Energy Quality Module
Kaizen: Continuous Improvement

Unit Length: 4-5 class periods

Lesson One:

Introduction: Energy: We have it, we use it, we need it!
In this lesson, students will take a pre-test on energy conservation, test their own energy usage, and write a persuasive piece.

Background: Energy is the ability to do work. Students will learn about the types of energy and their sources. They will learn about exhaustible and inexhaustible energy sources and will research ways to conserve energy.

Website Sources:
- http://www.ase.org (Alliance to Save Energy)
- http://keec.ky.gov (Kentucky Environmental Education Council)
- http://www.nrel.gov/learning (National Renewable Energy Laboratory)
- http://www.earthday.net/Footprint/index.asp#
- http://www.econedlink.org/lessons/index.cfm?lesson=EM526&page=teacher

Subject Area: Mathematics, Social Studies, Writing, Science

Kentucky Connection:
- Learner Goals: #1, #2, #5
- Academic Expectations: 1.11, 5.1, 2.18, 2.7, 2.8
- Core Content: MA-HS-4.1.2; MA-HS-4.2.1; MA-HS-4.1.2; WR-HS-1.2.0; WR-HS-1.2.3; SS-HS-5.3.6; SS-HS-4.4.2; SC-HS-4.6.7; SC-HS-4.7.5

Materials:
- Energy Pre-test
- Energy Power Point
- Computer lab/access to Internet
- Graph paper
- Calculators

Length of Lesson: Three class periods

Vocabulary Words:
- Energy – the ability to do work
- Exhaustible/Nonrenewable energy - any natural resource from the Earth that exists in limited supply and cannot be replaced if it is used up; also, any natural resource that cannot be replenished by natural means at the same rates that it is consumed

- Inexhaustible/Renewable energy - any naturally occurring, theoretically unending source of energy, as biomass, solar, wind, tidal, wave, and hydroelectric power, that is not derived from fossil or nuclear fuel.

Essential Question: How can I conserve energy? Who/what provides the energy for my everyday life?

Guiding Questions/Outcomes:

- Students will be able to define energy and describe different sources and types of energy.
- Students will calculate the impact their lifestyle has on the Earth.
- Students will research and write a proposal for an energy-efficient change in their household or school.

Skills Used:

- Data collection
- Data analysis
- Research

Activity 1: What is Energy?

- Students will take the true/false Energy Pre-Test. When all students have finished, the teacher will lead a class discussion and explain the correct answers
- Teacher will present the "What is Energy?" power point to the class in order to introduce the types of energy, and the sources and categories of energy
- Students will take notes from the presentation to build their basic understanding of the types of energy. They may refer to their notes in subsequent activities

Activity 2: How big is your energy footprint?

- The teacher leads a discussion of how much food a farm produces. Have students guess the number of acres in a small farm. Students might not even know how big an acre is (roughly 40,000 square feet or a square plot of land about 200 feet by 200 feet). Could one acre provide all the food needed for one person for one year? Could an acre: provide the materials needed to build a home; cover heating costs; provide wood for a fireplace; provide energy for equipment; etc.? Students may realize that a farm cannot provide gasoline or electricity (usually). There are many resources we need to support our comfort and lifestyle for a year. What is the average number of acres to provide for the needs of our students? What is the greatest amount? What is the least amount? Suppose this number of acres were to be translated into the number of planet Earths needed if everyone on the planet lived as a member of the class does. What would be a reasonable number?
- Each student will take the ecological footprint quiz using the Earth Day website: http://www.earthday.net/Footprint/index.asp# requiring the students to answer 13 questions about their personal lifestyles. The website will calculate how many acres it takes to sustain his/her lifestyle and will also convert that number into the

number of Earths it would take to sustain our population if everyone lived in that way. If it is not possible for every student to access a computer during class time, this can be assigned for homework a few days before the data will be needed in class

- When everyone has calculated how many acres and Earths he/she uses, each student will post his/her number on the board
- From the class data, each student will prepare a bar graph of the data and calculate the mean number of Earths and mean number of acres needed to sustain the lifestyles of people in the class. Identify the high and low numbers from the data. How do they affect the class results?
- Demonstrate how to calculate the standard deviation for a set of data (http://www.mathsrevision.net/gcse/pages.php?page=42):

$$\sigma = \sqrt{\frac{\Sigma\ (x - \bar{x})^2}{n}}$$

σ = **lower case sigma**
Σ = **capital sigma**
$\bar{x}$ = **x bar**

σ means 'standard deviation'.
Σ means 'the sum of'.
$\bar{x}$ means 'the mean'

Example: Find the standard deviation of 4, 9, 11, 12, 17, 5, 8, 12, 14
First work out the mean: 10.222
Now, subtract the mean individually from each of the numbers given and square the result. This is equivalent to the $(x - \bar{x})^2$ step. x refers to the values given in the question.

X	4	9	11	12	17	5	8	12	14
$(x - \bar{x})^2$	38.7	1.49	0.60	3.16	45.9	27.3	4.94	3.16	14.3

Now add up these results (this is the 'sigma' in the formula): 139.55
Divide by n. n is the number of values, so in this case is 9. This gives us: 15.51
And finally, square root this: 3.94

- Have students calculate the standard deviation for the class data
- Concluding Questions:

- What is the average number of acres for the students in the class? What is the average number of Earth's needed?
- Which statistic would you use if you wanted to point out the lack of awareness of the environment? Which statistic would you use if you did not want to alarm the public?
- What is the biggest factor that contributes to a high number of acres? Or, which area do you think could conserve the most of the earth's resources?
- Suppose you were to calculate the mean again eliminating the highest 3 values. Is the mean still greater than 1 Earth? What does that mean for future generations? Is it enough to change only the extreme lifestyles? Or does everyone need to change if we are to get the number down to below 1 Earth needed?
- What are the next steps? How can we carry this message to other people? The students might want to have their parents and other family members take the online questionnaire. Perhaps later in the year the class can repeat the lesson and see if the average number of acres has been reduced.
    - Activity adapted from "How Big is Your Footprint?" Lesson Plan from http://www.ase.org/section/_audience/educators/lessons/high/

Assessment:

- Students will research alternative energy sources and ways to conserve energy. If students need ideas, they can refer to their pre-test, which should spark some ideas for changes they can make in their daily lives
- Students will perform a writing task (a proposal, formal letter, feature article, editorial commentary, etc) supporting a single change in energy usage and explaining the benefits of that change

Extensions:

- Great lesson from National Council on Economic Education about the economics of energy conservation. http://www.econedlink.org/lessons/index.cfm?lesson=EM526&page=teacher

ENERGY Pre-Test *Adapted from "To Conserve or Not to Conserve?" Lesson Plan*
http://www.ase.org/section/_audience/educators/lessons/high/

True or False: Write "T" for True, and "F" for False.

____ 1.The United States uses more energy per person than any other nation in the world.
____ 2.The United States produces 2/3 of the oil we consume.
____ 3.On cold winter days, a roaring fire in the fireplace saves energy.
____ 4. In the afternoon, you should keep the drapes closed on all west-facing windows to block out the sun.
____ 5.Thermal-lined drapes and outdoor awnings can significantly reduce the energy required for air conditioning.
____ 6.You can warm up your house faster by turning the thermostat higher than the the desired temperature.
____ 7.Weather-stripping doors and caulking windows can save up to 10% of home energy costs.
____ 8 There is no reason to ventilate the attic in the summer if it is well insulated.
____ 9.The lower the temperature setting on your water heater, the less energy you will use.
____ 10.A frosty refrigerator uses less energy because frost acts as an insulator.
____ 11.Food cooks faster in a covered pan.
____ 12.You don't have to preheat the oven for broiling or roasting.
____ 13.On especially cold days, it is a good idea to get a little extra heat into the kitchen by turning on the oven and opening the oven door.
____ 14.It is usually less expensive to take a bath than a shower.
____ 15.It does not matter where the water heater is located in your home as long as it is in proper working order.
____ 16.The home heating and cooling system is the major residential user of energy.
____ 17.The home freezer operates most efficiently when it is ½ to 2/3 full.
____ 18.Refrigerators are designed to accept frequent and lengthy door openings without increased operating costs.
____ 19.Fluorescent and incandescent lights of the same wattage produce the same amount of light.
____ 20.There is no reason to defrost frozen foods before putting them into the oven.
____ 21.You will save energy by doing several small loads of wash rather than one large one.
____ 22.You should dry as many clothes as possible in each load.
____ 23.You can save up to 1/3 of your dishwasher operating costs by allowing the dishes to air dry rather than go through the dry cycle.
____ 24.About 1/3 of all private automobile mileage is for commuting to and from work.
____ 25 On cold days, it saves gas to warm up your car for 5-10 minutes before driving.
____ 26 It takes less gas to restart an engine than to idle it for more than one minute.
____ 27.The less air in the tires, the less gasoline you will burn.
____ 28.The heavier the car, the more gas it uses.
____ 29.Keeping your car tuned up will increase gas mileage.
____ 30.The old 55-mph national speed limit was imposed during the oil embargo to help conserve fuel. Higher speeds use significantly more fuel.

ENERGY Pre-Test (Answer Key) *Adapted from "To Conserve or Not to Conserve?" Lesson Plan*
http://www.ase.org/section/_audience/educators/lessons/high/

True or False: Write "T" for True, and "F" for False.

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T/F 4. In the afternoon, you should keep the drapes closed on all west-facing windows to block out the sun.
_T_ 5.Thermal-lined drapes and outdoor awnings can significantly reduce the energy required for air conditioning.
_F_ 6.You can warm up your house faster by turning the thermostat higher than the the desired temperature.
_T_ 7.Weather-stripping doors and caulking windows can save up to 10% of home energy costs.
_F_ 8 There is no reason to ventilate the attic in the summer if it is well insulated.
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_T_ 28.The heavier the car, the more gas it uses.
_T_ 29.Keeping your car tuned up will increase gas mileage.
_T_ 30.The old 55-mph national speed limit was imposed during the oil embargo to help conserve fuel. Higher speeds use significantly more fuel.

Energy Conservation Writing Task

Our recent lessons have focused on the types of exhaustible and inexhaustible energy sources and ways individuals and groups can conserve energy. You have conducted research on alternative energy sources and ways to conserve energy. You now must choose one change you can make in your energy usage and decide on a format that will help you get your message out to a specific audience.

Assignment:

- Select a specific change in energy usage/conservation you think can and should be implemented by your target audience (audience possibilities: students, school board, Congress, auto industry, public transportation industry, etc.).
- Write a persuasive piece convincing your audience that change is needed and explaining how they could make the change (format possibilities: speech, proposal, formal letter, feature article, editorial commentary, editorial, etc.).
- Your purpose is to convince your target audience that energy usage is a serious issue in today's society and to convince that audience to make the change you suggest. Be sure you also explain to them not only **why**, but **how** they should implement the change.

Note: If you would like to propose a different angle or energy usage/conservation issue, it will need to be approved by the teacher.

(Remember – your opinions are only valid if you can offer convincing evidence to support them.)

First - analyze your target audience and their need-to-know.

These questions will help you choose your angle and narrow focus:

What is going to give them a reason to even read what you have written or listen to what you have to say? (i.e. Why should they care?)
What kinds of information will they want (or need) to know?
Why do they need the information?
What do you want them to do when they finish reading or hearing your speech?

Here are some tips that will help you write an effective persuasive piece:

1. Your opening paragraph should:
   - hook your audience by engaging your reader's interest and enticing them to **want** to keep reading ***(Make your first sentence powerful.***)
   - provide some context for your audience, so they will understand what the current situation or problem is **and** why you, personally, are concerned
   (Otherwise, they may not think it's a problem, or they may not understand your concern.)

2. The last sentence of your opening paragraph must establish the purpose of the piece. **(This is your position sentence.)**

3. You will need at least 2 or 3 supporting paragraphs that contain your arguments (as the topic sentence) and at least 2 kinds of evidence or support to convince your audience.

4. Write using a respectful tone. A sarcastic or angry tone is not persuasive.

5. If you include research results, select the information you include based on audience interest and ***need-to-know***. (*What will be the most convincing evidence*?)

6. Remember - your conclusion needs to circle back to your focus and you must also end with a call-to-action (What do you want your audience to **do**?)

Lesson Two: Sources of Energy

Introduction: Activity adapted from http://www.classroomenergy.org/oil_natural_gas/adventures_in_energy/index.html Students will learn about sources of energy: oil, coal, natural gas, and electricity. They will learn the uses for a barrel of oil and facts concerning our current oil reserves.

Background: The use of oil to produce many varieties of energy consumed in our everyday lives is often gone unnoticed by consumers. Students should investigate and become aware of their own everyday energy consumption.

Website Sources:

- http://www.classroomenergy.org/oil_natural_gas/adventures_in_energy/index.html
- http://www.adventuresinenergy.org/main.swf
- http://www.adventuresinenergy.org/main.swf
- http://www.classroom-energy.org/oil_natural_gas/fuel_less/index.html
- http://www.classroom-energy.org/oil_natural_gas/progress_through_petroleum/index.html
- http://www.fueleconomy.gov/feg/bestworst.shtml

Subject Area: Mathematics, Science

Kentucky Connection:

- Learner Goals: #1, #2, #3, #6
- Academic Expectations**:** 2.1; 2.2; 2.3; 2.4; 2.6
- Core Content: SC-HS-2.3.7; SC-HS-3.5.5; SC-HS-4.6.1; SC-HS-4.6.4; SC- HS-4.6.7; SC-HS-4.6.8; SC-HS-4.6.9; SC-HS-4.7.2; SC-HS-4.7.3; SC-HS-4.7.5

Materials:

- Computer for each student or pair of students
- Copies of "Adventures in Energy" worksheet
- Free video from website http://www.classroom-energy.org/oil_natural_gas/fuel_less/index.html

Length of Lesson: Four class periods

Vocabulary Words:

- Oil- Oil (sometimes called petroleum) is formed from the decayed remains of animals and plants. Under the influence of heat and pressure, the decayed matter breaks down first into liquids and into gases. Both the liquid (petroleum) and gas phases (natural gas) collect in pools under the earth's surface. After a drilling and pumping process to extract it, oil is refined and turned into a variety of petroleum-based products.

- Petroleum Products- Petroleum is another word for oil. After being pumped up from the earth, petroleum is refined and turned into many products, including kerosene, benzene, gasoline, paraffin wax, and asphalt. Other materials that we use every day, like plastic and nylon, are also petroleum-based products.

- Natural Gas- An odorless, colorless, gaseous hydrocarbon mixture made up of methane (CH_4) and a small percentage of other light hydrocarbons. Natural gas is found naturally underground or produced by gasification of coal. Natural gas is the cleanest burning fossil fuel.

- Oil Refinery- An industrial process plant where crude oil is processed and refined into more useful petroleum products, such as gasoline, diesel fuel, asphalt base, heating oil, kerosine, and liquefied petroleum gas.[1][2] Oil refineries are typically large sprawling industrial complexes with extensive piping running throughout, carrying streams of fluids between large chemical processing units.

Essential Question/s: How is oil consumed for energy in everyday life?

Guiding Questions/Outcomes:

- Students will be able to identify where oil comes from.
- Students will be able to explain how oil is used in daily life.
- Students will be able to determine the cost, in terms of oil and gasoline, of using a car.

Skills Used: Observation, research, speculation, investigation, organization, discussion, comparison, communication

Activity:

Day 1:

- Using a computer, have students locate the web site http://www.adventuresinenergy.org/main.swf

- They are to view the video presentation and complete the accompanying worksheet entitled Adventures in Energy.

Adventures in Energy

Name _____ Date _____ Period _____

See how oil and natural gas have changed how we live as a society. Use the Adventures in Energy (http://www.adventuresinenergy.org/main.swf) website to answer these questions.

Oil and Natural Gas in Your Life

1. What are oil and natural gas used for?

2. What are some of the products that are made with oil?

3. Our society has become so dependent on oil. What would be different in your life if there were no petroleum products?

4. Where does oil and natural gas come from and how they get to us?

What are Oil and Natural Gas?

5. How do we find clues for oil and natural gas sources from the sky?

6. How does technology play a role on the ground in finding clues that there might be oil and gas underground?

7. What are the benefits of technologies used off-site when searching for oil and natural gas?

Transporting Oil to the Refinery

8. How is technology responsible for influencing transportation where oil is concerned?

9. How is the technology of communications and information processing used where oil is concerned?

10. Do you think oil is easily transported? Explain your answer.

11. How have modern day tankers helped reduce costs in obtaining oil?

Activity:
Day 2:

- Teachers need to order the free video involving uses of oil in a teenager's life at http://www.classroom-energy.org/oil_natural_gas/fuel_less/index.html
- Show the video and then have a class discussion about ways in which oil has an effect on everyday life.
- Some suggestions:
    - Tell students to go to the Adventures in Energy website. There they will read most of "Oil and Natural Gas in Your Life." As a class, discuss these questions:
        - What are oil and natural gas used for? (They are used for a variety of purposes, including fueling vehicles, providing the fuel needed to create electricity, heating buildings, and cooking food.)
        - What are some of the products that are made with oil? (There are a ton of examples in this interactive, including detergent, plastic wrap, the insides of juice boxes, packaging for cough syrup and shampoo, crayons, etc.)
        - Our society has become so dependant on oil. What would be different in your life if there were no petroleum products? Here are some talking points:

➢ More than 44 percent of the total demand for petroleum products is for motor gasoline. What if it weren't easy to fuel a car? Or what if it were more expensive?
➢ If airplanes and trucks couldn't be fueled easily or it was more expensive to fuel them, how would that affect products you and your parents buy in stores? Would we still be canning fruits for winter and farming our own vegetables in summer if trucks couldn't bring food to the supermarket? Or would things be more expensive? If our time was spent farming, would we have time for sports and television?
➢ Did you know that CD players, DVDs, ink, some clothing, computers, containers, telephones, and toothpaste are also petroleum products? You also read about quite a few. What would your life be like without these?

Activity:
Day 3:

- Using a computer, have students locate the web site http://www.classroom-energy.org/oil_natural_gas/progress_through_petroleum/index.html

- Have students complete the following interactive videos:

    - Progress thru Petroleum

    - Progress Through Petroleum Challenge

    - All About Petroleum

Activity:
Day 4:

- Determine the fuel economy or efficiency of at least 10 different varieties of cars by using the web page http://www.fueleconomy.gov/feg/bestworst.shtml .
- Find the car that you would like to purchase as your first car and determine the fuel economy or efficiency of that car.
- Figure out your share of the number of gallons of gasoline that you burn riding back and forth from school in a car for a week. To do this, figure the distance in miles you traveled and divide this by the fuel economy of the vehicle. For example, if you and one other person drive 60 miles to school each week in a car that gets 20 miles/gallons, then the car consumed three gallons of gasoline and your share would be half of that – because two were riding in the car – 1.5 gallons. You can convert gallons to liters by multiplying by 3.67, and miles to kilometers by multiplying by 1.61.
- Now multiply the amount calculated above by the number of weeks that school is in session. This represents the amount of gallons used to get back and forth from school.
- Now, based on current gasoline prices determine the value associated with the number of gallons used in your car.
- Next figure the amount of oil used in the car over a year long period. Most cars use 4 quarts of oil every 3,000 miles. To determine amount of oil, determine the approximate number of miles your drive, divide this by 3,000 miles to determine the number of times you should change the oil in your car. Multiply the number of times the oil should be changed by 4 quarts to find the amount of oil used on a yearly basis.
- Next, determine the cost of the oil by multiplying the cost per quart by the number of quarts used on a yearly basis.
- Have students discuss their choice of car and the fuel efficiency and cost.

Assessment:

Day #1 : Completion of the worksheet Adventures in Energy
Day #2 : Participation in the class discussion about ways in which your life is affected by petroleum products.
Day #4 : Determine the cost of using a car when driving back and forth from school.

TOYOTA CONNECTIONS

- TMMK has taken multiple steps to save energy in daily operations by encouraging use of compact fluorescent lighting, turning off lights in process areas during breaks, installing motion sensors in restrooms and administrative offices, and turning off all lights in vending machines.
    - Turning the lights off in the vending machines saves approximately $40.00 per machine per year. TMMK has approximately 200 vending machines.
- TMMK is manufacturing hybrid vehicles. Here are a few facts about the Toyota Camry Hybrid:
    - Toyota's Hybrid Synergy Drive consists of gas and electric power sources that are complementary and produce a combined 187 horsepower
    - System varies between gas and electric, or both, as needed
    - Camry Hybrid is equipped with an "ECO" button that limits energy consumption by the Heating/Ventilating/Air Conditioning (HVAC) system and under certain conditions can help improve fuel economy
    - Fuel efficiency rating of 40 mpg in the city, 38 mpg on the highway, and 39 mpg combined driving (2007)
    - Camry Hybrid is certified as an Advanced Technology Partial Zero Emissions Vehicle (AT-PZEV), one of a handful of cars to meet the strict AT-PZEV standard
- At TMMK, continuous improvement or *kaizen* is not only used in production. The concept is also applied to environmental activities such as replacing original utility system equipment with hi-efficiency units, i.e. chillers, compressors, etc, and replacing original equipment motors, as they go bad, with hi-efficiency motors.
    - Another specific example is TMMK produces and uses approximately 20 billion cubic feet of compressed air per year. This takes much energy to produce. Recently TMMK purchased a new program for running air compressors that has increased efficiency by 26 percent. In the first year of use, enough energy was saved to heat and cool 1500 single family homes for one year.
- TMMK also focuses on non-production energy reduction, for example, reducing weekend energy usage. A good rule of thumb is: "If it's not required, turn it off."

Lesson Three: Watts going on?

Introduction:
Students will set up a circuit consisting of a standard AC outlet, light bulb socket, variety of light bulbs, and a multi-meter to determine energy usage and output of incandescent and compact florescent bulbs (CFLs). Students will directly apply math, physics, chemistry, social studies, and practical living/vocational skills.

Note: The test should be conducted by the teacher first to demonstrate safety and understanding!!

Background:
One of the most commonly used forms of energy is electricity. Electricity is caused by the flow of electrons and is measured in units called watts. A watt is equal to current multiplied by voltage.

Website Sources:
- www.NEED.org
- http://www.energyquest.cagov/time_machine/index.html
- http://www.eia.doe.gov/quiz/quiz.htm

Subject Area: Mathematics, Practical Living, Science

Kentucky Connection:
- Learner Goals: #1, #2, #5, #6
- Academic Expectations**:** 1.11, 2.1, 2.7, 2.8, 2.30, 5.1, 5.4, 6.1, 6.2, 6.3
- Core Content: MA-HS-1.2.1, MA-HS-1.3.1, MA-HS-1.4.1, MA-HS-2.2.1, PL-HS-3.1.2, PL-HS-3.1.4, SC-HS-1.2.2

Materials:
(See Diagram)
- 1 Digital Multi-meter (class III) (must read AC Current)
- 1 Metal electrical box and cover
- 3 - ½" NM cable connector for electrical box
- 3 Wire nut connectors and 2 Push in type wire connectors-two hole
- 1 Metal ceiling electrical ceiling box for light
- 1 Plastic ceiling lamp holder (light socket)
- 2 foot 14/2 gauge solid strand electrical wire
- 8 foot 16/3 gauge replacement electrical extension cord
- 1 Mounting board 2"x 8" that is 18" long
- 3 Incandescent Bulbs (60 watt, 75 watt, 100 watt)
- 3 Florescent Bulb (13 watt, 20 watt, 23 watt)
- 4 - #8 x ¾" metal screws
- 1 Screw driver
- 1 Wire cutter/stripper
- Calculator

Length of Lesson: One class period

Vocabulary Words:

- CFL - Compact fluorescent light bulb
- Energy - Capacity to do work
- Electricity - Flow of electrons from one point to another
- Voltage - The rate at which energy is drawn from a source that produces a flow of electricity in a circuit
- Volts - Unit used to measure electric potential at a given point
- Amperes - Unit of electric current in the meter-kilogram-second system
- Joules - Unit of work or energy, equal to the work done by a force of one Newton when its point of application moves through a distance of one meter in the direction of the force
- Energy efficiency - Usable energy
- Lumens - Light output
- Watts - Equal to current (in amperes) multiplied by voltage (in volts)
- Kilowatt - A unit of power, equal to 1000 watts
- Kilowatt-hour - Unit of electric energy equal to the work done by one kilowatt acting for one hour
- Kinetic energy - Energy of motion
- Potential energy - Stored energy

Essential Question: How much energy is saved by using a CFL bulb in place of an incandescent bulb?

Guiding Questions/Outcomes:

- Students will be able to calculate energy consumption using Ohms Law (Watts = Volts x Amps)
- Students will be able to complete a basic wiring circuit
- Students will be able to explain energy consumption between incandescent and CFL bulbs

Skills Used:

- Observation
- Comparison
- Organization
- Planning
- Calculating

Activity:

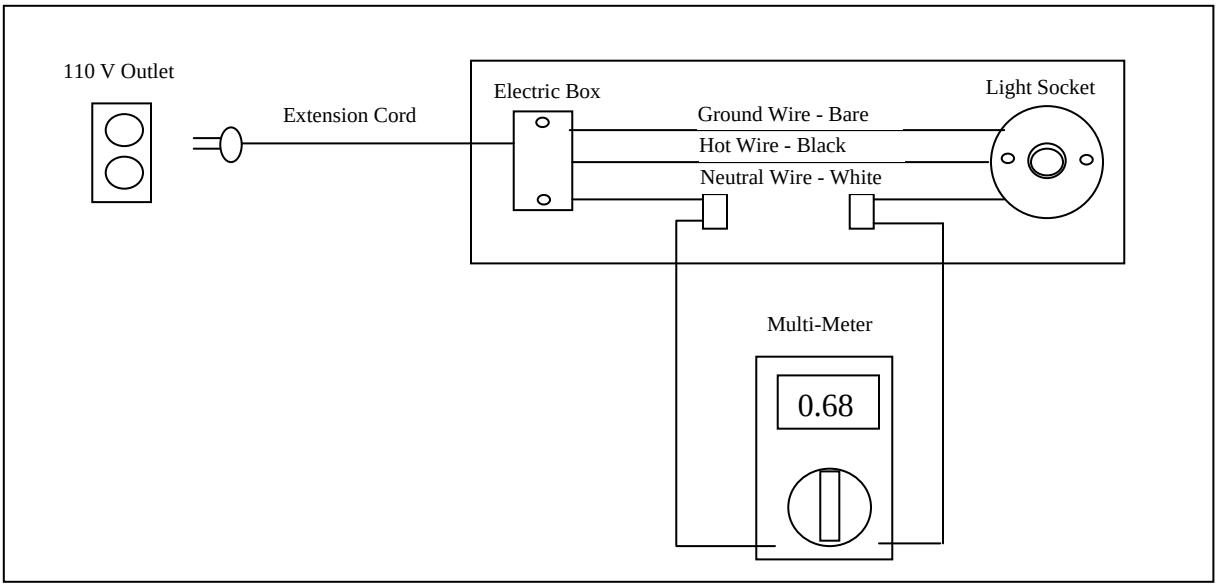
Setup

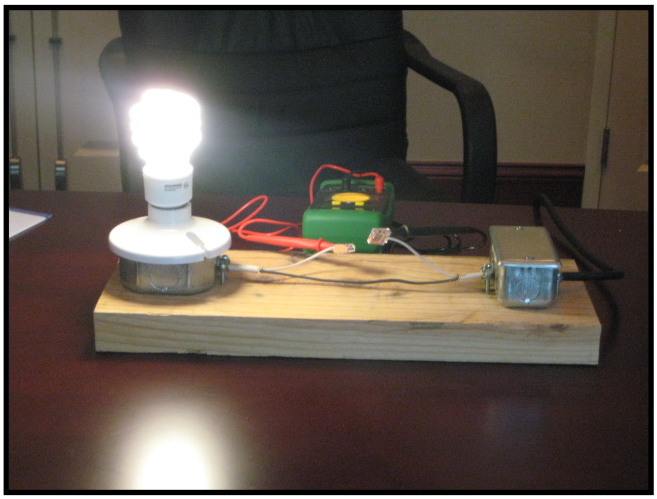
- Mount the ceiling box to the right hand side of the board using two screws.
- Mount the electrical box to the left side of the board using two screws.
- Cut female end off extension cord (if it has one) and splice ends to electric wire inside of electrical box using wire nuts– make sure to connect all colors to same color wire (green – bare copper)
- Secure wires to electrical box with the cable connectors to secure them
- Connect ground wire (bare copper) to the metal ceiling box with one of the mounting screws, hot wire to light socket terminal (Black = Hot), and white (neutral) wire to light socket terminal.
    - Mount light socket to the ceiling box on the right side of board
- Cut wire in between metal box and light socket, and strip wire from each cut end ½" and press a push in connector on each of the ends

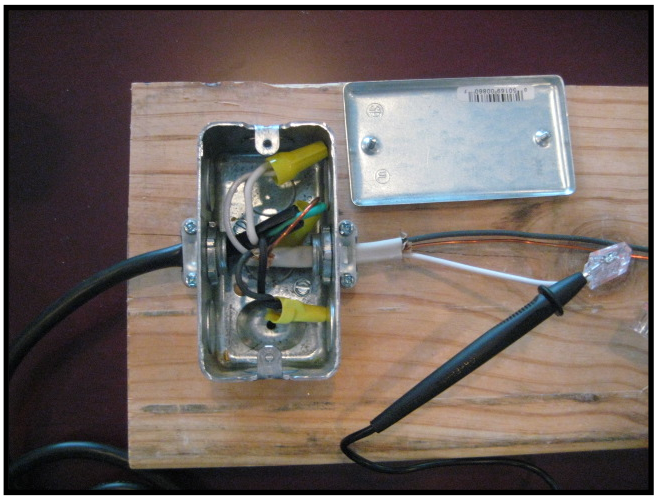
Test

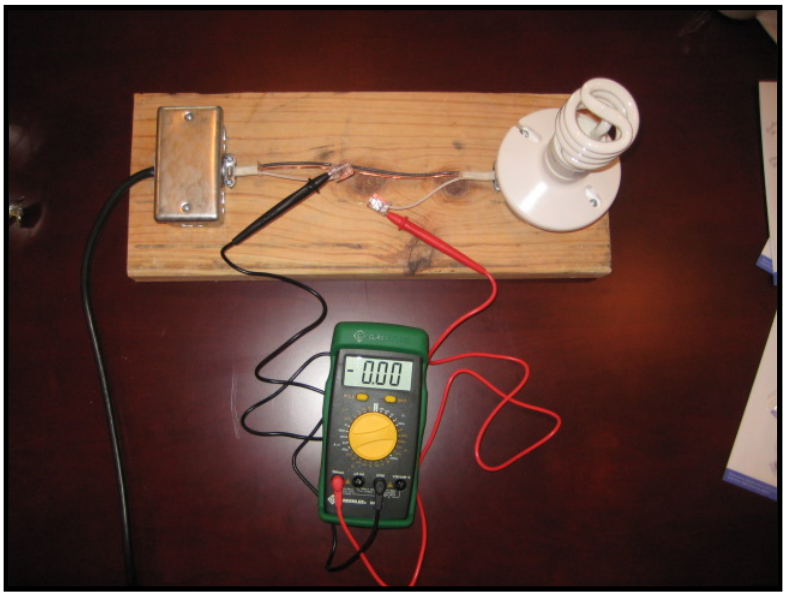
- Place an incandescent bulb in the light socket
- With the multi-meter set to measure current at 10 amps, place a lead into each plug in connector - Warning: DO NOT touch the metal part of the probe while the circuit is plugged into the wall
- Plug extension cord into a 110 volt outlet (the bulb should light up)
- Measure current reading (amps) on the meter
- Unplug the wall outlet
- Change bulb and repeat step 1
- Record steps on the chart

Diagrams and Photos:









Watts Going On?
Chart #1

Light Bulb	Volts	Amps	Watts
Incandescent 100w			
Incandescent 75w			
Incandescent 60w			
CFL 23w (=to 100w)			
CFL 20w (=to 75w)			
CFL 13w (=to 60w)			

- Voltage on standard outlets are normally 120 volts AC Current
- Amps should be read on the millimeter and should fall between 0.01 and 1.0 amps
- Watts can be calculated by Ohms Law (Watts = Volts x amps)

1. Which bulb uses the least amount of energy? Why?

2. Which bulb(s) produced the most light?

3. Compare a CFL 13w bulb to an incandescent 60w bulb. If energy rates are 5.7 cents per KWH, and the average light is on 6 hours per day, how much money will changing to the CFL bulb save in one year? How much for a house that has 15 bulbs?
   (A 60 watt bulb will consume 0.06 KW in 1 hour – Thus 0.06 KWH)

Watts Going On?
Worksheet #1

Home energy evaluation

Bring in a recent energy bill from your household. Look for the current energy cost (rate of KWH), current energy used, and average cost per day.

Have each student count the number of incandescent light bulbs in their home. Assuming all bulbs in their house are 60 watt bulbs, have each student assess how much money their family could save per month by converting to the 13 watt CFL.

- Total Energy cost (EC) can be calculated using the following formulas:
  KWH = (# of bulbs x 60*)(8 hours per day x 30 days per month) / 1000
  EC = KWH x energy cost from bill
  use 60 for the incandescent bulbs and 13 for the CFL bulbs

XXX	# of Bulbs	Total KWH	Total Cost
Incandescent Bulbs			
CFL Bulbs			
Total Savings Subtract CFL cost from Incandescent cost	XXX	XXX	

Example: 5 incandescent bulbs in your house and the energy cost is $0.10 per KWH

XXX	# of Bulbs	Total KWH	Total Cost
Incandescent Bulbs	5	72	$7.20
CFL Bulbs	5	12.48	$1.25
Total Savings	XXX	XXX	$5.95

Assessment:

- Participation in the activity and successful completion of the accompanying worksheet.

Extensions:

- Mercury is found in energy saver compact fluorescent light bulbs. www.lamprecycle.org provides information on the disposal of, or recycling of, fluorescent lights. Using information from this website, have students develop a recycling program for light bulbs containing mercury.

TOYOTA CONNECTIONS

- By installing fluorescent fixtures instead of using HID (High Intensity Discharge Lighting) TMMK saves 147 watts per fixture. TMMK has approximately 7000 fixtures in the plant. This saves enough energy to run 7900 36" color televisions.
- During breaks, lunches and in between shifts all of TMMK's process area lighting is shut off.
- Overhead lighting is wired to motion sensors and will shut off automatically when no movement is detected for 30 minutes.
- Replace original plant lighting with hi-bay fluorescent fixtures including motion sensors.
- TMMK has installed motion sensors in all office areas so lights will turn off automatically and Team Members are turning off computers, printers, and copiers daily, to reduce electricity usage.

Old Style Lighting Fixture 368 Watts

New Style Lighting Fixture 221 Watts