

## Derived units

Volume

$$m^3$$

space

Speed

$$m/s^{-1}$$

force

$$N$$

(newton)

$$kg \cdot m \cdot s^{-2}$$

space space

frequency

$$Hz$$

(hertz)

$$s^{-1}$$

You need to be able to convert units (factor labelling)

How many seconds in a week?

$$\text{last year: } x \text{ s} = 1 \text{ week} \left( \frac{7 \text{ days}}{1 \text{ week}} \right) \left( \frac{24 \text{ h}}{1 \text{ day}} \right) \left( \frac{3600 \text{ s}}{1 \text{ h}} \right)$$

$$\text{this year: } \cancel{1 \text{ week}} \left( \cancel{7 \text{ days}} \cancel{\text{ week}^{-1}} \right) \left( \cancel{24 \text{ h}} \cancel{\text{ day}^{-1}} \right) \left( \cancel{3600 \text{ s}} \text{ h}^{-1} \right)$$

$$= 604800 \text{ s}$$

Convert:20 cm<sup>2</sup> to m<sup>2</sup>

$$20 \cancel{\text{cm}^2} \left( 10^{-2} \text{m} \cancel{\text{cm}^{-1}} \right)^2 = 20 \times 10^{-4} \text{m}^2$$

$$20 \text{cm}^2 \left( \frac{1 \text{m}}{100 \text{cm}} \right)^2 = 0.0020 \text{m}^2$$

Convert:

$$60 \cancel{\text{km}} \cancel{\text{h}^{-1}} \left( 1000 \cancel{\text{m}} \cancel{\text{km}^{-1}} \right) \left( \cancel{1 \text{h}} \left( \frac{3600 \text{s}^{-1}}{3600 \text{s}} \right) \right)$$

$$60 \text{km} \text{h}^{-1} \left( \frac{1000 \text{m}}{\text{km}} \right) \left( \frac{1 \text{h}}{3600 \text{s}} \right)$$

17 ms<sup>-1</sup>

Example

How many joules of energy are there in one kilowatt-hour

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

$\text{kW}$   $\text{h}$   
(power) (time)

$$\text{Work} = \text{power} \times \text{time}$$

$$1\text{W} = 1\text{J s}^{-1}$$

$$= 1\text{kW} \cdot 1\text{h}$$

$$= 1000\text{J s}^{-1} \cdot 3600\text{s}$$

$$= 3.6 \times 10^6 \text{J} \quad (3.6 \text{MJ})$$

Conversion factor:  $1 \text{kWh} = 3.6 \times 10^6 \text{J}$

Examples

Convert an energy of  $120 \text{kWh}$  to J:

$$120 \text{kWh} \left( 3.6 \times 10^6 \frac{\text{J}}{\text{kWh}} \right)$$

$$4.3 \times 10^8 \text{J}$$

How many kWh of energy are produced if the work done is  $7.2 \times 10^8 \text{J}$ ?

$$7.2 \times 10^8 \text{J} \left( 1 \text{kWh} \left( 3.6 \times 10^6 \text{J} \right)^{-1} \right)$$

$$200 \text{kWh}$$

Another common conversion factor is for the electronvolt:

$$1 \text{eV} = 1.6 \times 10^{-19} \text{J}$$

(More about this in TOPIC 5)

## Scientific Notation + Metric Conversions

• Express  $1.2 \times 10^9 \text{ s}$  in units of  $\text{ns}$   $\Rightarrow 1.2 \text{ ns}$

• Express  $47 \text{ GJ}$  in  $\text{J}$  in "standard form" (scientific notation)

$$47 \times 10^9 \text{ J} = 4.7 \times 10^{10} \text{ J}$$

• Express  $4.3 \times 10^{-7} \text{ m}$  (the wavelength of violet light) in  $\text{nm}$ .

$$\rightarrow 430 \times 10^{-9} \text{ m} = 430 \text{ nm}$$

• Express  $1.0 \times 10^5 \text{ Pa}$  (atmospheric pressure) in  $\text{hPa}$

$$\rightarrow 1000 \times 10^2 \text{ Pa} = 1000 \text{ hPa}$$

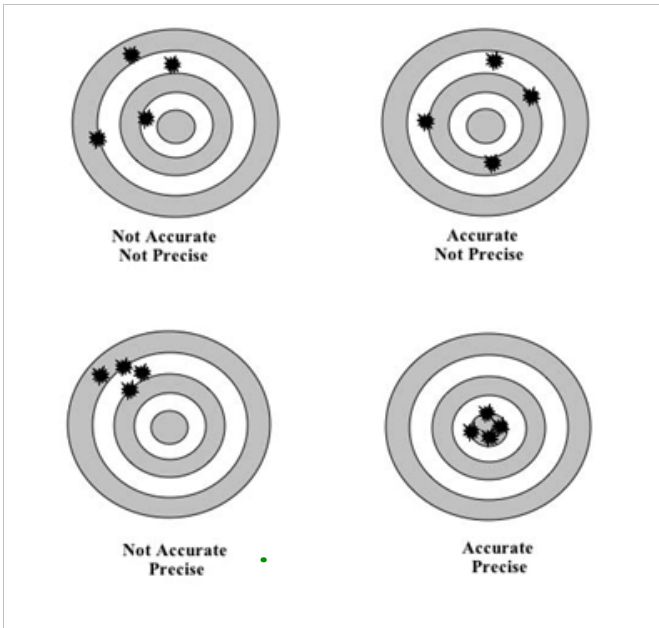
• Express  $1.5 \text{ mg}$  in  $\text{kg}$

$$1.5 \times 10^{-9} \text{ kg}$$

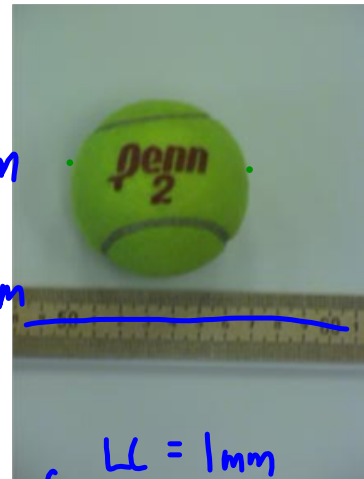
•  $25 \text{ nm}$  to  $\text{mm}$

$$0.025 \text{ mm}$$

$$2.5 \times 10^{-2} \text{ mm}$$

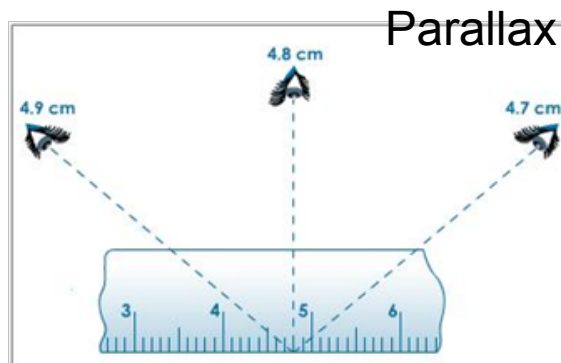


$(52 \pm 1) \text{ cm}$   
 ~~$(52.1 \pm 1) \text{ cm}$~~



LL = 1mm  
 if ball is moving  $\pm 1 \text{ cm}$

(Image Source: [http://celebrating200years.noaa.gov/magazine/tct/accuracy\\_vs\\_precision.html](http://celebrating200years.noaa.gov/magazine/tct/accuracy_vs_precision.html))



(Image Source: <http://www.tutorvista.com/content/physics/physics-i/measurement-and-experimentation/measurement-length.php>)

