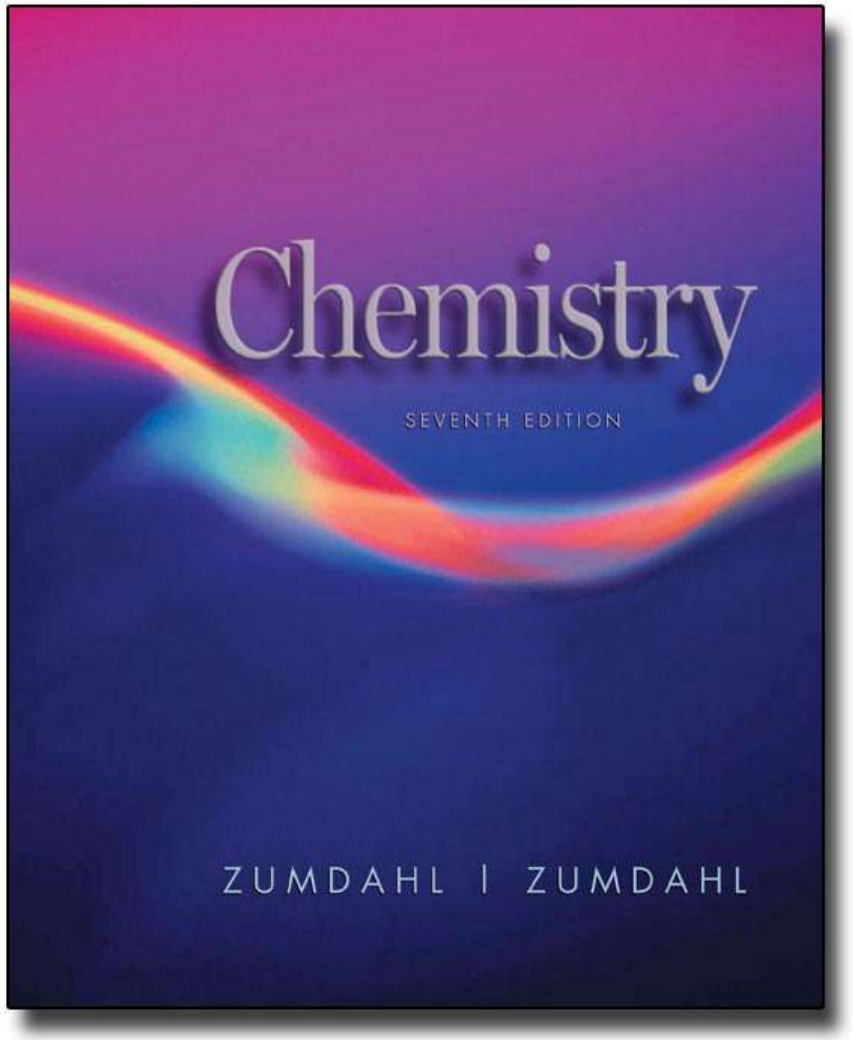
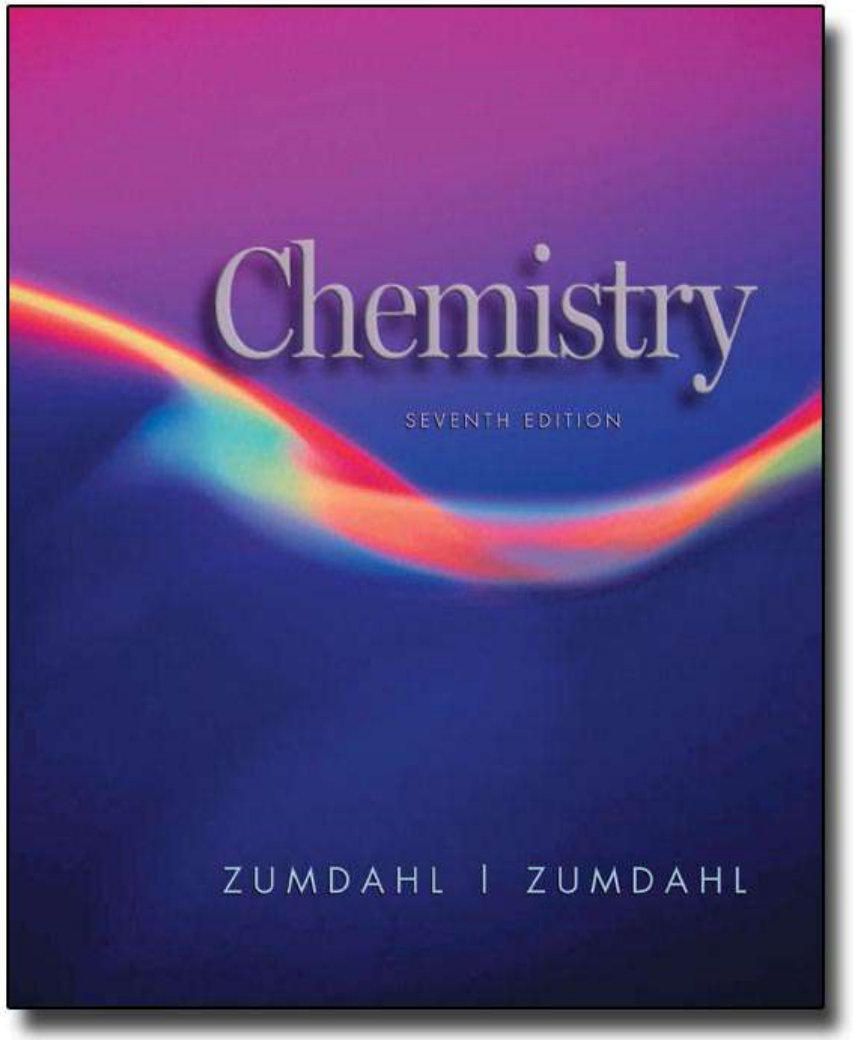


Chapter One:

CHEMICAL FOUNDATIONS



Chemistry: An Overview

Figure 1.1a The Surface of a Single Grain of Table Salt

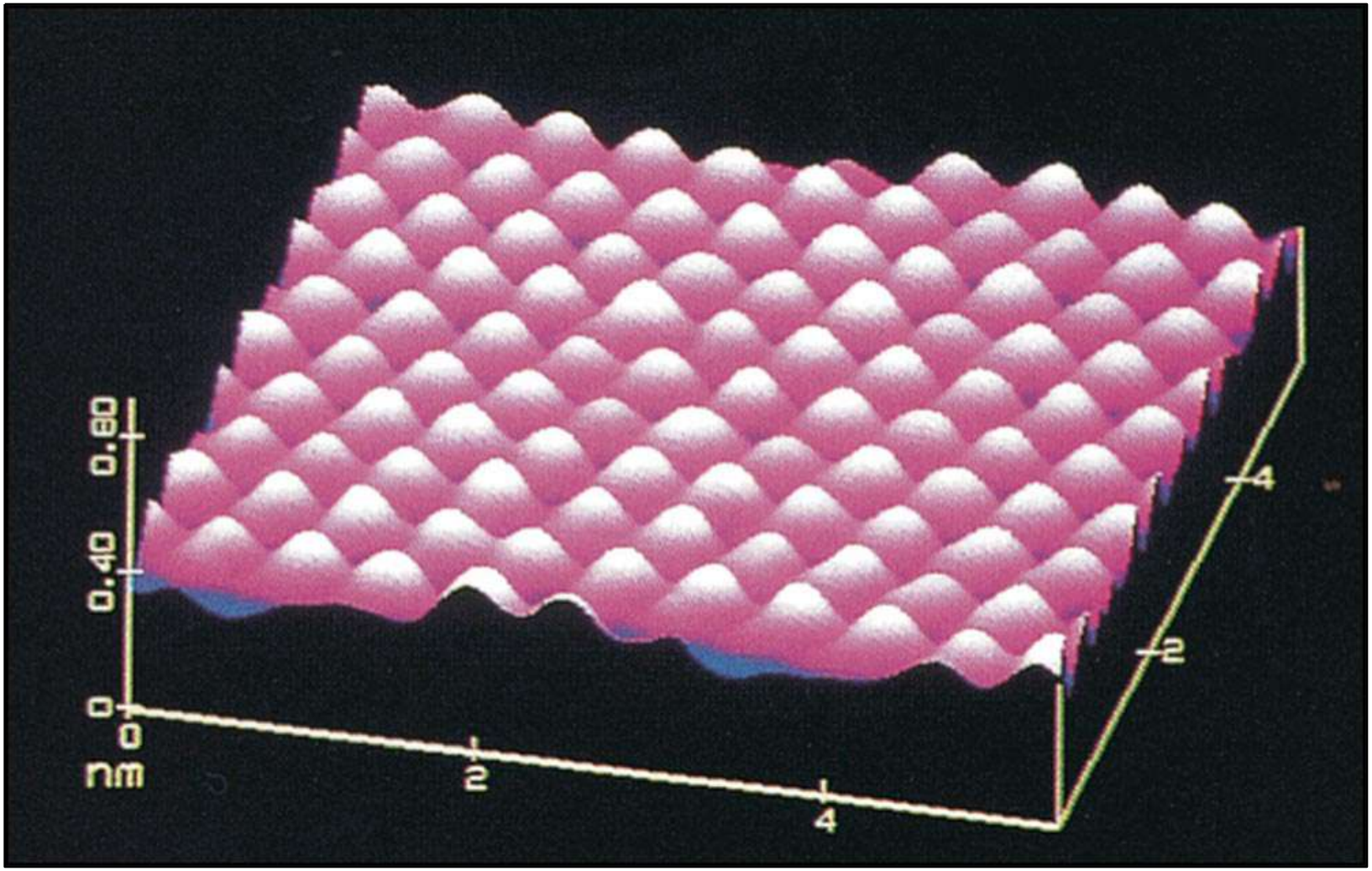


Figure 1.1b An Oxygen Atom on a Gallium Arsenide Surface

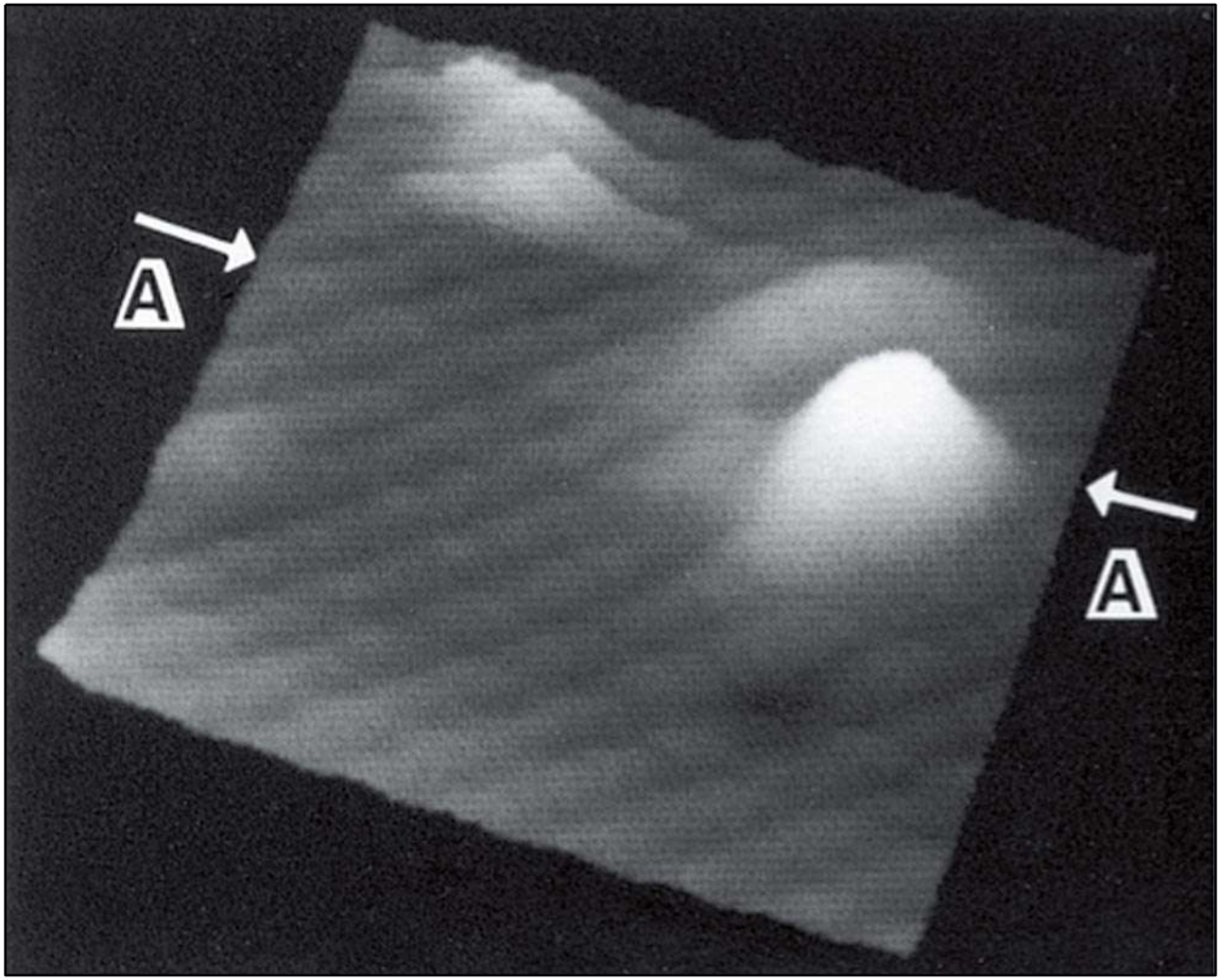


Figure 1.1c Scanning Tunneling Microscope Image

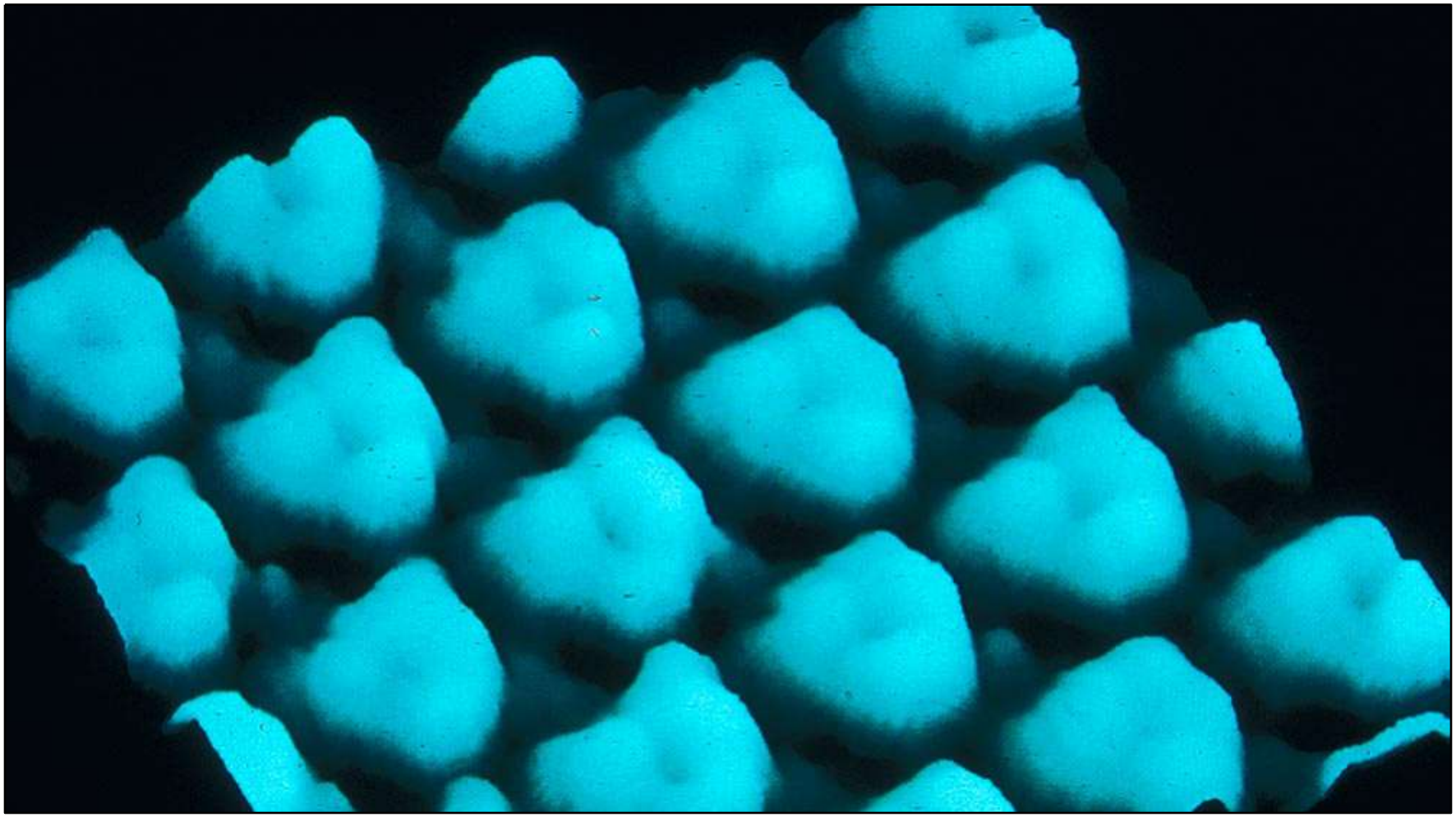


Figure 1.2 A Charged Mercury Atom

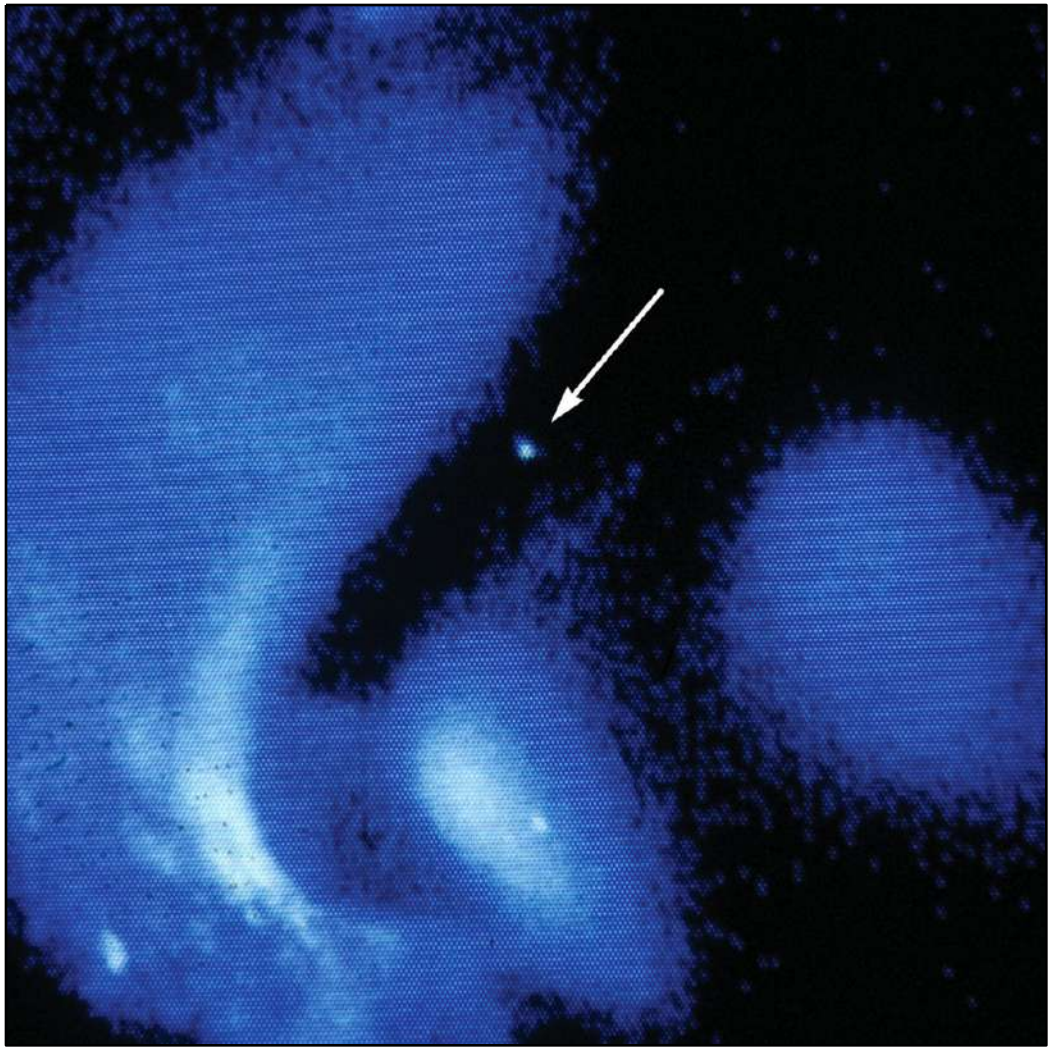


Figure 1.3b
Beach at
Big Sur

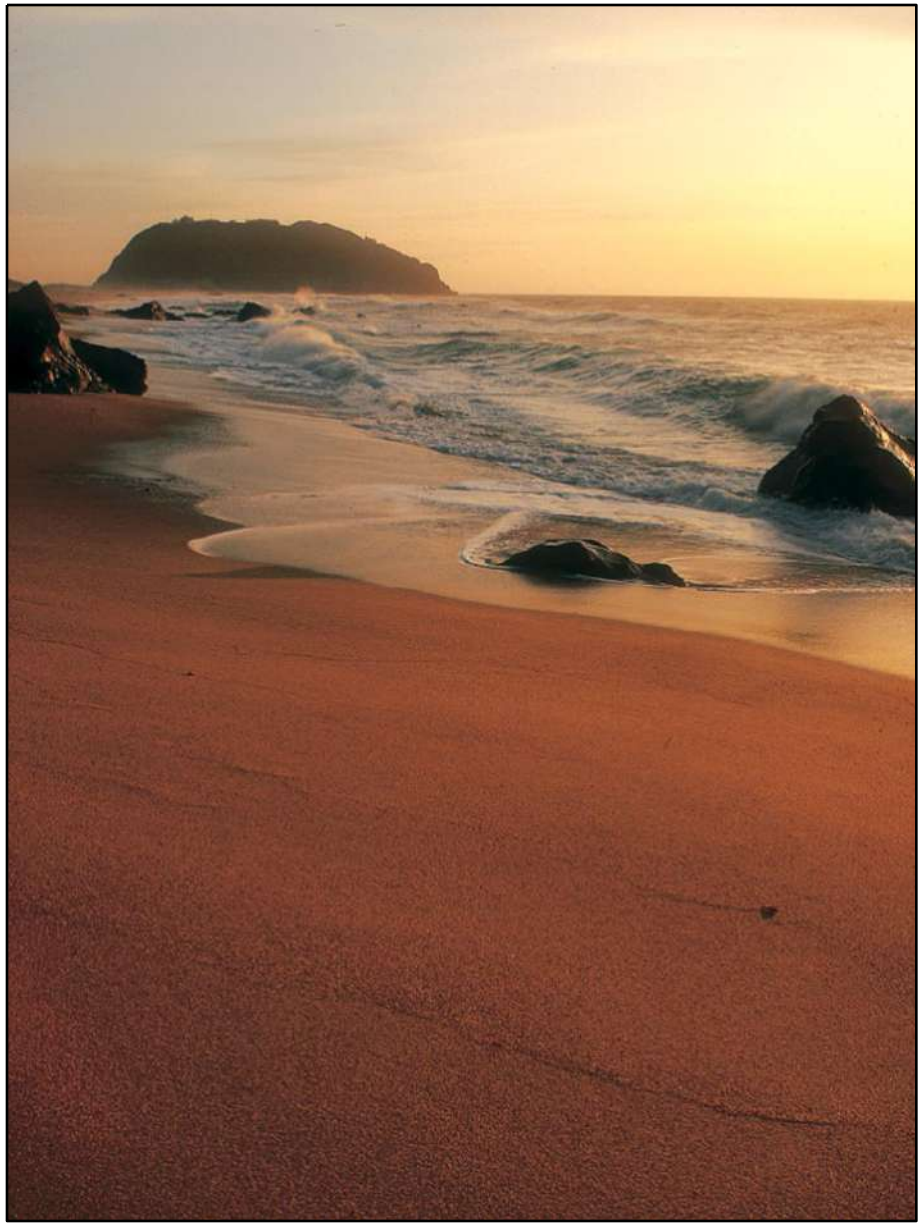
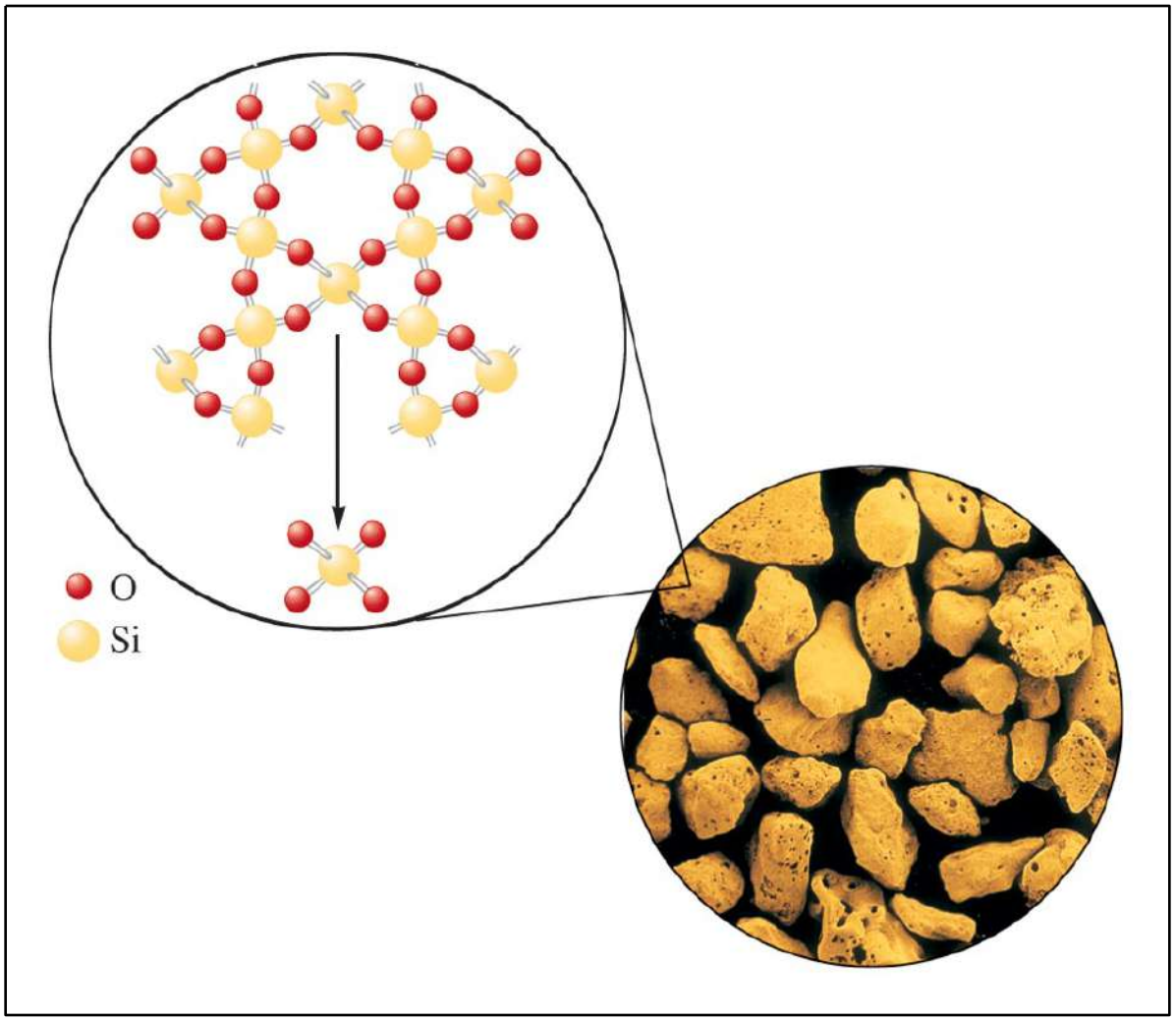
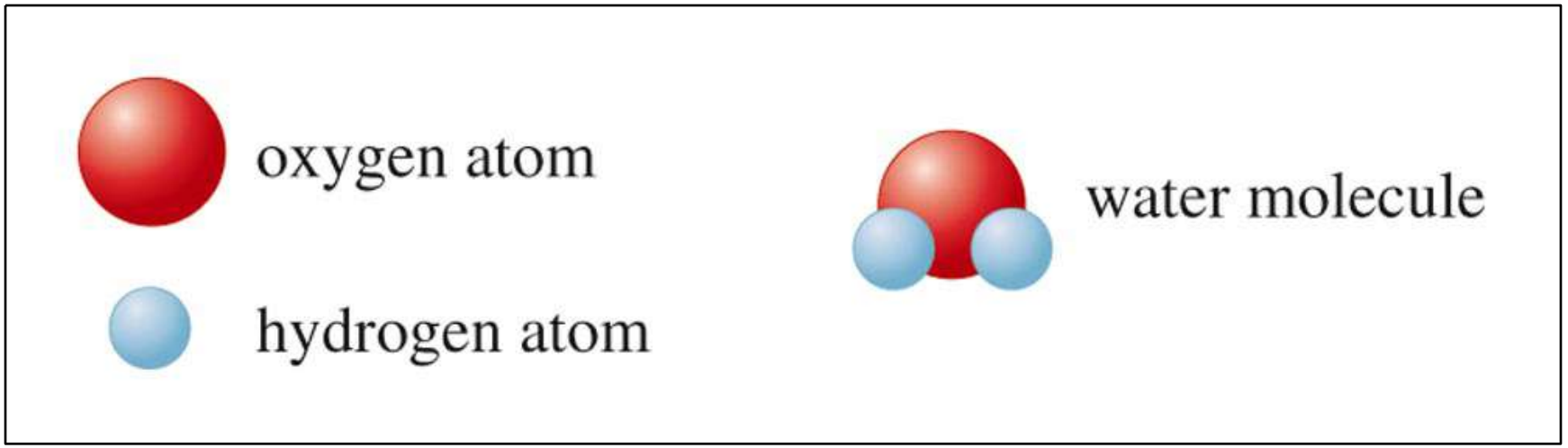


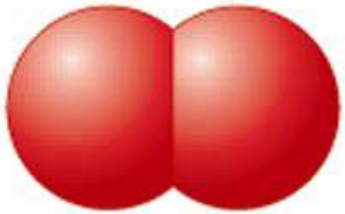
Figure 1.3a Each Grain of Sand is Composed of Tiny Atoms



Atoms vs. Molecules

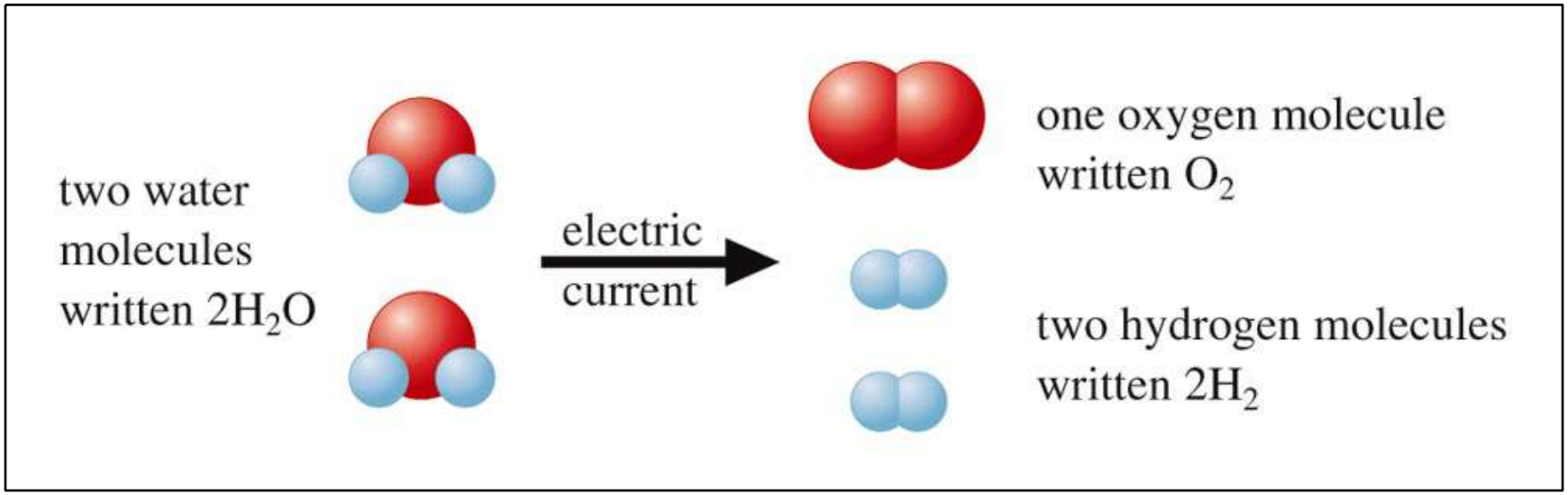


Oxygen and Hydrogen Molecules

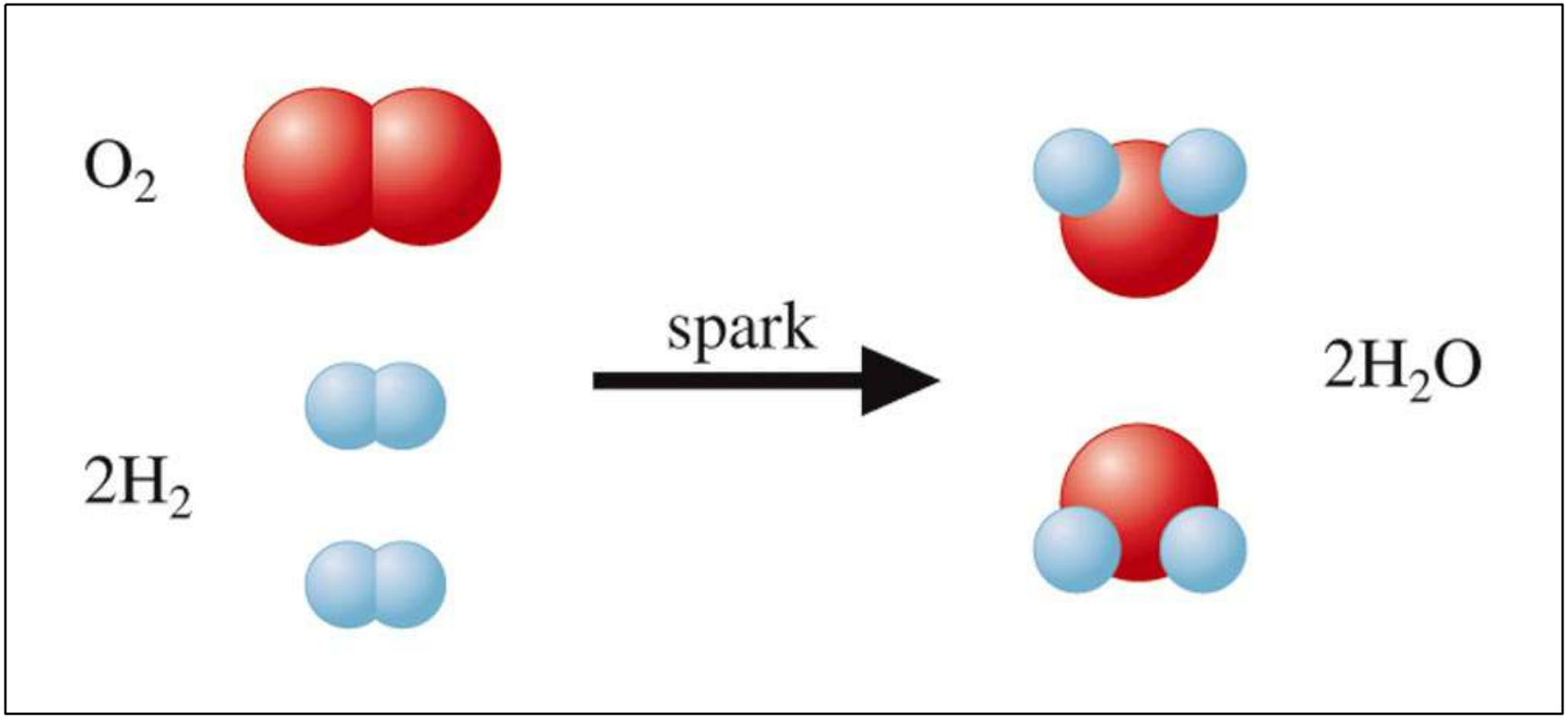
oxygen molecule  written O_2

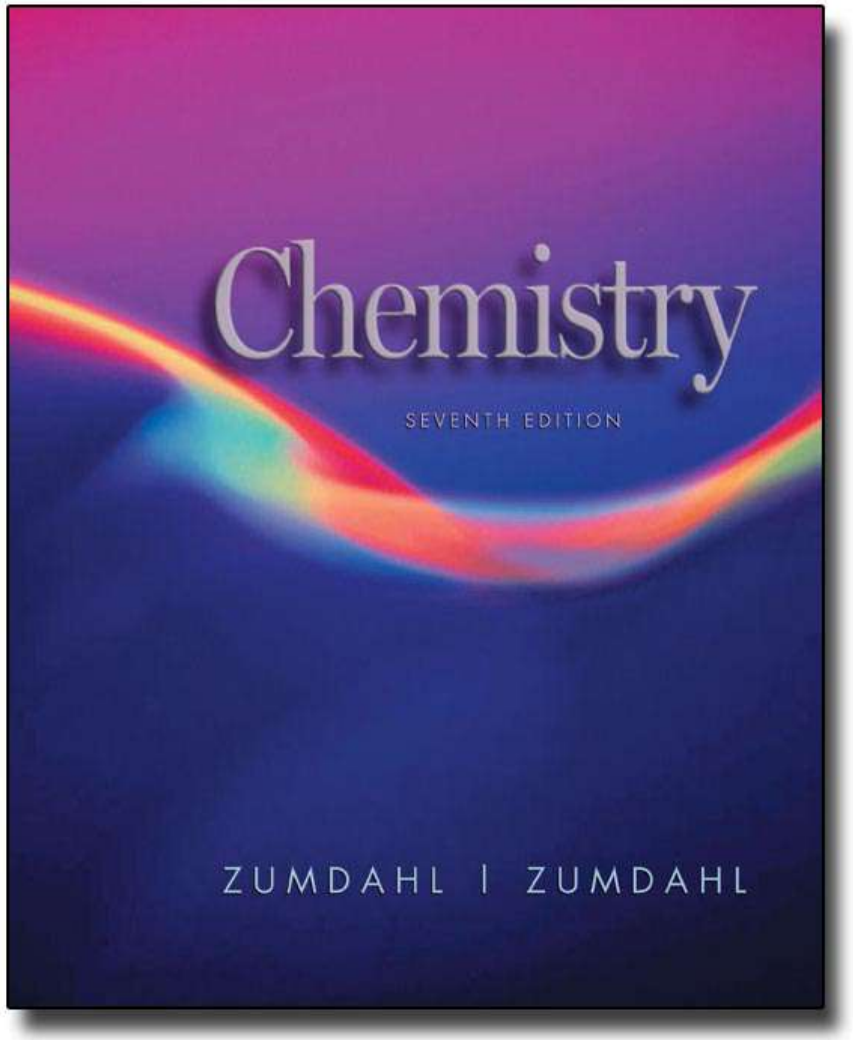
hydrogen molecule  written H_2

A Chemical Reaction



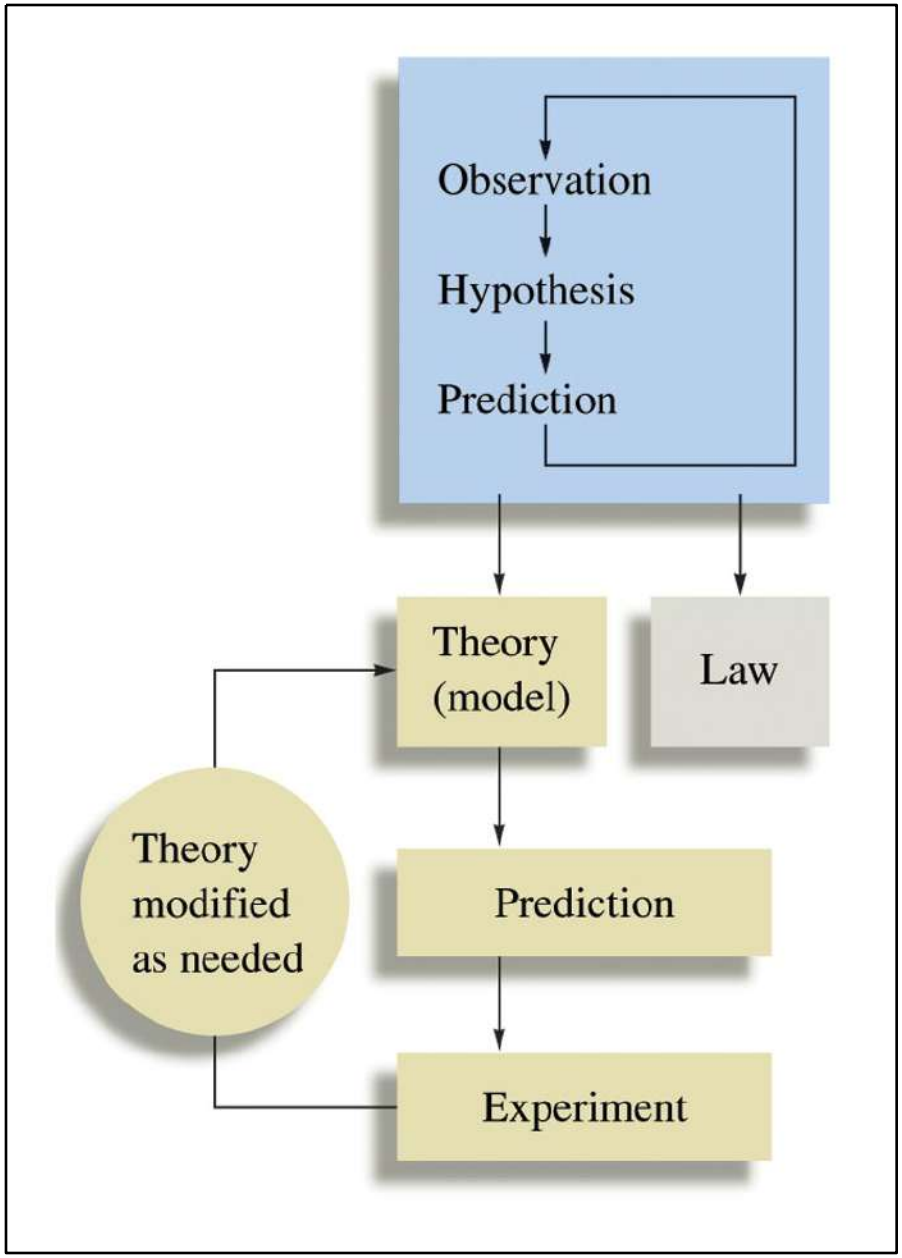
A Chemical Reaction



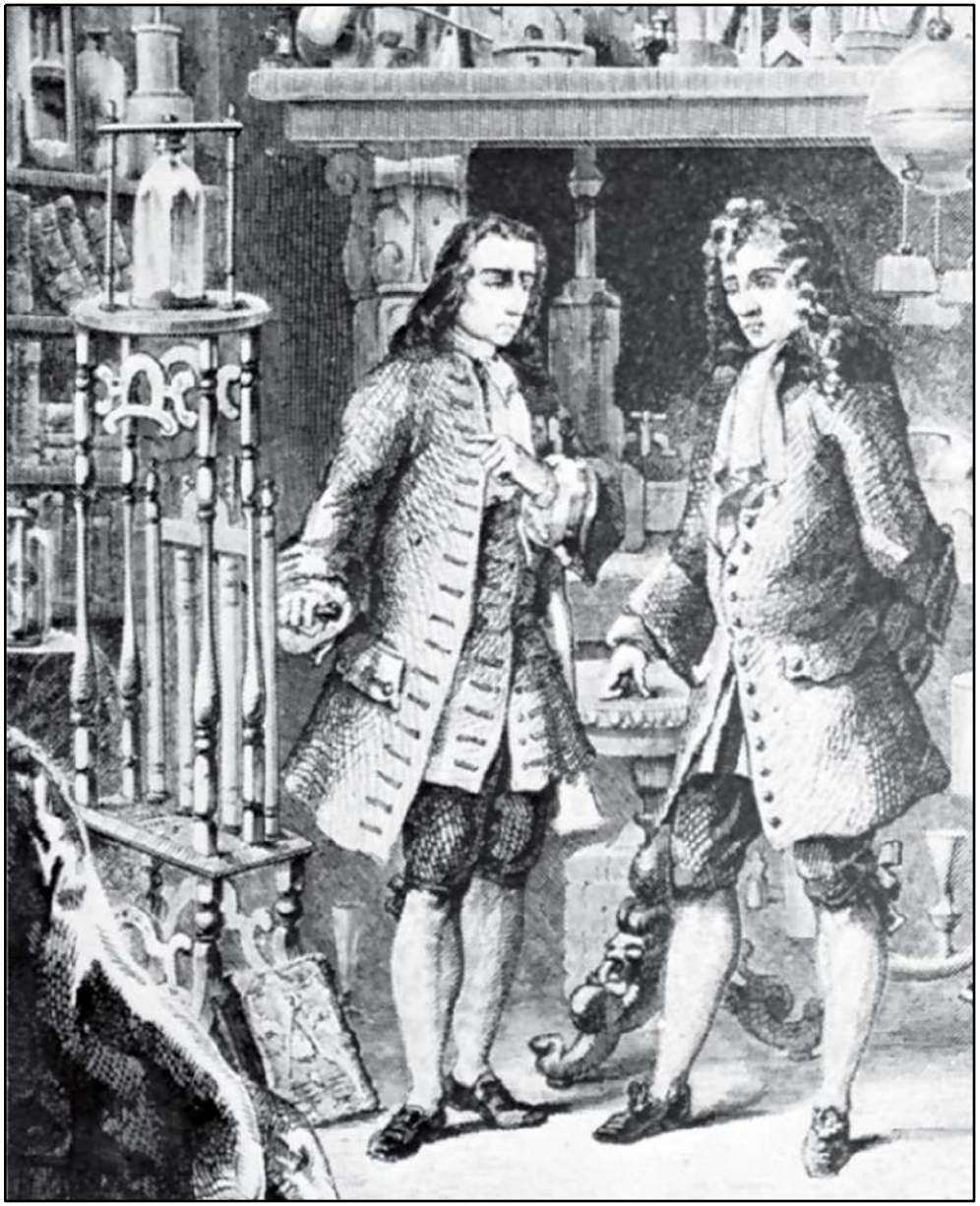


The Scientific Method

The Various Parts of the Scientific Method

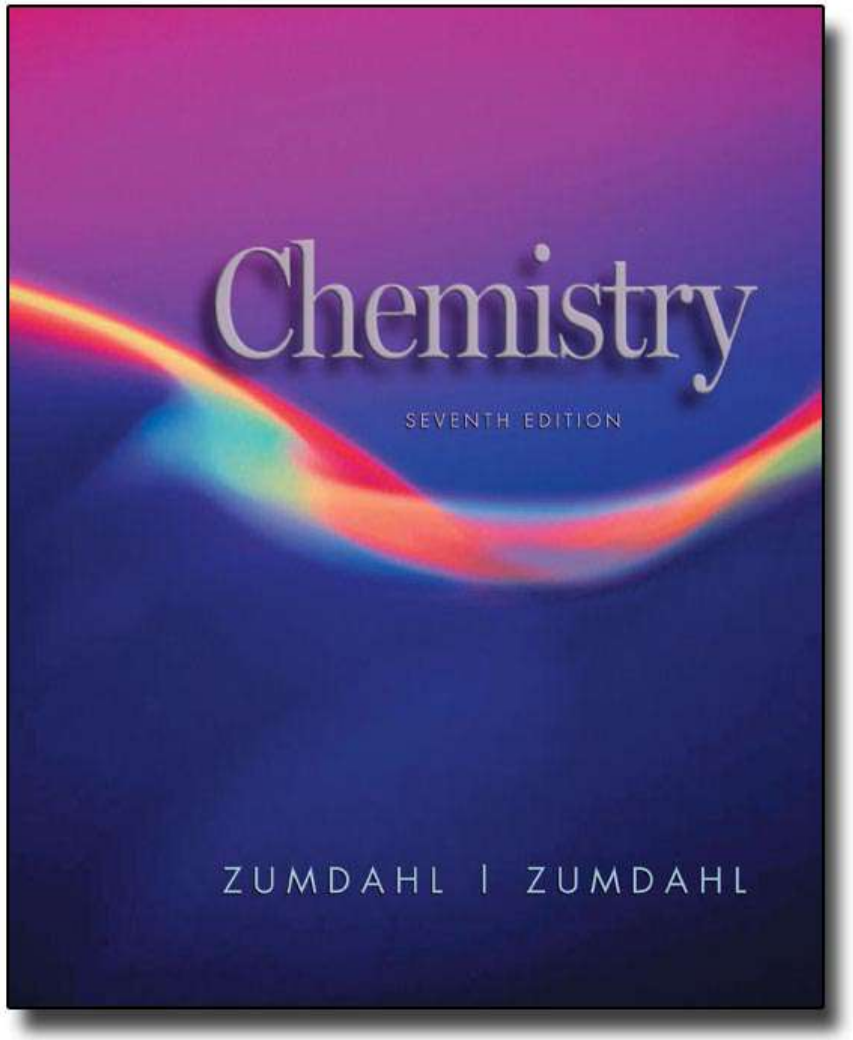


Robert Boyle



Law vs. Theory

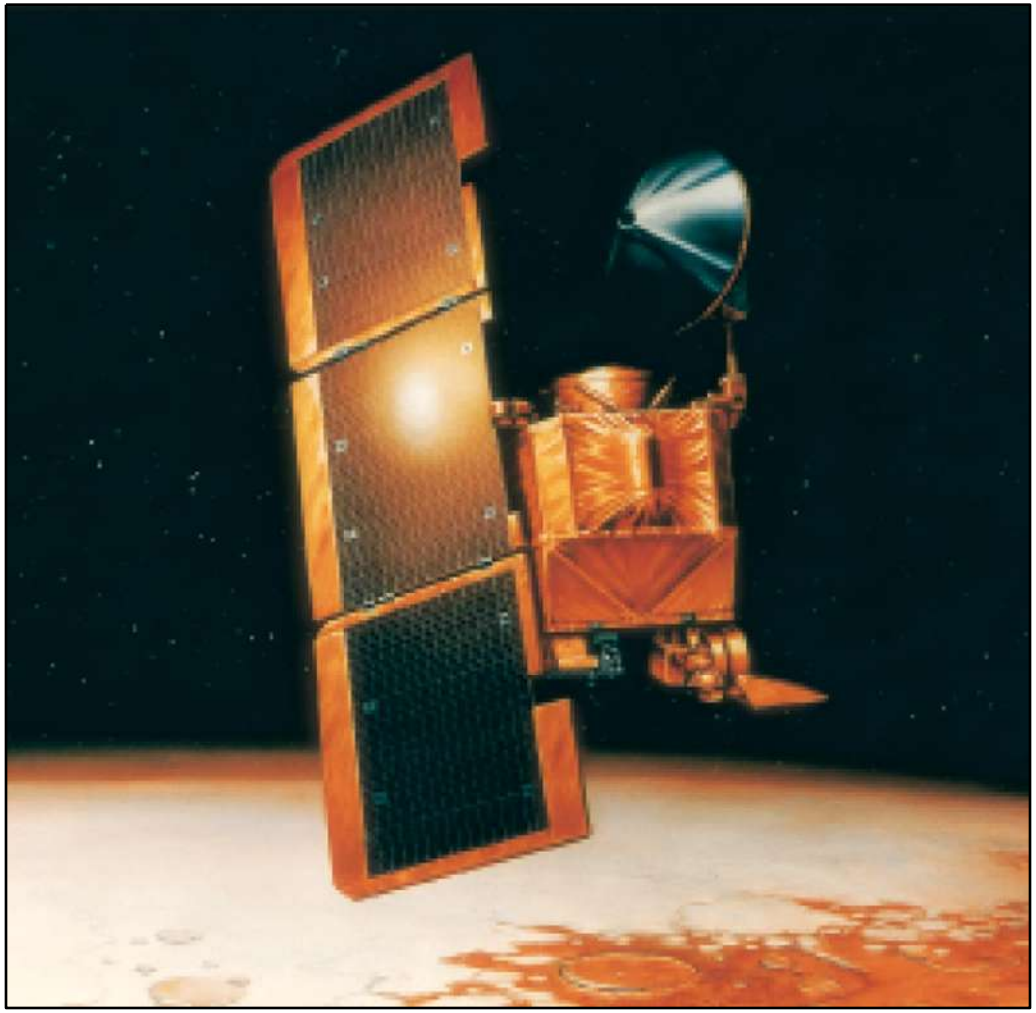
- A law summarizes what happens.
- A theory (model) is an attempt to explain why it happens.



Units of Measurement

Soda is Sold in 2-Liter Bottles- an Example of SI Units in Everyday Life

Artist's Conception of the Lost Mars Climate Orbital



Nature of Measurement

- Measurement - quantitative observation consisting of 2 parts
  - Part 1 – number
  - Part 2 – scale (unit)
- Examples:
  - 20 grams
  - 6.63×10^{-34} Joule seconds

The Fundamental SI Units

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

Figure 1.6
Measurement
of Volume

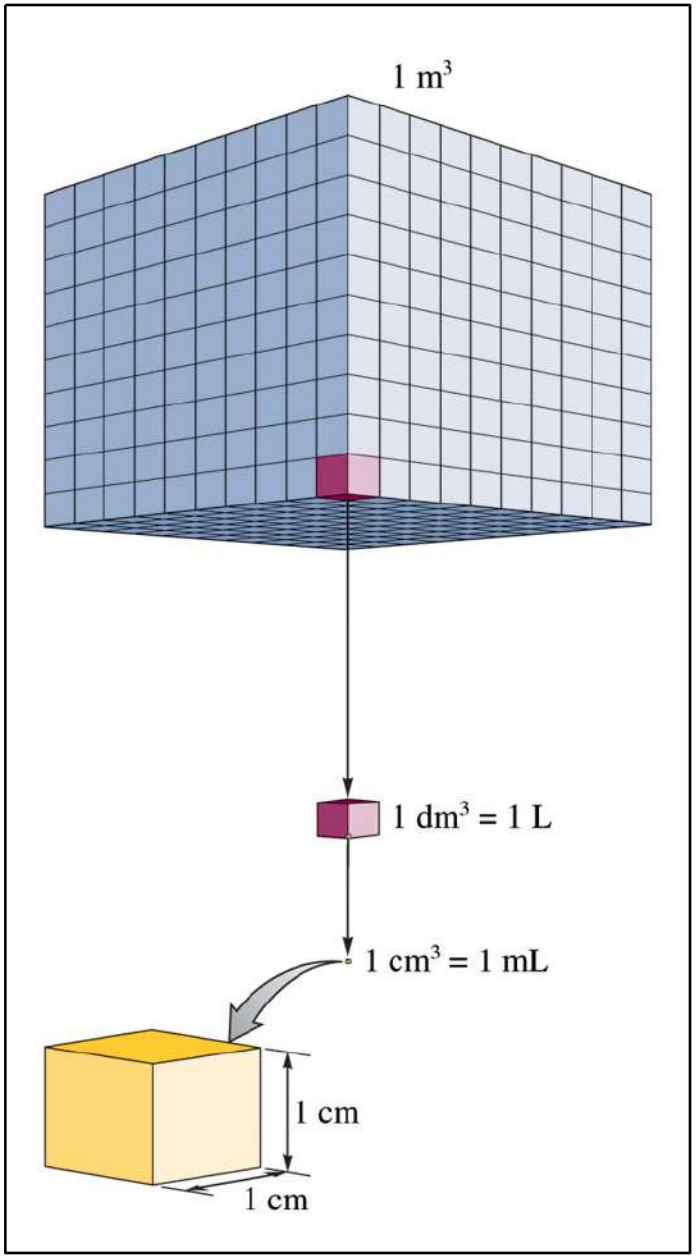


Table 1.2 The Prefixes Used in the SI System

TABLE 1.2 The Prefixes Used in the SI System (Those most commonly encountered are shown in blue.)

Prefix	Symbol	Meaning	Exponential Notation*
exa	E	1,000,000,000,000,000,000	10^{18}
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
—	—	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}
atto	a	0.000000000000000001	10^{-18}

*See Appendix 1.1 if you need a review of exponential notation.

Table 1.3 Some Examples of Commonly Used Units

TABLE 1.3 Some Examples of Commonly Used Units

Length	A dime is 1 mm thick. A quarter is 2.5 cm in diameter. The average height of an adult man is 1.8 m.
Mass	A nickel has a mass of about 5 g. A 120-lb person has a mass of about 55 kg.
Volume	A 12-oz can of soda has a volume of about 360 mL.

Figure 1.7 Common Types of Laboratory Equipment Used to Measure Liquid Volume

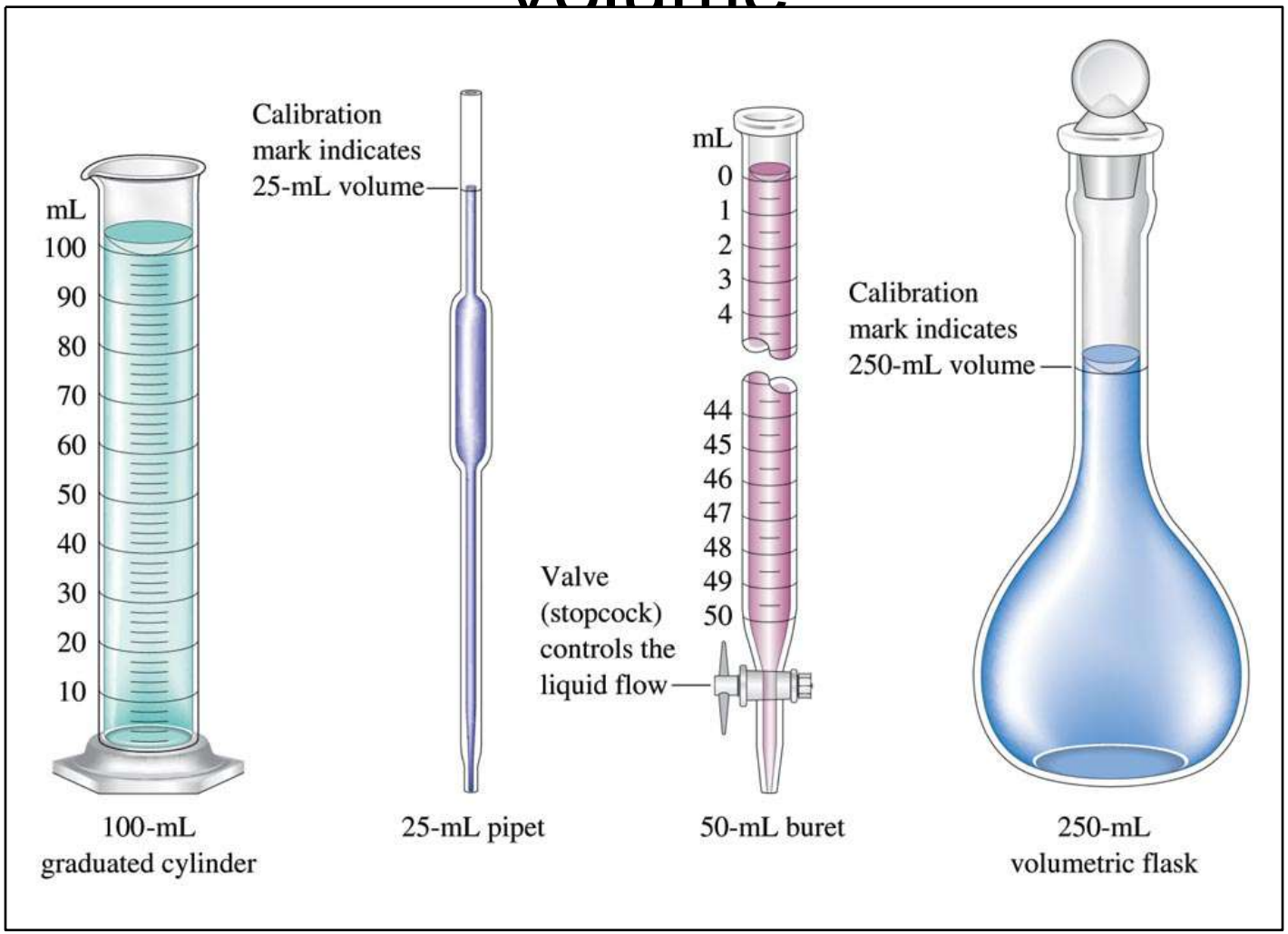
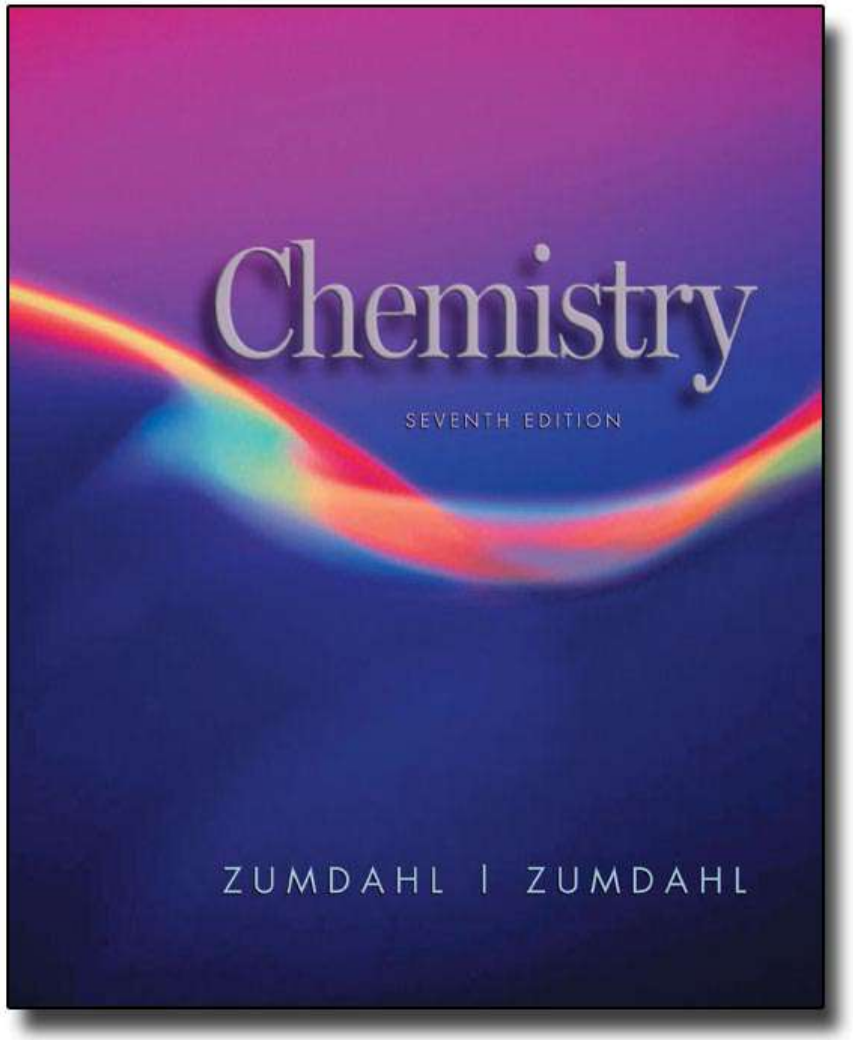


Figure 1.8
An Electronic Analytic Balance



Uncertainty in Measurement

Uncertainty in Measurement

- A digit that must be estimated is called uncertain.
- A measurement always has some degree of uncertainty.

Measurement of Volume Using a Buret

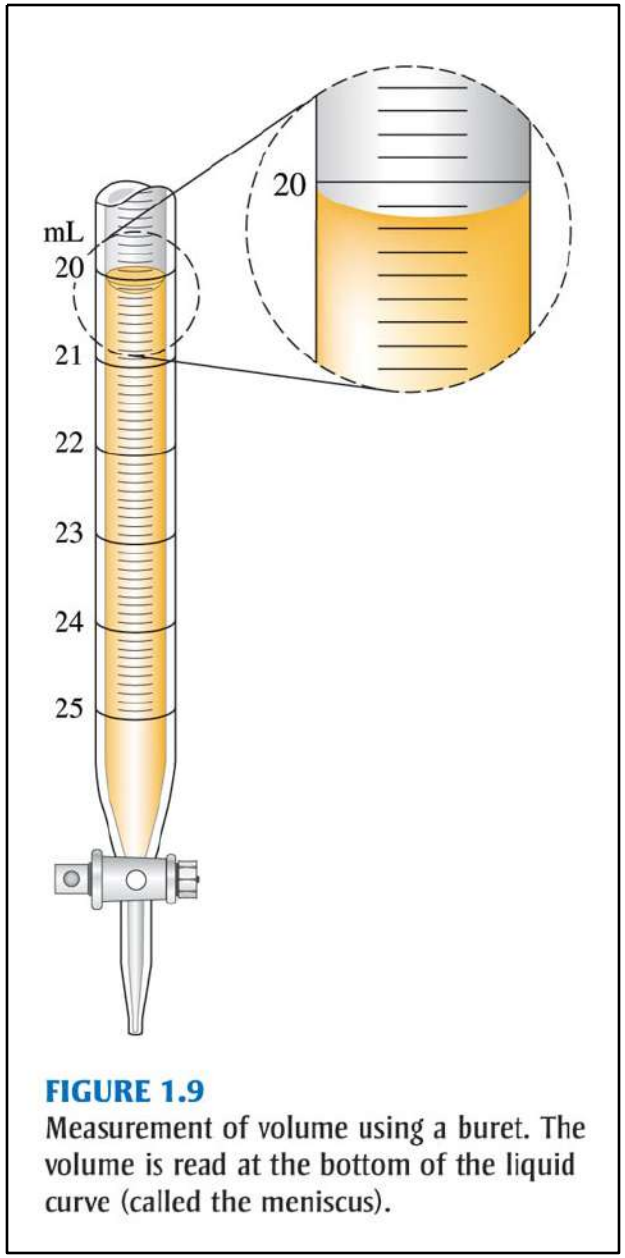


FIGURE 1.9
Measurement of volume using a buret. The volume is read at the bottom of the liquid curve (called the meniscus).

The Difference Between Precision and Accuracy

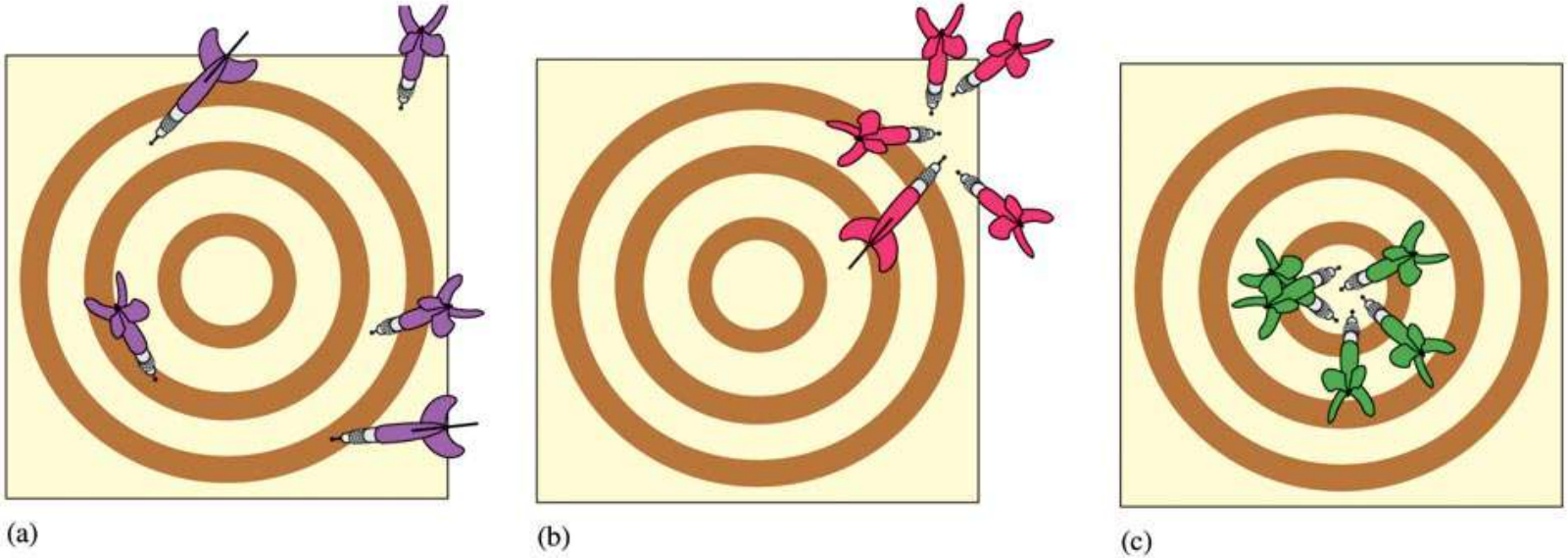
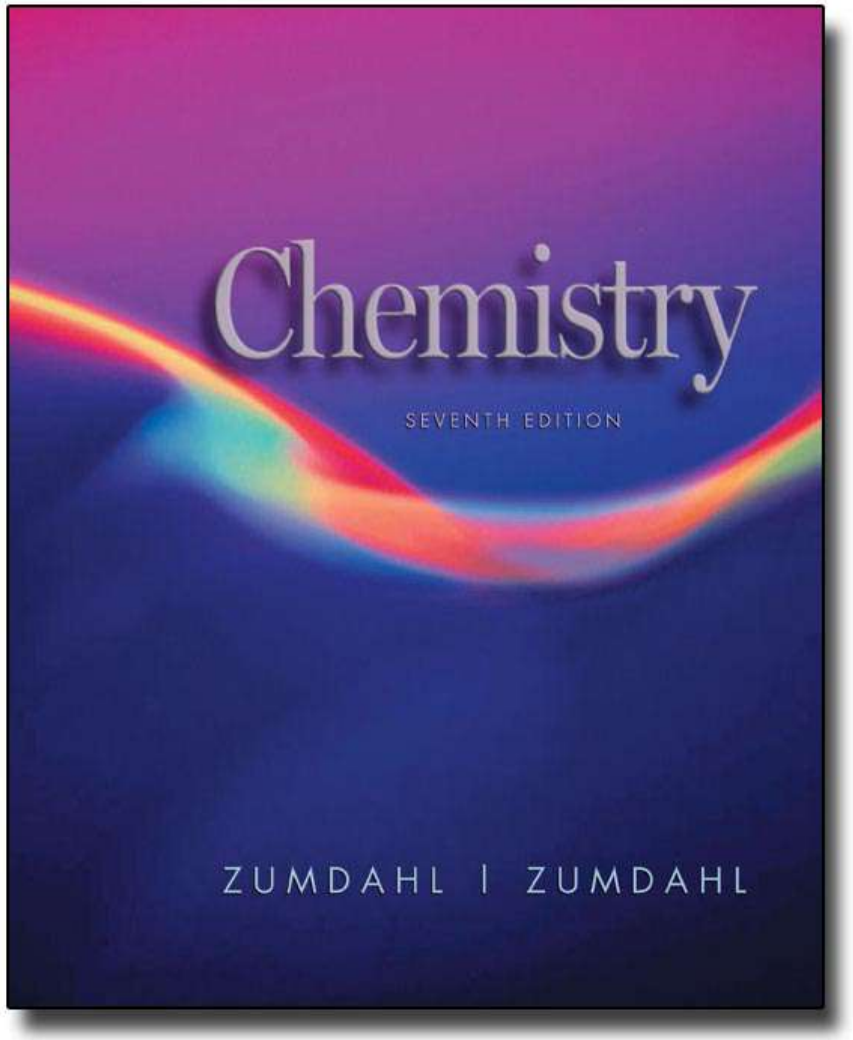


FIGURE 1.10
The results of several dart throws show the difference between precise and accurate. (a) Neither accurate nor precise (large random errors). (b) Precise but not accurate (small random errors, large systematic error). (c) Bull's-eye! Both precise and accurate (small random errors, no systematic error).



Significant Figures and Calculations

Rules for Counting Significant Figures - Details

- Nonzero integers always count as significant figures.
  - 3456 has 4 sig figs.

Rules for Counting Significant Figures – Details (continued)

- Leading zeros do not count as significant figures.
  - 0.048 has 2 sig figs.

Rules for Counting Significant Figures – Details (continued)

- Captive zeros always count as significant figures.
  - 16.07 has 4 sig figs.

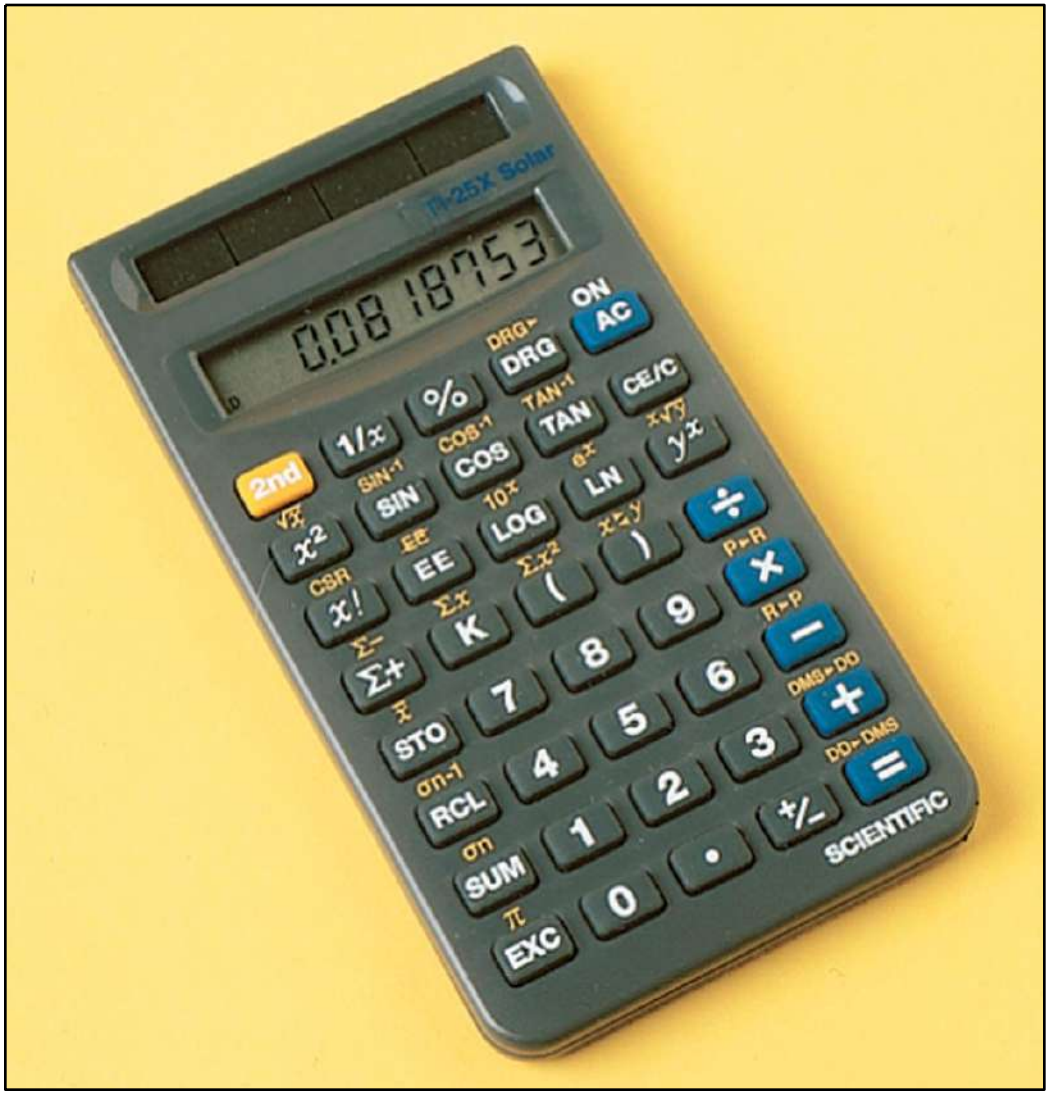
Rules for Counting Significant Figures – Details (continued)

- Trailing zeros are significant only if the number contains a decimal point.
  - 9.300 has 4 sig figs
  - 150 has 2 sig figs.

Rules for Counting Significant Figures – Details (continued)

- Exact numbers have an infinite number of significant figures.
  - 1 inch = 2.54 cm, exactly

Rounding Numbers

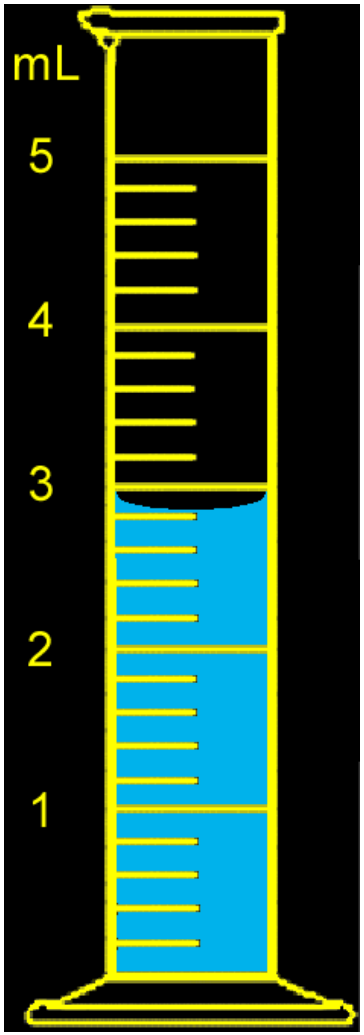


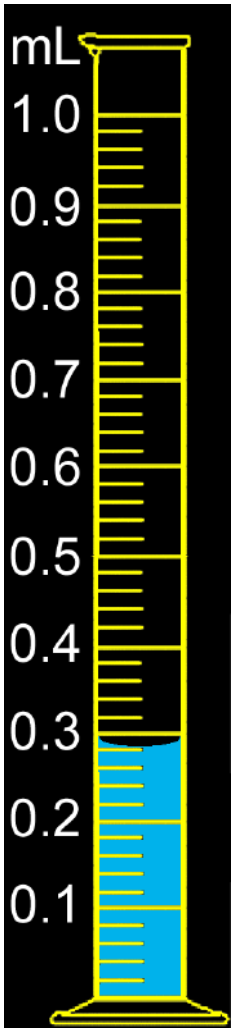
React 1

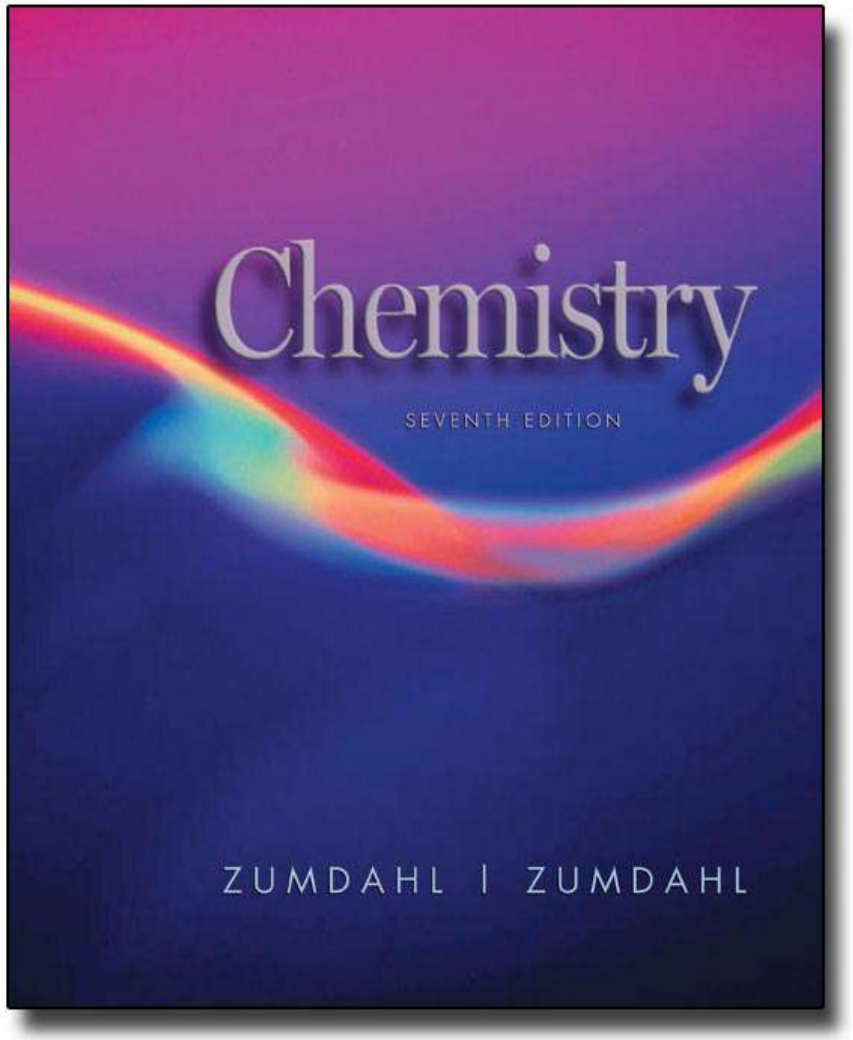
- Measure your textbook using the four rulers provided and fill in the table in your Course Guide.
- Justify the precision for each of your measurements, and the number of significant figures in each of your calculations.

React 2

- You have water in each graduated cylinder shown. You then add both samples to a beaker. How would you write the number describing the total volume? What limits the precision of this number?







Dimensional Analysis

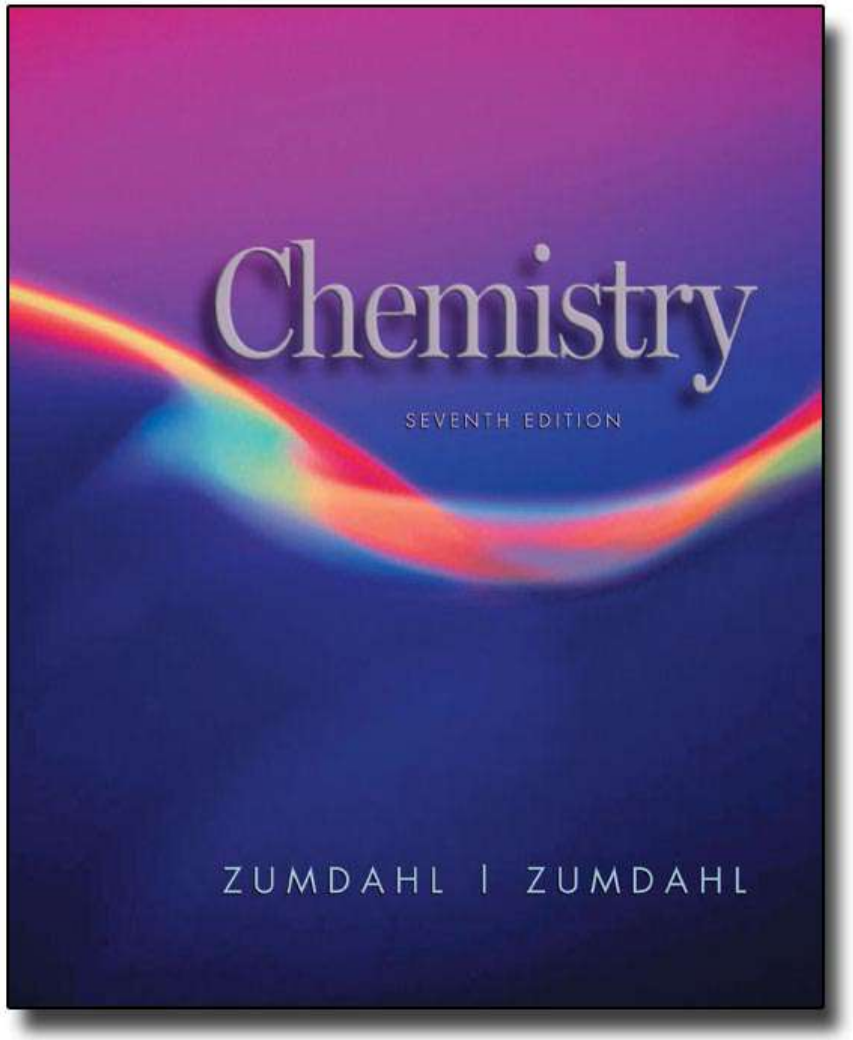
Table 1.4 English-Metric Equivalents

TABLE 1.4 English–Metric Equivalents

Length	1 m = 1.094 yd
	2.54 cm = 1 in
Mass	1 kg = 2.205 lb
	453.6 g = 1 lb
Volume	1 L = 1.06 qt
	$1\ ft^3 = 28.32\ L$

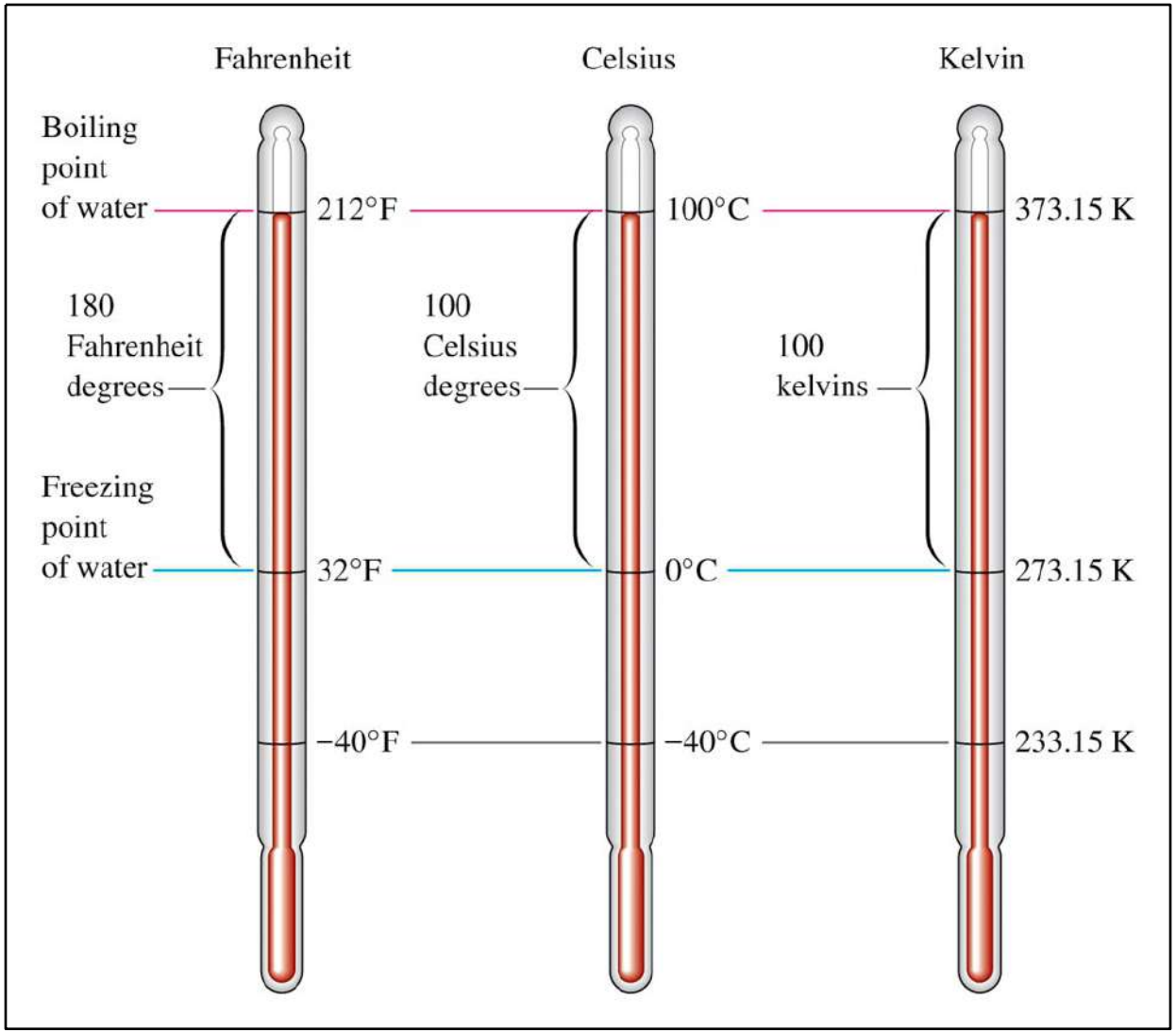
React 3

- What data would you need to estimate the money you would spend on gasoline to drive your car from New York to Chicago? Provide estimates of values and a sample calculation.



Temperature

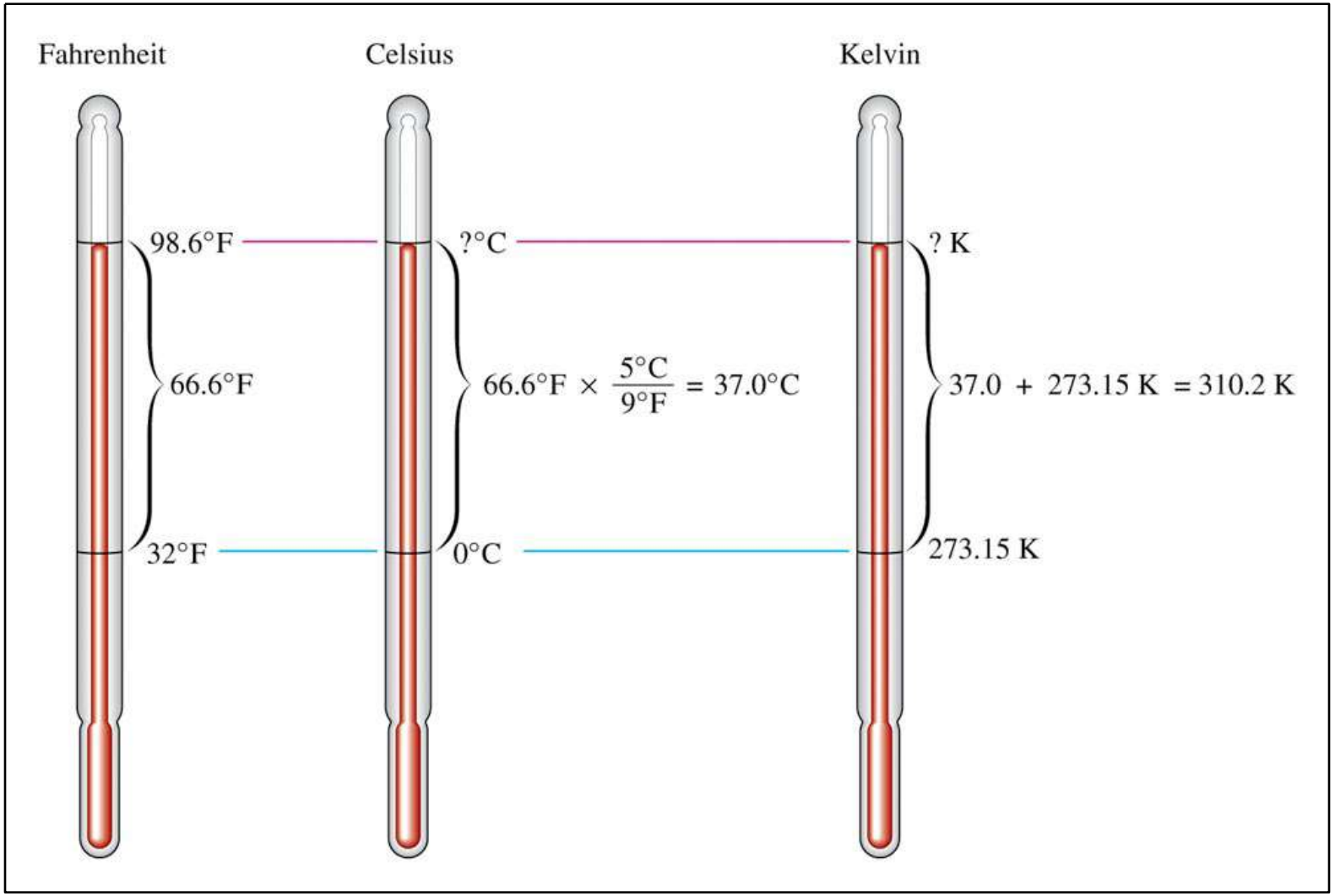
The Three Major Temperature Scales



React 4

- At what temperature does °C = °F?
- Prove your answer.

Figure 1.12 Normal Body Temperature



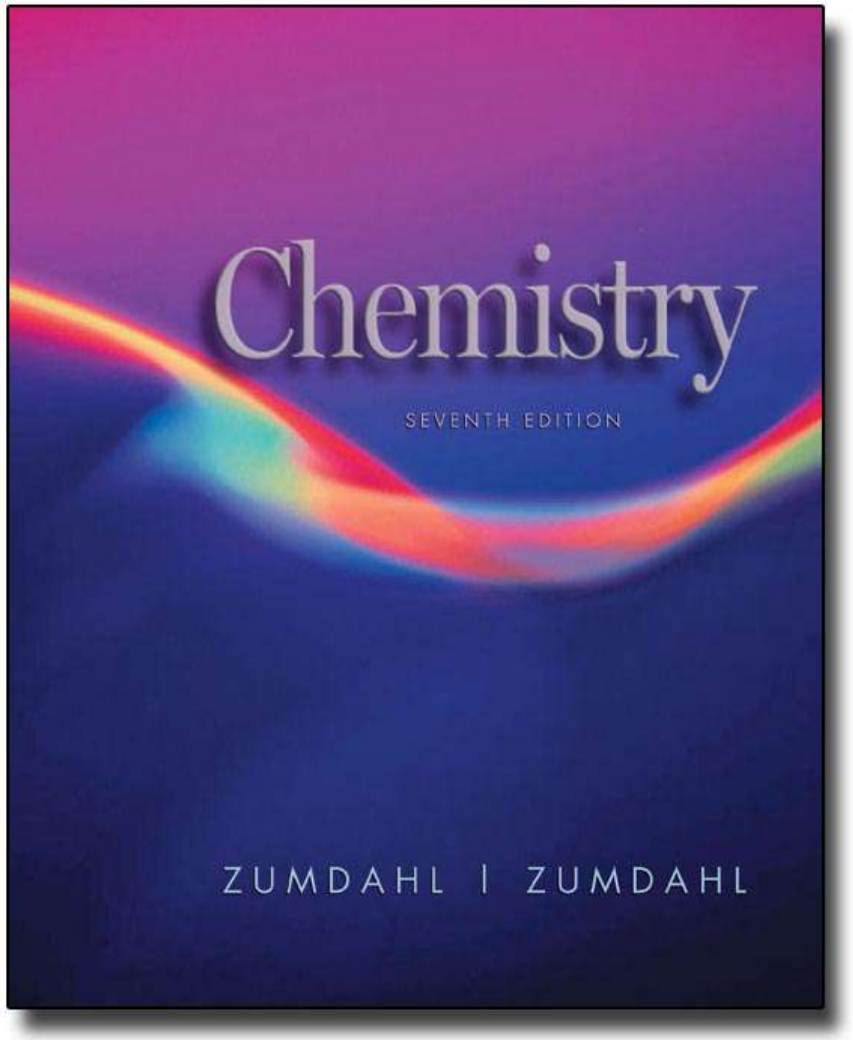
Liquid Nitrogen

Table 1.5 Densities of Various Common Substances* at 20° C

TABLE 1.5 Densities of Various Common Substances* at 20°C

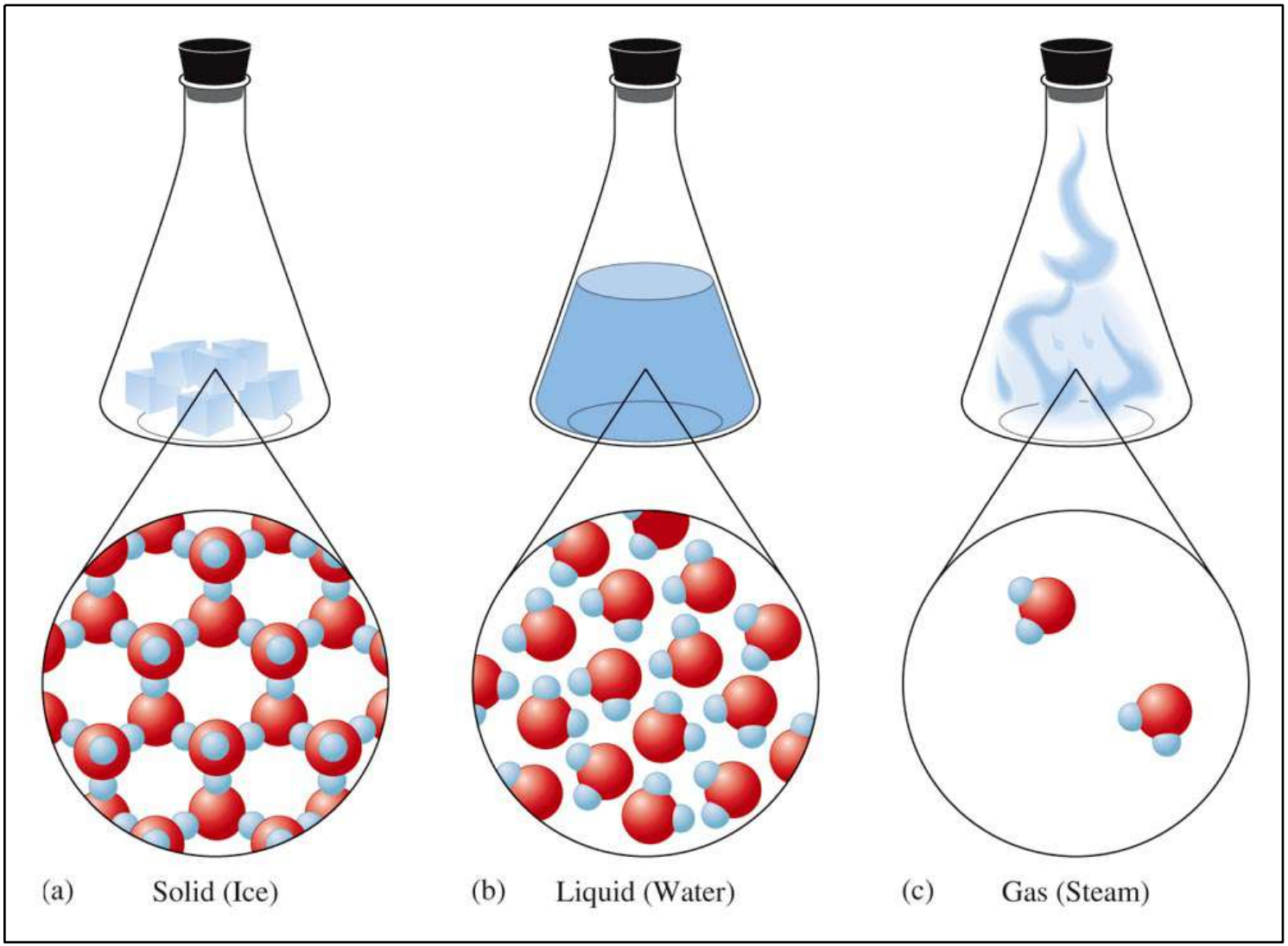
Substance	Physical State	Density (g/cm^3)
Oxygen	Gas	0.00133
Hydrogen	Gas	0.000084
Ethanol	Liquid	0.789
Benzene	Liquid	0.880
Water	Liquid	0.9982
Magnesium	Solid	1.74
Salt (sodium chloride)	Solid	2.16
Aluminum	Solid	2.70
Iron	Solid	7.87
Copper	Solid	8.96
Silver	Solid	10.5
Lead	Solid	11.34
Mercury	Liquid	13.6
Gold	Solid	19.32

*At 1 atmosphere pressure

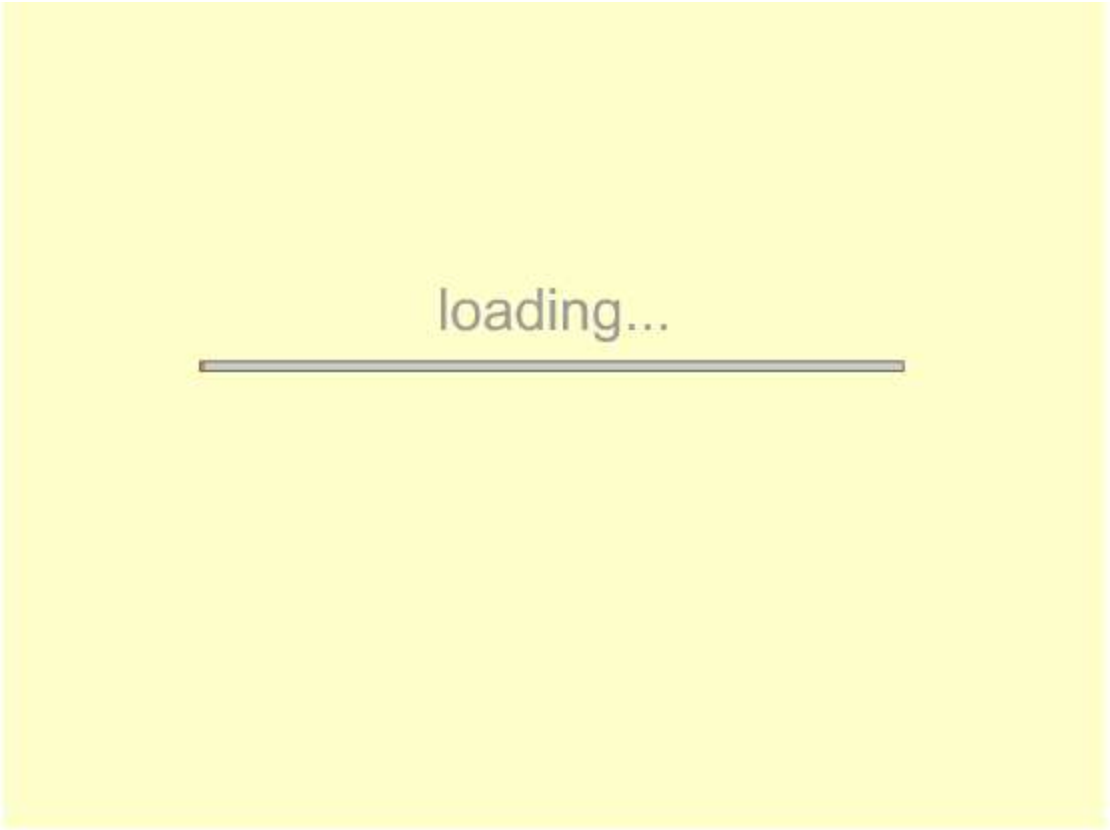


Classification of Matter

The Three States of Water



Structure of a Solid



Structure of a Liquid

Structure of a Gas

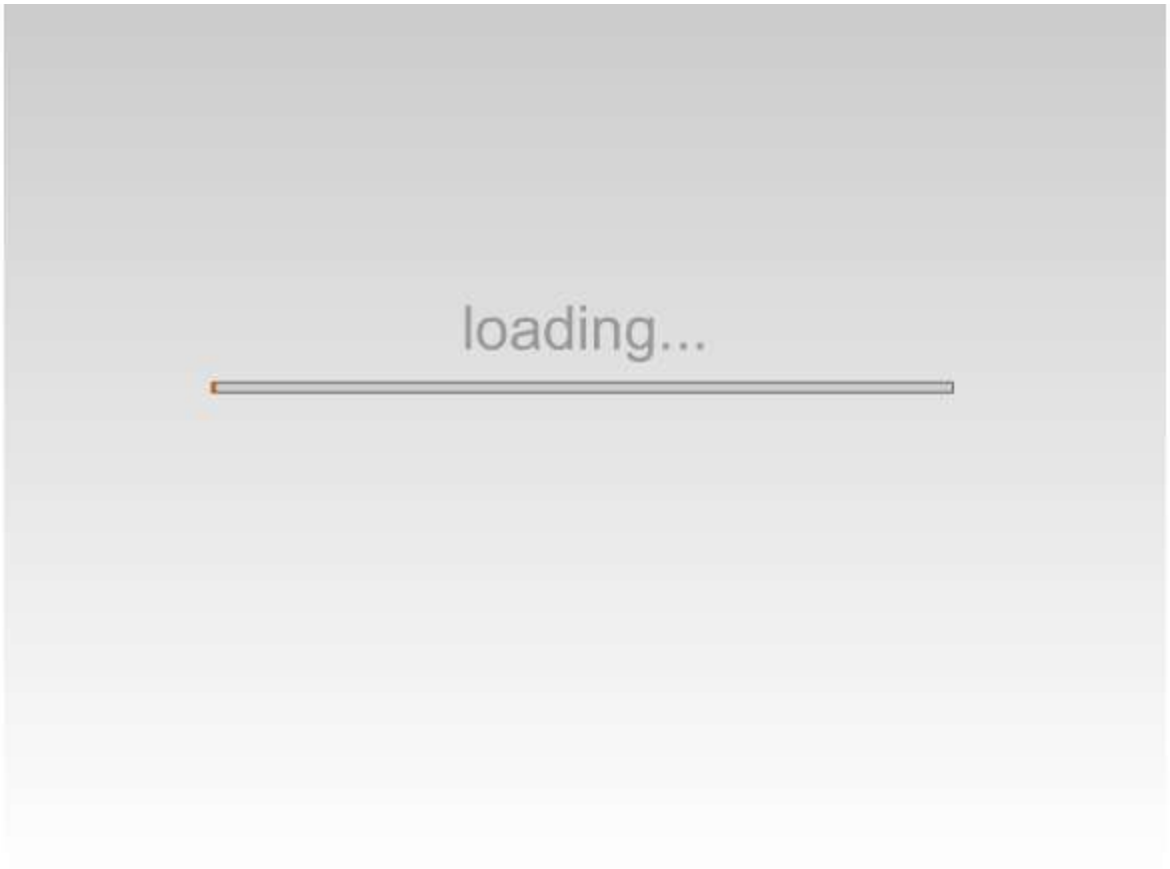


Figure 1.14 Simple Laboratory Distillation Apparatus

Simple Laboratory Distillation Apparatus

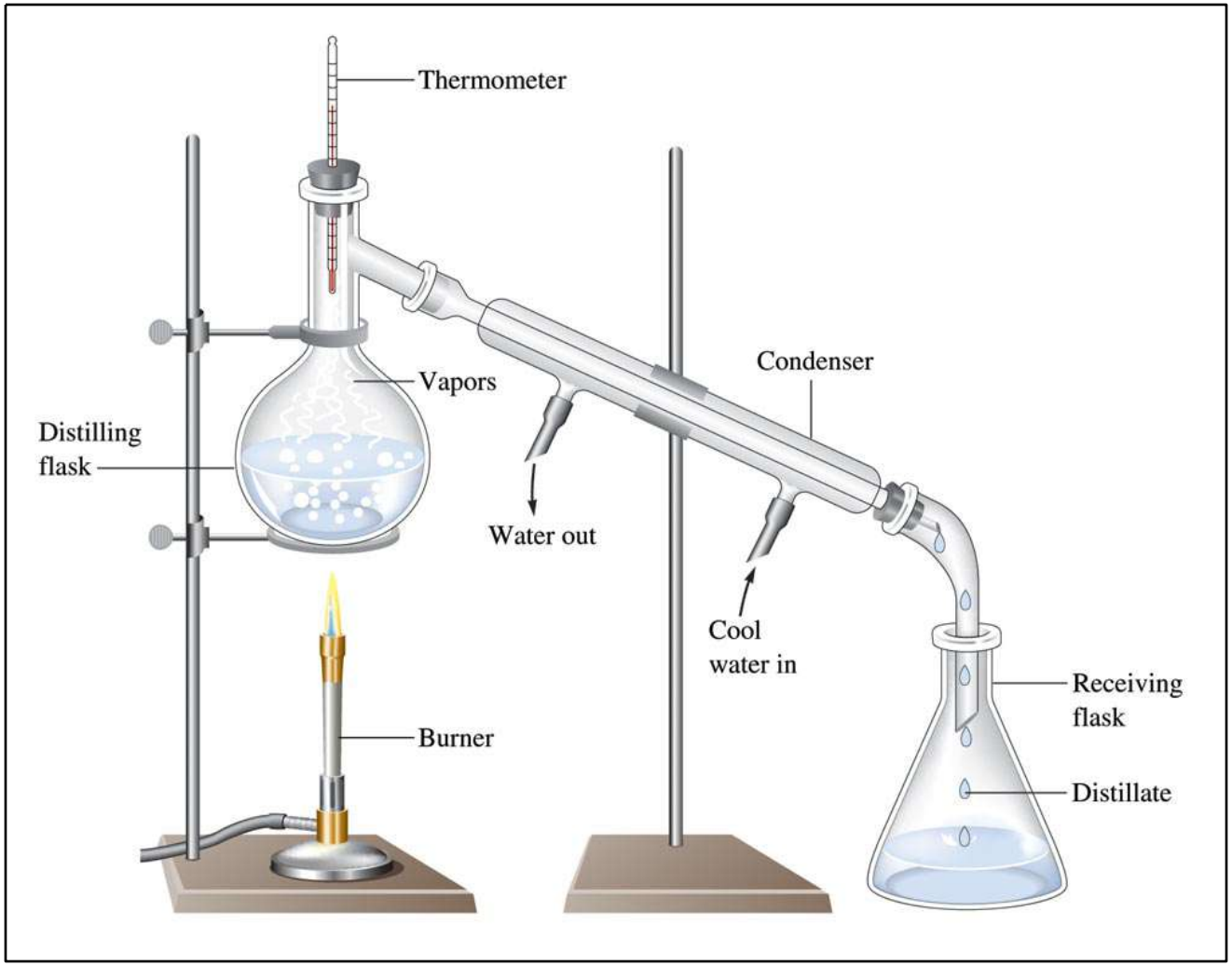


Figure 1.15a
A Line of the Mixture to be Separated is Placed at One End of a Sheet

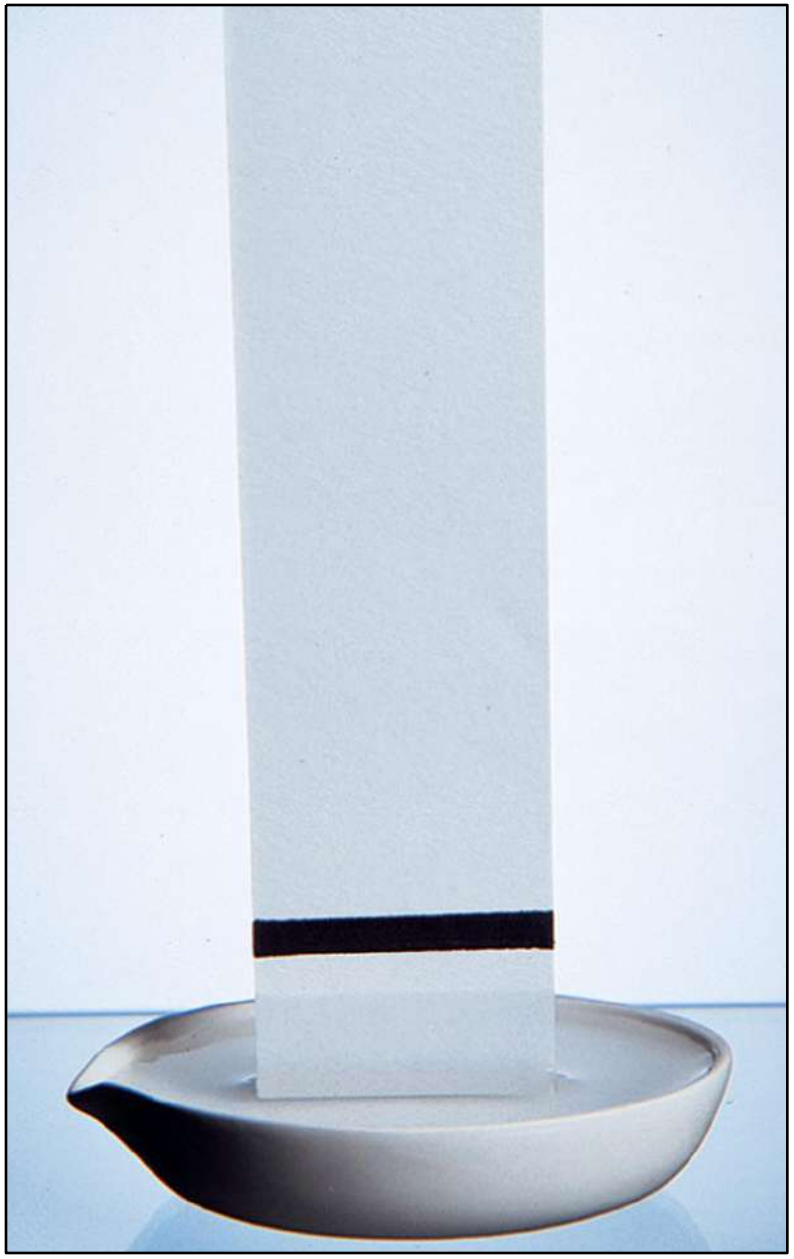


Figure 1.15b
The Paper
Acts as a
Wick to Draw
up the Liquid

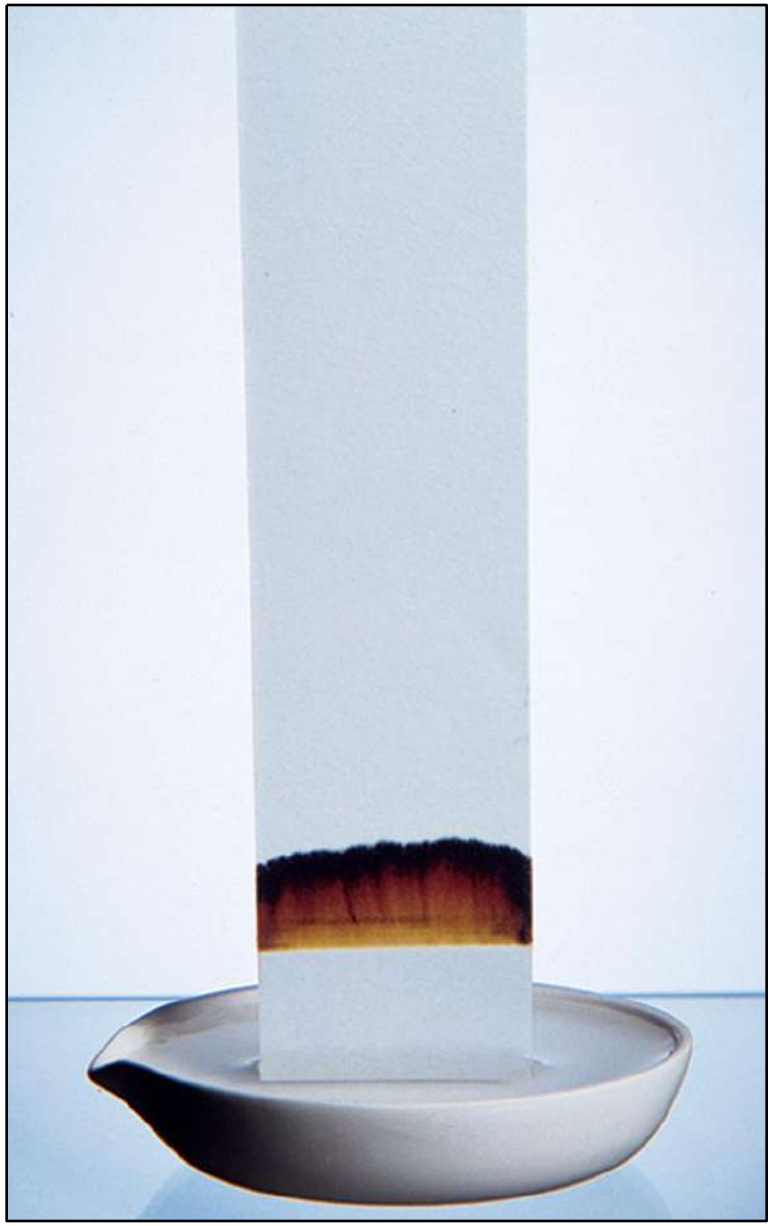
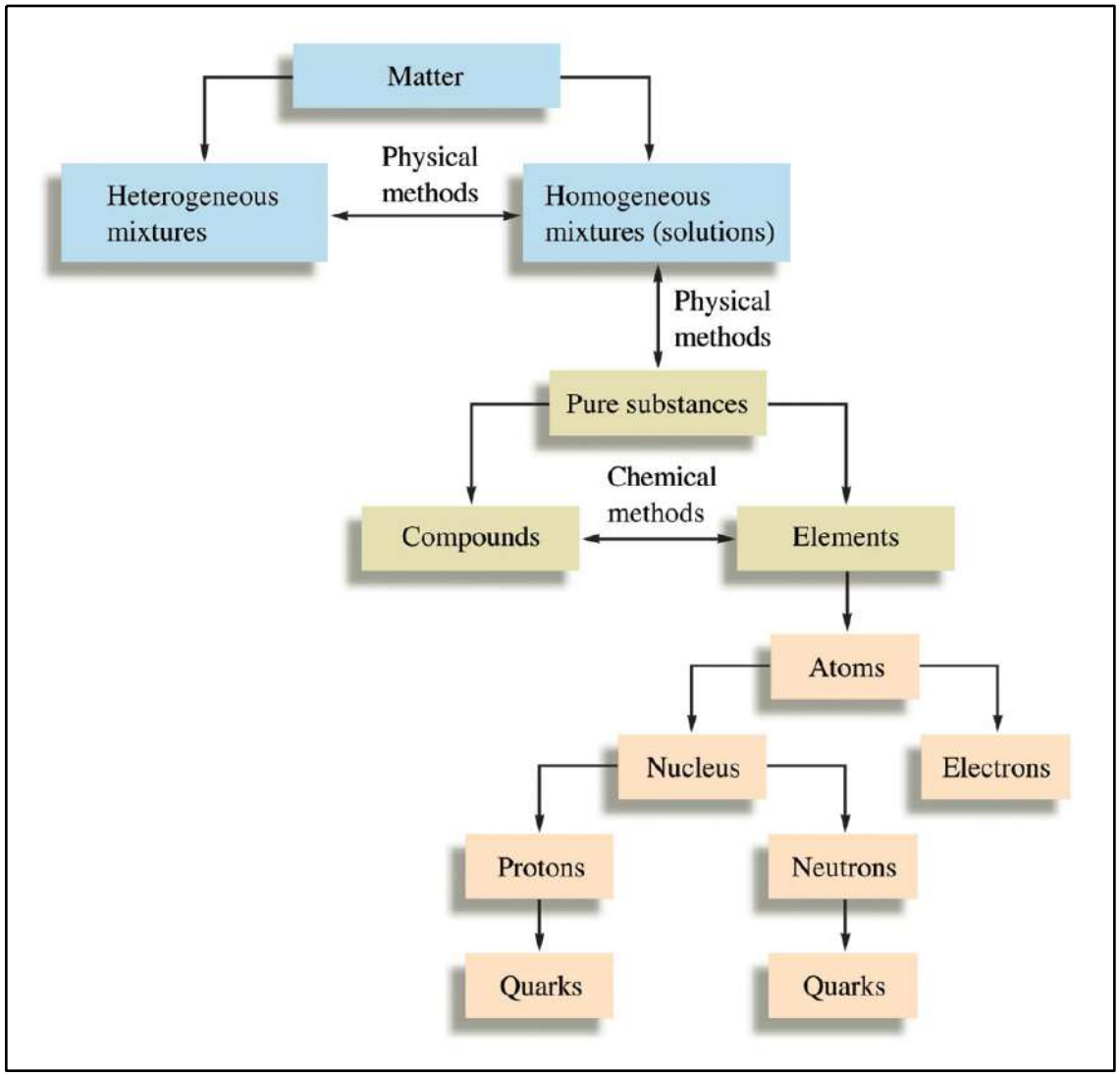
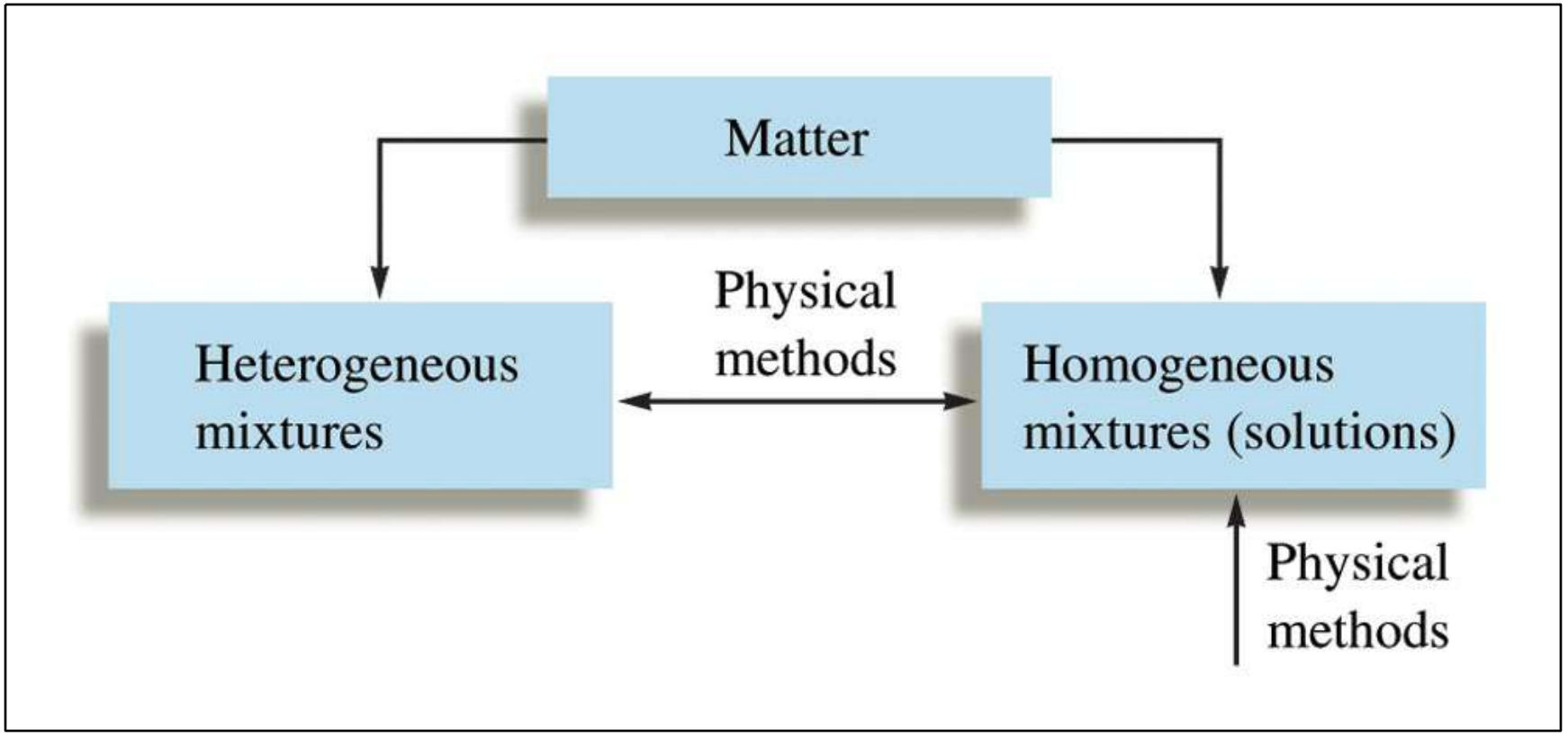


Figure 1.15c Component with the Weakest Attraction for the Paper Travels Faster

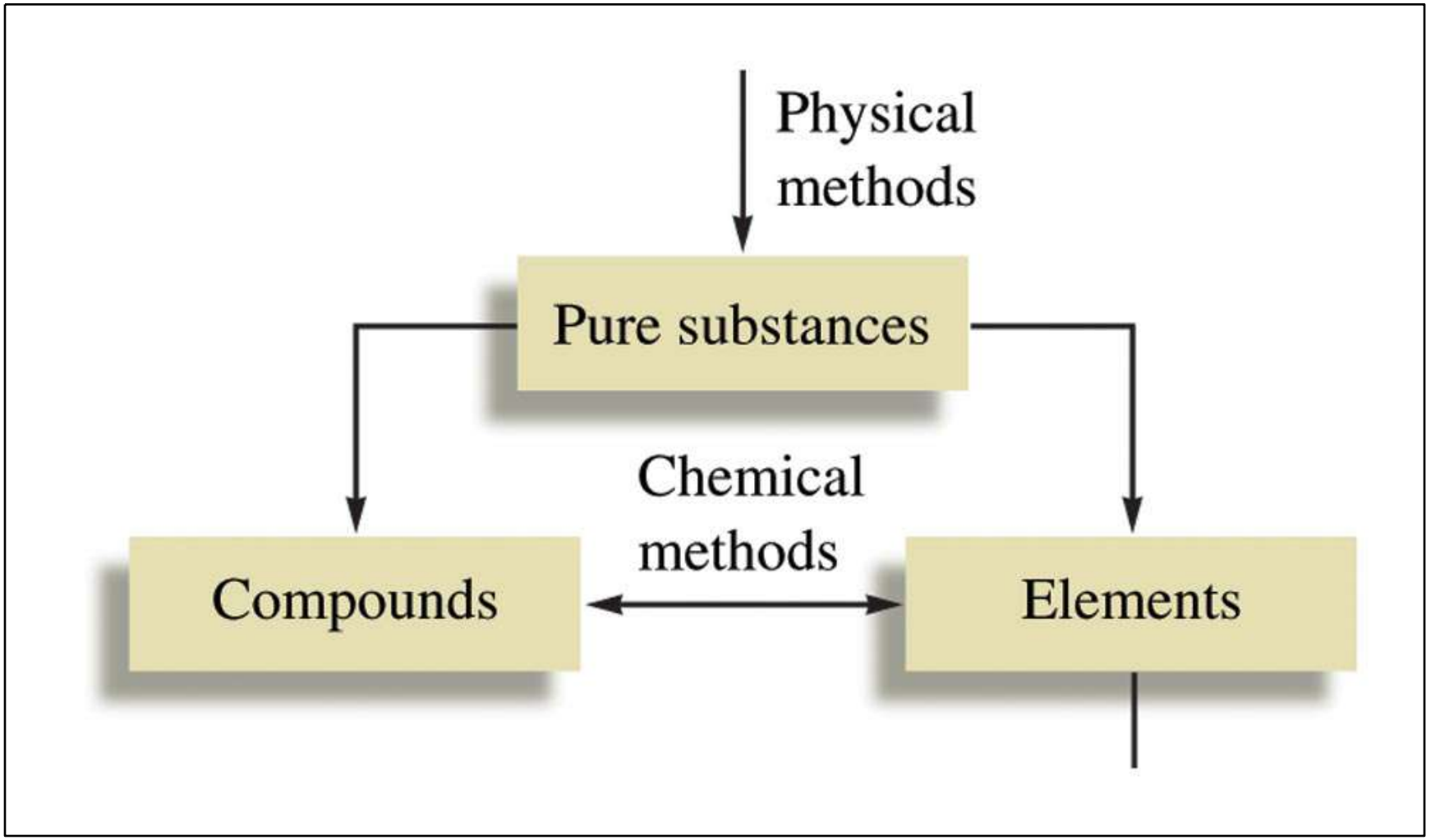
The Organization of Matter



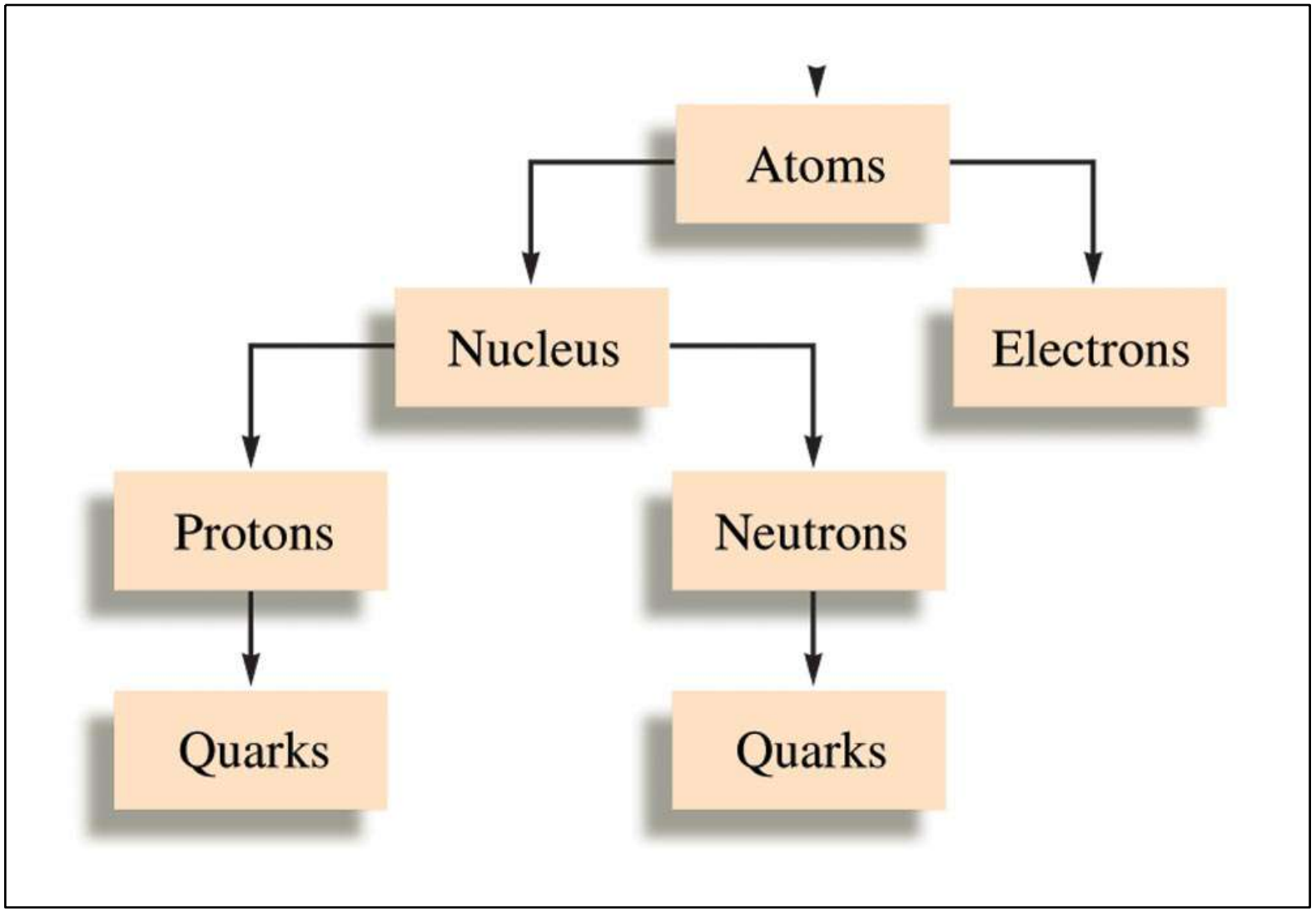
The Organization of Matter



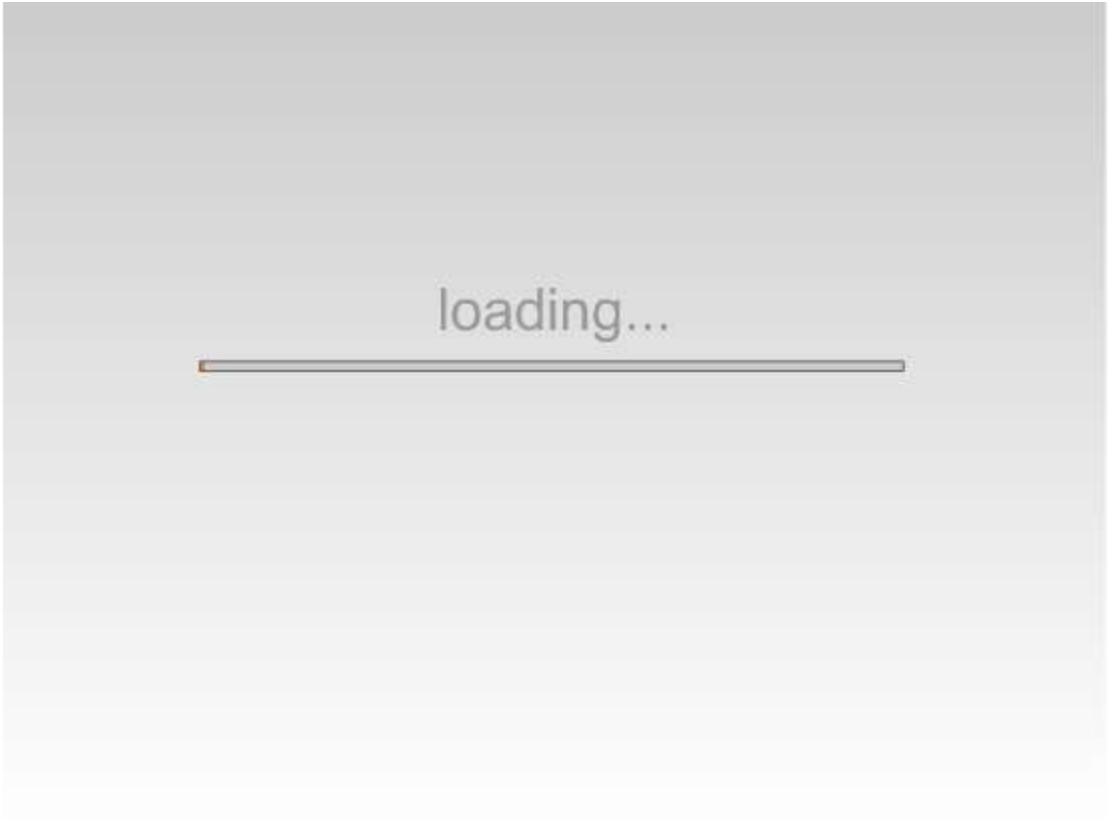
The Organization of Matter



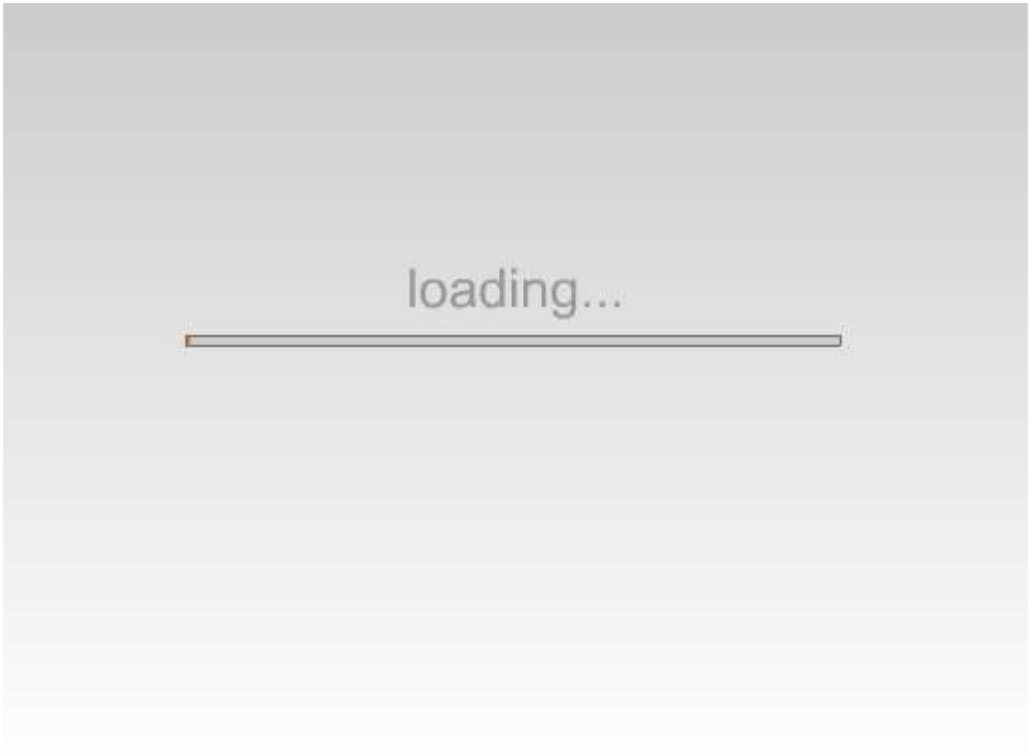
The Organization of Matter



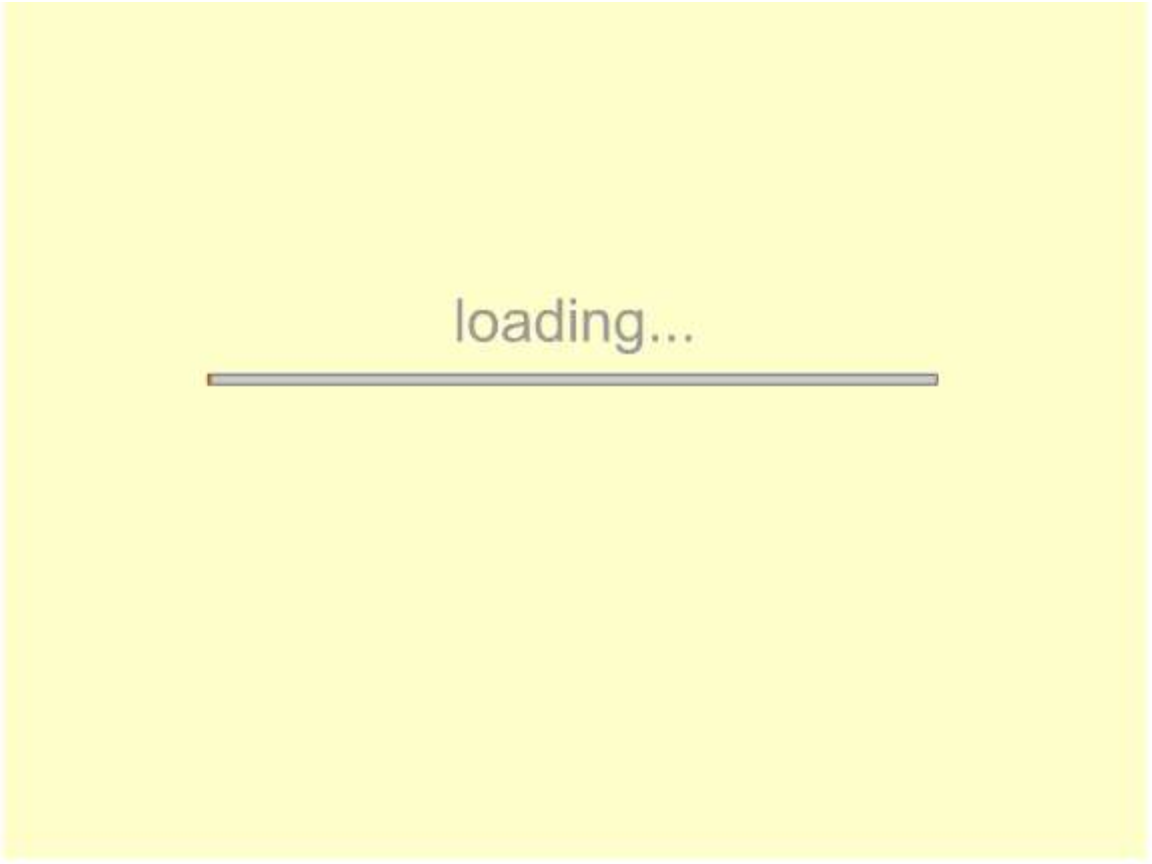
Homogeneous Mixtures



Mixture vs. Solution



Mixture vs. Compound



React 5

- Sketch a magnified view (showing atoms/molecules) of each of the following:
  - a heterogeneous mixture of two different compounds.
  - a homogeneous mixture of an element and a compound.