Lesson 4: Light Bulb or Heat Bulb?

Adopted/Revised From
National Energy Education Development Project, Xcel Energy

Grade Level
6-12

Objectives
- Identify the different types of light bulbs
- Compare different light bulbs efficiencies
- Describe the energy costs of each type of bulb
- Discuss carbon emissions of each type of bulb

Overview
Students compare the light output, heat output, electricity use, costs, and carbon emissions of incandescent, compact fluorescent, and LED light bulbs.

Materials
- One incandescent light bulb per group
- One compact fluorescent light bulb per group
- Two lamp sockets with AC plugs per group
- Two thermometers per group and one per entire class
- One Kill-a-watt power monitor or similar per group
- One LED light bulb per class (minimum)
- Access to two outlets (i.e. via a power strip) per group

Estimated Cost of Materials
$35 per group

Computer Required?
No

Duration
1-2 class periods

Primer References
1.1 Forms of Energy
2.1 Lighting

Related Articles
- "Mesa County Valley School District 51 Grand Junction, Colorado Case Study" – Southwest Energy Efficiency Project

Engagement

1. What does it mean to be "energy efficient"?
2. Why is it important?
3. What are some ways we can become more energy efficient at home and at school? (lighting)
4. Name some different types of light bulbs. (Use bulbs as visual aids.)

Investigation

Now we're going to see experimentally how efficient different light bulbs are and what this means for costs and carbon emissions:

1. Divide the students into small groups (no more than 5 per group recommended).
2. Supply each group with listed materials – power monitors may need to be shared depending on how many the class has in total.
3. Mention that each bulb emits approximately the same amount of light.
4. Demonstrate the activity using LED bulb in front of entire class:
5. Use a thermometer to read the room temperature aloud to the class.
6. Screw the LED bulb into a lamp socket.
7. Plug a power monitor into an outlet and then plug the lamp socket into the monitor.
8. Find the monitor's value for Watts and read aloud to class.
9. Place the thermometer 1.5 inches from the end of the bulb so that the bottom reader captures the heat of the bulb and read the temperature aloud to the class.
10. Tell them to repeat these activities with their incandescent and CFL bulbs (and LED is they have them) in order to compare light output, heat output, electricity use, and cost data using the activity sheet for this lesson.
11. Bulbs should be at least 8 inches away from each other
12. The bulbs should be on for 10 minutes in order to complete the activity sheets.

Class Review

1. Ask the groups to share the results of their experiments by reviewing each of the questions on the activity sheets as a class.
2. Which bulb would you purchase? Why?

Elaboration

Now we have to figure out why some bulbs are more efficient than others:

1. Have students read the Primer References.
2. How does each bulb produce light from electricity?
3. As a class, list or "map" the energy forms associated with the transfer of energy from its source at a coal-fired power plant to the light we see from each of the bulbs.
4. During which energy transfer does the most significant inefficiency take place?

Instructor Notes

- The bulbs purchased should provide approximately the same amount of lumens (light output). At the time of this writing, retail 8-watt LED bulbs can provide 429 lumens, which is about equivalent to a 9-watt CFL and a 40-watt incandescent.

- Two groups should be able to share the same power strip.
- Have these instructions on hand should a CFL break (also found in Appendix A): http://www.epa.gov/cfl/cflcleanup.pdf
- If a CFL burns out, recycle them by finding a location at Earth 911: http://earth911.com/recycling/hazardous/cfl/
- ***Warning: Bulbs will be VERY HOT to the touch during and after the activity.***

Extensions and Variations

- Conduct the Lighting portion of the Conduct a School Energy Audit lesson.

References/For More Information

U.S. Department of Energy:
www.energysavers.gov

Light Bulb or Heat Bulb?

	Temperature						
Bulb	**0 min.**	**2 min.**	**4 min.**	**6 min.**	**8 min.**	**10 min.**	**Delta T**
Incandescent							
CFL							
LED (data from teacher)							

Bulb	Initial cost	Wattage	kWh per day	kWh per year	Cost per year	Hours in lifetime	Number of bulbs needed over 24,000 hours	Cost of bulbs over 24,000 hours	kWh over 24,000 hours	Cost of electricity over 24,000 hours	Total costs over 24,000 hours	CO2 emissions over 24,000 hours (lbs.)
Incandescent	$0.50					1,000						
CFL	$1.50					8,000						
LED (data from teacher)	$10.00					24,000						

Assumptions

One kilowatt-hour = 1,000 watts running for one hour
Each bulb runs an average of 4 hours/day
Electricity costs 10 cents/kWh
1.4 lbs. of CO2 is emitted per kWh (as of 2011 in Xcel service territory)

Questions

1. Which bulb emits the least heat? The most?

2. Graph the relationship between the temperature delta T and electricity use in watts.

3. Compared to an incandescent, what is the difference in initial costs for a CFL and an LED?

4. How long would it take to make up for these differences through reduced electricity costs?

5. How much would 1 lb. of CO_2 emissions have to be worth (in dollars) to make an LED "cost-effective"?