Unit 1 - Physical Quantities and Units

QUANTITY	SIZE
DIAMETER OF AN ATOM	10^{-10} m
WAVELENGTH OF UV LIGHT	10 nm
HEIGHT OF AN ADULT HUMAN	2 m
DISTANCE BETWEEN THE EARTH AND THE SUN (1 AU)	1.5×10^{11} m
MASS OF A HYDROGEN ATOM	10^{-27} kg
MASS OF AN ADULT HUMAN	70 kg
MASS OF A CAR	1000 kg
SECONDS IN A DAY	90000 s
SECONDS IN A YEAR	3×10^{7} s
SPEED OF SOUND IN AIR	300 ms^{-1}
POWER OF A LIGHTBULB	60W
ATMOSPHERIC PRESSURE	1×10^{5} Pa

- Speed and velocity are examples of physical quantities. They can both be measured.
- All physical quantities have a magnitude (which is numerical) and a unit
- The letter *v* is used to represent the physical quantities of velocity, volume or voltage
- The units provide the context as to what *v* refers to
  - If *v* represents velocity, the unit would be m s^{-1}
  - If *v* represents volume, the unit would be m^3
  - If *v* represents voltage, the unit would be V

All physical quantities must have a numerical magnitude and a unit

Estimating Physical Quantities

- There are important physical quantities to learn in physics
- It is useful to know these physical quantities as they come in useful when making estimates
- A few examples of useful quantities to memorise are:

SI Units

All the different units in physics can be reduced to 6 base units from which every other unit can be derived: SI Base units.

Quantity	SI Base Unit	Symbol
Mass	Kilogram	kg
Length	Meter	m
Time	Second	s
Current	Ampere	A
Temperature	Kelvin	K
Amount of Substance	Mole	mol

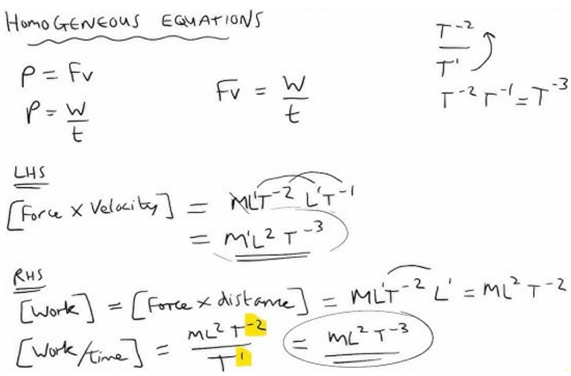
Derived units are derived from the seven SI Base units. The base units of physical quantities such as Newtons (N), Joules (J), and Pascals (Pa) can be deduced from them.

To deduce the base units, it is important to use the definition of the quantity:

Newtons (N), the unit of force, is defined by the equation: Force = mass × acceleration
N = kg × m s^{-2} = kg m s^{-2}
Therefore, the Newton (N) in SI base units is **kg m s^{-2}**

Joules (J), the unit of energy, is defined by the equation: Energy = ½ × mass × velocity2
J = kg × (m $s^{-1})^2$ = kg m^2 s^{-2}
Therefore, the Joule (J) in SI base units is **kg m^2 s^{-2}**

Pascals (Pa), the unit of pressure, is defined by the equation: Pressure = force ÷ area
Pa = N ÷ m^2 = (kg m s^{-2}) ÷ m^2 = kg m^{-1} s^{-2}
Therefore, the Pascal (Pa) in SI base units is **kg m^{-1} s^{-2}**



Homogeneity of Physical Equations

Homogeneity is when something is all the same, or when everything is the same kind. Homogeneity of equations means that the units on either side of the equation are balanced. To do this, we must:

- → Check the units on both sides of an equation
- → Determine if they're equal
- → If they aren't we must balance the equation

Powers of 10

Powers of 10 are numbers that are acquired by multiplying 10 a certain number of times by itself e.g. 10 times itself 6 times is 10^6.

PREFIX	ABBREVIATION	POWER OF TEN
TERA–	T	10^{12}
GIGA–	G	10^{9}
MEGA–	M	10^{6}
KILO–	k	10^{3}
CENTI–	c	10^{-2}
MILLI–	m	10^{-3}
MICRO–	μ	10^{-6}
NANO–	n	10^{-9}
PICO–	p	10^{-12}

Scalars and Vectors

A scalar is a quantity which only has a magnitude (size) while a vector is a quantity which has both a magnitude and a direction. For example, speed is a scalar quantity because it only has a magnitude: how fast the object is moving. Velocity on the other hand is a vector quantity because it has both direction and magnitude: the speed of the object and the direction in which it is going.

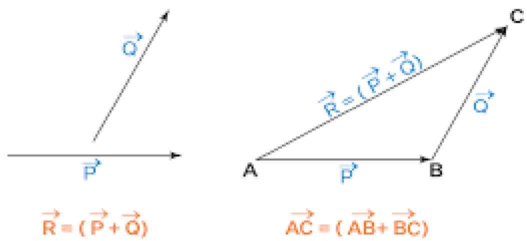
Combining vectors

Vectors are represented by an arrow. The arrowhead indicates the direction of the vector, and the length of the arrow represents the magnitude. Vectors can be combined by adding or subtracting them from each other to form a single vector known as the resultant vector.

There are two methods that can be used to combine vectors: the triangle method and the parallelogram method

The triangle method:

1) Link the vectors head-to-tail
2) The resultant vector is formed by connecting the tail of the first vector to the head of the second vector



To combine vectors using the parallelogram method:

1) Link the vectors tail-to-tail
2) Complete the resulting parallelogram
3) The resultant vector is the diagonal of the parallelogram