

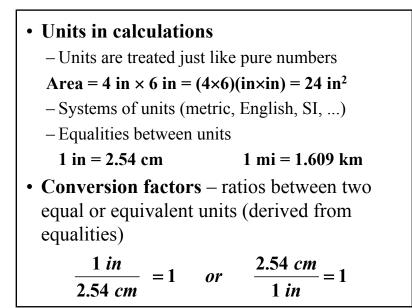
1.3 The Unit Conversion Method

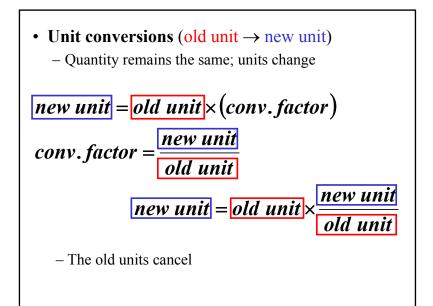
• Units of measurement

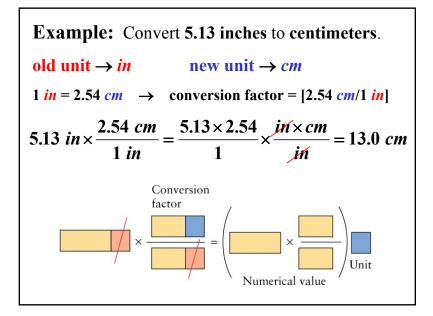
- Measurements quantitative observations
- Units standards used to compare measurements (yard → standard for comparison of length measurements)
- A measured quantity is reported as a number and a unit

(Measured quantity) = number × unit

5.5 seconds = 5.5×1 s







1.4 Measurement in Scientific Study

- Systems of units (metric, English, SI, ...)
- The International System of units (SI)
 - Based on the metric system
 - SI base units

Table 1.2 SI Base Units

Physical Quantity (Dimension)	Unit Name	Unit Abbreviation kg	
Mass	kilogram		
Length	meter	m	
Time	second	S	
Temperature	kelvin	K	
Electric current	ampere	А	
Amount of substance	mole	mol	
Luminous intensity	candela	cd	

Example:

The gas mileage of a car is 35 mi/gal. How many km can the car travel on a full 10 gal tank of gas?

1 mi = 1.609 km

$$10 \text{ gal} \times \frac{35 \text{ mi}}{1 \text{ gal}} = 350 \text{ mi}$$
$$350 \text{ mi} \times \frac{1.609 \text{ km}}{1 \text{ mi}} = 563 \text{ km}$$

• Prefixes used with SI units (denote powers of 10) – Used to express very small or very large quantities

Table 1.3 Common Decimal Prefixes Used with SI Units

Prefix*	Prefix Symbol	Meaning		
		Number	Word	Multiple ⁺
tera	Т	1,000,000,000,000	trillion	10^{12}
giga	G	1,000,000,000	billion	10^{9}
mega	Μ	1,000,000	million	10^{6}
kilo	k	1,000	thousand	10^{3}
hecto	h	100	hundred	10^{2}
deka	da	10	ten	10^{1}
		1	one	10^{0}
deci	d	0.1	tenth	10^{-1}
centi	с	0.01	hundredth	10^{-2}
milli	m	0.001	thousandth	10^{-3}
micro	μ	0.000001	millionth	10^{-6}
nano	n	0.00000001	billionth	10^{-9}
pico	р	0.00000000001	trillionth	10^{-12}
femto	ŕ	0.000000000000001	quadrillionth	10^{-15}

• Examples:

 $1 \text{ mm} = 10^{-3} \times (1 \text{ m}) = 10^{-3} \text{ m}$ $1 \text{ MW} = 10^6 \times (1 \text{ W}) = 10^6 \text{ W}$ $1 \mu s = 10^{-6} \times (1 s) = 10^{-6} s$ $1 \text{ ng} = 10^{-9} \times (1 \text{ g}) = 10^{-9} \text{ g}$

- Mass and weight
 - Mass is constant (depends on the amount of matter)
 - Weight can vary with the strength of the gravitational field
 - Mechanical balances actually measure mass

Example:

A jet engine consumes **1.1 gal** of fuel per second. How many liters of fuel does the engine need in order to operate for **1.5 hours**?

1 gal = 3.785 L 1 h = 60 min = 3600 s

Plan:

1.1 gal/s \rightarrow ? L/s 1.5 Hours \rightarrow ? minutes \rightarrow ? seconds Seconds $\times L/s \rightarrow ?L$

Example (cont.): $1.1 \frac{gal}{s} \times \left(\frac{3.785 L}{1 gal}\right) = 4.2 \frac{L}{s}$ $1.5 h \times \left(\frac{60 min}{1 h}\right) \times \left(\frac{60 s}{1 min}\right) = 5400 s$ $5400 s \times \left(\frac{4.2 L}{1 s}\right) = 22000 L$