



Brown Math Enrichment - Solar House

Unit Focus
Students design and build scaled model houses that incorporate solar energy features. They begin by investigating different aspects of solar energy-reflection, absorption, concentration-and ways to collect and store the sun's rays. They analyze their data to inform their own design, using both spreadsheet software and paper and pencil methods. While students investigate these science principles, they apply many math skills such as fractions, decimals, volume, surface area, conversions within measurement systems, and coordinate graphing. Student teams build model houses that incorporate passive and active solar features, and then test the models to see which designs allow the most collection and storage of solar energy. They create scaled side-view drawings and floor plans and use the plans to build the rooms in their model houses.

STAGE 1: DESIRED RESULTS – KEY UNDERSTANDINGS

ESTABLISHED GOALS	TRANSFER	
<p>Common Core Standards <i>Mathematics: 5</i> <i>920392 Number & Operations in Base Ten</i> <i>920400 Perform operations with multi-digit whole numbers and with decimals to hundredths.</i></p> <ul style="list-style-type: none"> • CCSS.MATH.CONTENT.5.NBT.B.5 Fluently multiply multi-digit whole numbers using the standard algorithm. • CCSS.MATH.CONTENT.5.NBT.B.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models. • CCSS.MATH.CONTENT.5.NBT.B.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. <p><i>920404 Number & Operations--Fractions</i> <i>920408 Apply and extend previous understandings of multiplication and division.</i></p> <ul style="list-style-type: none"> • CCSS.MATH.CONTENT.5.NF.B.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. <p><i>CCSS.MATH.CONTENT.5.NF.B.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.</i></p> <ul style="list-style-type: none"> • CCSS.MATH.CONTENT.5.NF.B.4A Interpret the product $(a/b) \times q$ as a 	<p>T1 Make sense of a problem, initiate a plan, execute it, and evaluate the reasonableness of the solution.</p> <p>T2 Represent and interpret patterns in numbers, data and objects.</p> <p>T3 Develop a product/solution that adheres to key parameters (e.g., cost, timeline, restrictions, available resources and audience).</p> <p>T4 Leverage connection(s) in other subject areas (including STEM) to make sense of a given problem, product, or solution.</p> <p>T5 Work together on a common goal to meet deadlines through addressing challenges and problems along the way both individually and collectively.</p> <p>T6 Work together on a common goal to meet deadlines through addressing challenges and problems along the way both individually and collectively.</p>	
	MEANING	
	UNDERSTANDINGS	ESSENTIAL QUESTIONS
	U1 Effective problem solvers work to make sense of the problem before trying to solve it.	Q1 How are people trying to preserve the Earth's resources and protect the environment?
	U2 Mathematicians overcome obstacles by employing strategies and learn from success and failure.	Q2 What kind of energy does the Sun provide and how can this energy be used as a renewable resource?
	U3 Mathematicians apply the mathematics they know to solve problems occurring in everyday life.	Q3 How does my family keep the house warm in the winter and cool in the summer?
U4 Mathematicians use geometric models, and spatial sense	Q4 How do engineers use math to heat and cool your	

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parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. For example, use a visual fraction model to show $(2/3) \times 4 = 8/3$, and create a story context for this equation. Do the same with $(2/3) \times (4/5) = 8/15$. (In general, $(a/b) \times (c/d) = ac/bd$.)

- CCSS.MATH.CONTENT.5.NF.B.4B Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

CCSS.MATH.CONTENT.5.NF.B.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.

- CCSS.MATH.CONTENT.5.NF.B.7C Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $1/3$ -cup servings are in 2 cups of raisins?

920421 Measurement & Data

920422 Convert like measurement units within a given measurement system.

- CCSS.MATH.CONTENT.5.MD.A.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

920426 Geometric measurement: understand concepts of volume.

CCSS.MATH.CONTENT.5.MD.C.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

- CCSS.MATH.CONTENT.5.MD.C.5A Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.

- CCSS.MATH.CONTENT.5.MD.C.5B Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

920435 Geometry

920436 Graph points on the coordinate plane to solve real-world and

to interpret and make sense of the physical environment.

U5 Energy can be transferred from place to place by sound waves, light waves, heat, and electric current or from object to object through collision.

U6 Energy, in everyday life, typically refers to the conversion of stored energy into a desired form for practical use.

U7 Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.

U8 When light shines on an object, it is reflected, absorbed, or transmitted (refracted) through the object, depending on the object's material and the frequency (color) of the light.

home?

ACQUISITION OF KNOWLEDGE AND SKILL

KNOWLEDGE	SKILLS
K1 Black pigment absorbs all colors of light and transfers light energy to heat energy; and white reflects all colors (wavelengths) of light and doesn't absorb heat.	S1 Measure and read temperature in both the Fahrenheit and Celsius scale.
K2 Volume and surface area of a right rectangular prism.	S2 Construct and read single, double, and triple line graphs.
K3 Which Earth materials are able to collect solar energy (dry soil, wet soil, water, and rocks).	S3 The various ways to represent the volume of 24 cubic inches.
K4 Multiply using the standard algorithm.	S4 How to draw various geometric shapes using protractors, rulers, and appropriate tools to scale.
K5 Multiply a whole number by a fraction and divide 3-digit whole numbers by a 1 digit whole number.	
K6 Add, subtract, multiply, and divide decimal numbers to the hundredths place value.	
K7 Orientation of windows and insulation for efficient home solar design.	
K8 Transparent materials allow light to pass through that can	

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mathematical problems.
 • CCSS.MATH.CONTENT.5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Next Generation Science Standards

Middle School Engineering Design: 6 - 8

MS-ETS1 Engineering Design

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Student Growth and Development 21st Century Capacities Matrix

Creative Thinking

- Design: Students will be able to engage in an appropriate process to refine their product.

Collaboration/Communication

- Collective Intelligence: Students will be able to work respectfully and responsibly with others, exchanging and evaluating ideas to achieve a common objective.
- Product Creation: Students will be able to effectively use a medium to communicate important information (findings, ideas, feelings, issues, etc.) for a given purpose.

be absorbed and converted to heat.

K9 Convert temperatures from Fahrenheit to Celsius and vice versa.