2.1 The Measures of Science

The Metric System and SI

base units- units that measure the most basic quantities found in nature

Base quantity	Base unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

base (fundamental) units- units that measure the most basic quantities found in nature

derived units- units that utilize two or more basic quantities to form a more complex quantity

Base quantity	Base unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Length divided by time is velocity

m ÷ t = v

$v = m/s$

Length divided by time divided by time is acceleration

m ÷ t ÷ t = a

$a = m/s^2$

Derived Units: combination of base units used to measure additional quantities (characteristics/properties) of an event

velocity = length/time = m/s

Volume = length x length x length = m^3

density = mass/volume = kg/length x length x length = kg/m^3

force = mass x acceleration = kg x [m/(s x s) = kg m/s^2 = N

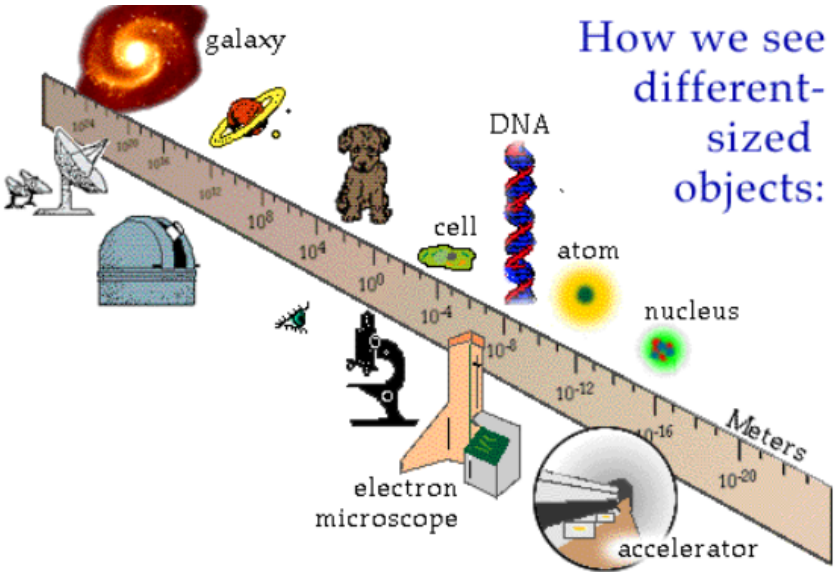
momentum = mass x velocity = kg x (m/s)

pressure = force/area = kg m/s^2 x $1/m^2$ = kg/ms^2

Metric prefixes

	prefix	*symbol*	*value*	*exponent*
	giga	G	1,000,000,000	10^9
	mega	M	1,000,000	10^6
	kilo	k	1,000	10^3
	hecto	h	100	10^2
	deka	da	10	10^1
meters, liters, etc..	base unit		1	10^0
	deci	d	0.1	10^{-1}
	centi	c	0.01	10^{-2}
	milli	m	0.001	10^{-3}
	micro	μ	0.000001	10^{-6}
	nano	n	0.000000001	10^{-9}

Scientific Notation



Converting units

key: the conversion factor is a fraction whose value is equal to "1", therefore, multiplying a measurement by it doesn't change the value of the quantity- just the units it's expressed in!

example: Little Jimmy observed an insect traveled 30 m in 1.5 hours. What is its speed in "m/s?

Note that the time is given in the wrong units, so you have to convert it before you calculate speed.

The conversion factor units have to be arranged so that the unwanted unit cancel out and the desired unit remains, so, there is only one possible arrangement of units in the conversion factor.

For changing "hours" to "seconds" you could have $\frac{1\text{ hr}}{3600\text{ s}}$ or, $\frac{3600\text{ s}}{1\text{ hr}}$

Only $\frac{3600\text{ s}}{1\text{ hr}}$ works because it's the only arrangement of units where "hours" cancel and "seconds" remain

$$1.5\text{ hr}\left(\frac{3600\text{ s}}{1\text{ hr}}\right) = 5400\text{ s}$$

Therefore v = d/t = 30 m / 5400 s = .0056 m/s

hint: if you always list the larger unit in the conversion factor at a value of "1", you will avoid fractions in your numerator or denominator

0.12 km = _____ m $\qquad$ $0.12\text{ km}\left(\frac{1000\text{ m}}{1\text{ km}}\right) = 120\text{ m}$

.12 x 1000 = 120
"km's" cancel and you're left with "m"

$\frac{1000\text{ m}}{1\text{ km}}$ NOT, $\frac{1\text{ m}}{.001\text{ km}}$ not, $\frac{1\text{ m}}{(1/1000)\text{km}}$

all three are correct and will work, but you will probably make fewer mistakes with the first one!

Another way to do the same conversion is to identify the exponent values of the measurement and the metric prefixes.

0.12 km = _____ m

1) express the measured value in scientific notation

$0.12\ km = 1.2 \times 10^{-1}\ km$

2) insert your conversion factor with the proper metric units (what you have and what you need)

$1.2 \times 10^{-1}\ km \left(\frac{\_\_\_\_m}{\_\_\_\_km} \right) = \_\_\_\_\_\ m$

3) put a "1" (or 10^0) by the largest prefix in the conversion factor

$1.2 \times 10^{-1}\ km \left(\frac{\_\_\_\_m}{10^0\ km} \right) = \_\_\_\_\_\ m$

4) outside the conversion bracket list the exponent value of the metic prefix(s) inside the bracket. In this case "m" is a base unit with a value of 1, or 10^0 , hence the 0, and kilo means 1000, or 10^3, hence, the "3"

$1.2 \times 10^{-1}\ km \left(\frac{\_\_\_\_m}{10^0\ km} \right)^{0}_{3} = \_\_\_\_\_\ m$

5) list the exponential separation of the metric units in the conversion factor (in this case there an exponential separation of 3 (meaning 10^3 or 1000)

$1.2 \times 10^{-1}\ km \left(\frac{\_\_\_\_m}{10^0\ km} \right)^{0}_{3} = \_\_\_\_\_\ m$

6) This is now the value to insert in the conversion factor

$1.2 \times 10^{-1}\ km \left(\frac{10^3 m}{10^0\ km} \right)^{0}_{3} = \_\_\_\_\_\ m$

7) Because you listed your measurement in scientific notation you can list your primary units in your answer and then and then determine the exponent

$1.2 \times 10^{-1}\ km \left(\frac{10^3 m}{10^0\ km} \right) = 1.2 \times 10^{-?}\ m$

8) determine you exponent by add (because you're multiplying) and subtracting (because you're dividing)

$1.2 \times 10^{-1}\ km \left(\frac{10^3 m}{10^0\ km} \right) = 1.2 \times 10^{-?}\ m = 1.2 \times 10^{2}\ m$

$10^{-1} \times 10^{3}$ is -1 + 3 which is 2 (10^2)
remember, when you multiply numbers (measurements) you're actually adding the exponents

$10^2 \div 10^0$ is 2 - 0, which is 2

2 stands for 10^2 - that's the exponent in you answer

recap: -1 + 3 - 0 = 2