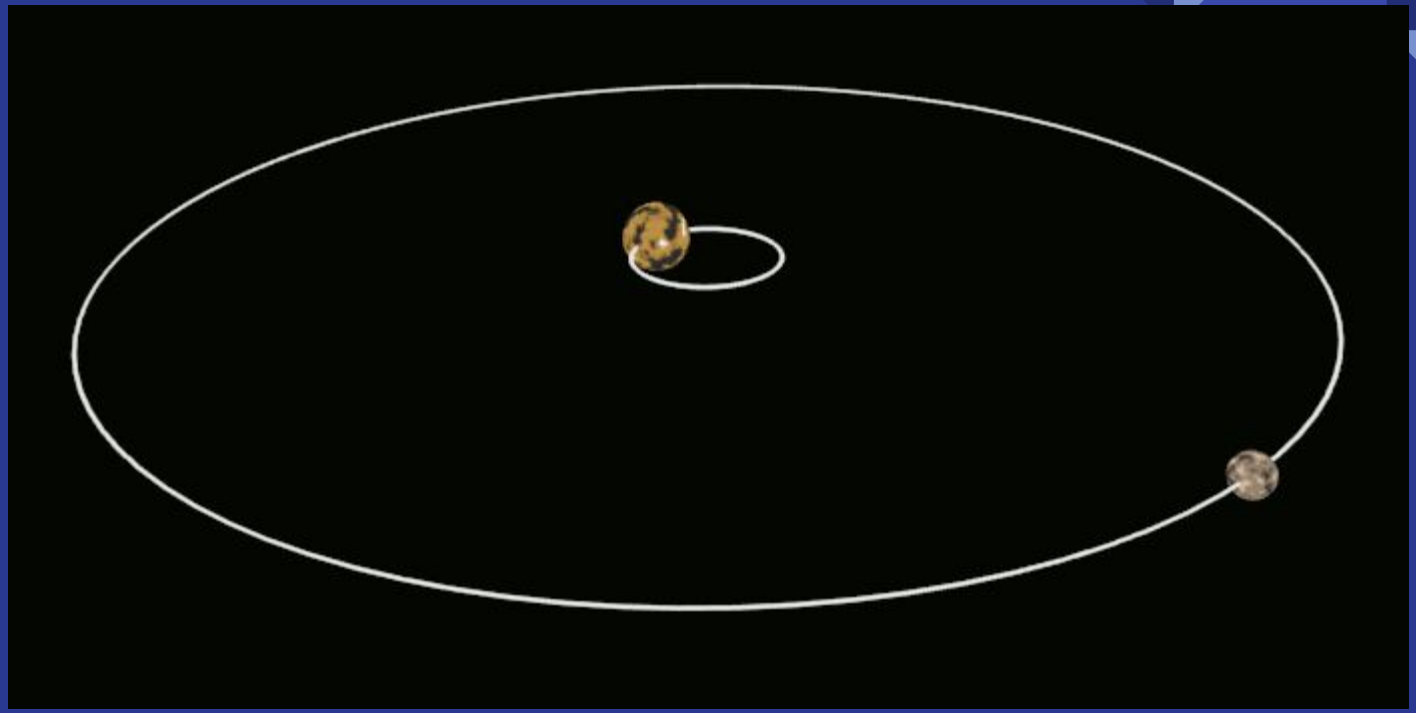
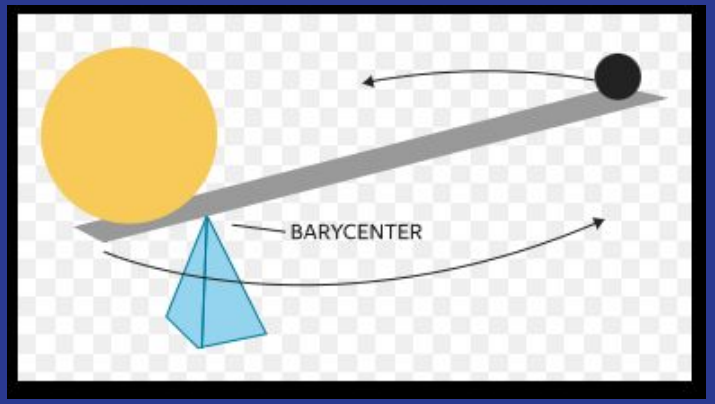
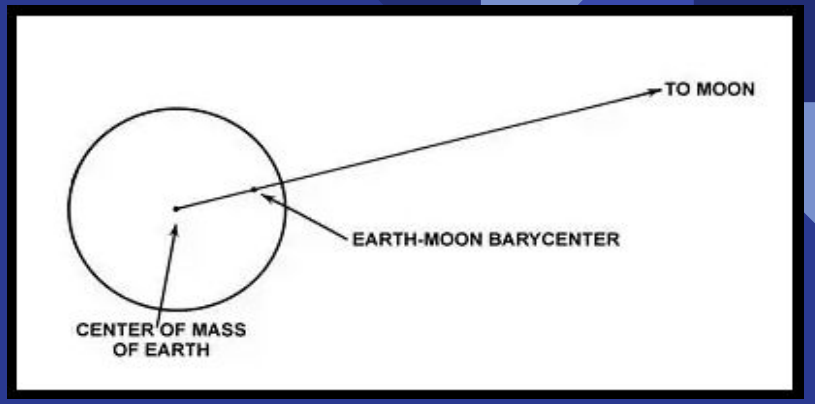
Pluto-Charon System



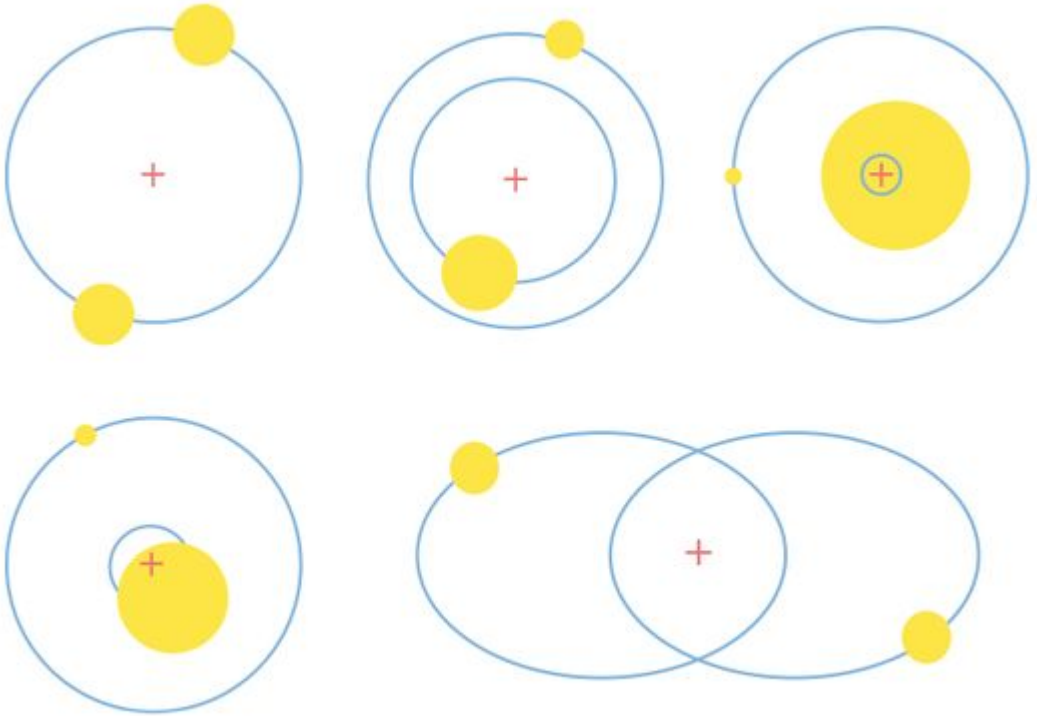
Elliptical Orbits (Why Planets and Satellites revolves in elliptical Orbits ??)

Barycentre:



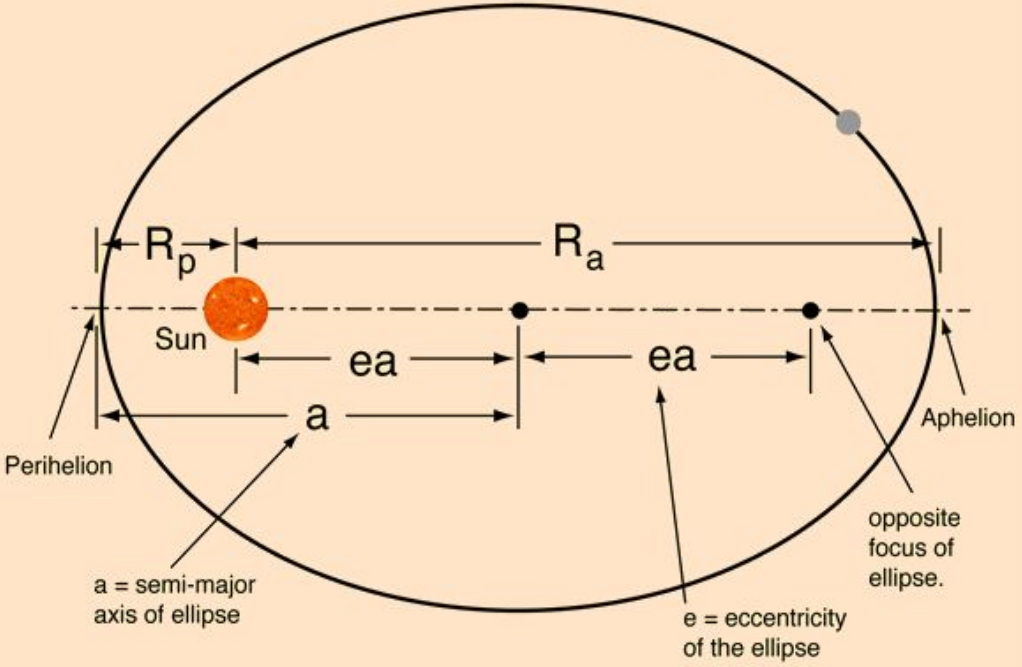

- **In the two body system, when the objects moving under the gravitational influence of each other,then the objects revolve around a common centre which is known as Barycenter.**
- Barycenter is the point lies between the centre of both the objects otherwise known as centre of the mass.
- Centre of mass of both the objects will be a point lying closer towards the heavier mass, but further away from the lighter mass.Lighter mass is revolving around the BC not around centre of heavier mass
- In Earth Moon System , In reality, the moon is revolving around the point,which lies inside the earth,around 4671 km (75 % of Earth Radius)



Different two-body systems with indicated orbits (blue) and barycenters (red).

# The Law of Orbits

**All planets move in elliptical orbits, with the sun at one focus.**



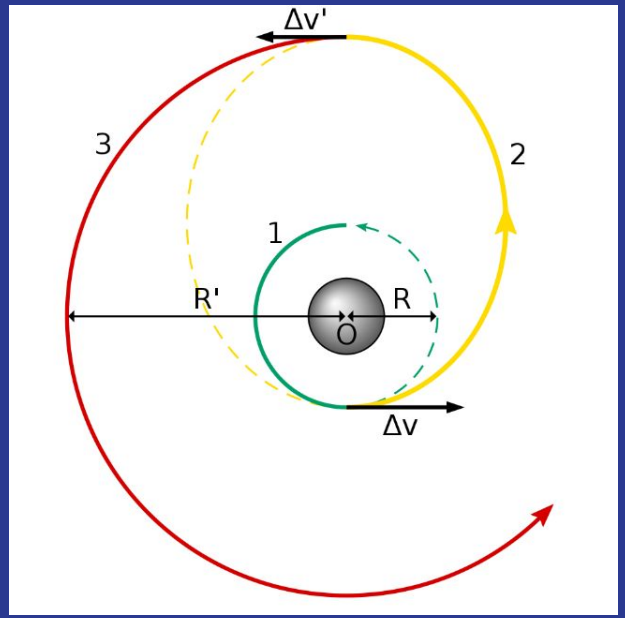

$R_a = a(1+e)$ $R_p = a(1- e)$

# Orbit Transfers

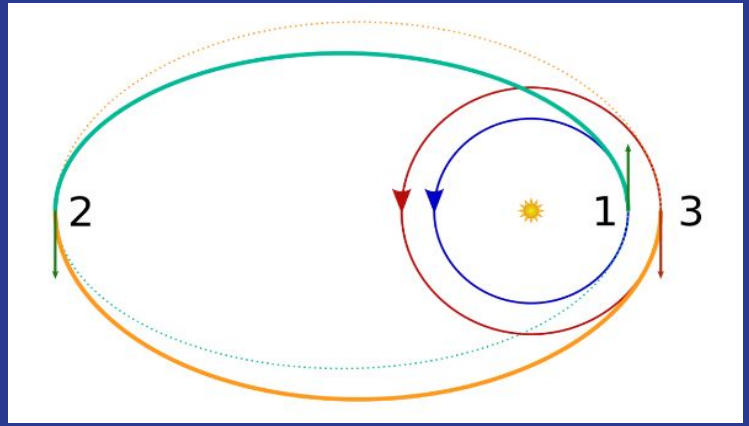
- **Gravity Assist:** A gravitational slingshot, gravity assist maneuver, or swing-by is the use of the relative movement and gravity of a planet or other celestial body to alter the path and speed of a spacecraft, typically in order to save propellant, time, and expense.

  Gravity assistance can be used to accelerate, decelerate and/or redirect the path of a spacecraft. The "assist" is provided by the motion (orbital angular momentum) of the gravitating body as it pulls on the spacecraft

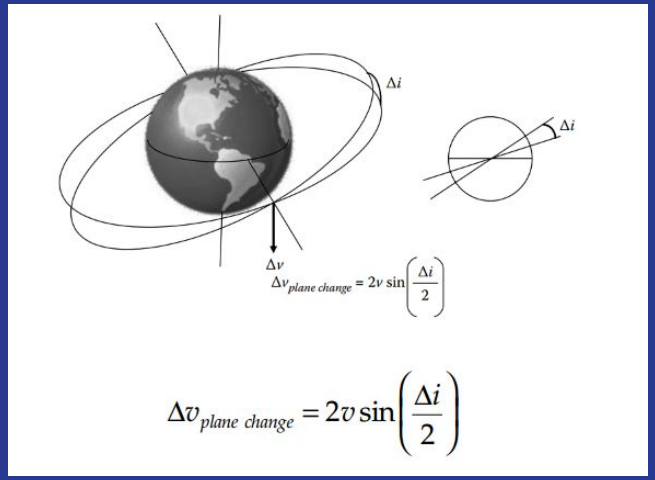
- **Hohmann transfer orbit** is an elliptical orbit used to transfer between two circular orbits of different altitudes, in the same plane.



**Bi-elliptic transfer** is an orbital maneuver that moves a spacecraft from one orbit to another and may, in certain situations, require less delta-v than a Hohmann transfer maneuver.

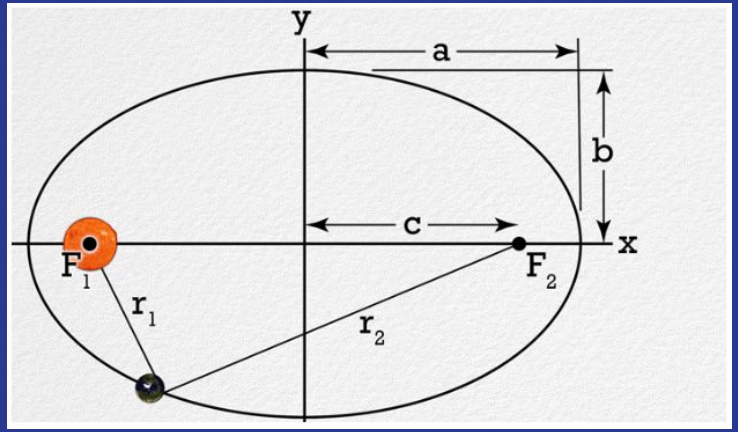



## Orbit plane inclination change




$$\Delta v_{plane\ change} = 2v \sin\left(\frac{\Delta i}{2}\right)$$

# Orbital Energy invariance Law (Vis-Via Equation)




- **Energy of an object in an orbit is the sum of kinetic energy and Potential Energy.**And Energy and Momentum remained **conservative** throughout the orbit.**Angular Momentum at Periapsis is equivalent to Angular momentum at apoapsis**.

- Total Energy = 0.5 mV*2 - (GMm/r)
- Specific Energy of mass(m) = 0.5 V*2 - (GM/r)
- Angular Momentum of mass (m) moving around Mass (M) = m * V * r
- Specific Angular Momentum = V*r

M = Mass of larger Object
m= Mass of smaller object
r= Distance of that smaller mass from the centre of the larger mass.
V = Velocity of smaller mass
(-) indicates gravitational potential energy is a negative term.

$$G = 6.673 \times 10^{-11} Nm^2 kg^{-2}$$

# Significance of Vis Via Eqn

WKT,**Angular Momentum at Periapsis is equivalent to Angular momentum at apoapsis**.Equating Angular Momentum at Periapsis and Apoapsis finally give Orbital Energy Invariance Law

$$0.5\ V^2 = GM\left[ (1/r) - (1/2a) \right]$$

Where, GM = Standard Gravitational Parameter (μ)

Significance of Vis Via Eqn,

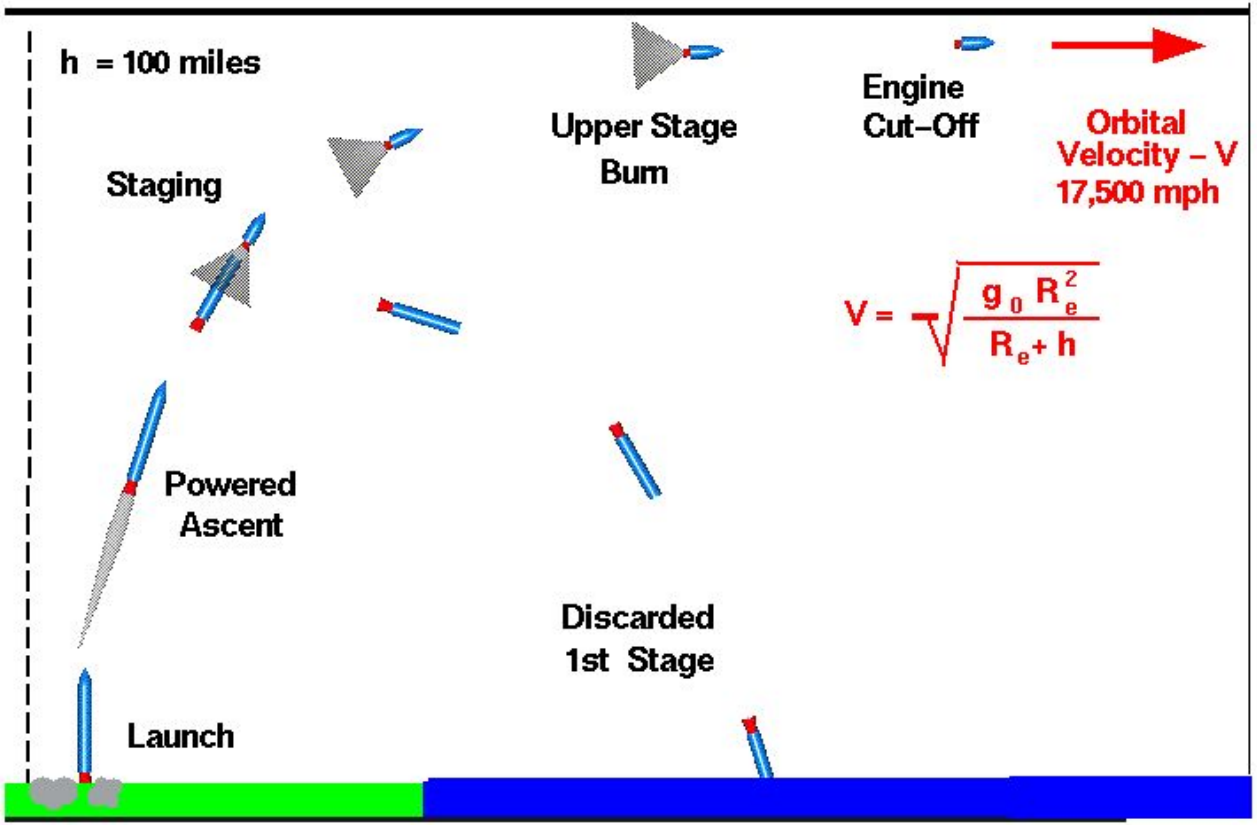
- This Equation connects the object going from circular orbit to elliptical orbit.
- For a Circular Orbit, Semi major axis is radius of a circle.So Orbital Velocity of an object for an orbit of radius ‘r’.

  $V = [GM/r]*0.5$
- Escaping from circular orbit to space.Elliptical orbit of semi major axis is infinity.

  $V = [2GM/r]*0.5$

  This is escape speed and not much related to direction

# Flight to Orbit



500km
400km
300km
탑재체
제주도
410km
700km
1,000km
2,000km
2,500km
1단 낙하위치
(예정 낙하구역 내·외 광범위하게 분포)
페어링 낙하위치
(740km)
2단 낙하위치
대만