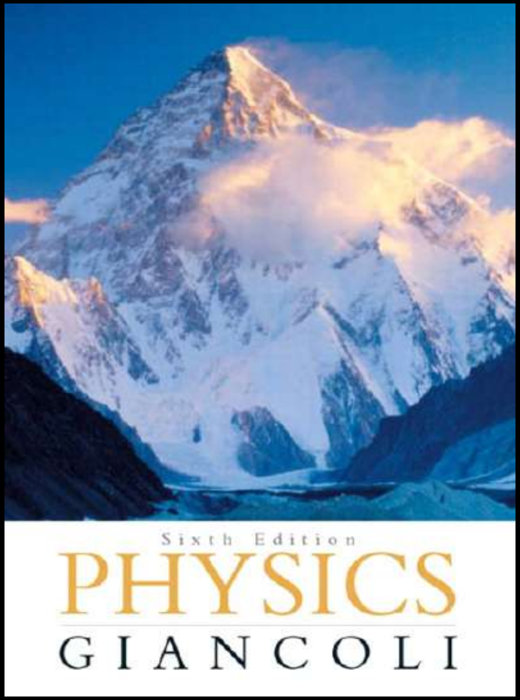


Lecture PowerPoints

Chapter 1

Physics: Principles with Applications, 6th edition

Giancoli

Chapter 1

Introduction, Measurement, Estimating

1-1 The Nature of Science

Observations: important first step toward scientific **theory**; requires **imagination** to tell what is important.

Theories: created to explain **observations**; will make **predictions**, i.e. theory of relativity.

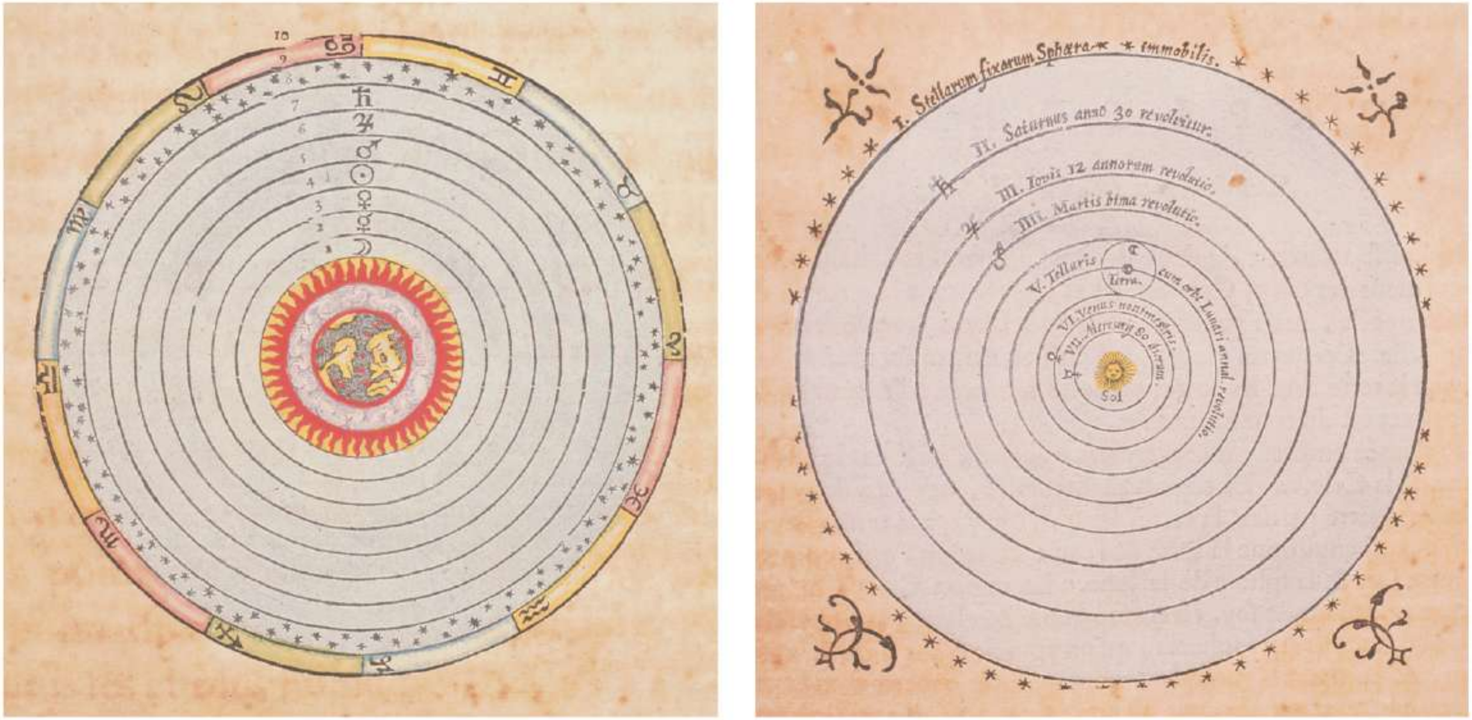
A theory is detailed and can give testable predictions.

Further **observations** will tell if the **prediction** is accurate, and the cycle goes on.

1-1 The Nature of Science

How does a **new theory** get accepted?

- **Predictions** agree better with data
- **Explains** a greater range of phenomena



(a) (b)

1-3 Models, Theories, and Laws

Models are very useful during the process of understanding phenomena. A model creates **mental pictures**; care must be taken to understand the **limits** of the model and not take it too seriously, i.e. model of the atom.

A **law** is a brief description of how nature behaves in a broad set of circumstances. It is an observable fact, i.e. law of gravity.

A theory never becomes a law. A law describes **WHAT** happens. A theory explains **WHY** it happens.

1-4 Measurement and Uncertainty; Significant Figures

No measurement is exact; there is always some uncertainty due to limited instrument accuracy and difficulty reading results.

The photograph to the left illustrates this – it would be difficult to measure the width of this 2x4 to better than a millimeter.

1-4 Measurement and Uncertainty; Significant Figures

Estimated uncertainty is written with a ± sign; for example: $8.8 \pm 0.1\ \text{cm}$

Percent uncertainty is the ratio of the uncertainty to the measured value, multiplied by 100:

$$\frac{0.1}{8.8} \times 100\% \approx 1\%$$

1-4 Measurement and Uncertainty; Significant Figures

The number of **significant figures** (or **significant digits**) is the number of reliably known digits in a number. It is usually possible to tell the number of significant figures by the way the number is written:

23.21 cm has **4** significant figures

0.062 cm has **2** significant figures (the initial zeroes don't count)

80 km is ambiguous – it could have **1** or **2** significant figures. If it has **3**, it should be written 80.0 km.

0.007020 km is how many significant digits?

1-4 Measurement and Uncertainty; Significant Figures

When **multiplying** or **dividing** numbers, the result has as many significant figures as the number used in the calculation with the **fewest** significant figures.

Example: 22.3 cm x 6.8 cm = 150 cm^2

When **adding** or **subtracting**, the answer is no more accurate than the least accurate number used. Round the answer to the **least precise** decimal place.

Example: 10.8 cm – 4.37 cm = 6.4 cm

1-4 Measurement and Uncertainty; Significant Figures

(a)

Calculators will not give you the right number of significant figures; they usually give too **many** but sometimes give too **few** (especially if there are trailing zeroes after a decimal point).

(b)

The top calculator shows the result of 2.0 / 3.0.

The bottom calculator shows the result of 2.5 x 3.2.

What is the answer to each problem?

1-5 Units, Standards, and the SI System

Quantity	Unit	Standard
Length	Meter	Length of the path traveled by light in 1/299,792,458 second.
Time	Second	Time required for 9,192,631,770 periods of radiation emitted by cesium atoms
Mass	Kilogram	Platinum cylinder in International Bureau of Weights and Measures, Paris

1-5 Units, Standards, and the SI System

TABLE 1–4
Metric (SI) Prefixes

Prefix	Abbreviation	Value
yotta	Y	10^{24}
zetta	Z	10^{21}
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deka	da	10^{1}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro†	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}
zepto	z	10^{-21}
yocto	y	10^{-24}

† μ is the Greek letter "mu."

These are the standard SI **prefixes** for indicating powers of 10. Many are familiar; Y, Z, E, h, da, a, z, and y are rarely used.

1-5 Units, Standards, and the SI System

We will be working in the SI system, where the basic units are **kilograms**, **meters**, and **seconds**. **MKS**

TABLE 1–5 SI Base Quantities and Units

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

Other systems: **cgs**; units are grams, centimeters, and seconds.

British engineering system has force instead of mass as one of its basic quantities, which are feet, pounds, and seconds.

1-6 Converting Units

Converting between metric units, for example from kg to g, is easy, as all it involves is powers of 10.

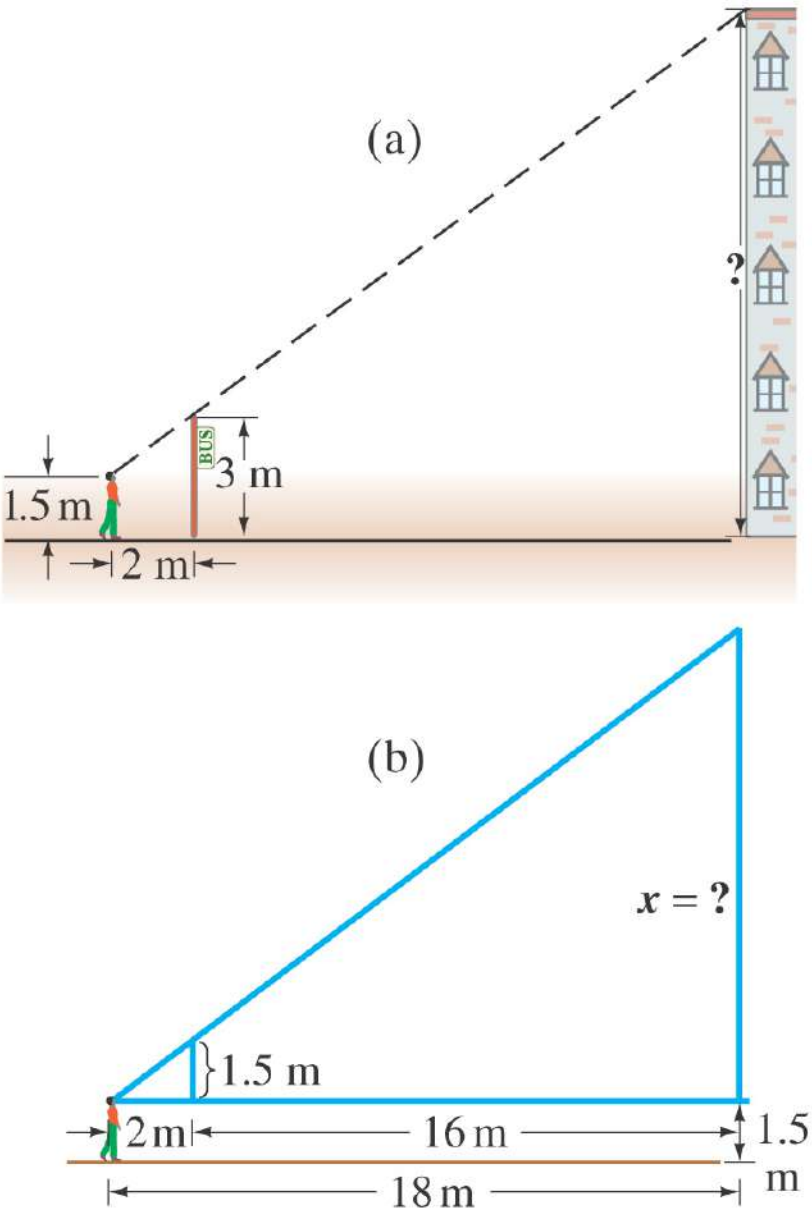
Converting to and from British units is considerably more work.

For example, given that 1 m = 3.28084 ft, this 8611-m mountain is 28251 feet high.

1-6 Converting Units

Convert 55 miles/hr to m/s. Use factor label.

1-7 Order of Magnitude: Rapid Estimating



A quick way to **estimate** a calculated quantity is to round off all numbers to **one** significant figure and then calculate. Your result should at least be the right **order of magnitude**; this can be expressed by rounding it off to the nearest power of 10.

Diagrams are also very useful in making estimations.

X = ?