

Activity 5.4: Grading the Explaining Combustion of Cellulose

*This tool has “grading” in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below.*

Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 19 points total on this worksheet.

Read about cellulose, then answer the questions below.

1. Explaining how cellulose burns. Write a paragraph about how the cellulose in a log burns in a campfire. Be sure to answer the four numbered questions on your Three Questions handout.

Level 4 responses should include answers to each of the four numbered questions on the Three Questions poster and handout:

- 1. Matter movement: After the heat of the flame breaks down the cellulose molecules, parts of cellulose molecules leave the wood and mix with air.*
- 2. Matter change: The carbon-containing pieces of the cellulose molecules combine with O_2 to produce CO_2 . The breakdown of cellulose molecules also produces H_2O .*
- 3. Energy change: Chemical energy in the C-C and C-H bonds is transformed into light and heat energy.*
- 4. Matter movement: Carbon dioxide and water leave the flame.*

1 point for answering each of the Three Questions. 4 points total

2. A tree that doesn't grow? A team of astronauts is preparing for a mission to Mars that will take 5 years. But they can't carry enough oxygen to breathe for 5 years. They thought about taking plants with them, since plants take in carbon dioxide and emit oxygen as they grow. But they figured out that the plants would grow too much—they wouldn't have enough space for all those plants.

Then, a plant breeder proposed with a solution. Here's what she said: “I will develop a new kind of tree, the smorgas board tree. The smorgas board tree will breathe in CO_2 and breathe out O_2 without growing. So you can take smorgas board trees to Mars with you, and they will keep producing oxygen without growing too big.”

Should the plant breeder get a contract to breed smorgas board trees? Here are some different ideas:

- Francois claims: “A tree like that is impossible. There are carbon atoms moving into the tree, so it has to grow.”
Circle one: **AGREE** DISAGREE
- Jamie claims: “Trees normally turn CO_2 into O_2 . It should be possible to breed a tree that does this without growing.”
Circle one: AGREE **DISAGREE**
- Robin claims: “It should be possible for something to turn CO_2 into O_2 without gaining mass, but there aren't any plants with the right genes, so the breeder won't succeed.”
Circle one: AGREE **DISAGREE**

1 point for each correct answer. 3 points total.

Explain your reasoning for your choices.

Level 4 responses should include:

- **Francois' claim is correct, because atoms (and mass) are conserved.**
- **Jamie's claim is incorrect, because the atoms in CO₂ (particularly C) cannot be "turned into" O₂, because atoms last forever.**
- **Robin's claim is incorrect, because the atoms in CO₂ (particularly C) cannot be "turned into" O₂, because atoms last. So even with the right genes, this is impossible because of the rules about atoms.**

1 point for correct reasoning for each claim. 3 points total.

Choose ONE claim above that you agree with. Explain how this claim could be further tested to offer evidence that better supports the claim.

A Level 4 response might offer a test that "followed all the rules" and that was focused on tracing matter from outside the tree to inside the tree.

- *1 point for tests that address the Matter Movement Question, identifying a source for the atoms that entered the tree.*
- *1 point for tests that address the Matter Change Question, identifying a process that brings atoms into the tree.*

2 points total.

3. What happens to matter when cellulose burns? Wood is a mixture of different organic compounds, including cellulose (about C₆₀₀₀H₁₀₀₀₀O₅₀₀₀). Choose whether each of the following can happen in a campfire where wood (with cellulose in it) is burned.

- | | | |
|----------|----------|---|
| T | F | Some of the atoms in the cellulose are incorporated into carbon dioxide in the air. |
| T | F | Some of the atoms in the cellulose are converted into energy that is used in the fire. |
| T | F | Some of the atoms in the cellulose are burned up and disappear. |
| T | F | Some of the atoms in the cellulose are converted into heat. |
| T | F | Some of the atoms in the cellulose are incorporated into water vapor in the atmosphere. |

1 point for each correct answer. 5 points total.

Explain the pattern in your answers. What happens to the cellulose when it's burned in a campfire?

Level 4 responses clearly recognize that the burning log's matter goes to the air in the form of CO₂ (and/or H₂O,) and does not disappear or become energy, based on the principles of conservation of mass and energy.

1 point for correct answer.

4. Something interesting about cellulose What is something interesting that you learned about cellulose?

Level 4 responses will provide something interesting about cellulose from the reading or other sources.

1 point for correct answer.