

Section 2: The Way Science Works

Preview

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- Units of Measure
- Units of Measurement
- SI (Le Système Internationale d'Unités)
- Math Skills

Key Ideas

- › How can I think and act like a scientist?
- › How do scientists measure things?

Bellringer

Your teacher has given you the following assignment: Investigate the impact that adding various amounts of fertilizer has on plant growth. Think about what you would need to do to conduct this experiment. Then answer the items on the following slide.



Bellringer, *continued*

Place a *Y* beside items that would be part of your plan to investigate plant height and fertilizer. Place an *N* beside items that will not help you investigate this particular connection.

- a. _____ Put one plant in a sunny windowsill and one in a dark corner.
- b. _____ Give plants the same amounts of water.
- c. _____ Give different plants different amounts of fertilizer without keeping track of which plant got extra fertilizer.
- d. _____ Use some new plants from seeds and some old plants that have been growing for months.
- e. _____ Start with plants that are the same size.
- f. _____ Keep all plants in a similar location.
- g. _____ Carefully note amounts of fertilizer each plant is given.
- h. _____ Keep one plant fertilized but with no water.

Bellringer, *continued*

2. Name at least five tools or supplies you will need to perform this experiment.
3. What do you think will need to be measured?
What units will you use to record these measurements?

Science Skills

- › How can I think and act like scientist?
- › Identifying problems, planning experiments, recording observations, and correctly reporting data are some of the most important science skills.
 - Scientists approach a problem by thinking logically.

Science Skills, *continued*

- Critical thinking helps solve problems logically.
- **critical thinking:** the ability and willingness to assess claims critically and to make judgments on the basis of objective and supported reasons
- Scientists use scientific methods to solve problems.
- **scientific method:** a series of steps followed to solve problems including collecting data, formulating a hypothesis, testing the hypothesis, and stating conclusions
 - The scientific methods are general description of scientific thinking rather than an exact path for scientists to follow.

Visual Concept: Scientific Methods



Science Skills, *continued*

- Scientists test hypotheses.
- *hypothesis*: a possible explanation or answer that can be tested
 - Scientists test a hypothesis by doing a controlled experiment.
 - *controlled experiment*: an experiment in which the variables that could affect the experiment are kept constant (controlled) except for the one that you want to measure
 - *variable*: a factor that changes in an experiment in order to test a hypothesis

Visual Concept: Hypothesis



Science Skills, *continued*

- Experiments test ideas.
 - No experiment is a failure.
 - The results of every experiment can be used to revise the hypothesis or plan tests of a different variable.
 - *Peer-reviewed research*: research that has been reviewed by other scientists

Science Skills, *continued*

- Scientists use special tools.
- There are many tools used by scientists for making observations, including
 - *telescopes*
 - *spectroscopes*
 - *particle accelerators*

Units of Measurement

- › How do scientists measure things?
- › Scientists use standard units of measure that together form the International System of Units, or SI.

Units of Measurement, *continued*

- SI units are used for consistency.
 - SI has seven base units.

Quantity	Unit	Abbreviation
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	cd

- *derived units*: combinations of the base units

SI (Le Système Internationale d'Unités)

Common SI Units		
Length 	meter (m) kilometer (km) decimeter (dm) centimeter (cm) millimeter (mm) micrometer (μm) nanometer (nm)	$1 \text{ km} = 1,000 \text{ m}$ $1 \text{ dm} = 0.1 \text{ m}$ $1 \text{ cm} = 0.01 \text{ m}$ $1 \text{ mm} = 0.001 \text{ m}$ $1 \mu\text{m} = 0.000\,001 \text{ m}$ $1 \text{ nm} = 0.000\,000\,001 \text{ m}$
Volume 	cubic meter (m^3) cubic centimeter (cm^3) liter (L) milliliter (mL)	$1 \text{ cm}^3 = 0.000\,001 \text{ m}^3$ $1 \text{ L} = 1 \text{ dm}^3 = 0.001 \text{ m}^3$ $1 \text{ mL} = 0.001 \text{ L} = 1 \text{ cm}^3$
Mass 	kilogram (kg) gram (g) milligram (mg)	$1 \text{ g} = 0.001 \text{ kg}$ $1 \text{ mg} = 0.000\,001 \text{ kg}$
Temperature 	Kelvin (K) Celsius ($^{\circ}\text{C}$)	$0^{\circ}\text{C} = 273 \text{ K}$ $100^{\circ}\text{C} = 373 \text{ K}$

Units of Measurement, *continued*

- SI prefixes are for very large and very small measurements.
 - The prefixes are multiples of ten.
 - SI prefixes for large measurements

Prefix	Symbol	Meaning	Multiple of base unit
<i>kilo-</i>	k	thousand	1,000
<i>mega-</i>	M	million	1,000,000
<i>giga-</i>	G	billion	1,000,000,000

Units of Measurement, *continued*

- SI prefixes for small measurements

Prefix	Symbol	Meaning	Multiple of base unit
<i>deci-</i>	d	tenth	0.1
<i>centi-</i>	c	hundredth	0.01
<i>milli-</i>	m	thousandth	0.001
<i>micro-</i>	μ	millionth	0.000001
<i>nano-</i>	n	billionth	0.000000001

Units of Measurement, *continued*

- You can convert between small and large numbers.
 - To convert to a smaller unit, multiply the measurement by the ratio of units so that you get a larger number.
 - To convert to a larger unit, divide the measurement by the ratio of units so that you get a smaller number.

Math Skills

Conversions within SI

The width of a soccer goal is 7 m. What is the width of the goal in centimeters?

1. List the given and unknown values.

Given: *length in meters, $l = 7$ m*

Unknown: *length in centimeters = ? cm*

Math Skills, *continued*

2. Determine the relationship between units.

$$1 \text{ cm} = 0.01 \text{ m}$$

$$1 \text{ m} = 100 \text{ cm}$$

Multiply by 100 because you are converting from meters, a larger unit, to centimeters, a smaller unit.

3. Write the equation for the conversion.

$$\text{length in cm} = \text{m} \times \frac{100 \text{ cm}}{1 \text{ m}}$$

Math Skills, *continued*

4. Insert the known values into the equation, and solve.

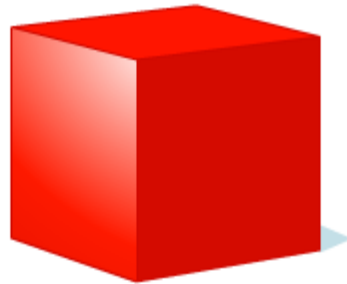
$$\text{length in cm} = 7 \cancel{\text{ m}} \times \frac{100 \text{ cm}}{1 \cancel{\text{ m}}}$$

$$\text{length in cm} = 700 \text{ cm}$$

Units of Measurement, *continued*

- Measurements quantify your observations.
- **length:** a measure of the straight-line distance between two points
- **mass:** a measure of the amount of matter in an object
- **volume:** a measure of the size of a body or region in three-dimensional space
- **weight:** a measure of the gravitational force exerted on an object

Visual Concept: Volume



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