ELECTRON FLOW

Post-Visit Class Activity

Energy Bill Math

Description:

This activity contains a series of four problems. They are designed to be used in sequence, though you may choose whether to do only one, two, or three problems.

Objectives:

Problems 1 – 4:

- Practice reading information from an electric bill.
- Practice calculating decimals.
- Develop awareness about the cost of electricity and how electricity consumption is calculated.

Problem 4 also:

- Practice analyzing data.

Duration:

- Preparation: 10 minutes
- Instruction: about 15 - 50 minutes for each problem

Correlations to California Academic Standards

California Content Standards

Fourth Grade

Mathematics – Number Sense

2.1 Estimate and compute the sum or difference of whole numbers and positive decimals to two places.

3.2 Demonstrate an understanding of, and the ability to use, standard algorithms for multiplying a multi digit number by a two-digit number and for dividing a multi digit number by a one-digit number; use relationships between them to simplify computations and to check results.

Students compute the kilowatt hour cost of CFLs and incandescent light bulbs.

Statistics, Data Analysis, Probability: *1.2 Identify the mode(s) for sets of categorical data and the mode(s), median, and any apparent outliers for numerical data sets.*

Students identify the mode, median, and range of a data set.

Fifth Grade

Mathematics – Number Sense *2.1 Add, subtract, multiply, and divide with decimals;*

Students compute the kilowatt hour cost of CFLs and incandescent light bulbs.

Statistics, Data Analysis, Probability: *1.1 Know the concepts of mean, median, and mode; compute and compare simple examples to show that they may differ.*

Students identify the mode, median, and range of a data set.

Sixth Grade

Statistics, Data Analysis, Probability: *1.1 Compute the range, mean, median, and mode of data sets.*

Students identify the mode, median, and range of a data set.

Materials List:

- Sample electricity bill copied onto a transparency.
- 100 Watt incandescent lamp screwed into a lamp with shade removed.
- 100 Watt-equivalent CFL (27 Watts) screwed into a second lamp with shade removed.
- For problem 4, 2 sticky note pads.

For each student:

- Calculator and pencil.
- 1 worksheet for each problem you will use with your class.

Getting Ready:

- Copy the sample electricity bill onto a transparency.
- Find out the current cost of a kilowatt hour for your local utility. In 2007, the average cost for a City of Roseville resident was $.08 per KWh

Procedure:

INTRODUCTION

- Place the lamp with the incandescent bulb on a desk visible to all students. Turn it on.
- Review students what efficiency means: the most work completed for the least amount of energy. Discuss why using energy efficiently is essential for maintaining our standard of living.
- Explain that students will determine the amount of money and energy that can be saved by using energy efficient lighting and appliances.
- Ask students to identify what type of lamp is lit and estimate how much it might cost to keep it on for an hour, day, or month. Record their responses on the board.

PROBLEM 1: HOW MUCH DOES IT COST TO LIGHT A LAMP?

- Explain that a kilowatt hour (KWh) is a standard unit for measuring electricity consumption. Utilities measure KWh's to determine how much energy a household uses. A KWh is 1,000 watts used over the span of an hour. Write: "1 KWh = 1,000 Watts in 1 hour".
- Write the current cost of a kilowatt hour. For example, write: "1 KWh = $.08".
- Distribute calculators, worksheet for problem 1, and pencils to students.
- Working through the worksheet's example, model how to calculate the cost of keeping the 100 Watt incandescent bulb lit for several time periods:
- Explain step one: convert the bulb's wattage to KW. Divide 100, the wattage, by 1,000 – the number of watts in a KW. Divide 100W ÷ 1000KW = 0.10 KW.
- Next, calculate the cost per hour to keep the bulb lit. Multiply $0.08 (the cost of 1 KWh) by 0.10 (the KW consumed by the bulb): $0.08 x 0.10 = $0.008 KWh
- Mention that this doesn't seem to cost very much – just look at that small number: $0.008, less than a penny.
- Using the worksheet, model how calculate the cost to keep that bulb lit for 10 hours each day. What would they need to calculate? (The cost per hour, $0.008 x10 = $0.08).
- Direct students to figure how much it would cost to light the bulb for 10 hours a day, for an entire month (30 days). Answer: 30 x 10 x $0.08 = $2.40.
- Discuss what "lifetime" means: the number of hours the bulb will last before wearing out.
- State that the lifetime of the incandescent bulb is about 1,000 hours. Direct students to calculate the number of watts consumed and energy spend to keep the bulb lit for its lifetime.
- Add the time interval "lifetime" to the chart on the board. Write the results next to the student estimates and compare.
- Turn on the CFL lamp. Point out that both lamps put out a similar amount of light.
- Noting the results for the incandescent on the board, direct class to calculate the cost of keeping the 27 Watt CFL lit for the same time periods: 1 hour, 10 hours, 30 days, lifetime.
- Discuss results. Emphasize how much more efficient CFLs are than incandescents.
- Compare costs to light for 1 hour, 10 hours, 30 days, and each bulb's lifetime.
- Point out that 1 CFL lasts for 10 times as long as an incandescent.
- Review the concept of efficiency. Say: *Do you remember what "efficiency" means? The most amount of work for the least amount of energy. Based on how much it costs to light each lamp, which is more efficient?*

PROBLEM 2: INCANDESCENT IMPACT

- Turn off lamps and place sample electric bill on the transparency. Explain that this bill reflects the typical energy consumption for a family of four.
- Point out the tiered billing – after so many KWh's, the cost of a KWh goes up. Discuss why consumers might be charged more if they use more electricity.
- Mention that your students can assume this family uses only 100-Watt incandescent bulbs for their lighting.
- Point out how many KWh's the family used during that month.
- Write on the board: Lighting = 25% of energy consumption.
- Distribute the "problem 2" worksheet to your students. Model how to calculate how many KWh's the family consumed just to light its home for the month.
- Check their answers, then ask students to estimate how much energy the family could save if they switched to using only CFL's. Write estimates on board.
- Direct students to use the worksheet to find exactly how much energy this family could save if it switched to using only 27 Watt CFLs.
- Discuss results:
    - Ask: *Did the results surprise you?*
    - Ask: *How could one family's choice of light bulb affect our community?* Answer: Because CFLs use so much less energy, there's more electricity available for everyone and fewer fossil fuels have to be burned to light everyone's home.
    - Ask: *Why is it important to think about how efficient our choice of lights bulbs are?*

PROBLEM 3: BULB SURVEY AND ENERGY COSTS HOMEWORK

- Distribute the worksheet “Problem 3: Bulb Survey”.
- Describe the assignment: students will conduct a survey of how many incandescent bulbs and CFLs they are using in their homes, determine how much it costs to run each lamp for 10 hours, and then figure the energy and cost savings if their family switched to just CFLs.
- Explain that students will need to ask to see their family’s most current electricity bill.
- Point out where students should determine the rate for a KWh.
- Model how to fill out the survey.

PROBLEM 4: DATA ANALYSIS

- Draw a 3-column chart on the board: percentage of CFL's, KWh's consumed, cost to light home. NOTE: if you plan to run the survey again later in the year, consider drawing this chart on a large piece of butcher paper you can save and compare.
- As students return, ask them to write each survey result on a different piece of post-it paper and post the results on your board.
- Direct students to determine the maximum (the highest), the minimum (the lowest) and the range (difference between maximum and minimum) for each variable in the data set.
- Direct students to determine the mode (average) and median (most frequently occurring number).
- Discuss the results of the survey. Point out the maximum, mode and median numbers for KWh's consumed. Is the class median and mode closer to the maximum or minimum?
- Could there be a relationship between the percentage of CFLs, the KWh's consumed, and the cost to light a home? Point out that because the sizes of homes and the number of people living in a home, there very well may not be a direct correlation that can be found.
- Consider holding onto the collected data and repeating the survey in a few months. Did the numbers change dramatically? Do the data reflect any possible changes in how the families consume electricity?

Customer Name: ROSEVILLE UTILITY CUSTOMER

Page: 1 of 2
Bill Date: 08/08/2007
Due Date: 09/04/2007

www.roseville.ca.us

CITY OF ROSEVILLE
UTILITIES ACCOUNT SUMMARY

Billing Inquiries: 916-774-5300
Electric Outage Hotline: 916-774-5428 Water Outage Hotline: 916-774-5750

Account Number	Service Address
111111-22222-6	123 MAIN ST

Previous Balance	Payments	Adjustments	* Balance Forward	Current Charges	Account Balance
$251.07	$251.07	$0.00	$0.00	**$278.48**	$278.48

DON'T BE LEFT OUT!
Your neighbors are becoming Power Partners and getting paid to help manage our summer energy demand. Sign up to receive a $10 bill credit plus an additional $10 every summer you participate. For details and to enroll, visit www.roseville.ca.us/PowerPartners today!

SAVE WATER! SAVE MONEY!
Turn your sprinklers off during the winter months and let Mother Nature do the watering for you. Call 916-774-5761 or visit http://www.roseville.ca.us/savewater to find out more information on efficient watering tips.

HAVE YOU HEARD?
Old electronics picked up at your doorstep for free!? Yes, its true. TVs, computers, printers and a long list of many other household items. Call Environmental Utilities at 916-774-5780 and well pick up selected items at your doorstep for free. For a list of what we will pick up, go to http://www.roseville.ca.us/batteries.

Electric	$198.95
Water	$27.08
Wastewater	$24.65
Solid Waste	$20.60
Subtotal	$271.28
Miscellaneous Charges	$7.20
Current Charges	**$278.48**

Current Charges due on or before 09/04/2007

Late Payments are subject to a $10 late fee.

Return this portion with your remittance in the envelope provided or deliver to 311 Vernon Street, Roseville, CA 95678.
For mailing address changes, please contact us at (916) 774-5300.

Current Charges due on or before September 4, 2007.

Account Number	Billing Date	Account Balance	Amount Paid	Thank You For Your Payment
111111-22222 6	08/08/2007	**$278.48**		

Blank

ROSEVILLE UTILITY CUSTOMER
123 MAIN ST
ROSEVILLE CA 95678

CITY OF ROSEVILLE
P.O. BOX 541007
LOS ANGELES, CA 90054-1007

11111122222000002784801

Roseville Electric

Meter Number	Register Type	From	To	DOS	Previous	Reading Current	Type	Usage
14169	KWH	07/06/2007	08/06/2007	31	49639	51247	A	1608.000
This month last year				28				2131.000

Description	Usage	Rate	Amount
Electric Residential kWh	500.00	0.0841000	$42.05
Electric Residential kWh	1108.00	0.1123000	$124.43
Green Roseville Program			$24.12
Monthly Cost of Basic Service			$8.00
State Energy Surcharge	1608.00	0.0002200	$0.35
Charges - Electric			**$198.95**

Environmental Utilities | Roseville's Water, Wastewater and Solid Waste Utilities

Water

Meter Number	Register Type	From	To	DOS	Previous	Reading Current	Type	Usage
58509036	WTR	07/06/2007	08/06/2007	31	33000	36300	A	3300.000
This month last year				28				3500.000

Description	Usage	Rate	Amount
Water Metered Residential 3/4"	1200.00	0.0027000	$3.24
Water Metered Residential 3/4"	2100.00	0.0054000	$11.34
Cost of Basic 3/4" Water Service			$12.50
Charges - Water			**$27.08**

Wastewater

Description	From	To	Amount
Sewer Residential Flat Rate	07/06/2007	08/06/2007	$24.65
Charges - Wastewater			**$24.65**

Solid Waste

Description	From	To	Amount
Solid Waste Res. 90 Gallon	07/06/2007	08/06/2007	$20.60
Charges - Solid Waste			**$20.60**

Miscellaneous Charges

Description	Amount
Water Meter Retrofit Surcharge	$7.20
Charges - Miscellaneous Charges	**$7.20**

The following information is provided for utility customers facing economic challenges.

- **HEAP** - Project Go administers the Home Energy Assistance Program (HEAP). They can be reached by telephone at 1-888-524-5705.
- **Salvation Army** - This organization offers assistance with payment of utility bills. For more information call 916-784-3382.
- **ERAP** - The City of Roseville offers a 15% discount to current residential electric customers who meet certain income guidelines. For more information, call 916-774-5300.
- **Senior Citizen Discount** - The City of Roseville offers utility discounts on solid waste, water, and wastewater services for Roseville residents aged 65 years and older who meet certain income guidelines. For more information, call 916-774-5300.
- **Payment Arrangements** - The City of Roseville offers payment arrangements on past-due balances. The arrangements require valid identification and customer signature in the office. Call 916-774-5300 for more information.

Name: Date: Class/Period:

Problem 1: How Much Does It Cost to Light a Lamp?

Cost of 1 KWh: _____

For each step, write the answer in each shape.
Use the same quantity in each shape for the next step.

Incandescent

Step 1: Convert bulb's wattage to KWs.

_____ ÷ 1,000 = ◯ KW
(Incandescent Wattage)

Step 2: Find cost to run bulb for 1 hour.

_____ × ◯ = △
(Cost of 1 KWh)

Step 3: Find cost to run bulb for 10 hours.

10 × △ = □

Step 4: Find cost to run bulb for a month.

30 × □ = ⬠

Step 5: Find cost to run for bulb's lifetime.

1,000 × ◯ = _____

CFL

Step 1: Convert bulb's wattage to KWs.

_____ ÷ 1,000 = ◯ KW
(CFL Wattage)

Step 2: Find cost to run bulb for 1 hour.

_____ × ◯ = △
(Cost of 1 KWh)

Step 3: Find cost to run bulb for 10 hours.

10 × △ = □

Step 4: Find cost to run bulb for a month.

30 × □ = ⬠

Step 5: Find cost to run for bulb's lifetime.

10,000 × ◯ = _____

Name: Date: Class/Period:

Problem 3: Bulb Survey (page 1 of 2)

Step 1: Locate all the lamps and light fixtures in your house. Take a tally of how many bulbs of each category are used. Be sure to note the wattage. This is usually printed on the top of a bulb or on a CFL's ballast - the part that is screwed into the light socket.

BULB TYPE	WATTAGE	TALLY	NUMBER	CONSUMPTION	CONSUMPTION PER HOUR (NUMBER × KWh)	CONSUMPTION PER 10 HOURS (NUMBER × KWh ×10)
INCANDESCENT	100			0.10 KWh		
	75			0.08 KWh		
	60			0.05 KWh		
	40			0.04 KWh		
FLOURESCENT (CFL)	27 (100 W equivalent)			0.03 KWh		
	18 (75 W equivalent)			0.02 KWh		
	13 (60 W equivalent)			0.01 KWh		
	8 (40 W equivalent)			0.01 KWh		
FLOURESCENT (TUBES)	160			0.16 KWh		
HALOGEN	300			0.30 KWH		

Problem 3: Bulb Survey (page 2 of 2)

Figure out how much energy and money your family could save by switching to CFLs. Write the answer in each shape, then use the same number each time you see the shape. Ask your parents for the most recent energy bill for your family's home.

Write down how many KWh's your family consumed: ☐

Write down the cost of the Tier 1 KWh's (the lower priced KWh's): ◯

Write down the cost of the Tier 2 KWh's (the higher priced KWh's): ◇

Find the average cost of a KWh:

1) Add the costs of both KWh tiers: ◯ + ◇ = ⬠

2) Divide by two: ⬠ ÷ 2 = ⏢

Determine about how much of your monthly energy bill was spent on lighting:

1) Calculate how many KWh's your family used for lighting:

0.25 × ☐ = ☐

2) Calculate the ratio of how efficient CFLs are compared to incandenscent bulbs.

Wattage for incandescent: _____

Wattage for CFL: _____ ÷ _____ = △

3) Calculate how many KWh's your family could have saved by just using CFL's:

△ × ☐ = _____

4) Calculate how much money your family would have saved by just using CFL's:

△ × ☐ × ⏢ = _____