Gravitation

Chapter 8

XI

Kepler's law

Kepler's laws of planetary motion, published by Johannes Kepler between 1609 and 1619, describe the orbits of planets around sun.

Three laws of Kepler's are

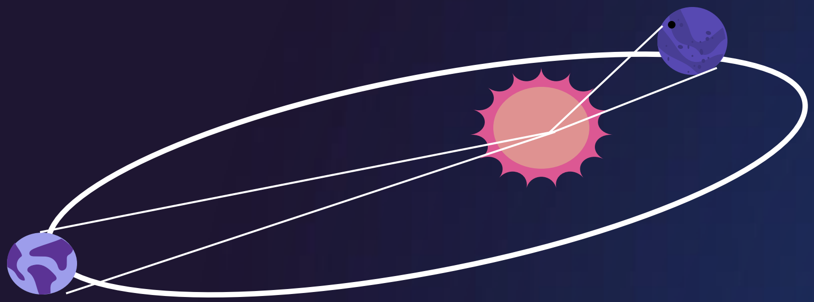
1. Law of orbit
2. Law of areas
3. Law of periods

Law of orbit

All planet moves in elliptical orbit with the sun situated at one of the foci.

Law of Areas

The line that joining any planet to the sun sweeps equal area in equal intervals of time.



Law of Areas (proof)

Hence, $\Delta A = \frac{1}{2} r.(r.\Delta\theta) = \frac{1}{2} r^2 \Delta\theta$

You can write, $\frac{\Delta A}{\Delta t} = \frac{1}{2} r^2 . \frac{\Delta\theta}{\Delta t}$

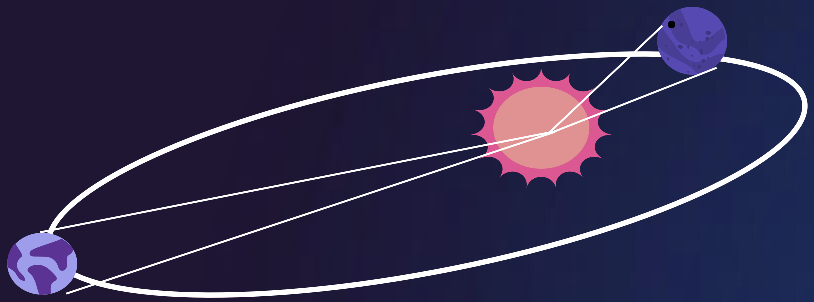
$\Rightarrow \lim_{\Delta t \to 0} \frac{\Delta A}{\Delta t} = \frac{1}{2} r^2 . \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t}$ Taking limits both side as, $\Delta t \to 0$

$\Rightarrow \frac{dA}{dt} = \frac{1}{2} r^2 \omega$

$\Rightarrow \frac{dA}{dt} = \frac{L}{2m}$

Now, by conservation of angular momentum, L is constant,

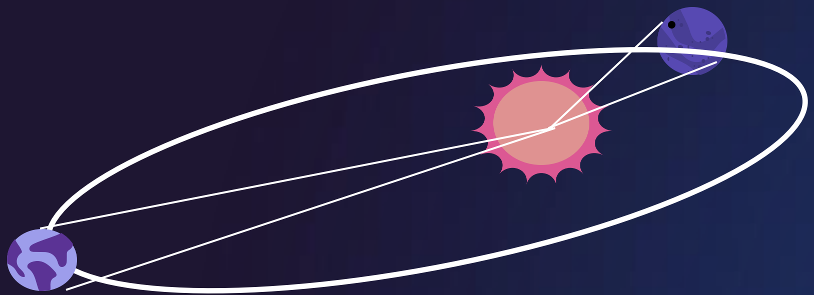
Thus, $\frac{dA}{dt}$ = constant



Law of orbits

The square of time period of revolution of a planet is proportional to the cube of the semi-major axis of the ellipse traced out by planet

$$T^2 \alpha R^3$$



Law of orbits

$T^2 \,\alpha\, R^3$

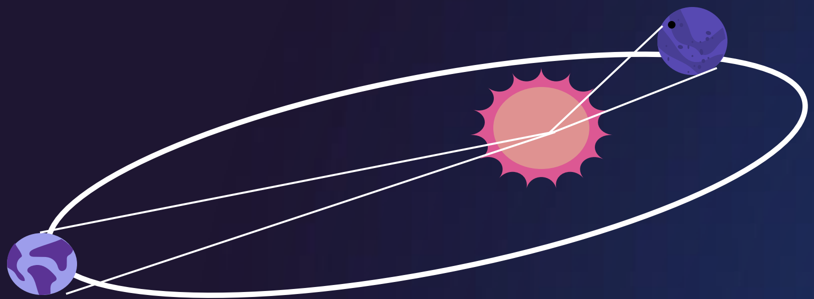
$$v = \frac{\text{circulference}}{\text{Time taken}} = \frac{2\pi R}{T}$$

Now,

$$\frac{GM}{R} = m\left(\frac{2\pi R}{T}\right)^2$$

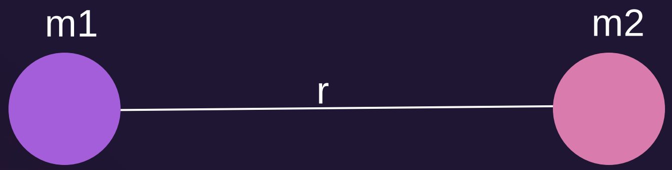
$$or, T^2 = \frac{4\pi^2 R^3}{GM}$$

$$or, T^2 \,\alpha\, R^3$$



Universal law of gravitation

Any particle of matter in the universe attracts any other with a force varying directly as the product of the masses and inversely as the square of the distance between them.



$$F = \frac{Gm_1m_2}{r^2}$$

G= gravitational constant ,**$6.67*10^{-11}$**

Acceleration due to gravity (g)

We have,

$$F_g = \frac{GMm}{r^2}$$

If g is the acceleration due to gravity

$$F_a = mg$$

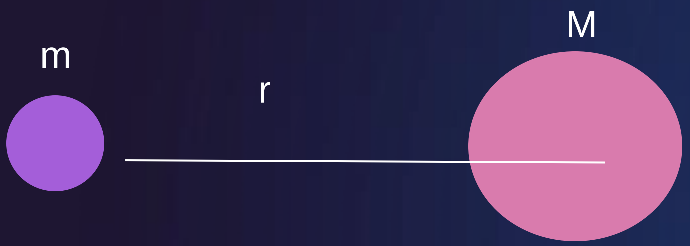
If Fg=Fa,

$$\frac{GMm}{r^2} = \frac{mg}{r}$$

And

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

G-gravitational constant
M-mass of earth
m-mass of object
r-distance between earth and object



Weightlessness

Weightlessness is **the complete or near-complete absence of the sensation of weight**. This is also termed zero-G, although the more correct term is "zero G-force". It occurs in the absence of any contact forces upon objects including the human body.

At zero-G, $g=0$

$$F=mg$$

$$F=m*0$$

$F=0$ N ie, force due to gravity is zero.

Class over...

Created and class taken by **Amal M.P**

Clear your doubt here-8943938099

Thankyou