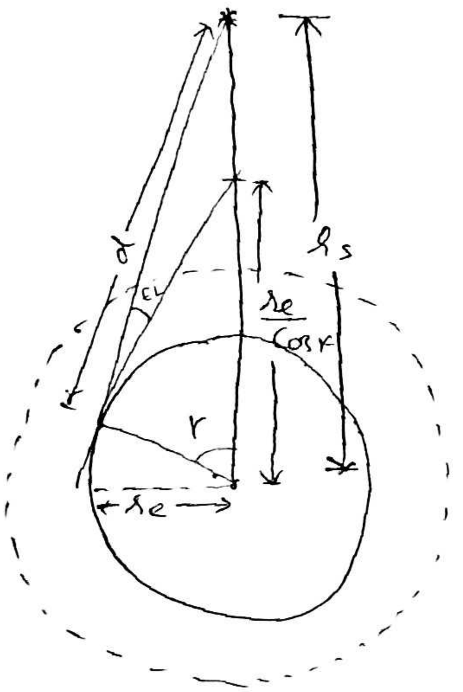
more distance in earth atmosphere.

Then attenuations are increases.



If Consider Elevation angle 5°, then.

$r = 76.3°$

For 5° elevation angle.

$$d^2 = r_e^2 + r_s^2 - 2 r_e r_s \cos r$$

$$d_{max} = 41127 \text{ km}.$$

$$\text{Round trip delay} = \frac{2d}{c}$$

$$= \frac{2 \times 41127 \times 10^3 \text{ m}}{3 \times 10^8 \text{ m/sec}} \simeq 274.$$

* **Launching of Vehicle:-** For launching a satellite following parameters are required-

→ 1. Height of orbit
→ 2. velocity required
→ 3. velocity vector of satellite.

A satellite can-not be placed into a stable orbit unless two parameters that are uniquely coupled together - The velocity vector & Orbital height - are mi simultaneously correct.

For Geostationary Satellite,

orbit height = 35706.03 km above the surface of the earth,

42164.17 km radium from centre of earth,

& velocity = 3074.7 m/sec tangential to the earth in the plane of orbit.

most launch vehicles have multistages.

ELV ⟶ Expendable launch vehicle
multiple stage vehicle.

STS ⟶ Space transmission system
space shuttle called space transportation system (STS). Partially reusable.

RLV ⟶ Reusable Launch vehicle

SSTO ⟶ Single stage to orbit,
more advanced Launched vehicle

X-33 & X-44 ⟶ Test vehicle of NASA.

* **Organisations places satellite in Geostationary orbit:-**

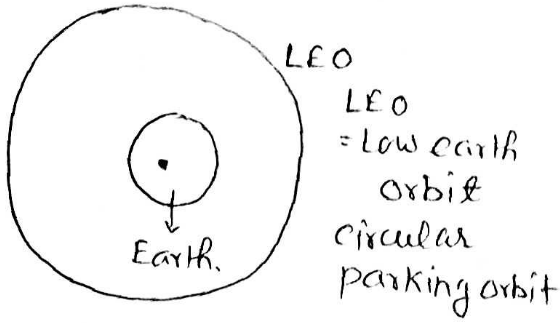
NASA ⇒ National Aeronautics and space Administration,

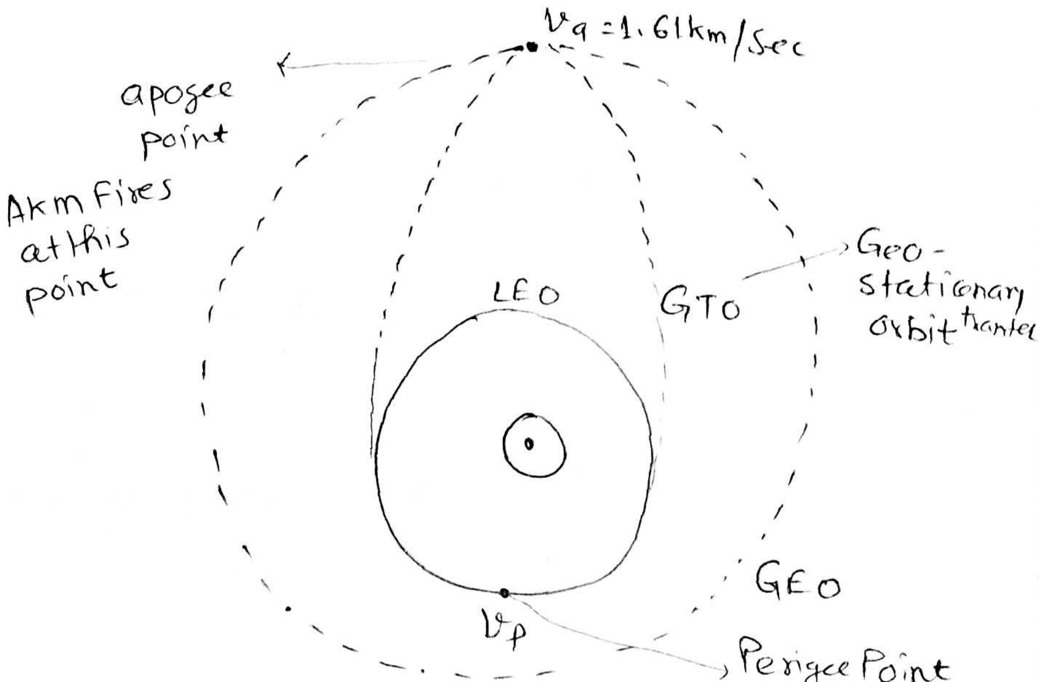
ESA ⇒ Europian Space Agency.

⇒ GTO / AKM approach to Geostationary orbit :-

GTO / AKM approach of placing a satellite in geostationary orbit is shown in the figure.

The combined aircraft or spacecraft and final rocket stage are placed into Low earth orbit (LEO) around the earth. After careful orbit determination measurements, the final stage is ignited in LEO and spacecraft inserted into a transfer orbit that lies between LEO and the geostationary orbit altitude, called GTO.





Perigee Point
GTO insertion start from this point

v_a = velocity at apogee = 1.61 km/sec

v_p = velocity at perigee = 10.15 km/sec

LEO

⇒ Low earth orbit also called circular parking orbit

Height about 300 - 500 km.

$i = 28°$

velocity = 7.73 km/sec

Again when spacecraft reached at apogee the apogee kick motor fired on the satellite and now the satellite in GEO.

Δv = 2.42 km/sec.

Height of perigee = 6678.2 km &
Height of apogee = 42164.2 km.

The satellite estabilished at the perigee so that ground control can communicate with the satellite. Apogee kick motor fired when space-craft reached at apogee point.

The circular orbit will be geostationary orbit if launching is carried out 0° that is equator –

$$v = \sqrt{\mu\left(\frac{2}{r} - \frac{1}{a}\right)}$$

for perigee, $r = 6678.2$

$$a = \frac{6678.2 + 42164.2}{2}$$

$= 24421.2$ km.

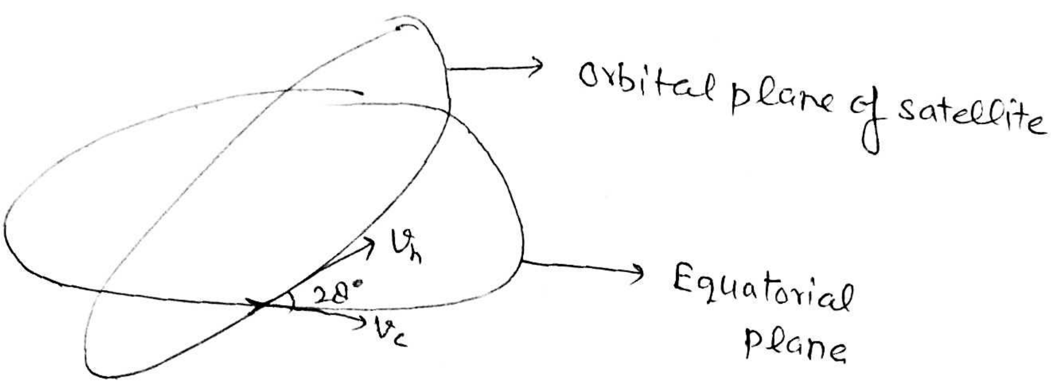
Hence. $v_p = 10.15$ km/sec &

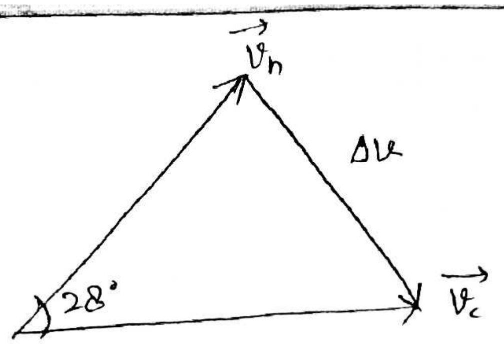
$v_a = 1.61$ km/sec

When, $r = a$,

$v_c = 3.07$ km/sec

Launch station → Cape kennedy.
⇒ 28° North Latitude.





$$\boxed{\vec{\Delta v} = \vec{v_c} - \vec{v_n}}$$

$$\boxed{\Delta v = \sqrt{v_n^2 + v_c^2 - 2 v_n v_c \cos i}}$$

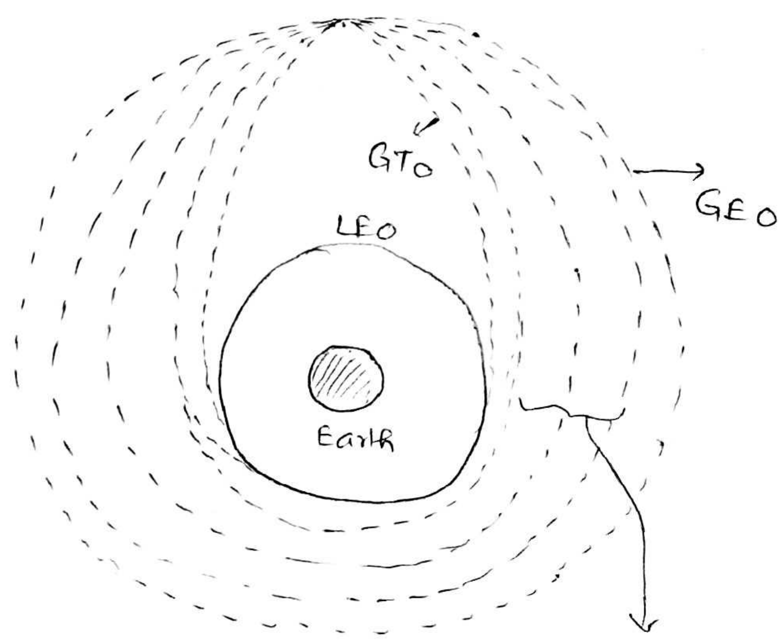
If the line connecting to opposite perigee is the node line and the inclination correction is made at the apogee in connection with orbit circularization, then-

$$v_n = v_a$$

$$\Delta v = 1.81 \text{ km/sec}$$

* **Geostationary transfer orbit with slow Orbit Raising:-** Figure shows the slow orbit raising procedure to geostationary orbit. The combined spacecraft and final rocket stage are placed into Low earth orbit (LEO) around the earth.

In this method space-craft thrusters are used to raise the orbit from GTO to GEO over a number of burns.



** Space-craft Thrusters are used to raised GTO to GEO