Gravitational Field:

$\boxed{g = \frac{N}{kg}}$ gravitational Field Strength

$F = G \cdot \frac{M \cdot m}{r^2}$ (gravitational force)

$F_c = K \cdot \frac{q_1 \cdot q_2}{r^2}$ (coulomb force)

$G = 6.67 \cdot 10^{-11} \frac{N \cdot m^2}{Kg^2}$ gravitational constant

$\boxed{G = \frac{F \cdot r^2}{M \cdot m}}$

Since the gravitational force can be equal to gravitational attractive force, we can derive that:

$F_g = F_{g\,attr.} \iff \cancel{m} \cdot g = G \cdot \frac{\cancel{m} \cdot M}{r^2} \iff$

$\boxed{g = G \cdot \frac{M}{r^2}}$

This relationship indicates that the gravitational field is proportional to the mass of the large object and inversely proportional to the square of its radius.

$V_g = -\frac{GM}{r}$ (gravitational potential)

infinite

r

So in order to bring an object from infinity to a point P in space (which is the gravitational potential) you consume energy (the object is supposed to have energy stored at infinity let it be kinetic energy for example)

$V_{potential} = \frac{W}{q}$

$V_g = -\frac{GM}{r}$

2 definitions can be given about Gravitational potential (and in comparison to the electric field electric potential):

1) One of them talks about energy / kg (or energy / coulomb - per charge)

2) The other talks about the consumption of energy in order to bring the point mass or point charge from one point in space to another.

Talking: Maya's

Gravitational Fields

$$g = -\frac{GM}{r}$$

$$g = -\frac{\Delta V_g}{\Delta r}$$

The difference in the gravitational field strength in a specific point or surface outside of the planet

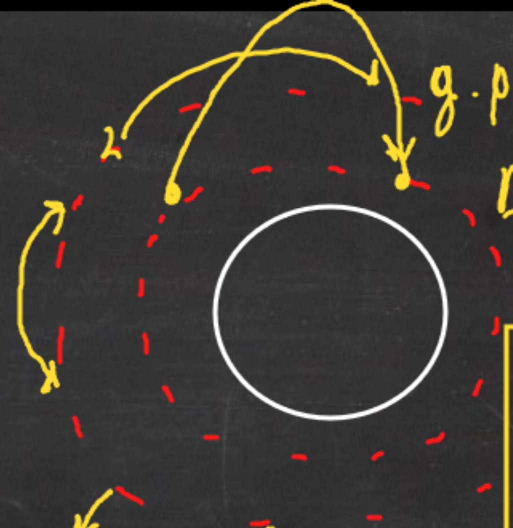
(from mechanics: $m \cdot g \cdot h$)

$$E_p = m \cdot V_g = -m \cdot \frac{G \cdot M}{r} = -G \cdot \frac{mM}{r}$$

$$F_g = G\frac{m \cdot M}{r^2}$$

$$\boxed{\begin{array}{c} F_g \cdot r = E_p \\ F \cdot x = W \end{array}}$$

:) we luv physics



g. potential

$$\Delta V_g = 0 \ \frac{MJ}{Kg}$$

equipotential surfaces.

The gravitational does not take into account the objects orbit (since it is also a scalar quantity)

If we apply conservation of mechanics in combination other rules as well we can derive a few other formulas for planetary and orbital motion:

$$V_{esc.} = \sqrt{\frac{2\,GM}{\rightarrow r \uparrow}}$$

(proportional to square root of mass, inversely proportional to the square root of radius)

$$g\downarrow = -\frac{GM}{r} \left(\frac{N}{Kg}\right)$$

$\uparrow V_{esc}$

So if the radius of a large mass object becomes greater this means that our field gravitational will become less, leading to a smaller magnitude of gravitational, therefore the escape wont have to be that large.

So mass has a greater priority when we are trying to assess the gravitational field strength of a planetary object compared to its radius.

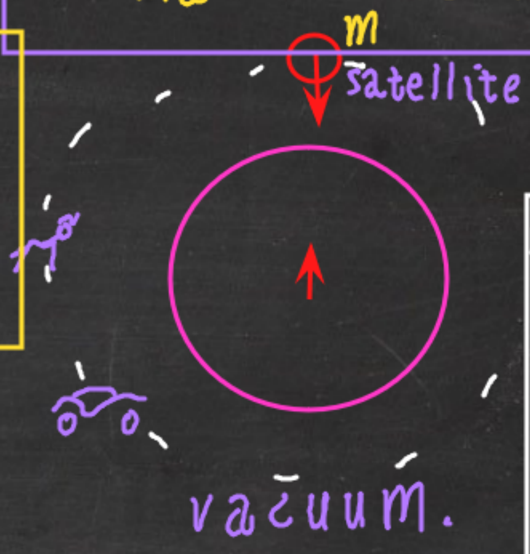
Relationships between circular motion and gravitational fields:

$$F_{cen} = F_{gattr.} \iff \frac{\cancel{m}\cdot v^2}{\cancel{r}} = G\cdot\frac{M\cancel{m}}{r^{\cancel{2}}}$$

$$v^2 = \frac{GM}{r} \Rightarrow \boxed{V_{orbital} = \sqrt{\frac{GM}{r}}}$$

Mass does not play a role to the orbital of an object when you are in VACUUM !!!

m = mass of the object



$$F_c = K\cdot\frac{q_1\cdot q_2}{r^2}$$

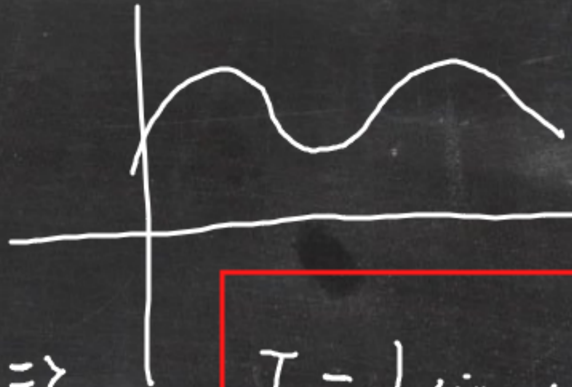
$$F_g = G\cdot\frac{M\cdot m}{r^2}$$

The coulomb force between 2 charges can be both attractive or repelling. The gravitational force is only attractive.

$$V_{orbital} = \omega\cdot r \Rightarrow \omega\cdot r = \sqrt{\frac{GM}{r}} \iff$$

$$\omega^2\cdot r^2 = \frac{GM}{r} \Rightarrow \omega^2 = \frac{GM}{r^3} \Rightarrow \left(\frac{2\pi}{T}\right)^2 = \frac{GM}{r^3} \Rightarrow$$

$$\frac{4\pi^2}{T^2} = \frac{GM}{r^3} \iff T^2\cdot GM = 4\pi^2 r^3 \Rightarrow$$



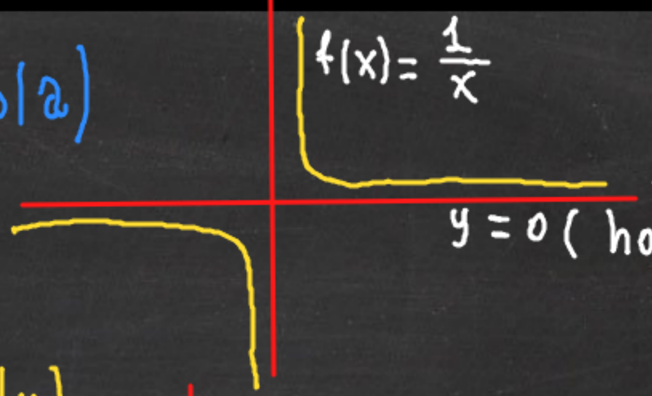
$b = \frac{2\pi}{T}$ angular velocity (frequency)

$$\boxed{T^2 = \frac{4\pi^2 r^3}{GM}} \Rightarrow \boxed{T = \sqrt{\frac{4\pi^2\cdot r^3}{GM}}} = 2\pi\cdot r\sqrt{\frac{r}{GM}} \Rightarrow \boxed{T = L_{circ.}\cdot\sqrt{\frac{r}{GM}}}$$

Mathematical that mass of an object doesn't play a role in its orbital period.

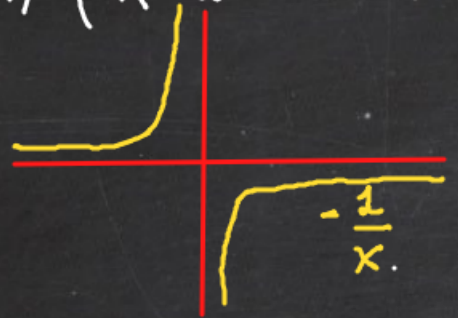
Background Knowledge:

$f(x) = \frac{1^{\neq 0}}{x}$ (hyperbola)

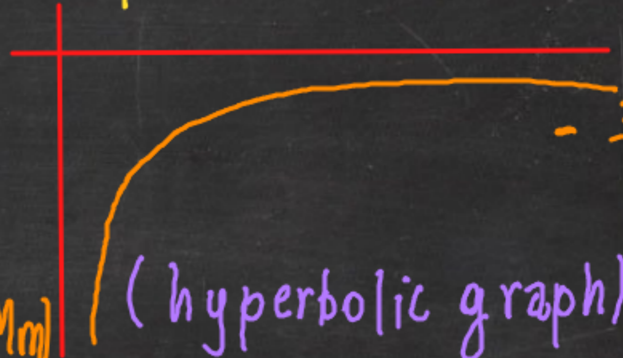


$f(x) \longrightarrow -f(x)$ (x-axis reflection).

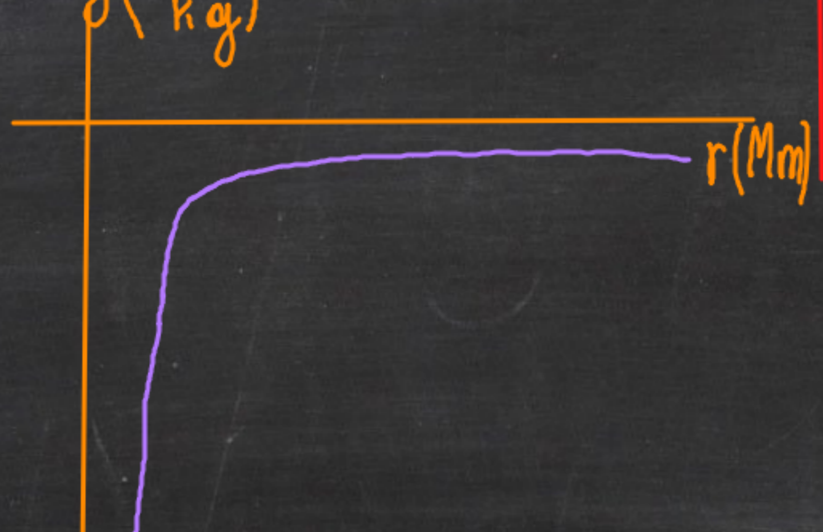
$-f(x) = -\frac{1}{x}$



what if $x > 0$ (only)



$V_g = -GM \cdot \frac{1}{r} = \frac{-GM}{r}$



$$E_{mech} = E_{Total} = E_T = E_p + E_K$$

$$-\frac{GMm}{r} + \frac{1}{2} m \cdot \left(\sqrt{\frac{GM}{r}}\right)^2$$

$$-\frac{GMm}{r} + \frac{1}{2} \cdot \left(\frac{GMm}{r}\right) =$$

$$\frac{G \cdot Mm}{r}\left(-1 + \frac{1}{2}\right) =$$

$$\boxed{-\frac{GMm}{2r}}$$

17.3 Motion in a gravitational field

Orbital motion

A satellite of mass m orbits a planet of mass M with speed v. The radius of the orbit is r (Figure 17.26). The total energy E_T of this system is the sum of the kinetic energy E_K and the gravitational potential energy E_P.

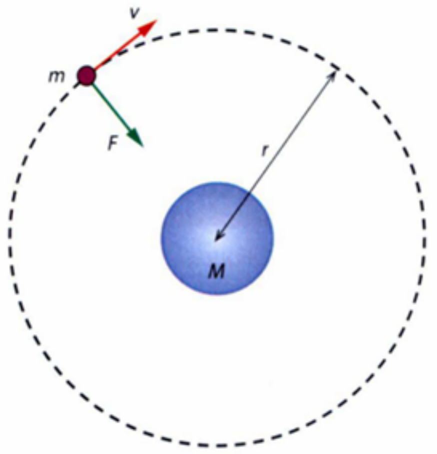


Figure 17.26: A system of a satellite orbiting a planet.

$E_K = \frac{1}{2}mv^2$ and $E_P = -\frac{GMm}{r}$

So:

$$E_T = \frac{1}{2}mv^2 - \frac{GMm}{r}$$

Note that we do not include any kinetic energy for the planet, as we assume it does not move.

Orbital speed is given by:

$$v_{orbit} = \sqrt{\frac{GM}{r}}$$

This means that the kinetic energy E_K is:

$$E_K = \frac{GMm}{2r}$$

The total energy of the system becomes:

$$E_T = \frac{GMm}{2r} - \frac{GMm}{r} = -\frac{GMm}{2r}$$

The total energy of an orbiting satellite is $E_T = -\frac{GMm}{2r}$.

The minus tells us that there is energy loss in order to maintain the object into planetary orbit