Name _____ Teacher _____ Date _____

Activity 5.4: Grading the Explaining Combustion of Octane

*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 gasoline and octane, then answer the questions below.

1. Explaining how octane burns. Write a paragraph about how octane burns inside a gasoline engine and makes a car move. 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: A mixture of air and gasoline vapor comes into the cylinder***
2. ***Matter change: A spark from the spark plug sets the gasoline vapor on fire. Octane and the other molecules in gasoline combine with oxygen in the air to produce CO_2 and H_2O.***
3. ***Energy change: Chemical energy in the C-C and C-H bonds is transformed into light and heat energy. The hot air expands and pushes out the piston. This is the energy that makes the car move.***
4. ***Matter movement: The release valve opens to let the CO_2 and H_2O leave the cylinder.***

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

2. A new kind of engine? An inventor says that she has invented a new kind of engine that makes gasoline instead of using it up. A scientist weighs the gas in the tank, then drives the car around for a day. Here is what she found.

Original mass of the gasoline: 12.5 kilograms

Mass of the gasoline after one day: 13.1 kilograms

- A student, Patrick, claims: "It might be possible to have an engine with backwards combustion, so it takes in CO_2 and H_2O and produces gasoline and oxygen, instead of the other way around."

  Circle one: AGREE ***DISAGREE***
- Another student, Joaquin, claims: "Driving around might warm up the gasoline, so it would expand and gain mass."

  Circle one: AGREE ***DISAGREE***
- Another student, Devin, claims: "It is impossible for the engine to get energy from the gasoline without burning some of it, so someone must have secretly added gasoline to the tank.'

  Circle one: ***AGREE*** DISAGREE

1 point for each correct answer. 3 points total.

Explain your reasoning for your choices.

Level 4 responses should include:

- ***Patrick's claim is incorrect, because the molecules of CO_2 and H_2O do not contain high-energy C-C or C-H bonds that could power the car.***
- ***Jamie's claim is incorrect, because even if volume increased, the mass would remain the same as there is the same number of atoms.***
- ***Devin's claim is correct, because mass only increases if atoms (or molecules) move into or are added to a system.***

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 tank/engine to inside the tank/engine.

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

2 points total.

3. What happens to matter when octane burns? After a car runs for a while, the gasoline in its tank weighs less. What happened to some of the matter that used to be in the gasoline? Select True or False for the following statements.

Some matter from the gasoline *was converted into:*
T ***F*** *motion energy*
T F *carbon dioxide*
T ***F*** *heat energy*
T F *water vapor*

1 point for each correct answer. 4 points total.

Which ONE of the following do you think MOST of the matter in the burning gasoline was converted into?
a. Motion energy
b. Carbon dioxide
c. Heat energy
d. Water vapor

1 point for correct answer.

Explain your choices. What happened to the matter in the gasoline as it burned?

Level 4 responses clearly recognize that the burning gasoline's matter goes to the air in form of CO_2 (and/or H_2O,) 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 Octane What is something interesting that you learned about Octane?

Level 4 responses will provide something interesting about octane (or gasoline) from the reading.

1 point for correct answer.