Introduction to Physical Science

Physical Quantities and Units

Presented by Robert Wagner

Numbers in Physics

- Physics deals with scales of both the very large and very small
  - Scientific Notation - based on powers of 10
- Systems of Units
  - SI Units - Used in science worldwide
  - English Units - Used primarily in the US, outside of science

SI Units

- Fundamental and derived units
  - Fundamental units - defined only in terms of the procedure used to measure them
  - Derived units - expressed as combinations of fundamental units (velocity = distance/time)

Length	Mass	Time	Electric Current
meter (m)	kilogram (kg)	second (s)	ampere (A)

Table 1.1 Fundamental SI Units

Image Credit: OpenStax College Physics Table 1.1 CC BY 4.0

Fundamental Units

- For now, we look at three fundamental units
  - Second - 9,192,631,770 vibrations os a cesium atom
  - Meter - Distance traveled by light in 1/299,792,458 second
  - Kilogram - Mass of a platinum-iridium cylinder kept near Paris. (Now defined using the Meter, Second and Planck's Constant.)

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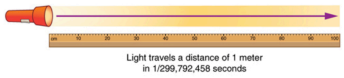

Figure 1.19 The meter is defined to be the distance light travels in 1/299,792,458 of a second in a vacuum. Distance traveled is speed multiplied by time.

Image Credit: OpenStax College Physics Figure 1.19 CC BY 4.0

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Metric Units

- Metric Prefixes:
  - Based on powers of 10
- Scientific Notation
  - Written as powers of10
  - 800 = 8 x 10^2
  - 0.045 = 4.5 x 10^{-2}

Prefix	Symbol	Value	Example (some are approximate)			
exa	E	10^{18}	exameter	Em	10^{18} m	distance light travels in a century
peta	P	10^{15}	petasecond	Ps	10^{15} s	30 million years
tera	T	10^{12}	terawatt	TW	10^{12} W	powerful laser output
giga	G	10^{9}	gigahertz	GHz	10^{9} Hz	a microwave frequency
mega	M	10^{6}	megacurie	MCi	10^{6} Ci	high radioactivity
kilo	k	10^{3}	kilometer	km	10^{3} m	about 6/10 mile
hecto	h	10^{2}	hectoliter	hL	10^{2} L	26 gallons
deka	da	10^{1}	dekagram	dag	10^{1} g	teaspoon of butter

Image Credit: OpenStax College Physics Table 1.2 CC BY 4.0

Unit Conversions

- Convert between units using dimensional analysis
  - 8000 m to km
  - 1.00 year to seconds
  - 60.0 km/hr to m/s

$$8000\ meters$$

$$8000\ meters\ x\ \frac{1\ kilometer}{1000\ meters}$$

$$8000\ \cancel{meters}\ x\ \frac{1\ kilometer}{1000\ \cancel{meters}}$$

$$\frac{8000}{1000} kilometers$$

$$8\ kilometers$$

Unit Conversions

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$$1.00\ year$$

$$1.00\ year \times \frac{365.25\ days}{1\ year} \times \frac{24\ hours}{1\ day} \times \frac{60\ minutes}{1\ hour} \times \frac{60\ seconds}{1\ minute}$$

$$= 365.25 \times 24 \times 60 \times 60\ seconds$$

$$= 31{,}557{,}600\ seconds$$

$$= 3.16 \times 10^{7}\ seconds$$

Unit Conversions

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  - 8000 m to km
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$$60.0 \frac{kilometers}{hour}$$

$$60.0 \frac{kilometers}{hour} \times \frac{1000\ meters}{1\ kilometer} \times \frac{1\ hour}{3600\ seconds}$$

$$= \frac{60.0 \times 1000}{3600} \frac{meters}{second}$$

$$= 16.7 \frac{meters}{second}$$

Summary

- Physics deals with both very large and very small numbers
- SI/metric units are used universally in science
- We can convert between units by dimensional analysis