Physical Science, 8e

Chapter 1
What Is Science?

Overview

Quantitative description
- Objects and properties
- Quantifying properties
- Measurement systems
- Standard metric units
- Metric prefixes
- Understanding from measurement

The nature of science
- The Scientific Method
- Explanations and investigations
- Laws and Principles
- Models and theories

Classroom Rules of Etiquette

1) Do not talk during class.
2) Show up on time. If you arrive after attendance has been called you will considered absence.
3) Do not text during class. You will miss a lot of the class and your grade will suffer.
4) Read the chapter before class. That way you will be able to ask questions.

Core Concept

Science is a way of thinking about and understanding your environment.

What is science?

Science (from the Latin meaning "knowledge") is an enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the world. From Wikipedia

- "Search for Sense"
- "Finding order out of Surroundings"
- "Tools and Rules"

Objects and Properties

- Objects - things that can be seen or touched
- Properties - qualities or attributes characteristic of an object
- Referents - comparative properties in other, more familiar objects (Examples: "sky blue," "lemon yellow")
- Problem - language can be subjective, ambiguous and ultimately circular!

Quantifying Properties

Measurement: uses quantitative referents - "units"

Three steps:

1. Comparing the referent unit to the property being described
2. Following a procedure specifying how the comparison is done
3. Counting how many standard units describe the property under consideration

Essential - a number and name for the referent unit

Measurement Systems
(based upon standardized units)

English system

- Many units based upon parts of the human body
- Different units are not systematically related

Metric (SI) system

- Established in 1791
- 7 base units: meter (m), kilogram (kg), second (s), ampere (A), kelvin (K), mole (mol) and candela (cd)
- All other units derive from these

Standard Metric Units for the Four Fundamental Properties

Length-Distance light travels in 1/299,792,458s

Mass-Referenced to standard metal cylinder

Time-Referred to oscillation of cesium atom

Charge-Current is the base unit

3 others

All other properties (e.g., volume) derived from these

Metric Prefixes

- Simplify the conversion process
- Help avoid writing large or small numbers
- A movie giving a perspective on powers of ten

Example 1

1)A basketball player weighs *220 lbs.* and is *6 ft*. tall. On a European tour, his weight and height are listed in kilograms and meters. What are they?

Understanding from Measurement

- Data
- Ratios and generalizations
- The density ratio
- Symbols and equations
- Problem solving made easy

Data

Measurement information used to describe

- Objects
- Conditions
- Events
- Changes

Example: Dimensions of a cube

Ratios and Generalizations

Ratio - analysis though a quotient of two numbers

Example: Area/volume of a cube

side	A	V	A/V
1 in	6 in^2	1 in^3	6
2 in	24 in^2	8 in^3	3
3 in	54 in^2	27 in^3	2

Applications: crushed ice melts faster; large potatoes are easier to peel

The Density Ratio

- Ratio of mass and volume
- Intrinsic property (independent of quantity)
- Characteristic of a given material
- "Weight density" = weight per unit volume

$$\rho = \frac{m}{V}$$

Mass per unit volume

Density (Greek letter rho)

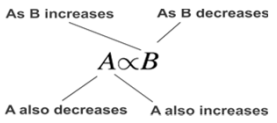
Symbols and Equations

Symbols
- Represent quantities, measured properties

Equations
- Mathematical relationships between properties
- Describe properties; define concepts; specify relationships

More Math…

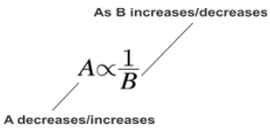
- Direct proportionality
- Inverse proportionality
- Proportionality constants
- Numerical constants



With proportionality constant

$$A = kB$$

The two sides are now equal



The Nature of Science

Beginnings ~300 years ago
- Associated with Galileo and Newton
- Ancient natural philosophers - “thinking only”
- Additional component here - understanding based upon experimental evidence

The Scientific Method

1. Observe some aspect of nature.
2. Propose an explanation for something observed.
3. Use the explanation to make predictions.
4. Test the predictions with experiments or more observations.
5. Modify the explanation as needed.
6. Return to 3.

The Scientific Method

There are several essential steps in the scientific method.

The first step is to develop curiosity about something then gather evidence about it usually in the form of observation or data.

Pattern Recognition

The second essential step in the scientific method is to analyze the data, which usually involves a process of pattern recognition.

The idea of searching for patterns in nature is at the heart of science.

Forming a Hypothesis

The third step in the scientific method is the development of an explanation of the results of the analysis.

Such an explanation is called a **Hypothesis**.

An essential aspect of a scientific hypothesis is that it must be testable.

Test and Test again

The last element of the scientific method is the critical evaluation of hypotheses through testing.

A hypothesis that has been tested repeatedly and successfully is usually called a **Theory**, indicating that is stronger then a mere working hypothesis.

The Scientific Method - Example

1. What are atoms made of?
2. Negative electrons orbiting positive nuclei.
3. Colliding two atoms will produce free electrons and nuclei.
4. Colliding two atoms yielded electrons, protons and neutrons.
5. Atoms are made of electrons orbiting nuclei made of protons and neutrons.
6. Collide two atoms at higher energy.

General Scientific Activities

- Collecting observations
- Developing explanations
- Testing explanations

Explanations and Investigations

Hypothesis - a tentative explanation for some observation

Experiment - recreation of an event or occurrence to test a hypothesis

Controlled experiment - comparing two situations with all factors alike except one

- Control group - fixed set for comparison
- Experimental group - differs from control group by one influencing factor

Pseudoscience

Misleading and often absurd claims of scientific results

Tests:

1. Academic and scientific background of claimant
2. History of review by scientific peers
3. Participation in scientific institutions and organizations
4. Claim published in peer-reviewed journal and independently validated by others

Laws and Principles

Laws
- Important relationship observed to occur time after time
- Descriptive in nature
- Example: Charles' Law - relationship between temperature and pressure in gases

Principles
- Also descriptive but more specific than laws
- Difference largely one of extent
- Not always a clear distinction
- Example: Archimedes' principle relating objects, fluids and buoyancy

Theories and Models

Theory
- Broadly based set of working hypotheses
- Based upon considerable experimental support
- Form the framework of thought and experiment

Model
- Collection of theories or ideas intended to represent a physical system
- Useful for regimes too small or too vast for direct observation
- Can be physical or mathematical, based on a sketch or an analogy

Model of a Rainbow

- A beautiful double rainbow!
- The result of the reflection and refraction of sunlight within individual raindrops