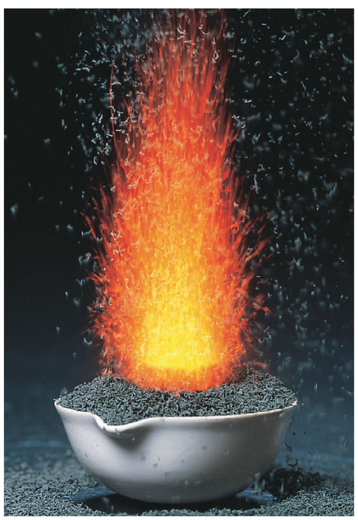
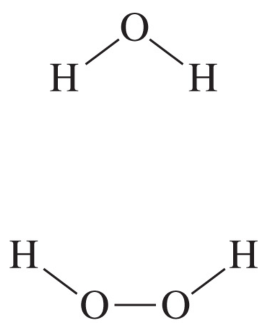
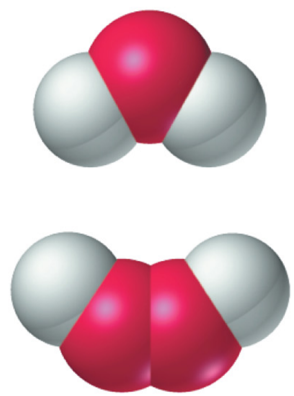
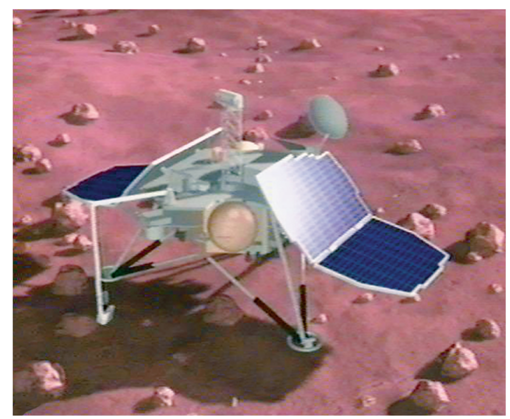
Chapter 1:
Keys to the Study of Chemistry









Properties of Matter

- **Matter:** occupies space and displays mass and inertia

- **Composition:** relative proportions of the components of a sample of matter
  - ex. water is 11.19% H and 88.81% O *by mass*

Properties of Matter

- **Physical property:**
  - a property that can be measured or observed without changing the matter's composition
- **Chemical property:**
  - a property that comes with observing a change in chemical composition
- **Extensive property:**
  - depends on the quantity of matter present
- **Intensive property:**
  - does NOT depend on the quantity of matter present

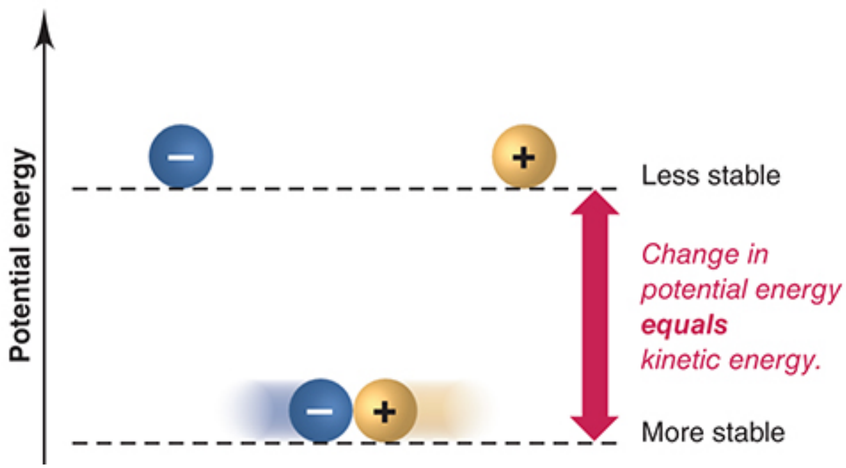
An example: Copper

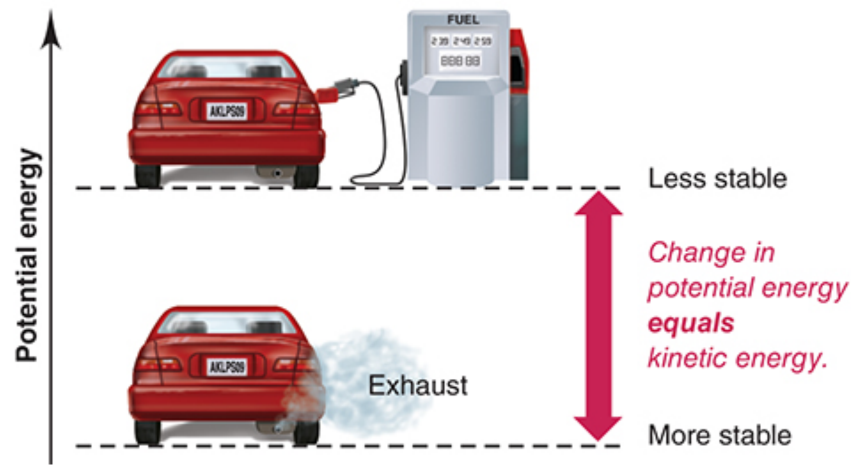
TABLE 1.1 Some Characteristic Properties of Copper

Physical Properties		Chemical Properties	
Easily shaped into sheets (malleable) and wires (ductile)	 	Slowly forms a blue-green carbonate in moist air	
Can be melted and mixed with zinc to form brass		Reacts with nitric or sulfuric acid	
Density = 8.95 g/cm^3 Melting point = 1083°C Boiling point = 2570°C		Slowly forms a deep-blue solution in aqueous ammonia	

Energy and Chemistry

kinetic energy ↔ **potential energy**





Measuring Matter

an observed measurement not followed by a unit is meaningless!

TABLE 1.2 SI Base Units

Physical Quantity (Dimension)	Unit Name	Unit Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	Cd

Who cares about units anyway?

- Mars Climate Orbiter
- probe sent by NASA to Mars to study its weather
- the $168 million probe was destroyed in 1999 after improperly entering the Martian atmosphere
- desired altitude: 140-150 km
- actual altitude attained: 57 km
- investigation revealed that the on board computer used **SI units**, while the computers on Earth were using **imperial units**

SI Prefixes

TABLE 1.3 Common Decimal Prefixes Used with SI Units

Prefix*	Prefix Symbol	Word	Conventional Notation	Exponential Notation
tera	T	Trillion	1 000 000 000 000	1×10^{12}
giga	G	Billion	1 000 000 000	1×10^{9}
mega	M	Million	1 000 000	1×10^{6}
kilo	k	Thousand	1 000	1×10^{3}
hecto	H	Hundred	100	1×10^{2}
deka	da	Ten	10	1×10^{1}
—	—	One	1	1×10^{0}
deci	d	Tenth	0.1	1×10^{-1}
centi	c	Hundredth	0.01	1×10^{-2}
milli	m	Thousandth	0.001	1×10^{-3}
micro	μ	Millionth	0.000 001	1×10^{-6}
nano	n	Billionth	0.000 000 001	1×10^{-9}
pico	p	Trillionth	0.000 000 000 001	1×10^{-12}
femto	f	Quadrillionth	0.000 000 000 000 001	1×10^{-15}

*The prefixes most frequently used by chemists appear in bold type.

Dimensional Analysis

- use conversion factors to convert a quantity from one unit to another

Quantity with desired unit	=	Quantity with given unit	x	Conversion factor

I will be using Dim. Analysis to solve in-class problems. If you want to learn more about this method, please attend or watch the first DGD!

Length

- typical macroscopic units:

1 cm = 10 mm

100 cm = 1 m

- typical microscopic units:

1 nm = 1×10^{-9} m

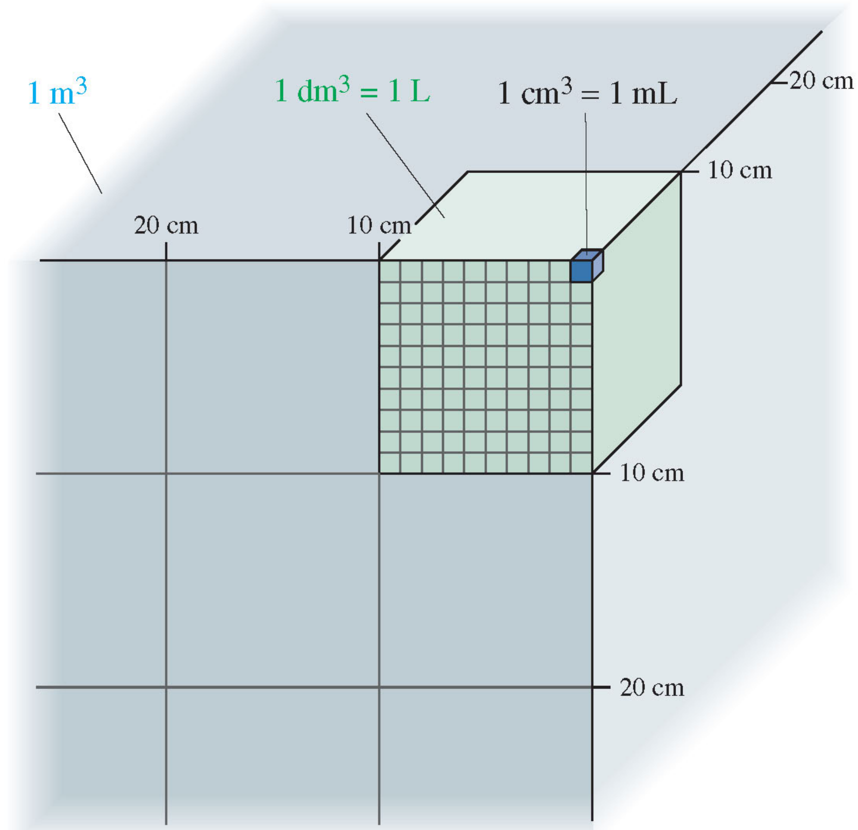
10 Å = 1 nm

Volume

- volume: the size of a cube (ex. m^3)
- we will most often use the litre (L) for measuring volumes

1000 mL = 1 L

1000 L = 1 m^3



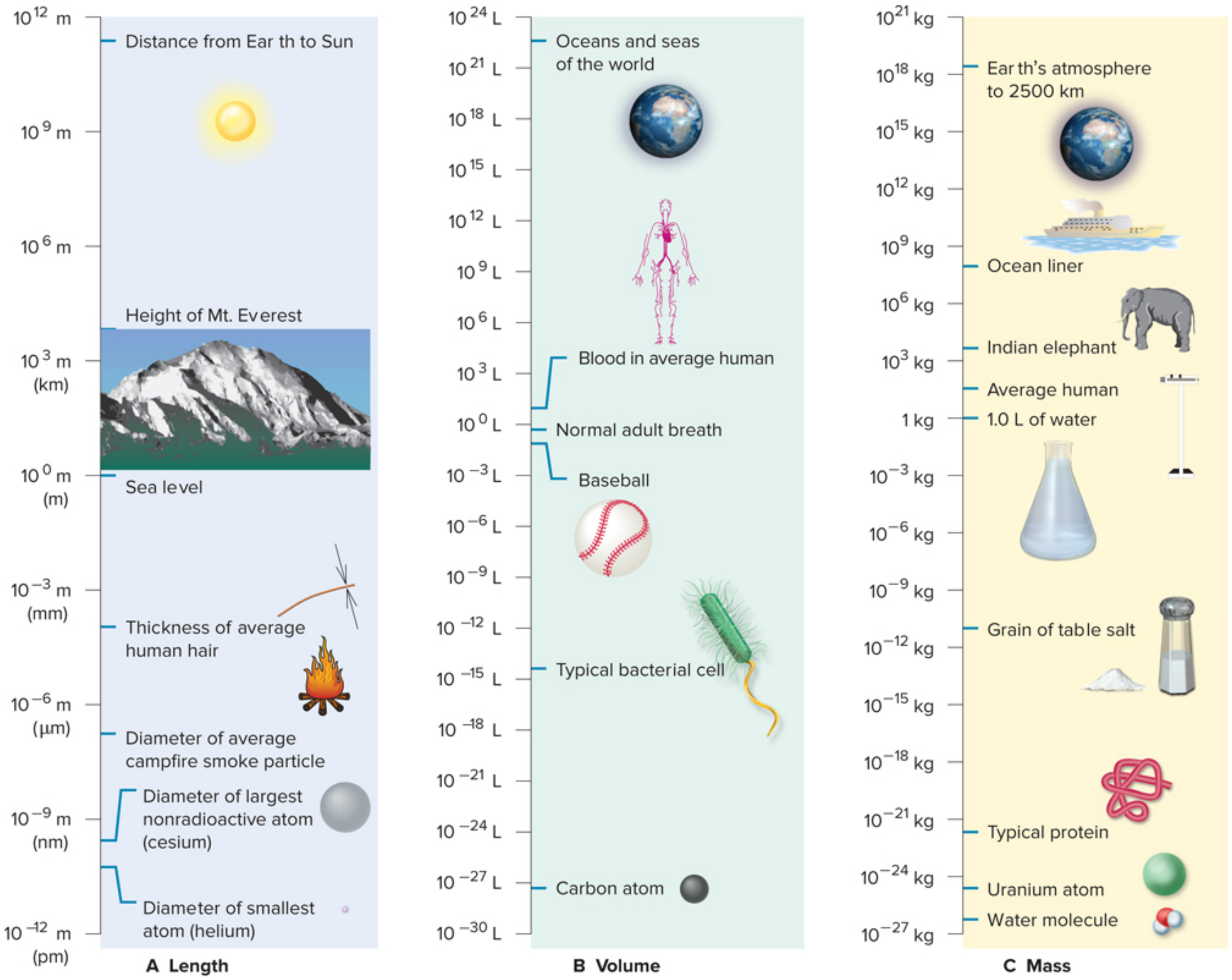
Mass v. Weight

- **mass:**
  - measures the quantity of matter in an object
- **weight:**
  - the force of gravity on an object

The kilogram (kg) is the official SI unit, but we will most often use the gram (g):

1 kg = 1000 g

Fig. 1.9: A Useful Reference…



Temperature

- the SI unit is the kelvin (K)
- absolute zero temperature is 0 K or -273.15^{o}C
- the freezing point of water is 273.15 K or 0^{o}C
- the boiling point of water is 373.15 K or 100^{o}C

Always use the temperature in K in your calculations!

Scientific measurements

- **Scientific notation:** N x 10^n

  6.022 x 10^{23} instead of 602 204 500 000 000 000 000 000

- **Significant figures**
  - digits considered to be significant in the calculation or measurement of a quantity

This balance is precise to ±0.01 kg.
An object that has a mass of 6.732 kg
will give a measurement of **6.73 ± 0.01** kg.

Rules for sig figs…

- all *non zero* digits are significant

6.732 kg has __4__ significant figures

- *zeros between* two sig figs are also significant

6.0061 kg has __5__ significant figures

- *zeros to the left* of a sig fig are not significant

0.0502 kg has __3__ significant figures

Rules for sig figs…

- if the value is greater than 1, all zeros to the right of the decimal point are significant

6.000 kg has _4_ significant figures

- when converting to scientific notation, it may sometimes be ambiguous whether "hanging zeros" are significant or not

4500 kg could be 4.5×10^3, 4.50×10^3, or 4.500×10^3 kg

therefore 4500 kg could have 2, 3, or 4 sig figs!*

*Note: to avoid this confusion, some textbooks will place a decimal (not a period) at the end of a number to clearly indicate the sig figs, *e.g.* 4500. means there are 4 sig figs.

Rules for sig figs

- a whole number with perfect precision has an infinite number of significant figures

if we determine the average of 3 trials,

we can assume it's **3.000 000 000**… trials

- this works for most conversion factors as well

1 m = **100.000 000 000**… cm

Rules for sig figs…

- **addition/subtraction:**
  - the answer must have the same number of sig figs after the decimal as the element of the calculation with the least number of sig figs *after the decimal point*

$$\begin{array}{r} +0.2225 \\ +2.73 \\ +0.321 \\ \hline +3.2735 \end{array} \qquad \begin{array}{r} +2.06 \\ -1.1 \\ \hline +0.96 \end{array}$$

rounded to 3.27

rounded to 1.0

Rules for sig figs…

- **multiplication/division:**
  - the answer must have the same number of sig figs as the element of the calculation with the *least number* of sig figs

2.2 x 3.7845 = 8.32590 → rounded to 8.3

3.76 ÷ 4.236 = 0.8876298 → rounded to 0.888

(2.27 x 7.324) ÷ 3.3 = 5.0380 → rounded to 5.0

Rules for sig figs…

- **Logarithms**
  - the answer must have the same number of sig figs as the log element

log(957) = 2.980911… → = 2.98 ??

= $\log(9.57 \times 10^2)$

= $\log(9.57) + \log(10^2)$

= 0.980911… + 2.00000… → = 2.981 ✔

Chapter 1: Key Concepts

- the properties of matter
- SI units and prefixes
- conversion factors
- scientific notation
- significant figures