Sustaining a Green Collar Workforce:
An Interdisciplinary Approach

Green Application Projects (GreenApps)

Title: Does changing a light bulb really make a difference?

Author: Barbra Maher

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Interdisciplinary Classification (Subject, Level?): Physical science, math, environmental science (HS, UG)

Prerequisite Skills: none

Materials Required: Incandescent bulb (100 W), CFL bulb (26 W), 3 digital thermometers, stopwatch, 2 bulb sockets (or lamp), power strip, metal ruler

Estimated Time:

In Class: 60 minutes

Outside of Class: optional follow-up work

Description of Project

Students complete hands-on investigations to determine which light bulb type produces the most heat and uses more energy. We as consumers pay for energy used, which is the power (in watts) expended times the period of use (in hours), expressed in units of kilowatt hours (kWh). The amount of energy required to operate a light bulb is divided between the energy needed to produce light and the rest of the energy goes into producing heat. Efficiency in a bulb is related to the percentage of light versus heat being generated by the bulb. The less heat being generated, the more efficient the bulb is at producing light. Incandescent bulbs are highly inefficient, emitting about 90% of the energy consumed as heat. Compact fluorescent bulbs (CFLs) are four times more efficient and last up to 10 times longer than incandescents. A 22 watt CFL has about the same light output as a 100 watt incandescent. CFLs use 50 - 80% less energy than incandescents.

This project involves students in making measurements of temperature to estimate energy efficiency for various types of light bulbs, as heat is an indicator of efficiency of a bulb. The student will collect temperature data for two types of similar wattage equivalent bulbs. The

energy each consumes will be compared to the amount of heat output for each bulb. Temperature measurements will be taken at various distances from the bulb as well as at different time intervals after turning on the bulb. The students will graph their results for analysis. Students will also calculate the cost of operating the different bulb types. The students will then evaluate their data to see what trends are recognized and make recommendations as to how to maximize their energy efficiency in their homes. As a follow-up activity, the student will price comparison shop for bulbs at their local store.

Replacing a single incandescent bulb with a CFL will keep a half-ton of CO_2 out of the atmosphere over the life of the bulb. If everyone in the U.S. used energy-efficient lighting, we could retire 90 average size power plants.

Procedure:

1. Observe each of the light bulbs provided for the experiment, record the information about the power requirements, lumens produced and light bulb life in Table 1.1

	Power (Watts)	Lumens	Bulb life (hours)
Incandescent bulb			
CFL bulb			

Table 1.1

2. Take the initial temperature of the incandescent bulb before turning it on, record in the Table 1.2

	Initial temperature (^oC)
Incandescent bulb	
CFL bulb	

Table 1.2: Initial temperature data

3. Place the incandescent bulb in the socket, plug the socket into the power strip.
4. Turn on the bulb, record the temperature of the bulb (^oC) at time intervals of 1 minute for seven minutes. These temperature measurements will be taken at the surface of the bulb, at a distance of 5 cm from the bulb and a distance of 10 cm from the bulb. ***Make sure the temperature stabilizes on the thermometer before recording***
5. Record all data for the incandescent bulb in Table 1.3.

6. Turn off bulb, replace with the CFL bulb. **Caution: bulb is hot***
7. Repeat measurements for CFL bulb and record in Table 1.4.

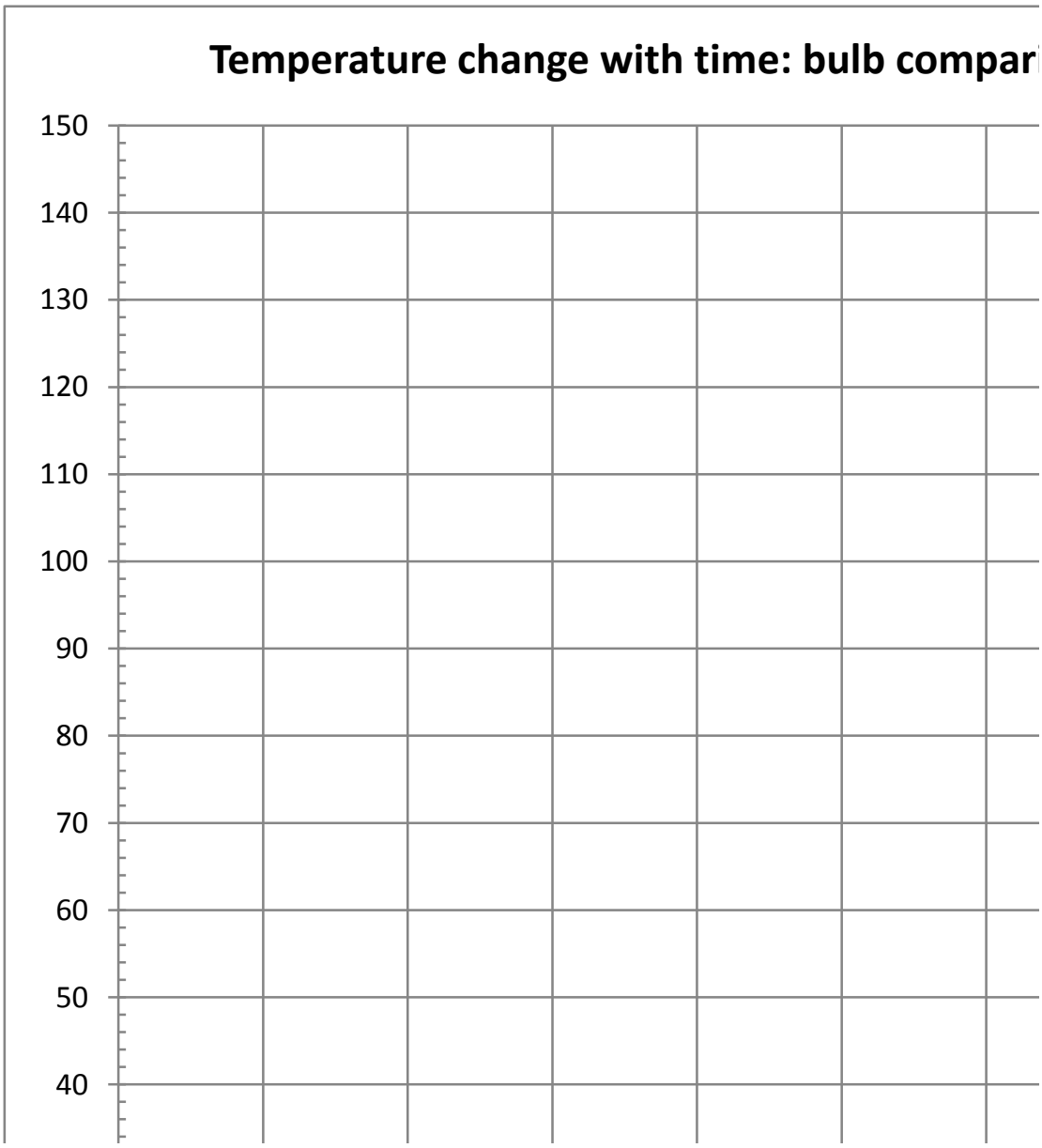
Incandescent Bulb	Surface Temperature(^oC)	5 cm distance Temperature(^oC)	10 cm distance Temperature(^oC)
0 minutes			
1 minute			
2 minutes			
3 minutes			
4 minutes			
5 minutes			
6 minutes			
7 minutes			

Table 1.3: Incandescent bulb data

CFL Bulb	Surface Temperature(^oC)	5 cm distance Temperature(^oC)	10 cm distance Temperature(^oC)
0 minutes			
1 minute			
2 minutes			
3 minutes			
4 minutes			
5 minutes			
6 minutes			
7 minutes			

Table 1.4: CFL bulb data

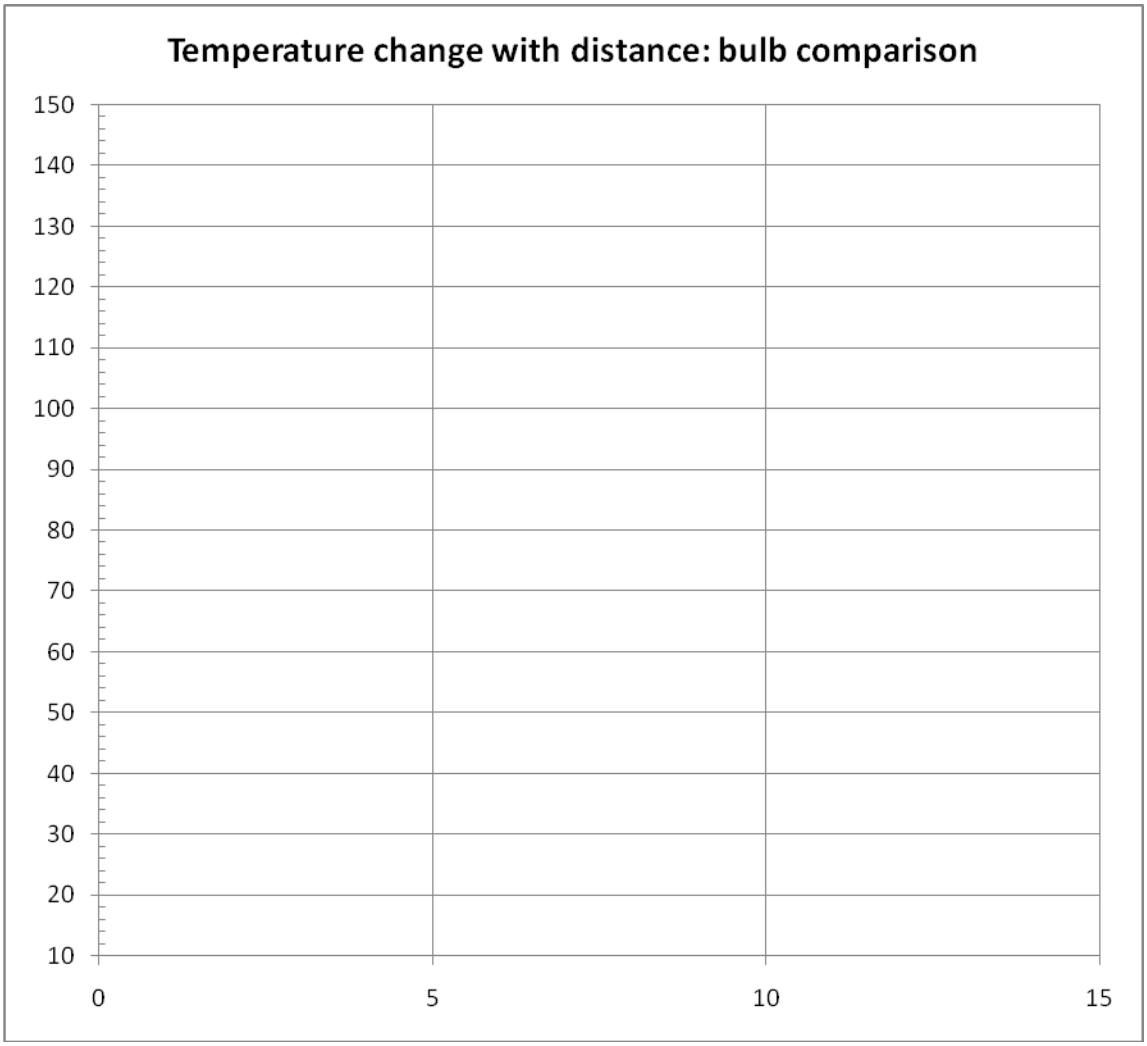
8. Graph the following data for both bulbs: In graph one, using two different symbols, graph the surface temperatures for each bulb. Be sure to *label your axes* with the appropriate units, and provide a legend.



Graph 1

9. What can be inferred from the graph?

10. In graph two, using two different symbols, graph the temperatures for the seven minute at each distance for each bulb. Be sure to *label your axes* with the appropriate units, and provide a legend.



11. How does the temperature change as you move away from the bulb?

12. Do you notice any difference between the two types of bulbs? Explain.

13. A) Calculate the cost of operating the incandescent bulb for the lifetime of the bulb (refer to Table 1.1) assuming the price of power is $0.08/kWh and B) calculate the cost of operating the bulb for one day, assuming it the bulb is in operation for 3 hours per day.

14. A) Calculate the cost of operating the CFL bulb for the lifetime of the bulb (refer to Table 1.1) assuming the price of power is $0.08/kWh and B) calculate the cost of operating the bulb for one day, assuming it is in operation for 3 hours per day.

15. What is the cost savings of using a CFL instead of an incandescent for one year?

16. How do the lives of the bulbs compare? How many incandescent bulbs would you need to last the lifetime of the CFL bulb?

Part 2:

Visit a local store to compare prices of the following bulbs:

Wattage (Incandescent vs CFL)	Price - Incandescent	Price - CFL	Price – LED (if available)
15W/3W			
40W/11W			
60W/14W			
75W/18W			
100W/23W			

Outcomes:

1. Experiment and compare general heat output between incandescent and compact fluorescent light (CFL) bulbs.
2. Calculate and evaluate the cost efficiency of incandescent and CFL bulbs. Conclude that CFLs are more cost efficient than incandescent lighting.
3. Recognize that the technology and use of CFLs can impact a large population in regards to energy conservation.
4. Communicate and present conclusions.

Assessment:

Students will hand in their data, questions and graphs.

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