Topic 3B: Frictional Forces, Spring Force, Circular Motion and Universal Gravitation

Skill 26: Universal Gravitation

Gravity is a Fundamental Force which causes attraction between all masses

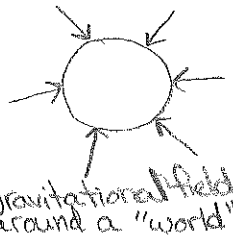
2 different equations are used to find F_g depending on the scenario

$F_g = mg$ and $F_g = \frac{Gm_1m_2}{r^2}$

Used for masses on the surface of a "world" ie moon, planet etc. Known as "uniform field"

Used for any 2 point masses ie Earth and moon etc.

Force due to gravity between any 2 objects is always equal (Newton's 3rd Law - equal & opposing forces)



Fields are actually 3d

Gravitational field around a "world"

Force Vectors between 2 masses

$F_g = G\frac{m_1m_2}{r^2}$

Values for Earth, Moon Sun

G is the "Universal gravitational constant" $= 6.67\times10^{-11}\frac{Nm^2}{kg^2}$

r is the distance between centers of mass

m_1 & m_2 are the masses of the object

F_g is the pull (Force) objects feel due to gravitational fields.

- Gravitational fields reach an infinite distance from a mass but weaken as the field spreads over a larger sphere
  - as the radius doubles the surface area quadruples
  - so the force field is spread over 4X the area as a result it is 4x weaker

F_g is directly related to the product of the masses (m_1, m_2)

F_g is related to the distance between masses (r) by an Inverse Square Law - any change in "r" means the opposite square change in F_g

Ex: If $r\times3$ $F_g \div 3^2$ so $\frac{F_g}{9}$

If $r/2$ $F_g \times 2^2$ so $4F_g$

If $r\times.5$ $F_g \div .5^2$ $4F_g$

If asked what happens to r when F_g changes

Rearrange equation solving for "r"

$F_g = \frac{Gm_1m_2}{r^2}$ so $r = \sqrt{\frac{Gm_1m_2}{F_g}}$

inverse square root

if $F_g\times4$	$r\div\sqrt{4}$	$r/2$
if $F_g\div9$	$r\times\sqrt{9}$	$3r$
if $F_g\times16$	$r\div\sqrt{16}$	$r/4$