Instruction

Prerequisite Skills

This lesson requires the use of the following skills:

- simplifying fractions (4.NF.1)
- canceling units in expressions (5.NF.6)
- creating ratios from context (7.RP.2c)

Introduction

Measurement is a way of describing and quantifying the real world. A **quantity** is a number with meaning, so when you **quantify** something you are giving it meaning or measure. For example, if a gardener says, "This pumpkin weighs 10 pounds," he is describing a property of the pumpkin (its heaviness) and quantifying the heaviness as "10 pounds." Sometimes, the way a measurement or quantity is described can make it hard to solve a problem. For example, it's hard to tell whether Mary will get to school on time if we are told she walks at a speed of 4,470 light years per aeon. Or, you might be trying to compare two measurements given in different quantities. For instance, suppose you need to know which is larger: a liter or a quart. In such situations, you must convert the units of measurement into more practical terms.

Key Concepts

- A **unit of measurement** is a defined quantity of whatever is being measured. For example, the current formal definition of a meter is "the length of the path traveled by light in a vacuum during a time interval of $\frac{1}{299{,}792{,}458}$ of a second." Another example of a unit of measure is "the width of my hand."
- Every measurement has two parts: a number and a unit.
- The unit of a measurement tells you what is being measured, while the number of a measurement tells you how much of the unit there is. For example, the measurement "3 inches" tells you that you are measuring a length and that the length is 3 when measured in inches.
- The same measurement can have very different numerical parts depending on the units used. For example, a measurement of 2 miles is the same as 3,218.69 meters.

Instruction

- **Standard units** are widely accepted units of measurement. Standard units are usually defined by law. For example, standard units in the United States include gallons, feet, and pounds.
- A **system of measurement** is a collection of units of measurements that all relate to each other. The metric system, or SI, is an example of a system of measurement.
- Two separate measurements generally need to be in the same unit before they can be compared.
- A **conversion factor** is a ratio of quantities given in different units that are equivalent. For example, the ratio $\frac{12 \text{ inches}}{1 \text{ foot}}$ is a conversion factor because 12 inches is the same length as 1 foot.
- To convert from one set of units to another, start with the quantity you want to convert, and multiply by a series of conversion factors that connect the beginning units with the ending units until you reach the desired units. The unwanted units should cancel with one another if the problem has been set up correctly.
- When setting up the conversion, unwanted units should appear in the numerator and the denominator an equal number of times, while the desired units should appear only once. It is also important to pay attention to the location of the units. Depending on what the target units are, the conversion factors and even the beginning unit ratio may need to be "flipped."
- For example, convert 10 meters per second to feet per second. When setting up the conversion, "feet" and "second" should each appear once. The unit "meters" is not wanted, so "meters" should appear in the numerator of the first ratio (comparing meters to seconds), and in the denominator of the second ratio (comparing feet to seconds). This leaves the unit "seconds" to be in the denominator of the first ratio, and the unit "feet" to be in the numerator of the second ratio. Therefore, the first ratio will be $\frac{10 \text{ meters}}{1 \text{ second}}$, because this places "meters" in the numerator and "seconds" in the denominator. Using the approximation 1 meter = 3.28 feet, we can write the second ratio, $\frac{3.28 \text{ feet}}{1 \text{ meter}}$. Finally, write the two ratios as a multiplication problem: $\frac{10 \text{ meters}}{1 \text{ second}} \cdot \frac{3.28 \text{ feet}}{1 \text{ meter}}$.

Instruction

- To complete the conversion, cancel units appearing in the numerator and denominator, then multiply the number values:

$$\frac{10\ \cancel{\text{meters}}}{1\ \text{second}} \bullet \frac{3.28\ \text{feet}}{1\ \cancel{\text{meter}}}$$ Cancel units.

$$\frac{10 \bullet 3.28\ \text{feet}}{1\ \text{second}}$$ Multiply the number values.

$$\frac{32.8\ \text{feet}}{1\ \text{second}}$$ Converted measurement

Common Errors/Misconceptions

- using the wrong conversion factor(s)
- misidentifying the initial or target units
- incorrectly manipulating units with powers; for example, cancelling the whole unit expression instead of just one power: $\frac{1\ \text{meter}}{1\ \text{second}} \bullet \frac{1000\ \text{liters}}{1\ \text{meter}^3} \rightarrow \frac{1000\ \text{liters}}{1\ \text{second}}$