

HOW DO FIRE SPRINKLERS WORK?

INVESTIGATION

YOUR NAME HERE:



ENGAGE

Driving Question:

**How do fire sprinklers work?**



To narrow our focus, we can explore:

**How is a liquid affected by changes in thermal energy?**



Make a prediction:

**How does a fire sprinkler work?**

1. Identify components of the fire sprinkler simulation that are similar to a real life fire sprinkler.
2. Identify the components of the “fire sprinkler” different from a fire sprinkler.
3. Return to your lists in 1 and 2. Beside each component in 1 describe its purpose in the investigation, beside each component in 2 describe why it is not needed.
4. What are some ways we could change the temperature surrounding the “fire sprinkler”?
5. In this version of the investigation we will use a bowl of hot water to increase the temperature around the “fire sprinkler.” Draw these new details about the investigation set up in Figure 1.
6. Predict what will happen.

Figure 1: Fire Sprinkler Simulation

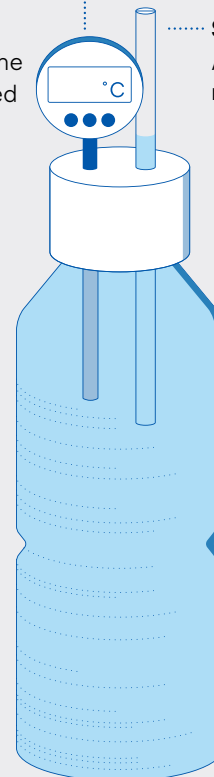
The components of a fire sprinkler are simulated in the set-up below.

**Temperature Probe**

Allows temperature of the liquid inside the bottle to be recorded

**Straw**

Allows us to see movement of the liquid



**Bottle filled with liquid**

Allows us to see how different liquids respond to changes in temperature outside the bottle

## MATERIALS

- Glass bowl or container to pour hot water. (e.g. heat-rated glassware like pyrex)
- Digital Thermometer
- Straw
- Assorted liquids (e.g. 1:3 alcohol to water solution, 1:3 sugar to water solution)
- Hot water (use an electric kettle or stove top to get water slightly cooler than boiling approximately 200°F or 100°C)

## SAFETY CONSIDERATIONS FOR THIS INVESTIGATION

1. Use heat resistant glass
2. Wear splash goggles
3. Use caution when handling hot water (e.g. use an oven mitt)



## EXPLORE

1. Consider how the investigation has been planned for us. Identify the variables:

### Independent Variable

What are you going to change in the investigation?

### Dependent Variable

What will you measure and observe for in this investigation?

### Constants

What will you keep the same about the investigation set-up?

2. Plan for data collection

How often will you take measurements?

What tools are necessary to gather the data?

What units will you use?

What qualitative observations might you collect?

3. Review the data table provided does it include everything you want to record? Make any modifications to the data table that will make data collection easier or more accurate.

4. Carry out the investigation using the procedure below:

- a) Place your sprinkler apparatus in the glass bowl.
- b) Use an electric kettle or stove to heat water to almost boiling (approximately 200°F or 100°C). Use caution when handling hot water. Consider an oven mitt or allowing your teacher to handle the hot water.
- c) Remove the water from heat. Use a thermometer or temperature probe to record the temperature of the water in the electric kettle or pot.
- d) Pour hot water into the reservoir that contains the plastic bottle apparatus.
- e) Immediately measure the starting temperature of the water in the bowl. Be sure the splash goggles cover your eyes and you are not exposing your hand to any of the steam.
- f) Then, observe what occurs as the thermal energy from the hot water transfers to the liquid in the apparatus.
- g) Read and record the temperature of the liquid inside the plastic bottle and in the liquid in the bowl every 30 seconds. Repeat for the next 5 minutes.

<b>DATA TABLE: HOW IS LIQUID AFFECTED BY INCREASING THERMAL ENERGY?</b>				
Time	Temperature Outside Bottle	Temperature Inside Bottle	Height of Liquid	Observations, Notes, Questions

1. Summarize 2-3 observations from your investigation

2. What patterns do you see in the outcomes of the investigations? What, if any, relationships emerged between the variables?



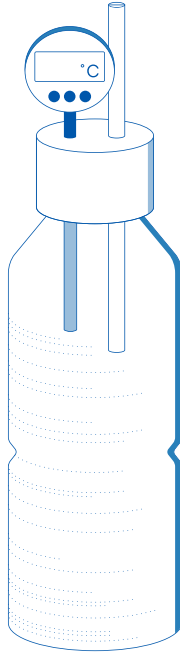
## EXPLAIN

3. Scientific concepts can support our understanding. Consider the following ideas:

- properties of liquids
- states of matter
- thermal energy
- particle motion
- particle models
- temperature
- thermal energy transfer

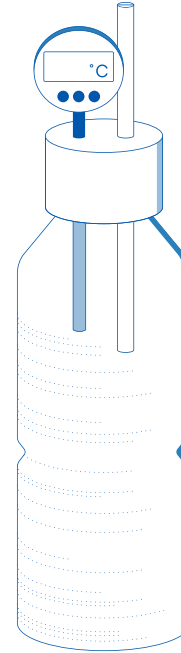
4. Develop and use a model to show how these scientific concepts may have been observed in your investigation.

Before Adding Thermal Energy



Create a caption using the vocabulary to better explain the relationships and observations from your investigation

After Adding Thermal Energy



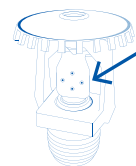
Create a caption using the vocabulary to better explain the relationships and observations from your investigation

5. Consider what you observed in this investigation, and the explanations you have come to understand to answer the following question: How do fire sprinklers activate?



## ELABORATE

6. Fusible link sprinklers do not have a glass bulb. Instead, they have two pieces of metal that are linked together. How do you think this type of fire sprinkler might activate?



## EXTEND

7. What other fire suppression tools, technologies, or designs utilize interactions between thermal energy from a fire and matter to create safer spaces?