**6th Grade Lesson Plan for Schools with Solar Energy**

Overview:

The following lesson plan is split into THREE chapters: Introduction to Solar Energy and Interpretation and Calculation using the Solar Panel Monitoring System. In Chapter 1, *Introduction to Solar Energy*, students will learn how to solve unit conversions with the unknown variable of “x,” be introduced to solar panels, and also learn about electrical vehicles. In Chapter 2, *Interpretation of the Solar Panel Monitoring System*, students will learn how to interpret and extrapolate data from the system. In Chapter 3, *Calculating using the Solar Panel Monitoring System*, students will learn how to use data to predict the production of energy and variability in production of energy from solar panels, and also, determine how much money using a solar system saves.

Chapter Overviews:

Chapter 1: Introduction to Solar Energy

LESSON 1: What is a ratio?

LESSON 2: Unit conversion FUNdamentals

LESSON 3: Playing with solar panels

LESSON 4: What is the Philly Solar Sprint?

LESSON 5: Who can make the most energy efficient car?

LESSON 6: Electric Vehicle v.s. Internal Combustion Vehicle Debate!

Chapter 2: How do you interpret data?

LESSON 1:

Chapter 3: How do you create new data?

LESSON 1:

**Chapter 1: Introduction to Solar Energy**

**Core Takeaways:**

**Lessons**

LESSON 1: What is a ratio?

LESSON 2: Unit conversion FUNdamentals

LESSON 3: Playing with solar panels

LESSON 4: What is the Philly Solar Sprint?

LESSON 5: Who can make the most energy efficient car?

LESSON 6: Electric Vehicle v.s. Internal Combustion Vehicle Debate!

**Vocabulary**

Ratio

Equivalent/equivalence

Conversion unit

Watt

|  |  |
| --- | --- |
| Mega-  Kilo- | Deci-  Centi-  Milli-  Micro- |

**Assessments**

**Learning Standards**

**CC.2.1.6.D.1** Understand ratio concepts and use ratio reasoning to solve problems.

**CC.2.1.6.E.1** Apply and extend previous understandings of multiplication and division to divide fractions by fractions.

**CC.2.2.6.B.1** Apply and extend previous understandings of arithmetic to algebraic expressions.

**STEELS**

**Ch 1, Lesson 1: What is a ratio?**

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| --- | --- |
| Time-frame: | 50 minutes plus time for extension activity |
| Big Ideas and/or Essential Questions | What is a ratio?  How do we conceptualize a ratio?  How can we use ratios in real life?  How can we think about ratios and solar energy? |
| Vocabulary: | Ratio  Equivalent/Equivalence |
| PA Standards: | **CC.2.1.6.D.1** Understand ratio concepts and use ratio reasoning to solve problems. |
| Students will be able to: | * Understand what a ratio is * Understand what it means for two ratios to be equivalent * Provide an example of equivalent ratios |
| Materials: | * Pen(cil) * Coloring tools, if needed * Math notebook * Ratio Equivalence Handout |
| Activity Procedures: | **Spark** What is a ratio? Ask the students to count the number of students in the classroom, and write the number on the board. Have the students take out their math notebook and write down the numbers with you. Then, ask the students the following questions, and have them raise their hands to answer and count: “Whose favorite subject is English (ELA)? Social Studies? Science? Math? Art? PE? Nutrition?” Tell the students to look at the board and ask them how we can make sense of all of this.  **5-10 minutes**  Have the students write down the definition of a ratio. Supplement their understanding by using this data to create ratios for their classroom. For example: Math:Total, Math:English, PE:Art, etc. This beginning activity will transition into Activity #1.  **Activity #1** Understanding ratios by forming their own questions. Give the students 5 minutes to come up with one similar question about their classmates, like “Who likes dogs?” “Who likes cats?” “Who watches cartoons?” etc. The student should write down their question in a notebook. Go around the class so that each student gets to ask their own question. *(If there are too many students in the classroom, then you can alter how many students can ask their question)*. Encourage students to raise their hand and participate. Also, encourage students to take similar questions and compare them, like the number of dog lovers and cat lovers can be expressed as a ratio. This should be a fun activity that can help students understand ratios and how they can even relate to their own classroom. The teacher can also represent these ratios by drawing shapes on the board so students can visualize the ratios.  Other example: ratio of tables to chairs  **15 minutes**  **Suggested teaching script:** Let’s take a look at the ratios about our classmates or classroom. Ask the students these questions or similar. What do we notice about the numbers? Are there ways to simplify the ratios? What ratios represent the same values? Let the students respond to these questions with a raised hand.    **Activity #2 –** Pass out the Ratio Equivalence Handout. Lead the class in explaining what equivalence means. Have students take a guess as to what it means. Include in your explanation that the word equal is part of the word “equivalence”. Then, ask students what it means for ratios to be equivalent.    What it means for ratios to be equivalent: *to determine if two ratios are equivalent, express them as fractions. If the simplest form of the fractions are equal, then the ratios are equivalent.*    Ask for students to give examples of equivalent ratios. After, lead the students through the first example problem, asking for students to raise their hands to answer. For the second example problem, let the students work by themselves for 15 minutes. Walk around the classroom if any of the students need any help.  **25 minutes** |
| Homework: | Ratio Equivalence Homework |
| Extension: | **Activity #3 –** Kahoot  <https://create.kahoot.it/share/equivalent-ratios/be4abaac-bded-4319-81df-ad1313c31d1c>  **Activity #4 –** Direct students to IXL to practice equivalent ratios: <https://www.ixl.com/math/grade-6/identify-equivalent-ratios>. |
| Assessment: | * Identify, simplify, and multiply ratios * Solve ratio word problems * Apply ratios to real-world situations |

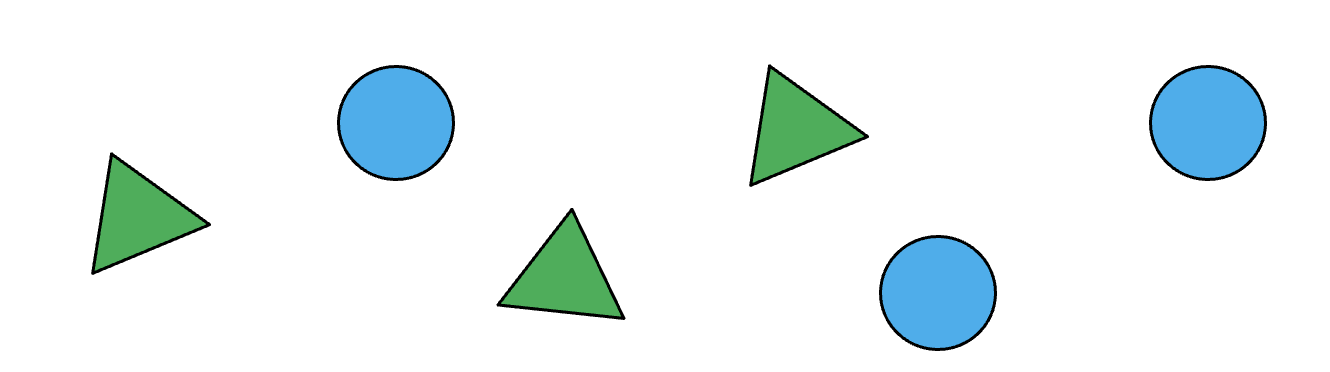
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**Ratio Equivalence Handout**

What does “equivalent” mean?

Then, what does it mean for ratios to be “equivalent to each other?” What are some examples of ratios that are equivalent?

**Example 1:**

Jeremiah has 3 triangle toys and 3 circle toys in their bedroom.

What is the ratio of TRIANGLES to CIRCLES?

What if Jeremiah had TWICE as many toys in their bedroom, how many would they have then? Draw what it would look like below to help solve this question.

If there were 10 TRIANGLE toys, how many CIRCLE toy(s) will there be?

If there was 1 CIRCLE toy, how many TRIANGLE toy(s) will there be?

**Example 2:**

Tony is making a paint palette for his art class. On his palette, he adds 5 dollops of magenta, 3 dollops of cyan, and 4 dollops of yellow paint.

1. How many total dollops of color are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the ratio of cyan to the total dollops? \_\_\_\_\_\_\_\_\_\_\_\_
3. Can your answer be simplified? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The ratio of all of the palette parts can be represented as:

**MAGENTA : CYAN : YELLOW** → 5:3:4

What do you notice about this ratio? Once a relationship is established, ratios like to stay the same, no matter how many colors Tony adds to his palette. If Tony adds 10 dollops of magenta, he MUST add 6 dollops of cyan AND 8 dollops of yellow. With that in mind, answer the following questions:

1. If Tony had 15 dollops of magenta on his palette, how many cyan dollops does he need? Yellow dollops? Answer in the blank space below.

1. What if Tony added 60 dollops of yellow? What would the total number of dollops be? Show your work.

1. **Challenge Question**: What if Tony added dollops of magenta? What are the values in fractions? What about in decimals?

**Ch 1, Lesson 2: Unit Conversion FUNdamentals**

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| --- | --- |
| Time-frame: | 50 minutes + 20 minute extension |
| Big Ideas and/or Essential Questions | How do we convert from one unit to another?  How do we divide fractions with fractions?  How does this apply to solar energy?  What units do we associate with electricity? |
| Vocabulary: | Conversion unit  Watt  Extension Activity   |  |  | | --- | --- | | Mega-  Kilo-  Hecto-  Deka- | Deci-  Centi-  Milli-  Micro- | |
| PA Standards: | **CC.2.1.6.E.1** Apply and extend previous understandings of multiplication and division to divide fractions by fractions.  **CC.2.2.6.B.1** Apply and extend previous understandings of arithmetic to algebraic expressions. |
| Students will be able to: | * From a given unit, the student will learn how to convert to a different unit. * Understand how to divide fractions with fractions. * Understand how to convert units associated with electricity. * Understand the prefixes of metric units |
| Materials: | * Pen(cil) * Math notebook * Dominos |
| Activity Procedures: | **Spark** What is a fraction? Come up with a prompt similar to: “What fraction of the class is wearing a T-shirt today?” In addition, you can throw in adding, subtracting, multiplying, and simplifying fractions. Have the students look around, count their peers, write down their answer, and share with their neighbors.  **5 minutes**  After the fact, introduce the students to how to divide fractions by fractions by use of dominos. Give students some sets of dominos to share amongst them. Place two dominos side by side, say ⅙ and ⅔. Tell the students to multiply these, for example, the answer is 2/18=1/9. In order to divide a fraction by a fraction, you take the reciprocal of the denominator and multiply by the numerator. How you can show them to divide is by taking the ⅙ domino and flipping the second domino to become 3/2. Then, tell them to multiply these values together, becoming 3/12=¼.  **Activity #1** Have students pair up and give them some dominos. Have the students choose two dominos from the pile and have their partner record the given fractions and divide. The other student can do this alongside to check their work. Each student gets multiple turns to practice! For an extra challenge, offer for students to attempt calculating for THREE dominos. Towards the end of the activity, lead a few domino questions and have students calculate and then raise their hand to answer.  **20 minutes**  **Suggested teaching script:** *At the beginning of class, we translated fractions into something in the real world. We can do the same with electricity and solar energy. Let’s use what we learned!*  Pre-assessment: What conversion factors does the class know? Come up together as a class on relevant information. Some answers are: 1 hour/ 60 minutes, 1 minute/ 60 seconds, 1 kW/ 1ooo W, etc. Make sure all the conversion factors necessary for the worksheet are covered.  **5 minutes**  **Activity #2** Show the students how to do unit conversion by hand and have students work on the Unit Conversion Madness Worksheet. Stress the importance of including units and demonstrate the ability to cancel out units. The worksheet will include fractions for an extra challenge.  **20 minutes** |
| Homework: | * Complete the Unit Conversion Worksheet they worked on in class |
| Extension: | **Activity #3** - **Metric Prefixes**  Introduce to the class the prefixes that clue into the value of a number. Go through the worksheet together and write on the board as you all fill out the sheet. After introducing each prefix, ask the class if they know any words with the same prefix and write them down. This probably won’t include pico- or yotta- but maybe prefixes like mega-, kilo-, or milli- might be familiar to them. For fun, tell the students the large and small prefixes like zeta- for 1021 or atto- 10-18 and maybe draw out all the zeros for scale.  **20 minutes**  The prefixes from the worksheet are referenced from: <https://www.nist.gov/pml/owm/metric-si-prefixes>  <https://www.learnalberta.ca/content/memg/division03/International%20System%20of%20Units/index.html> |
| Assessment: | * Ability to divide fractions by fractions * Ability to convert between multiple units * Ability to identify numbers by knowing their prefixes |

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

**Unit Conversion Madness**

Class Conversion Table

*(Fill out the conversion factor table with the class below.)*

|  |
| --- |
|  |

Solve and show your work:

1. 6.5 m to cm \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm
2. 10 years to hours \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hours
3. 450 kW to W \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
4. 1,256 V to kV \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kV

Now, let’s switch it up with more complicated conversion units!

1. If the distance from home to school is 13 miles, and the bus drives at an average speed of 40 mph, how long does it take to get to school in minutes?

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1. If the distance from my home to school is miles, and my turtle, Leonardo, walks at an average speed of mph, how many seconds does it take Leonardo to get to school?

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1. A plane flies at an average speed of 550 mph, and a flight from Philadelphia to Pittsburgh takes one hour. If the length of a football field is 120 yards, how many football fields long is the trip?

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1. Imagine your school has 4 solar panels that generate 300 watts per hour EACH. Say there are 10 lightbulbs in each classroom, and each lightbulb uses 6 watts per hour. How many classrooms are powered by solar panels?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Say a solar panel generates 300 watts per hour (wph) and one lightbulb uses 14 wph. If a chandelier needs 15 light bulbs and one solar panel costs $200, how many fully bulbed chandeliers can be purchased for $1000?

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1. A dancing toy robot has a small solar panel on its back that generates 15 watts. It uses the solar panel to self-charge its two batteries, which use 20 watts each. If it takes the solar panel hrs to generate 15 watts, how long will it take the robot to recharge?

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| CHALLENGE QUESTION:  Refer to Question 7. If the flight produces 90 kg CO2 emissions per hour, what is the carbon emission in g CO2/inches? |

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

**Metric Prefixes Worksheet**

What are the meanings to the prefixes on the metric units we see? Use this table as a cheat sheet once we fill in the table below. Do you know any of these already?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factor** | **Symbol** | **Prefix name** | **Number**  **name** | **Example** |
| 106 | M |  | million |  |
| 103 | k |  |  |  |
| 102 | h |  |  | hectogram, hectoliter |
| 101 | da | deka | ten |  |
| 100 | - | - | one | - |
| 10-1 | d |  |  | deciliter |
| 10-2 | c |  | hundredth |  |
| 10-3 | m | milli |  |  |
| 10-6 | μ  “mu” |  |  |  |

**Review**:

Write out how many zeros are in a kilo-: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many zeros are in a micro-?: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Solve and show your work (remember your units!):

1. What is 4 centimeters (cm) in kilometers (km)?
2. What is 8 dekaliters (daL) in kiloliters (kL)?
3. What is 15 milliseconds (ms) in seconds (s)?
4. What is 5 kilowatt hours (kWh) in hours (h)?
5. What is 154 kilowatts (kW) in centiwatts (cW)?

**Ch 1, Lesson 3: Playing with Solar Panels**

|  |  |
| --- | --- |
| Time-frame: | THREE 50 minute lessons |
| Big Ideas and/or Essential Questions | How can we use geometry to solve a problem with solar panels?  How do we calculate perimeter?  How do we calculate area?  How do we calculate surface area? |
| Vocabulary: | Perimeter  Area  Surface Area |
| PA Standards: |  |
| Students will be able to: |  |
| Materials: | * Pen(cil) * Math notebook * Graph paper * Ruler * 1-in cube, 3-in cube, 5-in cube, rectangular block of similar size |
| Activity Procedures: | **Preparing for this lesson:**  Prior to this lesson, hand the students a piece of graph paper one day before or a few days before, and assign that they draw a rough sketch of the floor plan of their home using rectangles! **If** they do not want to draw their home, they can draw the classroom or their favorite room in the school.  **DAY 1:**  Ask the students to take out their graph paper with their drawing on it and have them examine it.  **Write**   * Geometry   + Have students calculate the surface area of a solar panel. Is the rectangle the best shape for a solar panel?   **LAB:**   * Measure the cubes and then calculate the perimeter, the area, surface area and then see relationships through the ratios   **DAY 2:**   * **Solar panels** |
| Homework: |  |
| Extension: |  |
| Assessment: |  |