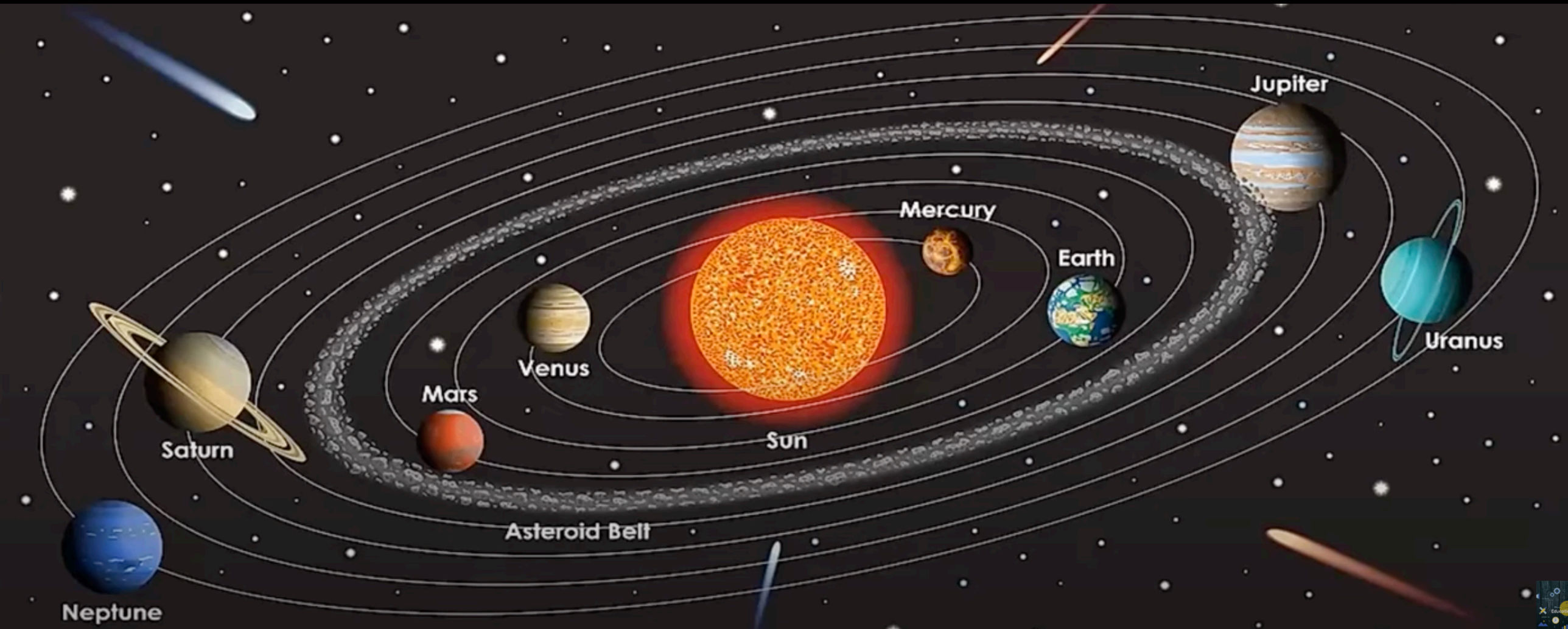
Chapter 24. Earth and Solar System



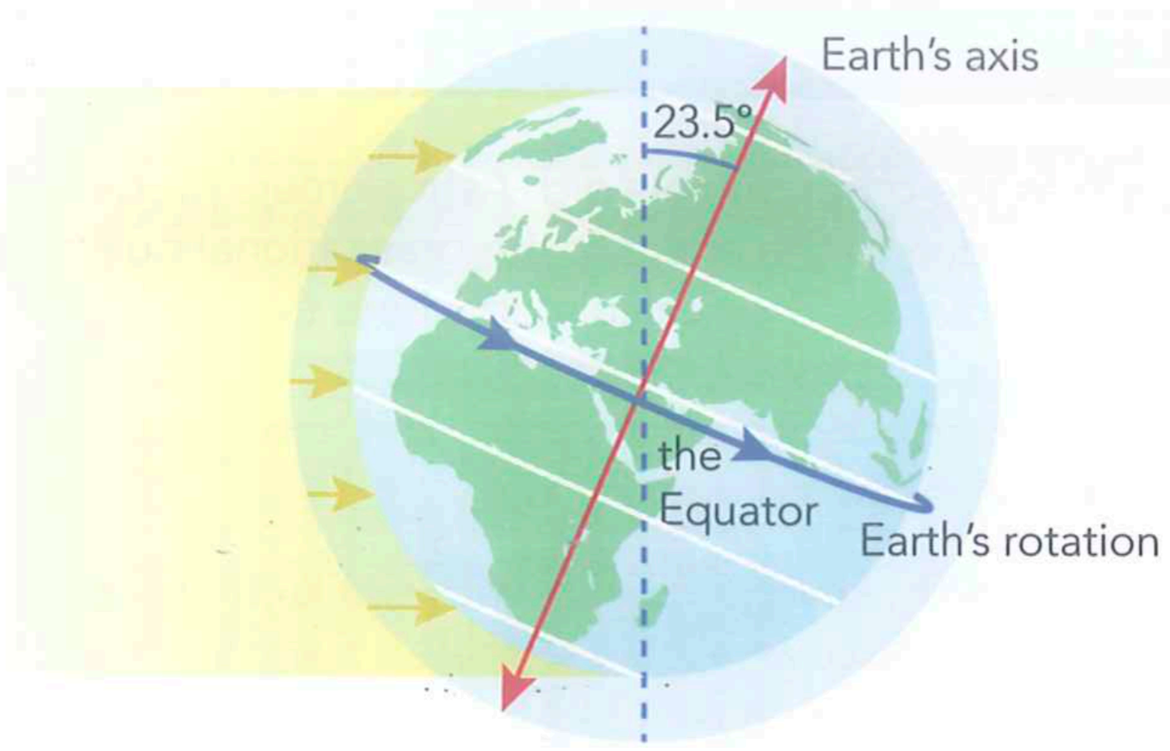
New Words

ellipse, elliptical, eccentricity, planet, minor planet, dwarf planet, Pluto, Eris, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, asteroid, comet, accrete, accretion, accretion disk, meteoroid, equator, nebula, swirling, orbit, tilt, cyclical, equator, hemisphere, correlation

Earth, Sun and Moon

→ Day and night ***<u><= Earth spin</u> on its axis***

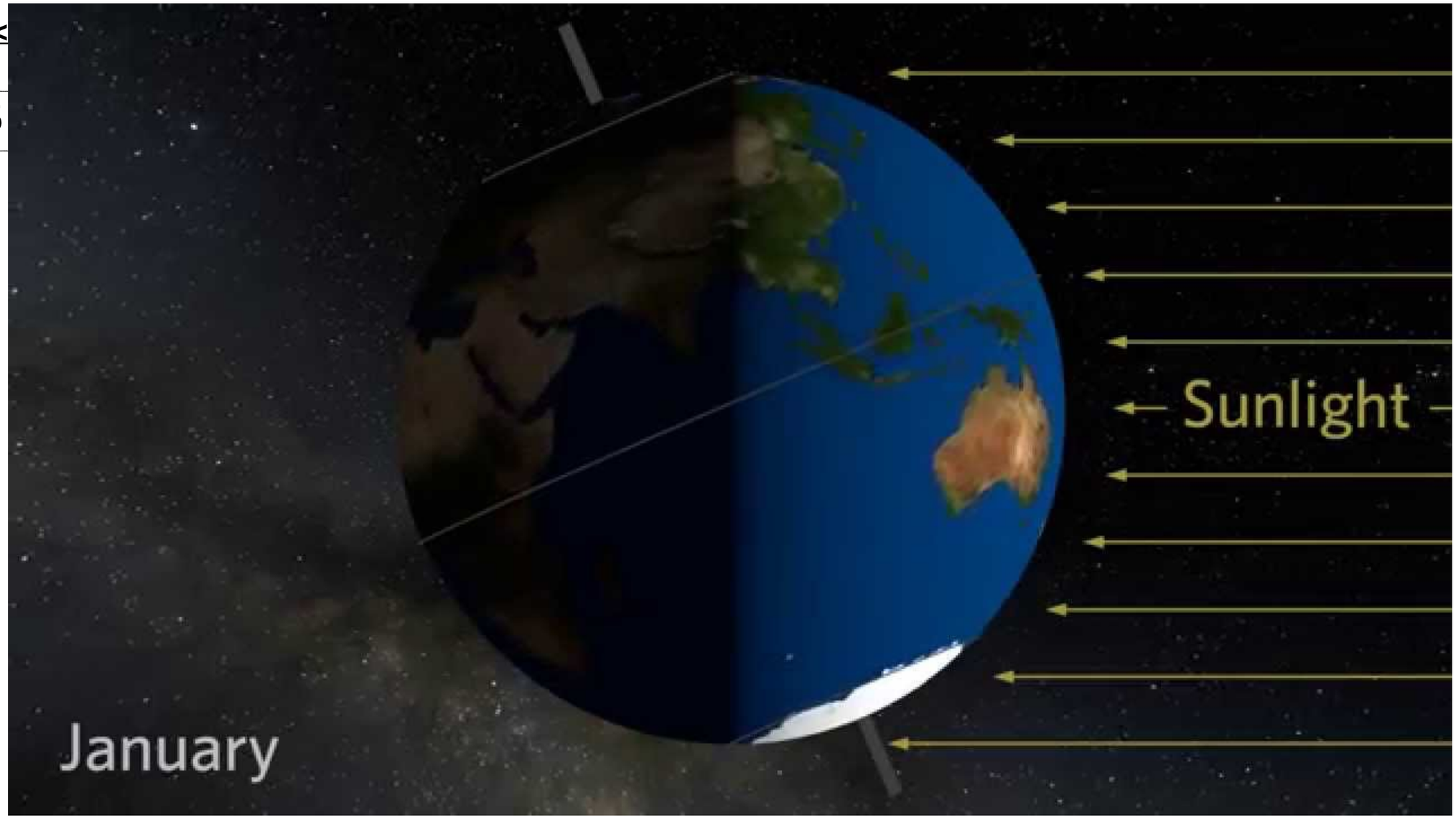
~24 hours



Earth, Sun and Moon

Years ≤

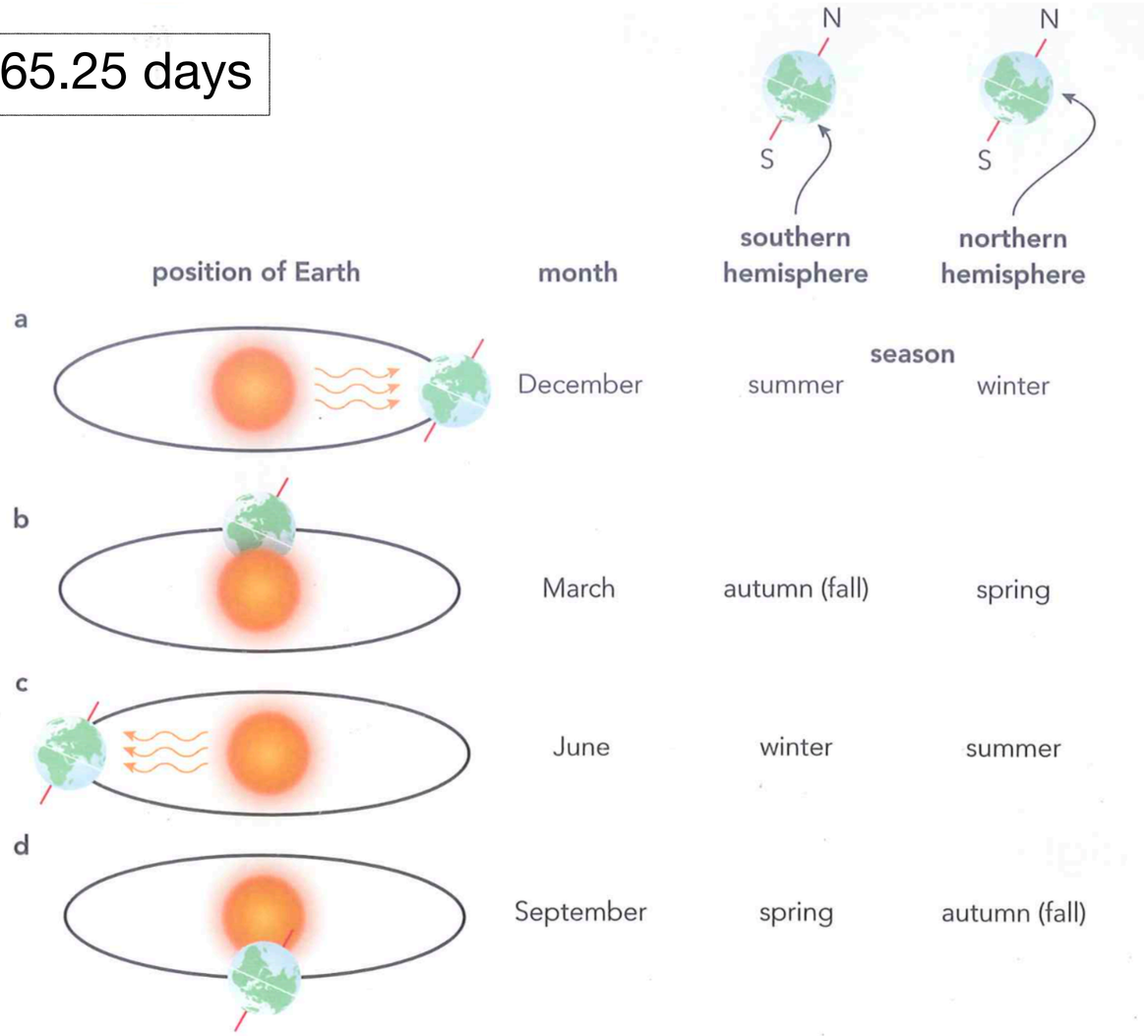
365.25



Earth, Sun and Moon

→ Years <= ***Earth*** *rotates around* ***Sun***

365.25 days



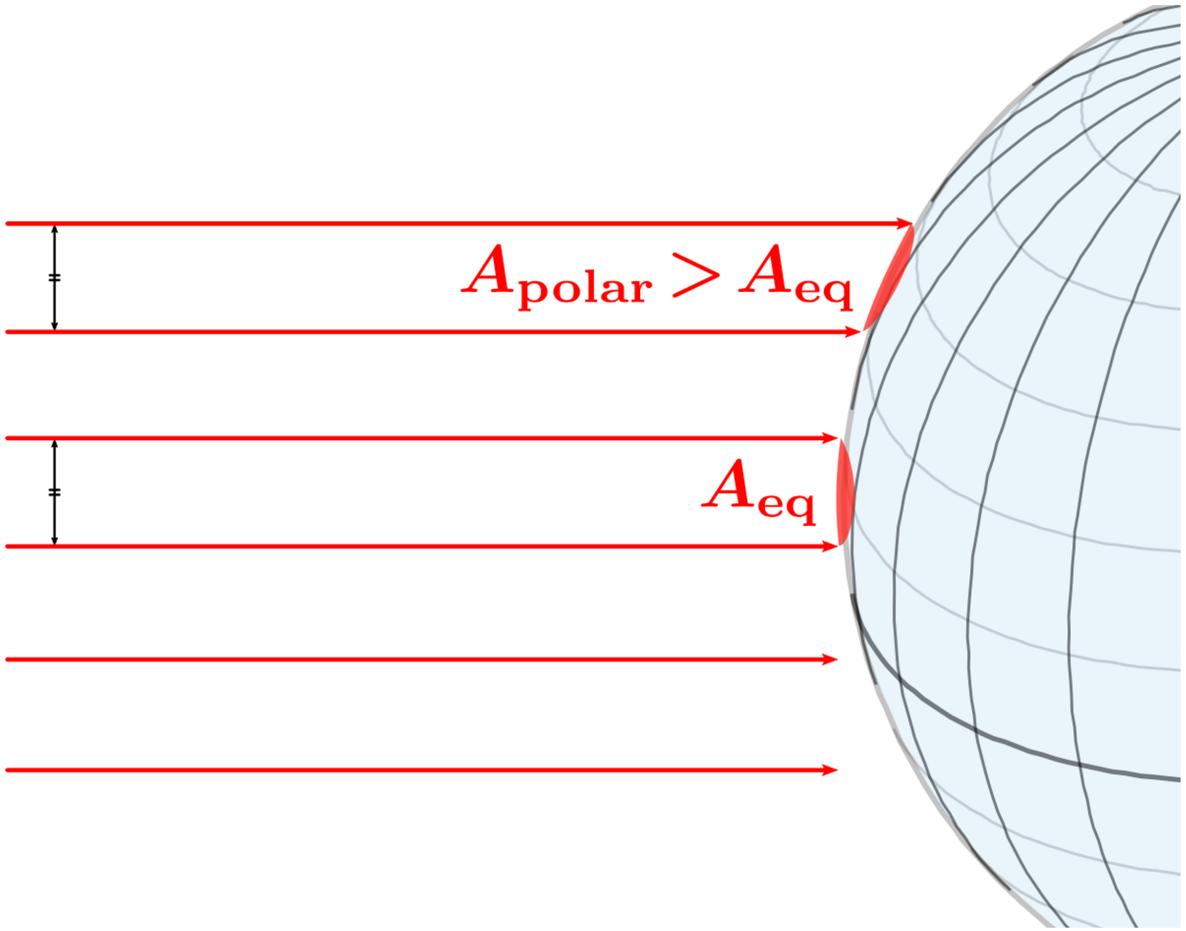
What causes seasons?

The spin axis of Earth is *tilted*.

Rays from Sun strikes the position *at different angles*

Rays from Sun strikes the position *different number of hours per day*

Earth, Sun and Moon



What causes seasons?

The spin axis of Earth is *tilted*.

Rays from Sun strikes the position *<u>at different angles</u>*

Rays from Sun strikes the position *<u>different number of hours per day</u>*

Earth's surface is curved, **sunlight intensity** (energy per unit area) is latitude dependent and is highest in equatorial regions.

Why no seasons in equator?

Exercise

Which of these causes seasons on Earth? Choose **one** answer.

A the Moon orbiting the Earth

B the pull of gravity from the Sun

C the Earth's axis is tilted

D the Earth takes 365 days to orbit the Sun

How long does the Moon take to orbit the Earth? .

A 1 day **B** 1 week **C** 1 month **D** 1 year

Exercise

Figure 24.2 shows the Sun and the Earth.

The figure is **not** to scale.

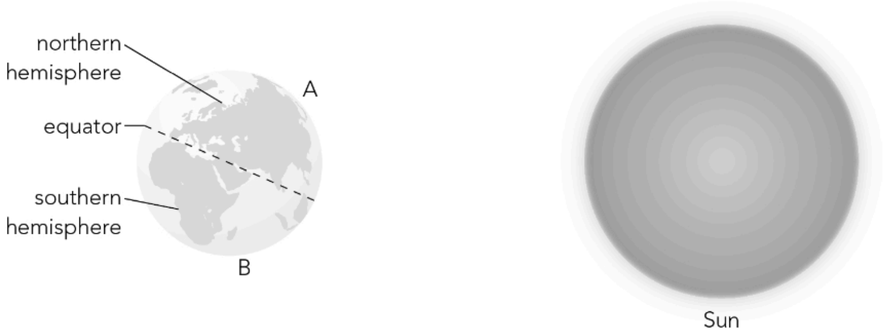


Figure 24.2

i State the season at position A on Figure 24.2.

_____

ii Positions A and B in the figure have different daytime temperatures. Explain why.

_____

_____

_____

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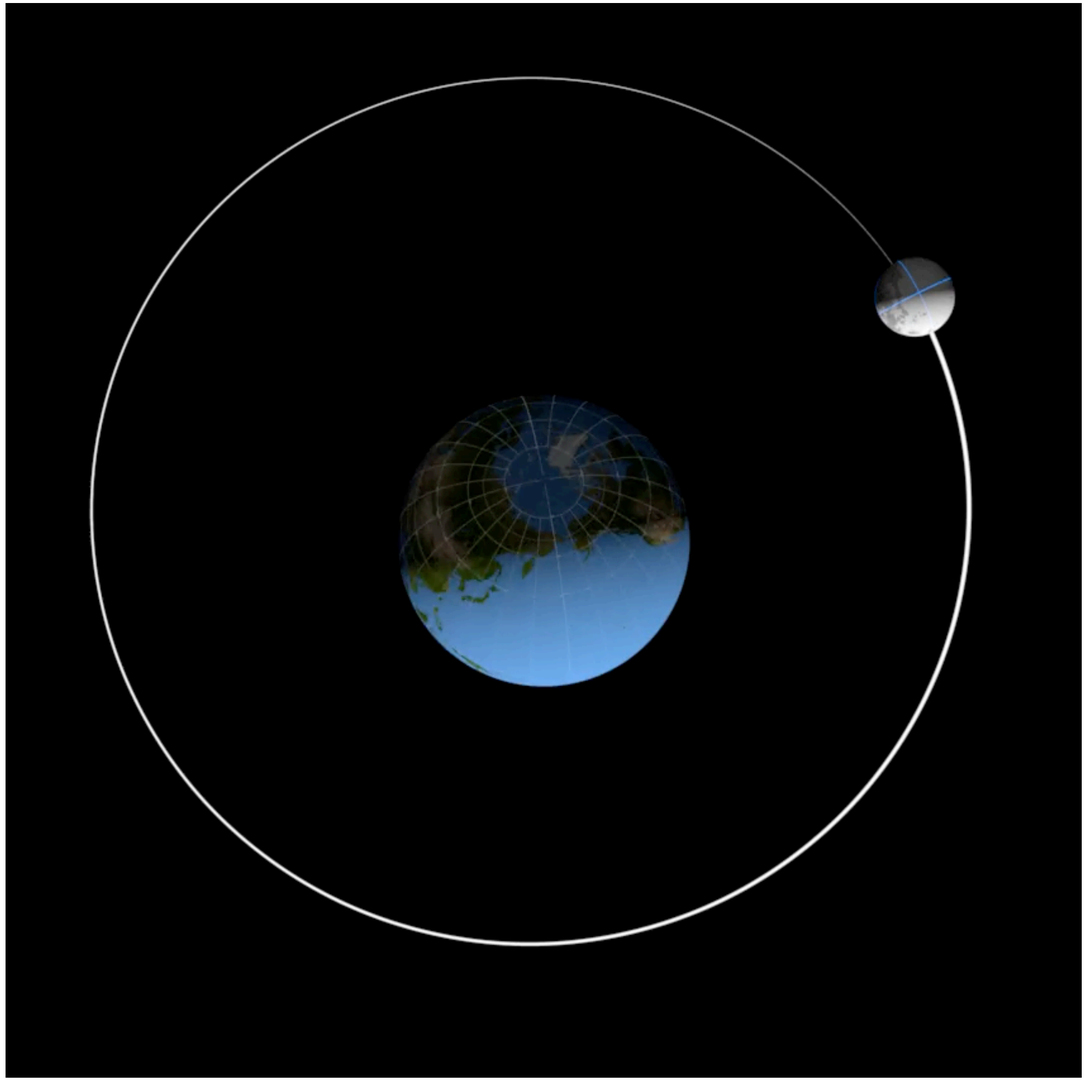
Earth, Sun and Moon

→ Months ***<u><= Moon</u>*** *<u>rotates around</u>* ***<u>Earth</u>***

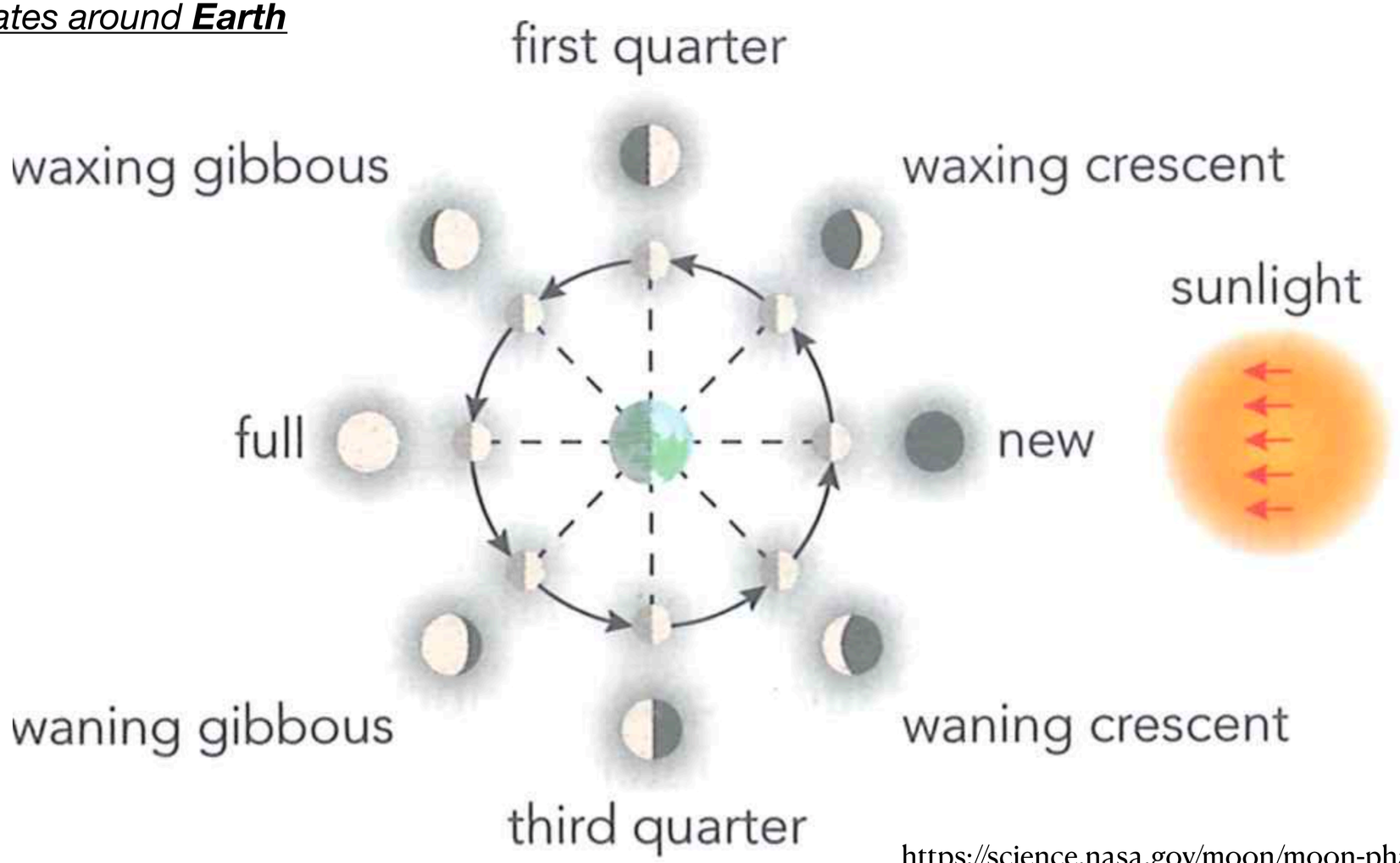
27.5 days



Earth, Sun and Moon

Months <= ***Moon*** *rotates around* ***Earth***

27.5 days



https://science.nasa.gov/moon/moon-phases/

Exercise

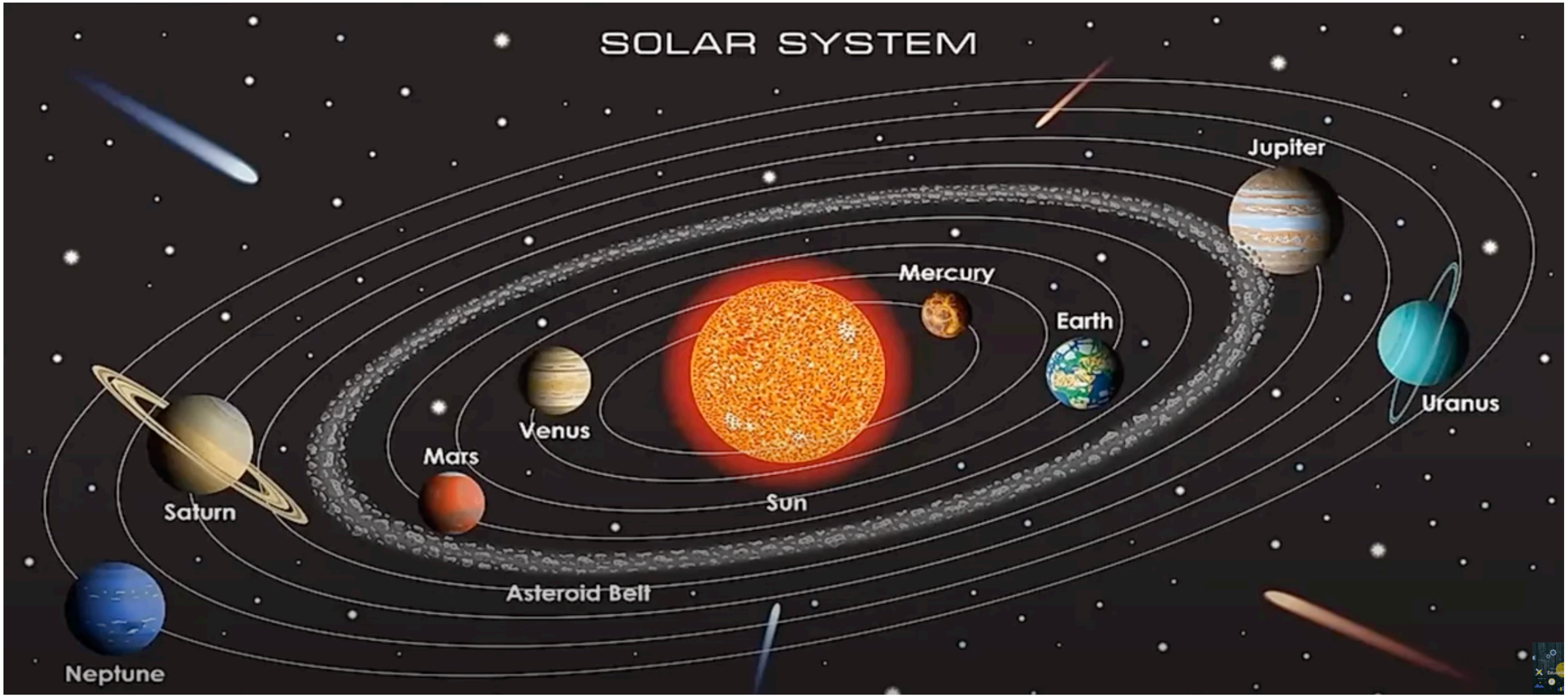
Which choice gives the phases of the moon in the correct order?

a) New → Waxing → Full → Waning
b) New → Waning → Full → Waxing
c) Full → Waxing → New → Waning
d) Full → Waning → New → Waxing

. Which one of the following phases of the lunar cycle immediately follows "First Quarter"?

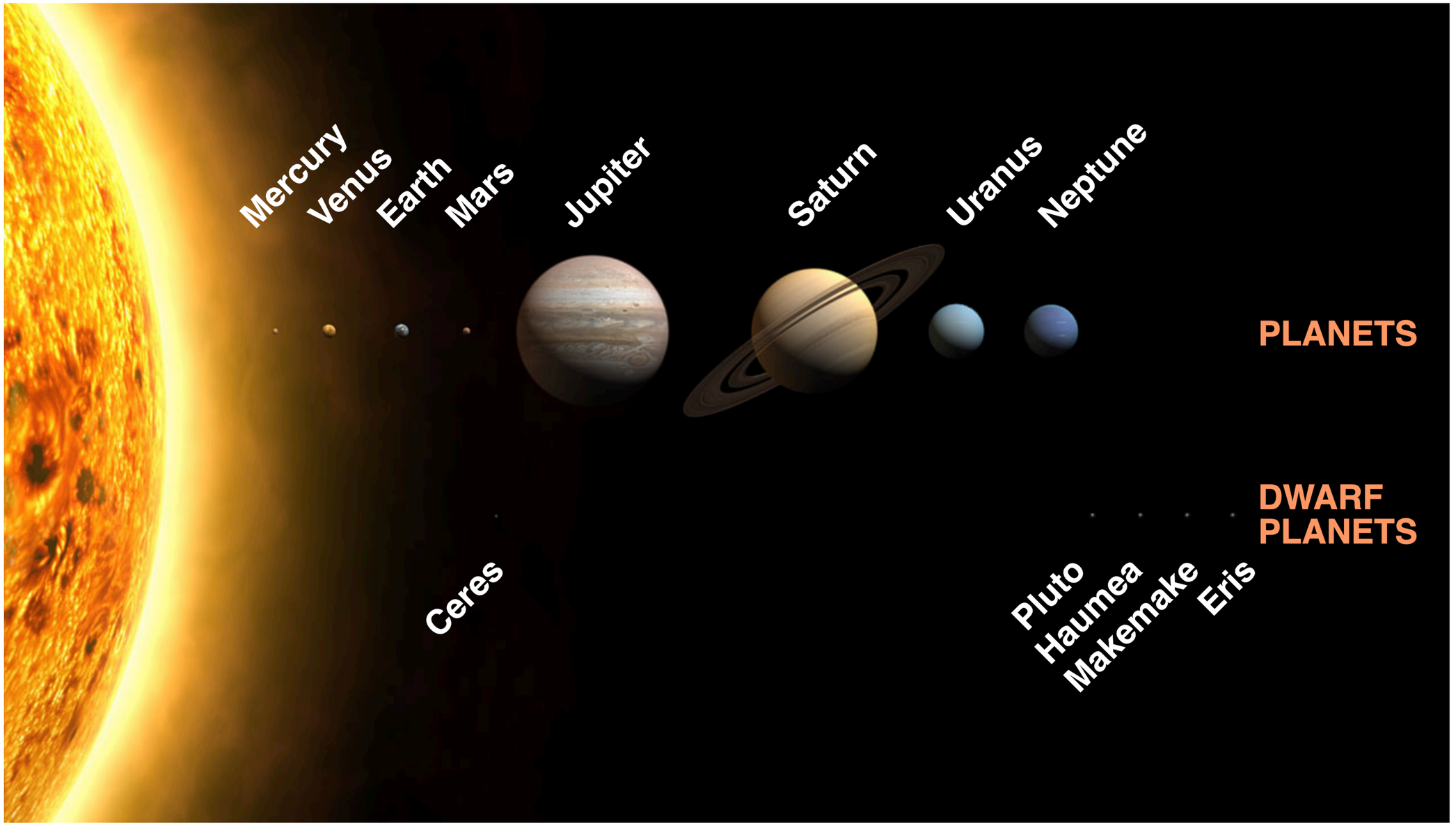
(A) Waxing Gibbous
(B) Waning Gibbous
(C) Waxing Crescent
(D) Waning Crescent
(E) New Moon

The Solar System



https://eyes.nasa.gov/apps/orrery/#/mercury?time=2025-02-28T09:41:52.663+00:00

The Solar System



The Solar System

Sun: 99.8% mass, greatest gravitational attraction<= all planets rotates around Sun

Eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune (outer => less attraction => smaller orbital speed)

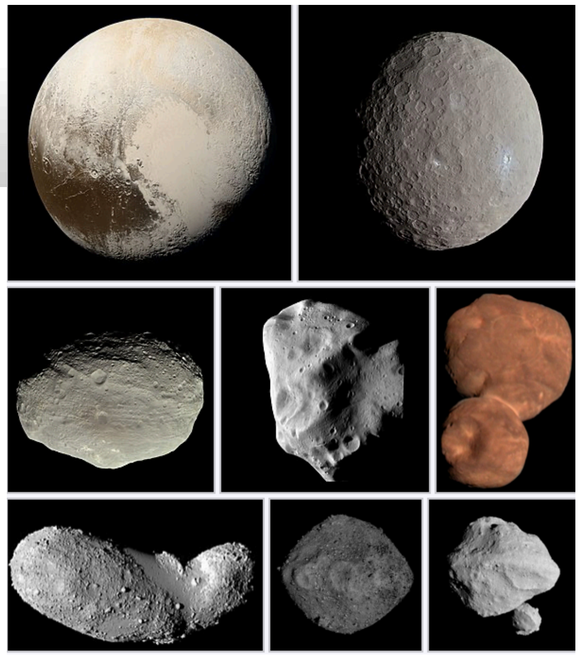
Mercury	*My*
Venus	*Very*
Earth	*Excellent*
Mars	*Mother*
Jupiter	*Just*
Saturn	*Served*
Uranus	*Up*
Neptune	*Noodles*

Asteroid belt

Minor(dwarf) planet: Pluto, Eris

Moons: orbits *planet*, e.g. Europa, Ganymede

Asteroids and meteoroids: rocky objects smaller than planets, most in asteroid belt btw Mars and Jupiter



Comets: giant snowball, very irregular orbits

Exercise

Which type of object listed below orbits the Sun?

A an interstellar cloud of gas and dust

B a comet

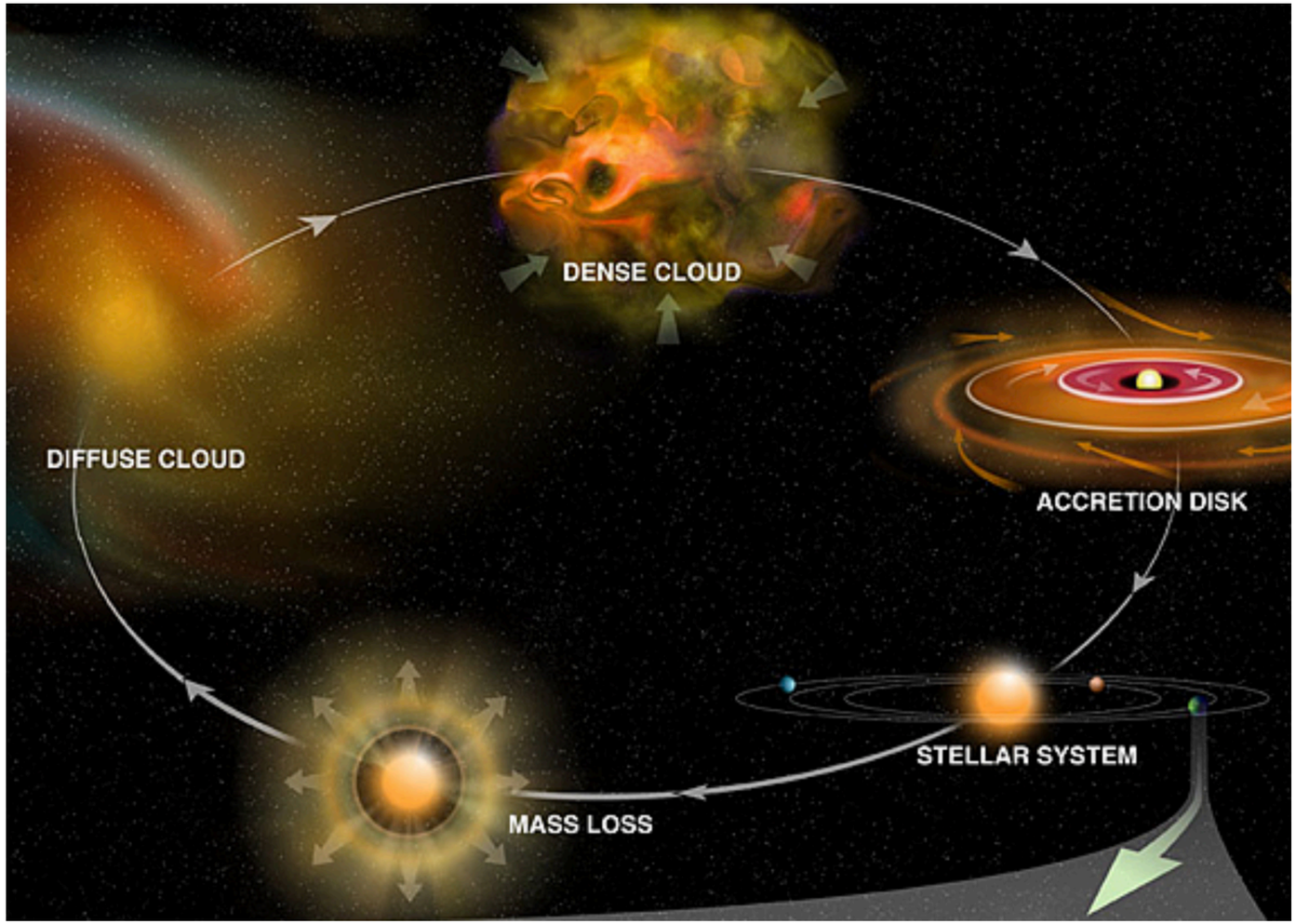
C a galaxy

D another star

Formation of planet

gravity pull mass together => ***accretion model***

Dust, gas -> rocks -> larger rocks



In astronomy, **gravitation** dominates, other forces negligible.

Exercise

One model for the formation of the Solar System is the accretion model.

Which of these is evidence that contradicts the accretion model?

A The planets all orbit the Sun in the same plane.

B The planets all orbit the Sun in the same direction.

C Venus and Uranus spin in the opposite direction to the other planets.

D The Sun has most of the mass of the Solar System and is at the centre of the Solar System.

Formation of planet

Why four inner planets small and rocky, four outer planets large and gaseous? Asteroid belt in the middle?

- Gravity pull mass together => form accretion disk
- Closer to the Sun, higher gravitational pull, interstellar of gas and dust **density** higher => ***rocky planet***
- Intense **heat** forced some of lighter materials further away = ***gas giants***

Gravitational Field Strength (g):

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

$$F = G\frac{M_s m_p}{r^2} = m_p g$$

$$F = G\frac{m_p m_o}{R^2} = m_o g$$

F = force

G = gravitational constant

m_1 = mass of object 1

m_2 = mass of object 2

r = distance between centers of the masses

Points towards center

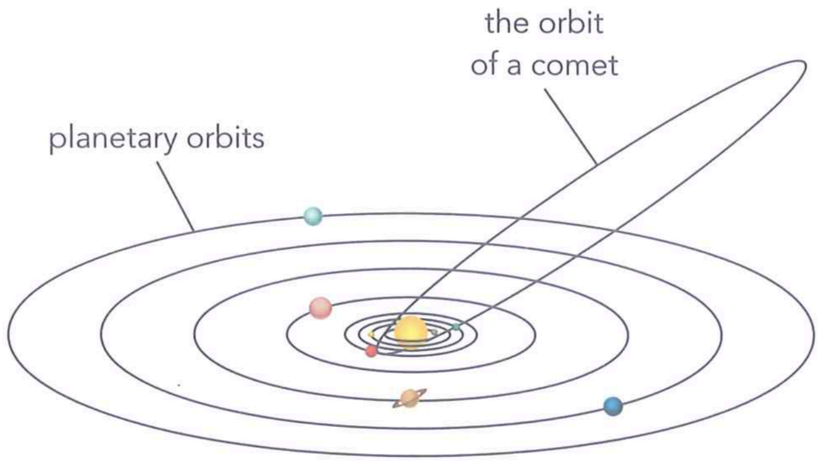
g around planet, depends on distance from Sun: larger distance => smaller g

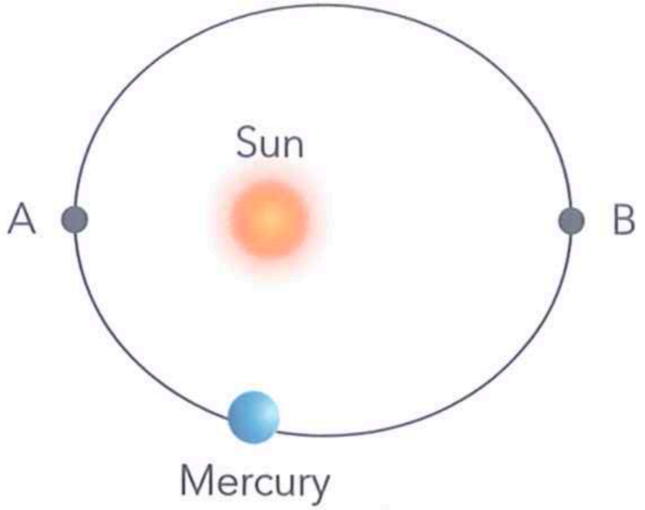
g around surface, depends on mass, radius of planet.

Planet	Average orbital distance / million km	Orbital duration / years	Density / kg/ m^3	Surface temperature / °C	Gravitational field strength at the surface of the planet / N/kg	Number of Moons
Mercury	58	0.2	5500	−18 to 460	4	0
Venus	108	0.6	5200	470	9	0
Earth	150	1	5500	−8 to 58	10	1
Mars	228	1.9	4000	−8 to −5	4	2
Jupiter	778	12	1300	15 to 20	26	16
Saturn	1427	30	700	−140	11	20
Uranus	2870	84	1300	−200	11	15
Neptune	4497	165	1700	−220	12	8

Orbits & Energy

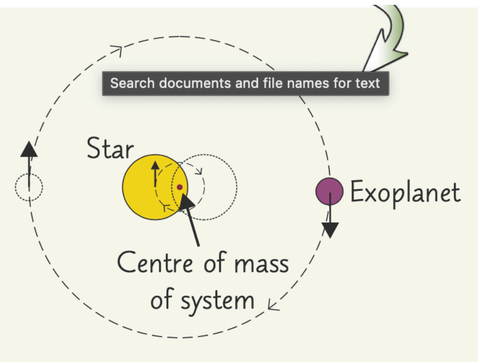
Orbits of planets are ***elliptical***. Sun is at one ***focus*** not center, unless almost circular.





No friction in space => energy conservation

A -> B, k.e. -> g.p.e, slows down. At A: max speed
B -> A, g.p.e -> k.e., speeds up. At B: min speed



Exercise

What can you say about Earth's kinetic energy and the Sun-Earth potential energy when Earth is closest to the Sun?

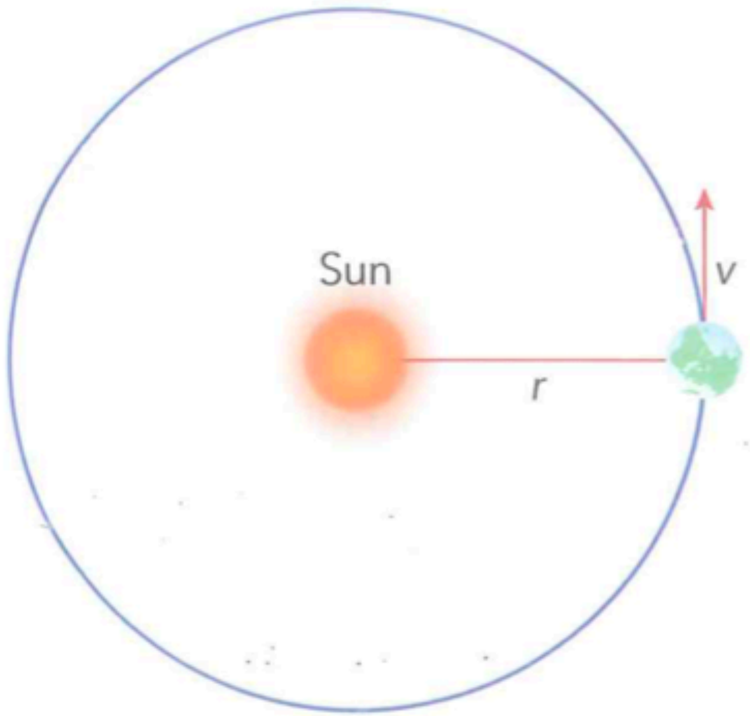
A kinetic energy is maximum; potential energy is maximum

B kinetic energy is maximum; potential energy is minimum

C kinetic energy is minimum; potential energy is maximum

D kinetic energy is minimum; potential energy is minimum

Orbital speed



Orbital radius: the average distance of the planet from the Sun

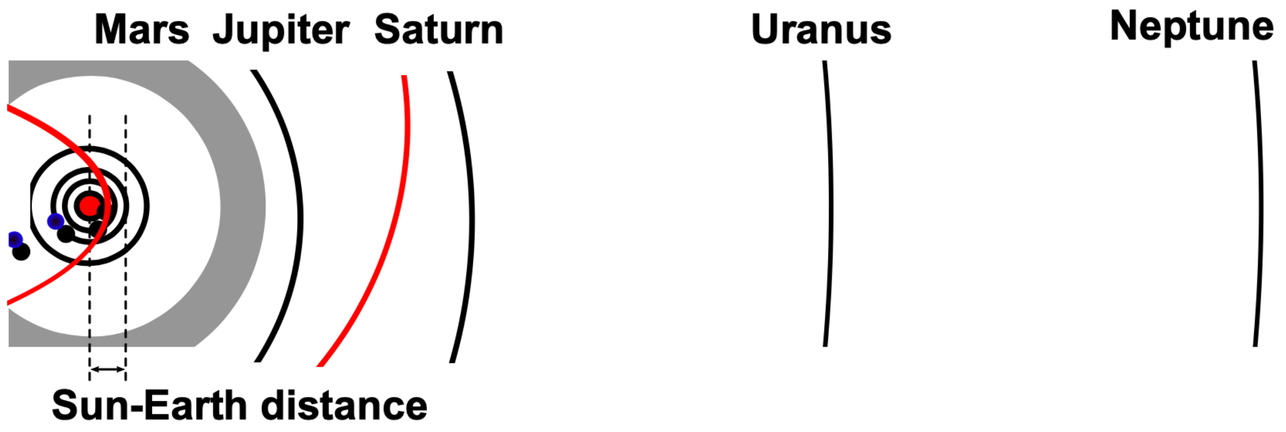
KEY EQUATION

$$\text{average orbital speed} = \frac{2 \times \pi \times \text{orbital radius}}{\text{orbital period}}$$

$$v = \frac{2\pi r}{T}$$

Outer => orbital speed smaller

Gravitational Field Strength (g):



$R\uparrow \rightarrow v\downarrow;\quad R\uparrow \rightarrow T\uparrow$

planet	$<R_{\text{orbit}}>/10^6$ km	$<R_{\text{orbit}}>$/AU	$<v_t>$/km/s	T_{orbit}/yrs	T_{light}/min
Mercury	58	0.39	48	0.2	3.2
Venus	108	0.72	35	0.6	6.0
Earth	150	1	30	1	8.3
Mars	228	1.52	24	1.9	13
Jupiter	778	5.19	13	12	43
Saturn	1427	9.51	9.7	30	79
Uranus	2870	19	6.8	84	159
Neptune	4497	30	5.4	165	250

Exercise

Explain why planets closer to the Sun have higher orbital speeds than those planets that are further away from the Sun.

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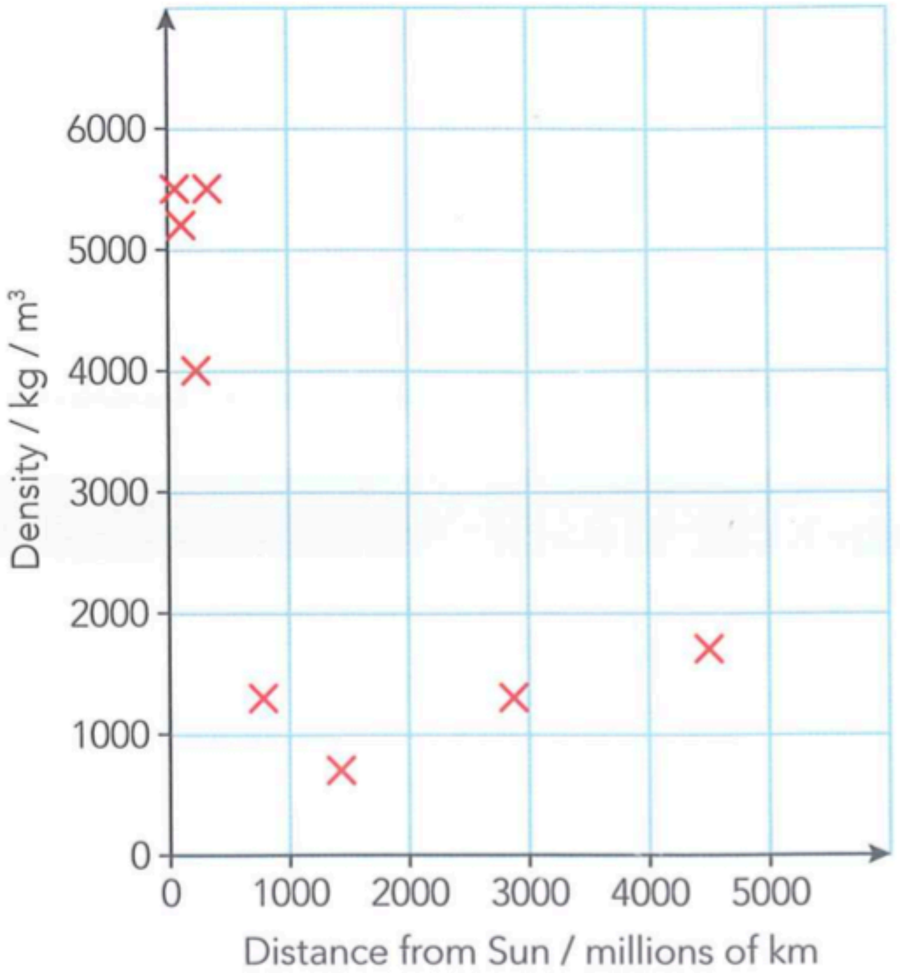
_____

Planetary Patterns



scatter graph => correlation