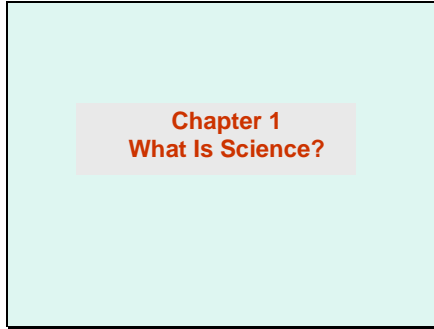
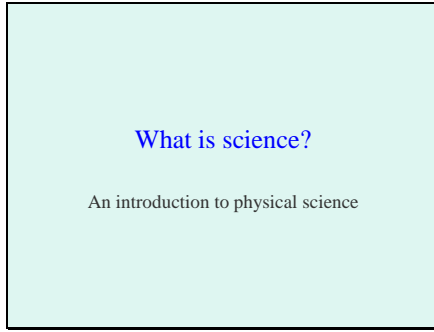


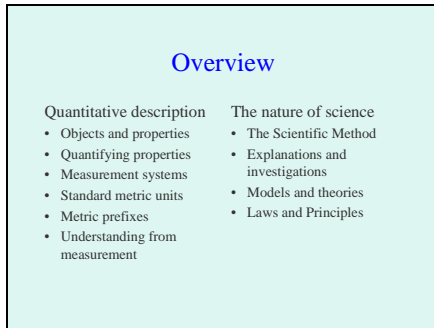
Slide 1



Slide 2



Slide 3



Slide 4

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")

Slide 5

Problem - language can be subjective, ambiguous and ultimately circular!

Slide 6

Quantifying properties

Measurement: uses quantitative referents - "units"

Essential - a number and name for the referent unit

Slide 7

Measurement systems
(based upon standardized units)

<p>English system</p> <ul style="list-style-type: none">• Many units based upon parts of the human body• Different units are not systematically related	<p>Metric (SI) system</p> <ul style="list-style-type: none">• 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
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Slide 8

Standard metric units for the 4 fundamental properties

Length

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

Mass

- Referenced to standard metal cylinder

Time

- Referred to oscillation of cesium atom

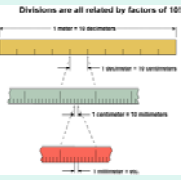
Charge (See electricity lecture)

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

Slide 9

Metric prefixes

- Simplify the conversion process
- Help avoid writing large or small numbers



Slide 10

Understanding from measurement

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

Slide 11


Data

Measurement information used to describe

- Objects
- Conditions
- Events
- Changes

Example: Dimensions of a cube

Cube with edge = s



Area of one face
 $A = s \cdot s = s^2$

Area of cube
 $A = 6s \cdot s = 6s^2$

Volume of cube
 $V = s \cdot s \cdot s = s^3$

Slide 12

The density ratio

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

Density (Greek letter rho)

Mass per unit volume

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

Slide 13

Symbols and equations

Symbols

- Represent quantities, measured properties

Equations

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

Slide 14

More math...

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

Ordinary, dimensionless numbers
2, 3, 4, 72,
 $\pi = 3.14159...$
Ratio of the circumference to the diameter of a circle

As B increases/decreases
 $A \propto \frac{1}{B}$
A decreases/increases
A also decreases A also increases

With proportionality constant
 $A = kB$
The two sides are now equal

Slide 15

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

Slide 16

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 explanation as needed
6. Return to 3.

Slide 17

General scientific activities

- Collecting observations
- Developing explanations
- Testing explanations

Slide 18

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

Models and theories

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, mathematical, based on a sketch or an analogy
