The Earth, Moon and Sky

Chapter 4

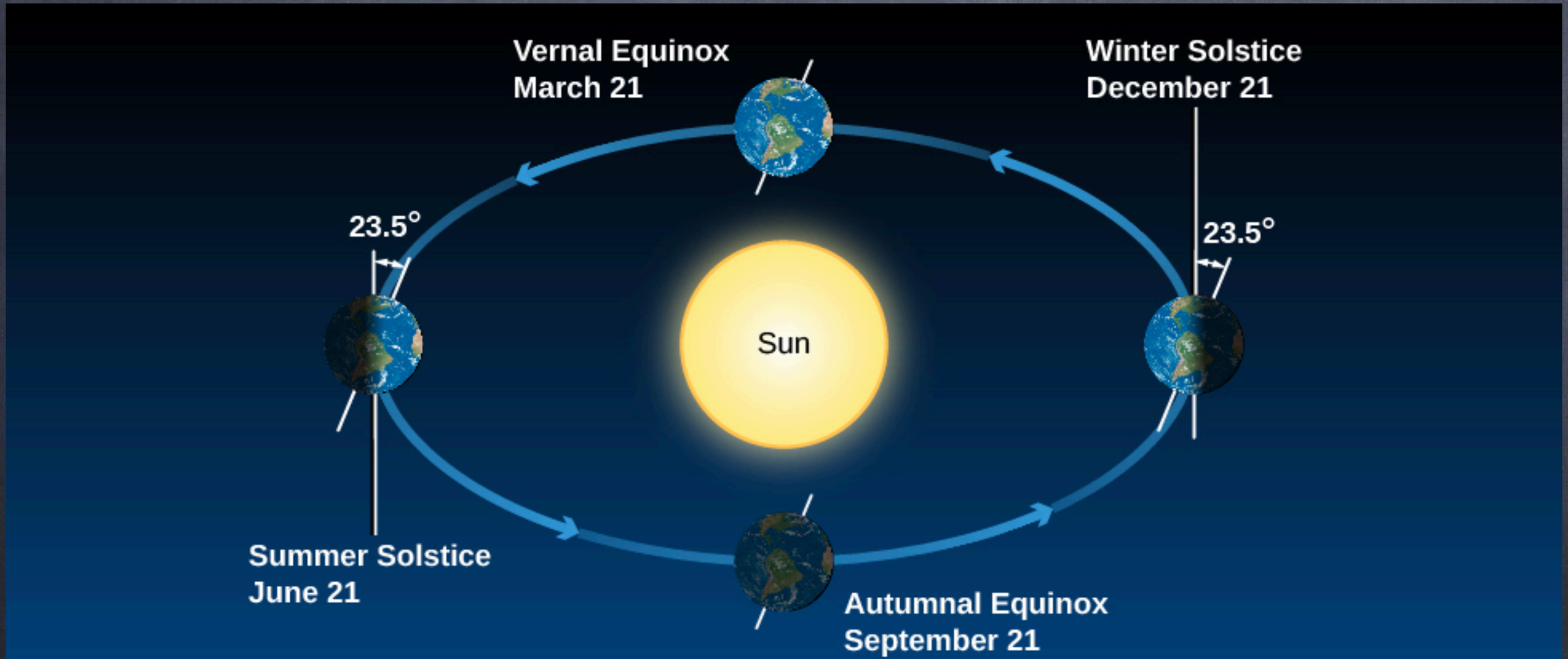
Coordinates

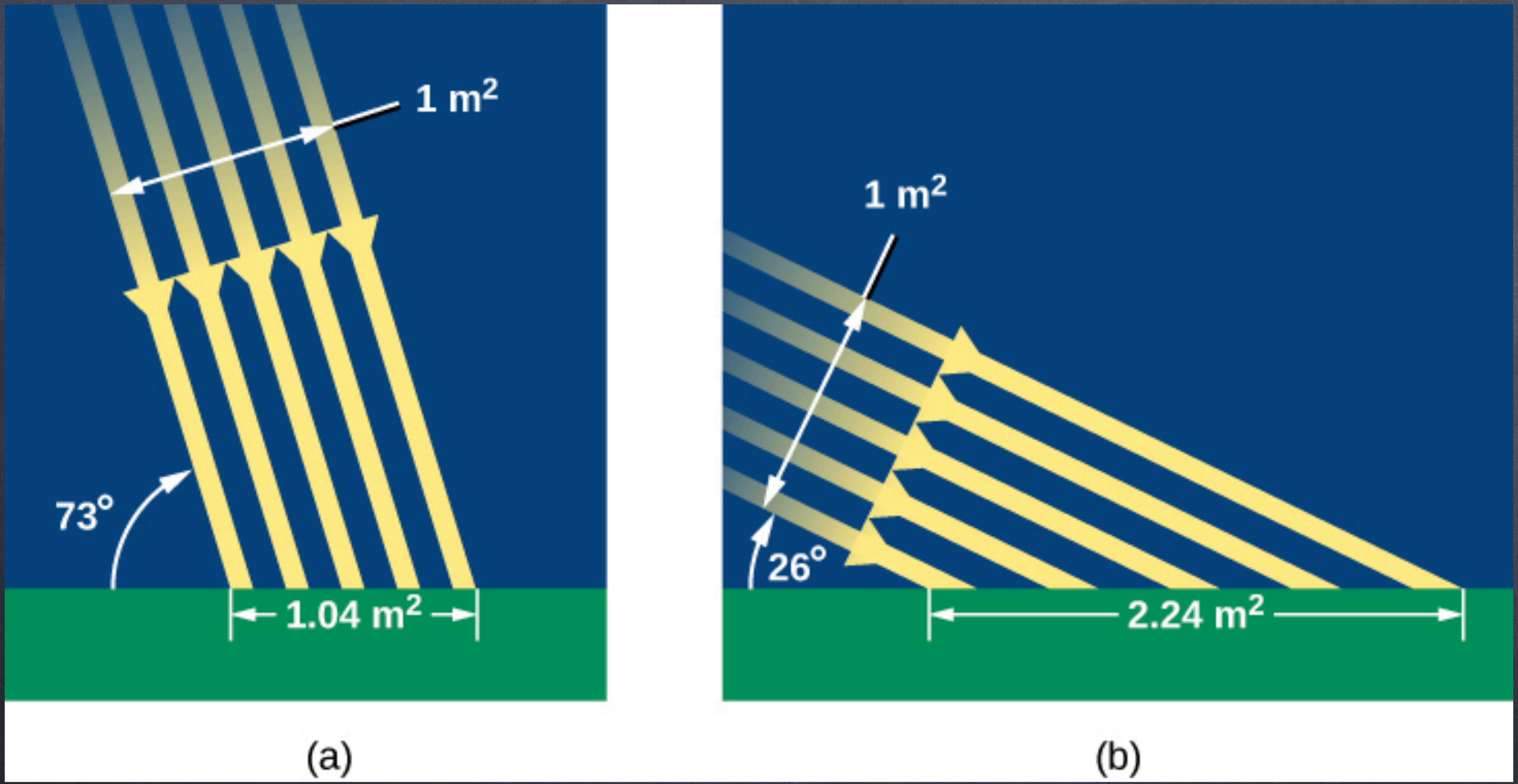
- In order to specify locations on the Earth we use longitude-latitude coordinates based on the Earth's rotation. Zero latitude is the Earth's equator with +90 and -90 at the Earth's north and south poles. Zero longitude was chosen to be Greenwich, England, that's just politics, nothing physical about that choice.
- Likewise we can use celestial coordinates to specify locations in the sky. Now they are called right ascension and declination, but they behave just like longitude and latitude. The only difference is that right ascension is measured in hours instead of degrees.

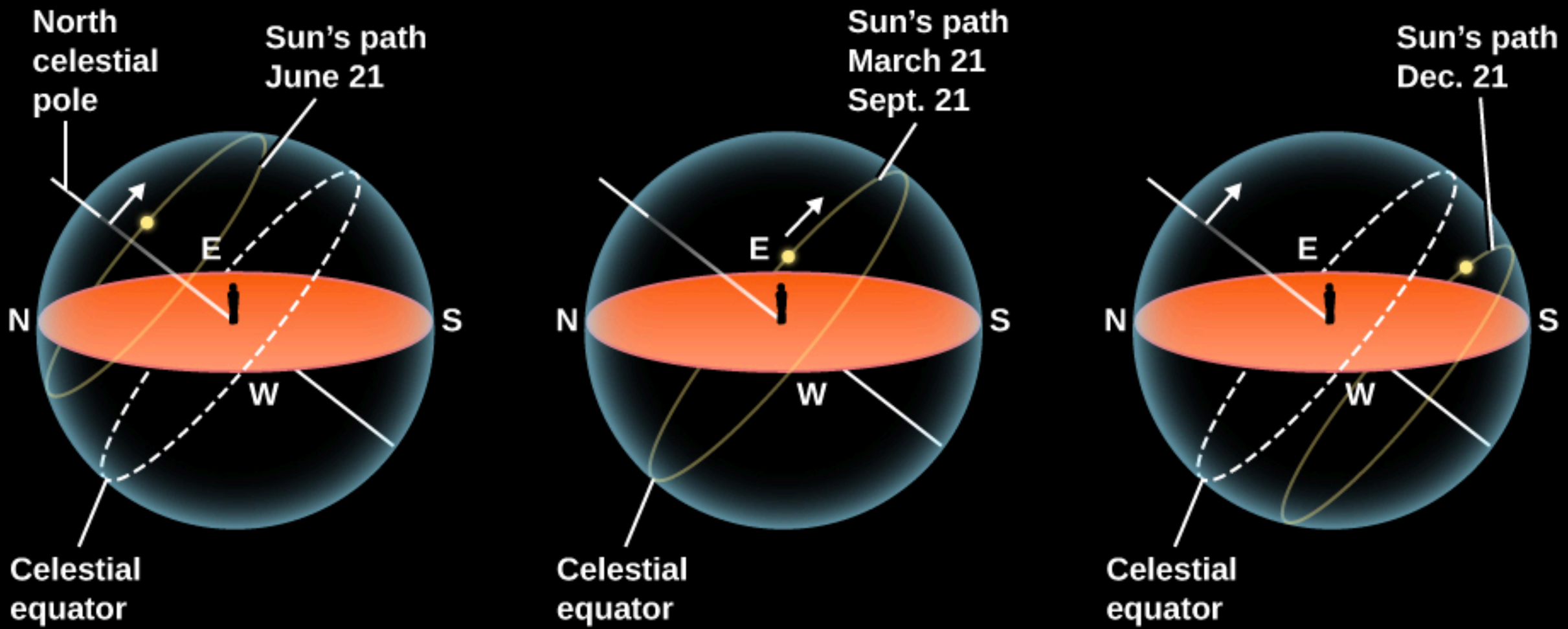
The Seasons

- One thing people who live in mid latitudes notice is that the outside temperature varies during the year.
- This happens because the Earth's axis of rotation is at an angle compared with it revolution around the Sun.
- Thus the position of the Sun in the sky changes over the year, and the energy an area gets from the Sun depends on the angle the Sun's rays make with the ground.

The Earth's axis is tilted compared to its revolution



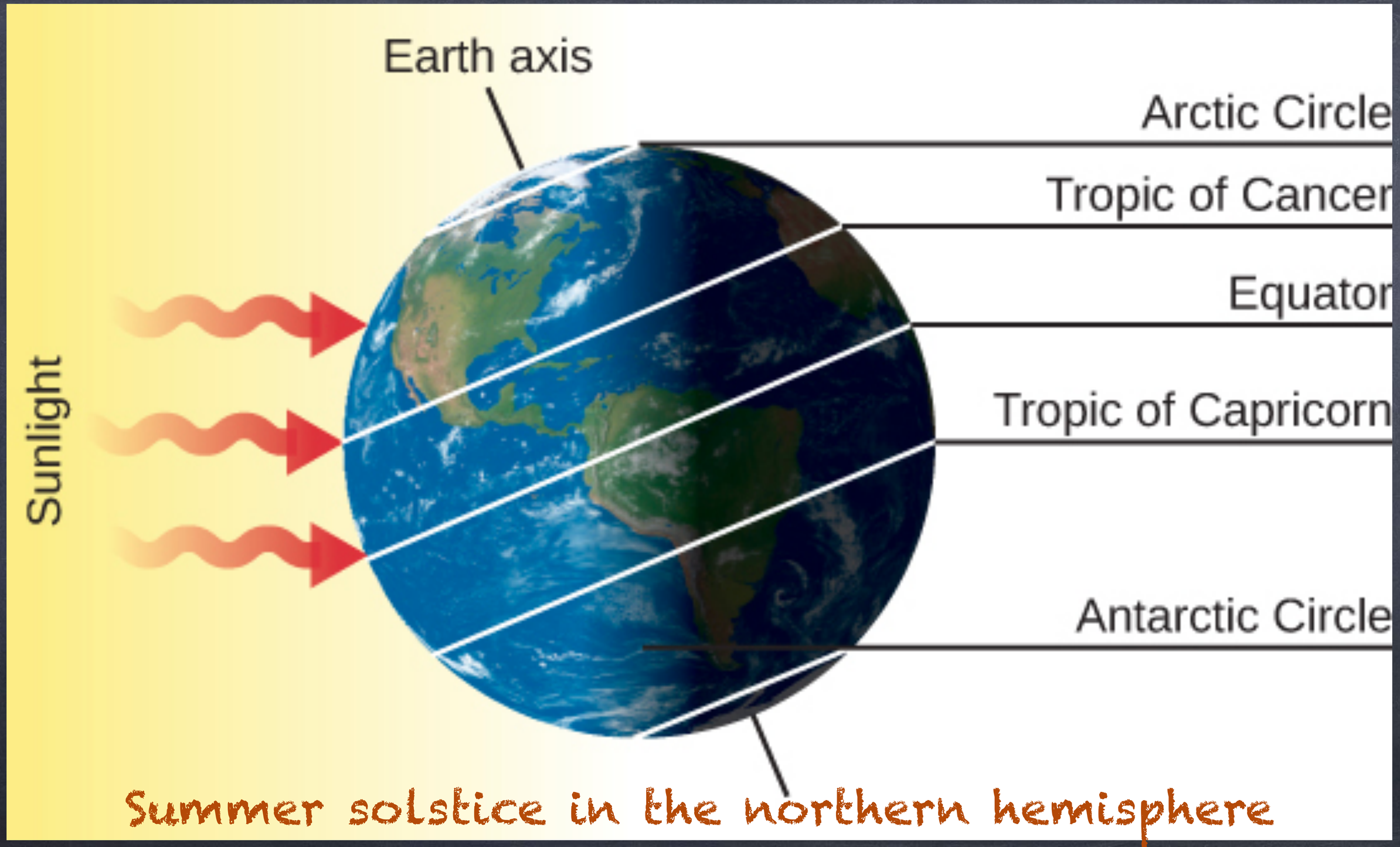

1 m²
73°
1.04 m²
(a)
1 m²
26°
2.24 m²
(b)



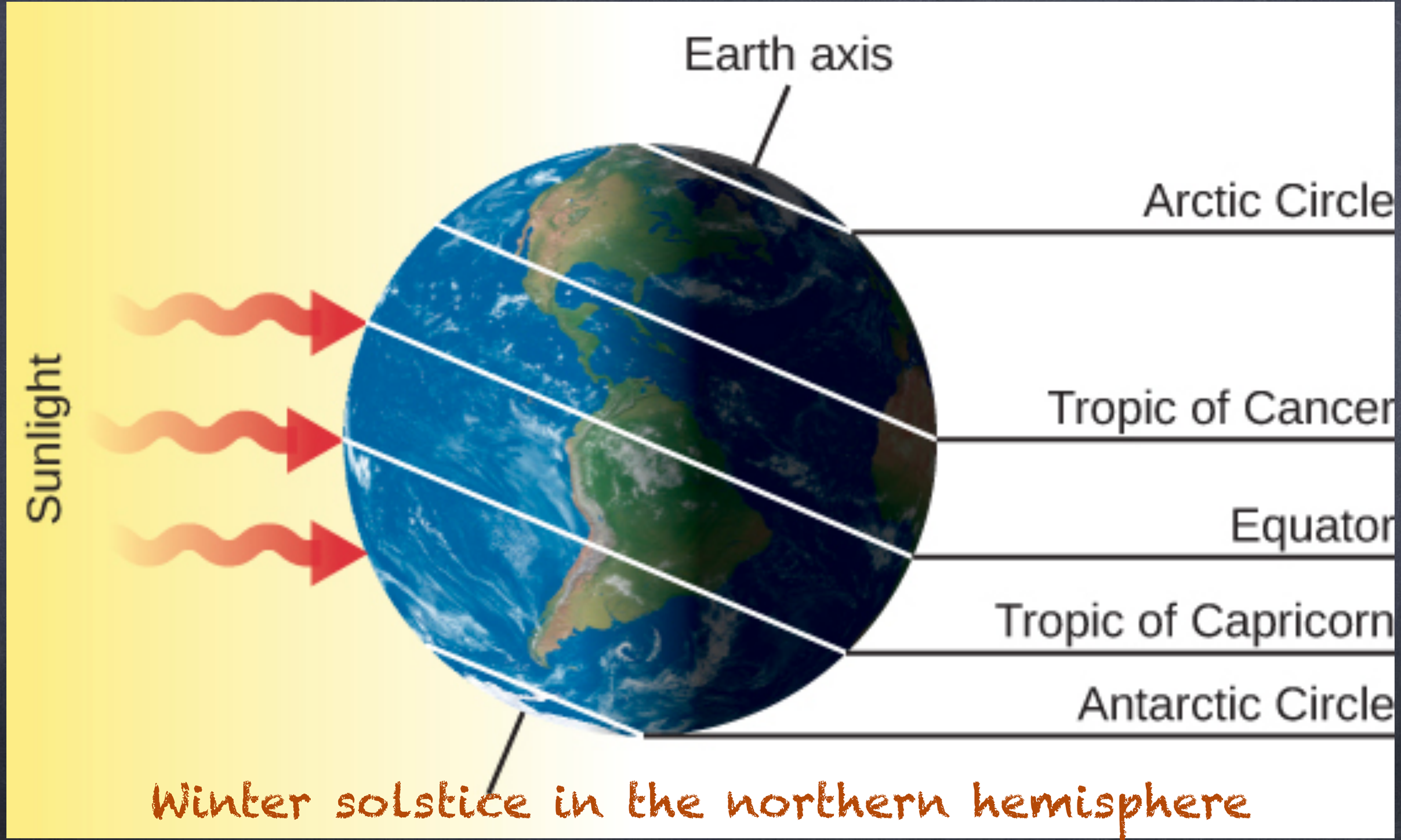
Because of this tilt the Sun's position in the sky changes over the year.
That is to say the ecliptic is not parallel to the celestial equator.

Solstice and Equinox

- As the Sun makes its way around the sky we have special names for certain days in that journay depending on what hemisphere we live in.
- When the Sun is at its most northern and southern points that is called a solstice.
- When the Sun is directly over the equator that is called an equinox.



Summer solstice in the northern hemisphere


Earth axis
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
Sunlight
Winter solstice in the northern hemisphere

Solstice and Equinox

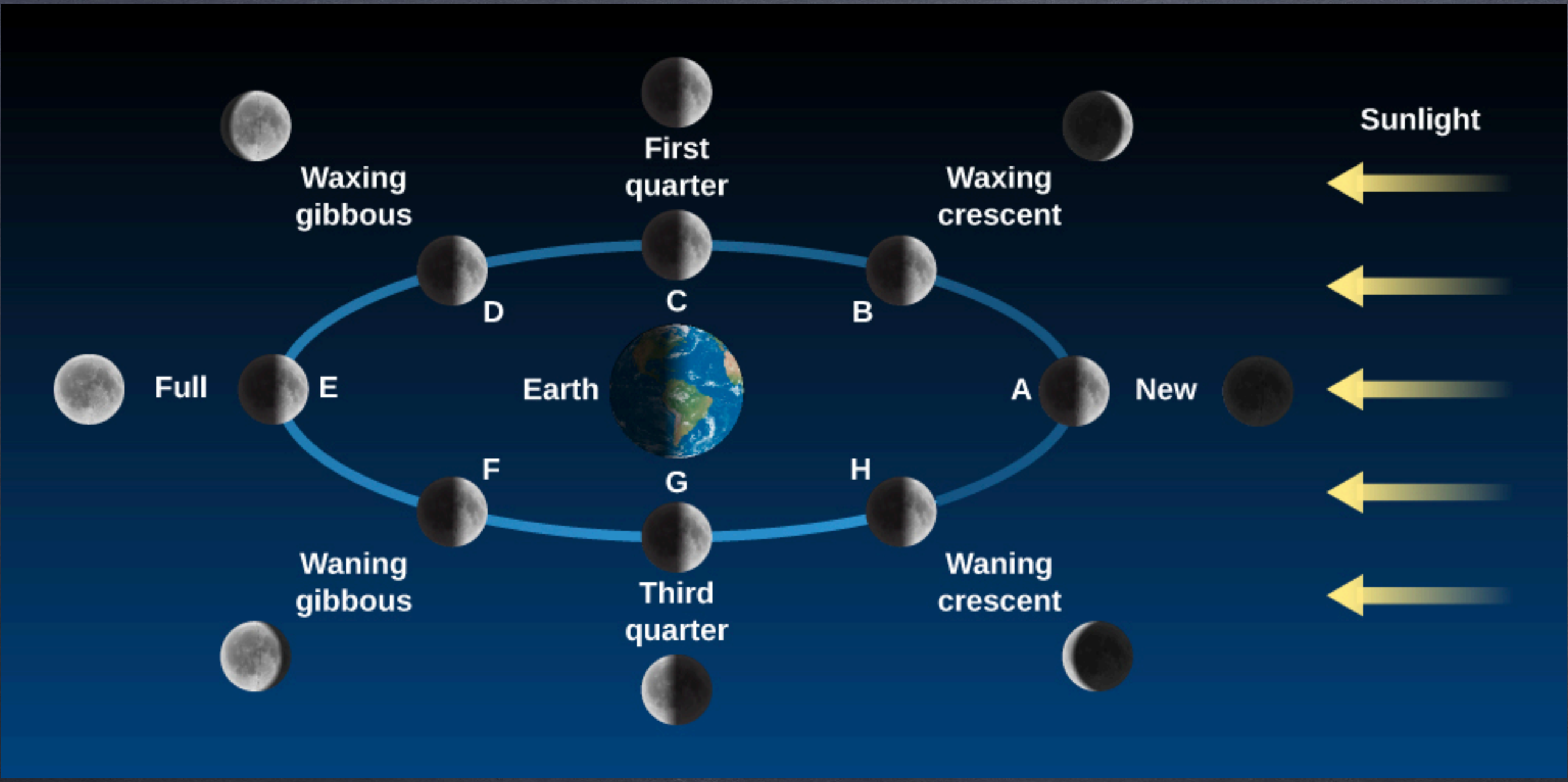
- On a solstice the Sun is directly above one of the tropics and there is 24 hours of daylight in one of the arctic circles and 24 hours of night in the other.
- On an equinox the Sun is directly overhead at the equator and there is 12 hours of daylight and 12 hours of night everywhere on Earth.
- The region between the Tropic of Cancer and the Troic of Capricorn is called the tropics. It is only in this area the the Sun can ever be directly overhead.

Phases of the Moon

- If you look at the Moon regularly you will notice that it looks different on different days.
- It goes through phases and then repeats the cycle.
- The cause of this is that the Moon does not emit its own light, it only reflects sunlight.
- In fact, everything in the Solar System aside from the Sun only reflects light and goes through phases.

Phases of the Moon

- The Moon goes through phases because we are looking at it from a different angle.
- The Moon actually always looks the same with the side facing the Sun light up and the side away from the Sun in darkness.
- What changes is the direction that we view the Moon from.

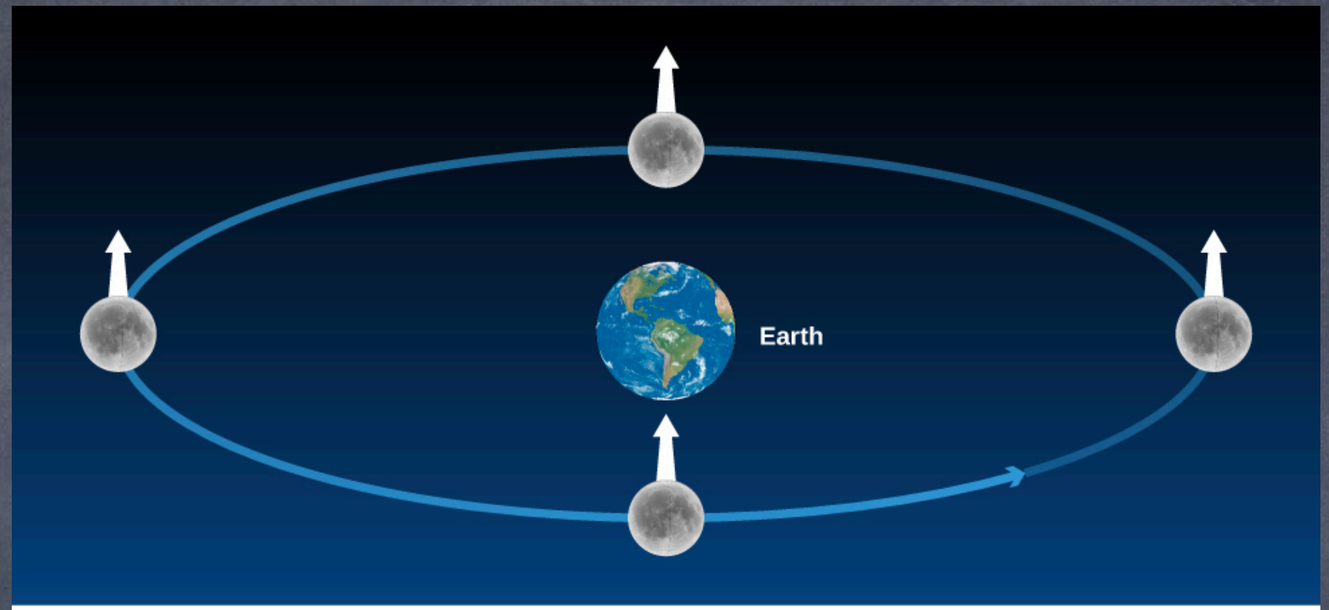

Sunlight
First quarter
Waxing gibbous
Waxing crescent
D
C
B
Full
E
Earth
A
New
F
G
H
Waning gibbous
Third quarter
Waning crescent

Phases of the Moon

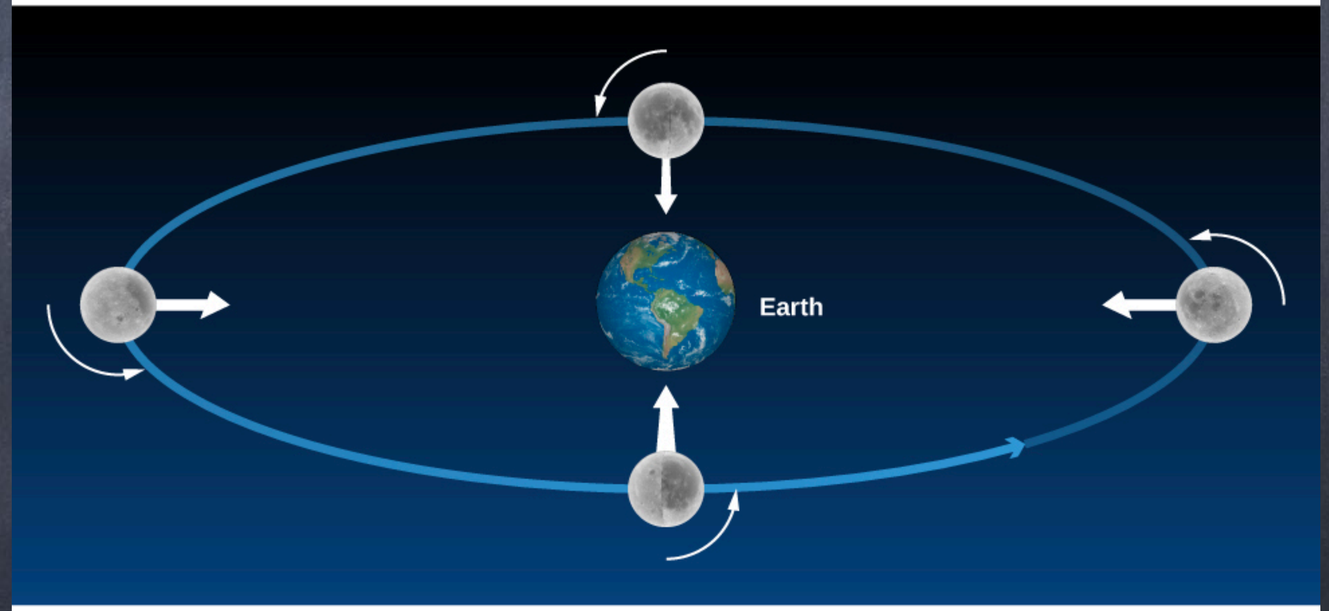
- The phase of the Moon is determined by its location relative to the Sun and Earth which depends on the time of the month. Thus the phase and where the Moon can be seen are closely related. Examples:
  - Full Moon, location - opposite the Sun. Overhead at midnight.
  - New Moon, location - same side as the Sun. Overhead at noon.
  - First Quarter Moon, location - perpendicular to Earth-Sun axis. Overhead at roughly sunrise.
  - Third Quarter Moon, Location - perpendicular to Earth-Sun axis. Overhead at roughly sunset.

Rotation of the Moon

- It takes one month for the Moon to rotate on its axis.
- That is a day on the Moon lasts one month.
- This is called a synchronous orbit and we will see it is rather common between moons and planets.
- It is caused by tidal forces between the planet and moon. The Earth's rotation is also slowing down because of these forces and eventually the Earth's day will be exactly one moon orbit too.



(a)



(b)