

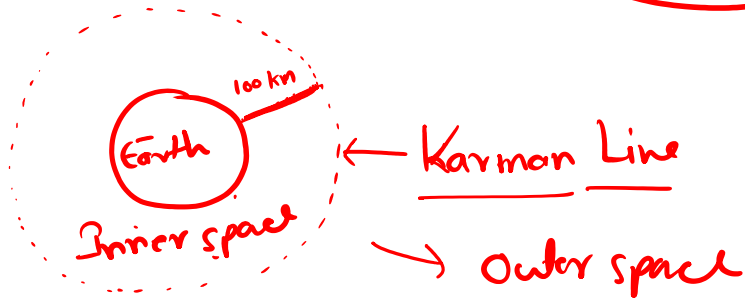
Earth and our Universe

Our Universe

Expanding Space

Outer space ✓

Inner Space ✓



- Study the formation of wind, storms, cyclones
- Gravitation. Tides.
- Universal law of gravitation
- Applications of law of gravitation in scientific development.
- Definitions: Gravity, Escape velocity

Gravitation

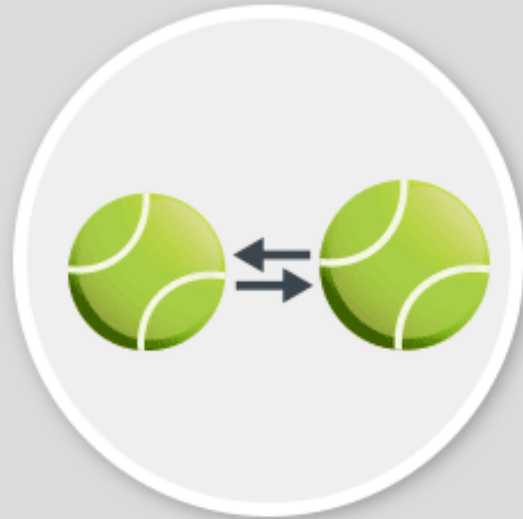
Sir Isaac Newton

* Gravitation force is prominent in celestial objects or heavenly objects.

• The force of gravitation depends on the mass of objects and distance between objects.

$F \propto \text{mass}$ [F is directly proportional to mass]

$F \propto \frac{1}{d}$ [F is inversally proportional to distance]



GRAVITATION

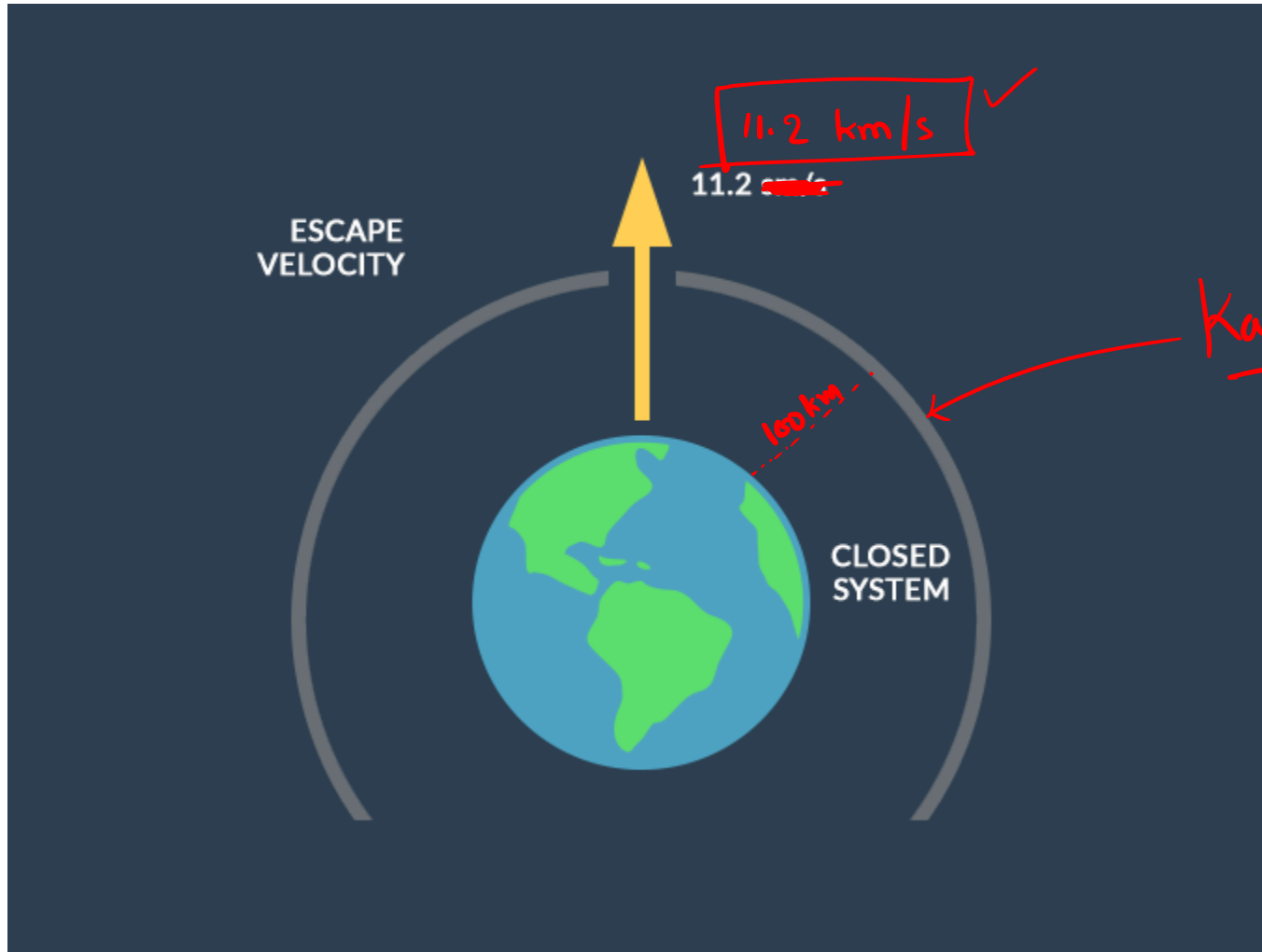
GRAVITATION IS THE FORCE OF ATTRACTION ACTING BETWEEN ANY TWO BODIES OF THE UNIVERSE.



GRAVITY

GRAVITY IS THE EARTH'S GRAVITATIONAL PULL ON A BODY, LYING ON NEAR THE SURFACE OF EARTH.

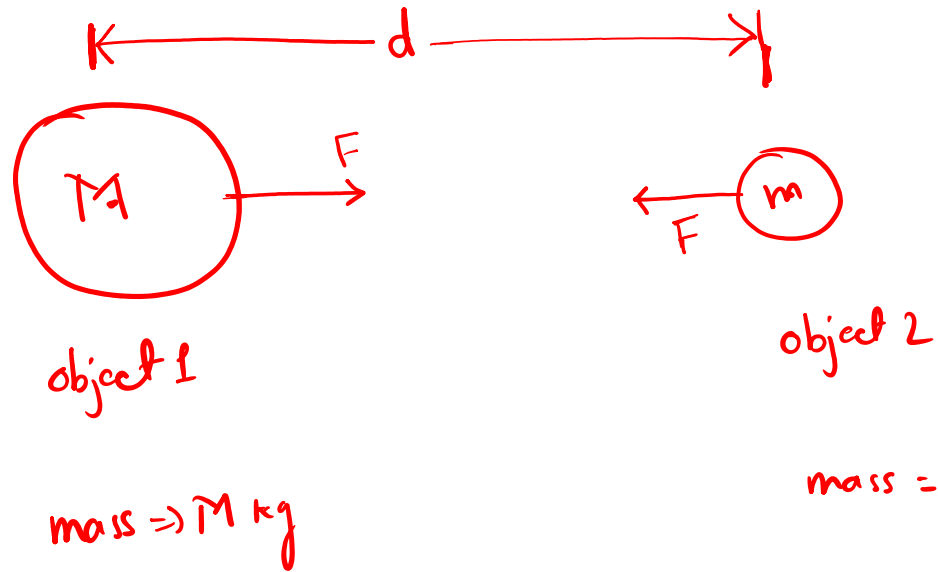
Escape Velocity



Minimum Velocity that an object must acquire so that it ~~can~~ escapes the earth's gravity.

Escape velocity of earth is —
11.2 km/s

Karman line



Mutual force of attraction (F),

$$F \propto M \cdot m \quad \text{--- ①}$$

$$F \propto \frac{1}{d^2} \quad \text{--- ②}$$

$$F = G_1 \left(\frac{M \cdot m}{d^2} \right)$$

$$F \propto \left(\frac{M \cdot m}{d^2} \right)$$

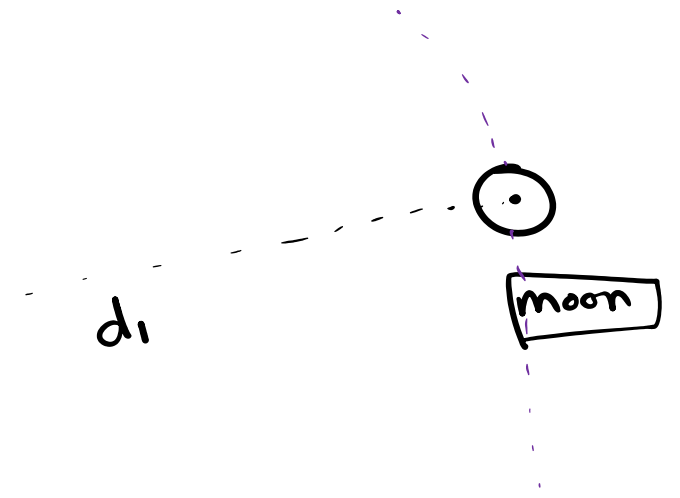
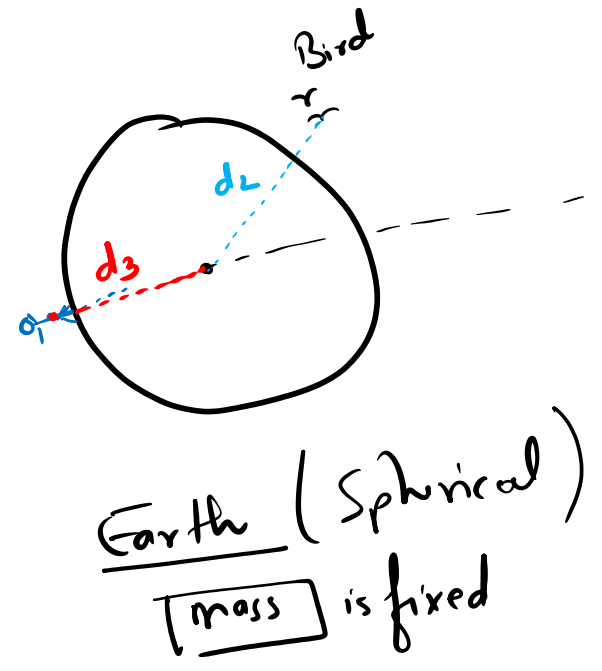
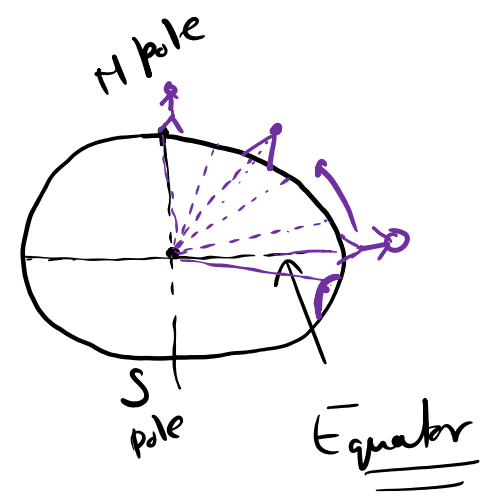
SI unit of force is newton (N)

$G_1 \Rightarrow$ Constant / proportionality constant / Universal Gravitation Constant.

$$G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$$

Need not to remember

$$F = G \left(\frac{M \cdot m}{d^2} \right)$$



Star

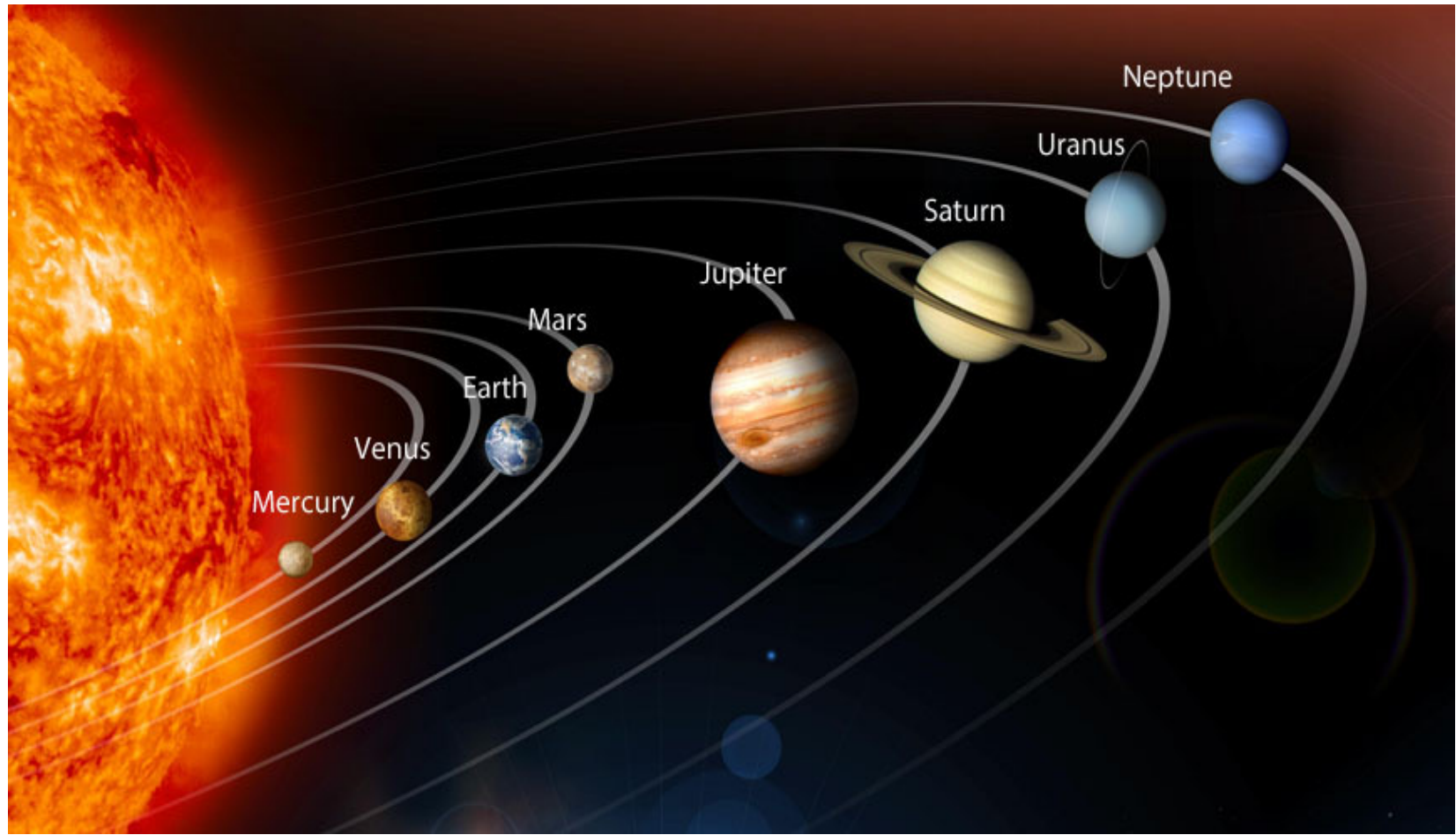
Lump of dust and gas that has its own light



Planet

3 Criteria :

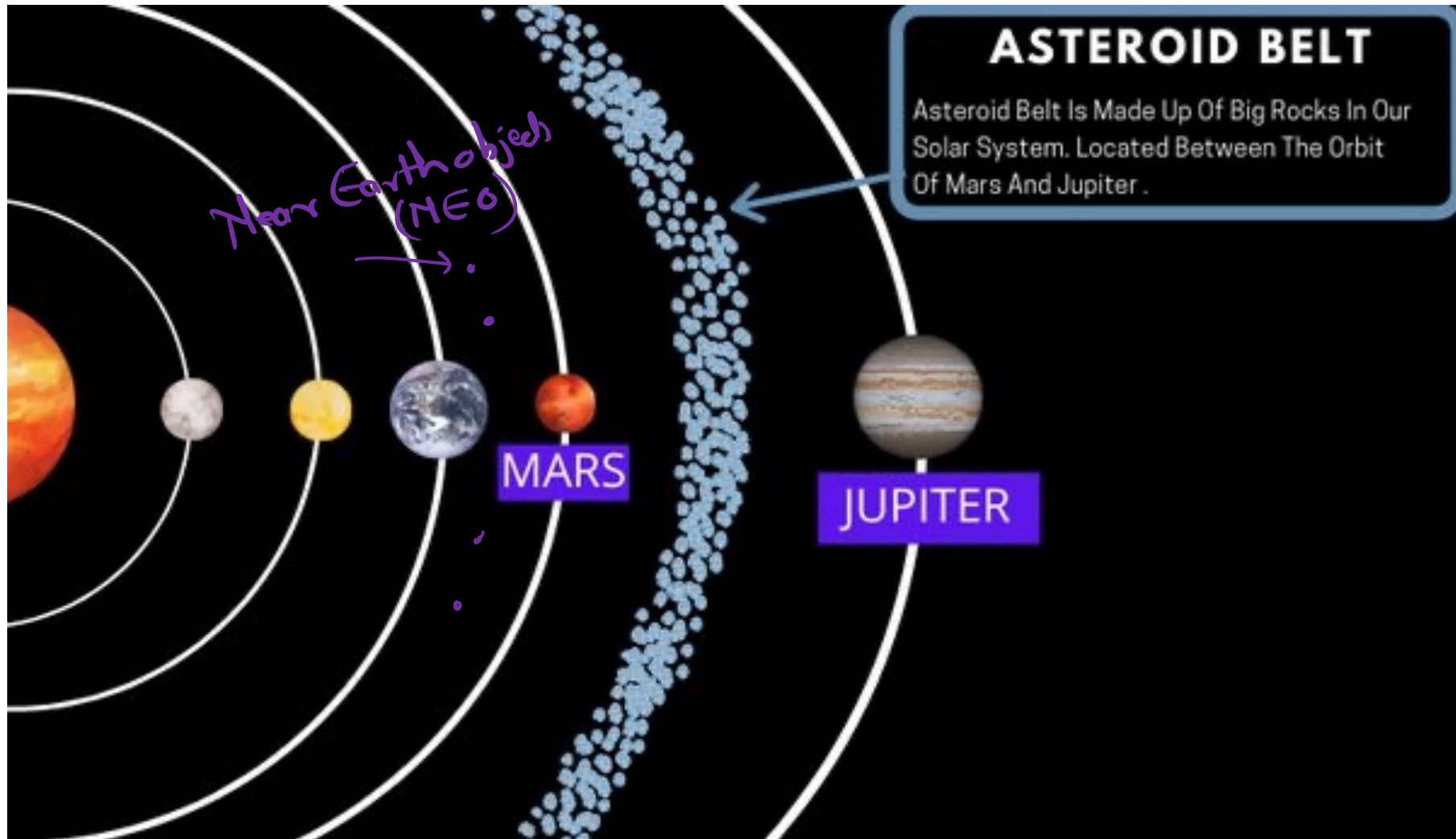
1. It should revolve around Sun.
2. It should have enough gravitational force to attain spherical or near-spherical shape.



3. It should have enough gravitational force to clear its ~~own~~ surrounding.

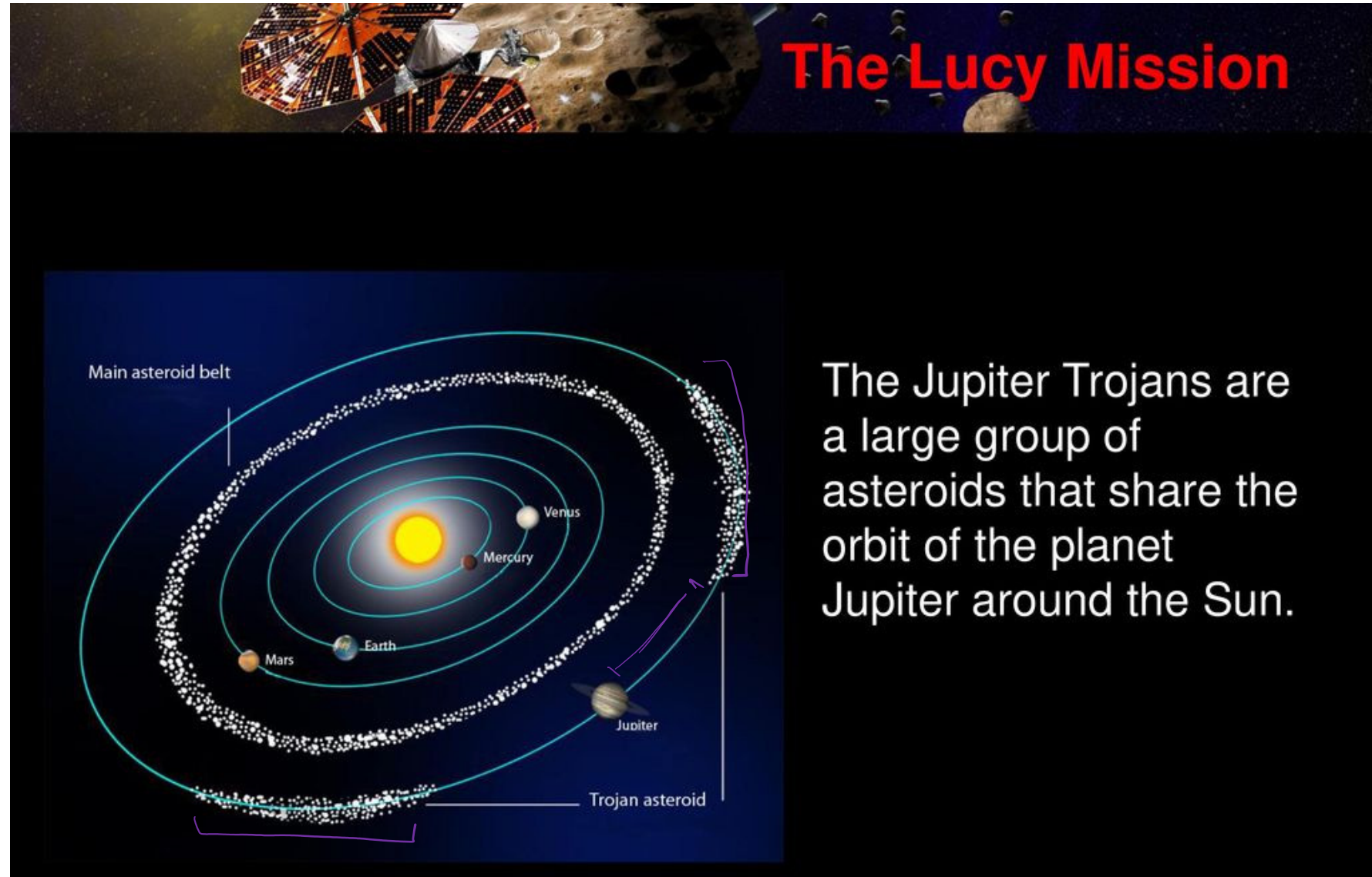
Asteroid

Asteroid \Rightarrow Rocky remnants of early solar system.




Asteroid

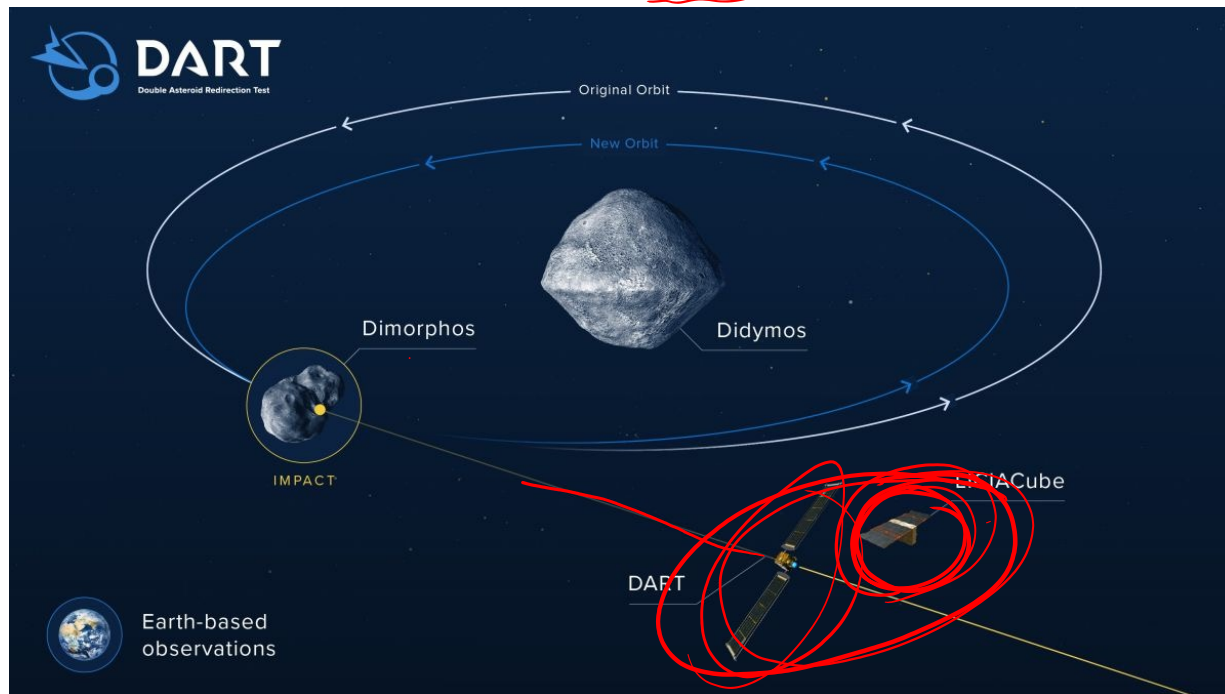
- **Launched:** Oct.16, 2021 at 5:34 a.m. EDT (09:34 GMT)
- **Launch site:** Kennedy Space Center
- **Rocket:** United Launch Alliance (ULA) Atlas V rocket
- **Target:** The Trojan asteroids
- **Estimated Cost:** \$981 million
- **Arrival at first target:** 2025
- **Status:** In progress



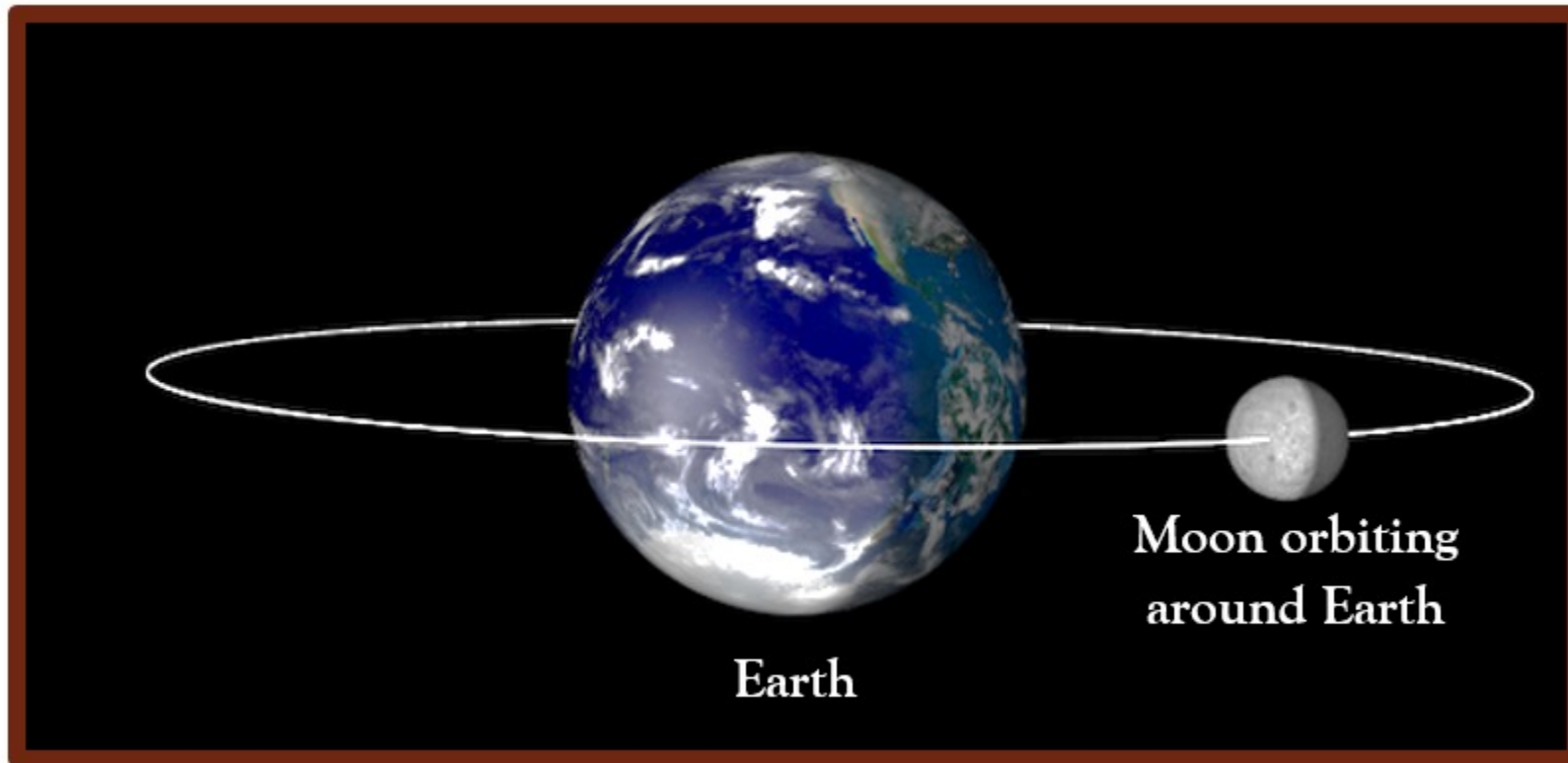
The Jupiter Trojans are a large group of asteroids that share the orbit of the planet Jupiter around the Sun.

Some Asteroid of Interest

- Bennu →  *change collision with earth.*
- Ryugu →
- Double Asteroid Redirection Test, Sep 2022

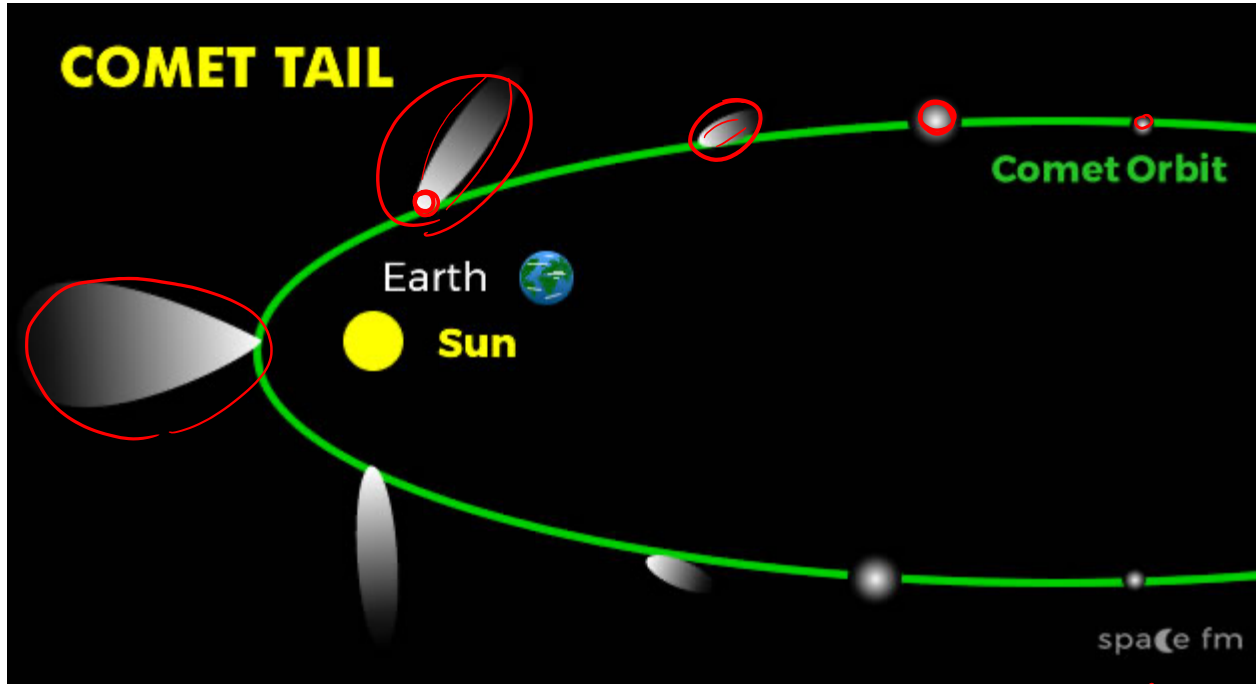


Satellite : Objects revolving around planets.
Natural Satellites



Comet

Icy objects + dust + gases
Sun (or star) in highly elliptical orbit move around



Nucleus
(Permanent)

Tail (Temporary)

- Kuiper Belt } → House of short period comet
- Oort cloud } → House of long-period comets

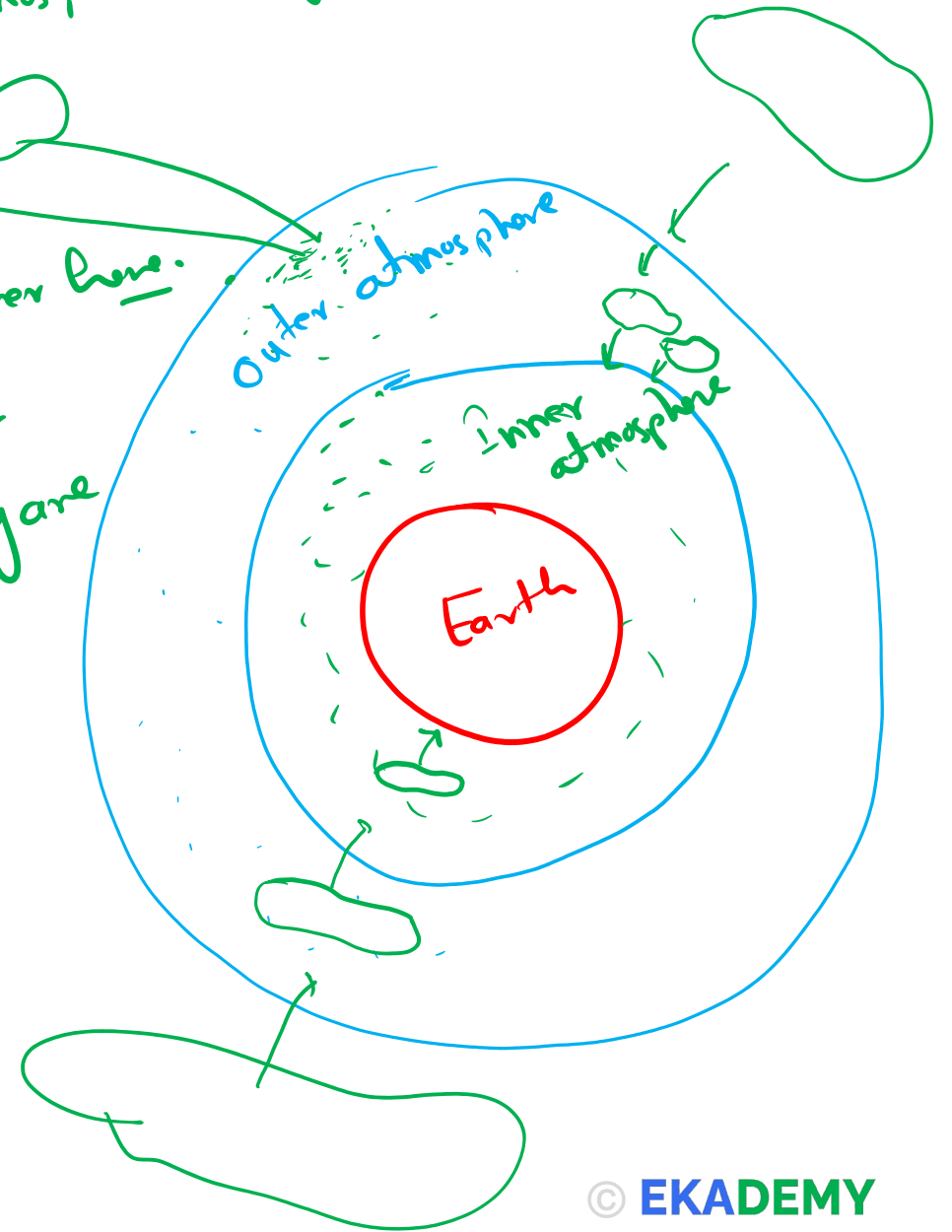
Meteoride

Chunk of asteroid or comet moving toward earth and entering its outer atmosphere.

On entering earth's outer atmosphere, most meteoride burn there itself and end over here.

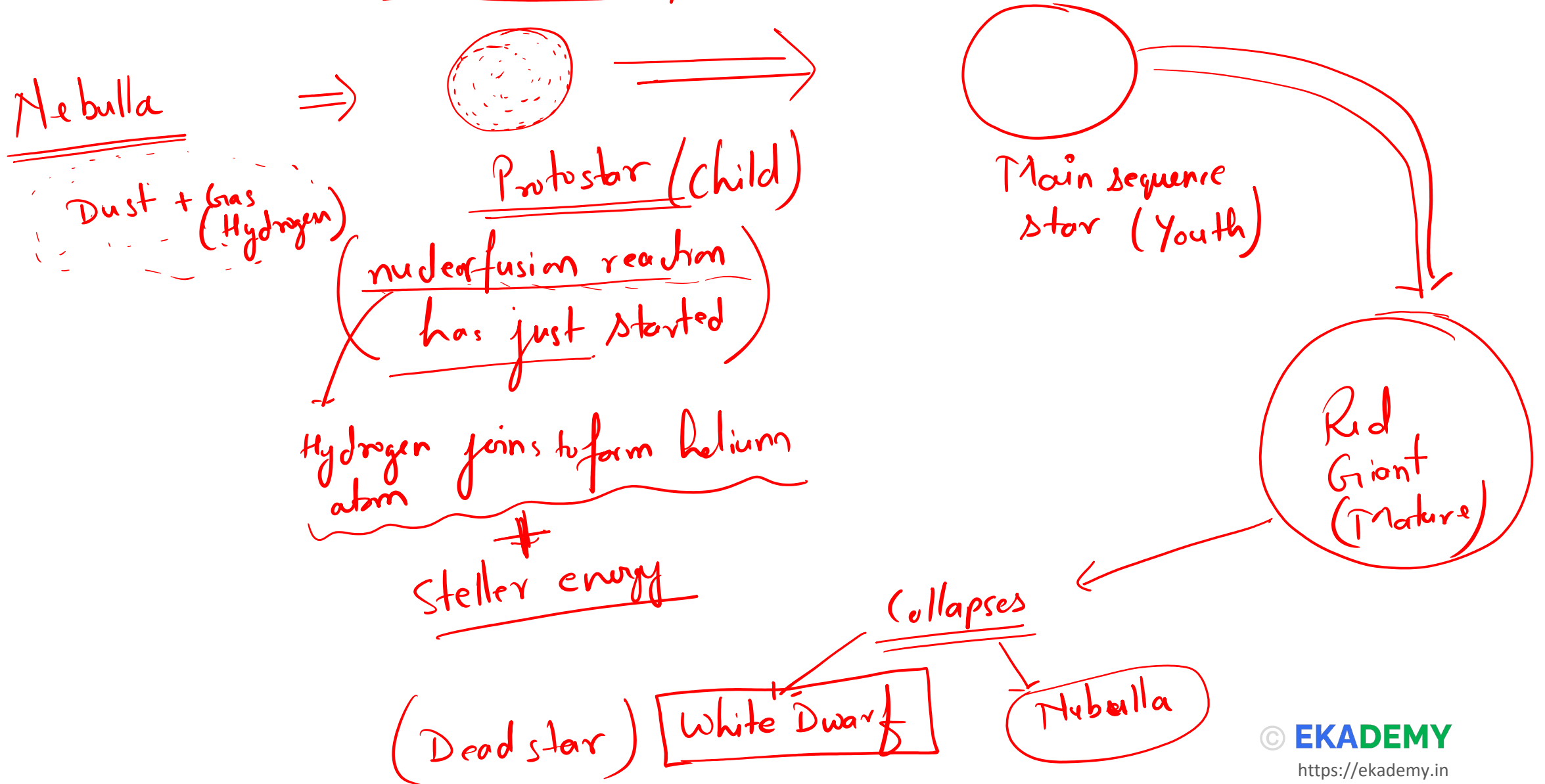
Meteors: Few meteoride enters the inner atmosphere and catch fire. They are called meteors

Meteorite: meteoride touching the surface of the earth is called meteorite.



Meteorite

Life Cycle of Small Star

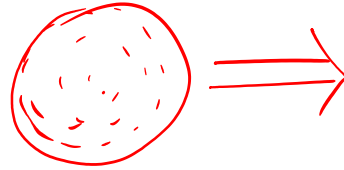


Life Cycle of Small Star

Life Cycle of a Big Star

Nebula (extremely huge)

Dust + gases
(H₂)



Protostar
(Child)



Main Sequence star

(Youth)



Super Red Giant

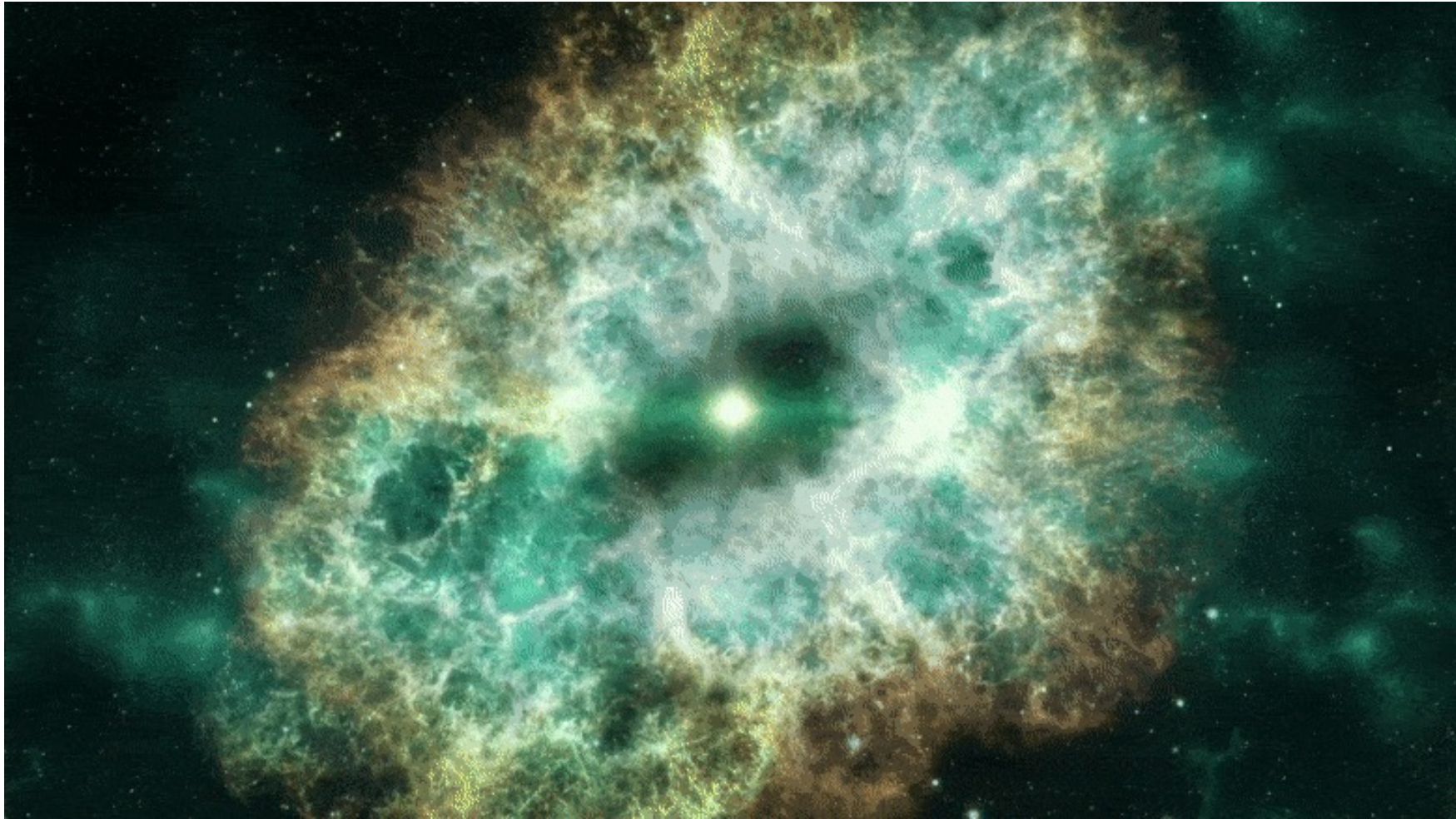


Collapses (Supernova Explosion)

Medium star
↓
Neutron star

Big star
↓
(Black hole)

Supernova Explosion



Blackhole

THE ANATOMY OF A BLACK HOLE

Accretion disk

Any material torn apart by the black hole circles these monsters like water swirling down a drain. A buildup of friction between the material causes it to glow, revealing the location of the black hole.

Event horizon

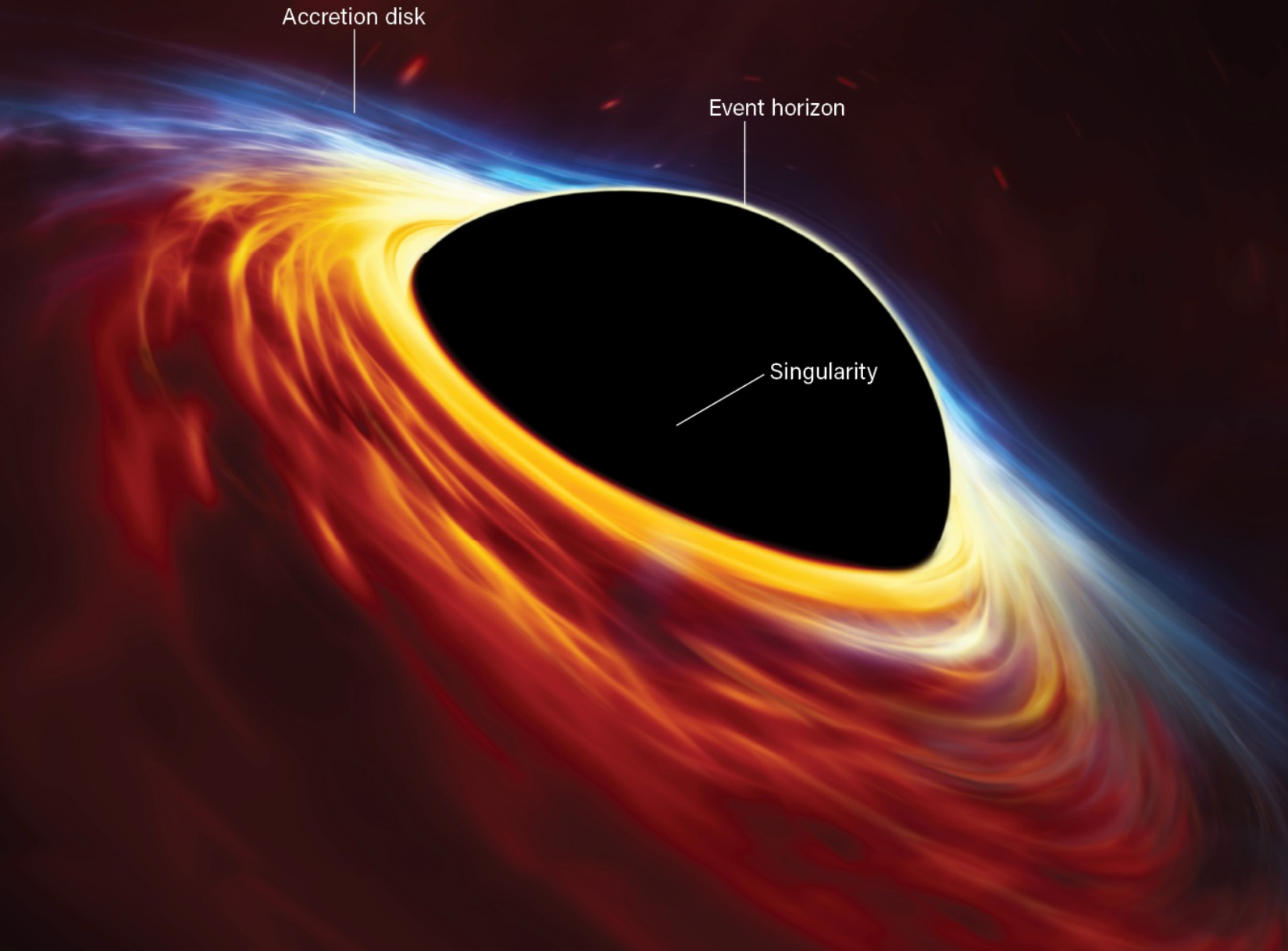
The so-called point of no return around a black hole. This shadow is the point inside of which nothing, not even light, can escape the gravitational pull of the black hole.

Singularity

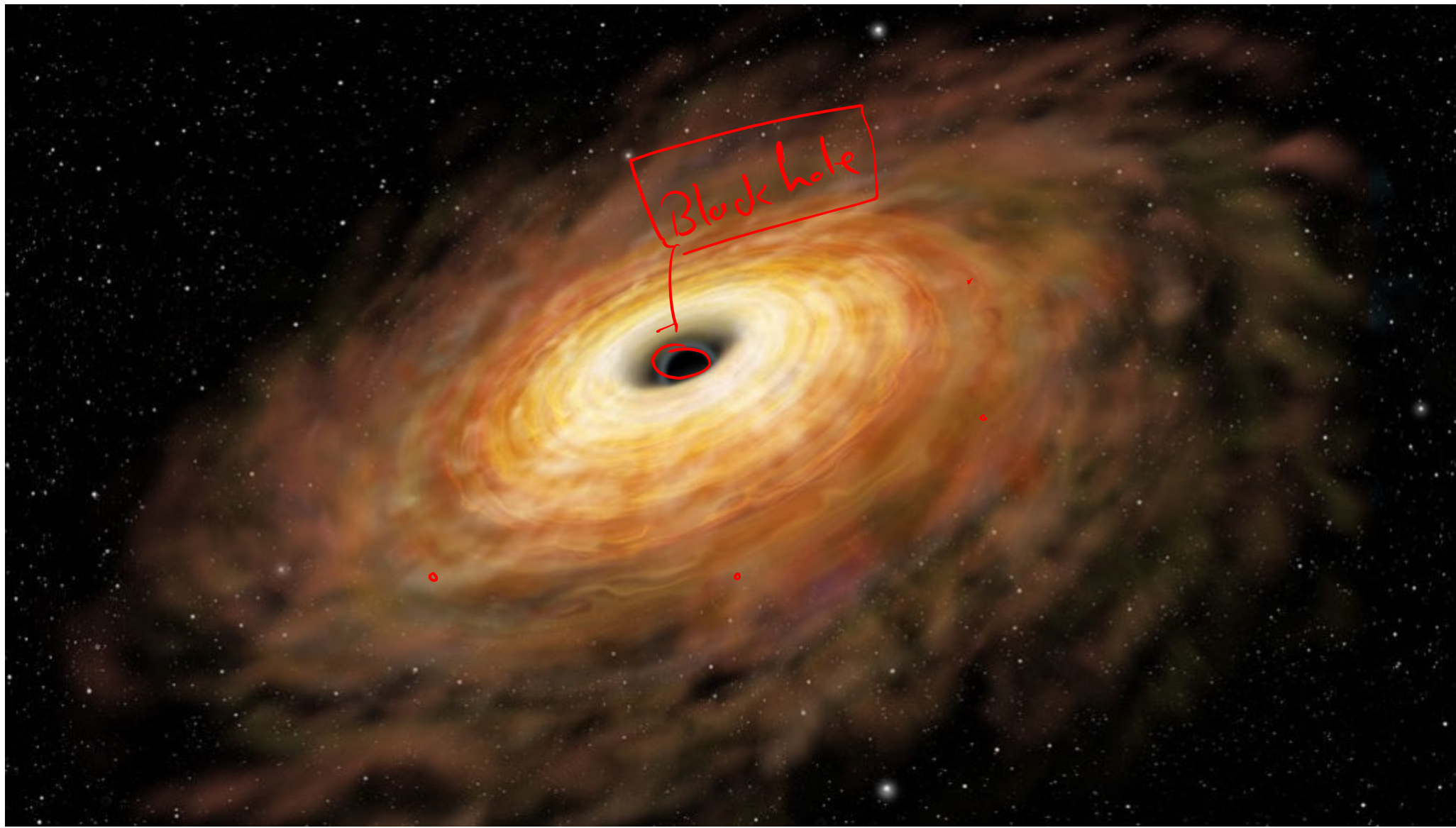
The very center of a black hole, where general relativity breaks down and gravity becomes infinite.

ESO, ESA/HUBBLE,

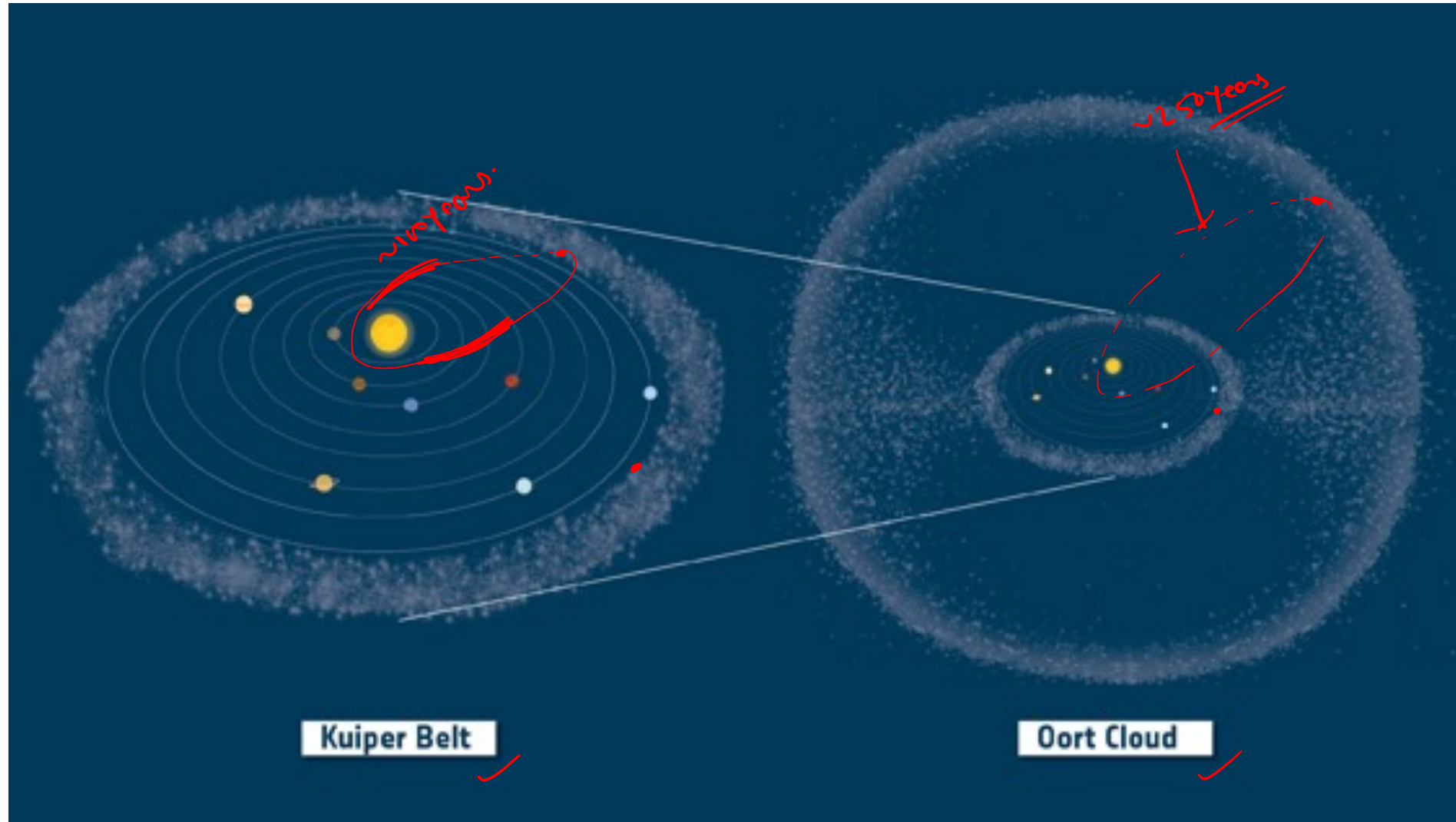
M. KORNMESSE



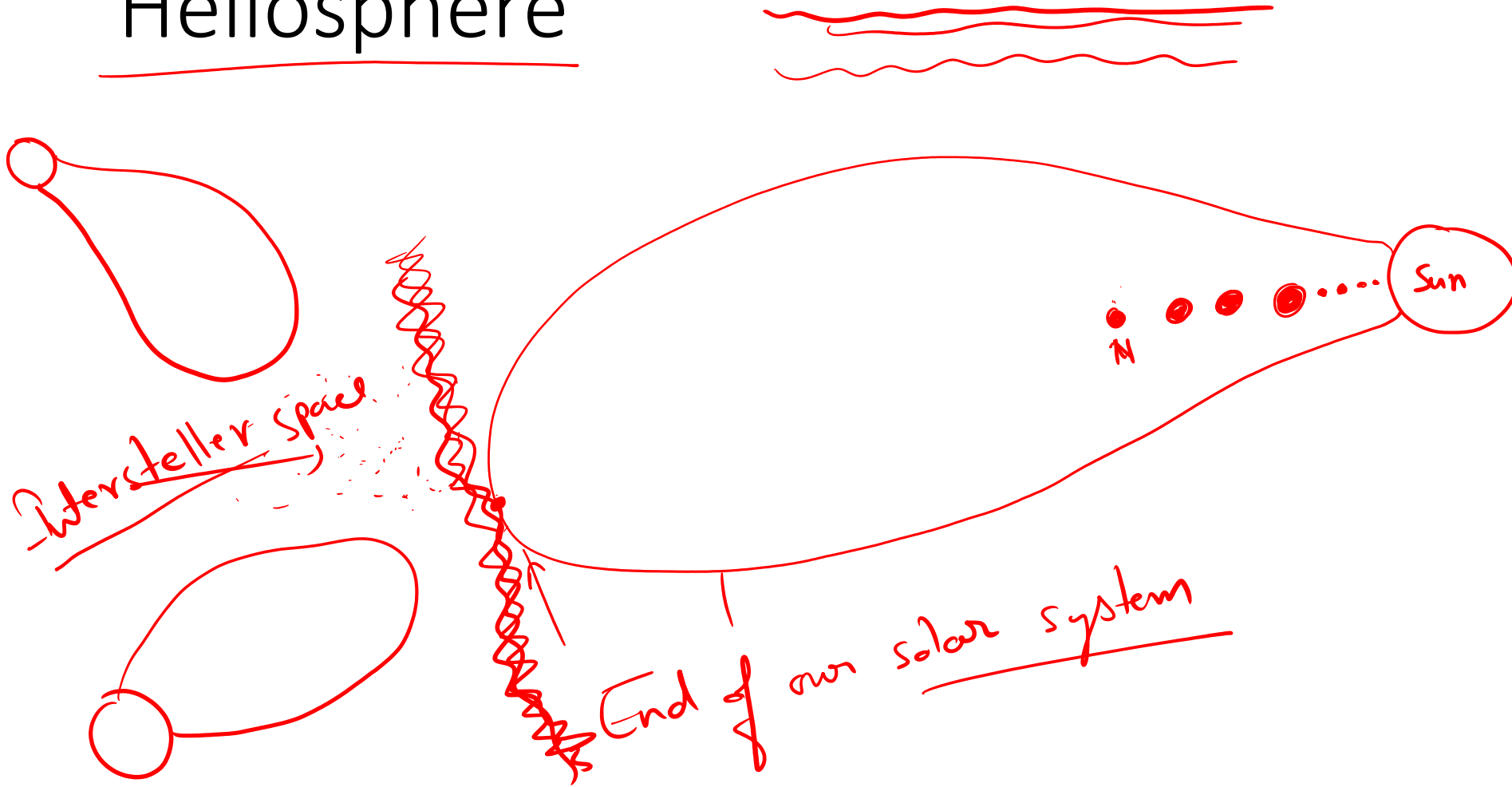
Galaxy



Kuiper Belt



Heliosphere



Moon's Gravitation

⇒ ∵ mass of moon is much smaller than earth, hence its gravitational force is also much smaller than earth.

⇒ Gravitational force on moon is $\left(\frac{1}{6}\right)^{\text{th}}$ of the gravitational force of earth.

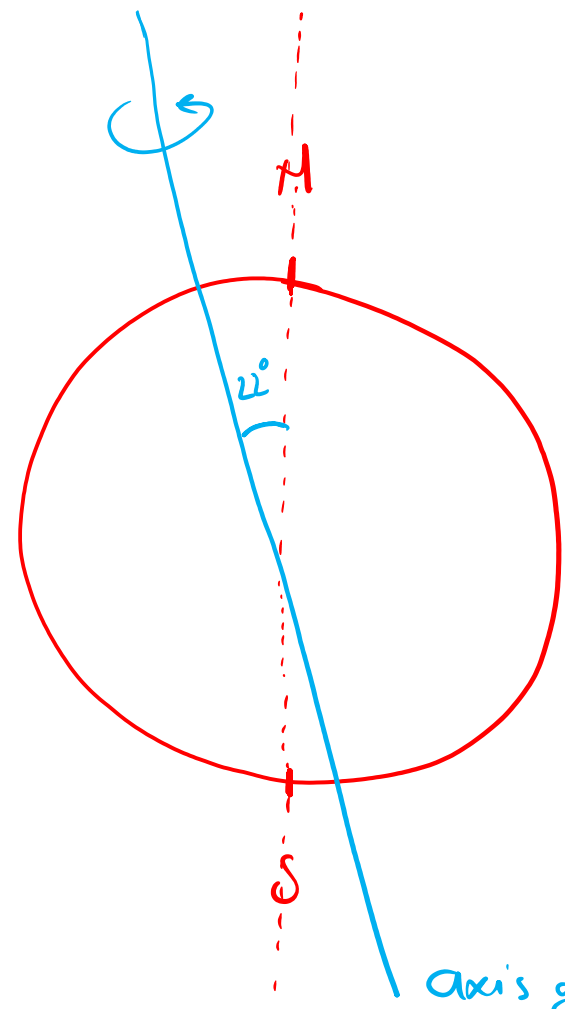
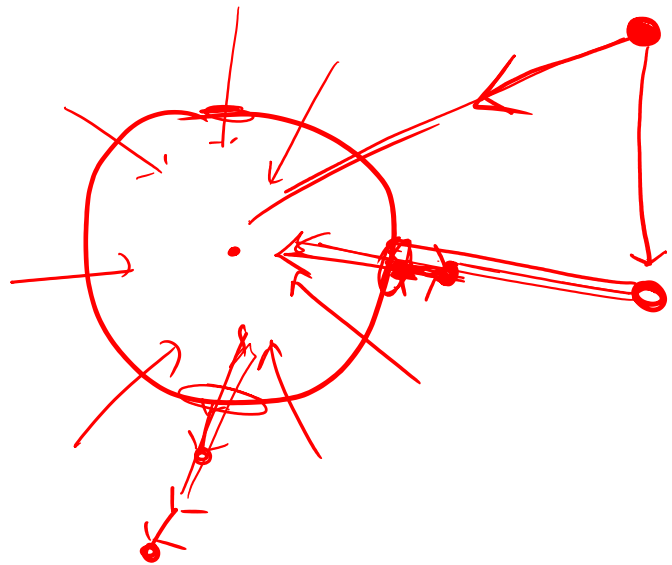
eg. A body of 60 kgwt. on earth will weigh 10 kgwt on moon.

* The moon has no atmosphere.

Because of small mass (low gravitational pull) moon is not able to hold ~~pull~~ gases ~~to~~ around its surface.

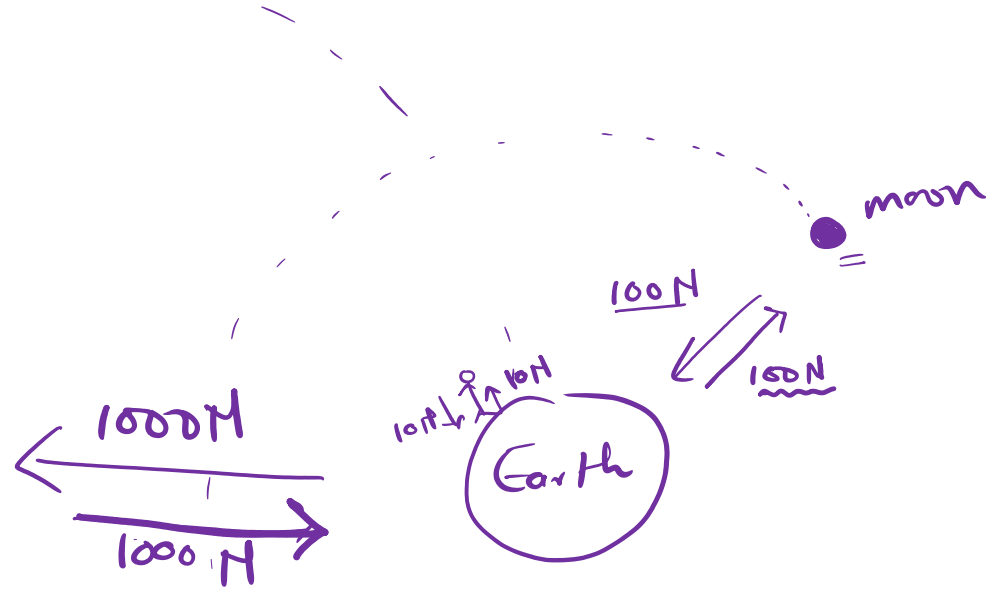
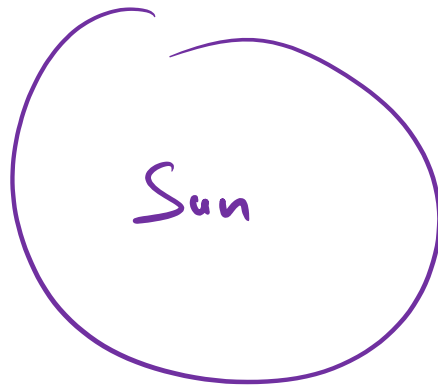
⇒ Moon is moving away from earth every ~~so~~ year { ~ 1 cm away/year }

Mon, Wed,

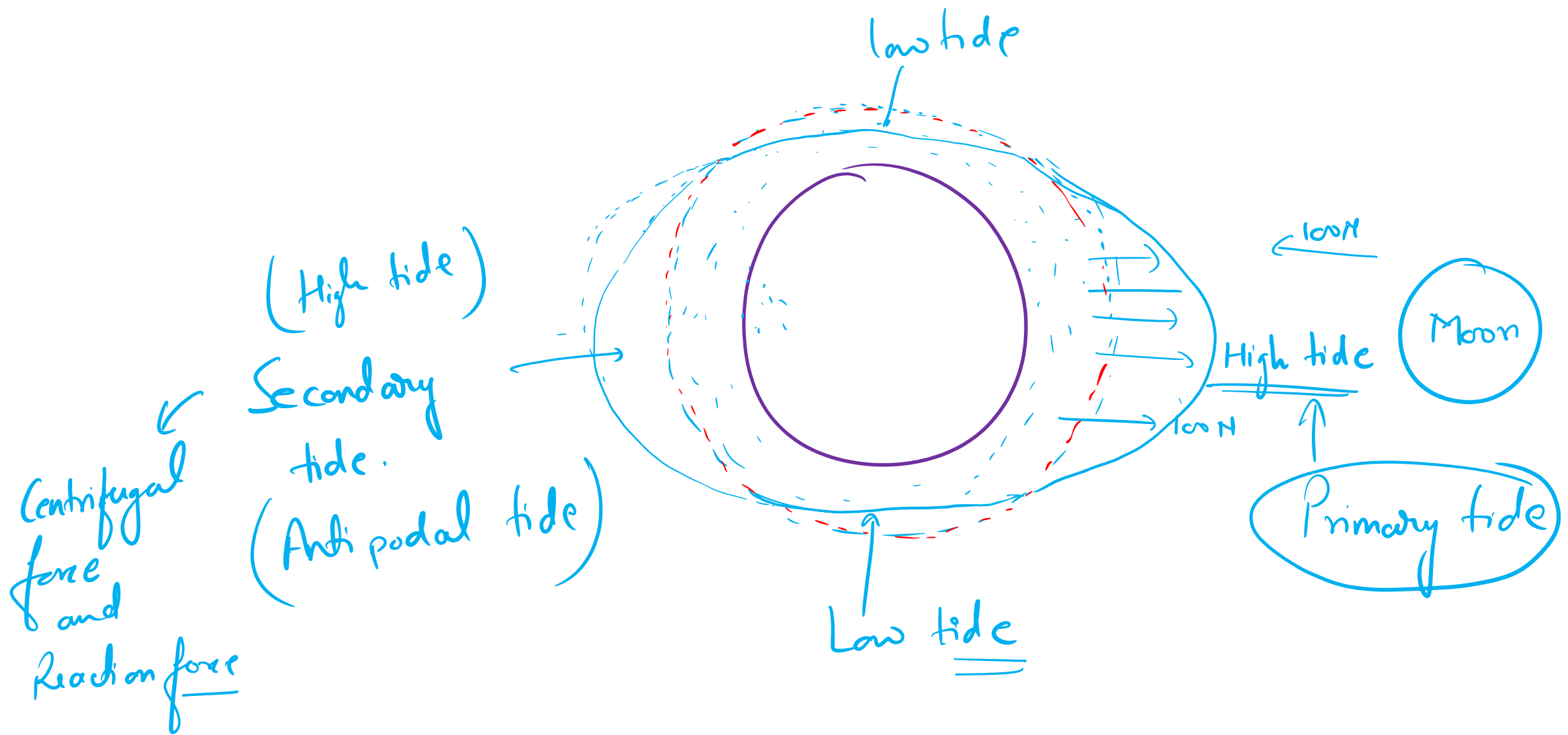


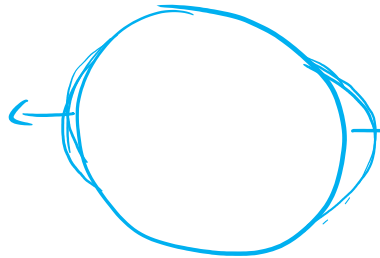
This tilt is responsible for different seasons.

Tides

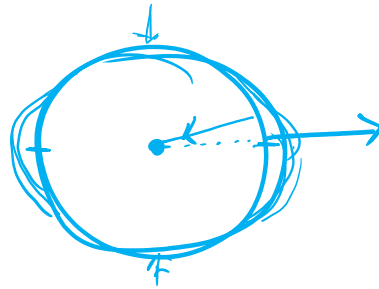


$$F = \frac{G m_1 m_2}{r^2}$$

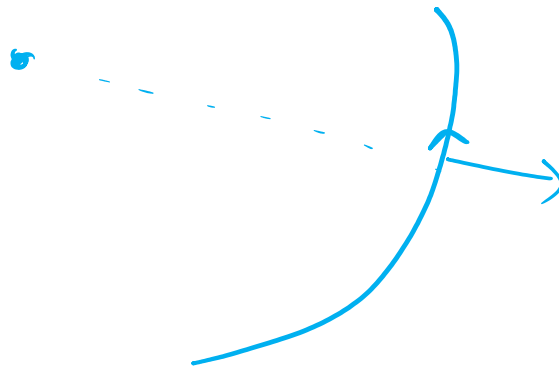


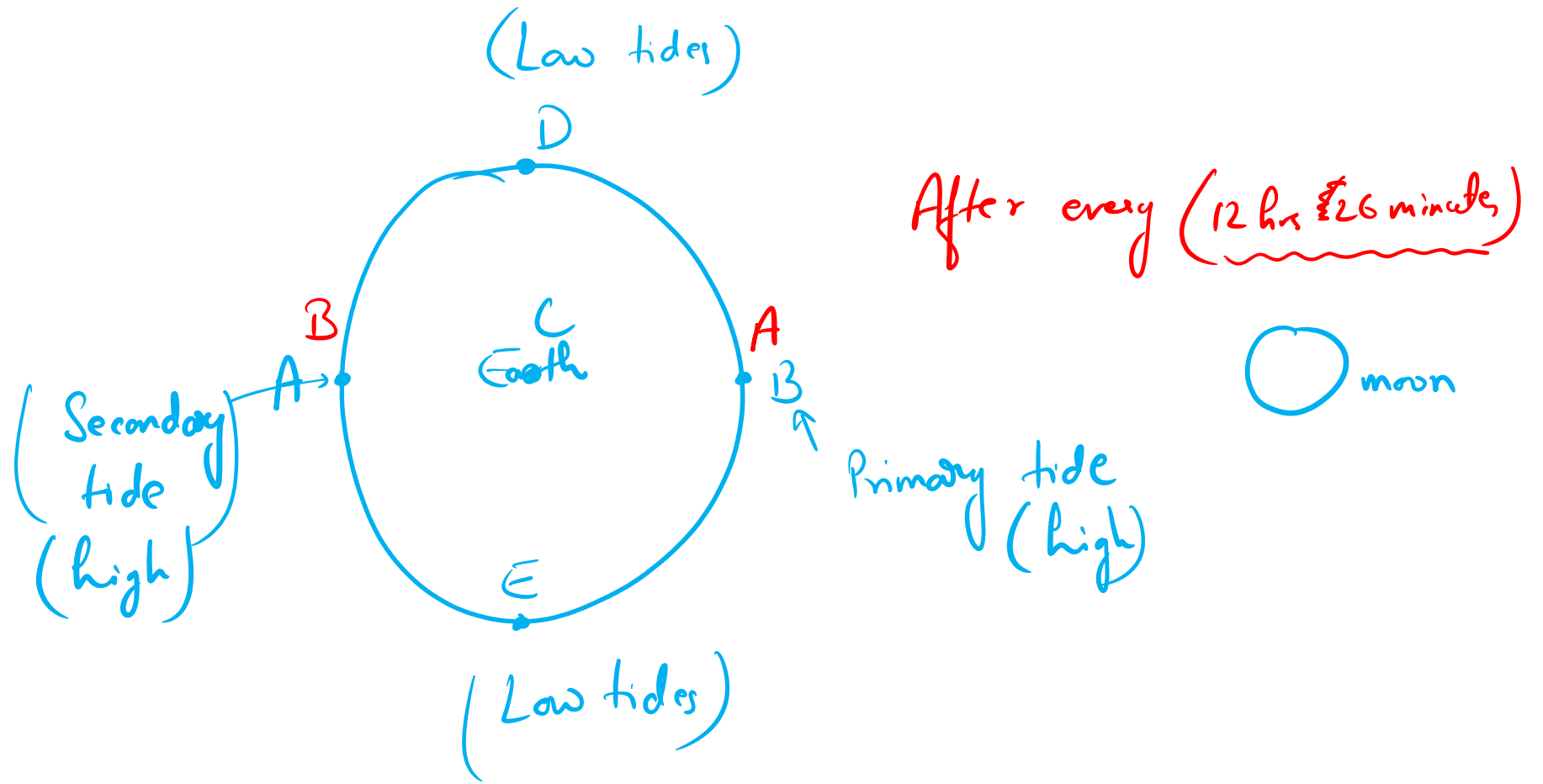


Centrifugal force is also responsible for tides.



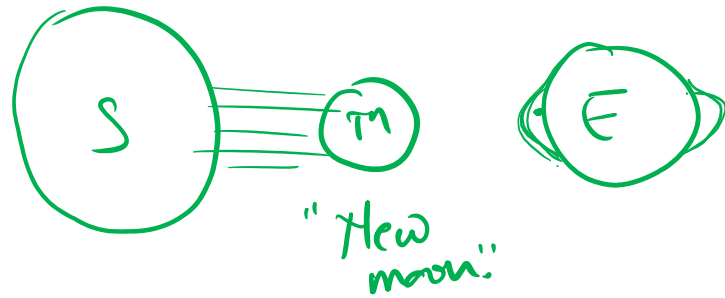
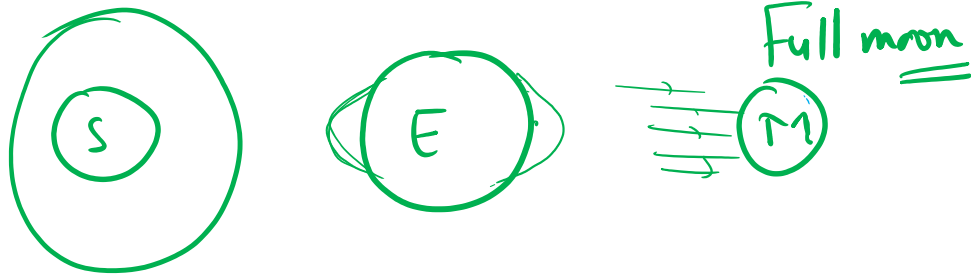
Centrifugal force.



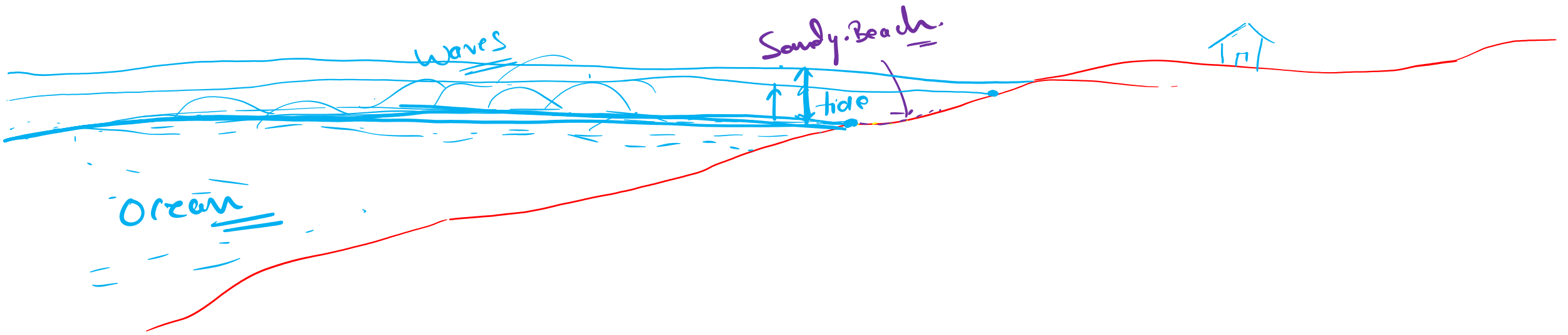


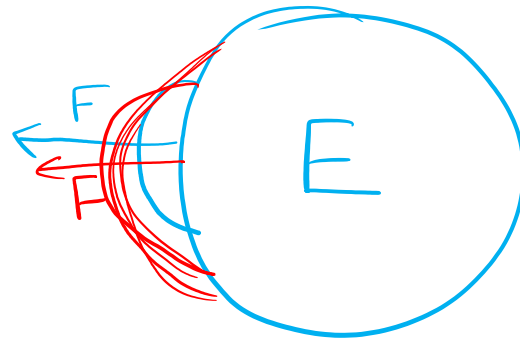
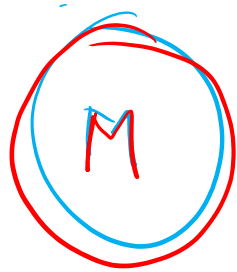
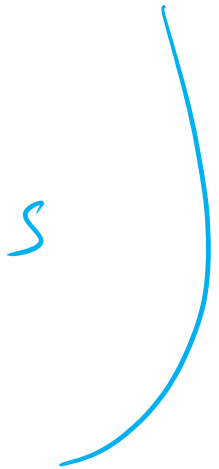
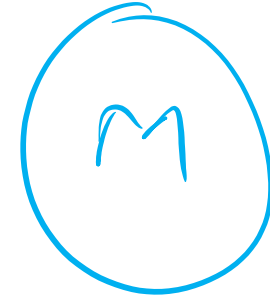
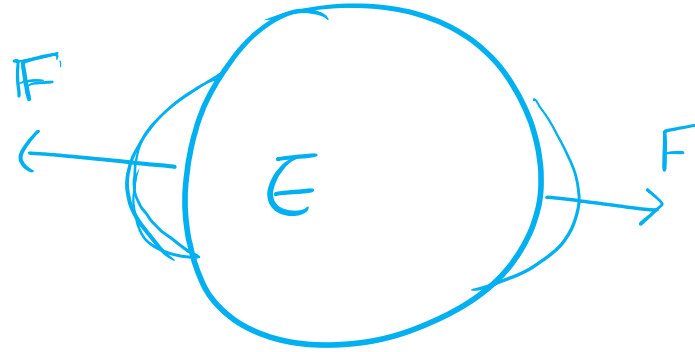
Types of tides

① Spring tides
(high tides)



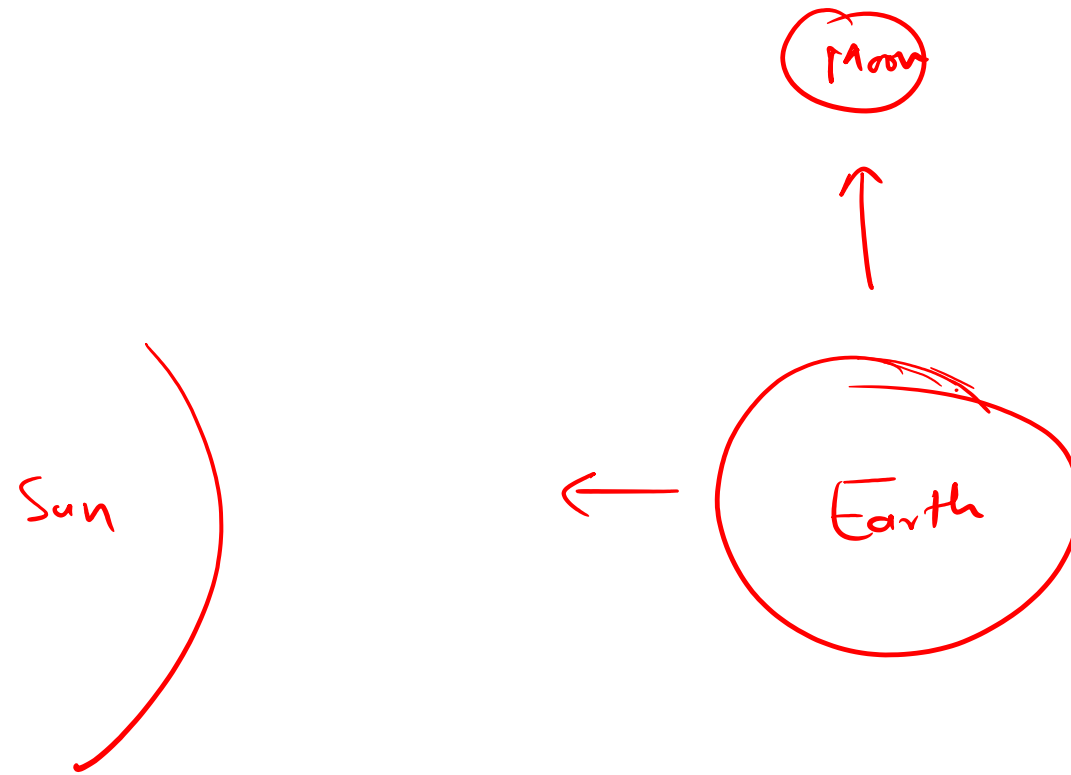
② Neap tide
(Low tide)





Spring tides formed on new moon day ~~is~~ are much stronger than that on full moon day.

Neap tides



- Neap tides occur when gravitational pull of moon and sun on the earth are ~~per~~ perpendicular to each other.
- Neap tides are low tides, because the net gravitational pull on earth is small.

Good Effects of tides

- ① During high tides fishes like salmon can swim back to rivers to lay eggs.
- ② Waste from the rivers are flushed out by receding tidal water.
- ③ Tidal energy can be used to generate electrical electricity.

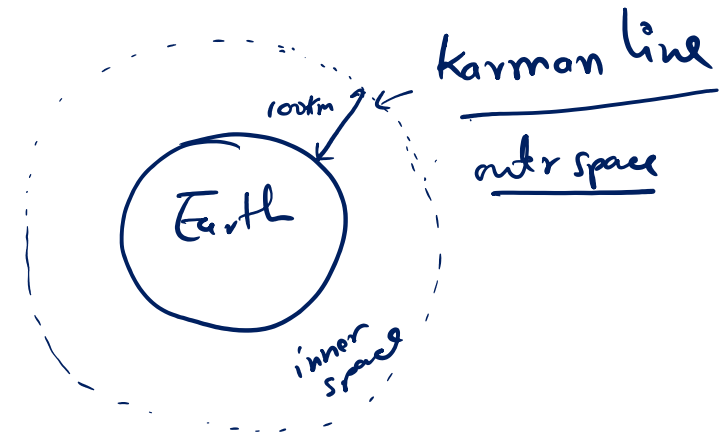
Bad effects:

- Tides make fishing difficult for fishermen.
- Tidal water can make river water undrinkable by depositing sediments.

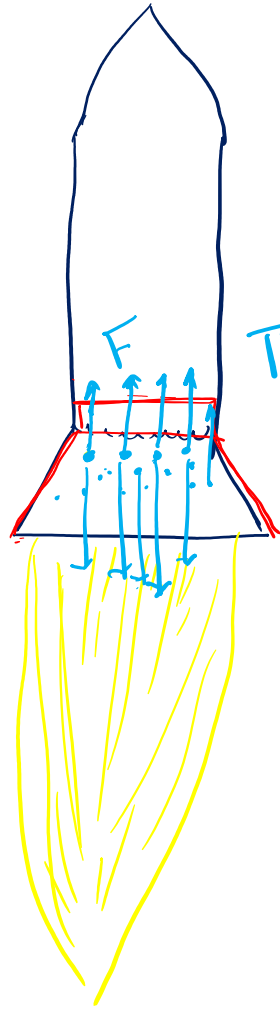
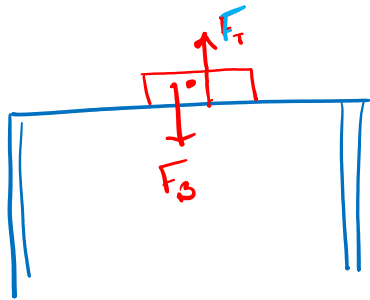
Rocket

The one used at the time of war.

The other for studying atmosphere and outer space.



⇒ ~~Workin~~ Rocket works on "Newton's third law of motion."



Thrust (Reaction force of exhaust on the rocket).

Rocket

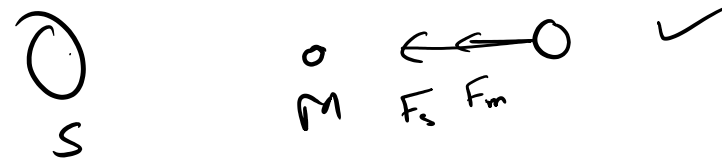
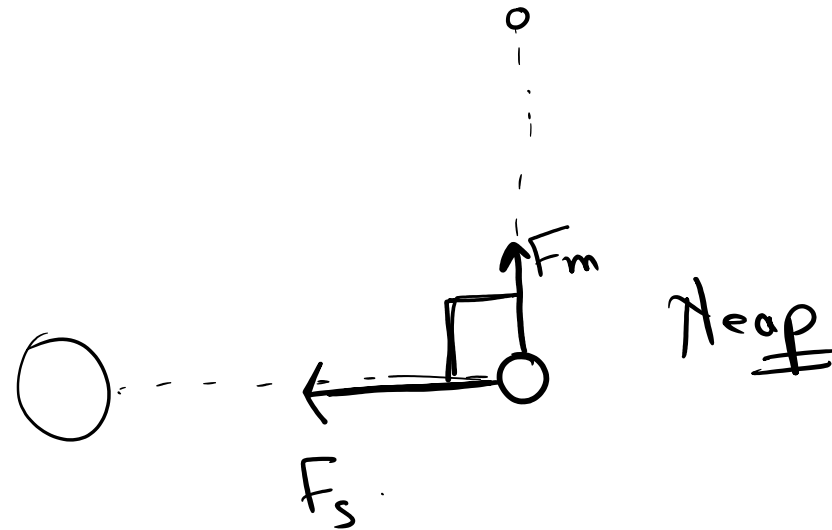
Third Law of motion:

For every action there is equal and opposite reaction

[action and reaction are] forces.

Most Common Rocket fuel

: [Liquid hydrogen + Liquid oxygen]

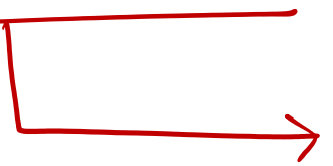


Use of Rocket

→ To take / ^(carry) any payload into outer atmosphere or space.

- Satellite ✓
- Spacecraft
- Warhead (explosive)

Artificial Satellites



⇒ These are object into various orbits and perform different functions.

To study geography of earth.

↓
[• Lower earth orbit [LEO] [~500 km — ~11000 km]]

→ [eg: GPS] Navigational satellites ←

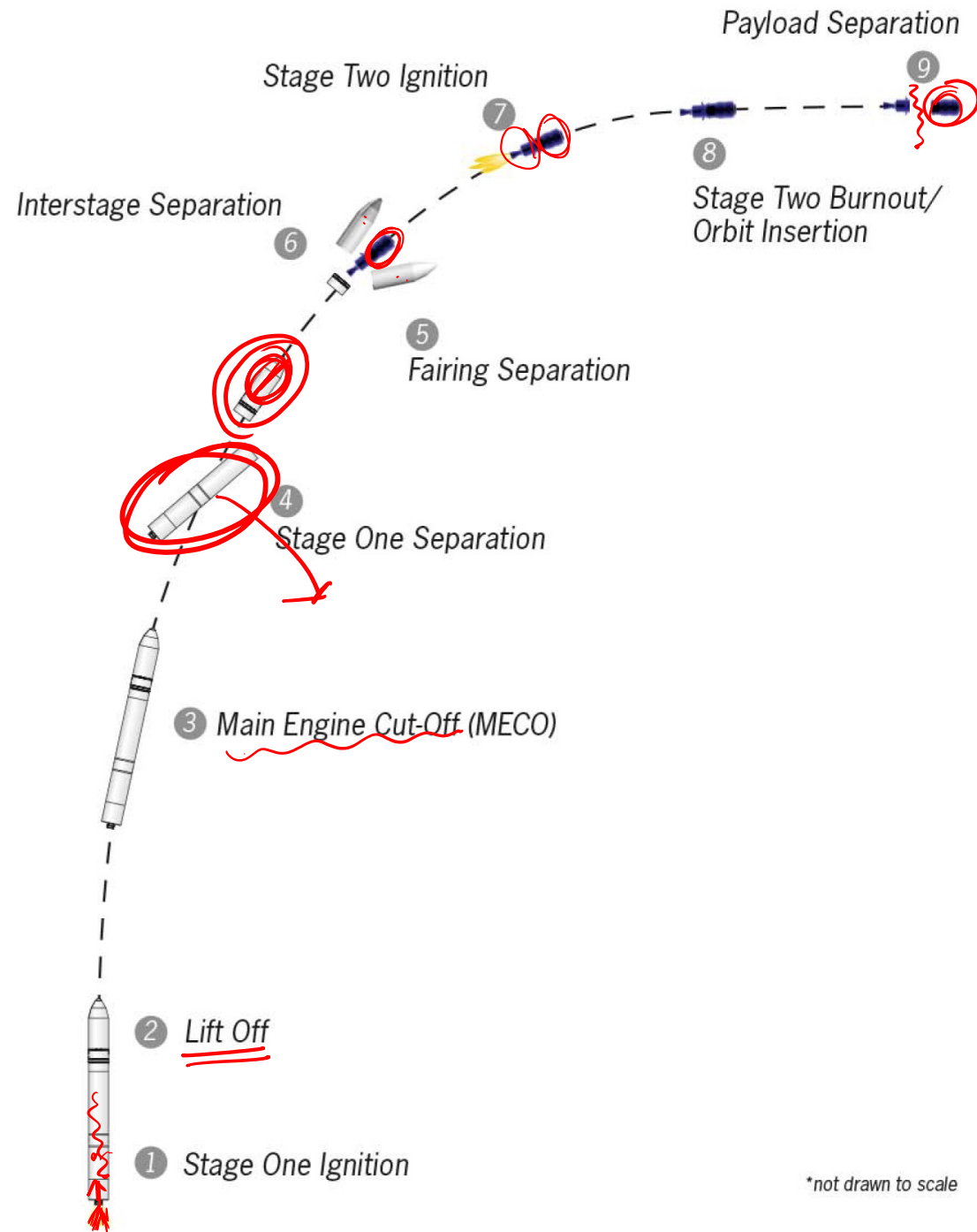
[• Medium earth orbit [MEO]]

[Communication Satellites]

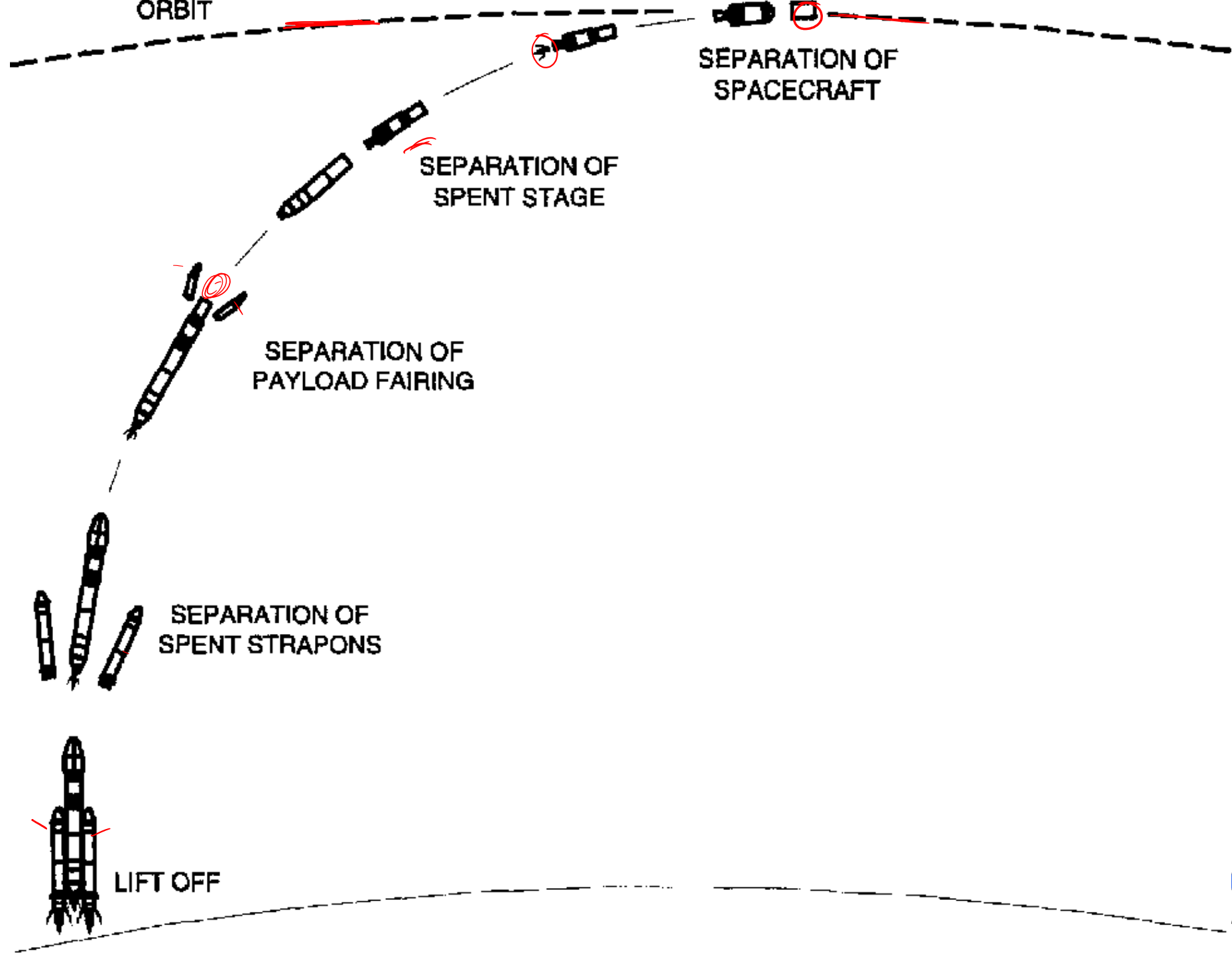
← [• Higher Earth Orbit [HEO]] ~ 36000 km

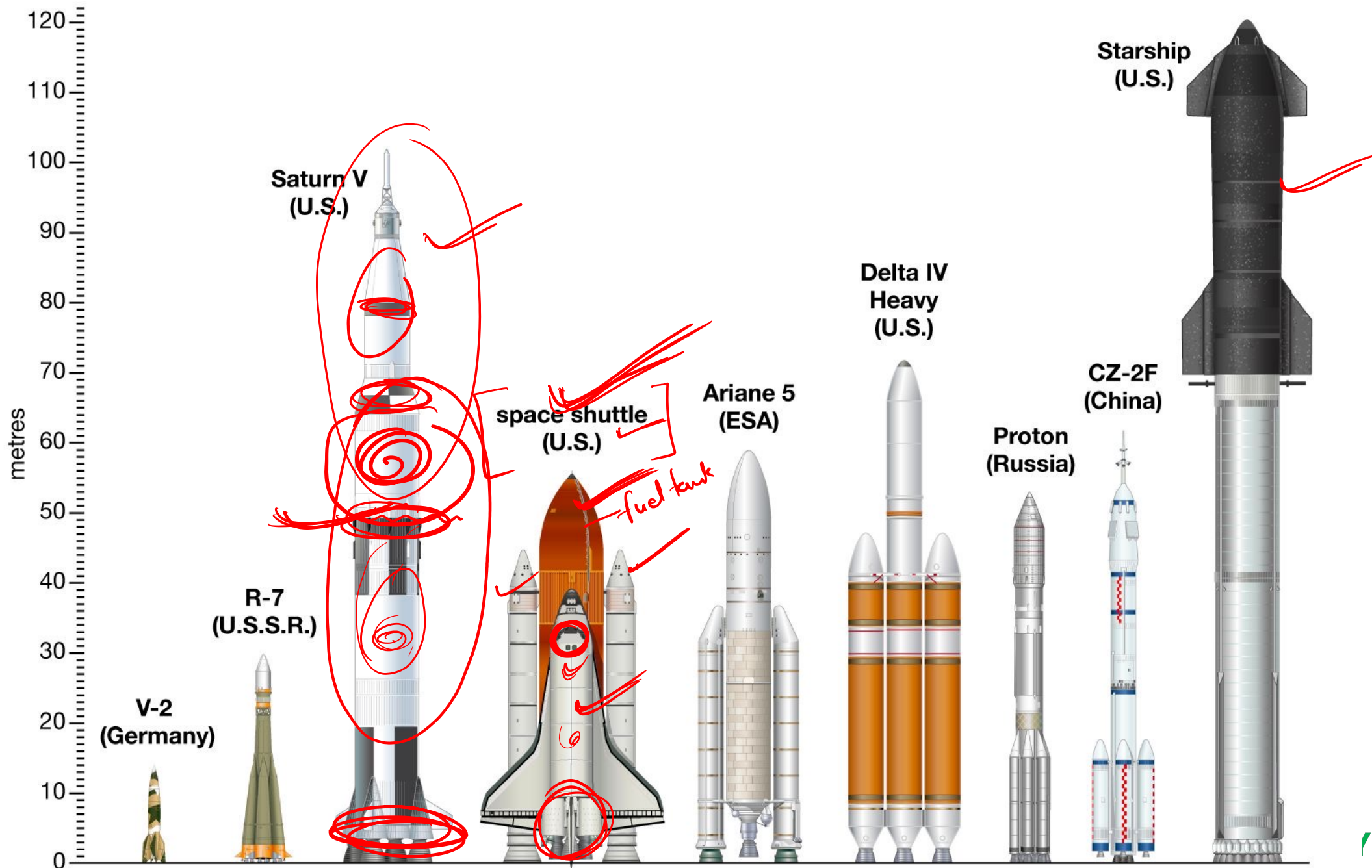
→ Satellites are launched into space using multi-stage launching systems, where different rockets are fired at different stages.





*not drawn to scale

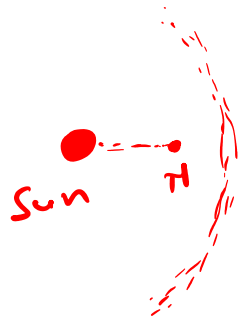




Voyager 1 & Voyager 2

Space Probes

Sputnik (USSR)
(1957)



V₁

V₂

Space Travel

- International Space Station (ISS)
 - ↳ Humans / astronauts lives in ISS.
(max. for 6 months)
- Humans have ~~be~~ travelled to moon (1969)
- NASA is again trying to take humans back to moon.
(Artemis I, II, III → 2025)

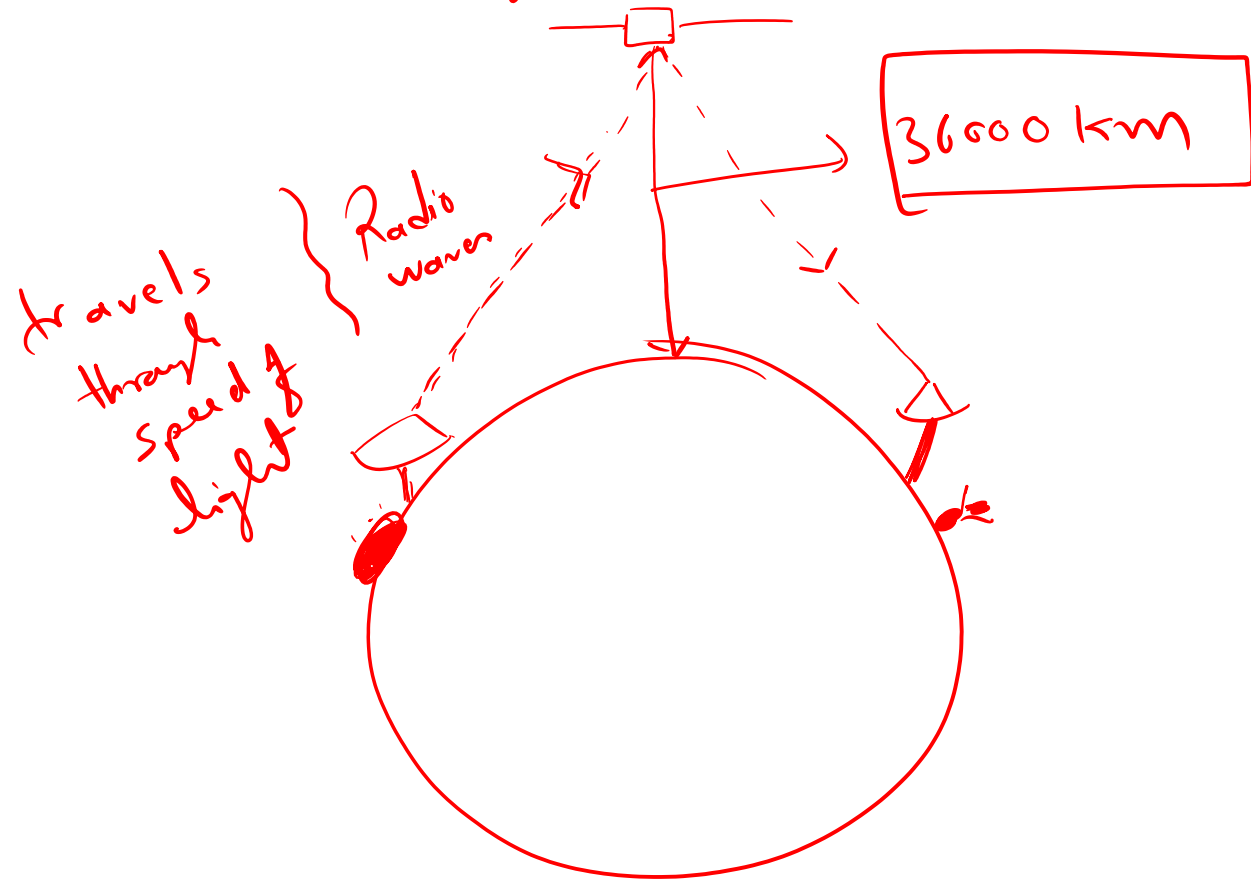
• Hubble Space Telescope

↳ used to study outer space.

• James Webb Space Telescope

Uses of Space Travel / exploration.

① Communication is possible because of communication satellites.



- ① Study of outer space and other heavenly body.
- ② Remote sensing satellites are used to locate water, mineral hidden under earth and fishes ~~in~~ inside sea/ocean.
- ③ Precise navigation and air travel ~~and~~ is possible because of Navigation Satellites
- ④ Forecasting of weather .
↳ Dedicated Satellites

• First Indian Satellite was launched in 1975 (19th April).

↓
Aryabhata

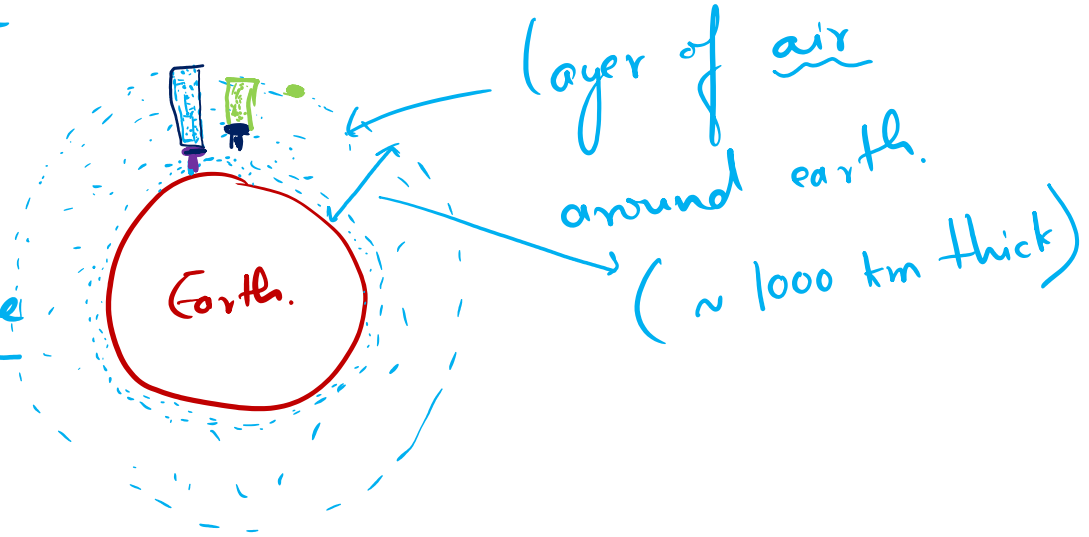
• 2008, first successful moon mission. (Chandrayan-1)

Winds, Storms and Cyclones

The pressure exerted by the atmospheric air is called atmospheric pressure.

↓
depends on temperature and other things.

⇒ Barometer is the instrument used to measure atmospheric pressure.

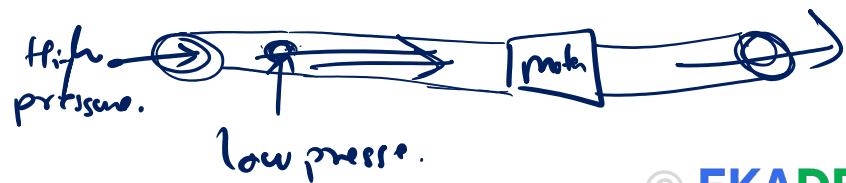
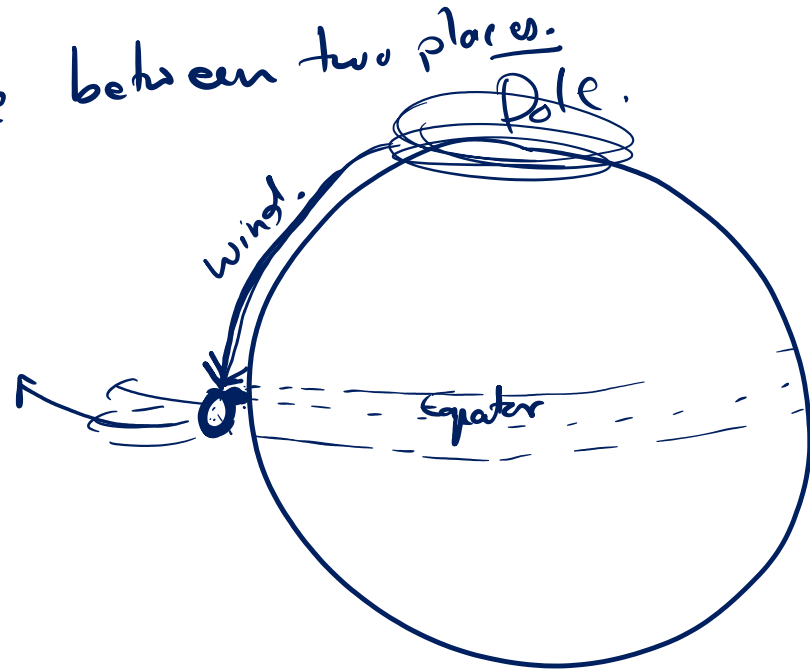
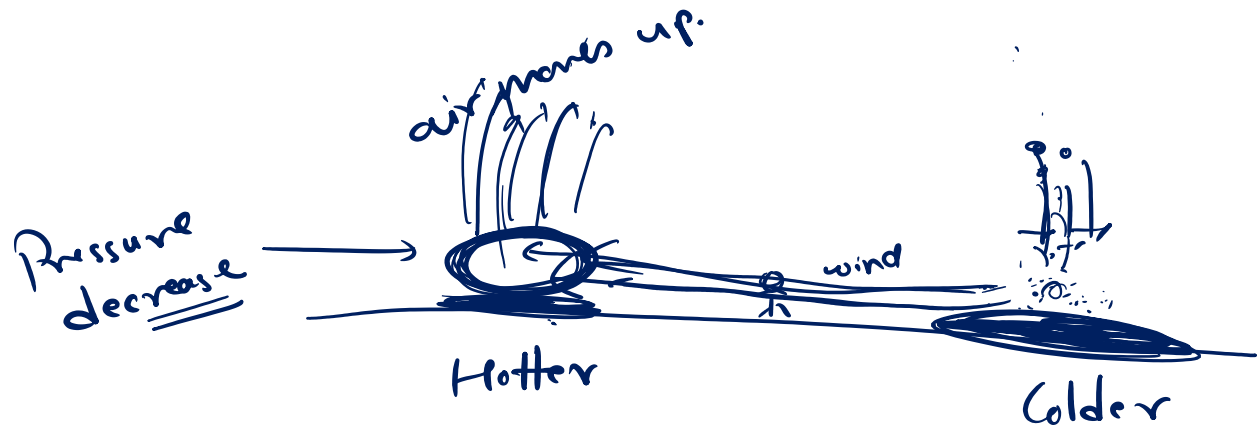


This envelope of air is called atmosphere.

Wind

Moving air is called wind

- Air moves because of temperature difference between two places.



End of the chapter