Lesson 10: Teacher Reference 1

Burning Fuels Instructions

Purpose of Demonstration

To give students convincing evidence that the products of a combustion reaction of fossil fuels are carbon dioxide and water.

The amount of evidence necessary to convince students that the combustion of many common fossil fuels produces the same two products—carbon dioxide and water—will vary. There are two examples in the teacher's guide and other options included here if your students need more evidence.

No-Flame Policy

If your school has a no-flame policy, use the *Burning Fuels Demonstration* video located here: www.teachersopensciedfieldtest.org/droughtsfloods , or pre-record your own video for students to make observations from.

SAFETY PRECAUTIONS

If you are able to do the demonstration in your classroom, follow these safety guidelines.
For the safety of the teacher and student volunteers

- move all flammable materials away from the demonstration area and
- tie back long hair, secure loose clothing, and remove dangling jewelry.

All students (even those just observing) and the teacher should wear safety goggles during the demonstration

Preparation notes

Note: This demonstration uses materials that are included in prior 7th grade OpenSciEd units. The carbon dioxide detector and bromothymol blue (BTB) are used in both *OpenSciEd Unit 7.3: How do things inside our bodies work together to make us feel the way we do? (Inside Our Bodies Unit)* and *OpenSciEd Unit 7.4: Where does food come from, and where does it go next? (Maple Syrup Unit)*. If you are not teaching the OpenSciEd units according to the scope and sequence, you will need to make sure you have these materials.

Prior to class

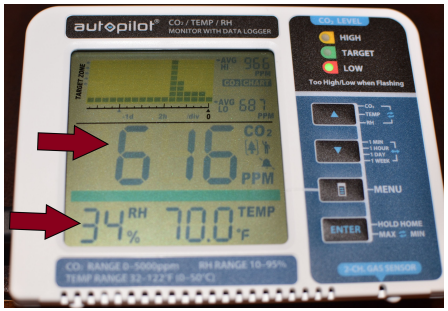
- Ensure that the carbon dioxide (CO_2) detector is in working condition.
- Dilute BTB if you are using it.
    - The ratio of dilution for BTB is 5 mL of BTB in water to make 200 mL of solution. Add 5 mL of BTB to a graduated beaker and fill to the 200 mL mark with water.

Setup for Class Demonstration 1 (Butane and CO_2 sensor)

Use the *Burning Fuels Demonstration* video located at www.teachersopensciedfieldtest.org/droughtsfloods to guide you through the setup and demonstration. Watch it before you do the demonstration with your class. If your school has a no-flame policy, this is the video you will show instead of doing the demonstration. Students will still be able to make readings every 10 seconds but will make them from the video. The steps below are the same as what appears in the teacher's guide.

1. Place the CO2/ humidity detector on a flat surface. Arrange the clear glass bowl (or inverted aquarium) and lighter as shown in the image to the right. In the set up shown, the CO2 detector is taped to the sides of the container.

2. Choose four student volunteers. Have them get ready to read off carbon dioxide and humidity values from the monitor every 10 seconds when you say "Go." The class can look for other changes in the system that might indicate changes in humidity levels. Have one person read off carbon dioxide readings, one person read off relative humidity readings, and one person say "Now" every 10 seconds. Alternatively, you can use a document projector so that all of the class can see the readings. Have another student record these on the board or on a piece of chart paper for the class to reference.



3. Light the butane lighter and hold the lighter so that the flame burns continuously. Ensure the flame does not burn the detector. (Note: The image below shows the flame very close to the detector but in reality there is about 3 inches between the flame and the detector.) Keep the flame going on the lighter for the duration of the readings. The bowl can rest on the lighter and you can allow the bowl to extend slightly over the edge of the table to allow more air to enter the system.. This is not an airtight system, but you will get good results with this setup. Say, "Go." Now have students read off and record carbon dioxide readings every 10 seconds.

4. After about a minute, the carbon dioxide reading in the container will get above 4,000 ppm. This will be the last reading students will be able to report before the "high" warning light comes on.

Setup for Class Demonstration 1 (Butane and BTB)

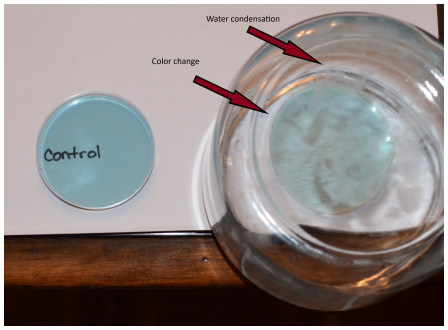
Prepare two dishes (a petri dish is good) of diluted BTB solution according to the instructions above.

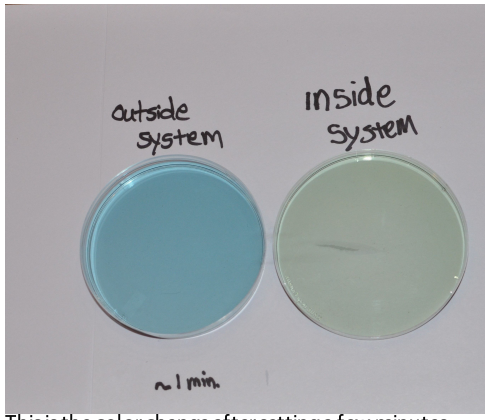
2. Place the dishes of diluted BTB on a flat surface. Place one dish outside of the system on white paper to use as a comparison. Mark this dish the control. The other dish will go under the clear bowl and also on white paper. Arrange the clear glass bowl and lighter as shown in the image to the right.

3. Choose three student volunteers. Have them get ready to describe any color change in the BTB every 10 seconds when you say “Go.” The class can look for other changes in the system that might indicate changes in humidity levels. Note: The dish of BTB placed outside of the system should be close to the bowl to use as a reference for color changes. Have one person describe color changes in the BTB, one person read off relative humidity readings, and one person say “Now” every 10 seconds. Alternatively, you can use a document projector so that all of the class can see color changes. Have another student record these on the board or on a piece of chart paper for the class to reference.

4. Light the butane lighter. Keep the flame going on the lighter for the duration of the observations. The bowl can rest on the lighter. You may want to let the bowl hang off the table slightly so that more air can enter the system. This is not an airtight system, but you will get good results with this setup. Say, “Go.” Now have students read off and record the color of the BTB every 10 seconds.

5. You will see color changes in the BTB solution after about 1 minute. Allow the flame to burn under the glass bowl until students are convinced that a color change has occurred. Once the flame has gone out (because of lack of oxygen), remove the lighter but leave the set up as is. The color of the BTB will continue to change as more CO2 is absorbed into the solution.

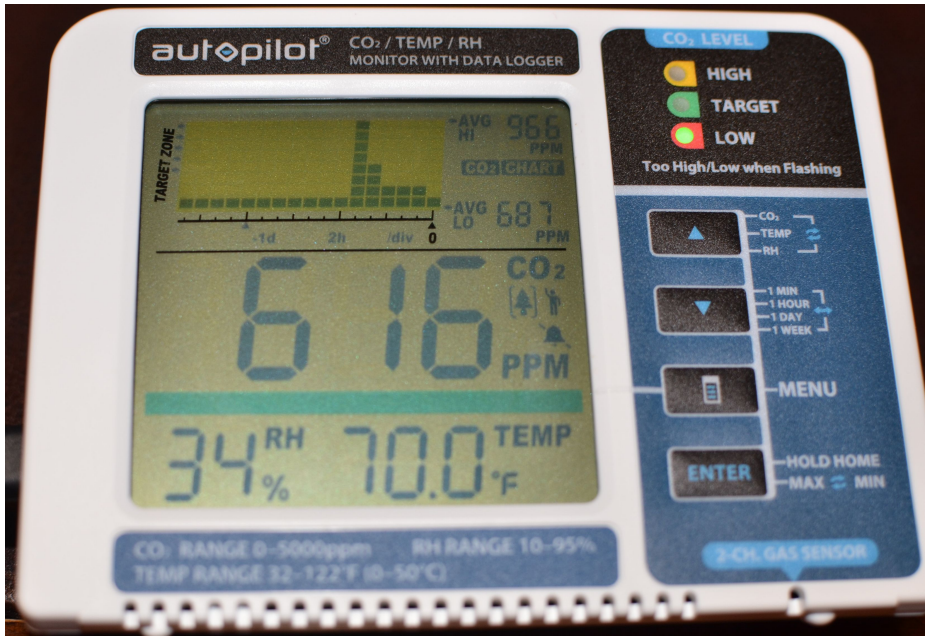




This is the color change after setting a few minutes once the flame has gone out. Swirl the dish to even out the color.

Setup for Class Demonstration 2 (Methanol fuel gel and CO2 Sensor)

Fuel gel is made from various fuels—usually methanol or ethanol. Ethanol is most often made from plant-based biomass and is not made from fossil fuels. Methanol, however, is often made from fossil fuels. Be sure to use fuel gel made with methanol even though the products will be the same. Use the butane lighter to light the surface of the gel.



You will do this demonstration similar to the previous demonstration by replacing the butane lighter with the fuel gel. Rest the edge of the bowl on the neck of the lighter or another object to give a space between the glass bowl and the table. This will allow air to enter the system and keep the fuel gel ignited. Results with the fuel gel should give similar results to the butane lighter.

Additional Evidence

If students are not convinced that carbon dioxide and water are products of all fossil fuel combustion reactions after the two demonstrations and the molecular model activity, you may want to assign those students a fossil fuel and have them research the products of the combustion of the fuel. Use the fossil fuel examples on the handout, *Fuel Molecule Cards*. This can be a home learning assignment.

Additional Resources:

This is a set up using a butane lighter and a Pasco CO_2 sensor	This graph shows results of burning a butane lighter with a Pasco CO_2 sensor