Math Skills Toolbox

- Units of measurement
  - > S.I. Units
  - > Conversions
- Uncertainty in measurements
  - > Significant figures
- Scientific notation
- Rearranging and solving equations
- Organizing your work (GRASS)

Fri Feb 3

Scientific Measurement

Physics is a branch of science that deals with the behaviour and properties of the universe. It is the study of matter and energy, and involves measurable quantities of all sorts and sizes.

Every number you deal with in physics means something important. Even if you didn't perform the measurement yourself, you must assume that someone, somewhere did a measurement to produce that number. This means that all numbers require a meaningful unit of measurement, and you must account for the accuracy with which it was measured in your calculations.

A **measurement** is quantity that has both a **number** and a **unit.** In some cases, it may also require a **direction** (if it's a vector).

Example:

Measurement

Scientific Measurement

The units typically used in the sciences are those of the **International System of Measurements (SI Units)**

Quantity	Base Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric Current	ampere	A
Temperature	Kelvin	K
Light intensity	candela	cd
Amount of substance	mole	mol

measurements

Unit Conversions

Dimensional Analysis is all about canceling units - "boxes" or "building a bridge"

Conversion factors are ratios (fractions) of equivalent measurements - the metric scale provided on the top of your formula sheet shows some conversion factors.

Example of Unit Conversions:
1 dollar = 4 quarters = 10 dimes = 20 nickels (all equivalent)

1 year = 365 days
1 day = 24 hours
1 hour = 60 minutes
1 minute = 60 seconds
1 m = 100 cm
1km = 1000 m

1 HOUR
60 min

(small number, larger unit)

Unit Conversions

Metric System Conversions

Prefix	*tera*	*giga*	*mega*	*kilo*	*hecta*	*deka*		*deci*	*centi*	*milli*	*micro*	*nano*	*pico*
Sym.	T	G	M	k	h	da		d	c	m	u	n	p
Scale	10^{12}	10^{9}	10^{6}	10^{3}	10^{2}	10^{1}	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}

Steps to follow:

1) Write down what you are given, including units.

2) Set up a ratio (fraction) beside it. Put in the units first so that they cancel out properly (top & bottom).

3) Your conversion factor (numbers) will depend on what units you start & end with. Check your metric scale to see how many places you must jump. *"There are 10^{2}cm in 1 m"*

4) Think logically. For example, km are a larger unit than cm. A large number of cm will equal a small number of km.
(Remember that positive exponents make large numbers & negative exponents make tiny decimals)

Conv. Factor Rules

Metric System Conversions

Prefix	*tera*	*giga*	*mega*	*kilo*	*hecta*	*deka*		*deci*	*centi*	*milli*	*micro*	*nano*	*pico*
Sym.	T	G	M	k	h	da		d	c	m	u	n	p
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Ex 1: Convert 6.5 km to m

Ex 2: Convert 2.3 ng to mg

Ex 3: Convert 1.0 Mg to cg

Ex 4: Convert 47 cm to km

Metric Conversion Factors

Unit Conversions

Some units are composite, and made of more than one kind of unit, while some are **not metric** (sets of 10), like the units used to measure **time**...

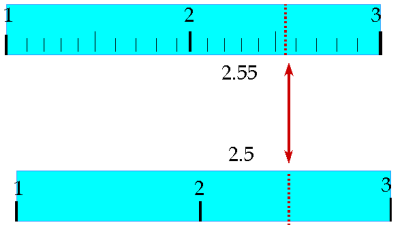
Ex 1: Mrs Logan turned 30 in October. How many seconds old was she on her birthday?

Ex 2: Physicists prefer to measure velocity in meters per second (SI Units). Convert 50 km/h into m/s.

Conv. Factor Rules

Scientific Measurement

Every measurement is an estimate - our certainty depends on how well we use the tool, and the precision of the tool itself.



For example, you can get a more accurate measurement if you use a tool that is divided into smaller units, but the final decimal place you record is still always a guess.

Uncertainty in measurements\

Carrying Uncertainty through Calculations

Math cannot magically make your final answer more precise than any of the original measurements you used... so as a general rule, make sure your answer's precision matches the least precise measurement that you put into the math...

There are two main rules:

RULE 1:
When **adding and subtracting,** match your answer to the original measurement that had the fewest **decimal places.**

Ex: 12.65 m + 0.306 m - 9.1 m =

Uncertainty in Math

Carrying Uncertainty through Calculations

RULE 2:
When **multiplying and dividing,** match your answer to the original measurement that had the fewest **significant figures.**

All digits in a standard number are significant (need to be counted) EXCEPT leading zeros.

How many sig figs?

24.7 m	**0.006702 m**	**43.00 g**
1.010 s	**300 mg**	**3.00 x 10^2**

Ex: *(12.65 m)(0.306 m) =*

Sig Figs

Scientific Notation

Scale of the Universe Applet

Sometimes we need to write HUGE numbers or TEENY numbers but we're only allowed a certain number of significant figures...

Examples:
- the velocity of a car (110 km/h)
- the distance to the nearest galaxy (2,900,000 ly)
- the radius of a hydrogen atom (0.000000000053 m)

Bulky numbers like this can be hard to deal with, so a system called ***Scientific Notation*** was created to make them shorter and easier to handle. The normal version is called Standard Form.

Ex 1: 2,900,000 ly =

Ex 2: 0.000000000053 m =

Sci Not

Scientific Notation

To compress a standard number into scientific notation
- Move the decimal to the right/left until you only have 1 digit befor the decimal.
- Count the number of places you had to move the decimal. This number is the exponent in your power of 10.
- >If you had a large number and moved the decimal left, use a positive exponent.
- >If you had a small number and moved the decimal right, use a negative exponent.

Try it! Convert each to Scientific Notation with only 3 sig figs:

Ex 1: 842,700,164 s =

Ex 2: 0.00060347 km =

SF to Sci Not

Scientific Notation

To expand a number from scientific notation to standard form

- Check the exponent in your power of 10. It tells you the number of places you must move the decimal point.
  - >If the exponent is negative, your number is small and the decimal must move left.
  - >If the exponent is positive, your number is big and the decimal must move right.

Try it! Convert each back to Standard Form:

Ex 1: 7.63×10^{6} g =

Ex 2: 9.221×10^{-8} km =

Sci Not to SF

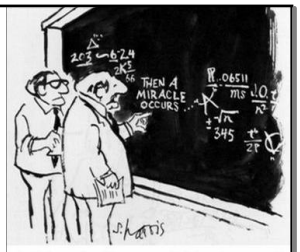
Rearranging Equations

Use BEDMAS backwards to "undo" everything that's being done to the variable you want to isolate.

Ex 1: Solve for m in $y = mx + b$

Ex 2: Solve for a in $v_f = v_i + at$

Ex 3: Solve for v_i in $d = \frac{(v_f + v_i)t}{2}$



"I think you should be more explicit here in step two."

Rearranging Equ

Problem Solving using GRASS

Given
Required
Artwork/**A**nalysis
Solution/**S**ig. Figs
Statement

Ex: Find the volume of a box that has a length of 30.0 cm, a height of 10.0 cm, and a depth of 5.0cm.

GRASS

Attachments

chtr22.pdf

chtr35.pdf

chtr33.pdf

chtr21.pdf

chtr34.pdf

chtr37.pdf