**5th and 6th Grade General Math Lessons**

**Solar Schools Curriculum**

Overview:

The first module, "Exploring Solar Energy Math," spans two 60-minute sessions, designed to provide students with a comprehensive understanding of solar energy and its mathematical applications. The overarching goal is to equip students with the knowledge and skills to calculate solar panel energy output, analyze efficiency, assess cost-effectiveness, and perform unit conversions related to solar energy systems.

The second module, "Exploring Home Energy Efficiency and PECO Bills," spans two 60-minute sessions, focusing on empowering students with the knowledge and skills to understand and enhance home energy efficiency. The central idea revolves around the importance of comprehending utility bills, specifically PECO bills, and how this understanding can lead to informed decisions promoting energy conservation.

**Module 1.** General Mathematics: Basic Electricity & Energy Efficiency, and Exploring Solar

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| Title: | Exploring Solar Energy Math |
| Time-frame: | 2 hours (two 60-minute lessons) |
| Big Ideas and/or Essential Questions | Big Idea: Solar energy is a renewable source of energy with various applications.Essential Questions:1. How can we harness and utilize solar energy efficiently?
2. How does mathematics help us understand and work with solar energy?
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| Vocabulary: | Solar panelWatt (W)Kilowatt (kW)* Latin prefixes for electricity measurement: kilo-, mega-, giga-, tera-

Kilowatt-hour (kWh)EfficiencyPhotovoltaic (PV)Solar energyRenewable energy |
| PA Standards: | **Standard CC.2.1.6.D.1** Understand ratio concepts and use ratio reasoning to solve problems.**Standard CC.2.3.6.A.1** Apply appropriate tools to solve real-world and mathematical problems involving area, surface area, and volume.**Standard CC.2.4.6.B.1** Demonstrate an understanding of statistical variability by displaying, analyzing, and summarizing distributions. |
| Students will be able to: | 1. Calculate the energy output of a solar panel.
2. Understand the concept of efficiency in solar energy systems.
3. Analyze the cost-effectiveness of using solar energy.
4. Convert units between watts and kilowatt-hours.
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| Materials: | 1. Whiteboard and markers
2. Solar panel specifications (provided by the teacher)
3. Calculators
4. Worksheets for calculations
5. Internet access for research (if available)
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| Activity Procedures: | Day 1 (60 minutes):1. Introduction (20 minutes)
* Begin by asking students if they have heard about solar energy and what they know about it.
* Explain that renewable energy sources, like solar energy, are crucial for a sustainable future.
* Define key vocabulary terms:
* Watt (W): A unit of power that measures how fast energy is used or produced.
* Kilowatt (kW): A unit of power worth 1000 Watts. Explain what “kilo” means and where it comes from. Ask students if they can think of other words with kilo, i.e. kilogram, kilometer, etc.
* Kilowatt-hour (kWh): A unit of energy that measures the total amount of electricity consumed or generated over time measured in hours.
* Efficiency: The measure of how effectively a device or system converts input energy into useful output energy.

→ Spend a little time explaining the efficiency of solar panels: how much total sunlight does a panel convert to electricity? How has efficiency improved in recent years? How are solar panel manufacturers improving efficiency?* Share examples of renewable energy sources, such as solar panels and wind turbines, and mention their benefits.
1. Understanding Watts (20 minutes)
* Start by defining what a watt (W) is:
* A watt is a unit of power that tells us how much energy an appliance or device uses per second.
* It's like the speed at which energy flows, and it's commonly used to rate the power consumption of electrical devices.
* Provide examples of common household appliances and their power ratings in watts. For instance:
* A laptop may use around 50-100W.
* A refrigerator could use about 350-780W.
* A hairdryer might use 800-1800W.
* Activity: Light Bulb Energy Use Analysis. Engage the students by asking them to calculate the energy consumption of a 100W light bulb running for 5 hours. Encourage them to use the formula: Energy (kWh) = Power (kW) x Time (hours). Guide them through the calculation:
* Energy (kWh) = 0.1 kW x 5 hours = 0.5 kWh
1. Solar Panel Efficiency (20 minutes)
* Start by introducing the concept of solar panel efficiency:
* Explain that solar panel efficiency measures how effectively a solar panel converts sunlight into electricity.

→ Specifically, it is the percentage of the total sunlight hitting the panel that is converted to useful electricity. * It's typically represented as a percentage, with higher percentages indicating better efficiency.

→ Typically it would be 20%. This means that only 20% of the sunlight hitting the solar panel is converted to electricity.* Discuss factors that affect the efficiency of a solar panel:
* Location: Solar panels in sunnier areas generally have higher efficiency.
* Angle: The angle at which solar panels are mounted affects their efficiency. Panels should be tilted to face the sun.
* Weather: Cloudy or rainy weather reduces the amount of sunlight available and, consequently, solar panel efficiency.
* Explain how to calculate the energy output of a solar panel:
* Energy Output (kWh) = Solar Panel Size (W) x Daily Sunlight Hours x Efficiency.
* Provide an example where a 5 kW solar panel system with 4 hours of daily sunlight and 18% efficiency produces:
* Energy Output = 5 kW x 4 hours x 0.18 = 3.6 kWh.

Day 2 (60 minutes):1. Cost Analysis (30 minutes)
* Introduction:
* Begin by discussing the cost of electricity bills and how they can be a significant expense for households.
* Explain that installing solar panels can help reduce electricity costs and be financially beneficial in the long run.
* Calculating Solar Panel Cost:
* Provide students with a scenario where a solar panel costs $200 each.
* Ask them to calculate the cost of installing a solar panel system with a certain capacity (e.g., 5 kW). Ensure they understand that the capacity is the total power output of all panels combined.
* Guide them through the calculation:

→ Cost = Number of Panels x Cost per Panel→ For example, if they need 25 panels: Cost = 25 panels x $200/panel = $5000.* Analyzing Payback Period:
* Explain that the payback period is the time it takes for the cost of the solar panel system to be offset by the savings on electricity bills.
* Explain that the payback period is the time it takes for the cost of the solar panel system to be offset by the savings on electricity bills.
* Provide an example where the annual savings on electricity bills is $800 due to the solar panel installation.
* Ask students to calculate the payback period in years using the formula:

→ Payback Period (years) = Cost of Solar Panels / Annual Savings→ In the example, if the cost is $5000 and savings are $800 per year: Payback Period = $5000 / $800 = 6.25 years.1. Unit Conversion (30 minutes)
* Introduction:
* Begin by explaining the importance of unit conversion in energy-related calculations.
* Emphasize that it helps us understand and compare energy usage and production accurately.
* Watts to Kilowatt-hours:
* Explain the conversion between watts (W) and kilowatt-hours (kWh):

→ 1 kilowatt-hour (kWh) = 1,000 watts (W).* Provide an example of converting watts to kilowatt-hours:

→ If an appliance uses 500W for 4 hours, how many kilowatt-hours does it consume?→ Guide students through the calculation: Energy (kWh) = Power (kW) x Time (hours)Energy (kWh) = 0.5 kW x 4 hours = 2 kWh.* Practice Conversions:
* Provide students with several practice problems involving unit conversions:

→ Convert 1,200W to kilowatts.→ Convert 3.5 kW to watts.→ Convert 1,800 kWh to watts.* Encourage students to solve these problems individually or in pairs and review the answers as a class.
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| Homework: | Assign homework problems related to the topics covered in class, with an emphasis on energy use calculation and computation of household appliance energy use and solar energy efficiency.  |
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| Assessment:  | Formative Assessment: During class discussions and activities, assess students' understanding of the concepts and their ability to perform calculations.Homework: Assign homework assignments where students must analyze a real-world solar energy scenario, calculate energy production and cost, and demonstrate their understanding of unit conversion and efficiency. Grade for correctness and understanding. |

# **Exploring Solar Energy Math Worksheet**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## **Day 1: Understanding Watts and Solar Panel Efficiency**

### **Introduction (20 minutes)**

* What is solar energy, and why is it considered a crucial resource for a sustainable future?

Response:

### **Understanding Watts (20 minutes)**

* Define the following terms:
a. Watt (W):
Response:
b. Kilowatt (kW):
Response:
c. Kilowatt-hour (kWh):
Response:
* Calculate the energy consumption of a 100W light bulb running for 5 hours using the formula: Energy (kWh) = Power (kW) x Time (hours).
Response:

### **Solar Panel Efficiency (20 minutes)**

* Define solar panel efficiency and explain why it's a crucial factor in solar energy systems.

Response:

* List three factors that can affect the efficiency of a solar panel.
a.
b.
c.
* Calculate the energy output of a 6 kW solar panel system with 5 hours of daily sunlight and 22% efficiency.
Response:

## **Day 2: Cost Analysis and Unit Conversion**

### **Calculating Solar Panel Cost (30 minutes)**

* If each solar panel costs $250 and you need 30 panels for a solar panel system, calculate the total cost.
Response:
* Explain what the payback period is in the context of installing solar panels. Calculate the payback period if the cost of the solar panel system is $10,000, and the annual savings on electricity bills are $1,500.
Response:

### **Unit Conversion (30 minutes)**

* Explain the conversion between watts and kilowatt-hours.

Response:

* Convert the following:

a. 800W to kilowatts.

Response:

b. 4.5 kW to watts.

Response:

c. 2,000 kWh to watts.

Response:

* Solve the Light Bulb Energy Use Analysis from Day 1, Question 3, using the unit conversion method.

Response:

## **Homework: Real-world Applications**

* Research and analyze a real-world solar energy scenario, including calculations of energy production, cost analysis, and unit conversion. Provide detailed explanations for your answers.

Response:

## **Assessment:**

* Formative Assessment: Evaluate understanding during class discussions and activities.
* Homework: Assess correctness and understanding of real-world solar energy scenarios.

**Module 2.** Home Energy Auditing

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| Title: | Exploring Home Energy Efficiency and PECO Bills |
| Time-frame: | 2 hours (two 60-minute lessons) |
| Big Ideas and/or Essential Questions | Big Idea: Understanding home energy usage and reading utility bills promotes energy efficiency.Essential Questions:1. How can we analyze our home energy usage to make informed decisions?
2. What strategies can be employed to save energy and reduce electricity costs?
 |
| Vocabulary: | Kilowatt-hour (kWh)Utility billEnergy auditElectricity consumptionEnergy-efficientConservation |
| PA Standards: | **Standard CC.2.1.6.D.1** Understand ratio concepts and use ratio reasoning to solve problems.**Standard CC.2.3.6.A.1** Apply appropriate tools to solve real-world and mathematical problems involving area, surface area, and volume.**Standard CC.2.4.6.B.1** Demonstrate an understanding of statistical variability by displaying, analyzing, and summarizing distributions. |
| Students will be able to: | 1. Read and interpret a typical PECO utility bill.
2. Calculate the cost of energy consumption using multiplication.
3. Identify areas for potential energy savings in their homes.
4. Propose strategies to improve energy efficiency and reduce electricity costs.
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| Materials: | 1. Sample PECO utility bills (for demonstration).
2. Whiteboard and markers.
3. Calculators.
4. Worksheets for calculations.
5. Energy audit checklist (worksheet).
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| Activity Procedures: | Day 1 (60 minutes):1. Introduction (20 minutes)
* Opening Discussion
* Begin with a general discussion about the concept of utility bills and why it's important for individuals and families to understand them.
* Prompt students to share their thoughts on why knowing about home energy usage is crucial, touching on both environmental and financial aspects.
* Introduction of Key Terms
* Define key terms:

→ Kilowatt-hour (kWh): Remind that it's a unit of energy measurement, commonly used on utility bills to represent electricity consumption.→ Energy Audit: Briefly introduce the idea of an energy audit, explaining that it's a systematic process of evaluating energy use and identifying areas for improvement.* Class Discussion
* Facilitate a brief discussion on the importance of being conscious of energy consumption in daily life.
* Encourage students to consider how their families use energy at home and why it matters in terms of environmental impact and financial responsibility.
1. Reading a PECO Bill (20 minutes)
* Display Sample PECO Bill
* Show a sample PECO utility bill on a projector or hand out copies.
* Point out key sections, including the account information, usage details, rates, and charges.
* Guided Discussion
* Break down each section of the bill and explain its significance:

→ Account Information: Identify the account number, billing period, and meter readings.→ Usage Details: Explain how to read the usage details, focusing on the kWh consumption.→ Rates and Charges: Discuss the different rates and charges, such as the cost per kWh and any additional fees.* Importance of kWh
* Emphasize the importance of understanding kWh usage:

→ Discuss how kWh is a measure of energy consumption and how it directly influences the cost on the bill.→ Illustrate the connection between energy efficiency, kWh usage, and financial savings.1. Calculating Energy Cost (20 minutes)
* Teaching the Calculation:
* Introduce the formula for calculating energy cost: Cost = Power (kW) x Time (hours) x Rate (cost per kWh).
* Explain that power (kW) is the rate at which energy is used, time (hours) is the duration, and the rate is the cost per kWh.
* Example Calculation:
* Provide an example calculation based on the information from the sample bill.
* Walk through the steps of multiplying power, time, and rate to find the total cost.
* Practice Session:
* Distribute worksheets with different scenarios involving power, time, and rates.
* Allow students to practice calculating energy costs for various situations independently or in small groups.

Day 2 (60 minutes):1. Energy Audit Practice (20 minutes):
* Distribute Energy Audit Checklist:
* Hand out the energy audit checklist worksheet to each student.
* Explain the purpose of the energy audit: to identify areas of energy waste in homes and find opportunities for improvement.
* Discuss Common Energy Wasters:
* Facilitate a brief discussion on common areas where energy may be wasted in homes. Examples include:
* Inefficient Appliances: Old or inefficient appliances can consume more energy.
* Drafts: Poor insulation and drafts contribute to energy loss.
* Lighting: Incandescent bulbs are less energy-efficient than LED or CFL bulbs.
* Worksheet Completion:
* Instruct students to complete the energy audit checklist for their own homes or a hypothetical home.
* Encourage them to be specific and thorough in their observations.
* If possible, provide additional resources or guidance for students to research energy-efficient practices.
1. Strategies for Energy Efficiency (20 minutes)
* Introduction to Energy Efficiency Strategies
* Discuss the concept of energy efficiency and its importance in reducing energy consumption.
* Introduce various strategies to improve energy efficiency at home, such as:

→ Upgrading to energy-efficient appliances.→ Sealing drafts and improving insulation.→ Using LED or CFL bulbs instead of incandescent bulbs.* Proposal Activity
* Instruct students to propose at least three specific strategies based on their energy audit findings.
* Encourage creativity and critical thinking in their proposals.
* Emphasize the connection between their proposed strategies and potential energy and cost savings.
* Small Group Discussion
* Divide the class into small groups and have students share their proposed strategies within their groups.
* Encourage discussion and collaboration, allowing students to refine their ideas based on peer feedback.
1. Sharing and Discussions (20 minutes)
* Sharing Audit Findings
* Invite students to share their energy audit findings with the class.
* Encourage them to explain the areas of concern identified in the audit.
* Sharing Proposed Strategies
* Ask each student or group to share at least one of their proposed strategies with the class.
* Facilitate a discussion on the feasibility, potential impact, and cost-effectiveness of the proposed strategies.
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| Homework: | Assign students to implement at least one energy efficiency strategy from their proposed list in their homes and report back on any observable changes in energy usage. |
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| Assessment:  | 1. Energy Audit Checklist:
* Evaluate the completeness and accuracy of students' energy audit checklists.
1. Proposed Strategies:
* Assess the creativity and feasibility of students' proposed energy efficiency strategies.
1. Class Participation:
* Evaluate students' engagement and contribution during the sharing and discussion sessions.
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# **Exploring Home Energy Efficiency and PECO Bills Worksheet**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## **Day 1: Understanding PECO Bills and Energy Consumption**

### **Opening Discussion (20 minutes)**

* Why do you think it's important for individuals and families to understand their utility bills, specifically focusing on home energy usage? Explain from both environmental and financial perspectives.

Response:

### **Introduction of Key Terms (20 minutes)**

* Define the following key terms:
a. Kilowatt-hour (kWh):
Response:
b. Energy Audit:
Response:

### **Reading a PECO Bill (20 minutes)**

* Identify and briefly explain the significance of the following sections on a utility bill:
a. Account Information:
Response:
b. Usage Details:
Response:
c. Rates and Charges:
Response:
* Why is understanding the concept of kilowatt-hours (kWh) crucial when analyzing a utility bill?

Response:

### **Calculating Energy Cost (20 minutes)**

* Write the formula for calculating energy cost using power (kW), time (hours), and rate (cost per kWh).

Response:

* Based on the sample bill, perform the calculation for total energy cost using the provided formula.

Response:

* Practice Session: Calculate the energy cost for a scenario where power is 3 kW, time is 5 hours, and the rate is $0.15 per kWh.

Response:

## **Day 2: Energy Audit and Efficiency Strategies**

### **Energy Audit Practice (20 minutes)**

* List three common areas where energy may be wasted in homes.
a.
b.
c.
* Complete the energy audit checklist for your own home or a hypothetical home.

Response:

### **Strategies for Energy Efficiency (20 minutes)**

* Name three strategies to improve energy efficiency at home.

a.

b.

c.

* Proposal Activity: Propose at least three specific strategies based on your energy audit findings.

a.

b.

c.

### **Sharing and Discussions (20 minutes)**

* Share one area of concern identified in your energy audit with the class.

Response:

* Share at least one proposed energy efficiency strategy. Discuss its feasibility and potential impact.

Response:

## **Homework: Implementation and Report Back**

* Implement at least one energy efficiency strategy from your proposed list at home. Report back on any observable changes in energy usage.

Response:

## **Assessment:**

* Energy Audit Checklist: Evaluate the completeness and accuracy of your energy audit checklist.
* Proposed Strategies: Assess the creativity and feasibility of your proposed energy efficiency strategies.
* Class Participation: Evaluate your engagement and contribution during the sharing and discussion sessions.

Homework Set 1: Understanding Watts

1. Calculate the energy consumption of a 750W microwave running for 10 minutes.
2. You have a computer that uses 150W of power. If it's used for 4 hours daily, how many kilowatt-hours (kWh) does it consume in a month?
3. A TV consumes 120W of power when it's on. If it's on for an average of 6 hours a day, how much energy does it consume in a week?

Homework Set 2: Solar Panel Efficiency

1. Given a solar panel with a capacity of 6 kW and an efficiency rating of 15%, calculate the daily energy production in kWh if it receives 5 hours of sunlight.
2. Research and find the average solar panel efficiency in your region. Calculate the daily energy output of a 4 kW solar panel system with this efficiency rating if it receives 7 hours of sunlight.
3. You are considering installing solar panels with a combined capacity of 10 kW. Calculate the monthly energy production in kWh during summer (8 hours of sunlight) and winter (4 hours of sunlight) based on the panel's efficiency of 18%.

Homework Set 3: Energy Audit and Conservation

1. Perform an energy audit of your home, identifying at least three appliances or areas where energy conservation is possible. Note the power ratings (in watts) of these appliances.
2. Calculate the annual energy consumption (in kWh) for one of the appliances you identified in question 7 if it runs for 5 hours daily. How much money could you save in a year by using this appliance more efficiently?
3. Create an energy-saving plan for your home, outlining steps you can take to reduce energy consumption. Estimate the potential annual savings in kWh and dollars.

Homework Set 4: Solar Energy and Cost Analysis

1. Find the average annual electricity usage of a typical PECO customer in your region. Compare this with the annual energy production of a 6 kW solar panel system (given the efficiency and daily sunlight hours in your area). Will the solar production offset the customer's usage?