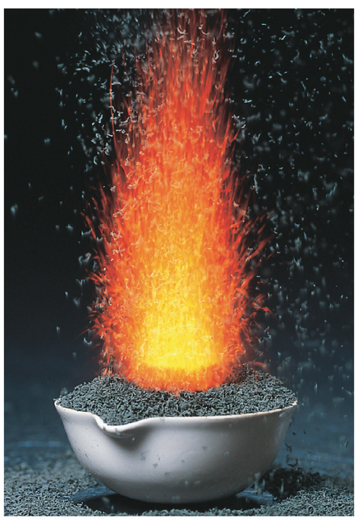
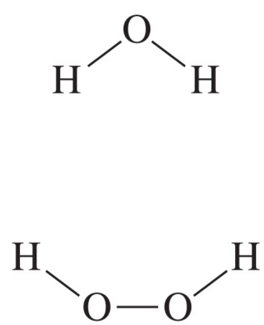
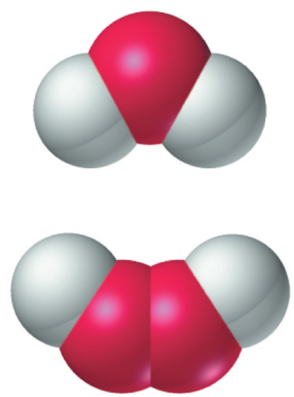
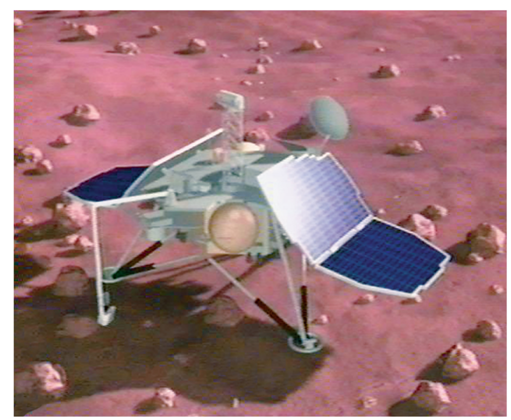
Chapter 1:
Keys to the Study of Chemistry









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

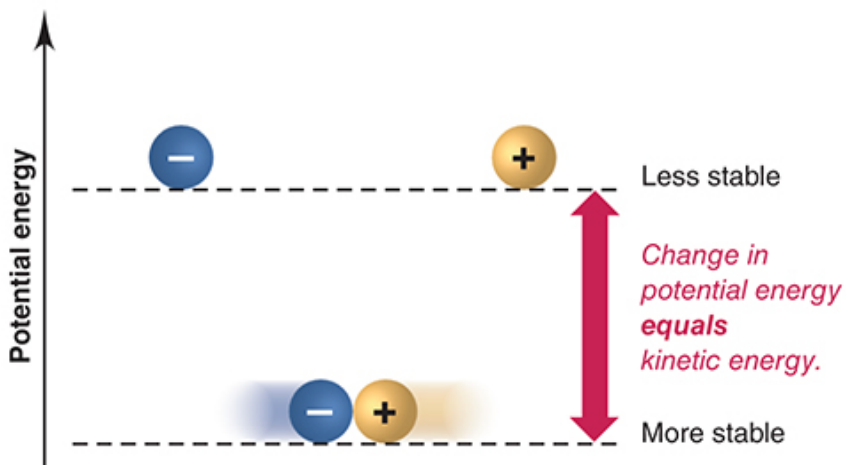
An example: Copper

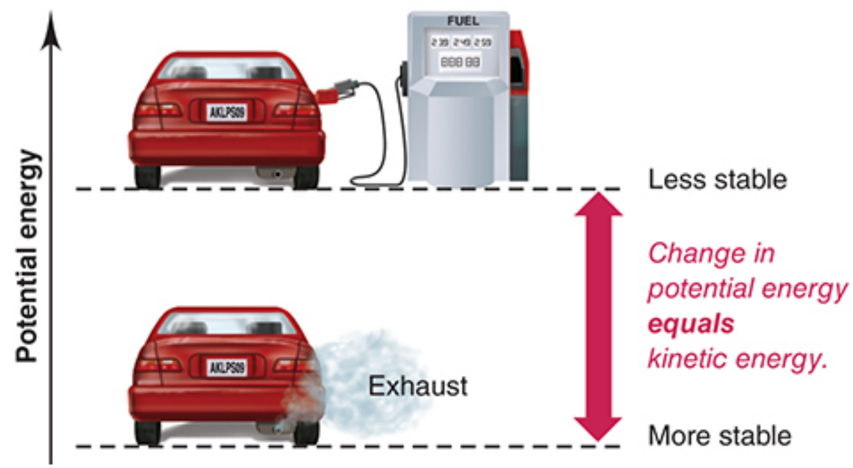
TABLE 1.1 Some Characteristic Properties of Copper

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 entering the Martian atmosphere
- desired altitude: 140-150 km
- altitude attained: 57 km
- investigation revealed that the on board computer used SI units, while the computers on Earth were using BE 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}

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

Length

- typical macroscopic units:

  1 cm = 10 mm

  100 cm = 1 m

- typical microscopic units:

  1 nm = 1×10^{-9} m

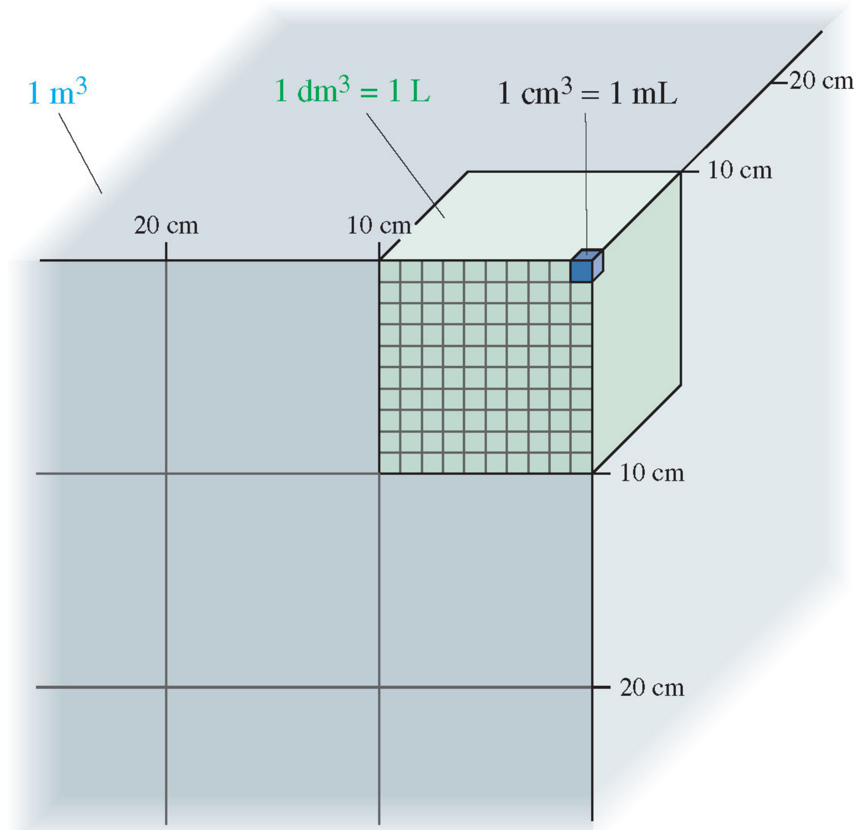
  10 Å = 1 nm

Volume

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

$1000\ mL = 1\ L$

$1000\ L = 1\ m^3$



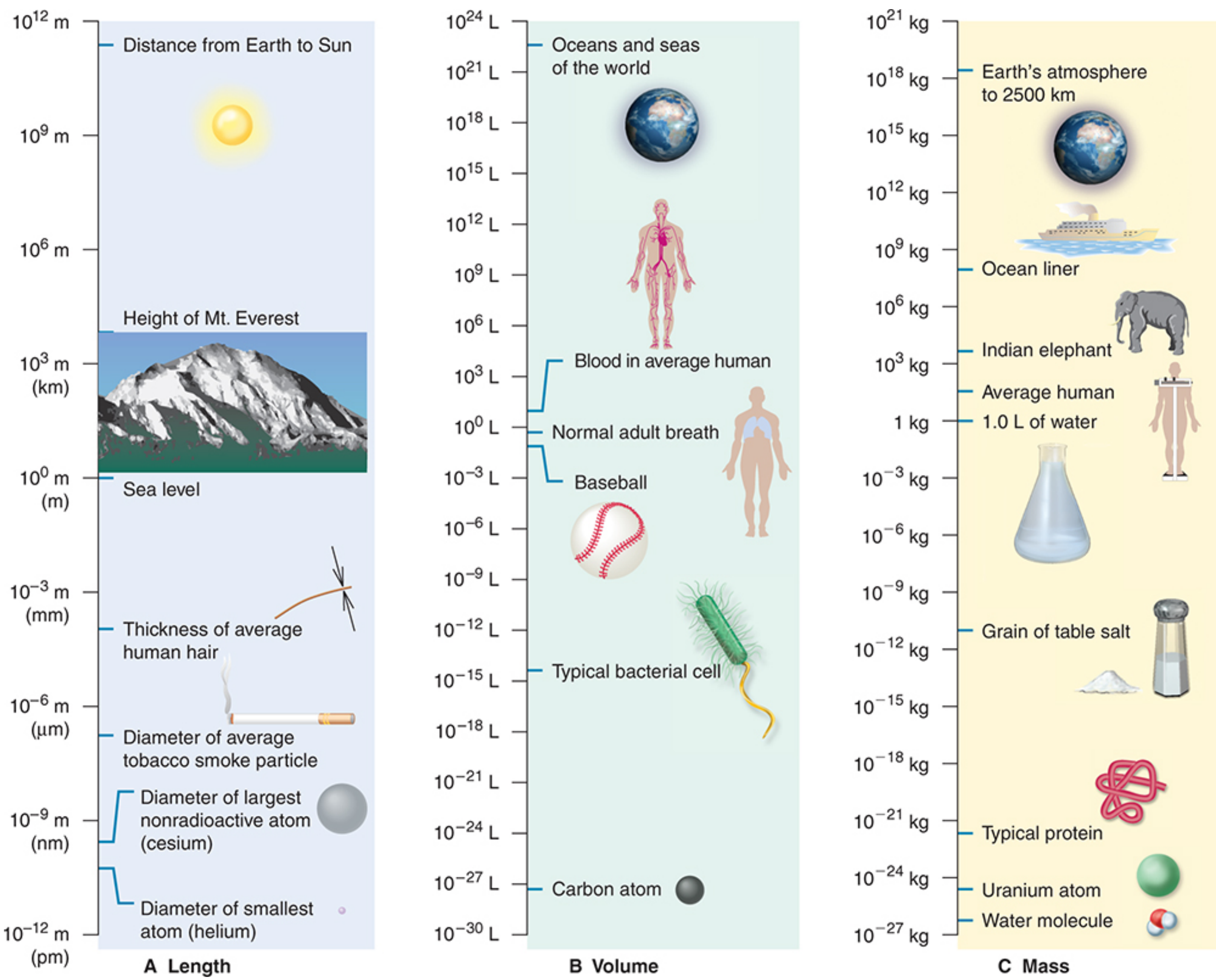
Mass

- 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):

$$1 \text{ kg} = 1000 \text{ g}$$

Fig. 1.9: A Useful Reference…



Temperature

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

Always use the temperature in K in your calculations!

Scientific measurements

- Scientific notation: N x 10^n

  6.022×10^{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 $\underline{6.73 \pm 0.01}$ 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 <u>4</u> 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!

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

$$\begin{array}{r} +0.2225 \\ +2.73 \\ +0.321 \\ \hline +3.2735 \end{array}$$

rounded to 3.27

$$\begin{array}{r} +2.06 \\ -1.1 \\ \hline +0.96 \end{array}$$

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

$2.2 \times 3.7845 = 8.32590$ → rounded to 8.3

$3.76 \div 4.236 = 0.8876298$ → rounded to 0.888

$(2.27 \times 7.324) \div 3.3 = 5.0380$ → rounded to 5.0

Rules for sig figs…

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

$\log(957) = 2.980911\ldots$ → $= 2.98$??

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

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

$= 0.980911\ldots + 2.00000\ldots$ → $= 2.981$

In summary…

- on tests and the final exam,

DON'T BE RIDICULOUS!

- on online assignments,

BE PRECISE!

Chapter 1: Key Concepts

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

Chapter 1: Suggested Problems

1.6, 1.21, 1.36, 1.44,

1.46, 1.58, 1.66, 1.71,

1.72, 1.76, 1.82, 1.86