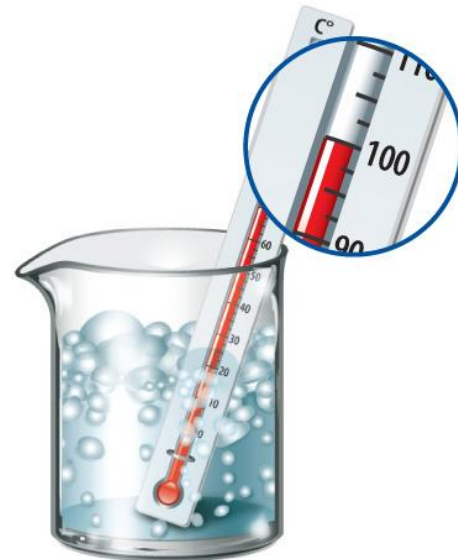**Chapter Menu**

Chapter Introduction

Lesson 1   Understanding Science

Lesson 2   Measurement and Scientific Tools

Lesson 3   Case Study

Chapter Wrap-Up

What processes do scientists use when they perform scientific investigations?

Understanding Science

Key Concepts

- What is scientific inquiry?

- How do scientific laws and scientific theories differ?

- What is the difference between a fact and an opinion?

Understanding Science

Vocabulary

- science
- observation
- inference
- hypothesis
- prediction

- technology
- scientific theory
- scientific law
- critical thinking

What is science?

- **Science** is the investigation and exploration of natural events and of the new information that results from those investigations.

- Scientific knowledge is the result of a great deal of debate and confirmation within the science community.

- People use science in their everyday lives and careers.

Branches of Science

There are three main branches of science—Earth science, life science, and physical science.

WORD ORIGIN

physical

from Latin *physica*, means "study of nature"

Branches of Science (cont.)

- **The study of Earth**, including rocks, soils, oceans, the atmosphere, and surface features, is **Earth science**.

- **The study of living things** is life science, or **biology**.

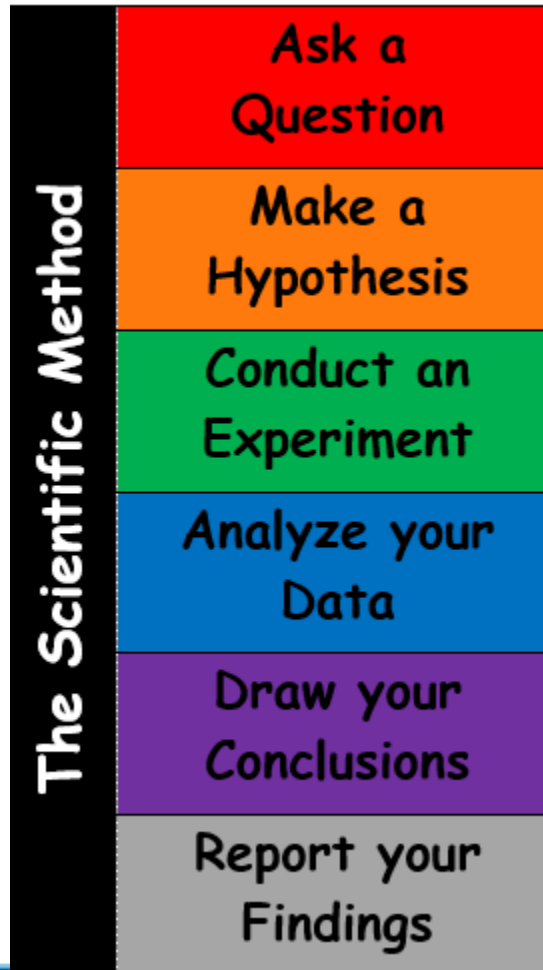- **The study of matter and energy**— including both physics and chemistry— is **physical science**.

Scientific Inquiry

Scientific inquiry is a process that uses a set of skills to answer questions or to test ideas about the natural world.

Scientific inquiries include many possible steps.

Scientific Inquiry (cont.)

Scientists follow the Scientific Method:

The Scientific Method

- Ask a Question
- Make a Hypothesis
- Conduct an Experiment
- Analyze your Data
- Draw your Conclusions
- Report your Findings

Scientific Inquiry (cont.)

KEY CONCEPT CHECK

What is scientific inquiry?

Scientific Inquiry (cont.)

- **Observation** is the act of using one or more of your **senses** to gather information and taking notes of what occurs.

- An **inference** is a logical explanation of an observation that is drawn from prior knowledge or experience.

Scientific Inquiry (cont.)

- A **prediction** is a statement of what will happen next in a sequence of events.

- A **hypothesis** is a possible explanation for an observation that can be tested by scientific investigations.

  (If…then…because…)

Scientific Inquiry (cont.)

- When you test a hypothesis, you often test whether your predictions are true.

- After testing your hypothesis, you analyze your results using various methods.

Scientific Inquiry (cont.)

- Once you find the relationships among data and make several inferences, you can draw <u>conclusions</u>.

- **A conclusion is** a summary of the information gained from testing a hypothesis.

Results of Science (cont.)

- Scientific investigation can have various outcomes, including new technology, new materials, and possible explanations as to how or why something happens.

- **Technology** is the practical use of scientific knowledge, especially for industrial or commercial use.

Results of Science (cont.)

- Another outcome of science is the development of scientific theories and laws.

- A **scientific theory** is an explanation of observations or events that is based on knowledge gained from many observations and investigations.

- A **scientific law** is a rule that describes a pattern in nature.

Methods of Science
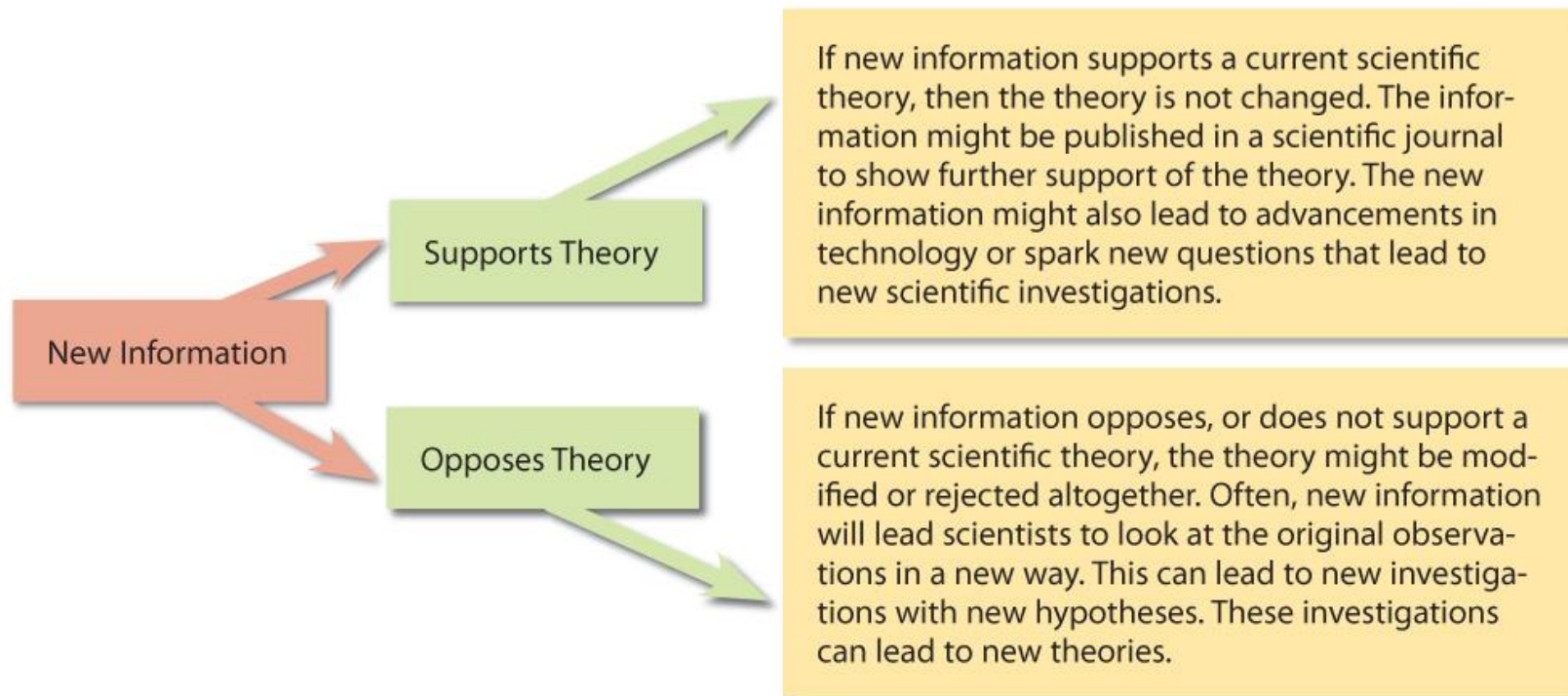
Results of Science (cont.)

KEY CONCEPT CHECK

How do scientific laws and theories differ?

New Information

Scientific information constantly changes as new information is discovered or as previous hypotheses are retested.

New Information

Supports Theory

If new information supports a current scientific theory, then the theory is not changed. The information might be published in a scientific journal to show further support of the theory. The new information might also lead to advancements in technology or spark new questions that lead to new scientific investigations.

Opposes Theory

If new information opposes, or does not support a current scientific theory, the theory might be modified or rejected altogether. Often, new information will lead scientists to look at the original observations in a new way. This can lead to new investigations with new hypotheses. These investigations can lead to new theories.

New Information (cont.)

- To determine if information is scientific or pseudoscientific, you should be skeptical and identify facts and opinions.

- **Critical thinking** refers to comparing what you already know with the information you are given in order to decide whether you agree with it.

- Questions that deal with opinions, beliefs, values, and feelings cannot be answered through scientific investigation.

New Information (cont.)

KEY CONCEPT CHECK

How do fact and opinion differ?

Lesson Review

Which is an explanation of observations or events that is based on knowledge gained from many observations and investigations?

A. scientific law

B. scientific theory

C. prediction

D. hypothesis

Lesson Review

Which of these includes the study of physics and chemistry?

A. Earth science

B. life science

C. physical science

D. biology

Methods of Science

Lesson Review

Which term refers to the act of using one or more of your senses to gather information and taking notes of what occurs?

A. prediction

B. hypothesis

C. inference

D. observation

Measurement and Scientific Tools

Key Concepts

- Why is it important for scientists to use the International System of Units?

- What causes measurement uncertainty?

- What are mean, median, mode, and range?

Lesson 2

Measurement and Scientific Tools

Vocabulary

- description

- explanation

- International System of Units (SI)

- significant digits

Description and Explanation

- A **description** is a spoken or written summary of observations.

- **Qualitative description-** use your senses to describe an observation.

- **Quantitative description-** you use numbers and measurements to describe an observation.

- An **explanation** is an interpretation of observations.

Description and Explanation (cont.)

- At one time, scientists in different parts of the world used different units of measurement.

- Sharing scientific information was difficult and led to confusion.

Description and Explanation (cont.)

- A system of measurement was adopted to eliminate confusion.

- The **International System of Units (SI)** is the internationally accepted system for measurement.

Description and Explanation (cont.)

A base unit is the most common unit used in the SI system for a given measurement.

SI Base Units

Quantity Measured	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	Kelvin	K
Amount of substance	mole	mol
Intensity of light	candela	cd

Get Animated

Description and Explanation (cont.)

- SI uses prefixes to identify the size of a unit.

- Prefixes are used to indicate a fraction of ten or a multiple of ten.

Prefixes	
Prefix	**Meaning**
Mega- (M)	1,000,000 (10^6)
Kilo- (k)	1,000 (10^3)
Hecto- (h)	100 (10^2)
Deka- (da)	10 (10^1)
Deci- (d)	0.1 (10^{-1})
Centi- (c)	0.01 (10^{-2})
Milli- (m)	0.001 (10^{-3})
Micro- (μ)	0.000 001 (10^{-6})

Description and Explanation (cont.)

To convert SI units, you must multiply or divide by a factor of ten.

Math Skills ×÷+ **Use Proportions**

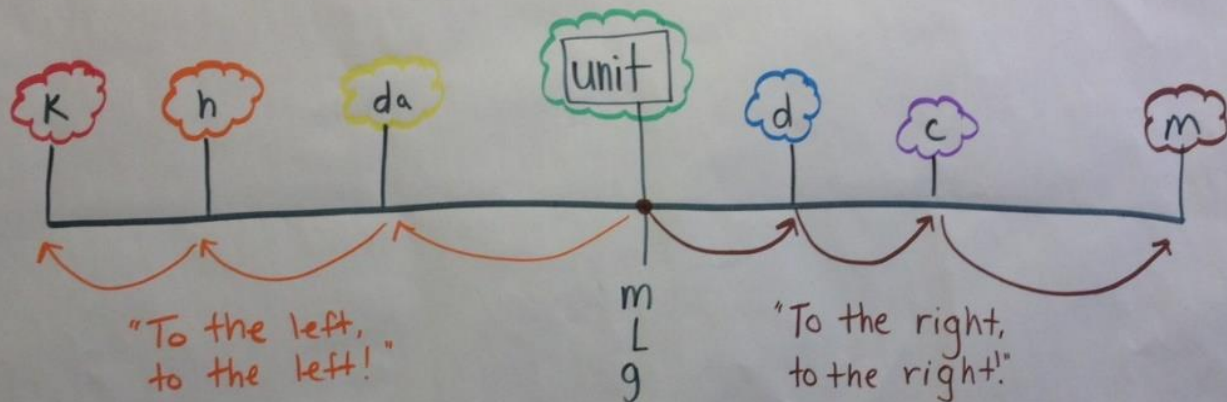A book has a mass of **1.1 kg**. Using a proportion, find the mass of the book in grams.

1 Use the table to determine the correct relationship between the units. One kg is 1,000 times greater than 1 g. So, there are 1,000 g in 1 kg.

2 Then set up a proportion.

$$\left(\frac{x}{1.1\ \text{kg}}\right) = \left(\frac{1{,}000\ \text{g}}{1\ \text{kg}}\right)$$

$$x = \left(\frac{(1{,}000\ \text{g})(1.1\ \cancel{\text{kg}})}{1\ \cancel{\text{kg}}}\right) = 1{,}100\ \text{g}$$

3 Check your units. The answer is 1,100 g.

Conversions

K h da unit d c m

m
L
g

"To the left,
to the left!"

"To the right,
to the right!"

ex| 72L = ___ mL

72.000. = 72,000 mL

ex| 72g = ___ kg

0.0.72. = 0.072 kg

Kilo-
Hecto-
Deka-
Unit
Deci-
Centi-
Mili-

Methods of Science
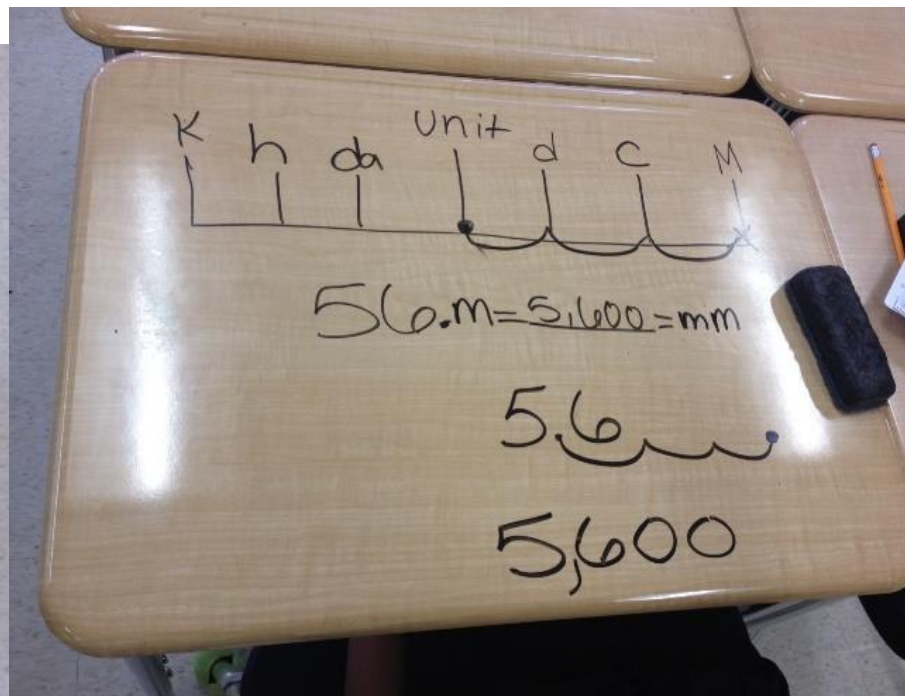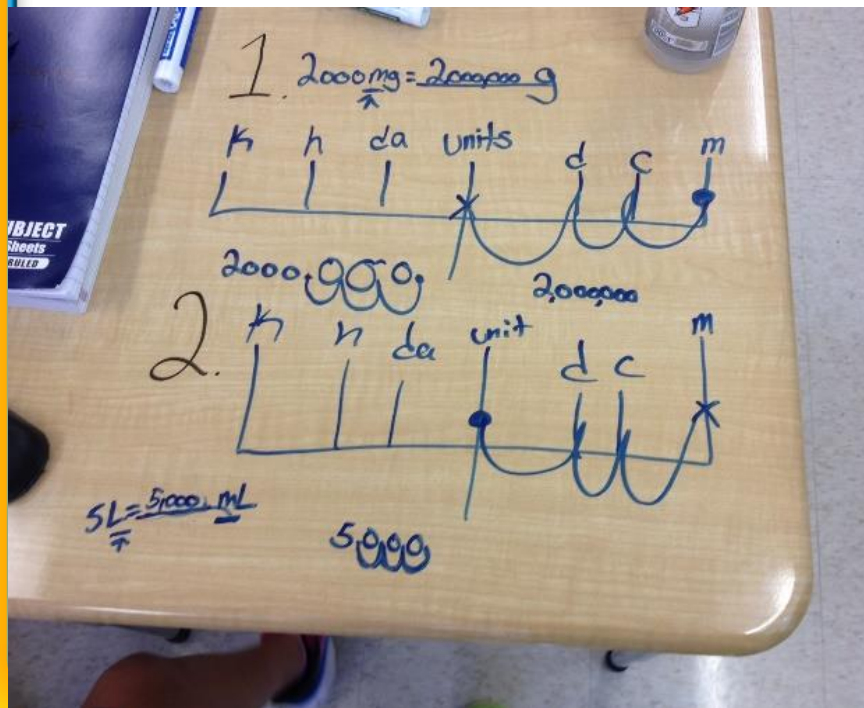
Description and Explanation (cont.)

KEY CONCEPT CHECK

Why is it important for scientists to use the International System of Units (SI)?

Description and Explanation (cont.)

- All measurements have some uncertainty.

- The tools used to take measurements can limit the accuracy of the measurements.

Methods of Science

Description and Explanation (cont.)

KEY CONCEPT CHECK

What causes measurement uncertainty?

Description and Explanation (cont.)

- Because scientists duplicate each other's work, they must record numbers with the same degree of precision as the original data.

- **Significant digits** are the number of digits in a measurement that you know with a certain degree of reliability.

- There are rules for determining whether digits are significant.

Significant Digits Rules

1. All nonzero numbers are significant.

2. Zeros between nonzero digits are significant.

3. One or more final zeros used after the decimal point are significant.

4. Zeros used solely for spacing the decimal point are NOT significant. The zeros only indicate the position of the decimal point.

* The blue numbers in the examples are the significant digits.

Number	Significant Digits	Applied Rules
1.234	4	1
1.02	3	1, 2
0.023	2	1, 4
0.200	3	1, 3
1,002	4	1, 2
3.07	3	1, 2
0.001	1	1, 4
0.012	2	1, 4
50,600	3	1, 2, 4

Description and Explanation (cont.)

- Scientists often need to analyze their data to obtain information.

- Four values often used when analyzing numbers are median, mean, mode, and range.

Description and Explanation (cont.)

Median

The median is the middle number in a data set when the data are arranged in numerical order. The rainfall data are listed in numerical order in Table 4b. The items in red are the two middles numbers. If you have an even number of data items, add the two middle numbers together and divide by two to find the median.

$$\text{median} = \frac{8.18 \text{ cm} + 8.84 \text{ cm}}{2}$$

$$= 8.51 \text{ cm}$$

Rainfall Data

Month	Rainfall
January	7.11 cm
February	11.89 cm
March	9.58 cm
April	8.18 cm
May	7.11 cm
June	1.47 cm
July	18.21 cm
August	8.84 cm

Mean

The mean of a data set is the sum of the numbers in a data set divided by the number of entries in the set. To find the mean, add the numbers in your data set and then divide the total by the number of items in your data set.

$$\text{mean} = \frac{(\text{sum of numbers})}{(\text{number of items})}$$

$$= \frac{72.39 \text{ cm}}{8 \text{ months}}$$

$$= \frac{9.05 \text{ cm}}{\text{month}}$$

Description and Explanation (cont.)

Mode

The mode of a data set is the number or item that appears most often. The number in blue in Table 4b appears twice. All other numbers only appear once.

mode = 7.11

Rainfall Data
(numerical order)

1.47 cm
7.11 cm
7.11 cm
8.18 cm
8.84 cm
9.58 cm
11.89 cm
18.21 cm

Range

The range is the difference between the greatest number and the least number in the data set.

range = 18.21 − 1.47

= 16.74

Methods of Science

Description and Explanation (cont.)

KEY CONCEPT CHECK

What are mean, median, and mode?

Scientific Tools

- **A science journal** is used to record observations, questions, hypotheses, data, and conclusions from scientific investigations.

- **Rulers and metersticks** are used to measure lengths and distances; the SI unit is meter (m).

- **Graduated cylinders** measure the volume of a liquid; the typical units are liters (L) or milliliters (mL).

Scientific Tools (cont.)

- **A triple-beam balance** is used to measure the mass of an object; mass is measured in grams (g) or kilograms (kg).

- **A thermometer** is used to measure the temperature of a substance.

- **Computers** are used to collect, organize, and store information about a research topic or scientific investigation.

Tools Used by Earth Scientists

- **Binoculars** are instruments that enable people to view faraway objects more clearly.

- **A compass** is an instrument that shows magnetic north and is used by scientists to navigate when they are in the field.

Tools Used by Earth Scientists (cont.)

- **A wind vane** is a device, often attached to the roofs of buildings, that rotates to show the direction of the wind.

- **An anemometer**, or wind-speed gauge, is used to measure the speed and the force of wind.

- **A streak plate** is a piece of hard, unglazed porcelain that helps you identify minerals.

Lesson Review

Which term refers to the number of digits in a measurement that you know with a certain degree of reliability?

A. International System of Units

B. mean

C. median

D. significant digits

Lesson Review

Which refers to the most common unit used in the SI system for a given measurement?

A. base unit

B. mode

C. prefix

D. range

Lesson Review

Which is used to measure lengths and distances?

A. beaker

B. ruler

C. triple-beam balance

D. thermometer

Case Study

Key Concepts

- How are independent variables and dependent variables related?

- How is scientific inquiry used in a real-life scientific investigation?

Lesson 3

Case Study

Vocabulary

- variable

- independent variable

- dependent variable

The Iceman's Last Journey

- In 1991, two hikers discovered the remains of a man in a melting glacier on the border between Austria and Italy.

- Controlled experiments were needed to unravel the mystery of who the Iceman was.

The Iceman's Last Journey (cont.)

- When scientists design a controlled experiment, they have to identify factors that might affect the outcome.

- A **variable** is any factor that can have more than one value.

- The **independent variable** is the factor that you want to test. It is changed by the investigator to observe how it affects a dependent variable.

The Iceman's Last Journey (cont.)

- The **dependent variable** is the factor you observe or measure during an experiment.

- When the independent variable is changed, it causes the dependent variable to change.

The Iceman's Last Journey (cont.)

- A controlled experiment has two groups.

  - The experimental group is used to study how a change in the independent variable changes the dependent variable.

  - The control group contains the same factors as the experimental group, but the independent variable is not changed.

The Iceman's Last Journey (cont.)

- Scientists concluded that the Iceman is about 5,300 years old.

- The Iceman traveled from the high alpine region in spring to his native village in the lowland valleys.

- There, during a conflict, the Iceman sustained a fatal injury.

- He retreated back to the higher elevations, where he died.

The Iceman's Last Journey (cont.)

- Scientists recognize their hypotheses can never be proved, only supported or not supported.

- With advances in technology, scientists are able to more thoroughly investigate mysteries of nature.

Lesson Review

Which is used to study how a change in the independent variable changes the dependent variable?

A. control group

B. experimental group

C. hypotheses

D. inference

Lesson Review

Which term describes the factor a scientist observes or measures during an experiment?

A. control group

B. dependent variable

C. experimental group

D. inference

Lesson Review

Which term describes the factor that a scientist wants to test?

A. control group

B. dependent variable

C. experimental group

D. independent variable

Menu

Key Concept Summary

Chapter Review

Standardized Test Practice

Scientists creatively use the process of scientific inquiry to formulate investigable questions, collect and evaluate appropriate data, and then communicate the evaluations.

Lesson 1: Understanding Science

- Scientific inquiry is a process that uses a set of skills to answer questions or to test ideas about the natural world.

- A scientific law is a rule that describes a pattern in nature. A scientific theory is an explanation of things or events that is based on knowledge gained from many observations and investigations.

- Facts are measurements, observations, and theories that can be evaluated for their validity through objective investigation. Opinions are personal views, feelings, or claims about a topic that cannot be proven true or false.

Lesson 2: Measurement and Scientific Tools

- Scientists worldwide use the International System of Units because their work is easier to confirm and repeat by their peers.

- Measurement uncertainty occurs because no scientific tool can provide a perfect measurement.

SI Base Units		
Quantity Measured	**Unit**	**Symbol**
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	Kelvin	K
Amount of substance	mole	mol
Intensity of light	candela	cd

- Mean, median, mode, and range are statistical calculations that are used to evaluate sets of data.

Lesson 3: Case Study: The Iceman's Last Journey

- The independent variable is the factor a scientist changes to observe how it affects a dependent variable. A dependent variable is the factor a scientist measures or observes during an experiment.

- Scientific inquiry was used throughout the investigation of the Iceman when hypotheses, predictions, tests, analysis, and conclusions were developed.

Chapter Review

Which is a logical explanation of an observation that is drawn from prior knowledge or experience?

A. hypothesis

B. inference

C. prediction

D. scientific theory

Chapter Review

Which term refers to a rule that describes a pattern in nature?

A. scientific theory

B. scientific law

C. prediction

D. inference

Chapter Review

Which is used to indicate a fraction of ten or a multiple of ten, to identify the size of a unit?

A. SI unit

B. prefix

C. median

D. base unit

Chapter Review

Which is used to show the direction of wind?

A. wind vane

B. streak plate

C. compass

D. anemometer

Chapter Review

Which is used to measure the speed and force of wind?

A. wind vane

B. streak plate

C. compass

D. anemometer

Standardized Test Practice

Which of these describes the investigation and exploration of natural events?

A. hypothesis

B. science

C. scientific law

D. scientific theory

Standardized Test Practice

Which is a statement of what will happen next in a sequence of events?

A. hypothesis

B. inference

C. observation

D. prediction

Standardized Test Practice

Which term refers to an interpretation of observations?

A. base unit

B. description

C. explanation

D. significant digit

Standardized Test Practice

The mass of a small object is usually measured in which of these?

A. liters

B. grams

C. milliliters

D. kilograms

Standardized Test Practice

What would a scientists do if a conclusion does not support the hypothesis?

A. change the results

B. communicate their results

C. find a new question to investigate

D. revise the hypothesis