Section 2.4 International Units of Measure

SI (Système International) is a system of measurement developed in France around the time of the revolution in the 1790's. It is used worldwide because calculations and conversions are easier than other systems. There are three countries in the world still officially using non-metric systems of measure: Liberia, Myanmar, and the US. The seven base units and their respective quantities are in the table below

Base quantity	Base unit name	Base unit symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Intensity of light	candela	cd

In the SI system, each type of unit, for example the metre or the gram, is used as a base. Then to change the unit of measure, you just need to use the system of prefixes given below.

Prefix	tera	giga	mega	kilo	hecto	deca	deci	centi	milli	micro	nano
Symbol	T	G	M	k	h	da	d	c	m	μ	n
Conversion factor	10^{12}	10^{9}	10^{6}	10^{3}	10^{2}	10^{1}	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}

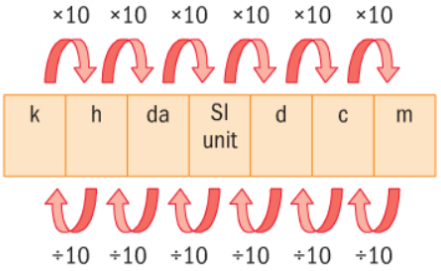
Below are non-SI units defined in terms of SI units.

Quantity	Name of unit	Symbol	Equivalents in SI units
time	minute	min	1 min = 60 s
	hour	h	1 h = 60 min = 3600 s
	day	d	1 d = 24 h = 86 400 s
area	hectare	ha	1 ha = 1 hm^2 = 10^4 m^2
volume	litre	L, ℓ	1 ℓ = 1 dm^3
mass	tonne	t	1 t = 10^3 kg

There are three temperature scales. Kelvin (K) is the only SI base unit and is mainly used by scientists. Celsius (C) is an SI derived unit used in most countries. A few other countries, including the United States use Fahrenheit (F). At the right is a table comparing Freezing and Boiling Points in each scale.

Scale	Freezing point of water	Boiling point of water
Fahrenheit (°F)	32	212
Celsius (°C)	0	100
Kelvin (K)	273.15	373.15

To convert from one SI unit of measure to another, either multiply or divide by the appropriate power of 10.



Example: Convert 34 km to cm

Using the diagram as a guide, I am going to the right. So I would multiply by 10^5.

$$34 \text{ km} \times 10^5 = 3{,}400{,}000 \text{ cm}$$

Or if it is easier, convert km to m and then m to cm...
1 km = 1000 m so 34 km = 34,000 m
1 meter = 100 cm so ⇨ 34,000 × 100 = 3,400,000 cm

Example: The volume of a vase is 1570 ml. Find the volume of the vase in litres.

There are a 1000 milliliters in a liter. Since I am going to a "larger" unit I will divide.

$$\frac{1570}{1000} = 1.57 \text{ litres}$$

Remember that when converting a unit of area or volume, each unit needs to be converted. For instance, if converting a volume in m^3 to cm^3 you have to convert $m \times m \times m$ to $cm \times cm \times cm$.

Example: A field is 91.4 m long and 68.5 m wide.

a. Calculate the area of the field in m^2

(91.4)(68.5) = 6260.9 m^2

b. Calculate the area of the field in cm^2

So to convert *m* to *cm* I would multiply by 100. Since I need cm^2 I would multiply by 100^2

$$6260.9 \text{ m}^2 \times 100^2 = 62{,}609{,}000 \text{ cm}^2$$

Example: The speed of sound in air is given as 300 ms–l(meters per second).
How many metres does sound travel in air in one hour?

There are 60 seconds in a minute and 60 minutes in an hour.

That means (60)(60) = 3600 seconds in an hour.

So meters per hour would be (300)(3600) = 1,080,000 meters

Example: The SI unit for force is the newton. If F = *ma* where F is the force on an object, *m* is the object's mass in kg, and *a* is the acceleration of the object in m s^{-2} (meters per $second^2$), find the units of a newton in terms of kg, m, and s.

Just substitute the units into the formula

F = *ma* = (kg)(m s^{-2}) = kg m s^{-2}

Example: The density ρ of an object is equal to the mass of the object divided by the volume of object. If the dimensions of a 1 kg cube of metal are 10 cm on each side, find the density of the cube in kg m^{-3}

First convert 10 cm to meters.

$$\frac{10}{100} = 0.1 \text{ meters}$$

So if it is a cube, the volume of the cube would be $(0.1)^3 = 0.001$ m^3

To find the density...

$$\rho = \frac{mass}{volume} = \frac{1 \text{ kg}}{0.001 \text{ m}^3} = 1000 \text{ kg m}^{-3}$$