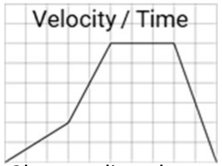
Vectors have a number with a unit and a direction.
Displacement / Velocity / Forces / Acceleration / Momentum
Scalars only have a number with a unit.
Distance / Speed / Mass / Temperature / Energy $g = 10m/s^2$

Slope on line shows speed. Steeper line= faster speed.
No slope = No motion = Stationary



Slope on line shows acceleration. Steeper line= greater acceleration.
No slope = No acceleration
Area under line = distance

N1 – forces affect motion (resultant force)
N2 – F = a x m (a is proportional to f/m)
N3 – Equal and opposite reaction (forces from 2 objects interacting)

Stopping d = braking d + thinking d
Stimulants ↑rxn
Depressants ↓rxn

-v and +v are the same rate but opposite directions.
(H) Momentum before collision = momentum after.
(H) a at constant speed if changing direction.

Δ = Delta means change and g = 10N/Kg

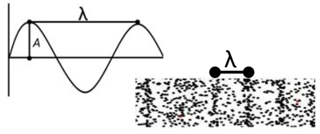
Energy transferred also known as work done. Energy is the ability to do work. Unit is joules
(GPE) E_p= high objects / (KE) E_k=moving objects
Thermal = internal energy / Chemical = burn / charge
Falling objects all GPE = all KE before impact

Forces also called transfers. Transfers are actions.
Heating / Forces (incl. weight/gravity) / Radiation / Electrical Work

Friction – heat is lost in mechanical systems (lubrication)
Insulation – reduces heating of surroundings by object
Conductivity – how easy to let heating occur, more is bad

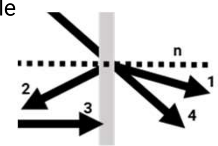
Efficiency – how much energy is used usefully.
0 to 1 or 0% to 100% - nothing is 100%
Sometimes we assume 100% efficiency (falling rock)

Transverse waves oscillate perpendicular to the direction of the wave
Light, EM waves (RMIVUXG), water ripples
Longitudinal waves oscillate parallel to the direction of the wave.
Sound, some seismic waves



Frequency (f) – waves per second
Wavelength (λ) – length of one wave
Period (T) – time for one full wave $T = \frac{1}{f}$
Amplitude (A) – displacement of particle / wave energy

Refraction (1) – slows / speeds & bends (towards n = slows)
Reflection (2) – bounces at same speed and angle
Absorb (3) – doesn't pass through medium
Transmit (4) – goes through medium



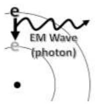
Normal line (n) – measure angles from ray to n
The path light takes if there is no refraction
When light goes from less dense to more dense – slows down and λ↓
Δλ mean different degrees of refraction. Lower Lambda Loads of R

EM wave velocity 300,000,000m/s in a vacuum, change v in new media
all EM waves are transverse and transfer energy.

R M I V U X γ
ROYGBIV
Red light travels faster through denser media as it has longer λ

γ causes more tissue damage as higher f (Hertz more, Hurts more)
Higher f means more energy transferred (mutate = cancer)
M: heat cells / I: skin burns / U: damage cells, mutate / X,γ: mutate

R:TV, radio (refracts in atmosphere) M: cooking, comms, satellite
I: cooking, thermal images, optical fibres V: vision, photography
U: security marks, fluorescent, disinfection X: internal scans (medical)
γ: sterilisation, cancer treatment.



Electrons oscillate in wires = makes radio waves
EM waves released when electron fall from higher energy levels.

	Mass	Charge	Location
Proton	1	+	nucleus
Neutron	1	0	nucleus
Electron	0	-	shells

Isotopes: same number of protons, different neutrons.
C_6^{12} 6P, 6N, 6e / C_6^{13} 6P, 7N, 6e / C_{14}^{6} 6P, 8N, 6e (massive number)

Atoms form positive ions by losing electrons.
Electrons ↑ energy levels with absorption of EM radiation
Electrons ↓ energy levels with emission of EM radiation

This is not nuclear radiation. Nuclear decay releases radiation.
Unstable atoms decay randomly and release energy as radiation.
Releasing energy makes atom more stable (nuclear decay)

Background radiation: constant, natural low level radiation.
Radon gas, cosmic rays, food and drink, medical scans, nukes
Activity(rate of decay, unit is Bq). Count-rate number of decays per s

Alpha (α or $^{2}_{4}He$) 2 P and 2 N emitted from the nucleus.
Beta minus (β^- or $^{0}_{-1}e$) electron emitted from the nucleus. N → P + e^-
Positron (β^+ or $^{0}_{+1}e$) positron emitted from the nucleus. P → N + e^+
Gamma (γ) EM radiation, no mass, no charge.

Type	Ionisation	Penetration	Charge
Alpha	High	Low	+2
Beta -	Medium	Medium	-1
Beta +	Medium	Medium	+1
Gamma	Low	High	0

PeePee? NoNo!
No Pee ☹
Pee Now ☺

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$$

Atoms - p1900: simple spheres p1911: electron plums in pudding
1911: alpha scattering, foil, nucleus +ve. Bohr, electron levels.
Half life: time taken for ½ the nuclei in sample to decay or activity to ½

Radiation damage: ionise cells, damage cells, mutations, cancer
Contamination: in contact with source, object radioactive after.
Irradiation: exposed to radiation, not radioactive after.
Protection: distance, limit dose, protective clothing, no licking

Usually – physics experiments are about measuring values of terms in equations. Eg. find speed, measure distance and time. For experiments or other questions ALWAYS try to find an equation.

E – what equipment do you need to measure the terms / DV
P – how do you use the equipment
I – how are you measuring the IV / important value
C – how can you keep all other variables the same.
RAVE – Repeat and average / repeat and change it slightly.

CV must be limited so any change is due to IV changing:
Reduce reaction time using automatic timer (not just electronic)
Sound moves at 330m/s so use big distances or microphones + PC
Use markers when resetting experiments = same place of release
Lightgates only useful for trolleys not large objects
Measuring (radioactivity) keep detector same distance for same time
Repeats are only useful if averaged
Reduce friction with lubrication, insulation reduces heating transfers

Example: find the speed of waves in a water tank.
Equation is v=x÷t.
E:ripple tank, ruler, stopwatch, camera.
P:place ruler next to ripple shadows / edge of tank. Use stopwatch, time how long one wave takes to travel 20cm (0.2m)
I:the important value is v so v=x÷t
C: keep tanks at eye level, if waves are moving too fast use camera to record exact times, use markers to easily see 0cm and 20cm
RAVE: repeat 10 times, find average.

Example: find the speed of waves in a metal bar.
Equation is v=f x λ
E:metal bar, rubber band, 2 clamps, hammer frequency app.
P: measure length of bar and x2 to measure standing wave length, place frequency measuring app next to bar, hit with hammer.
I:the important value is v so v=f x λ
C: if testing different metals use same length bar / same rubber bands.
RAVE: repeat 10 times, find average.

prefix	Symbol	Multiply by
Giga	G	$X10^{9}$
Mega	M	$X10^{6}$
Kilo	k	$X10^{3}$
Centi	c	$X10^{-2}$
Milli	m	$X10^{-3}$
Micro	μ	$X10^{-6}$
Nano	n	$X10^{-9}$
Pico	p	$X10^{-12}$

Triangles for formulas are not proof you know the formula. Use them, but then write the equation in full.
Terms that are multiplied together form the base of the triangle.
Terms at the top of the top of a division (numerator) are at the top of the triangle.

Meter (m), speed (m/s), velocity (m/s), acceleration (m/s^2), time (s), force (N), energy (J), mass (kg), frequency (Hz), wavelength (m), work done (J), energy transferred (J), power (W)

If asked for significant figures, then mark the first three numbers from the left. Round the third number (x>5 up, x<5 down)