Chapter 1

Physics, the Fundamental Science
Spirit of Inquiry

- Why does the rainbow appear in the east?
- What causes the different colors?
- Why are the colors in the fainter rainbow in reverse order?
Scientific Enterprise

- How do scientists go about explaining things?
- How do scientific explanations differ from other types of explanations?
  - Read previous ideas
  - Test these ideas against observations
  - Invent an explanation or hypothesis
  - Devise experiments to test hypothesis
  - Report results of experiments
  - Withstand the test of criticism and modifications
An acceptable explanation must agree with what is observed.
An acceptable explanation must have predictions that can be tested.
An acceptable explanation must stand up to criticism.
Fig. 1.2
Which of the following represent the best explanation we currently have?

a) Einstein’s Theory of Relativity
b) Newton’s Law of Gravitation

The concept of *theory*, as used in science, is often misunderstood.

- A theory consists of a set of basic principles.
- These principles are often widely accepted.
Spirit of Inquiry

At times, we all use the scientific method in our everyday activities.
Scope of Physics

- The study of the basic nature of matter
- The most fundamental science
  - Explains fundamental interactions of chemistry, biology, etc. at the atomic or molecular level

Life Sciences
- Biology
- Health-related disciplines

Physical Sciences
- Physics
- Chemistry
- Geology
- Astronomy, etc.
Scope of Physics

- The study of the basic nature of matter
- The most fundamental science
  - Explains fundamental interactions of chemistry, biology, etc. at the atomic or molecular level
- The most quantitative science
  - Heavy use of mathematics
  - Numerical measurements
- Can be described more simply and cleanly than other sciences
- NOT just a collection of facts to memorize!
Subfields of Physics

- Classical Physics
  - Mechanics - forces and motion
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  - Thermodynamics - temperature, heat, energy
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- Modern Physics
  - Atomic physics - atoms
  - Nuclear physics - nucleus of the atom
  - Particle physics - subatomic particles: quarks, etc
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- Modern Physics
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  - Nuclear physics - nucleus of the atom
  - Particle physics - subatomic particles: quarks, etc
  - Condensed matter physics - solids and liquids
Subfields of Physics

- Interdisciplinary Fields
  - Biophysics
  - Geophysics
  - Astrophysics

- Physicists: fundamental understanding
- Engineers: practical applications
  - Often overlapping roles
Measurement and Mathematics

- *Careful measurements* are needed to test explanations
  - Different theories predict different results
  - Measurement reveals which theory is correct
  - For example, motion of a cannonball
Measurement and Mathematics

- The *language of mathematics* is convenient
  - Fundamental relationships can be stated precisely
  - Equations can be manipulated to form different relationships
  - For example, altering a pancake recipe
Why study everyday phenomena?

- The same *physical principles* that govern our everyday experiences also govern the entire universe.
  - A bicycle wheel, an atom, and a galaxy all operate according to laws for angular momentum.