

Light Bulb or Heat Bulb

Teacher Lesson Plan



Background Information

Using the physical science standards of light and heat, the concepts of energy efficiency and energy conservation are introduced. These terms can be defined as:

- Energy Efficiency - the use of technology that requires less energy to perform the same function.
- Energy Conservation - any behavior that results in the use of less energy.

An example of energy efficiency would be replacing an incandescent light bulb with a compact fluorescent light bulb. An example of energy conservation would be turning the lights off every time you leave a room.

- Incandescent Bulb-a filament in the bulb gets so hot it emits light and glows. This also produces a lot of heat. 90% of the electricity going into the bulb is transformed into heat/thermal energy while only 10% is light/radiant energy.
- CFL-a tube of gas. When electricity flows through the gas, it emits ultraviolet light (UV). That UV light strikes a painted white coating on the inside of the bulb that emits visible light when struck by UV light, so the coating glows. This technology does not produce as much heat. 60% of the electricity going into a CFL is transformed into heat/thermal energy and 40% is transformed into light/radiant energy.

Lighting accounts for 10-20% of a home's electricity bill. This experiment will prove which light bulb is more energy efficient and will save both electricity and money.

Content Standards

- **Mathematics**
 - Represent and solve problems involving multiplication and division.
 - Solve problems involving measurement and estimation of intervals of time, liquid volume, and masses of object.
 - Represent and interpret data.
- **Physical Science**
 - Heat, electrical energy, light, sound and magnetic energy are forms of energy.
- **Earth Science**
 - Some of the earth's resources are limited.
 - Earth's non-living resources have specific properties.

Student Activities

This experiment is broken into three parts. For Lesson 1, students compare the structure of each light bulb and the heat generated by each bulb measured by the change in temperature. For Lesson 2, students compare the costs of purchasing and operating each type of bulb. A 13 watt CFL is the equivalent of a 60 watt incandescent bulb in terms of light output. Lesson 3 is a take home assignment and Lesson 4 considers energy saving behaviors around the school.

LESSON 1: Light Bulb vs. Heat Bulb

Lesson Materials:

- 8 lamp bases
- 8 digital thermometers
- 8 boxes
- 4 sixty watt incandescent light bulb
- 4 thirteen watt compact fluorescent light bulb (CFL)
- Student Lab Sheet Lesson 1
- Teacher Background Information-*The Basic of CFL's and Incandescent Light Bulbs*
- Not Included: Stopwatch or timer

Preparation:

1. Prior to the classroom lesson, cut two windows and a door in the boxes. Cover the windows with transparencies or packing tape. The electrical cord can be run out of the door. Insert a bulb and lamp base in the center of each box, making sure the bulb is not touching any of the walls. Close the roof.

Procedure:

1. Lighting Introduction
 - a. Discuss the many uses of lighting.
 - b. Instruct the students to note the type of lighting in the classroom. Ask students how it is different from the lighting they have at home.
 - c. Show an incandescent and CFL light bulb. Tell the students that the CFL is the same technology as the fluorescent tube lights in their classroom. A CFL is like a rolled up tube light that they can put in a lamp.
2. Have the students make a hypothesis based on the three questions on the student lab sheet for Lesson 1. The students will complete the chart at the end of the experiment. A hypothesis can be defined as an educated guess.
3. Have students observe the structure of each type of bulb in the lamp base. Ask students to sketch each bulb and put observations about the structure of each bulb on their student lab sheet.
4. Insert the thermometer in the roof of the house along a side wall. Make sure the thermometer is not touching the light bulb. The thermometer should be in the same position for each house. Be sure to close the roof of the box to keep heat from escaping.

5. The students will be measuring the change in air temperature each light bulb causes in each box. Take the starting temperature of each house. Round to the nearest whole number. Have the students record the starting temperature on the data table.
6. At the same time, begin the stopwatch and turn on both light bulbs. Make sure the thermometer is not touching the light bulb.
7. At 1 minute, record the temperature in each house on the student worksheet. Round to the nearest whole number. Repeat every minute for 5 minutes. Students can take turns reading the thermometers. As the students read the thermometer, instruct them to put their hand near the roof of each house. Can they feel a difference in temperature between the two houses?
8. At the end of 5 minutes, take the final temperature reading and turn off the light bulbs. Calculate the change in temperature for each light bulb.
9. Optional Extension Activity-Graph Bar/Line/Picture the change in temperature for each light bulb.
10. When the students have completed the calculations, discuss the results of Lesson 1.
 - a. Discuss the variables that were controlled (kept the same) in the experiment (e.g. house, position of thermometer in the house, lamp bases, time interval). Discuss the variables that were changed (e.g. type of light bulb). Discuss how the experiment might be changed for improvement.
 - b. Discuss the temperature change in each of the two houses. Why did the incandescent bulb get so much hotter? (See *The Basic of CFL's and Incandescent Light Bulbs* for a more in-depth explanation.)
 - i. Incandescent Bulb-a filament in the bulb gets so hot it emits light and glows. This also produces a lot of heat. 90% of the electricity going into the bulb is transformed into heat/thermal energy while only 10% is light/radiant energy.
 - ii. CFL-a tube of gas. When electricity flows through the gas, it emits ultraviolet light (UV). That UV light strikes a painted white coating on the inside of the bulb that emits visible light when struck by UV light, so the coating glows. This technology does not produce as much heat. 60% of the electricity going into a CFL is transformed into heat/thermal energy and 40% is transformed into light/radiant energy.
 - c. Return to the chart where the students made their experiment hypothesis. Have them mark the response that the experiment proved. Were their hypotheses correct?
 - d. Based on the results from this lab, which light bulb is more energy efficient? Describe why. Could one bulb really be called a "heat" bulb instead of a light bulb?

LESSON 2: Incandescent Bulb vs. CFL Bulb Cost Comparison

Lesson Materials:

- Watt Meter
- Student Lab Sheet Lesson 2

Preparation:

1. Explain that in Part 2 of the lab, they will compare the costs of purchasing and using incandescent and CFL bulbs.

Procedure:

1. Electricity and Lighting Vocabulary - refer to the student worksheet chart "CFL vs. Incandescent Cost Comparison Sheet". Review the following vocabulary:
 - **Life Cycle Cost:** The actual cost to operate an appliance over its life. It includes the initial cost of the appliance (in our case the light bulb) + the operating (electricity) costs over the appliance life.
 - **Watt:** Unit of power. The rate at which an appliance or bulb uses energy.
 - **Kilowatt:** 1,000 watts. It is more useful to talk about kilowatts when discussing electricity because we use thousands of watts.
 - **Kilowatt-hour (kWh):** The unit in which we buy electricity. It is equal to 1,000 watts used for one hour. The average cost of electricity in Ohio is \$.11 per kWh.
 - **Lumens:** A measure of the brightness of light.
 - **Life Expectancy:** The average time a light bulb has been tested and expected to operate under normal use. Measured in hours.
2. Show the students the light bulb packaging (information also shown in student data table.)
 - a. Compare the lumens between the two bulbs. Are they comparable? Which one is actually a little brighter?
 - b. Compare the life expectancy of the two bulbs.
 - i. If we are comparing 12,000 hours of light, how many CFL's will we need? (one)
 - ii. How many incandescent bulbs will we need? (12)
 - iii. Calculate the cost of light bulbs for 12,000 hours of light.
 1. CFL-one bulb = 12,000 hours of light X \$1.50/bulb = \$1.50
 2. Incandescent-one bulb = 1,000 hours of light X 12 = 12,000 hours of light X \$.50 = \$6.00.
3. Optional Extension Activity: Using the watt meter, measure how many watts the CFL (13 watts) and the incandescent (60 watts) use. The watt meter might not measure the bulbs at exactly 13 & 60 watts, however, for the purpose of our calculations; these are the numbers we will use.
4. From the data table, have the students fill in the cost of 12,000 hours of electricity for each bulb. Then calculate the life cycle cost for 12,000 hours of light.

5. Complete the chart by calculating the life cycle savings for installing a CFL.
6. Discuss the life cycle energy savings for one light bulb.
 - a. Which light bulb is more efficient? Why?
 - b. Why do they think people still use incandescent bulbs?
 - c. Have the students estimate how many light bulbs they have in their home. Would it be significant to replace all the incandescent bulbs in your home?

LESSON 3: Home Light Bulb Audit

Lesson Materials:

- Student Lab Sheet Lesson 3

Procedure:

1. Review the At Home Activity Sheet with your students. Encourage them to share the CFL vs. Incandescent Cost Comparison Sheet with their families.
2. Send home the CFL with each student.
3. Some parents may be concerned with the mercury contained in CFL's. A CFL information sheet from the Environmental Protection Agency is included and you may want to distribute with the CFL's. It also includes proper disposal protocol.
4. Sheets and report to OEP the number of students that will purchase additional CFL's.

LESSON 4: Energy Conservation at Home & School

Lesson Materials:

- *The Energy I Used Today* Student Activity Sheet and *Energy Buck Values*
- Energy Patrol Tickets
- Most Wanted Energy Waster Posters

Procedures:

1. The Energy I Used Today - students complete *The Energy I Used Today* worksheet by thinking through all the ways they used energy.
 - Circle any activities that they did or devices they used. Students may add any activities or devices they used that are not included on the list.
 - Assign Energy Buck Values. You can make up Energy Buck Values for any items not on the list. Consider not only how much energy they use, but how long they are used.
 - Have students complete a journal entry using the questions on *The Energy I Used Today Connections* worksheet.

2. Energy Patrol

- Divide students into small groups (or select a small number of students) to serve as your school's Energy Patrol.
- Copy Energy Patrol Tickets. Students patrol your building looking for energy wasting behaviors and leave a ticket if a violation is spotted.

3. Most Wanted Energy Posters

- Take a picture of the "energy criminal." Report their offense on the Most Wanted Poster. Hang in the hallway to remind students to make smart energy choices.