Fighting Fire with STEM

Introduction: What is fire?

Objectives

The students will:

- Develop an understanding of the concept of fire
- Explore and identify the factors involved in the creation of fire
- Make hypothesis based on observations
- Explore pattern recognition

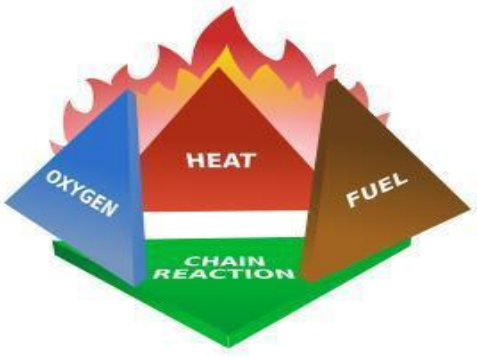
Standards

4-PS3-2	CCSS.3.G.A.2
4-PS3-3	SEP1
SEP2	SEP2
W.3.1	SEP6
CCSS.3.G.A.1	SEP7

Background

The phenomenon of fire is not a new concept. Fire has been around the human being since the beginning of time. Early humans did not know how to create or control fire. After human beings learned how to create and control fire it has become a great tool for human development.

Fire is combustion, a chemical reaction among elements. Four factors are necessary for fire: fuel (any material liquid, solid, or gas that can undergo combustion), heat (activation energy, minimum amount of energy needed for the chemical reaction to take place), an oxidation agent (oxygen in the air), and a chemical chain reaction (energy released to produce more activation energy for other atoms to produce more chemical reactions feeding the combustion). The combination of factors is called the fire tetrahedron, a four-sided geometrical shape, with



Fire Tetrahedron

all sides working together to create fire. In contrast, if one of these four elements is removed from the fire tetrahedron, the fire will stop.

Moreover, fire can be explained as a reduction-oxidation (redox) chemical reaction produced by interaction of elements or substances in which one element is reduced (the element gains electrons) and the other is oxidized (the element loses electros) during the chemical reaction. The redox chemical reaction is exothermic, meaning that it releases heat, light and energy while the reaction is taking place. For example,

$$\text{Fuel} + O_2 \longrightarrow H_2O + CO_2 + \text{Energy}$$

The chemical reaction will release energy affecting other atoms in the close by environment pushing these new atoms to vibrate and to bounce around crashing with other atoms releasing more energy and heat creating initial energy for other atoms to bond together.

In the year 1983, the physicist Richard Feynman, explained the phenomenon of fire in a very interactive way during an interview with BBC news. He mentioned that oxygen likes to be close to carbon and if they are close together with the optimal activation energy such as high heat, a spark, or intense sunlight, they will attract each other and snap together. This bonding action will create more heat and energy around them prompting other atoms to vibrate and bump into each other. Thus, creating more energy and more bonding by creating a chain reaction between atoms. However, if there is not enough energy for them to get close to each other instead of attracting to each other they will repel away from each other.

Even though, oxygen is in contact with everything around us it does not mean that everything should be on fire. Specific amount of energy is required to push the oxygen molecules in contact with the carbon or other elements that will provide the activation energy for fire to start.

Inquiry Overview

Students will be introduced to the concept of fire. First, they will make observations to create an explanation of how fire works or the factors needed for fire. Then, students will explore the interaction between elements that constitute the creation of fire by constructing a model to represent these elements.

Suggested Inquiry Approach

Students will be watching a series of short videos illustrating how fire starts by using different ignition sources. At the same time, students will use a graphic organizer to record their thoughts about some of the essential elements involved in the creation and continuation of fire.

Activity One

Work in Pairs

Estimated Time: 90 minutes

Introduction: 10 min.
Video series activity: 20 min.
Modeling fire initiation: 35- 45 min.
Debrief: 10-15 min.

Students will share their ideas with the rest of the class and find similarities with their reasoning of the factors needed for fire.

Materials

Activity #1 for each pair of students:

- Fire video
- Plastic cone
- Ping-Pong balls
- Masking tape
- Plastic triangles (1 class set)
- Ruler

How does fire start?
What happens during the fire?
What happens to the elements after the fire?

The main idea of the videos is to show the students the main components of fire which are heat, fuel, and oxygen. It is very important for the students to complete statement #1 before moving on to the next part of the activity.

During the next part of the activity, students will construct a model of the fire tetrahedron. First, students will follow steps 1-3 in the student pages. Assist students as needed during the set up. The teacher will provide the materials.

Ask the students to go back to the first statement they did and compare it to the last statement. They will find out that the first statement was done based on observation and background knowledge or information. While the second statement will represent the scientific explanation of how fire starts.

By using the tetrahedron, model students snapped together will explain to the students the interaction of the four sides and the importance of their connection. The chain reaction element can be explained by using the example of a set of dominos hitting each other transferring emery to each other. Ask the students what would happen if one of the dominos is removed from the sequence.

Debrief

- Where is fire used?
- What are some ways you know to stop a fire?
- Remove one element of the fire tetrahedrons. Were there any effects on the fire? Explain.
- What apparatus do you know of that will stop a fire?
- Which component of the fire tetrahedron is eliminated by adding sand to the fire?
- What is needed for the fire to continue?