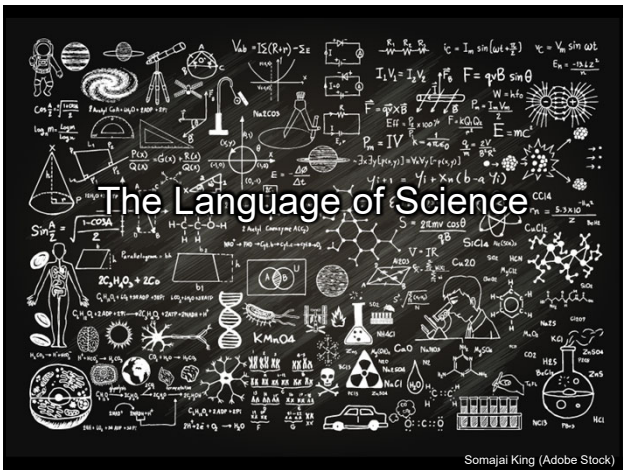


Somajai King (Adobe Stock)

Units

- The measurements of physical quantities are expressed in terms of units.

Physical Quantity	Units
time	second (s)
mass	kilogram (kg)
distance	meter (m)
volume	liter (L)
speed	meters/second (m/s)
temperature	Celsius (°C)

SI Prefixes

Small

centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Large

kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{9}
terra	T	10^{12}

Converting Units

- Calculations are done using base units.
- To convert to base units, multiply the value by the appropriate multiplier.

$$2\ \text{nm} = ?\ \text{m}$$

The multiplier for nano is 10^{9}.

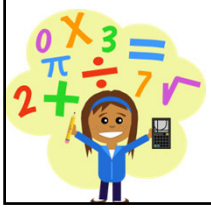
$$2\ \text{nm} = 2 \times 10^{-9}\ \text{m}$$

- To convert from base units to a prefixed value, divide by the appropriate multiplier.

$$5000\ \text{m} = ?\ \text{km}$$

The multiplier for kilo is 10^{3}.

$$\frac{5000\ \text{m}}{10^{3}} = 5\ \text{km}$$



Examples

$$50\ \mu\text{m} = \underline{\quad 50 \times 10^{-6} \quad}\ \text{m}$$

$$250\ \text{g} = \underline{\quad 0.25 \quad}\ \text{kg}$$

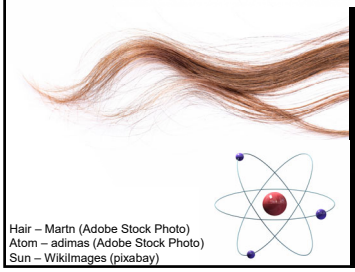
$$\frac{250}{10^{3}}$$

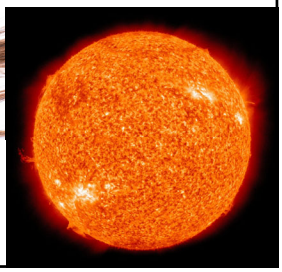
Scientific Notion

- Many measurements we encounter are values that are easily understood and manipulated.
  - Volume of a soda can = 355 mL
  - Distance from Winnipeg to Toronto = 2000 km

Soda – Aaron Holmes (Pixabay)
Map – Jill (Pixabay)

- But there also are extreme values.
  - Width of a human hair = 0.00005 m
  - Radius of an electron = 0.00000000000047 m
  - Mass of the sun = 2000000000000000000000000000000 kg

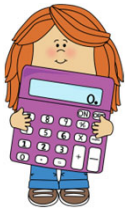




Hair – Martn (Adobe Stock Photo)
Atom – adimas (Adobe Stock Photo)
Sun – WikiImages (pixabay)

- A shorthand method of writing very small and very large numbers is called scientific notation, in which we express numbers in terms of exponents of 10.
- Scientific notation follows the general format $a \times 10^n$. Where a is a decimal number and n is an integer.
  - 1.67×10^{-27}
  - 5.97×10^{24}

- To write a number in scientific notation, move the decimal point to the right of the first digit in the number.
- Count the number of places that you moved the decimal point.
- The number of places moves is the exponent.



- For large numbers, the decimal moves to the left and the exponent will be positive.

$$123.000.000.000.$$

$$1.23 \times 10^{11}$$

- For small numbers, the decimal moves to the right and exponent will be negative.

$$0.000.000.001.23$$

$$1.23 \times 10^{-9}$$

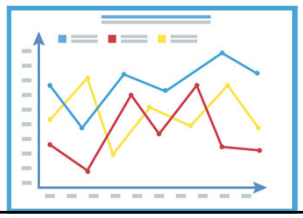
Examples

$250\ 000\ 000\ \text{m} =$ $2.5 \times 10^{8}\ \text{m}$

$0.000\ 006\ 8\ \text{kg} =$ $6.8 \times 10^{-6}\ \text{kg}$

Graphing

- Making a graph helps you see how two factors called variables are related.
- A line graph has a horizontal x-axis and a vertical y-axis.



robu_s (Adobe Stock)

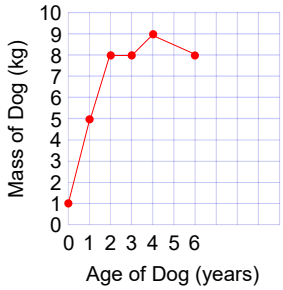
- When making a line graph make sure to:
  - Create an appropriate title and axis labels.
  - Place the independent variable (the one that we change) on the x-axis.
  - Place the dependent variable (the one that we are measuring) on the y-axis.
  - Create a reasonable scale for each axis.
  - Plot the points and connect them with straight lines.

Example

- Use the data to draw a line graph.

Age of Dog (years)	Mass of Dog (kg)
0	1
1	5
2	8
3	8
4	9
6	8

Mass of a Dog vs. Its Age



Algebra

- Scientists use equations to express physical relationships between measurable quantities.
- Algebra is the tool that scientists use to relate one equation to another, or to convert an equation into a more useful form.

- To solve an algebraic equation, we need to "undo" the operations and isolate the variable.

$x + 3 = 5$

To undo the addition, we need to subtract 3 from both sides of the equation.

$x + 3 - 3 = 5 - 3$

$x = 2$

$x - 2 = 6$

To undo the subtraction, we need to add 2 from both sides of the equation.

$x - 2 + 2 = 6 + 2$

$x = 8$

$2x = 8$

To undo the multiplication, we need to divide 2 from both sides of the equation.

$\frac{2x}{2} = \frac{8}{2}$

$x = 4$

$\frac{x}{3} = 4$

To undo the division, we need to multiply 3 from both sides of the equation.

$3 \times \frac{x}{3} = 4 \times 3$

$x = 12$

- Some equations take more than one step to solve.

$$2x + 3 = 7$$

Subtract 3 from both sides.

$$2x + 3 - 3 = 7 - 3$$

$$2x = 4$$

Divide both sides by 2.

$$\frac{2x}{2} = \frac{4}{2}$$

$$x = 2$$

$$\frac{x - 4}{3} = 1$$

Multiply both sides by 3

$$3\frac{x - 4}{3} = 1 \times 3$$

$$x - 4 = 3$$

Add 4 to both sides.

$$x - 4 + 4 = 3 + 4$$

$$x = 7$$

$$\frac{6}{x} = 3$$

Multiply both sides by x

$$x\frac{6}{x} = 3x$$

$$6 = 3x$$

Divide both sides by 3.

$$\frac{6}{3} = \frac{3x}{3}$$

$$2 = x$$

or

$$x = 2$$