22s

A group of students are at summer camp. To start a fire, they need wood ($C_6H_{10}O_5$), oxygen ($O_2$) and energy. As the fire burns, it produces carbon dioxide ($CO_2$) and water ($H_2O$). Carbon dioxide and water are invisible, so the students cannot see them come off the fire.




Chemical reaction of burning wood:

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\longrightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

| Material | Wood | Oxygen | Carbon Dioxide | Water Vapor |
|---|---|---|---|---|
| Mass (kg) | 2.32 Kg | 2.75 Kg | 3.78 Kg | 1.29 Kg |

Relaxing Campfire Video

**Your Task**

In the questions that follow, you will be using a model of wood in a campfire to explain whether or not matter is conserved.

**Question 1:**

The students remember learning about reactions in science class. a student asks, "When we light a fire, what are the **products** and what are the **reactants**?"

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

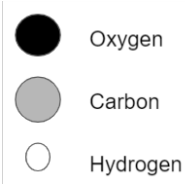
Using the chemical equation above, help the student identify each.

| Name of molecules in **products** | Name of molecules in **reactants** |
|---|---|
| | |

**Question 2:**

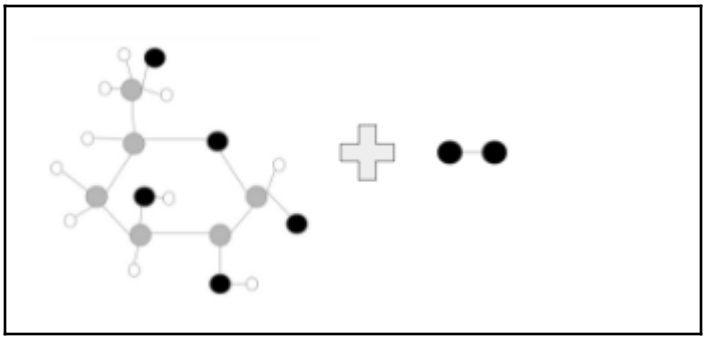
| Reaction: $C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor) |
|---|

Key:

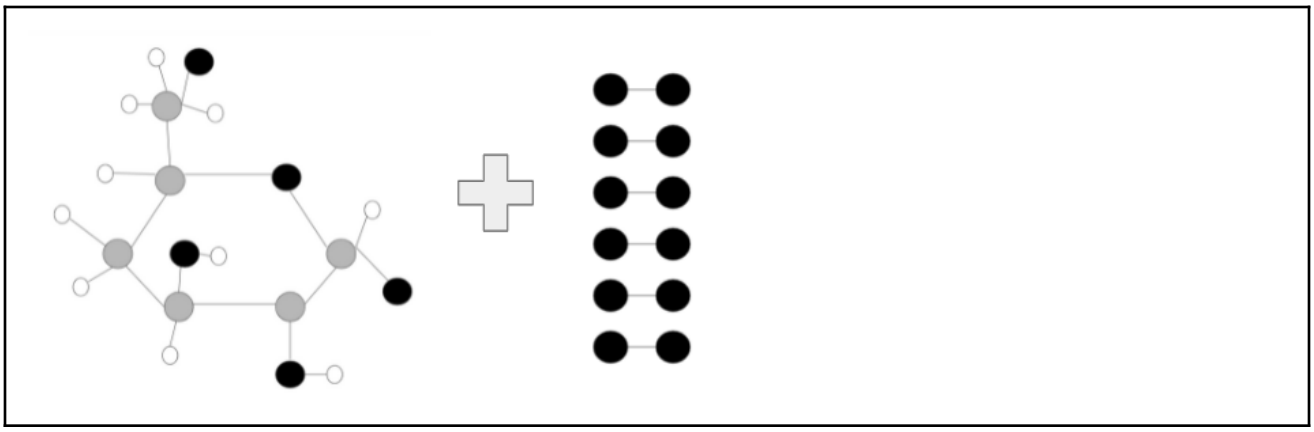



Before the students light the fire, they draw models of the molecules. Which model do you agree with?

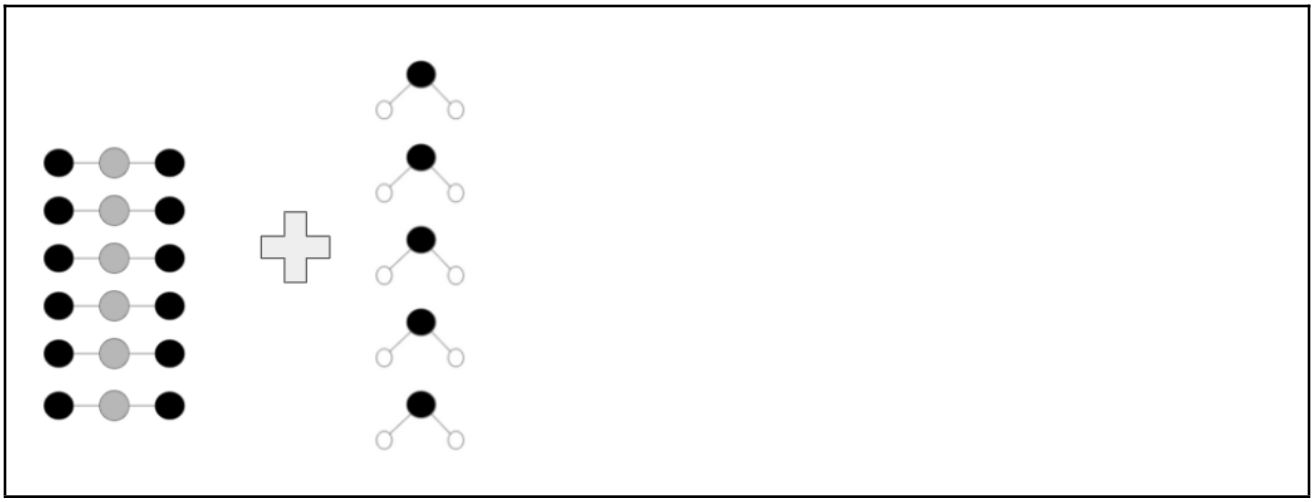
A. Student A



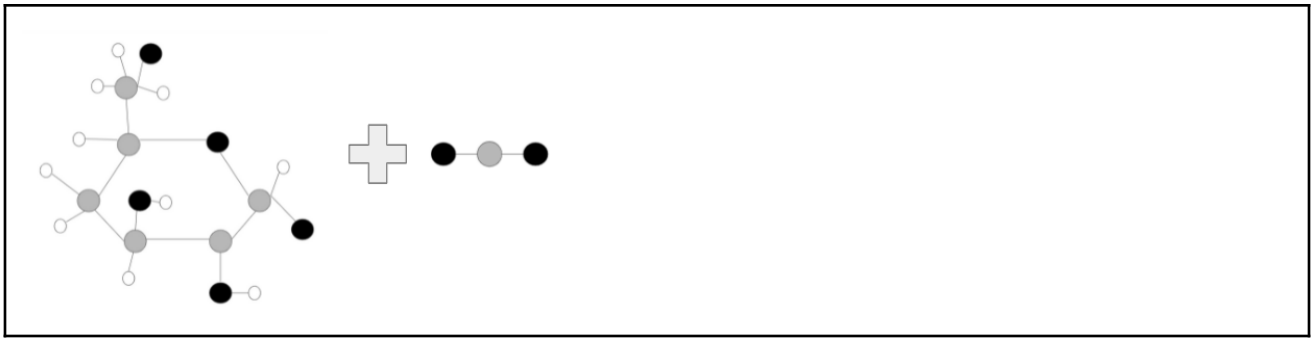
B. Student B



C. Student C



D. Student D

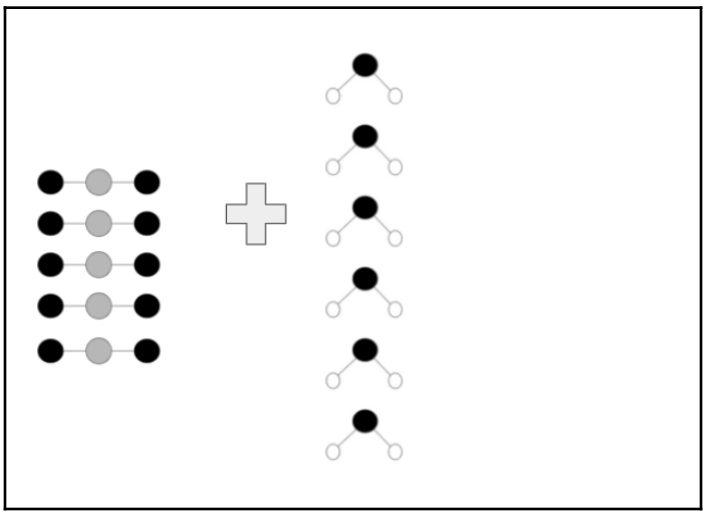


**Question 3**

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

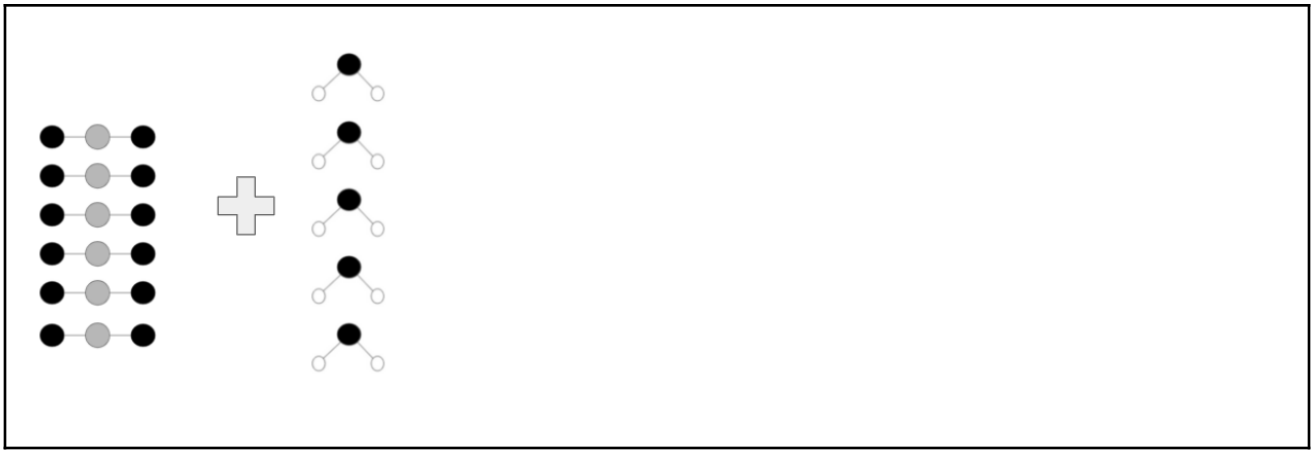
After the fire is lit, the students observe what they see and draw models of the molecules. Which model do you agree with?

A. Student A

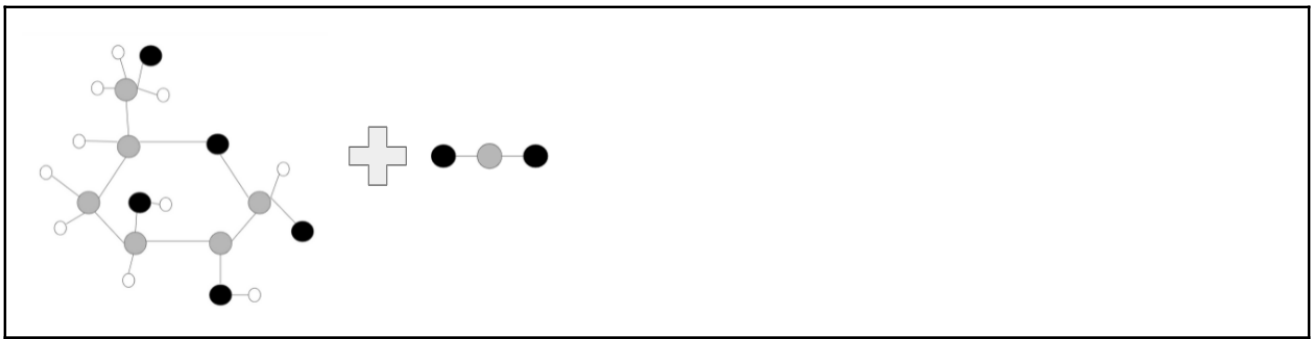


B. Student B

C. Student C



D. Student D



**Question 4**

Compare the total mass of the products to the total mass of the reactants. Be sure to explain your reasoning.

| Material | Wood | Oxygen | Carbon Dioxide | Water Vapor |
|---|---|---|---|---|
| Mass (kg) | 2.32 Kg | 2.75 Kg | 3.78 Kg | 1.29 Kg |

_____

_____

**Question 5**

Identify what reactants become what products.

Reaction:

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

The carbon in the _____ becomes the carbon in the _____.

The hydrogen in the _____ becomes the hydrogen in _____.

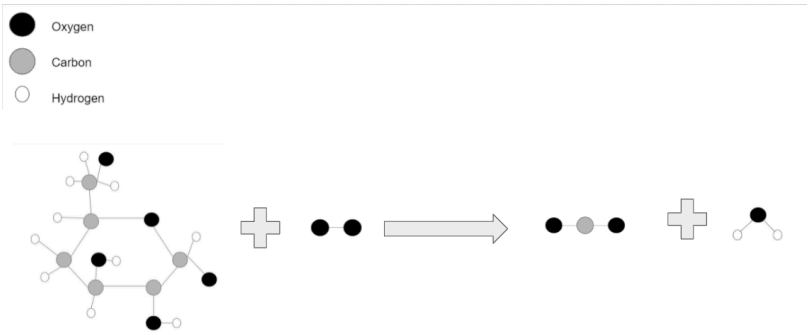
**Question 6**

Was the change a chemical change or a physical change? How do you know?

_____

_____

**Question 7**




Reaction:

$C_6H_{10}O_5$ (wood) + $6O_2$ (oxygen) + HEAT $\rightarrow$ $6CO_2$ (carbon dioxide) + $5H_2O$ (water vapor)

A student created the following model to show what happens to wood when it is burned. Using the chemical equation below, do you think this model accurately portrays the reaction? Why or why not?

_____

_____