Slide 1: The first lesson about the fire triangle primarily focused on how heat and fuel can influence fire. That lesson only introduced oxygen as part of the conceptual model. This activity will explore the importance of oxygen in the combustion reaction. Before we move on, draw and label a diagram of the fire triangle on your worksheet. *Monitor students to see when they have completed their diagrams.* Let's check to see what to remembered. Click

Slide 2: As you recall, the fire triangle is a conceptual model that can be used to understand the factors needed for fire to begin and to continue. Can anyone explain what a conceptual model is? *In science, a conceptual model is a simplified representation of a concept or of concepts related to a phenomenon. Often depicted as diagrams, conceptual models show processes or describe the relationships between concepts or factors essential to a phenomenon.* Check your diagram and make any necessary corrections as we quickly review the fire triangle. The three required factors in the fire triangle conceptual model are heat, Click fuel, Click and oxygen. Click When the quantities of these three factors are not restricted, Click fire will continue. Remember that firefighters use this model to understand how to extinguish fires. Since we recently conducted an activity investigating heat and fuel, we'll only review oxygen. Click

Slide 3: In the last activity we learned that heat and fuel often limit combustion because those factors may either not be present or not be in sufficient quantities. Oxygen, on the other hand, is usually more than sufficient for terrestrial fires since it makes up nearly 21% of Earth's atmosphere. Click

Slide 4: Complete "Table 1" on your worksheet. *After a minute allow students to compare their work with that of their colleagues.* Now compare your responses with those of your colleagues. Make any necessary changes or additions. *Allow students more time to interact. Monitor students to determine when they have completed their responses.* Would anyone like to share their definition for physical change? Can anyone give me an example of a physical change? *When water freezes, the relationship between H_2O molecules changes, but the configuration of atoms in the form of H_2O does not change.* Click What about a chemical change? Examples? *For example, during thermolysis, a chemical change takes place as H_2O molecules are split into H_2 (hydrogen gas) and O_2 (oxygen gas).* Click Now write the balanced equations for photosynthesis and cellular respiration in "Table 2." *Give students some time to work on their own. Then allow students to compare with their neighbors.* Let's check your chemical equations. Click

Slide 5: Click Can anyone tell me the reactants and products for photosynthesis? *If students don't include sunlight, ask them if photosynthesis can take place in the dark.* Check your balanced chemical equation for photosynthesis and make any necessary changes. Click *Give students time to correct their equations.* Click What are the reactants and products for cellular respiration? *Students will probably include energy in their responses since you brought "sunlight" to their attention earlier if it was necessary.* Check and correct your equations for cellular respiration. Click *Allow students to change to their equations.* Does anyone remember how to modify the cellular respiration equation so it will represent combustion? *Students need to include heat with the reactants so all three components of the fire triangle are present on the reactant side of the equation. Students should also state that the energy produced will be in the form of heat and light.* Click If vegetative biomass is being burned, glucose is probably in the form of which organic polymer? *Cellulose.* Take a moment to answer the two prompts beneath "Table 2." Click

Slide 6: Use the "Procedure" on the worksheet to complete the laboratory portion of this activity.

The following slides are an "Extension" that could be used to review atomic *mass and how to calculate molecular mass. It might be a good idea to go through this extension after students have completed the activity. The extension concludes with why CO_2 accumulated in the plastic cups when vinegar and baking soda were combined. The accumulation of CO_2 displaced air containing O_2. The absence of O_2 kept students from relighting the candle in the plastic cup.*

Slide 7: Click What is the "white powder" used in this activity? *Give students a moment to respond. If baking soda is said, ask students if they know the "chemical" name or the chemical formula for baking soda.* Click Click What is the "clear liquid" used in this activity? *Give students the same opportunity to respond and the same prompts if they only respond vinegar.* Click Click … Click

Slide 8: Click The purple reactants are vinegar (acetic acid/CH_3COOH) and baking soda (sodium bicarbonate/$NaHCO_3$). They react to produce carbonic acid (H_2CO_3), in blue, and sodium acetate ($NaCH_3COO$). Sodium acetate is the "goo" at the bottom of the plastic container. Click The carbonic acid (H_2CO_3) immediately breaks down into CO_2 and H_2O according to this equation.

*If **Slides 7 & 8** are shown before students perform the laboratory activity, go to **Slide 6** now.*

***Slides 9-14** are an "Extension" that could be used to review atomic mass and how to calculate molecular mass. It might be a good idea to go through this extension after students have completed the activity. The extension concludes with why CO_2 accumulated in the plastic cups when vinegar and baking soda were combined. The accumulation of CO_2 displaced air containing O_2. The absence of O_2 kept students from relighting the candle in the plastic cup.*

Slide 9: ***EXTENSION SLIDE:** Let's take a moment to learn or review how to determine the atomic mass of an element. The atomic mass of an element is important not only to figure out what the mass of an atom of a particular element is but also as a necessary step when calculating molecular mass.

We will begin by focusing on the noble gases. Can anyone name a few of the noble gases? *Helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), radon (Rn), and oganesson (Og).* Click Can anyone explain why the noble gases are considered to be unusual? *The noble gases are usually unreactive because all noble gases have an outer electron shell that is full. They are typically encountered as monatomic gases.* Refer to a periodic table. What is the atomic mass of helium? *4.003 "atomic mass units" or "grams per mole."* Click The atomic mass of Helium is 4.003 atomic mass units or 4.003 grams per mole. Since we will only be making comparisons between elements or between molecules, it is not important which units are used. However, the magnitude (value) of the mass is extremely important! Does anyone remember what the "2" is? *The atomic number which is the number of protons in the nucleus of that element. Thus, helium has 2 protons in its nucleus.* What is the atomic mass of neon? Click … of argon? Click … of krypton? Click Which of these gases makes up about 1% of Earth's atmosphere? *Argon* Click You might want to make a note of argon's atomic mass. Click

Slide 10: *EXTENSION SLIDE: What we covered in the previous slide will help us calculate molecular mass. We will calculate the molecular masses of the prominent gas molecules in Earth's atmosphere. Be sure you take notes and show your work on "page 4" of your worksheet. You can either round atomic mass values to simplify calculations or you can use a calculator. Nitrogen (N_2) will be our example. What element is represented by "N?" *Nitrogen* Click Now let's make our calculation of N_2's molecular mass. Be sure to follow along and to show your work. Which molecule are we working with? Click Which elements are present in N_2? Click How many atoms of each element are present? Click What is the atomic mass of each element present? Click For each element, find the product of the number of atoms multiplied by the atomic mass. Click Finally, sum all of the "products" together to get the molecular mass. Click This calculation was fairly simple since only one element was involved. Click

Slide 11: *EXTENSION SLIDE: Now I would like for you to calculate the molecular mass of O_2. Show your work beneath the N_2 example on your worksheet. Click Here is the "periodic table" information for oxygen. *Give students time to attempt the problem and assist students when necessary. Monitor students to see when they are finishing.* Now take a moment to compare your work to a colleague's. *Give students time to check their work.* Here's the solution. Click Which molecule has more mass, N_2 or O_2? *N_2 is lighter, or O_2 is heavier.* How does one atom of argon compare? *Argon is heavier than both N_2 and O_2.* Click

Slide 12: *EXTENSION SLIDE: Now let's do an example of a slightly more complicated molecule, CO_2. If you are comfortable with calculating molecular mass, feel free to work this out on your own. Otherwise, be sure to show your work as you follow along. First, which elements are in CO_2? Click How many atoms of each element are present? Click What is the atomic mass of each element present? Click For each element, find the product of the number of atoms multiplied by the atomic mass. Click Finally, sum all of the "products" together to get the molecular mass. How does CO_2's molecular mass compare to the masses of argon, N_2, and O_2? *CO_2 has the greatest mass*. Click

Slide 13: *EXTENSION SLIDE: Time for one last example, H_2O or water vapor. Calculate the molecular mass of H_2O. Show your work on your worksheet. Click Here is the "periodic table" information for hydrogen. *Give students time to attempt the problem and assist students when necessary. Monitor students to see when they are finishing.* Now take a moment to compare your work to a colleague's. *Give students time to check their work.* Here's the solution. Click Now rank all five of the substances we have gone over from the greatest mass to the least mass. Click

Slide 14: *EXTENSION SLIDE: This is the abstract from a study investigating why CO_2 concentrations can be greater within cave systems. Click Here's a table from the published journal article resulting from the study. Take a look at the molar/molecular masses (M_{mol}) for the listed gases. What do you notice? *Give students time to draw some conclusions such as: 1) the values for nitrogen, oxygen, and water vapor are the same as what was calculated in class; 2) the value for carbon dioxide is different (we're correct, this article is wrong); and air has a mass slightly greater than nitrogen.* The value for CO_2 is different than the one we calculated! Who's correct? *We are!* What mistake did the author make? *A value of "6 amu" was used for carbon in the calculation instead of 12.011 amu.* Click What is the molecular mass of methane (CH_4)? *Around 16 amu.* The author confused carbon's atomic number with its atomic mass!