Name: _____ Class: _____ Date: _____

1.2 Assessing the Expressing Ideas and Questions and Questions Tool: What do *you* think happens when ethanol burns?

This Expressing Ideas and Questions Tool should be part of a brainstorming and elicitation session: the goal is to get students to express a wide range of ideas, even if they are incorrect. Ideally, students will come to recognize that they have many different ideas about what happens when ethanol burns, as well as unanswered questions.

Carbon TIME Discourse Routine around the Expressing Ideas and Questions Tool:

1. *Introduction: Establish the purpose for completing the tool as eliciting a range of ideas.*
2. *Private Writing: Students complete the Expressing Ideas and Questions Tool individually with a range of responses, some of which may be incorrect.*
3. *Sharing Ideas: Students share and compare ideas in pairs/small groups, with the goal of hearing a variety of ideas.*
4. *Consensus-seeking discussion accompanied by public writing: Class discussions focus on coming to consensus about similarities and differences among students' ideas for each of the Three Questions, issues and points of disagreement, and questions about the system. You may highlight ideas and questions that help move the unit "forward".*

*Level 4 responses are in **bold blue italics** below. Remember Level 4 is the eventual learning goal; we do NOT expect most, possibly any, students to produce these responses at this point in the unit. This worksheet has "assessing" in the title because we do NOT recommend giving your students a grade based on the scientific accuracy of their responses at this point in the unit. It is designed to be used as a tool for formative assessment.*

Use this page to explain your ideas about what happens to the air and ethanol when ethanol burns.

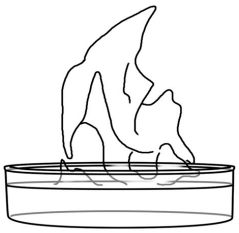
Draw labeled arrows to show your ideas about what might be moving into, out of, or through the flame. Think about what materials are moving and how they might be moving.

Look to see if students draw and label arrows that represent materials (air, ethanol) or also energy (heat, light). Notice common responses among your students.

Level 2 responses will depict the flame as "burning up" the ethanol. They may or may not include arrows indicating that ethanol goes into the flame. If they draw any arrows for materials leaving the flame, the arrows will probably be identified with vague terms such as "smoke."

Level 3 responses may think of the flame as "converting the fuel into energy" (matter-energy conversion). They are likely to draw arrows showing ethanol and air or oxygen going into the flame and forms of energy such as heat and light coming out.

Level 4 responses will understand that there is a chemical reaction taking place in the flame. They will draw arrows for ethanol and air or oxygen going into the flame and for carbon dioxide (and possibly water) coming out of the flame.



What goes in: List all the things you can think of that go into the flame.	**What comes out:** List all the things you can think of that come out of the flame.
Level 3 and 2 responses may include macroscopic materials in their list of inputs, like air or fuel. They may use material and energy words interchangeably ***Level 4 responses will describe material inputs in chemical terms: O_2, ethanol. They may also mention chemical energy as a form of energy going into the flame.***	*Level 3 and 2 responses may include macroscopic materials in their list of outputs, like air or smoke. They may also list forms of energy such as heat and light. They may use material and energy words interchangeably.* ***Level 4 responses will describe material outputs in chemical terms: water or H_2O, carbon dioxide or CO_2. They may also describe different forms of energy: heat and light.***

Your Explanation: Write your explanation for what happens when ethanol burns. Think about what materials and processes you listed in your drawing above.

At this point in the unit, we expect most students to express Level 2 or Level 3 ideas.

Level 2 responses are likely to say that the fuel is "burned up", and they may treat the flame as an actor, with needs (air, fuel, heat). They may also mention how human actors or sparks are needed to start the flame.

Level 3 responses are likely to describe a "matter-energy conversion."

- *Matter: They are likely to list materials that go into the flame such as ethanol and oxygen, without corresponding substances leaving the flame; they may not recognize H_2O and CO_2 as important products; they may indicate that gas has no mass.*
- *Energy: They may mention forms of energy produced by the flame, but they will not mention chemical potential energy going into the flame.*

Level 4 responses will trace matter and energy separately through the flame and will connect the macroscopic flame with atoms and molecules.

- ***Matter: They will name molecules or chemical substances as both reactants (ethanol and O_2) and products (H_2O and CO_2), which are released into the air as gases.***
- ***Energy: The chemical energy from the ethanol molecules is transformed into heat and light energy.***

Your Questions: What questions do you currently have about how ethanol burns?

Use responses here to help you gauge how your students are thinking about matter and energy at different scales in the context of combustion.

Note questions that you can remind students of when they are answered in later lessons.