PHYSICS A LEVEL NOTES: UNIT 1

KINEMATICS I

Scalars and Vectors:

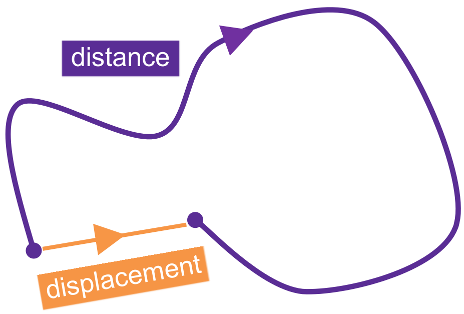
Scalar: quantity that only has magnitude (size)

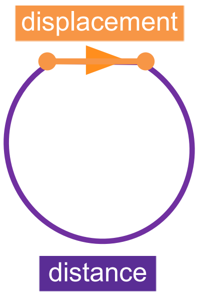
Vector: quantity that has magnitude AND direction

Scalars	Vectors
mass, time, distance, speed, energy, temperature, length	velocity, acceleration, displacement, force, momentum

Distance (scalar quantity): a measure of the total length you have moved

Displacement (vector quantity): a measure of how far you are from the starting position in a given direction





If you complete a lap of an athletics track:
distance travelled = 400m
displacement = 0

- Speed: how fast something is moving (regardless of direction)
- Velocity (v): the rate of change of displacement (its speed in a given direction)
- Acceleration (a): the rate of change of velocity

Acceleration could mean a change in speed or direction or both (turning →acceleration)

Motion with constant velocity/speed

A body covers the same distance in fixed time intervals in a specific direction

$$speed = \frac{distance}{time} \qquad v = \frac{d}{t}$$

$$velocity = \frac{change\ in\ displacement}{time} \qquad v = \frac{\Delta x}{\Delta t}$$

Uniform=constant

u = initial velocity

v = final velocity

a = acceleration

t = time taken

FLUIDS

Fluid: any substance that can flow (usually gas or liquid)

Density

- **Density** is a measure of the mass per unit volume of a substance
- It only depends on the **material** an object is made of. It does NOT depend on size or shape

$$density = \frac{mass}{Volume}$$

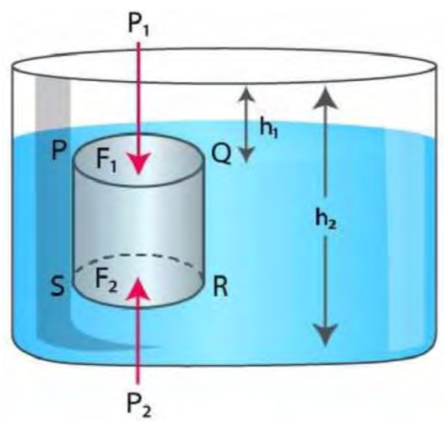
The units of density are g cm^{-3} or kg m^{-3}

1 g cm^{-3} =1000 kg m^{-3}

$$\rho = \frac{m}{V}$$

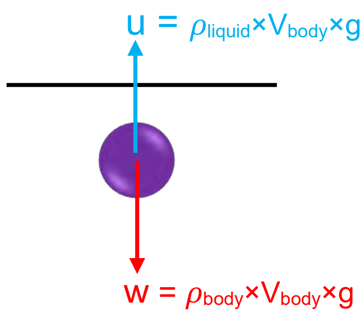
Upthrust

Upthrust is a constant **upward force** that fluids exert on objects that are completely or partially submerged in it



It's caused because the top and bottom of a submerged object are at different depths. Since p = ρgh there is a difference in pressure which causes an overall upward force known as upthrust

Archimedes' principle says that when a body is completely or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid it has displaced



$$upthrust = weight\ of\ displaced\ liquid$$

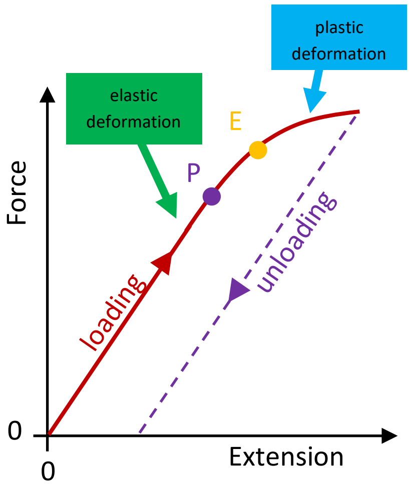
$$U = \rho g V$$

ρ: density of surrounding liquid displaced

V: volume of the object immersed

mass, if the object was filled with the surrounding liquid

Loading-Unloading graph



• This graph is for a metal wire that has been stretched beyond its limit of proportionality (P) so it starts to curve. As the load is gradually removed, the extension decreases

• The **unloading line** is **parallel** to the **loading line** because the stiffness constant, k is still the same

• The wire was stretched beyond its elastic limit (E) and deformed plastically so it has been permanently stretched. That's why the unloading line doesn't go through the origin

• The area between the two lines is the work done to permanently deform the wire

Elastic strain energy

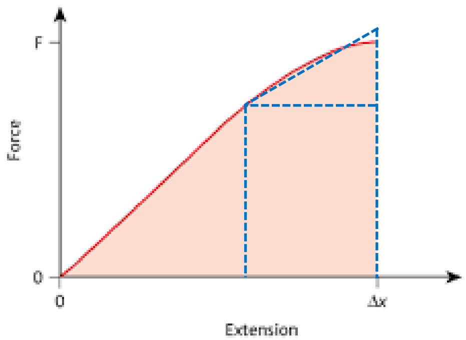
The work done in stretching a spring is stored as **elastic strain energy** in the material (before the elastic limit is reached). The energy stored in the stretched spring is equal to work done on it as it is stretched which is a result of the average force used to stretch it to extension, Δx. Since the force increases from 0 to F as the spring is stretched force is given by $\frac{0+F}{2} = \frac{F}{2}$

So, work done is:

$$work\ done = E_{el} = \frac{1}{2}Fx$$

or : $$E_{el} = \frac{1}{2}kx^2$$

The formulae only apply when Hooke's Law is obeyed



On a force-extension graph the elastic strain energy is equal to the area under the graph. If the graph is non-linear (a curve) we can only estimate the area by counting squares or dividing the curve into trapeziums