

Scalar: Magnitude only (distance, speed, energy).

Vector: Magnitude and direction (velocity, displacement, acceleration).

- Remember to distinguish between **Average** velocity and **INSTANTANEOUS** velocity. Make sure to underline such words.
- If a direction is given, answer in terms of direction. If not, answer in terms of $\pm$ or $\rightarrow$ or $\leftarrow$ if needed.
- Remember to always keep the $\pm$ sign in front of vectors if they have them during calculations!

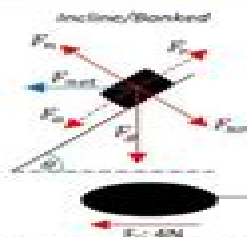
$$x = \frac{1}{2}(u + v)t$$

$$v = u + at$$

$$v^2 = u^2 + 2ax$$

$$x = ut + \frac{1}{2}at^2$$

$$x = vt - \frac{1}{2}at^2$$



Incline diagram

Banked diagram



Work done by car ON THE ROAD would be 4N times the distance if it's at constant v , if it is accelerating, it would be 4N plus ma (mass of rock, times distance. 4N plus ma would also be the tension in the string, as it is the force on the rock to move it PLUS the force of friction being fought. 9N would be the force to accelerate the WHOLE SYSTEM, so you would use that to work out acceleration.

- 1st = A body in motion will remain in motion unless acted upon by an unbalanced force.
- 2nd = $F = ma$.
- 3rd = Every force has an equal and opposite force.

Remember to always add up velocities and stuff with vectors, which allows you to account for 90 degree turns and what not. Do not use this for more complicated things such as momentum. Use conservation of energy instead.

For Gravity:

F = force exerted on one body by the other

G = gravitational constant = $6.67 \times 10^{-11} \text{Nm}^2/\text{kg}^2$

R = distance between centre of bodies (and radius of orbit in most cases)

T = period of orbit

NOTE: Altitude $\neq R$, if R = altitude + radius of earth.

M = mass of bigger object

m = mass of smaller object

R = distance between centre of bodies (and radius of orbit in most cases)

T = period of orbit

NOTE: Altitude $\neq R$, if R = altitude + radius of earth.

$$F \propto \frac{1}{R^2}$$

Two significant bodies acting upon each other:

$$F = \frac{GMm}{R^2}$$

where F is the force acting on each body and R is the centre of bodies. (This is Newton's Law of Gravitation)

$$a = \frac{GM}{R^2}$$

where a is the acceleration on M or m from the other body.

Point between two bodies where acceleration due to gravity equals 0:



$$\frac{M}{x^2} = \frac{m}{(R-x)^2}$$

Where x = distance from M

Then simply solve for x as you are basically using the acceleration equation to find where acceleration due to one body = acceleration due to the other.

Satellite orbits:

The mass of the satellite is too small to consider the centre of the orbit as the centre

Elastic collisions: Momentum and energy is **ISOLATED** system and conserved.

Inelastic collisions: Momentum is conserved but energy is not.

$$p = mv$$

$$I = F\Delta t = \Delta p$$

Time in this case is the impact/contact time, amount of time required to change momentum, not touching time.

Force-time graphs: Area = Impulse

So you often have to work with the change in momentum and calculate forces depending on contact time. Increased contact time with the same impulse equals a lower force exerted.

Energy: The ability of an object to do work.

Power: The rate at which work is done.

Gravitational Potential Energy: Potential energy able to be exerted due to force of gravity. (Often done by gravity is mgh or $mgh/2$)

Elastic Potential Energy: Potential energy able to be exerted due to force from elastic constraint.

$W = Fx$ (J or Nm) Remember to get the force in the direction of the displacement.

$$KE = \frac{1}{2}mv^2$$

$$GPE = mgh$$

$$EPE = \frac{1}{2}kx^2$$

k is the spring constant (new m^{-1})

$$P = \frac{Fx}{t} = Fv \text{ (Watts)}$$

Hooke's Law:

Force exerted by a spring during compression or extension. $F = -kx$, it is negative because the force is applied in the opposite direction to compression or extension.

Note: This equation is only for the equilibrium point! (When masses are hung on springs)

Force compression/extension graphs:

Gradient of straight section = k (New m^{-1})

Where the graph curves off is the elastic limit, where any further compression/extension causes permanent distortion.

Area = EPE at a specific point of compression/extension.

Steeper gradient = stiffer, so more force must be exerted for greater distortion.

Circular motion:

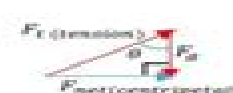
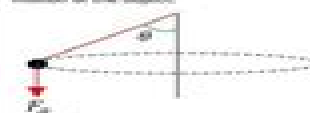
There is always a constant centripetal force to the centre of circular path (horizontally) to keep an acceleration a_c towards the centre.

$$v = \frac{2\pi r}{t}$$

$$a = \frac{v^2}{r} = \frac{4\pi^2 r}{t^2}$$

$$F = ma = \frac{mv^2}{r} = \frac{4\pi^2 rm}{t^2}$$

Note that the centripetal force does no work on the object in circular motion, as it applies force perpendicular to the direction of motion of the object.



Banked track derived formula:

$$\text{Angle of bank } \theta = \tan^{-1} \left(\frac{v^2}{gr} \right)$$

Vertical motion:

Critical speed: Speed required to complete a loop (under) without experiencing a normal force from the top due to the track, and the speed required to complete a loop (over) without lift off, so there is again no normal force from track below.

For loops over, speed ABOVE critical causes lift off, and for loops under, speed BELOW critical causes object to lift off track (or roll back down if bound to track).

For over, centripetal acceleration greater than gravity causes lift off.

For over and under, speed AT critical velocity causes apparent weightlessness AT THAT POINT. This is related to the apparent weightlessness felt in orbit.

$$v = \sqrt{gr}$$

Vce Notes Physics Unit 1 Cheat Sheet

Eddy J. De Jong



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