LED Lights the Way

Mount Alvernia Academy Grade 6

Maria Lyons Science Teacher

Grade 6 students conducted the Light Bulb Investigations from the NEED Project's School Energy Experts Intermediate Kits. They performed the activities in groups and analyzed the data. They learned how to measure Thermal Energy with the Infrared Meter, Illumination with the Light Meter and Energy Use with the Kill-o-Watt Meter. They determined and compared the energy efficiencies of three light bulbs, Incandescent, CFL and LED.

We made up take-home kits with all the equipment and directions for the Light Bulb Investigations activity. Students are in the process of taking the kits home and conducting them with their families so that they will all learn how to save energy.

Goals

The Goals of the Grade 6 LED Lights the Way Project are

- **Students will learn about the relationship between electricity, light and heat**
- **Students will learn how to use a Kill-o-Watt Meter, a Light Meter and an Infrared Meter and understand their units of measure**
- **Students will conduct the NEED Light Bulb Investigations Activity on 3, 60 watt light bulbs, Incandescent, CFL and LED**
- **Students will keep records of their data and analyze their results**
- **Students will determine which light bulb is more energy efficiency and least expensive to use**
- **Students will take a “Light Bulb Investigation Kit” home and conduct the activities with their families, teaching them how to save energy and save money.**

Three Types of Bulbs

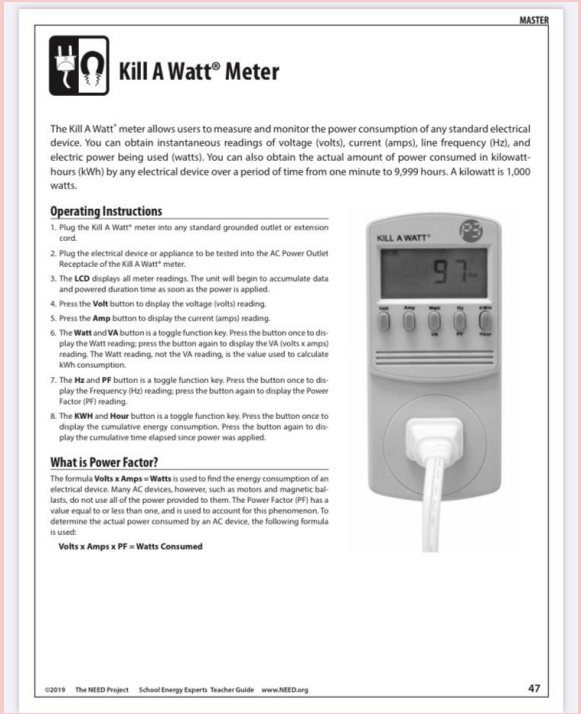
LED

Incandescent

	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Brightness	850 lumens	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	3,000 hours	10,000 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	$0.50	$1.50	$1.50	$1.33

CFL

Measuring the Electricity Usage
Kill-o-Watt Meter



MASTER

Kill A Watt® Meter

The Kill A Watt® meter allows users to measure and monitor the power consumption of any standard electrical device. You can obtain instantaneous readings of voltage (volts), current (amps), line frequency (Hz), and electric power being used (watts). You can also obtain the actual amount of power consumed in kilowatt-hours (kWh) by any electrical device over a period of time from one minute to 9,999 hours. A kilowatt is 1,000 watts.

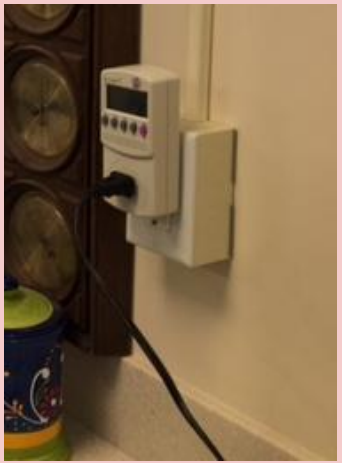
Operating Instructions

1. Plug the Kill A Watt® meter into any standard grounded outlet or extension cord.
2. Plug the electrical device or appliance to be tested into the AC Power Outlet Receptacle of the Kill A Watt® meter.
3. The **LCD** displays all meter readings. The unit will begin to accumulate data and powered duration time as soon as the power is applied.
4. Press the **Volt** button to display the voltage (volts) reading.
5. Press the **Amp** button to display the current (amps) reading.
6. The **Watt** and **VA** button is a toggle function key. Press the button once to display the Watt reading; press the button again to display the VA (volts x amps) reading. The Watt reading, not the VA reading, is the value used to calculate kWh consumption.
7. The **Hz** and **PF** button is a toggle function key. Press the button once to display the Frequency (Hz) reading; press the button again to display the Power Factor (PF) reading.
8. The **KWH** and **Hour** button is a toggle function key. Press the button once to display the cumulative energy consumption. Press the button again to display the cumulative time elapsed since power was applied.

What is Power Factor?

The formula **Volts x Amps = Watts** is used to find the energy consumption of an electrical device. Many AC devices, however, such as motors and magnetic ballasts, do not use all of the power provided to them. The Power Factor (PF) has a value equal to or less than one, and is used to account for this phenomenon. To determine the actual power consumed by an AC device, the following formula is used:

Volts x Amps x PF = Watts Consumed



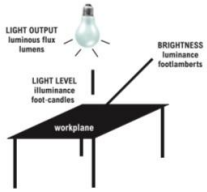
Measuring the Light Intensity
Light Meter

MASTER

The Light Meter

Operating Instructions

1. Insert the battery into the battery compartment in the back of the meter.
2. Slide the ON/OFF Switch to the ON position.
3. Slide the Range Switch to the B position.
4. On the back of the meter, pull out the meter's tilt stand and place the meter on a flat surface in the area you plan to measure.
5. Hold the Light Sensor so that the white lens faces the light source to be measured or place the Light Sensor on a flat surface facing the direction of the light source.
6. Read the measurement on the LCD Display.
7. If the reading is less than 200 fc, slide the Range Switch to the A position and measure again.



Light Output or Luminous Flux

A lumen (lm) is a measure of the light output (or luminous flux) of a light source (bulb or tube). Light sources are labeled with output ratings in lumens. A T12 40-watt fluorescent tube light, for example, may have a rating of 3050 lumens.

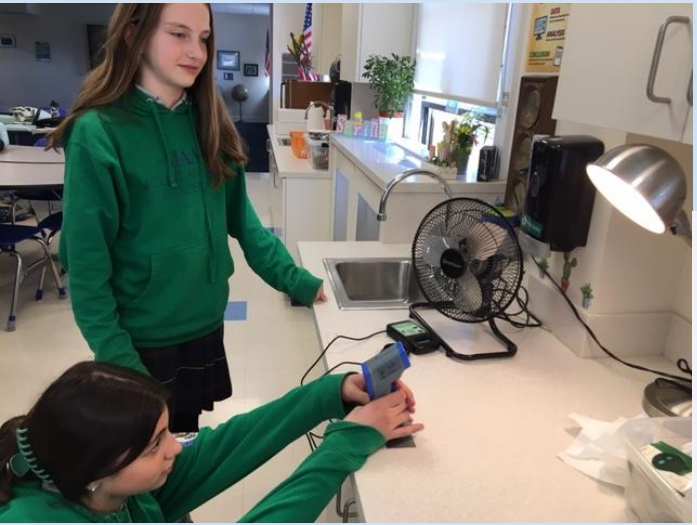
Light Level or Illuminance

A foot-candle (fc) is a measure of the quantity of light (illuminance) that actually reaches the workplane on which the light meter is placed. Foot-candles are workplane lumens per square foot. The light meter can measure the quantity of light from 0 to 1000 fc.

Brightness or Luminance

Another measure of light is its brightness or luminance. Brightness is a measure of the light that is reflected from a surface in a particular direction. Brightness is measured in footlamberts (fL).

Measuring the Thermal Energy
Infrared Meter



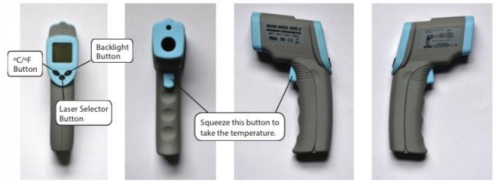
MASTER

Infrared (IR) Thermometer

A thermometer measures the temperature of objects. An infrared thermometer can do so remotely by measuring the amount of infrared radiation leaving an object. A red-colored laser directs the user to the object being measured. This is a safe way to measure the temperature of objects that are very high off the floor or very hot.

Operating Instructions

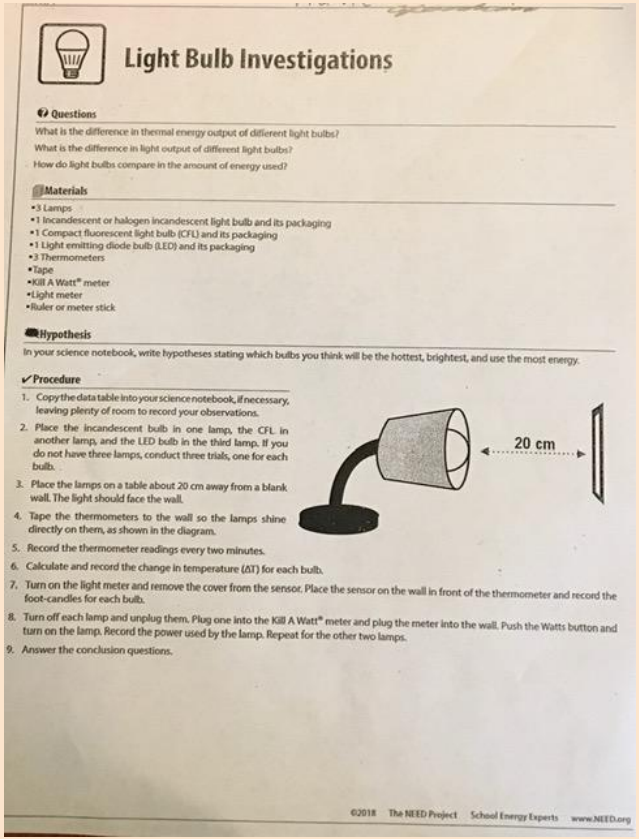
1. Aim the IR thermometer at the object you wish to measure.
2. Squeeze the button on the handle with your finger, holding it down briefly.
3. The thermometer will measure the temperature of the object at which you aim. The further away you are from the object, the less likely it is you are measuring an exact point, but the area near the point. Try and stand as close as possible.
4. To be certain you are measuring what you think you are measuring, depress the laser button and squeeze the trigger button on the handle again. The laser will show you the object you are measuring.
5. To change from °C to °F or °F to °C, press the °C/°F button.
6. In a dark room, press the backlight button to illuminate the LCD display.
7. The thermometer will turn itself off when left alone.



Lasers and Eyeballs: What's the Big Deal?

You've been told over and over again, don't focus a laser directly in someone's eyes. But why is this an issue? The reason is because laser light is unlike most light with which you are familiar. The word laser is an acronym, meaning Light Amplification by Stimulated Emission of Radiation. In a nutshell, lasers are produced when specific substances are energized, and the laser light is the result. Lasers are intense for two reasons. First, the light from a laser is only one wavelength, or color, of light. Most light sources you see, even colored bulbs, are a range of wavelengths. Lasers emit only one specific wavelength. Second, the light from a laser is focused and aligned and can be directed across great distances, even to the moon! Because of the intensity of the light from a laser, it can at best cause "flash blindness" and temporarily blind a person, and at worst can cause permanent damage to the *retina*, the part of the eye that detects light and transmits the light information to the nerves in the eye.

Collecting Data and Analyzing Data



Light Bulb Investigations

Questions

What is the difference in thermal energy output of different light bulbs?

What is the difference in light output of different light bulbs?

How do light bulbs compare in the amount of energy used?

Materials

- 3 Lamps
- 1 Incandescent or halogen incandescent light bulb and its packaging
- 1 Compact fluorescent light bulb (CFL) and its packaging
- 1 Light emitting diode bulb (LED) and its packaging
- 3 Thermometers
- Tape
- Kill A Watt® meter
- Light meter
- Ruler or meter stick

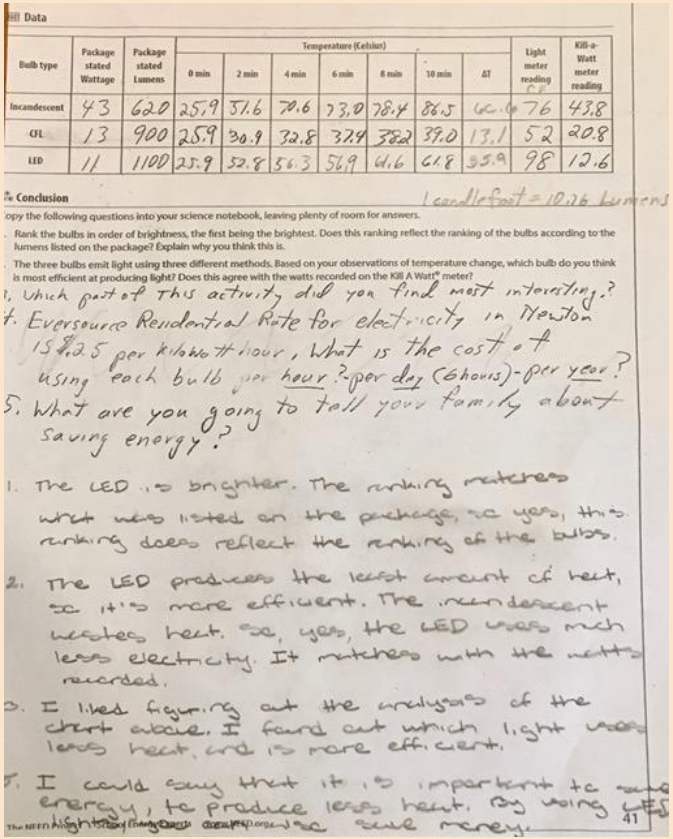
Hypothesis

In your science notebook, write hypotheses stating which bulbs you think will be the hottest, brightest, and use the most energy.

Procedure

1. Copy the data table into your science notebook, if necessary, leaving plenty of room to record your observations.
2. Place the incandescent bulb in one lamp, the CFL in another lamp, and the LED bulb in the third lamp. If you do not have three lamps, conduct three trials, one for each bulb.
3. Place the lamps on a table about 20 cm away from a blank wall. The light should face the wall.
4. Tape the thermometers to the wall so the lamps shine directly on them, as shown in the diagram.

5. Record the thermometer readings every two minutes.
6. Calculate and record the change in temperature (ΔT) for each bulb.
7. Turn on the light meter and remove the cover from the sensor. Place the sensor on the wall in front of the thermometer and record the foot-candles for each bulb.
8. Turn off each lamp and unplug them. Plug one into the Kill A Watt® meter and plug the meter into the wall. Push the Watts button and turn on the lamp. Record the power used by the lamp. Repeat for the other two lamps.
9. Answer the conclusion questions.



Data

Bulb type	Package stated Wattage	Package stated Lumens	Temperature (Celsius) 0 min	2 min	4 min	6 min	8 min	10 min	ΔT	Light meter reading	Kill-a-Watt meter reading
Incandescent	43	620	25.9	31.6	70.6	73.0	78.4	86.5	60.6	76	43.8
CFL	13	900	25.9	30.9	32.8	37.4	38.2	39.0	13.1	52	20.8
LED	11	1100	25.9	32.8	36.3	36.9	41.6	41.8	15.9	98	12.6

1 candle foot = 10.76 lumens

Conclusion

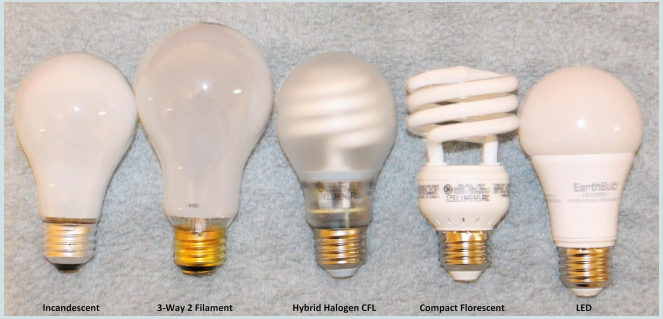
Copy the following questions into your science notebook, leaving plenty of room for answers.

1. Rank the bulbs in order of brightness, the first being the brightest. Does this ranking reflect the ranking of the bulbs according to the lumens listed on the package? Explain why you think this is.
2. The three bulbs emit light using three different methods. Based on your observations of temperature change, which bulb do you think is most efficient at producing light? Does this agree with the watts recorded on the Kill A Watt® meter?

3. Which part of this activity did you find most interesting?
4. Eversource Residential Rate for electricity in Newton 15.25 per kilowatt hour, What is the cost of using each bulb per hour? per day (6hours) - per year?
5. What are you going to tell your family about saving energy?

1. The LED is brighter. The ranking matches what was listed on the package, so yes, this ranking does reflect the ranking of the bulbs.
2. The LED produces the least amount of heat, so it's more efficient. The incandescent wasted heat. So, yes, the LED uses much less electricity. It matches with the watts recorded.
3. I liked figuring out the analysis of the chart above. I found out which light uses less heat, and is more efficient.
5. I could say that it is important to save energy, to produce less heat. By using LED we save money.

Results Question 1



1. Rank the bulbs in order of brightness, the first being the brightest. Does this ranking reflect the ranking of the bulbs according to the lumens listed on the package? Explain why you think this is.

The bulbs in order of brightness are LED, incandescent, and CFL. This ranking does not reflect the ranking of the bulbs on the package because, according to the package, the order would have been LED, CFL, and incandescent. -Zoey

Result Question 2

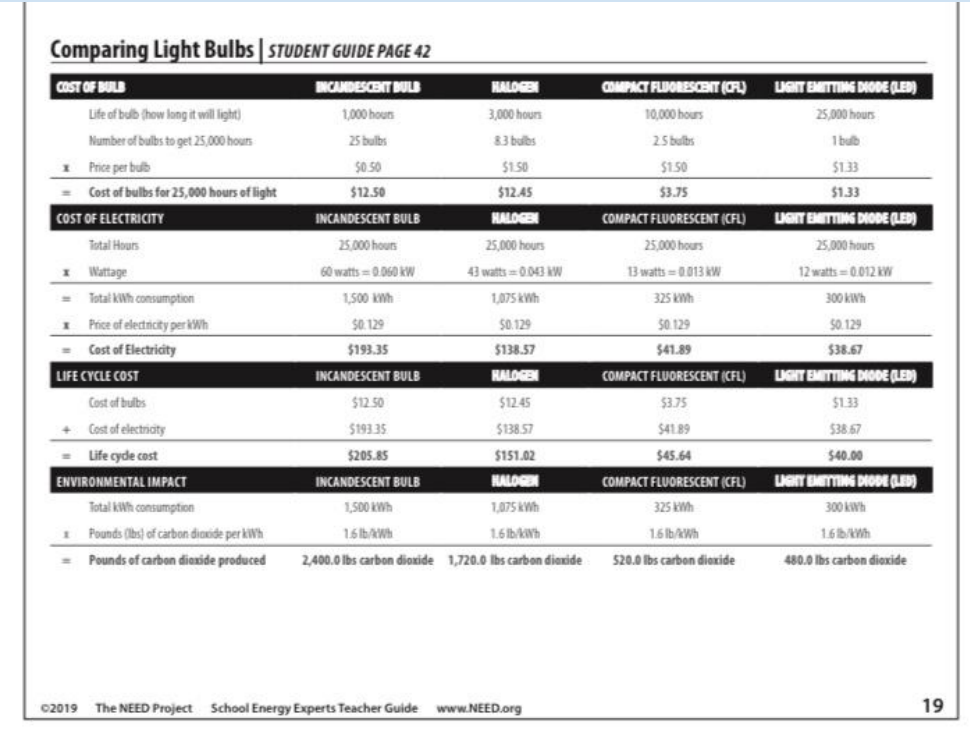
2. The three bulbs emit light using three different methods. Based on your observations of temperature change, which bulb do you think is most efficient at producing light? Does this agree with the watts recorded on the Kill A Watt® meter?

The LED light bulb is more efficient because it is using much less energy measuring 12.6 on the Kill-a-Watt reading and the Incandescent light bulb measuring 43.8 on giving off energy. The LED bulb is wasting only 35.9 whereas the Incandescent light bulb is measuring at 60.6, losing a lot more heat. Cameron

“Home Work”

We are taking turns taking the Light Bulb Investigation Kits home and teaching our families about saving energy and money with LED Light Bulbs.

Cost of Lightbulbs



Comparing Light Bulbs | *STUDENT GUIDE PAGE 42*

COST OF BULB		INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
	Life of bulb (how long it will light)	1,000 hours	3,000 hours	10,000 hours	25,000 hours
	Number of bulbs to get 25,000 hours	25 bulbs	8.3 bulbs	2.5 bulbs	1 bulb
x	Price per bulb	$0.50	$1.50	$1.50	$1.33
=	**Cost of bulbs for 25,000 hours of light**	**$12.50**	**$12.45**	**$3.75**	**$1.33**
COST OF ELECTRICITY		**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Total Hours	25,000 hours	25,000 hours	25,000 hours	25,000 hours
x	Wattage	60 watts = 0.060 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
=	Total kWh consumption	1,500 kWh	1,075 kWh	325 kWh	300 kWh
x	Price of electricity per kWh	$0.129	$0.129	$0.129	$0.129
=	**Cost of Electricity**	**$193.35**	**$138.57**	**$41.89**	**$38.67**
LIFE CYCLE COST		**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Cost of bulbs	$12.50	$12.45	$3.75	$1.33
+	Cost of electricity	$193.35	$138.57	$41.89	$38.67
=	**Life cycle cost**	**$205.85**	**$151.02**	**$45.64**	**$40.00**
ENVIRONMENTAL IMPACT		**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Total kWh consumption	1,500 kWh	1,075 kWh	325 kWh	300 kWh
x	Pounds (lbs) of carbon dioxide per kWh	1.6 lb/kWh	1.6 lb/kWh	1.6 lb/kWh	1.6 lb/kWh
=	**Pounds of carbon dioxide produced**	**2,400.0 lbs carbon dioxide**	**1,720.0 lbs carbon dioxide**	**520.0 lbs carbon dioxide**	**480.0 lbs carbon dioxide**

We determined the cost for 25,000 hours of electricity for each light bulb at today's cost of Electricity for Newton, Ma. which is $0.25 / KWH

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Incandescent
25,000hourd x 0.060 KW= 1,500 KWHours
1500 KWH x $0.25/KWH = **$375**

CFL
25,000Hours x 0.013kw = 325 KWH
325 KWH x $0.25= **$81**

LED
25,000Hours x 0.012 KW= 300 KWH
300 KWH x $0.25 = **$75**

Cost of Experimental Bulb Use

We determined the Cost of our Experimental Bulbs for 1 year.

Incandescent

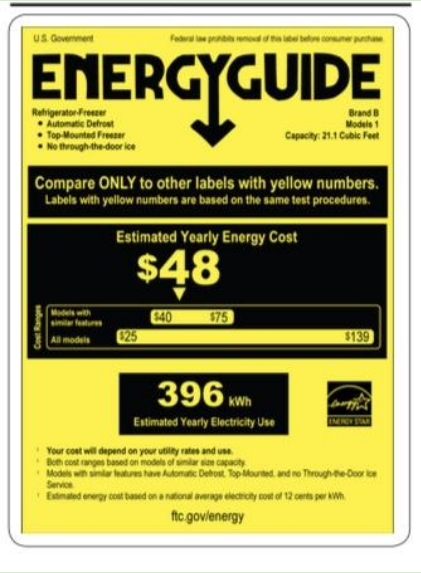
43.8W= 0.0438KW x 6 hours a day x 365 days = 95.9 KWH x $0.25 = **$ 23.97 per year**

CFL

20.8 W=0.0208 KW x 6 hours x 365 days = 45.55KWH x $0.25 = **$11.38 per year**

LED

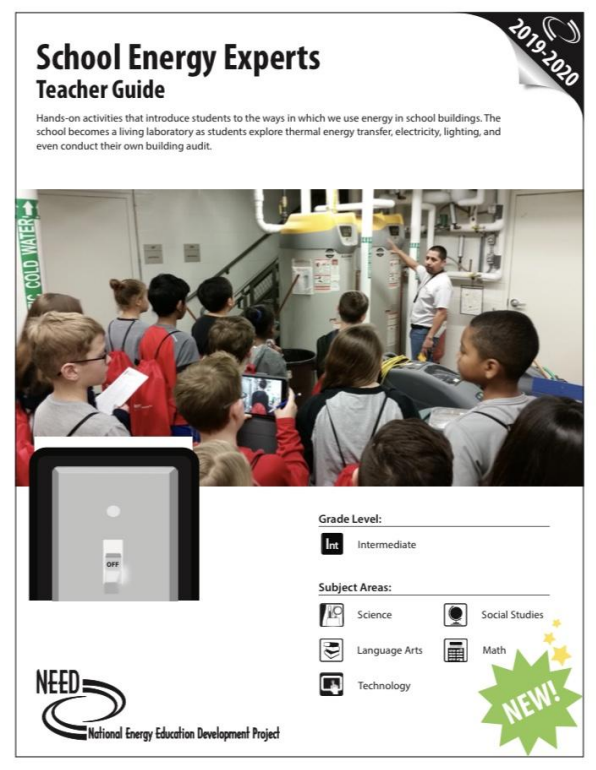
12.6 w=0.0128 KW x6 Hours x 365 days = 28 KWH x $0.25 = **$7.00**



I am going to tell my family that the LED is a lot brighter than the other light bulbs, and it does not give off so much useless heat, and the most important thing is that it costs less.
-Aiden

Conclusions

I’m going to tell my family that we should use LED bulbs because they would save us the most money. To make a change my family could only use energy when we need to by turning lights off when you leave rooms or other actions. Eric



Summary

Students successfully completed the Investigating Light Bulb Activities from the NEED Energy Expert Kit.

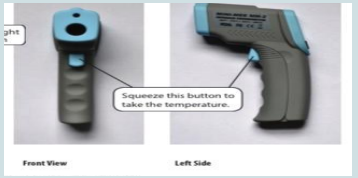
Students understood the relationship between Electricity Heat and Light. They came to the conclusion that heat was waste energy.

Students collected and correctly analyzed their data. They found that the LED was the most efficient and least costly of the three light bulbs.

Students are sharing what they learned with their families.

Student recognize that anytime that energy is saved, the Earth benefits.

Thank You NEED!



I found the most interesting part of this experiment to be all the equipment that we got to use. I'd never heard of a light meter or Kill-a- Watt meter before I started. It was fun taking a reading of all three light bulbs and I was surprised by the differences in the light, heat, wattage that I took. Caroline

I find the most interesting part of the activity is to measure the degrees of the lightbulbs. It is a very fun to use the special equipment and lay hands on the equipment myself. It feels amazing. Anny

The part of this activity that is most interesting is when you record the data using the materials and instruments given to you. When finding out about the light meter reading you have to use tools that show what it says and how you use it and how it works truly makes the experiment fun since you are involving new things that you have never learned of. WOrking with people around you on these projects alo makes a difference so everyone has a turn and everyone enjoys the experiment working with new people on science and new tools. Niara