2. Making Fires Burn or Go Out 1: Introduction to the Fire Triangle

Lesson Overview: In this activity, students describe and organize what they already know about fire so it fits into the conceptual model of the Fire Triangle. They examine the geometric stability of a triangle and how that property applies to fire.

Lesson Goal: Increase students' understanding of how fires burn and why they go out.

Subjects: Science, Mathematics, Writing, Speaking and Listening, Health and Safety

Duration: one half-hour session

Group size: Whole class. Students work in groups of 2-3.

Setting: Indoors

Vocabulary: *Fire Triangle, fuel, heat, ianition. oxvaen. model*

Objectives:

- Students can construct a triangle out of toothpicks and gumdrops, and can label its legs with the three components of the Fire Triangle.
- Students can demonstrate that removing one side of the triangle makes it collapse.
- Students can identify the component(s) of the Fire Triangle that are removed in various scenarios, and explain how this makes the fire go out.

Standards:		1st	2nd	3rd	4th	5th
CCSS	Writing	2, 7, 8	2, 7, 8	2, 7, 10	2,7, 9, 10	2,7, 9, 10
	Speaking/Listening	1, 2, 4, 6	1, 2, 4, 6	1, 2, 4, 6	1, 2, 4, 6	1, 2, 4, 6
	Language	1, 2, 4, 6	1, 2, 4, 6	1, 2, 3, 4, 6	1, 2, 3, 4, 6	1, 2, 3, 4, 6
	Math	MP.4, MP.5	MP.4, MP.5,	MP.4, MP.5	MP.4, MP.5	MP.4, MP.5
NGSS	Matter and Its Interactions		PS1.A, PS1.B			PS1.B
	From Molecules to Organisms: Structure/Processes					LS1.C
	Engineering Design		ETS1.B			ETS1.B
EEEGL	Strand 1	A, B, C, E, F, G				A, B, C, E, F, G

Teacher Background: This activity explores the chemistry of combustion as described by a conceptual model called the Fire Triangle. A fire cannot start without three things: fuel, oxygen, and a heat source. If a fire runs out of any of these things, it will stop. The three requirements for fire are conceptualized in the Fire Triangle. This is an appealing model because the

geometric properties of the triangle are analogous to the requirements for combustion: A triangle is very stable as long as all three legs are present, and it collapses if one leg is removed.

Fuel + Oxygen + Heat ⟶ Carbon dioxide + Water + Heat&Light

For more background on the chemistry of combustion, see the **Teacher Background** section of Middle School Activity 3 (M03) or High School Activity 3 (H03).

William Cottrell's *The Book of Fire* (2004, available from https://mountain-press.com/) contains well illustrated and easy-to-read descriptions of the physical science of combustion and wildland fire.

Materials and preparation:

- Locate the Fire Triangle poster in the trunk (***FireTrianglePoster.pptx***) or prepare to draw the figure on the board. But do not display it right away. See Step 4 below.
- Gumdrops (3 or more/student group)
- Toothpicks (3 or more/student group)
- Paper, scissors, tape, pen or pencil

Procedure:

1. Explain: Students will share what they already know about fire and then organize this knowledge to better understand what makes fires burn and what makes them go out.
2. Ask students what is needed to make a fire. List their responses on the board (they may include matches, paper, cardboard etc. as well as wildland fuels). Try to write them in three loose clusters (fuel, heat, and oxygen), which you'll label later.
3. Ask students to come up with a word that describes each category. Guide them to the concepts of fuel, heat, and oxygen, and then label the categories. These are the 3 parts of the Fire Triangle. You may need to explain what oxygen is: an invisible gas, one of several "ingredients" in the air we breathe. It comprises about 21% of air, and we use only about 20% of that in a single breath. If we used all of it, cardiopulmonary respiration (CPR) would not work!
4. Display the Fire Triangle poster (***FireTrianglePoster.pptx***) and/or label the sides of your drawing. Explain: you can use a triangle to illustrate what makes fires burn and what makes

them go out. Triangles are used in constructing buildings and bridges because they are much stronger shapes than squares or other many-sided shapes. (OPTIONAL MATHEMATICAL EXERCISE: Ask students to use their gumdrops and toothpicks to make a triangle, a square, and a pentagon. See which one is most stable and which is easiest to deform.)

5. Ask each student group to:

   a) Build a triangle from gumdrops and toothpicks, make a small label for each leg of the triangle (fuel, heat, oxygen), and attach the label with tape.

   b) Show each other what happens when one leg of a triangle is removed. (The triangle collapses.)

   c) Put the triangle back together and use it to explain to each other what happens to a fire when one component of the Fire Triangle is removed. (The fire goes out, or fire cannot start in the first place.)

6. Ask students to explain how you can put a fire out using the components of the Fire Triangle. Examples:

   - When you throw water (or dirt, or use a household fire extinguisher) on a fire, you cut off oxygen and remove heat.
   - Fire retardant dropped from airplanes removes heat and cuts off oxygen from wildland fires.
   - When all the wax is gone from a candle, or all the fuel is burned in a campfire, or the gas tank in the car is empty, the fires go out.

7. Ask: Burnable things surround us every day—why are they not on fire? (An external source of heat is needed to ignite the fuels. Once a fire has started, it produces more than enough heat to continue burning.)

Assessment: Demonstrate or show a video of "stop, drop, and roll" (information available at http://burnprevention.org/programs-services/teachers-corner/). Have students practice this and then identify (in writing) which part(s) of the Fire Triangle are removed, making the fire go out.

Evaluation:	Excellent	Good	Fair	Poor
"Stop, Drop, and Roll" response	-Identified oxygen and heat as the parts of the Fire Triangle removed.	-Identified oxygen or heat as a part of the Fire Triangle removed.	- Did not identify oxygen or heat as part of the Fire Triangle removed, but showed some understanding of the concept of Fire Triangle.	-Did not identify oxygen or heat as part of the Fire Triangle removed. -Did not show understanding of the concept of Fire Triangle.

Extension: In 2012, the Alan Alda Center for Communicating Science (https://www.aldacenter.org/) sponsored a competition to find an explanation of flames that would be understandable to an 11-year-old. The winning entry was a 7-minute video produced by Austrian scientist Ben Ames. As of August 2016, it is available at http://vimeo.com/40271657. This video cartoon describes the basic chemistry of combustion and the related processes of pyrolysis, oxidation, chemiluminescence, and incandescence. It even contains a theme song that helps viewers learn and pronounce these technical terms.