Weekly Focus: slope
Weekly Skill: application

LESSON 35: Finding Slope and Graphing, part 2

Lesson Summary: For the warm-up, students will solve a problem about the cost of clothing with tax. In Activity 1, students will do problems in the workbook. In the application activity, they will compare the costs of different types of light bulbs. Estimated time for the lesson is 2 hours.

Materials Needed for Lesson 35:

- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Workbook (pages 106 – 109)
- Application Problem Worksheet with answers
  - Note: For better copies, you may want to use the link to the application activity in the lesson plan below.

Objectives: Students will be able to:

- Solve the item cost and tax problem
- Solve various slope and graphing problems
- Compare the costs of different types of light bulbs by using a table and a graph

ACES Skills Addressed: N, CT, LS
CCRS Mathematical Practices Addressed: Building Solution Pathways, Reason Abstractly and Quantitatively
Levels of Knowing Math Addressed: Intuitive, Abstract, and Application

Notes:
You can add more examples if you feel students need them before they work. Any ideas that concretely relates to their lives make good examples.

For more practice as a class, feel free to choose some of the easier problems from the worksheets to do together. The "easier" problems are not necessarily at the beginning of each worksheet. Also, you may decide to have students complete only part of the worksheets in class and assign the rest as homework or extra practice.

The GED Math test is 115 minutes long and includes approximately 46 questions. The questions have a focus on quantitative problem solving (45%) and algebraic problem solving (55%).

Students must be able to understand math concepts and apply them to new situations, use logical reasoning to explain their answers, evaluate and further the reasoning of others, represent real world problems algebraically and visually, and manipulate and solve algebraic expressions.

This computer-based test includes questions that may be multiple-choice, fill-in-the-blank, choose from a drop-down menu, or drag-and-drop the response from one place to another.

The purpose of the GED test is to provide students with the skills necessary to either further their education or be ready for the demands of today's careers.

Lesson 35 Warm-up: Solve the socks problem	Time: 10 Minutes

Write on the board: Lydia went to the store to buy some clothes. With tax, she paid $49.14 for a $26 shirt and 6 pairs of socks. (She doesn't live in MN).

Basic Questions:

- If the tax rate is 8%, how much was each pair of socks?
  - First, we need to figure out the tax. Students may just divide $49.14 by 1.08 (the price plus 8% tax) or may set up a proportion first: $\frac{\$49.14}{1.08} = \frac{\$x}{1}$. x = $45.50 = the cost of the items before tax
  - $45.50 – $26 for the shirt = $19.50 for 6 pairs of socks
  - $19.50/6 = $3.25 for each pair
  - Check answer

Extension Question:

- Write an equation for the problem. Let x = the number of pairs of socks
  - (6x + 26)(1.08) = $49.14
  - 6.48x + 28.08 = 49.14
  - 6.48x = 21.06
  - x = $3.25

Notes:

- Discuss the different ways of solving the problem. An equation would usually be setup with the 1.08 in front of the parentheses, but some students may find it easier to write in the order it happens: all of the items times the tax.
- Making the tax 1.08 is a shortcut. Students may understand better the items times 0.08 and adding those to the price of the items. Explain how they are the same.

Lesson 35 Activity 1: Practice Problems	Time: 40 Minutes

1. Solve the problems in the **workbook pages 106-109**.
2. Do #1 and #2 on page 106 together first.
3. Circulate to help.

4. If there is extra time now or at the end of class, add to the following problems:
   - Question 5: Graph the two parallel lines
   - Question 8: Make a table
   - Questions 13 and 14: Make a table and graph
   - Questions 20 and 21: Make a table and a graph
   - Or choose other problems to expand

Lesson 35 Application: Which Light Bulb is Best?	**Time: 45 Minutes**

1. The attached activity about the cost of using light bulbs connects math and science skills.
2. As you introduce the activity, have a short discussion about the different types of bulbs. Encourage students to explain the differences and give examples of when each type might be used (i.e. LEDs are used on bicycles). Show images that are different from those on the worksheet if you have internet access.
3. The activity is a review of decimals and practice with graphing also.
4. Students may use calculators to fill in the table.
5. The last activity, number 9, can be left out or assigned as homework.
6. Close the activity by measuring the slope of each line on the first graph (if possible). Count the change in y units divided by the change in x units. (It is a little difficult to see on the answer sheet but may be easier to count from a student's graph or yours if you made one.)
7. Here is a suggestion on how to group the different sections of the activity:
   a. Discussion of light bulbs, #1 and #2 (10 minutes)
   b. Filling out chart, #3 and #4 (10 minutes)
   c. First graph and #5 (10 minutes)
   d. #6, #7, and 2nd graph (10 minutes)
   e. #8 and figuring slope (5 minutes)
   f. #9 and #10: homework

Lesson 35 Application: Light Bulbs

Light bulbs are almost burnt out

Incandescent Compact Fluorescent (CFL) Light Emitting Diodes (LED)

The House of Representatives voted last year to withhold funding to enforce part of a 2007 law that increases efficiency standards for light bulbs.

The bill, signed into law in December 2007, provided these changes to U.S. energy policy.

- There should be roughly 25 percent greater efficiency for light bulbs, phased in from 2012 through 2014. This effectively bans the manufacturing and importing of most current incandescent light bulbs.
- Various specialty bulbs, including appliance bulbs, "rough service" bulbs, colored lights, plant lights, and 3-way bulbs, are **exempt** from these requirements as well as light bulbs currently less than 40 watts or more than 150 watts. This exempts stage lighting. Stage lighting is generally thousands of watts, far more than any home installation.

So the bill requires roughly 200 percent greater efficiency for light bulbs, or similar energy savings, by 2020.

Traditional incandescent bulbs, which use essentially the same design invented by Thomas Alva Edison more than 130 years ago, use only about 10 percent of the energy they consume to produce light, according to the Congressional Research Service. The other 90 percent is wasted as excess heat.

1. If you lived in Minnesota where much of the year is cold and requires home heating, would you think that incandescent bulbs that use energy to heat is such a bad idea?

2. How about if you lived in Florida?

2

Electricity is measured in kWh = kilowatts per hour of use. My 60-watt incandescent bulb uses 60 watts in one hour. There are 1000 watts in a kilowatt. If you want to figure out my bulb's kWh, you would find out what decimal part of a kilowatt those 60 watts are = $\frac{60\ watts}{1{,}000\ watts} = .06\ kWh$

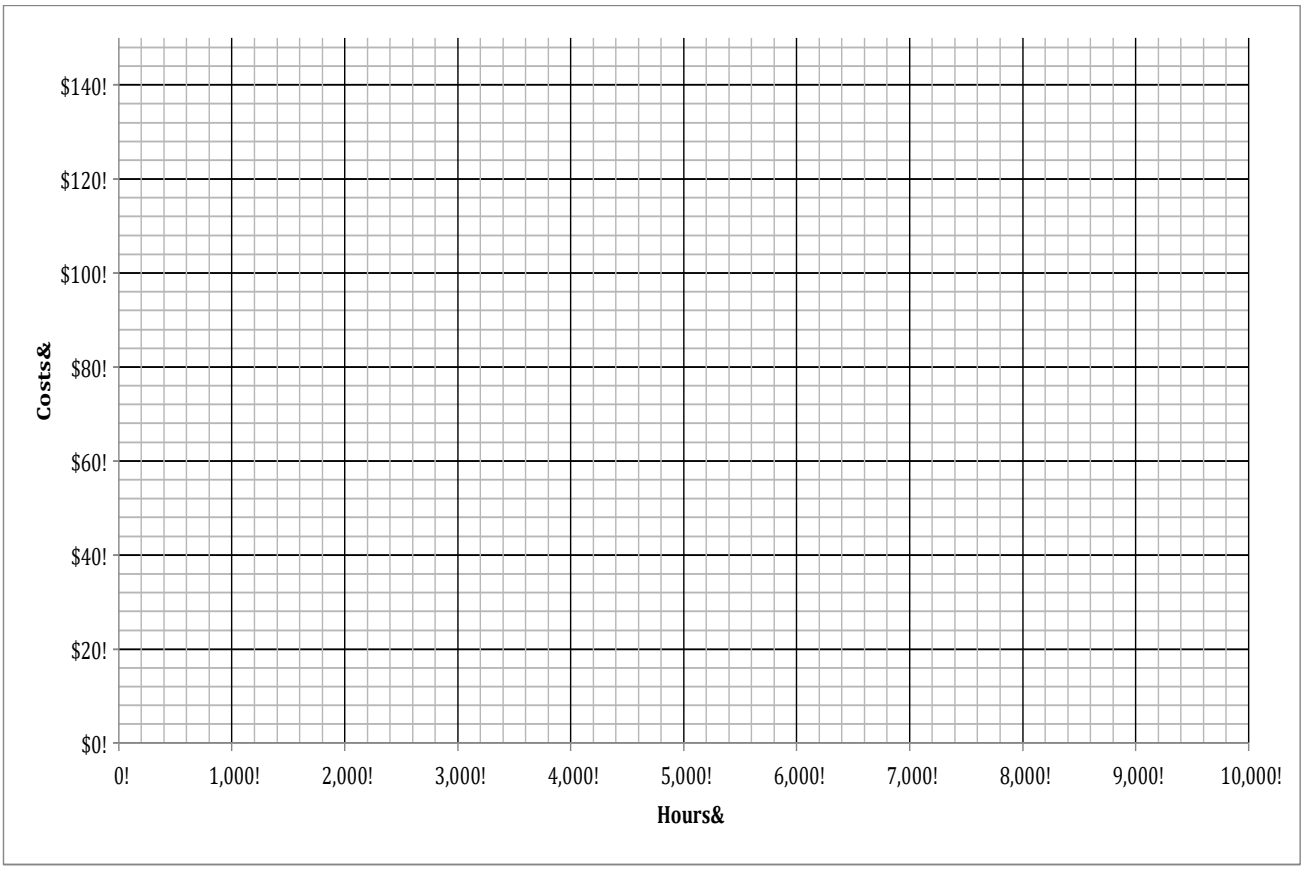
People have been complaining about the expense of all of these new bulbs. An incandescent bulb costs about $1.00; a compact florescent bulb costs about $5.00 and a light emitting diode bulb might cost $20.00. Who carries that kind of cash on them? That seems like a huge difference. But is it? Lets crunch the numbers and find out how much it might cost us. Complete the chart below.

Kind of light bulb	Approximate kWh needed to operate this bulb	Cost for using this bulb for **one hour**, given that electricity costs about $0.150 per kWh (rates will vary)	Cost of using the bulb for **5 hours** per day	Cost of using the bulb **for 5 hours per day for an entire year**	Initial cost of the bulb	Number of years that the bulb is expected to last at 5 hours per day = $\frac{life\ expectancy\ in\ hours}{hours\ per\ day * days\ per\ year}$	Cost of the bulb per year = $\frac{initial\ cost}{number\ of\ years\ of\ life}$	Total yearly expense of that bulb = cost of the bulb per year + cost of the energy per year.
75 watt incandescent bulb	$= \frac{75\ watts}{1{,}000\ watts}$ $= 0.075kWh$				$0.75	1000 hours		
23 watt CFL bulb with the equivalent lighting of a 75 watt incandescent light bulb					$5.00	8000 hours =		
9 watt LED bulb equivalent to a 75 watt incandescent bulb					$20.00	25,000 hours =		

3. Analyze your data in the table, in particular the last column. What do you notice? Reflect on the yearly cost of each bulb.

4. I know that buying LED or CFL bulbs will save me money on my bills, but I am not sure that they are worth it considering the bulbs are so expensive. Help me better understand the cost over the next several years for just one bulb. Graph the cost for me to use each type of bulb for 10,000 hours. Remember to include the cost of new bulbs if they run out (do not include the cost of the bulb into the cost, add it in as an additional cost).

3

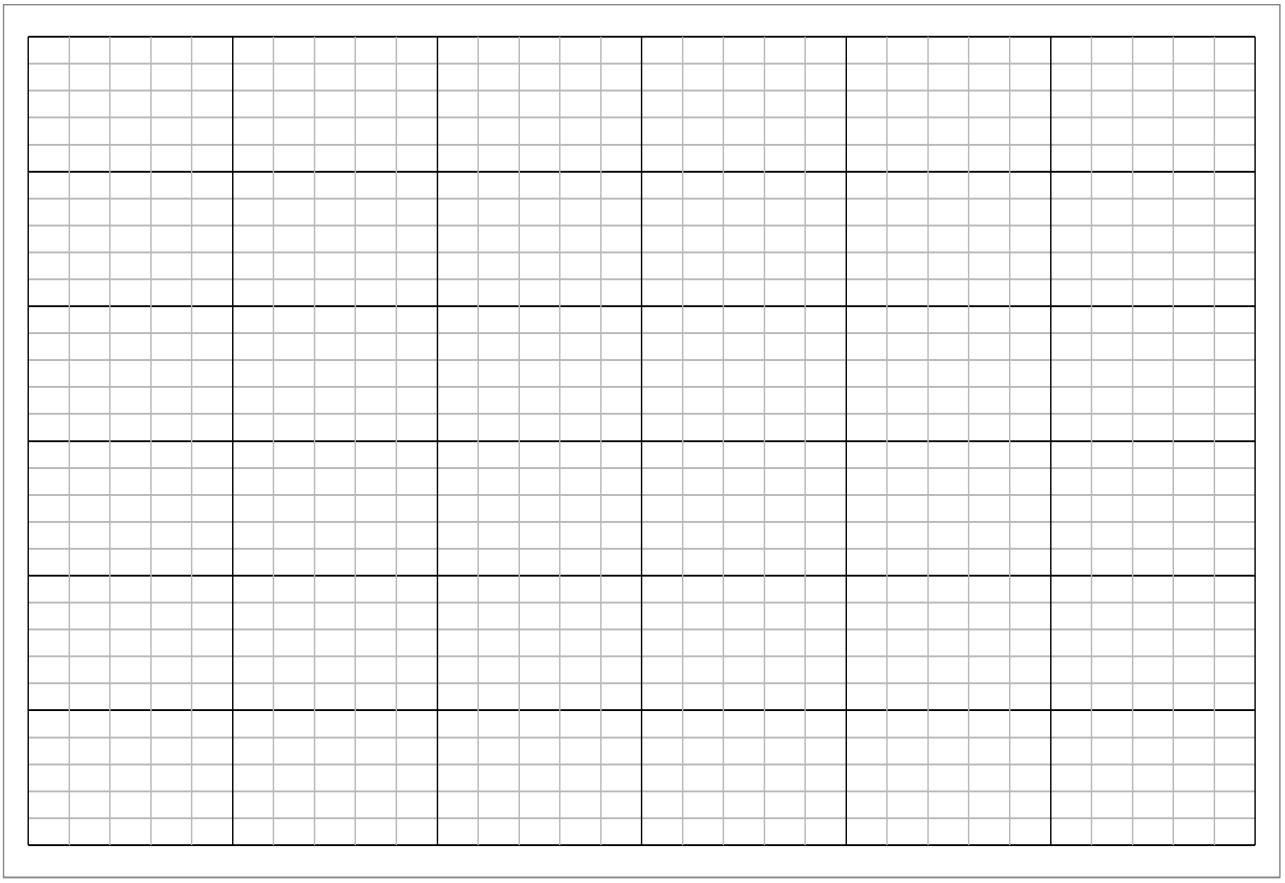


5. According to your graph, for what hours of light usage is the incandescent bulb the cheapest? For what hours of light usage is the CFL bulb the cheapest? For what hours of light usage is the LED bulb the cheapest? Should I be so worried about the high upfront cost of the LED and CFL bulbs?

6. So far we have been looking at the cost of just one bulb. How many light bulbs do you think you have in your house (if you are not sure take a couple minutes to make an educated guess)? How much money will you lose or save per year by switching bulb types?

7. The average house in the U.S. has about 40 light bulbs. Consider the average cost per year for each type of bulb. Graph the cost per year (the average cost including energy and the actual bulb) for 40 light bulbs (assuming they are used for an average of four hours a day). Be sure to graph costs over at least ten years, if not longer. Hint: For this graph you will be including the cost of each bulb in your graph.

4



By 2020, a second tier of restrictions would become effective, which requires all general-purpose bulbs to produce at least 45 lumens per watt (similar to current CFLs). The phase-out of incandescent light bulbs was supported by the Alliance to Save Energy, a coalition of light bulb manufacturers, electric utilities and conservation groups. The group estimated that lighting accounts for 22% of total U.S. electricity usage, and that eliminating incandescent bulbs completely would save $18 billion per year (equivalent to the output of 80 coal plants).

8. If 22% of the total yearly U.S. electricity usage costs $18 billion dollars, what is the total cost of electricity usage in the U.S.?

5

9. Here are some items that you might use in your every day life. Complete the table to see the approximate cost per year of each item.

machine	watts used per hour	kWh	cost per hour at $0.150 per kWh	number of hours per day that you might use this item	cost per year
Most desktop Computer					
CPU (asleep/awake}	120 / 30 or less				
Monitor (asleep/awake}	150 / 30 or less				
Laptop computer	50				
Flat Screen TV	120				
Hair dryer	1200 - 1875				
Clothes dryer	1800 - 5000				

10. What did you learn? Do you have CFL or LED bulbs in your home? What are the pros and cons of switching to these bulbs? Should your home make the switch?

Sources:
http://www.nytimes.com/2011/07/16/business/house-votes-to-withhold-funding-for-light-bulb-law.html?_r=1&ref=electriclightbulbs
http://en.wikipedia.org/wiki/Energy_Independence_and_Security_Act_of_2007
http://www.pawpaw.net/forms/generalinfo/howmuchelec.pdf, http://www.bls.gov/ro1/cpibosap.pdf,
http://www.oru.com/energyandsafety/thepowerofgreen/calculatingenergyuse.html

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Lesson 35 Application Answers

Light bulbs are almost burnt out

Incandescent | Compact Fluorescent (CFL) | Light Emitting Diodes (LED)

The House of Representatives voted last year to withhold funding to enforce part of a 2007 law that increases efficiency standards for light bulbs.

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- There should be roughly 25 percent greater efficiency for light bulbs, phased in from 2012 through 2014. This effectively bans the manufacturing and importing of most current incandescent light bulbs.
- Various specialty bulbs, including appliance bulbs, "rough service" bulbs, colored lights, plant lights, and 3-way bulbs, are **exempt** from these requirements as well as light bulbs currently less than 40 watts or more than 150 watts. This exempts stage lighting. Stage lighting is generally thousands of watts, far more than any home installation.

So the bill requires roughly 200 percent greater efficiency for light bulbs, or similar energy savings, by 2020.

Traditional incandescent bulbs, which use essentially the same design invented by Thomas Alva Edison more than 130 years ago, use only about 10 percent of the energy they consume to produce light, according to the Congressional Research Service. The other 90 percent is wasted as excess heat.

1. If you lived in Minnesota where much of the year is cold and requires home heating, would you think that incandescent bulbs that use energy to heat is such a bad idea?
   It might be warming and save on heating energy to have incandescent bulbs.

2. How about if you lived in Florida?
   When the weather is hot you might have to spend even more money cooling your home if you use incandescent light bulbs.

Electricity is measured in kWh = kilowatts per hour of use. My 60-watt incandescent bulb uses 60 watts in one hour. There are 1000 watts in a kilowatt. If you want to figure out my bulb's kWh, you would find out what decimal part of a kilowatt those 60 watts are = $\frac{60\ watts}{1{,}000\ watts} = .06\ kWh$

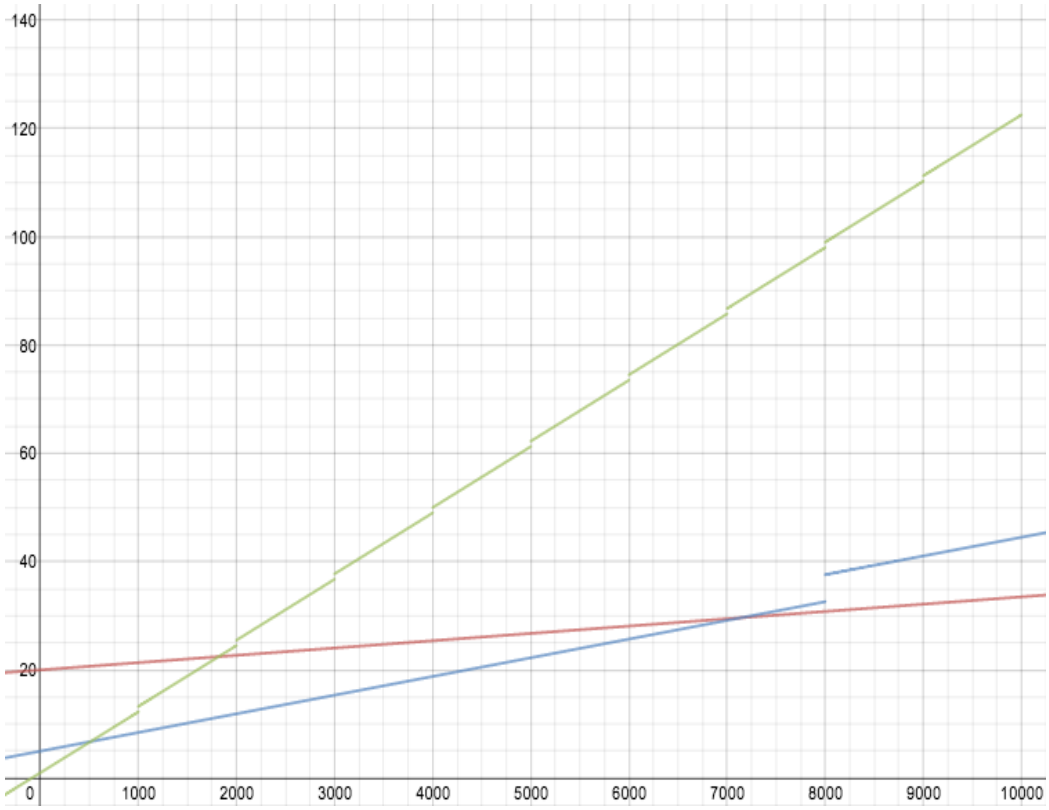
People have been complaining about the expense of all of these new bulbs. An incandescent bulb costs about $1.00; a compact florescent bulb costs about $5.00 and a light emitting diode bulb might cost $20.00. Who carries that kind of cash on them? That seems like a huge difference. But is it? Lets crunch the numbers and find out how much it might cost us. Complete the chart below.

Kind of light bulb	Approximate kWh needed to operate this bulb	Cost for using this bulb for **one hour**, given that electricity costs about $0.150 per kWh (rates will vary)	Cost of using the bulb for **4 hours** per day	Cost of using the bulb **for 4 hours per day for an entire year**	Initial cost of the bulb	Number of years that the bulb is expected to last at 4 hours per day = $\frac{life\ expectancy\ in\ hours}{hours\ per\ day * days\ per\ year}$	Cost of the bulb per year = $\frac{initial\ cost}{number\ of\ years\ of\ life}$	Total yearly expense of that bulb = cost of the bulb per year + cost of the energy per year.
75 watt incandescent bulb	$= \frac{75\ watts}{1{,}000\ watts}$ $= 0.075kWh$	=$0.150 x .075kWh =$0.01125	=$0.0112 5 x 4 = $0.045	=$0.045 x 365 =$16.43	$1.00	1,000 hours $\frac{1{,}000\ hours}{4\ hrs * 365\ days} =$ .685 years	$\frac{\$1.00}{.685} = \$1.46/yr$	= $1.46 + $16.43 = $17.89
23 watt CFL bulb with the equivalent lighting of a 75 watt incandescent light bulb	$= \frac{23\ watts}{1{,}000\ watts}$ $= .023\ kWh$	=$0.150 x .023 kWh =$0.00345	=$0.0034 5 X 4 = $0.014	$0.014 x 365 = $5.04	$5.00	8000 hours = $\frac{8{,}000\ hours}{4\ hrs * 365\ days} =$ 5.48 years	$\frac{\$5.00}{5.48} = \$0.91/yr$	=$0.91+ $5.04 =$5.95 per year
9 watt LED bulb equivalent to a 75 watt incandescent bulb	$= \frac{9\ watts}{1{,}000\ watts}$ $= .009\ kWh$	=$0.150 x .009 kWh = $0.00135	= $0.00135 x 4 = $0.0054	$0.0054 x 365 = $1.97	$20.00	50,000 hours = $\frac{50{,}000\ hours}{4\ hrs * 365\ days} =$ 34.25 years	$\frac{\$20.00}{34.25} = \$0.58/yr$	= $0.58 + $1.97 = $2.55 per year

3. Analyze your data in the table, in particular the last column. What do you notice? Reflect on the yearly cost of each bulb.
   Given how long the new light bulbs last even their initial cost is small when thought of per year. Their energy use cost is small also. Seems like we should all change to LED and CFL bulbs immediately.

4. I know that buying LED or CFL bulbs will save me money on my bills, but I am not sure that they are worth it considering the bulbs are so expensive. Help me better understand the cost over the next several years for just one bulb. Graph the cost for me to use each type of bulb for 10,000 hours. Remember to include the cost of new bulbs if they run out (do not include the cost of the bulb into the cost, add it in as an additional cost).
   CFL cost = $5.00 initially + $0.00345 * hours used
   LED cost = $20.00 initially + $0.00135 * hours used

3



5. According to your graph, for what hours of light usage is the incandescent bulb the cheapest? For what hours of light usage is the CFL bulb the cheapest? For what hours of light usage is the LED bulb the cheapest? Should I be so worried about the high upfront cost of the LED and CFL bulbs?

It looks like the incandescent bulbs (the green line) is the cheapest until you get to 500 hours. Then the CFL bulbs are the cheapest until you ge to about 7,000 hours. After 7,000 hours the LED bulbs (red line) are the cheapest.

This graph makes for a great opportunity to get into piecewise functions. Students can still graph the relationships with getting into a formal understanding of piecewise functions.

6. So far we have been looking at the cost of just one bulb. How many light bulbs do you think you have in your house (if you are not sure take a couple minutes to make an educated guess)? How much money will you lose or save per year by switching bulb types?

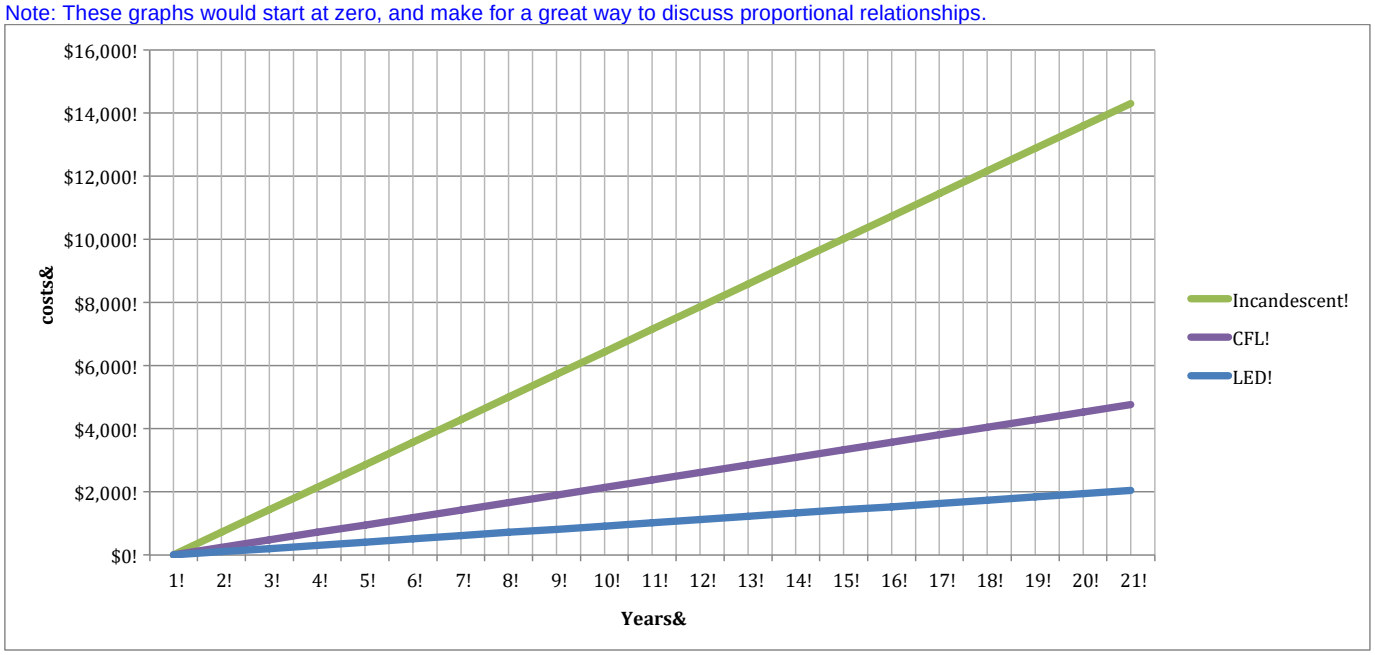
Answers will certainly vary … Most homes have more than 40 bulbs. The national average is around 40 to 45 bulbs. For 40 bulbs:

By switching to CFLs = ($17.89 – $5.95 = $11.94) times 40 = $477.60 saved

By switching to LEDs = ($17.89 – $2.55 = $15.34) times 40 = $613.60 saved

7. The average house in the U.S. has about 40 light bulbs. Consider the average cost per year for each type of bulb. Graph the cost per year (the average cost including energy and the actual bulb) for 40 light bulbs (assuming they are used for an average of four hours a day). Be sure to graph costs over at least ten years, if not longer. Hint: For this graph you will be including the cost of each bulb in your graph.

Note: These graphs would start at zero, and make for a great way to discuss proportional relationships.



By 2020, a second tier of restrictions would become effective, which requires all general-purpose bulbs to produce at least 45 lumens per watt (similar to current CFLs). The phase-out of incandescent light bulbs was supported by the Alliance to Save Energy, a coalition of light bulb manufacturers, electric utilities and conservation groups. The group estimated that lighting accounts for 22% of total U.S. electricity usage, and that eliminating incandescent bulbs completely would save $18 billion per year (equivalent to the output of 80 coal plants).

8. If 22% of the total yearly U.S. electricity usage costs $18 billion dollars, what is the total cost of electricity usage in the U.S.?

   .22 x T = $18,000,000,000

   T = $ 81,818,181,818 = 81.81 billion dollars worth of electricity

9. Here are some items that you might use in your every day life. Complete the table to see the approximate cost per year of each item.

machine	watts used per hour	kWh	cost per hour at $0.150 per kWh	number of hours per day that you might use this item	cost per year
Most desktop Computers				Students will write different number of hours used for this column	And will consequently have different yearly costs
CPU (asleep/awake}	120 / 30 or less	.120 kWh / .03 kWh	$.018 / $.0045	8	$52.56/$13.40
Monitor (asleep/awake}	150 / 30 or less	.150 kWh / .03 kWh	$.0225 / $.0045	8	$65.70/$13.14
Laptop computer	50	.05 kWh	$ 0.0075	8	$21.19
Flat Screen TV	120	.120 kWh	$.018	4	$26.28
Hair dryer	1200 - 1875	1.2 kWh – 1.875 kWh	$ .18 - $ 0.28125	.2	$13.14 - $20.53
Clothes dryer	1800 - 5000	1.8 kWh – 5.0 kWh	$.27 - $.75	2	$197.10 - $547.50

10. What did you learn? Do you have CFL or LED bulbs in your home? What are the pros and cons of switching to these bulbs? Should your home make the switch?

Yes, you should switch over to LED bulbs! They are much cheaper overtime and you don't have to worry about constantly replacing burnt out bulbs. LED or GCF bulbs are more energy efficient and cost effective than the old incandescent bulbs.

Sources:
http://www.nytimes.com/2011/07/16/business/house-votes-to-withhold-funding-for-light-bulb-law.html?_r=1&ref=electriclightbulbs
http://en.wikipedia.org/wiki/Energy_Independence_and_Security_Act_of_2007
http://www.pawpaw.net/forms/generalinfo/howmuchelec.pdf, http://www.bls.gov/ro1/cpibosap.pdf,
http://www.oru.com/energyandsafety/thepowerofgreen/calculatingenergyuse.html

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