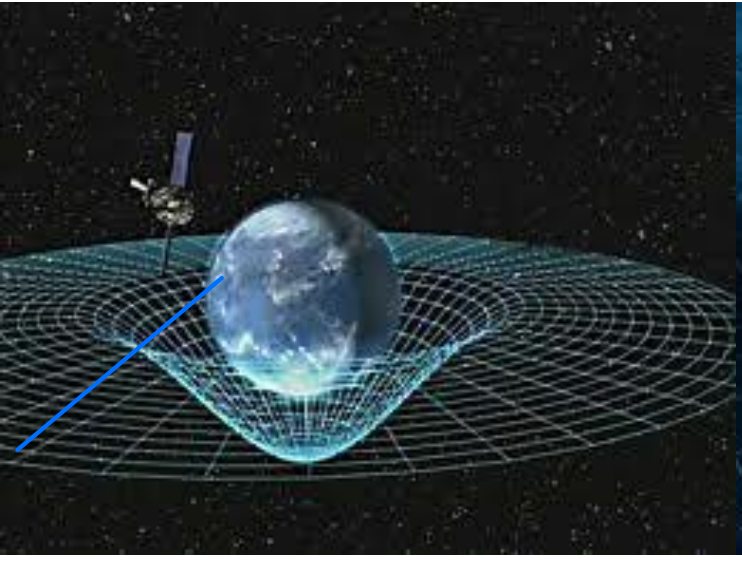
What is Gravity?

- What is gravity?

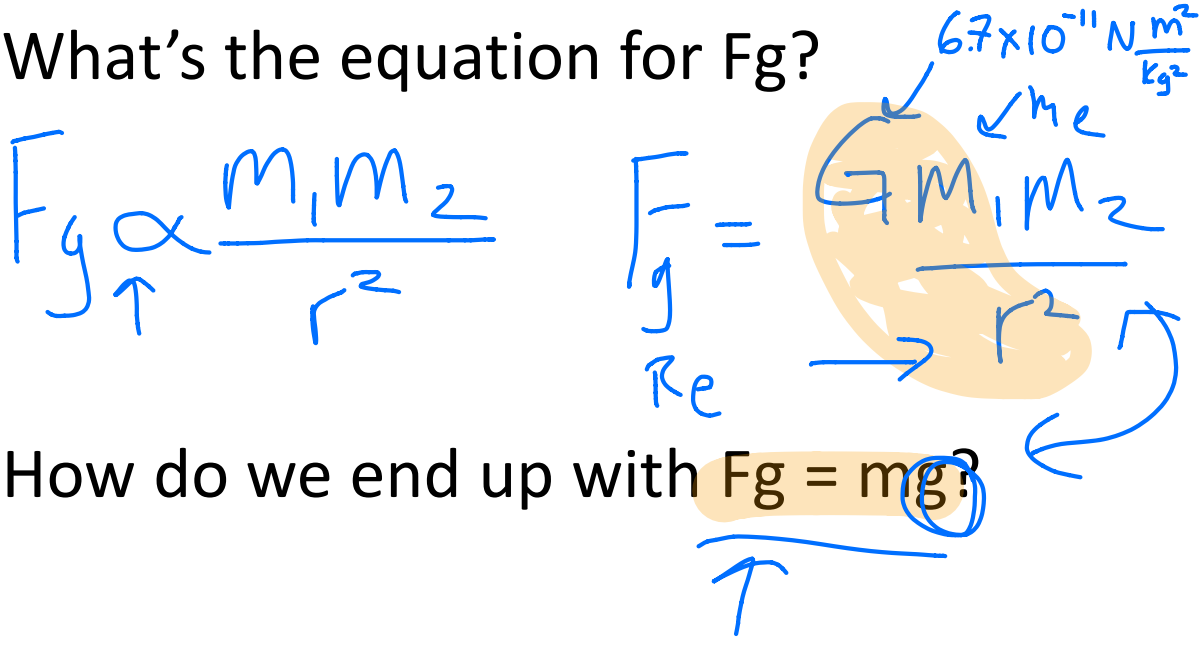


What is Gravity?

- What are the reaches of the force of gravity?
  - Why do astronauts on the ISS float?

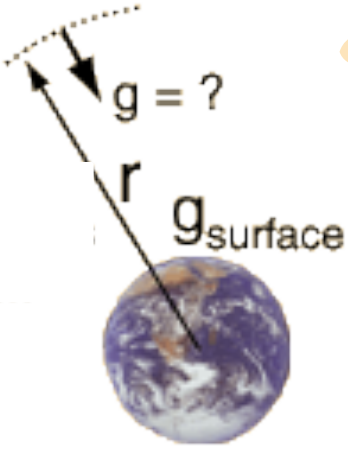
From Gravity Simulation Lab

- What's the equation for Fg?



- How do we end up with Fg = mg?

$g = \frac{GM_{mars}}{r^2_{mars}}$



obj on earth

$$F_{gravity} = m\frac{GM_{Earth}}{R^2_{Earth}} = mg$$

$$M_E = 5.98x10^{24}kg$$

$$R_E = 6.38x10^{6}m \quad (Average)$$

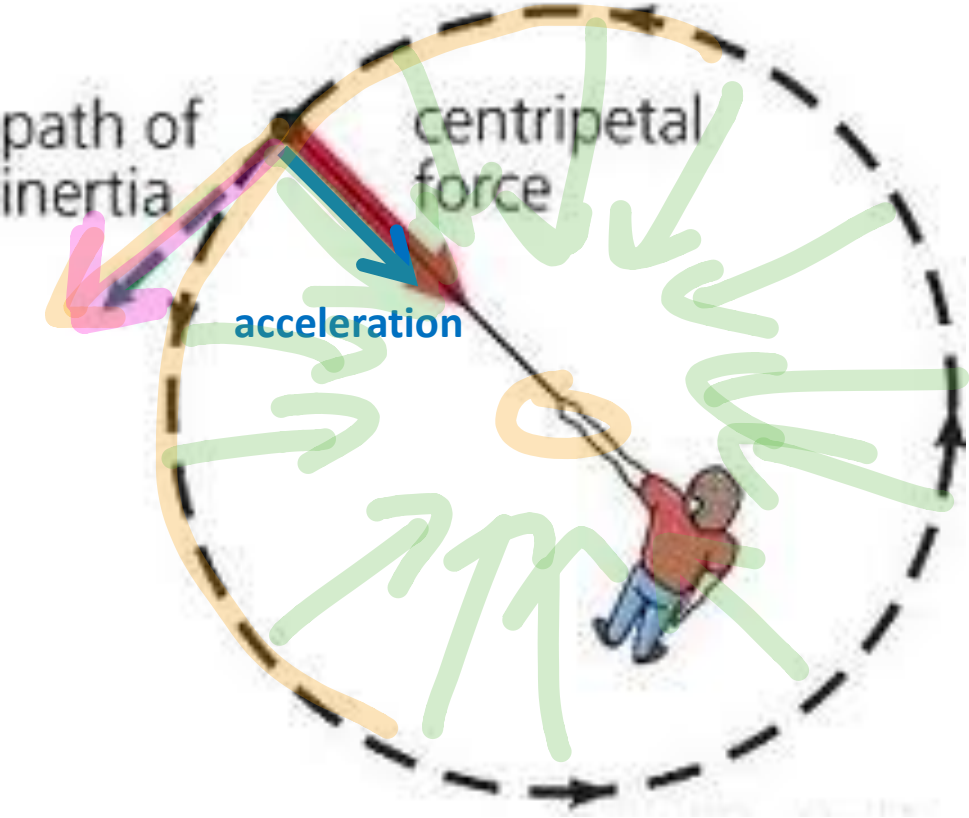
$$G = 6.67259x10^{-11}Nm^2 / kg^2$$

$g = 9.8\ m/s^2$

How to Calculate “g”

- $F_g = mg$ is a simplified formula for gravity
  - This equation is only good for estimations close to the earth’s surface.
- $F_g = Gm_1m_2/r^2$ is the full equation and is dependent on the distance from the earth’s core.
  - $G = 6.67 \times 10^{-11} Nm^2/kg^2$, m_1 = mass of object 1, m_2 = mass of object 2, and r = distance between objects’ centers.

Centripetal Force



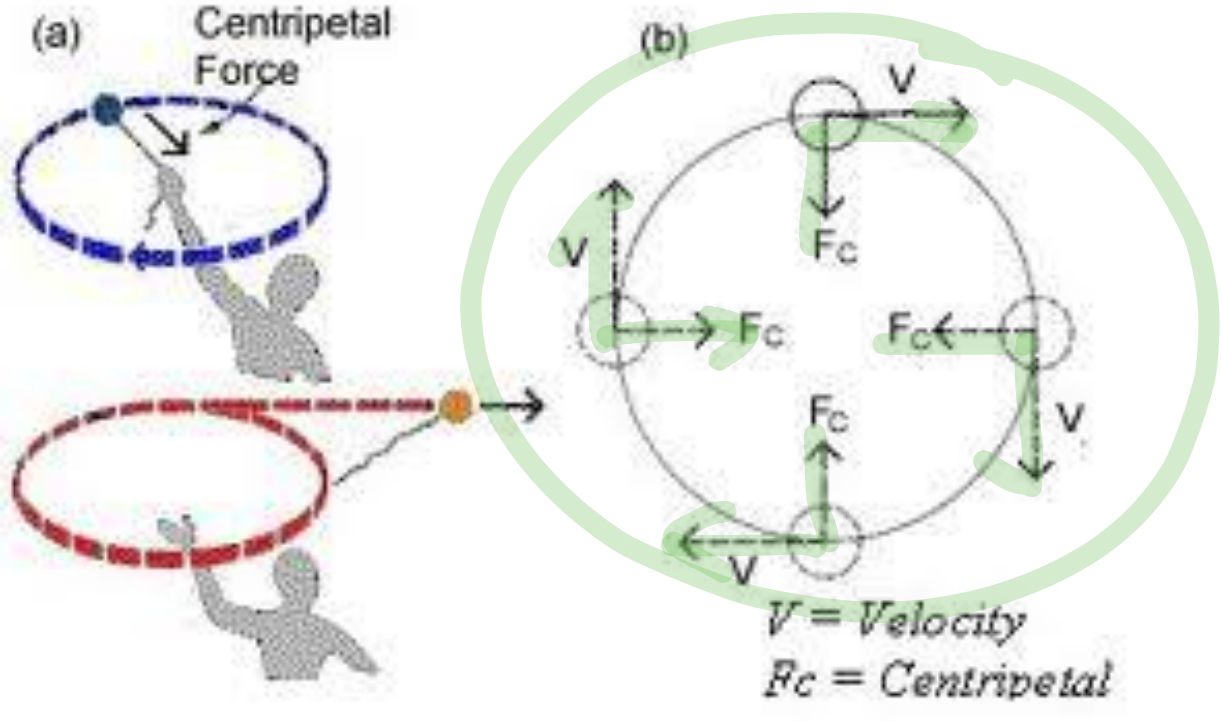
- For an object to move in a circular pattern, an inward-pointing force must be applied.
- We call this centripetal force.
- Centripetal acceleration:

$a_c = v^2/r$

- Centripetal Force:

$F_c = mv^2/r$

Centripetal Force



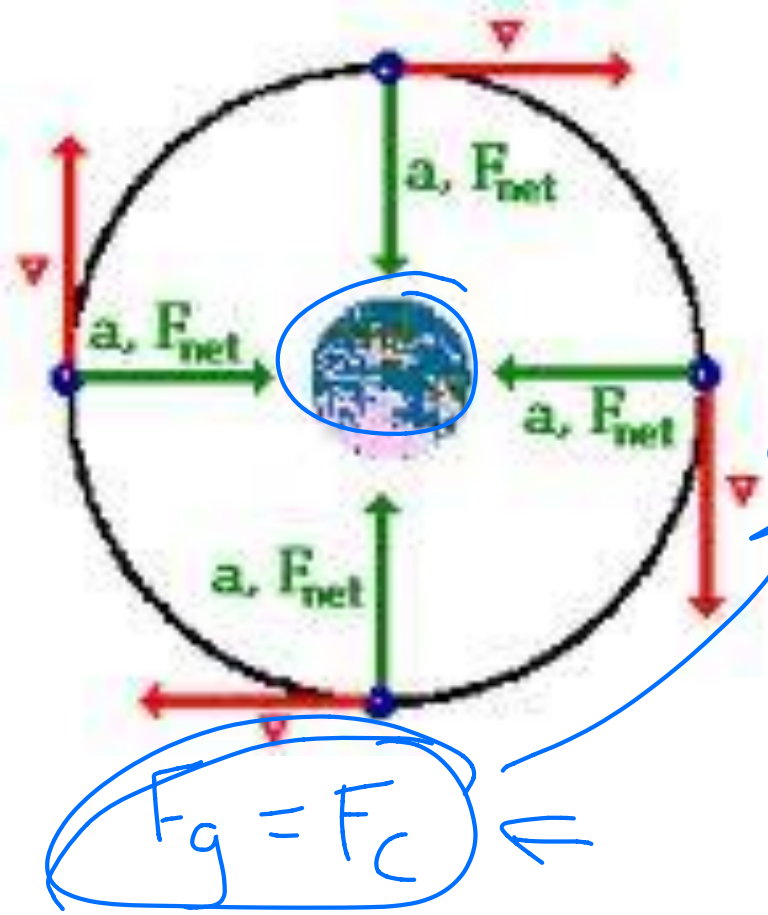
Centripetal Acceleration:

$$a_c = v^2/r$$

Centripetal Force:

$$F_c = mv^2/r$$

Gravity as Centripetal Force



- For orbiting objects, $F_g = F_c$
- $F_g = Gm_1m_{orb}/r^2$
- $F_c = m_{orb}v^2/r$
- $Gm_1m_{orb}/r^2 = m_{orb}v^2/r$
- $Gm_1/r = v^2$
- $v = \sqrt{(Gm_1/r)}$
- This is the velocity required for an object to orbit around a body with a mass (m_1) at a radius (r)

Practice Problem

- The space station travels with a tangential velocity of approximately 7,700 m/s. How far from the earth's surface does the satellite orbit? $R_E = 6.38 \times 10^6$ m, $M_E = 6 \times 10^{24}$ kg

$$F_C = \frac{mv^2}{r} \qquad F_C = F_g$$

$$\frac{mv^2}{r} = \frac{GmM_e}{r^2}$$

d = dist. from Earth's surface to satellite

$$r = R_E + d$$

$$\frac{7{,}700^2 = (6\times10^{24})6.7\times10^{-11}}{(6.38\times10^6+d)}$$

$(6.38\times10^{6}+d)(7{,}700^{3}) = 6\times10^{24}\cdot 6.7\times10^{-11}$

Practice Problems

- Our moon has a mass of $7\text{x}10^{22}$ kg and is $3.9\text{x}10^{8}$ m from earth's core. What is the tangential velocity of our moon as it orbits the earth?