Forces, Torque and Equilibrium

Newtons Laws

First Law - How things Move
- An object at rest stays at rest unless acted upon by an external force
- (External Force) Needs a force to get things to move
-An object in motion stays moving at a constant speed unless acted upon by an external force

Second Law - How we calaculate the size of a force
Force = mass x Acceleration
F=ma
Any accelerating object and the force that is pushing or pulling it

Third Law - Forces come in Pairs
Every action produces an equal and opposite reaction

Force Vectors

Use trigonometry to separate the force vector into vertical and horizontal components.

Torque

Name of a turning effect that causes rotation
-Pivot point from centre of mass which it can rotate around.
Torque is produced if the force that is applied is not directed at the pivot point.
- Distance Between the pivot point and the point where the force is apple X by the perpendicular component of the force. Unit Nm.
t=Fd
The longer or further distance less net force
Torques Balanced = Stationary or rotate at a constant speed

Equilibrium

Consequence of Newtons First La
- An object is at equilibrium when it is either stationary or moving at a constant speed
No net external force (all force down are balanced and all forces up are balanced)
No net torque(clockwise torque = anticlockwise torque)

Linear Motion

Displacement and Velocity

Displacement

Is measured in metre and takes into the account of the direction.

Vectors

represented by an arrow - the length of the arrow gives us the vectors magnitude

Velocity

desplacement of an object over the time it takes to reach that displacement ms^{-1}. includes direction different direction different velocity

$v=d/t$

Acceleration and Kinematic Equations

Acceleration

Rate of and objects velocity - how much the velocity changes divided by time taken, measured in ms^2.

$a=v/t$

Kinematic Equations

$Vf = Vi +at$

$d=(Vi +Vf)/2 \times t$

$Vf^2=Vi^2 +2ad$

$d-Vit +1/2\ at^2$

Vectors

Vector Operations

Vector has a magnitude and size. When you divid or multiply vector by scalar the magnitude changes but direction does not unless scalar is negative. The magnitude is always positive. Adding vectors add tip to tail then find resultant. resultant goes other way

Momentum and Impulse

Momentum

Mass of an object multiplied by its velocity

$p=mv$

Big objects moving fast have a large momentum used to solve collision problems

$Kgms^{-1}$

Impulse

Change in Momentum

- Momentum changes when a force is applied to the object over a certain amount of time

$P=Ft$

To maximise an objects change in momentum you can apply a greater force or apply it over a longer time

$Kgms^{-1}$ or Ns

Conservation of Momentum

When a external force acts on an object it changes momentum.

When we consider multiple objects with internal force between them - teh total momentum stays the same - tells us that the total momentum of a system is always the same

Allows us to solve problems with two objects that collide with each other

net force= 0

$P=Pt$

P=momentum of first + momentum of second

Pf = momentum of both first and second

Projectiles and Circular Motion

Gravitation

Describes what happens to an object when its falling

When an object is falling the only force acting on it is gravity when we ignore other forces like air resistance

Constant vertical acceleration $9.8ms^{-2}$

- the gravity can be used in kinematic equations

Projectiles

Is an object moving through the air under the influence of gravity . doesn't have its own power source

Ignore air resistance. Gravity only force acting on the projectile while in the air.. The vertical component changes in the velocity vector and accelerates downwards at $9.8ms^{-2}$through the whole fight.

The Horizontal component does not change.

The path is perfectly symmetrical - the speed going up = the speed coming down

Find the x an y components by using trig.

Circular Motion

Concerns any object that moves around in a circle.

Even if the speed is constant it keeps changing direction meaning the velocity is always changing.

a change in velocity over time produces acceleration. acceleration directed at the centre of the circle - call it centripetal acceleration

Acceleration X mass = centripetal force. this force is directed at the centre of the circle. responsible for keeping object on the circle.

Velocity is at a tangent to the circle at right angles to the force

$Ac=v^2/r$

$Fc=mv^2/r$

v=speed, m= mass, r= radius

Energy, Work and Power

Mechanical Energy and Springs

Spring is a device that stores all elastic potential energy- stretched or compressed.
amount of energy stored is:
$Ep = 1/2kx^2$
K= spring constant(stiffness of the spring) the higher K is the more force need to stretch or compress
x = change in length (the distance it is stretched or compressed). This does not include the normal length of the spring.
When the spring is stretched or compressed there is no elastic potential energy.

Hooke's Law
F=-kx
shows the amount of force required to stretch or compressed a string by a certain amount
(Negative sign ignored)

Work and Power

Work
Force required to move an object across a certain distance
W=Fd
measured in Joules (J)
Energy is the input the output is work

Power
P=W/t
measured in watts (W)

Conservation of Energy
Energy never goes away, it cannot be created or destroyed only transferred from one form to another