KILOWATTS TO DOLLARS

Teacher version & answer key

ABOUT THIS ACTIVITY

Students will complete a series of math- and science-related questions to see the financial impact energy-efficient upgrades and decisions can have. They'll be able to see the material benefit of making small changes like turning off a gaming system when it's not in use or switching to LED light bulbs.

GOALS/OBJECTIVES

The activity challenges students to use their math skills and apply them to the context of energy efficiency.

LESSON PLAN

1. Review the "All about energy" and/or "Energy efficiency at school" presentation with your class to teach your students about the basics of energy efficiency. We can also come to your class to deliver a presentation; email us at hello@generation-e.ca if you're interested!
2. Give the students the student version of the activity. You can choose to have students work through the problems individually or in teams.
3. After the students have had time to work on the problems, go over the answers together as a class.

GENERATION E

ANSWER KEY

CURRENT RATES (RESIDENTIAL)

Electricity: 9.324¢/kWh
Natural gas: 20.55¢/m^3

Note: Taxes and other charges are added on top of these prices, so the money savings we'll calculate would likely be even more in real life!

Note: The natural gas rate used for this exercise assumes 100% of gas comes from a primary (rather than supplemental source) and includes transportation and distribution costs.

QUESTION 1

Let's say you have a freezer in your garage that's plugged in year-round but only really used in the summer for freezies and popsicles. This old freezer uses a whopping 1,200 kWh per year! How much money can you save annually by unplugging your freezer and removing it from your home?

Hint: For this question (and every other question), you'll need to convert the electricity rate noted above to dollars per kilowatt-hour, or $/kWh).

Answer: Rate conversion: [9.324¢/kWh / 100] = $0.09324/kWh
Annual bill savings = [1,200 kWh * $0.09324/kWh] = $111.89

QUESTION 2

Your family has decided to upgrade your old kitchen fridge to a new ENERGY STAR® certified model. Your old fridge used 1,450 kWh per year while the new energy-efficient fridge, which cost $1,400 to purchase, uses 430 kWh per year.

a) How much electricity will your family save every year?

Answer: Annual energy savings = 1,450 kWh/year – 430 kWh/year = 1,020 kWh/year

b) How much money will your family save on their energy bills each year?

Answer: Annual bill savings = [1,020 kWh/year * $0.09324/year] = $95.10/year

c) How many years will it take for this new fridge to pay for itself based on the energy savings alone?

Answer: Payback period = [$1,400 / $95.10/year] = 14.7 years

QUESTION 3

Did you know that the average gaming system, when left idle (i.e. in standby mode), uses 90 watts of power? For this question, let's assume your gaming system is left idle for 20 hours per day.

a) How much electricity would your gaming system use per day (in kWh)?

Note: 1000 watts (W) = 1 kW (kilowatt)

Answer: Power conversion: [90 watts / 1,000] = 0.09 kW
Daily energy use = [0.09 kW * 20 hours/day] = 1.8 kWh/day

b) How much electricity would your gaming system use per year?

Answer: Annual energy use = [1.8 kWh/day * 365 days/year] = 657 kWh/year

c) How much would it cost per year to leave your gaming system in standby mode?

Answer: Annual cost = [657 kWh/year * $0.09324/kWh] = $61.26/year

QUESTION 4

A home has 20 light bulbs: 13 are incandescent bulbs, and seven are CFL bulbs. The incandescent bulbs are used for four hours per day, and the CFL bulbs are used for seven hours per day. The homeowner decides to upgrade all 20 of these bulbs to LEDs.

The following chart shows how much power (in watts) each type of bulb uses:

Type of bulb	Power rating
Incandescent	60 watts
CFL	13 watts
LED	9 watts

a) How much electricity do the 13 incandescent bulbs use per year?

Answer: Rate conversion: 60 watts = 0.06 kW
Daily energy use = [0.06 kW * 4 hours/day * 13 bulbs] = 3.12 kWh/day
Annual energy use = [3.12 kWh/day * 365 days] = 1,138 kWh/year

b) How much electricity do the seven CFL bulbs use per year?

Answer: Rate conversion: 13 watts = 0.013 kW

Daily energy use = [0.013 kW * 7 hours/day * 7 bulbs] = 0.637 kWh/day

Annual energy use = [0.637 kWh/day * 365 days] = 233 kWh/year

c) How much electricity do all 20 bulbs use per year

Answer: Current annual energy use = 1,138 kWh/year + 233 kWh/year = 1,371 kWh/year

d) Let's say the 13 incandescent bulbs have now been replaced with LED bulbs. How much electricity would these LED bulbs use per year?

Answer: Rate conversion: 9 watts = 0.009 kW

Daily energy use = [0.009 kW * 4 hours/day * 13 bulbs] = 0.468 kWh/day

Annual energy use = [0.468 kWh/day * 365 days] = 171 kWh/year

e) The seven CFL bulbs have also been replaced with LED bulbs. How much electricity would these LED bulbs use per year?

Answer: Daily energy use = [0.009 kW * 7 hours/day * 7 bulbs] = 0.441 kWh/day

Annual energy use = [0.441 kWh/day * 365 days] = 161 kWh/year

f) How much electricity would all 20 LED bulbs use per year?

Answer: New annual energy use = 171 kWh/year + 161 kWh/year = 332 kWh/year

g) How much electricity would be saved per year by upgrading the 13 incandescent bulbs and seven CFL bulbs to LED bulbs?

Answer: Annual energy savings = 1,371 kWh/year – 332 kWh/year = 1,039 kWh/year

h) How much money would be saved per year on energy bills?

Answer: Annual bill savings = [1,039 kWh/year * 0.09324 $/kWh] = $96.88/year

QUESTION 5

When you conducted the review of your home, you measured the flow rate of your showerhead. You also collected data about your home's shower usage, including the number of showers taken by your household per week and the average length of everyone's showers. We're going to use that data in this exercise.

Assume your family decides to upgrade your existing showerhead to one that uses only 5.7 litres per minute.

Note: students will have collected the following data before completing this activity:

- Existing flow rate of showerhead (in litres per minute, or LPM)
- Number of showers taken by household per week
- Average shower length (in minutes)

a) How many LPM would your family save by making this upgrade?

Answer: Difference in flow rate = Existing LPM – 5.7 LPM

b) How many showers does your family take per year?

Answer: Number of showers per year = [Number of showers per week] * 52

c) What's the average amount of time your showerhead is being used each year?

Answer: Average time = [Number of showers per year] * [Average shower length]

d) How much water can you save per year by making this change?

Answer: Annual water savings = [Average time] * [Difference in flow rate]

e) Using the following formula, determine how much energy you'll save by upgrading your showerhead. If you have a natural gas water heater, multiply your result by 0.12 to determine the cubic metres you'll save.

Energy saved (kWh) = Litres of water saved * 30°C * 0.00116 kWh/L·°C

Where:

- Litres of water saved = the result you got in part D
- °C = an assumed average difference between the temperature of the water coming into your home (approximately 10°C) and the temperature of your shower water (approximately 40°C).
- 0.00116 kWh/L·°C = a constant that expresses the amount of energy required to heat water by 1°C