Announcements

- First homework set is up on ICON and is due on Tuesday at midnight.
- For those taking the lab:
  - All 29:50 labs have been moved to 665 VAN.
  - Print out the lab write up from the web site before going to lab next week.

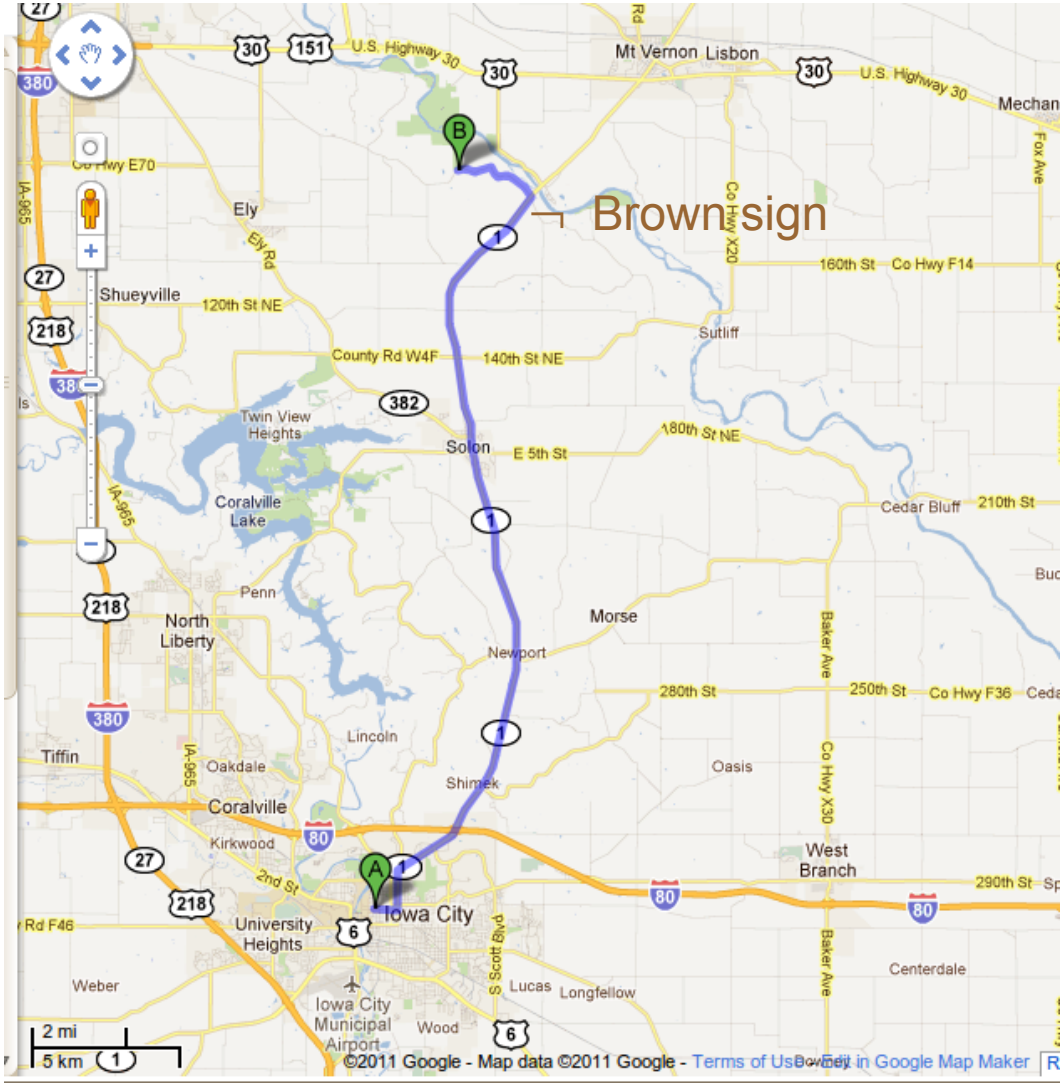
Astronomy Tutorial

- Available for students who have questions about topics covered in class
- Held in Van Allen Hall room 310
- Currently scheduled for Tuesdays 7-9 pm
- Suggestions for other times?

Announcements

- First public observing event at Eastern Iowa Observatory and Learning Center is this Saturday, August 27, at 8 pm.
- EIOLC is at 1365 Ivanhoe Rd, Ely, IA 52227.
- Directions:
  - Take Highway 1 north out of Iowa City.
  - Follow until you see a brown sign for Palisades-Dows State Park (if you cross the river, you have gone too far).
  - Take the left onto Ivanhoe Road and follow until you see the observatory's driveway on the right.

Eastern Iowa Observatory and Learning Center



19.3 miles, 33 minutes from Van Allen Hall

Today's lecture

- How to locate objects on the sky
- Celestial sphere, coordinates on the sky
- Motion of stars on the sky
- Motions of the sun and planets
- The seasons
- Precession of the Earth
- Phases of the Moon
- Lunar and solar eclipses

What causes the seasons?

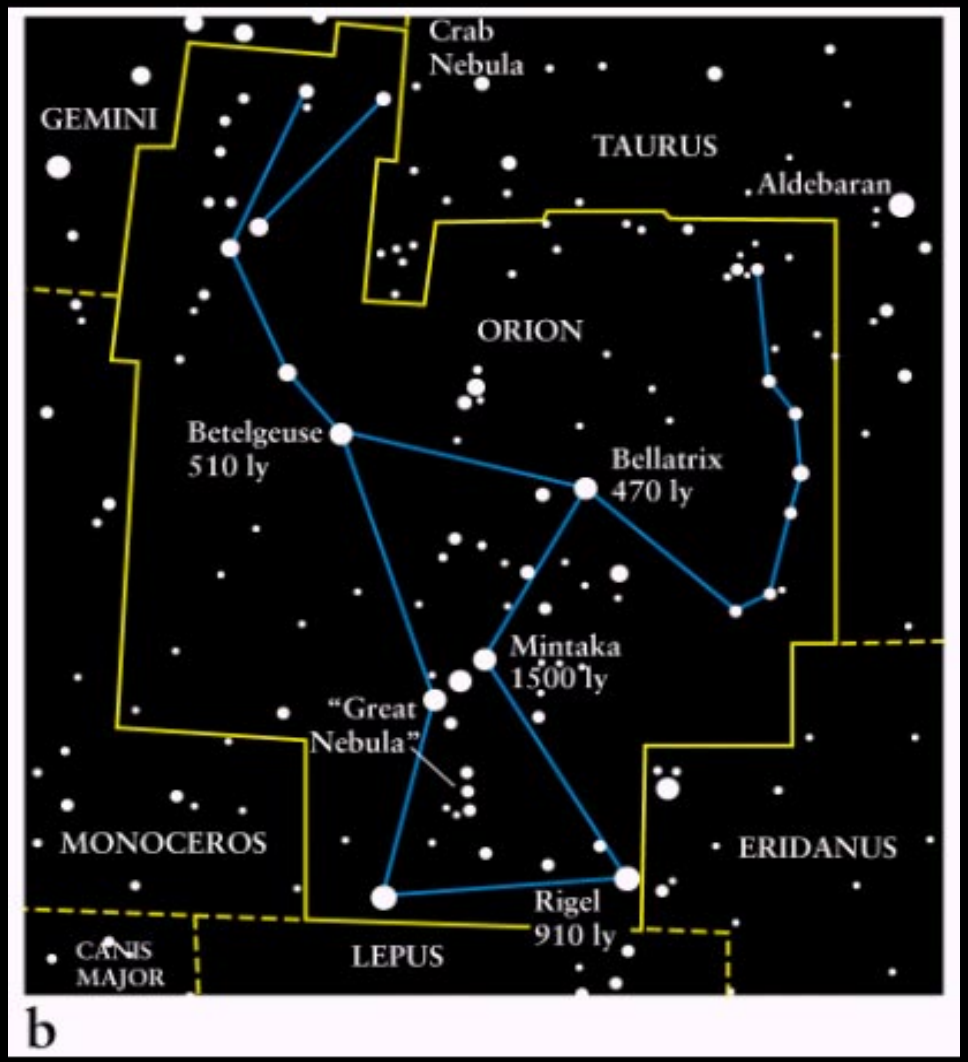
A) The orbit of the Earth is an ellipse, not a circle, and the Earth is closer to the Sun in summer than in winter.

B) The rotation of the Earth is tilted relative to its orbit.

How does one locate an object on the sky?

1. By drawing imaginary patterns on the sky (the constellations) and then locating the object relative to the stars in the constellations.
2. By drawing an imaginary coordinate system on the sky, then specifying the objects coordinates.

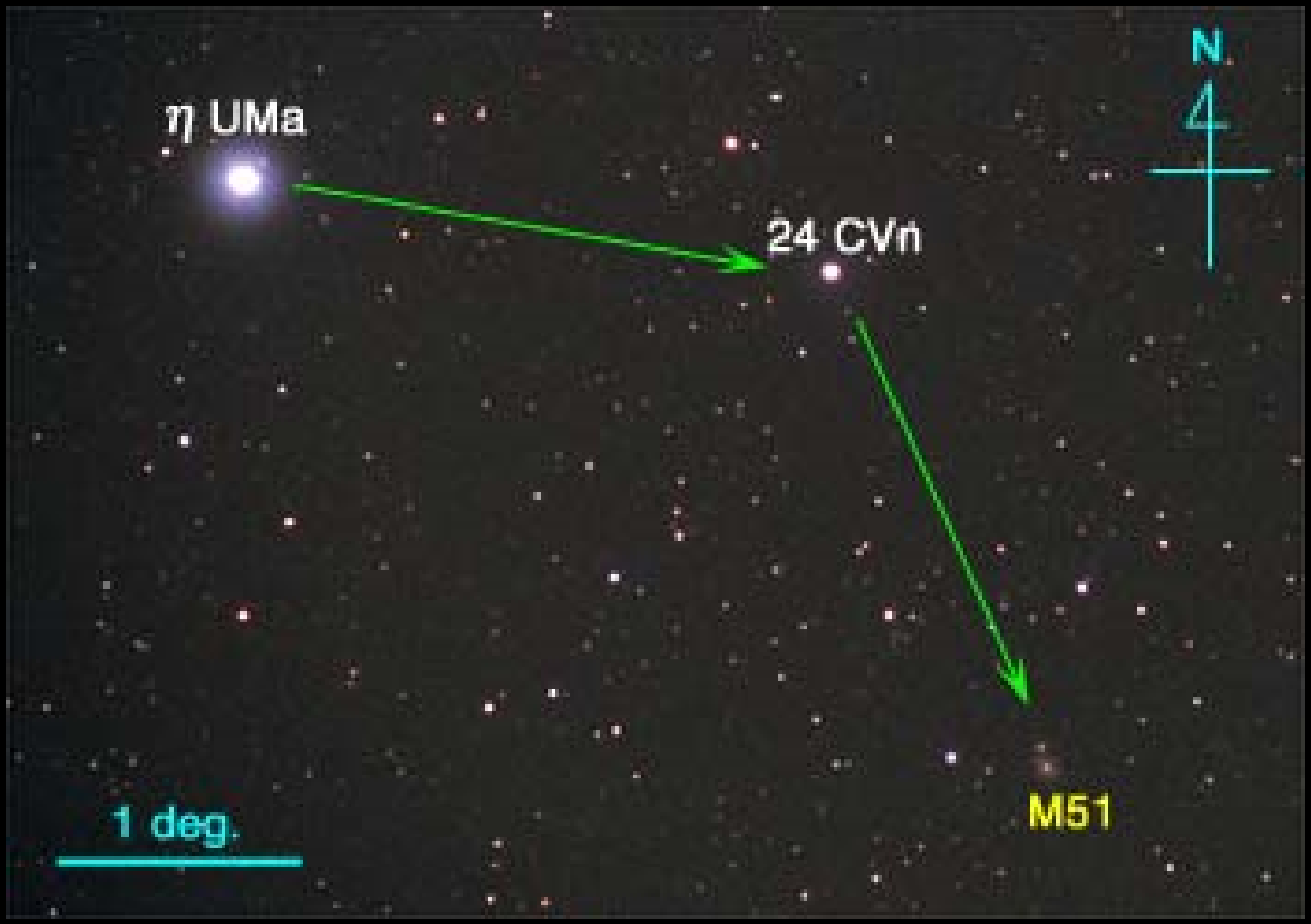
Eighty-eight constellations cover the entire sky.



- 6000 stars visible to unaided eye (only half are above the horizon).
- 88 semi-rectangular groups of stars called constellations.
- Some stars in the constellations are quite close while others are very far away.

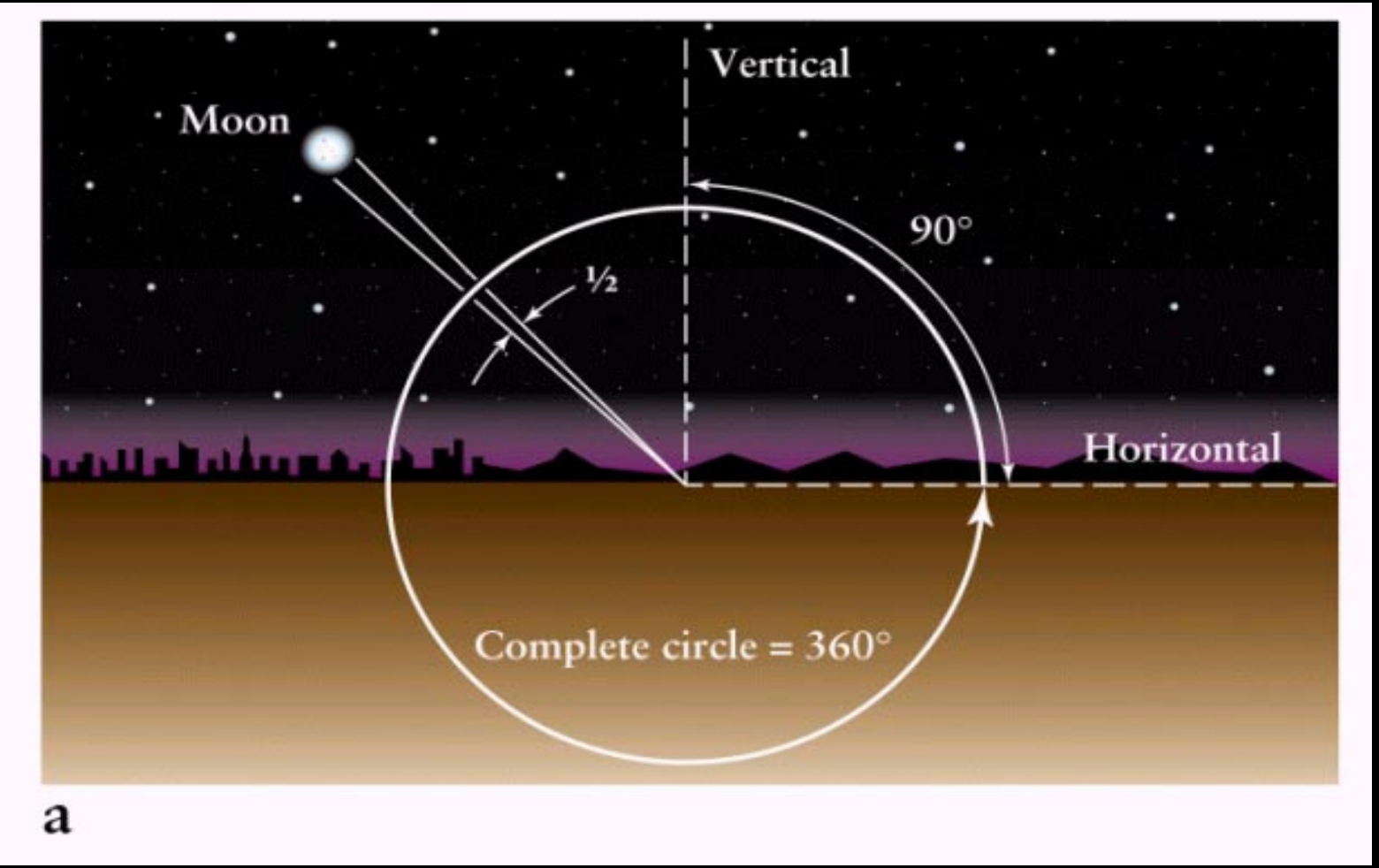
Finding M51

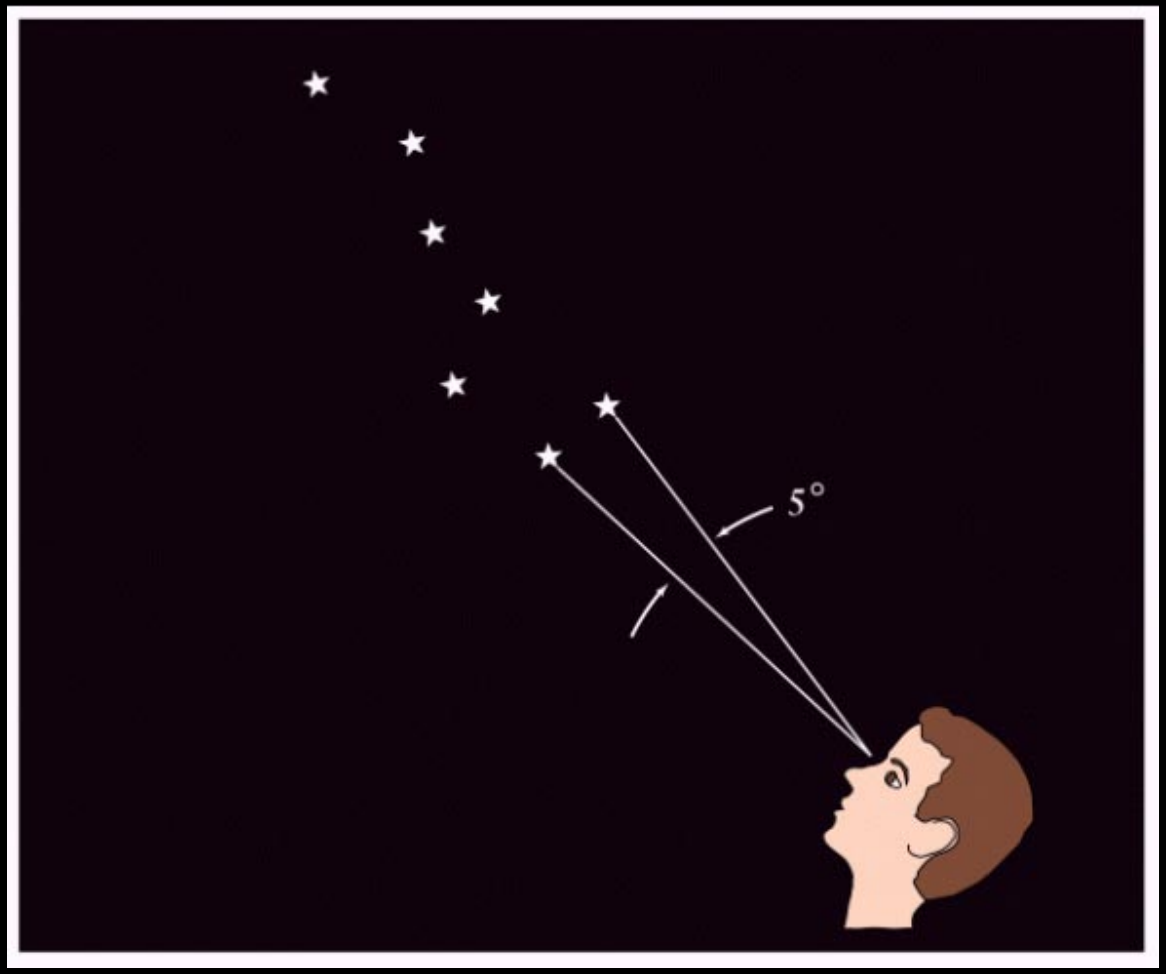
Finding M51



Finding M51

We use angles to denote the positions and apparent sizes of objects in the sky.





Your hand at arm’s length is about 10 degrees wide

Your thumb at arm’s length is about 2 degrees wide

Constellations are NOT:

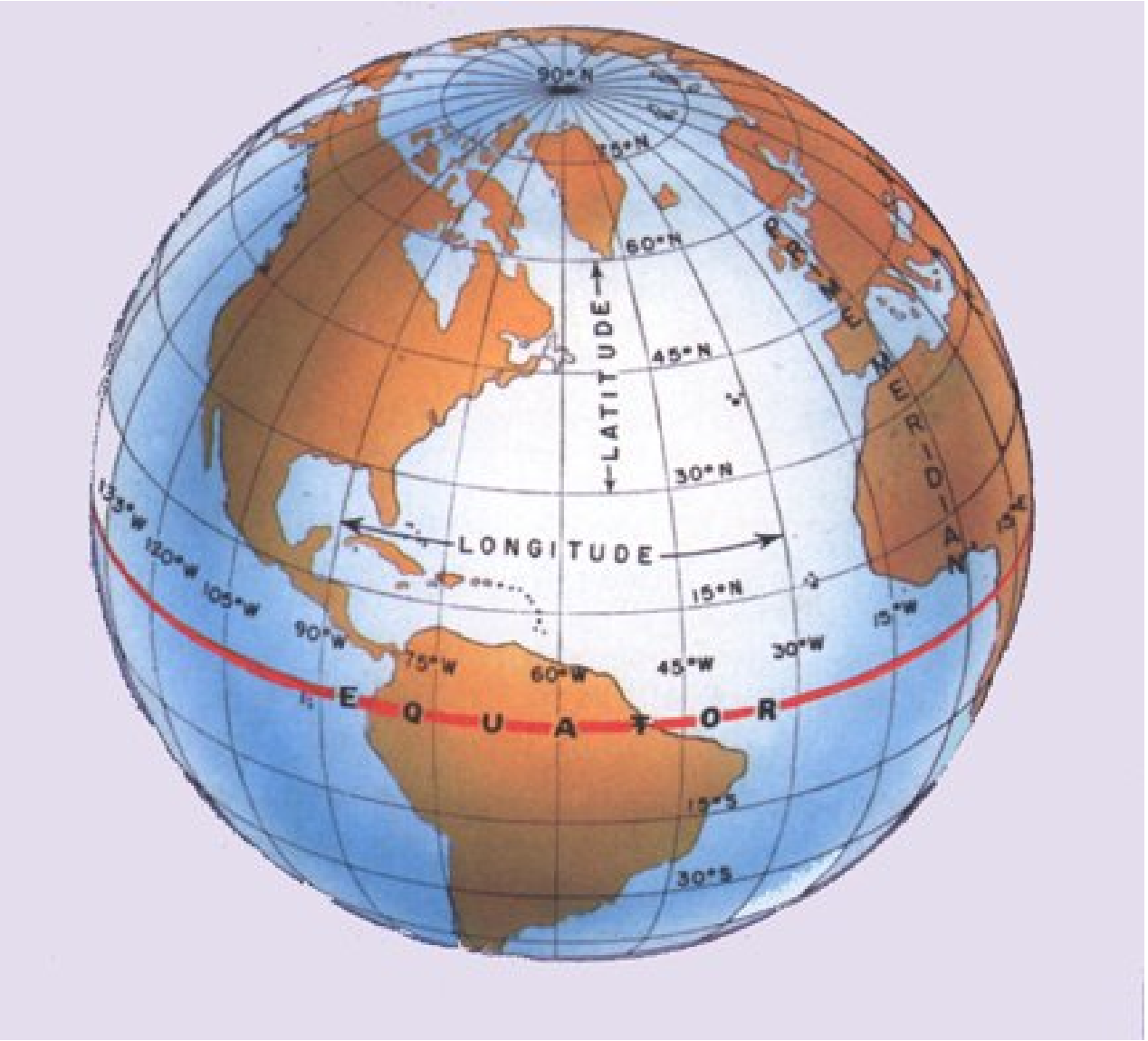
A) Groupings of stars on the sky as seen from Earth

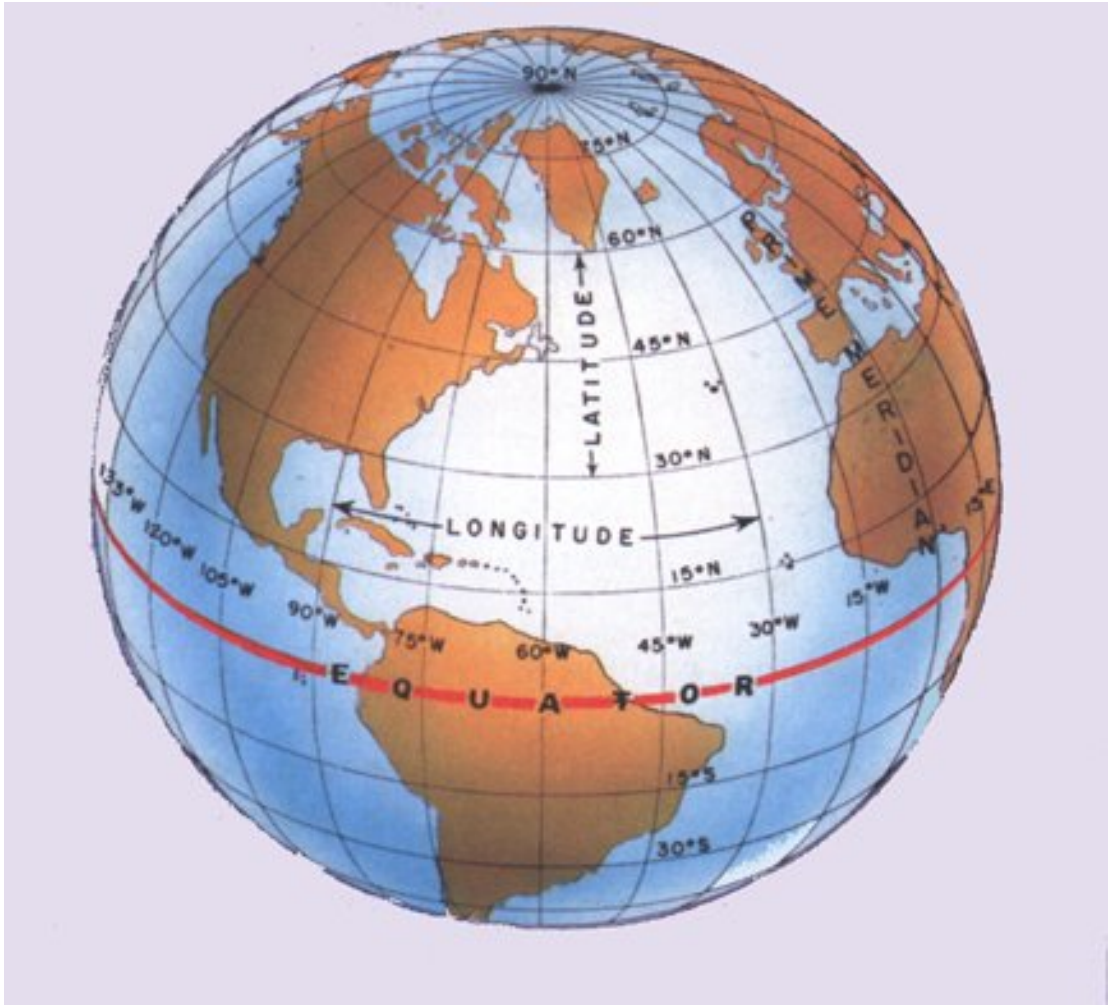
B) Useful in finding objects on the sky

C) Groups of stars all created in one star formation event

D) Different sizes

Coordinate system



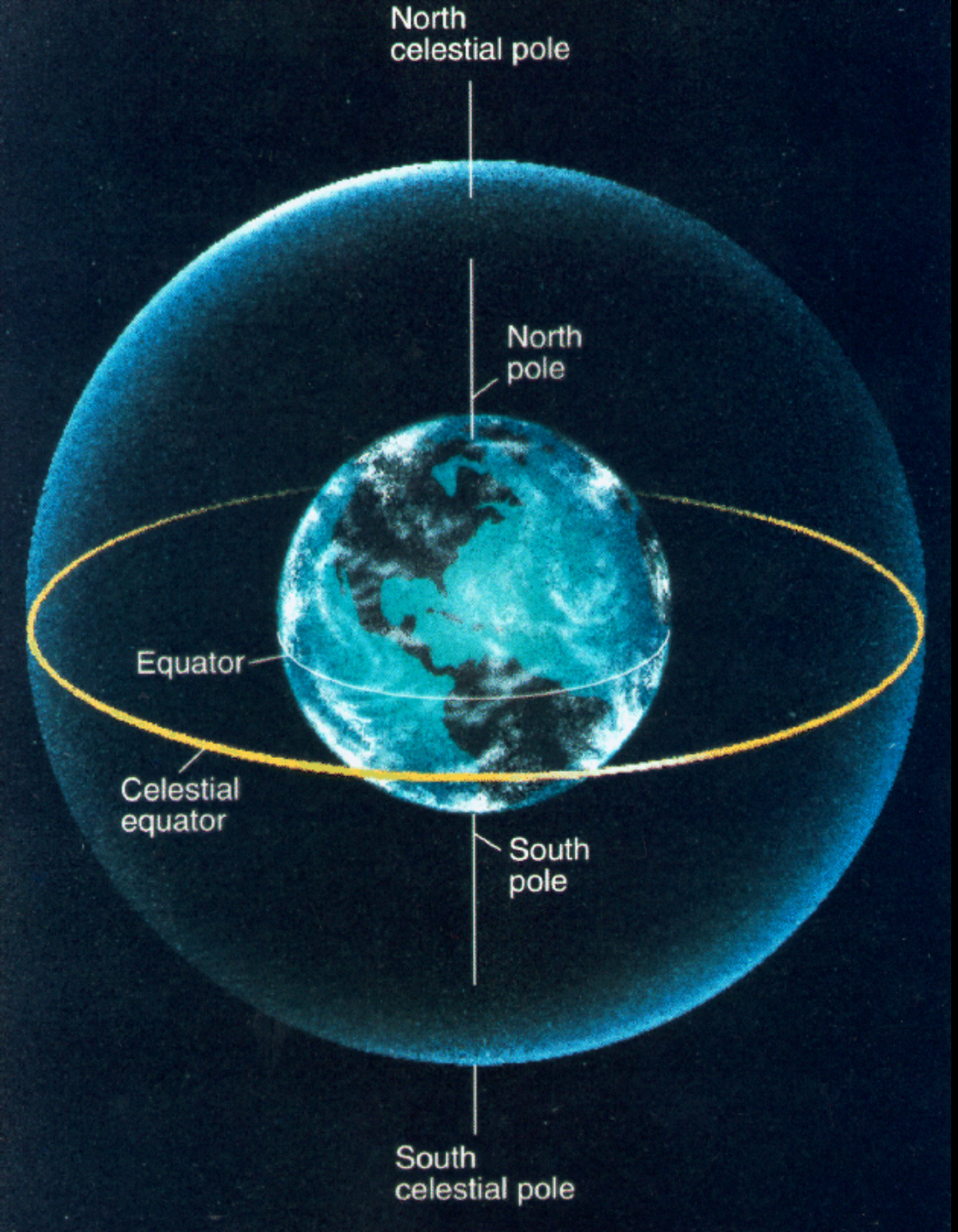


Coordinates are

Latitude = degrees North or South of the equator

Longitude = degrees East or West of the "Prime meridian"

Prime meridian is historically defined as longitude of the Royal Observatory in Greenwich, England

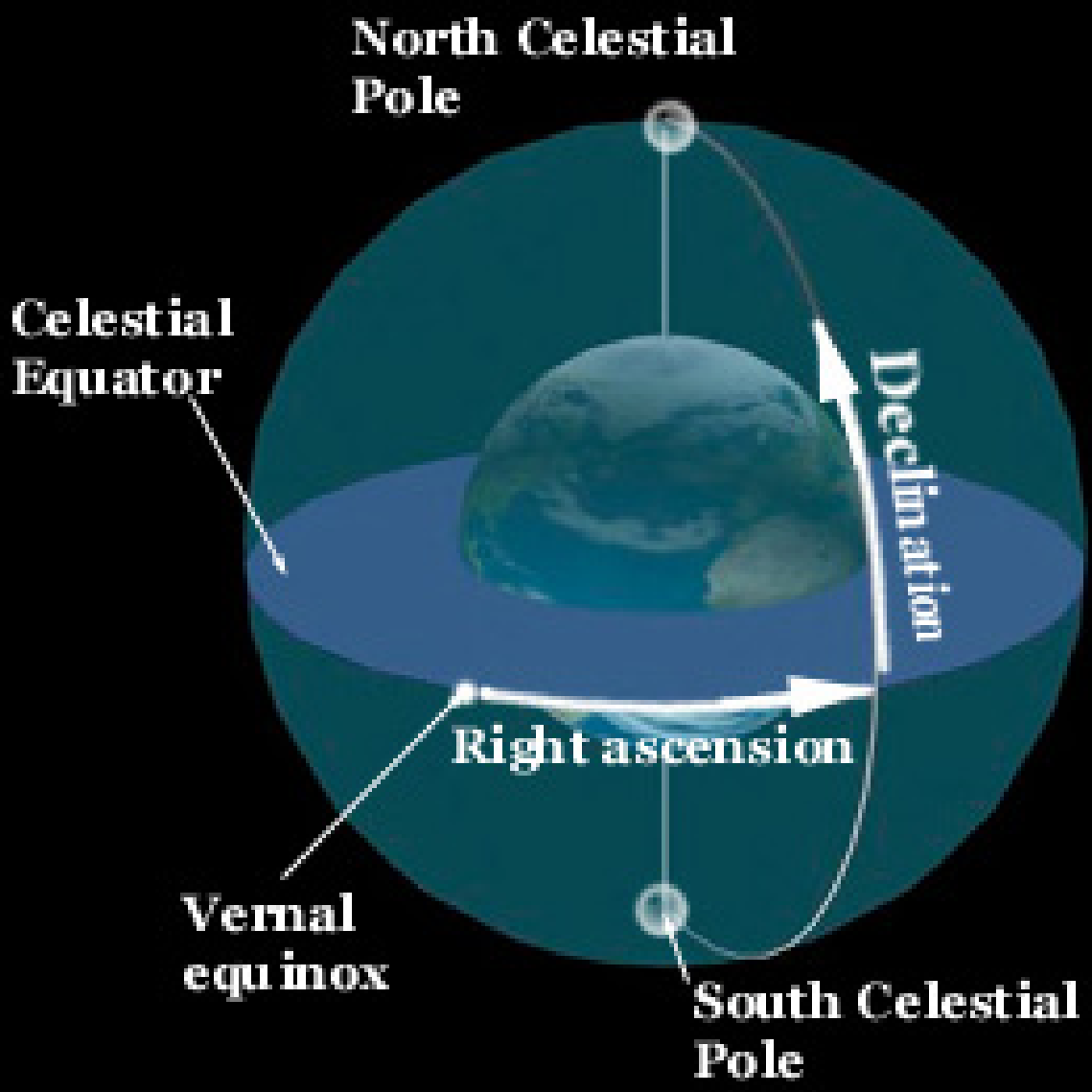


Sky coordinate system

Introduce the
'celestial sphere'

This is an imaginary sphere drawn in space with the earth at its center.

We align the sphere with the Earth.



Coordinates are:

Declination = degrees North or South of the equator.

Right ascension = degrees East of the “Vernal equinox”.

Vernal equinox is defined as the position of the Sun on the first day of spring. Note it is a point on the sky, not the earth.

Which of the following is true?

A) longitude is to declination as latitude is to right ascension

B) longitude is to right ascension as latitude is to declination

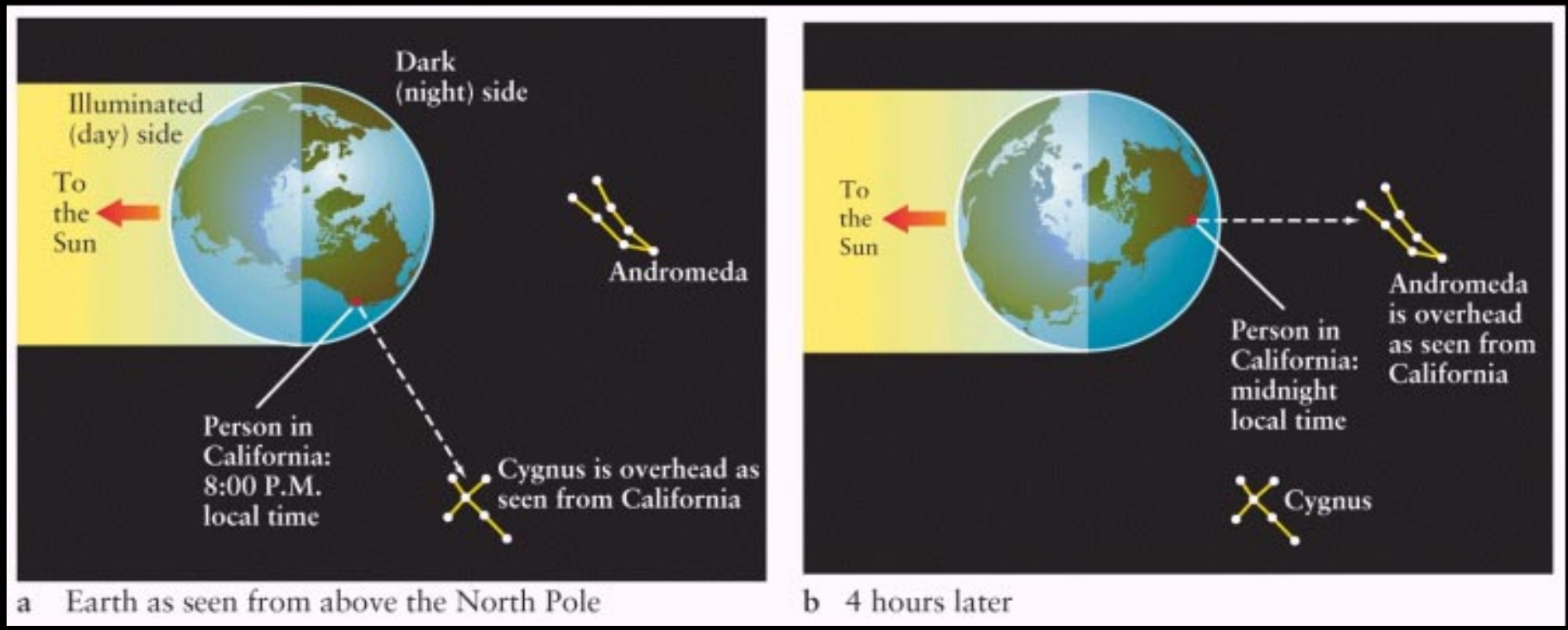
C) longitude is to elevation as latitude is to declination

D) longitude is to elevation as latitude is to right ascension

Finding North

Motion of stars on the sky

The rotation of the Earth causes the stars to appear to move on the sky.



Angular Measure for Small Angles

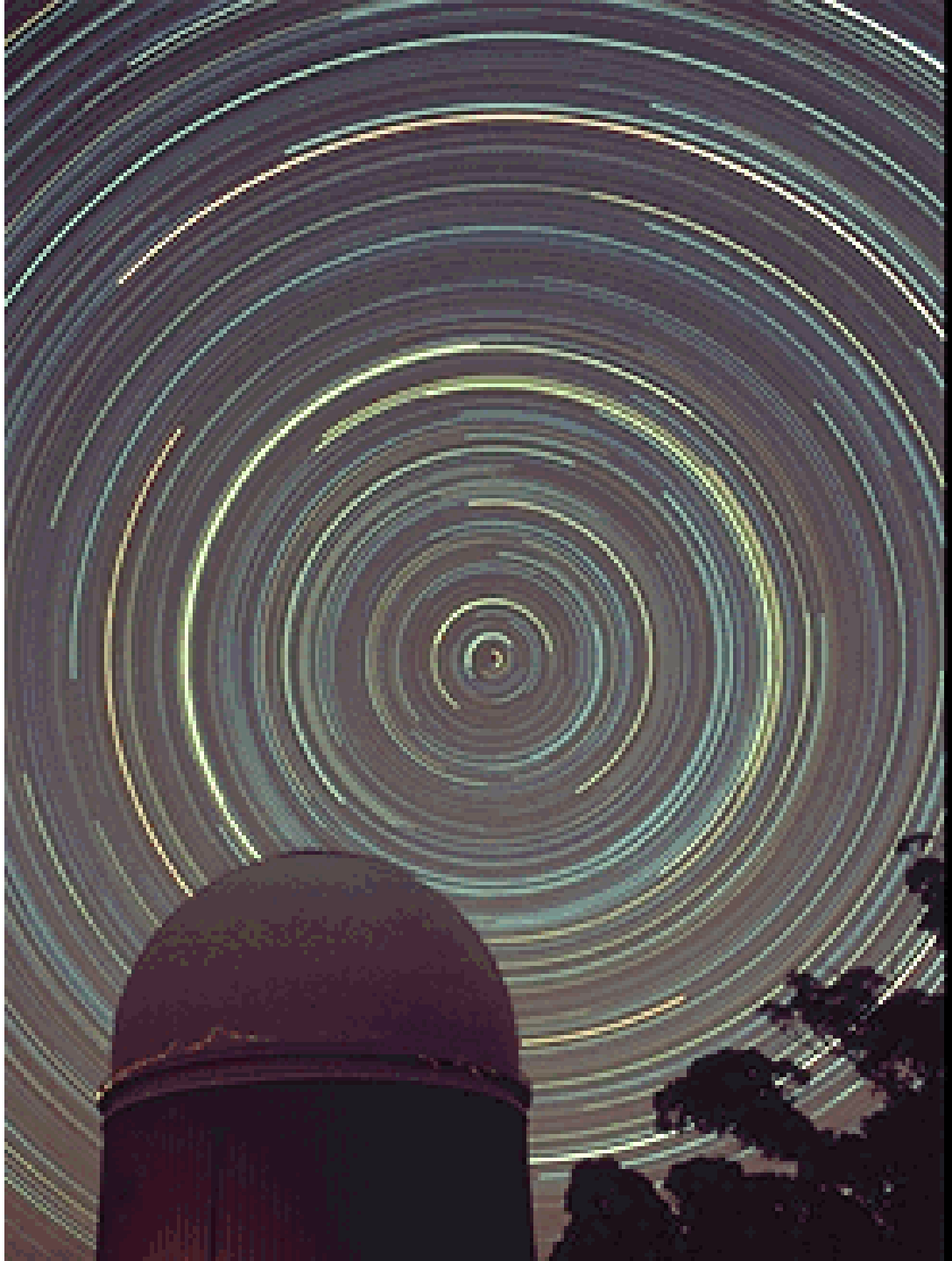
1º = 60 arcminutes = 60′

1′ = 60 arcseconds = 60″

e.g., On January 1, 2004, the planet Saturn had an angular diameter of 19.7" as viewed from Earth.

How long was the exposure for this photograph?

A) 4 hours
B) 6 hours
C) 10 hours
D) 12 hours
E) 20 hours



Motion of the sun and planets on the sky

The Earth and other planets orbit around the Sun.

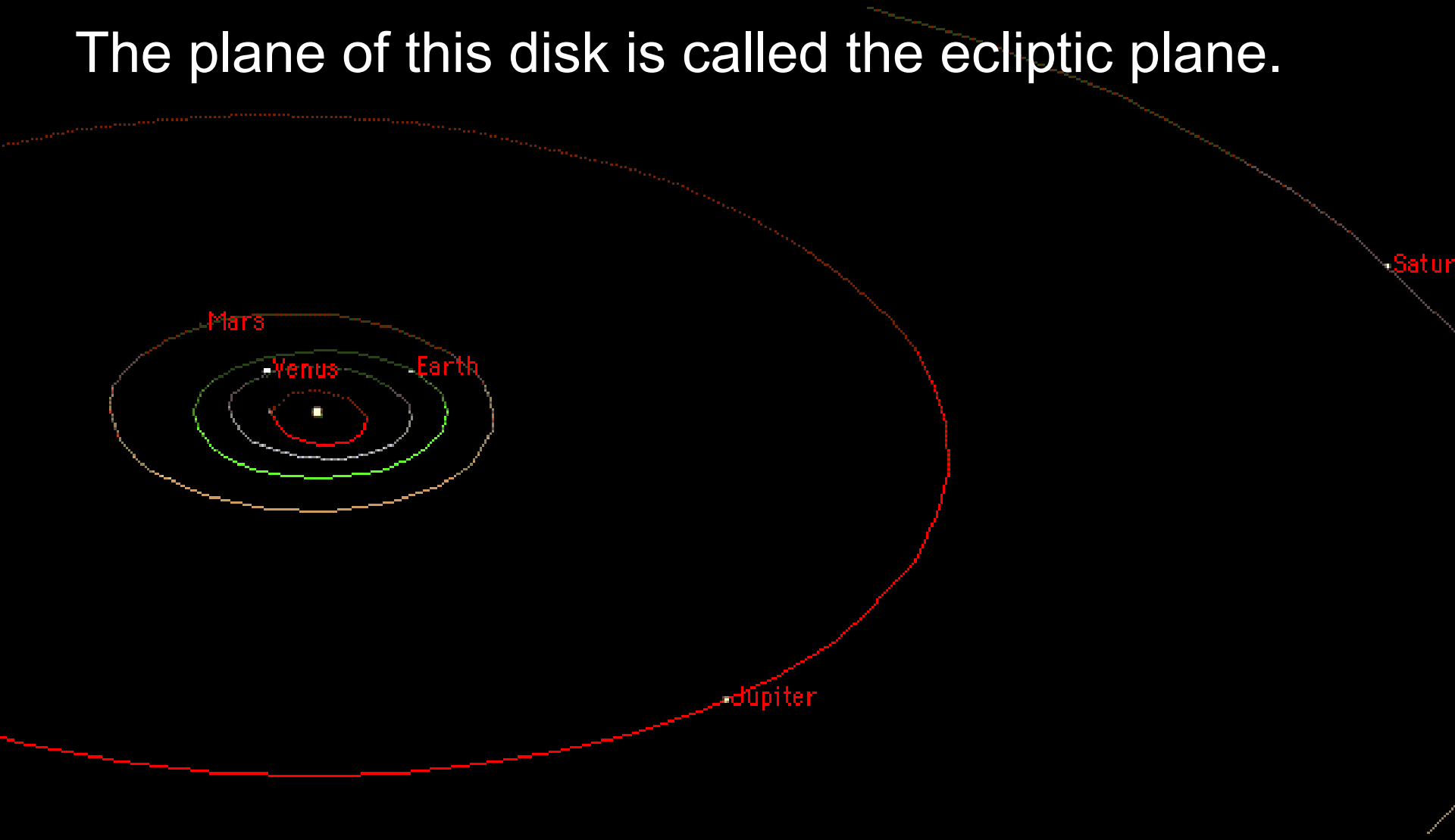
This causes the Sun and the planets to appear to move in the sky when viewed from Earth.

How does this work?

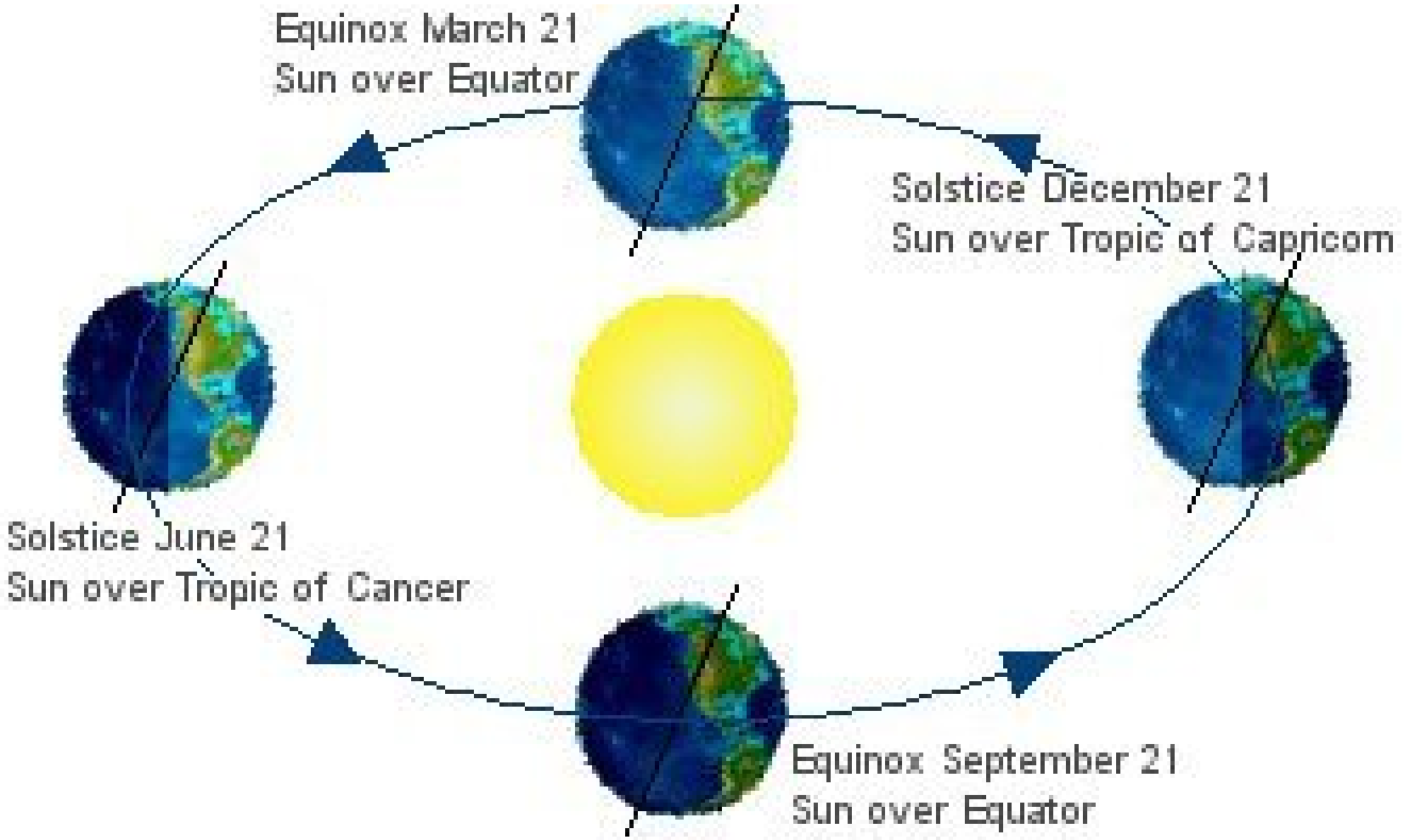
Crucial facts are that:

1) All of the planets lie in one disk around the sun.

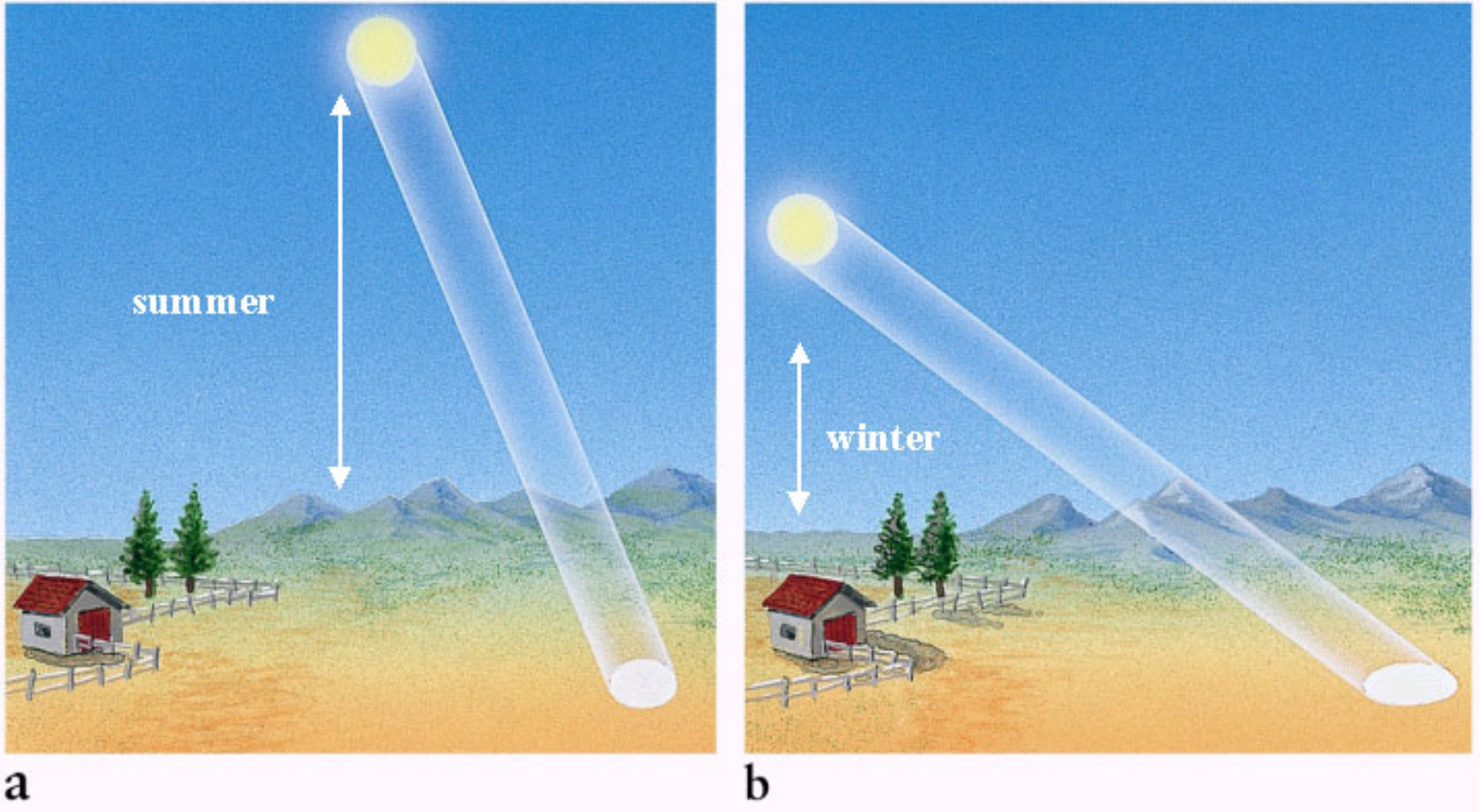
The plane of this disk is called the ecliptic plane.



2) The rotation of the Earth is tilted relative to its orbit by 23.44°



Over the course of a year, the Sun's position in the sky changes.



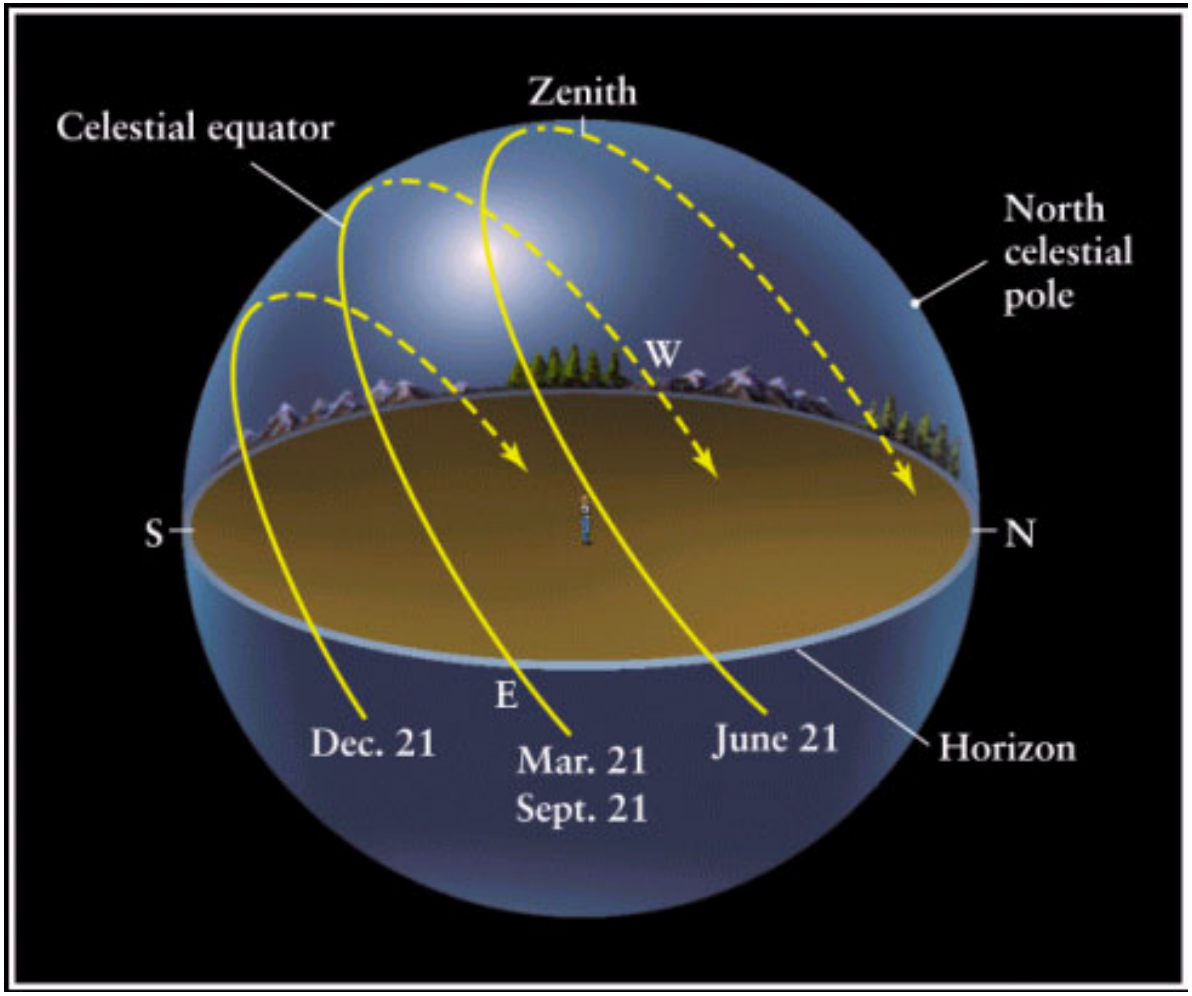
The ground receives more light, thus more heat, per square meter in the summer than in the winter.

Dec. 21
Winter Solstice

March 21
Vernal Equinox

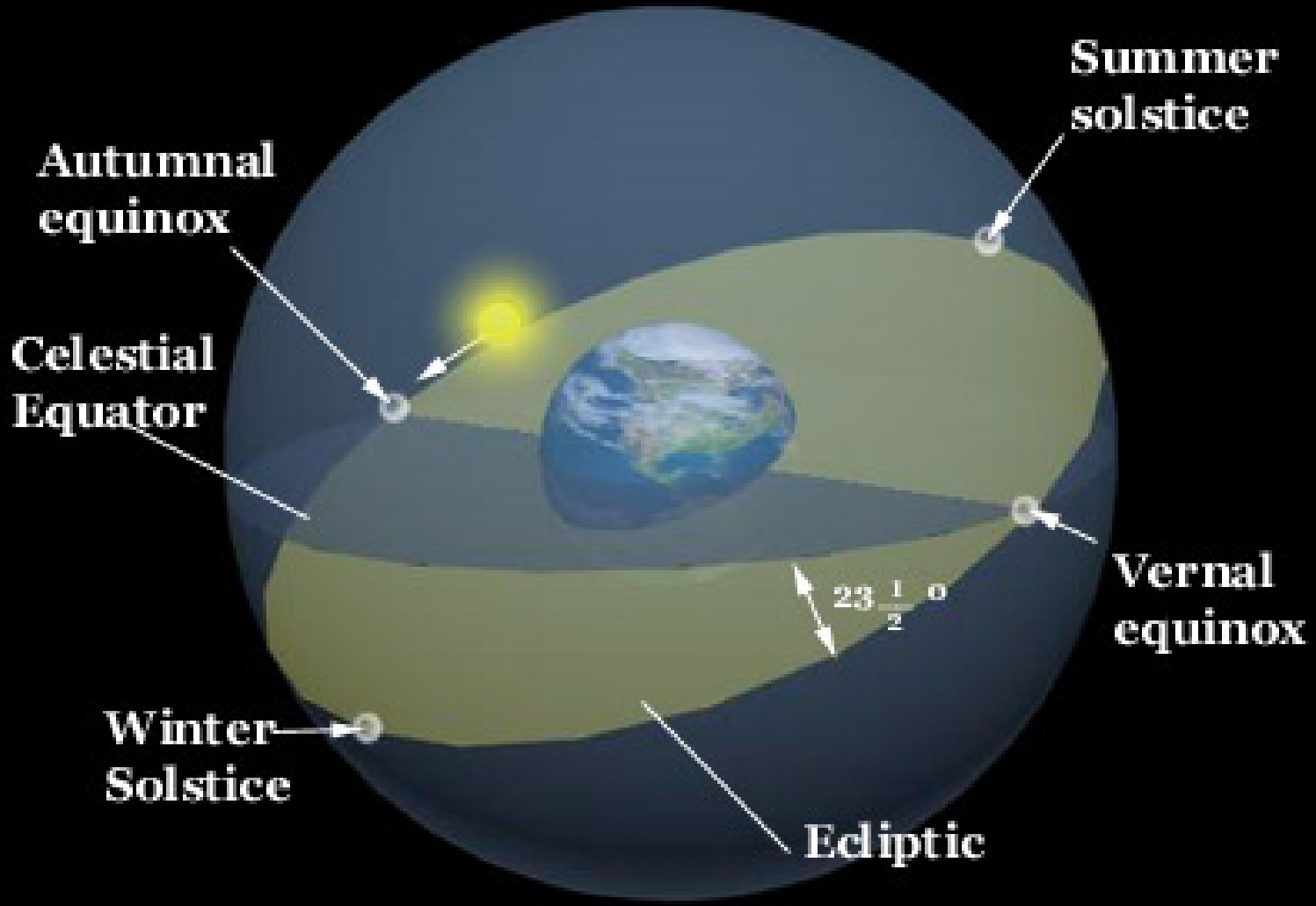
June 21
Summer Solstice

Sept. 21
Autumnal
equinox

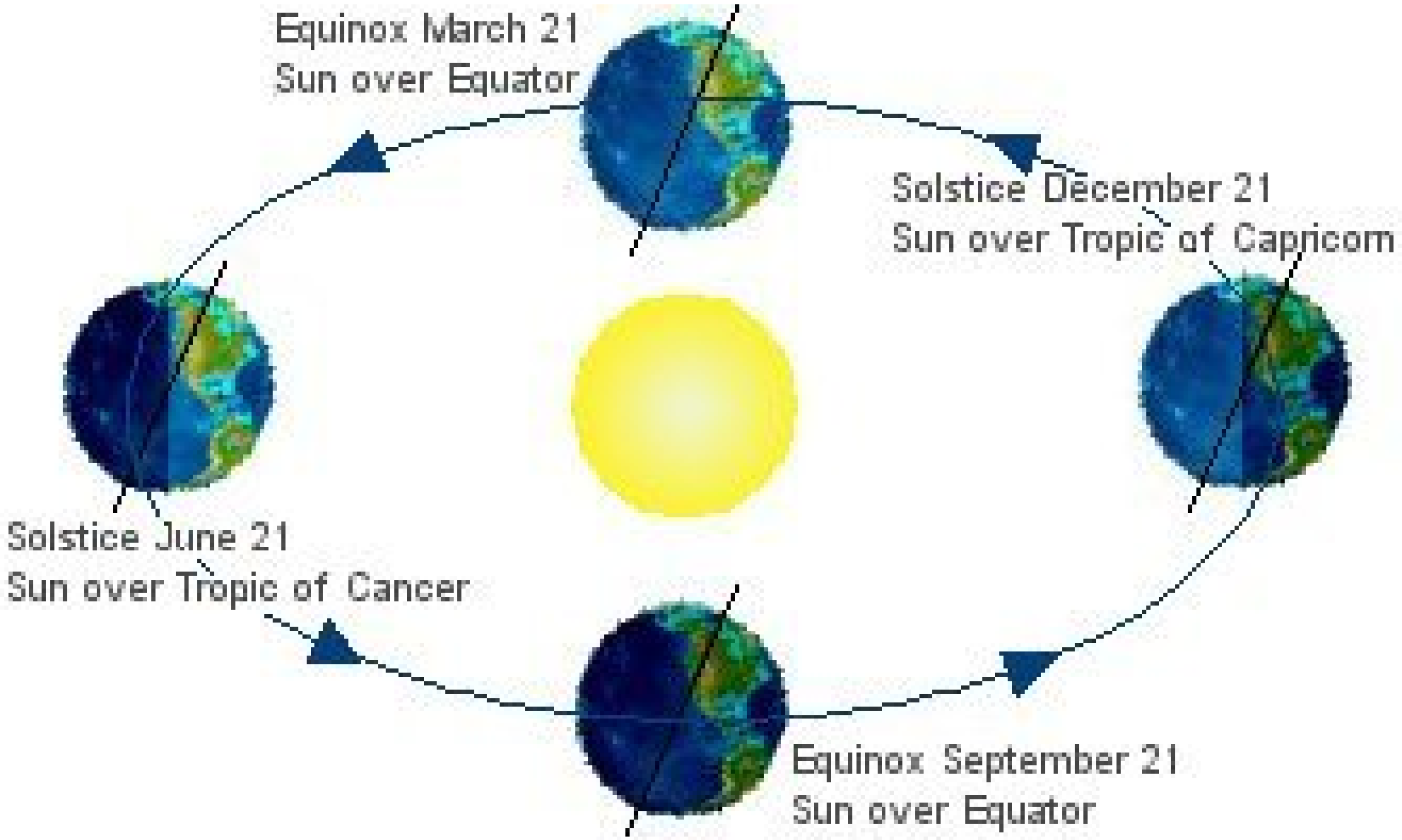


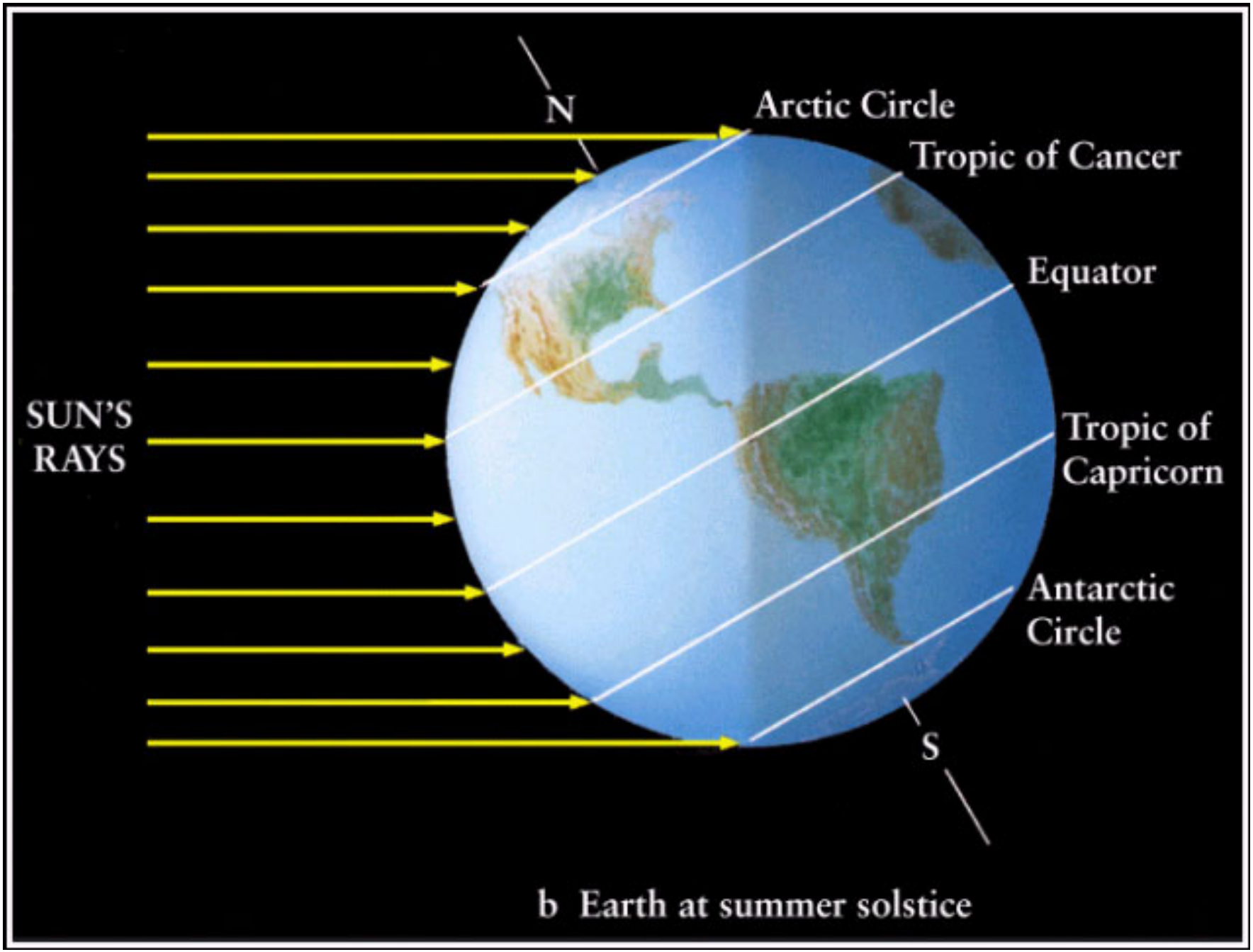
The sun is up longer in the summer than in the winter.
Again, the ground receives more sunlight in the summer.

Therefore, the sun and planets move around a circle (the ecliptic) on the celestial sphere which is tilted relative to the celestial equator

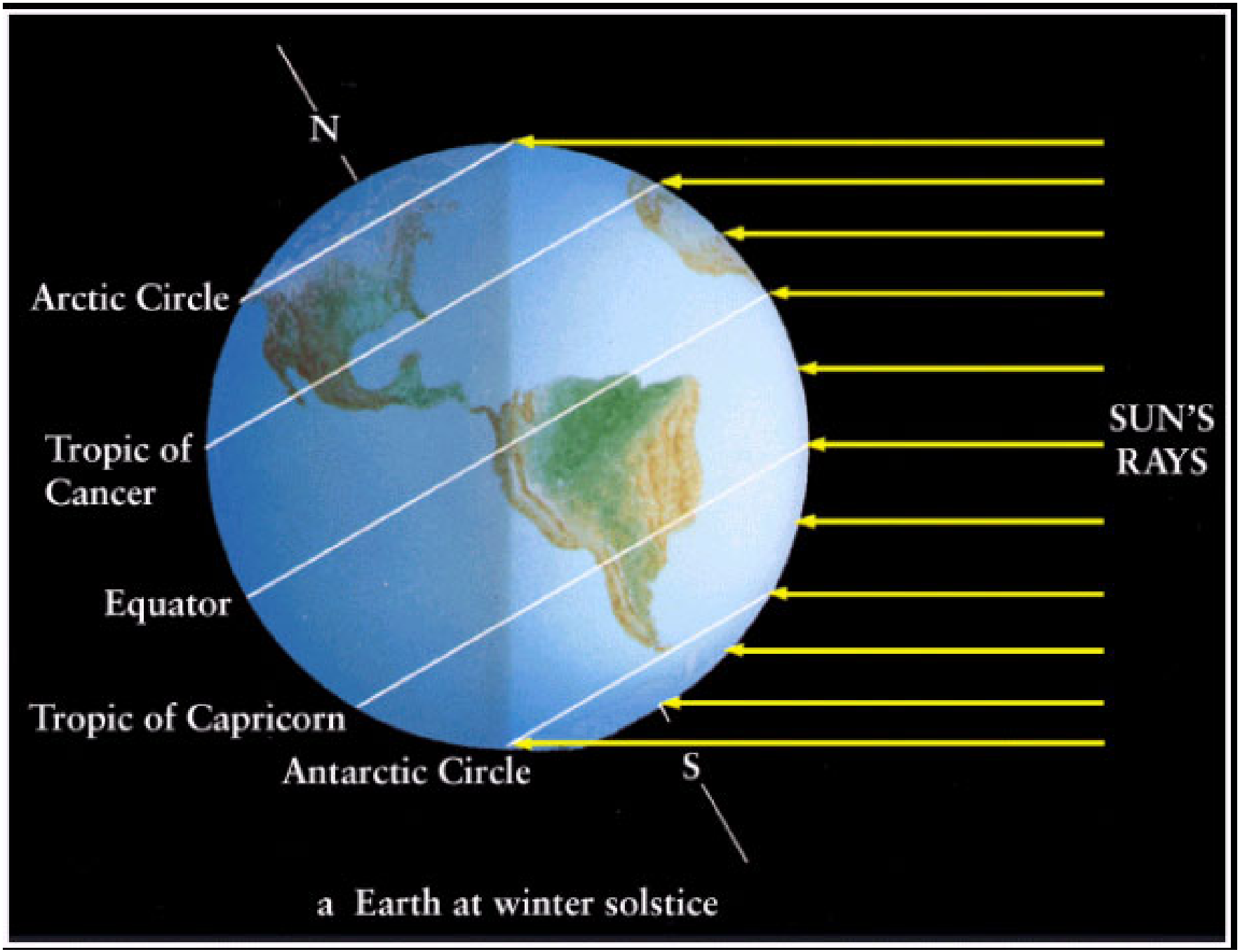


Earth's tilt causes the seasons





b Earth at summer solstice



a Earth at winter solstice

What causes the seasons?

A) The orbit of the Earth is an ellipse, not a circle, and the Earth is closer to the Sun in summer than in winter.

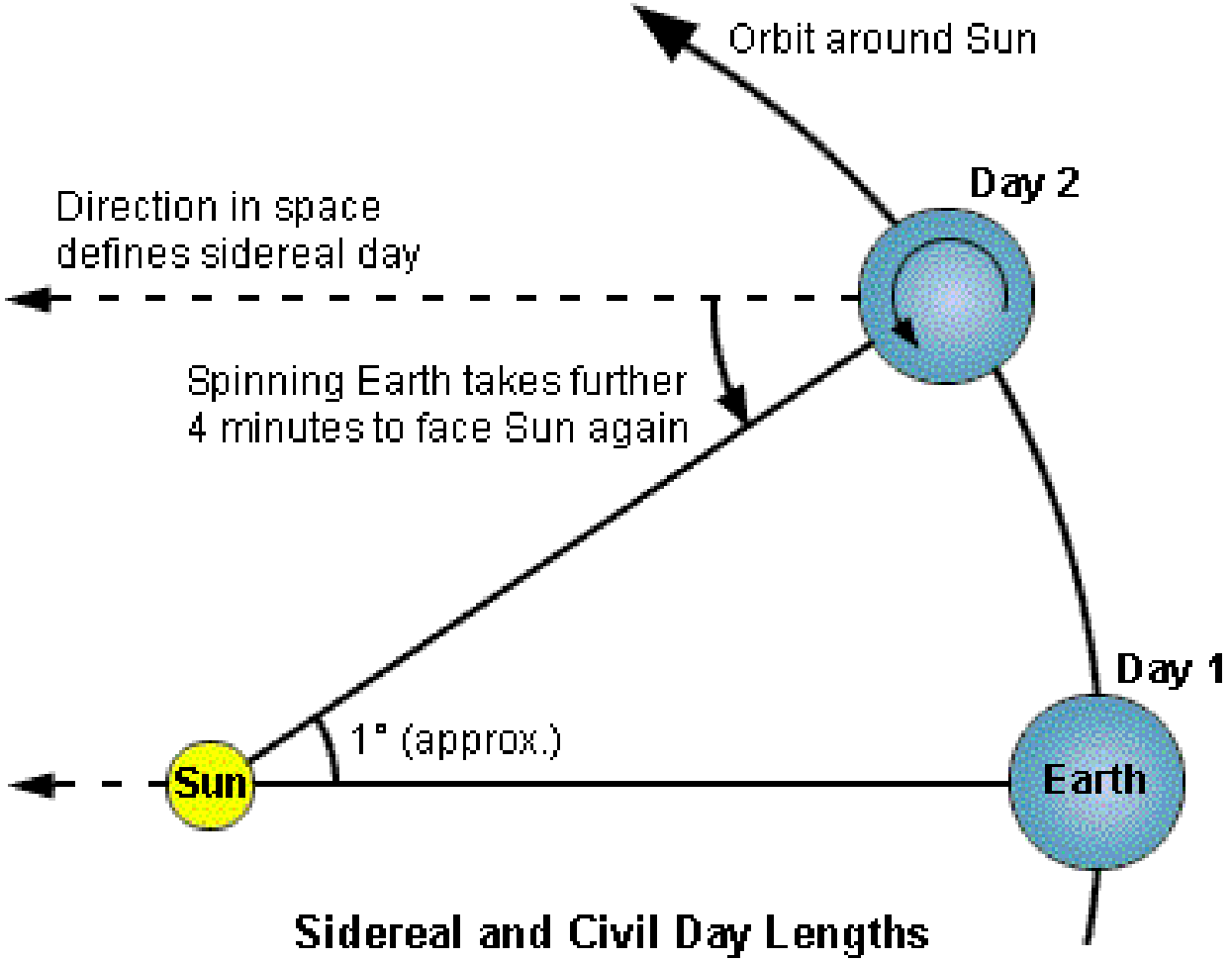
B) The rotation of the Earth is tilted relative to its orbit.

How long does it take the Earth to make one full rotation?

A) 24 hours
B) 23 hours 56 minutes 4 seconds
C) 24 hours 3 minutes 56 seconds
D) 365.242199 days

Sidereal vs. Solar Day

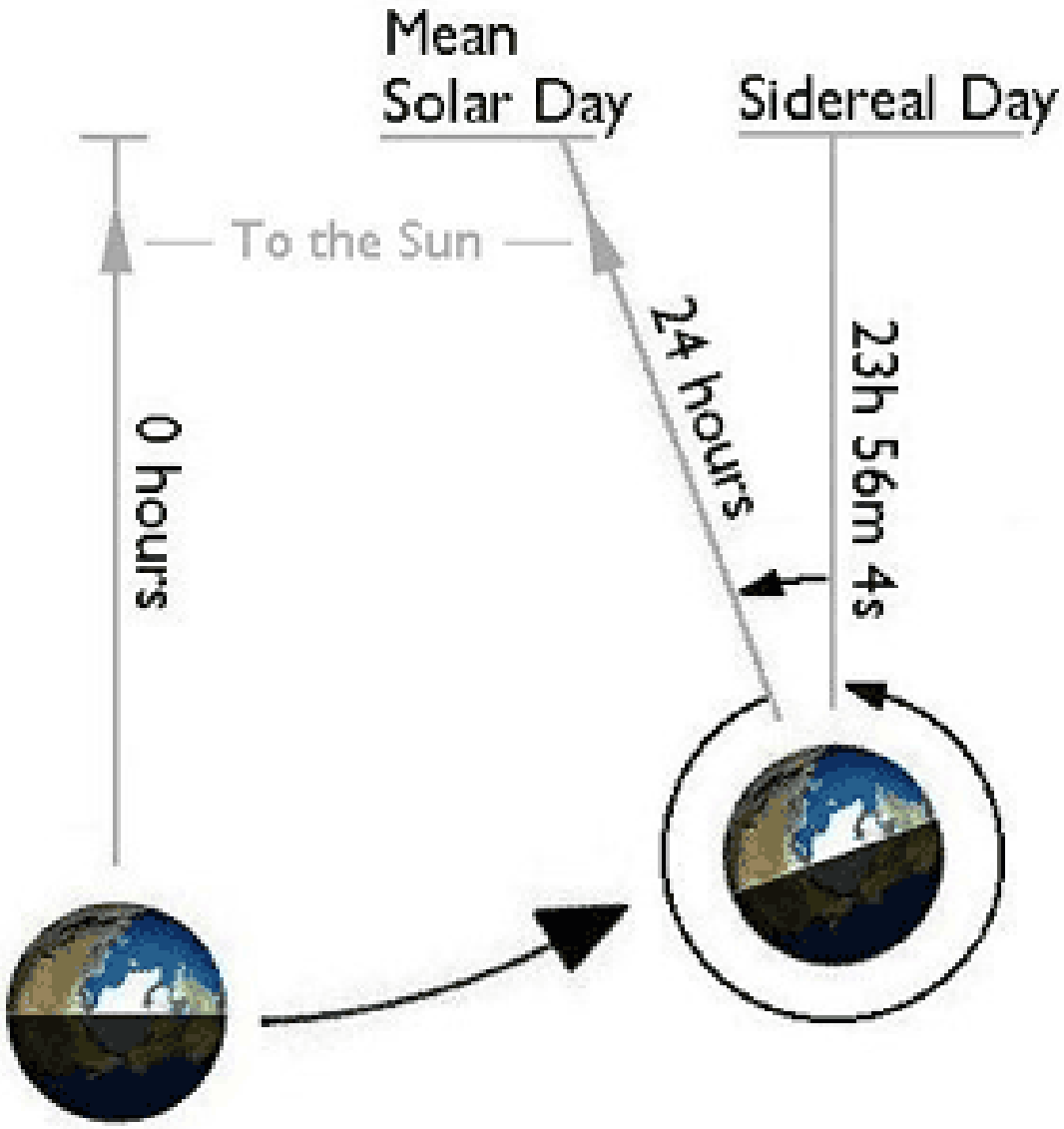
- The Earth's TRUE rotation period is 23h 56m 4s, not 24hrs! This is called the sidereal period or the rotation period relative to the stars.



Sidereal and Civil Day Lengths

It takes about 4 minutes more rotation for the Sun to be in the same place as yesterday. Hence a solar day, or time from noon to noon, is 23h 56m + 4m = 24 hours

Sidereal vs. Solar Day

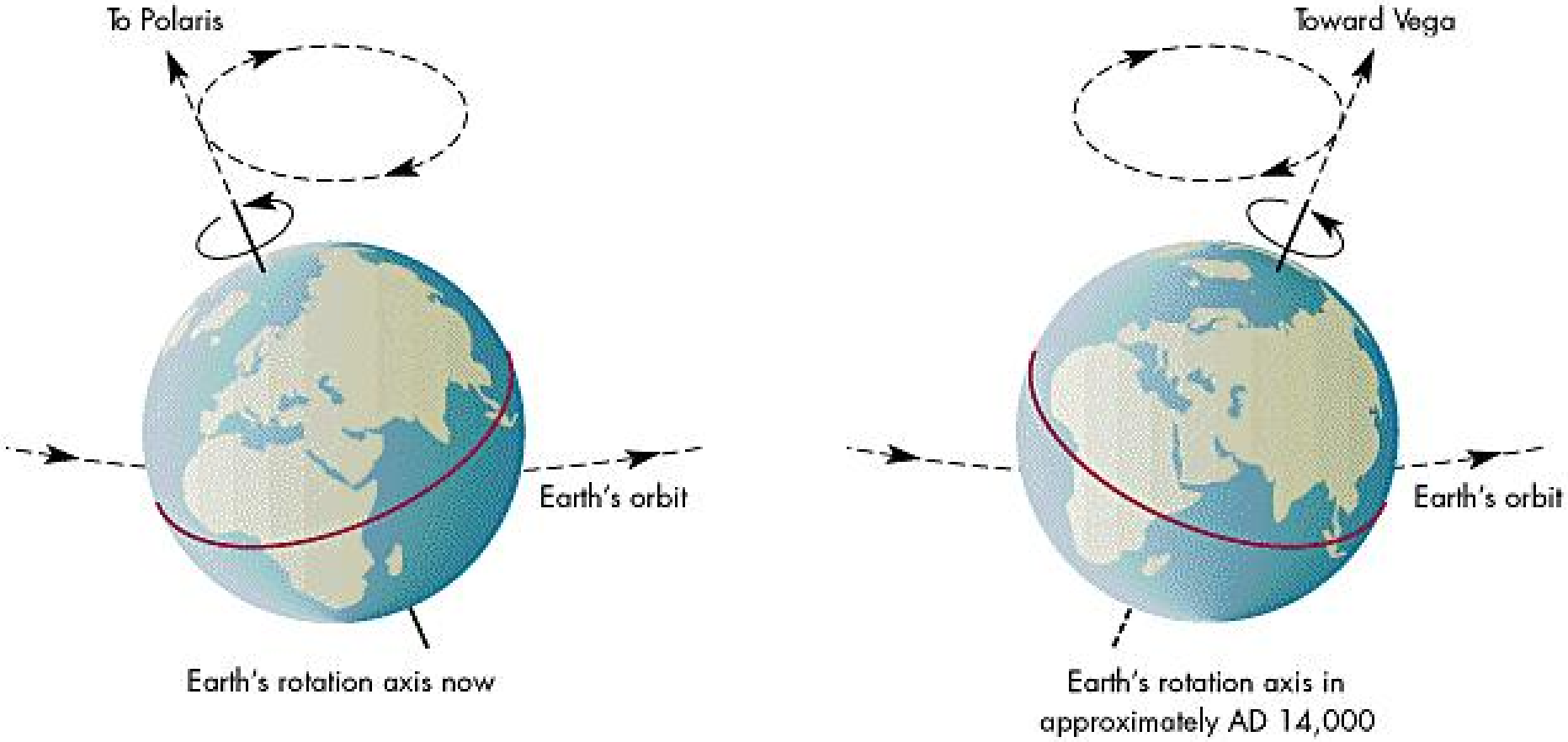


Precession

- If you spin a top, its very hard to get it to spin exactly straight – usually it wobbles around in a circle

- The spinning Earth wobbles in exactly the same way – this is called precession

Precession of the Earth



This causes the celestial pole to move. Thus, the coordinates of stars change slowly from year to year.

The path followed by the sun as it appears to move among the stars is the

A) Ecliptic
B) Equator
C) Meridian
D) Zenith
E) Don't know

Stars observable at midnight in January differ from stars observable at midnight in July because

A) the Earth rotates on its axis.

B) the Earth revolves around the Sun.

C) the Earth precesses like a top.

D) the Earth’s axis is tilted.

I plan to do the homework for 29:50

A) by myself
B) with friends
C) by copying from my friends
D) never
E) We have homework?

Discovery of the coolest class of Star

- Yesterday NASA scientist working with the Wide-field Infrared Survey Explorer (WISE) announced discovery of a new type of star.

Discovery of the coolest class of Star

- These stars, called “Y-dwarfs”, have surface temperatures as low as 80 F.
- The closest of these stars is about 9 light years away, the 7th closest star to the Sun.

Phases of the Moon

Phases of the Moon

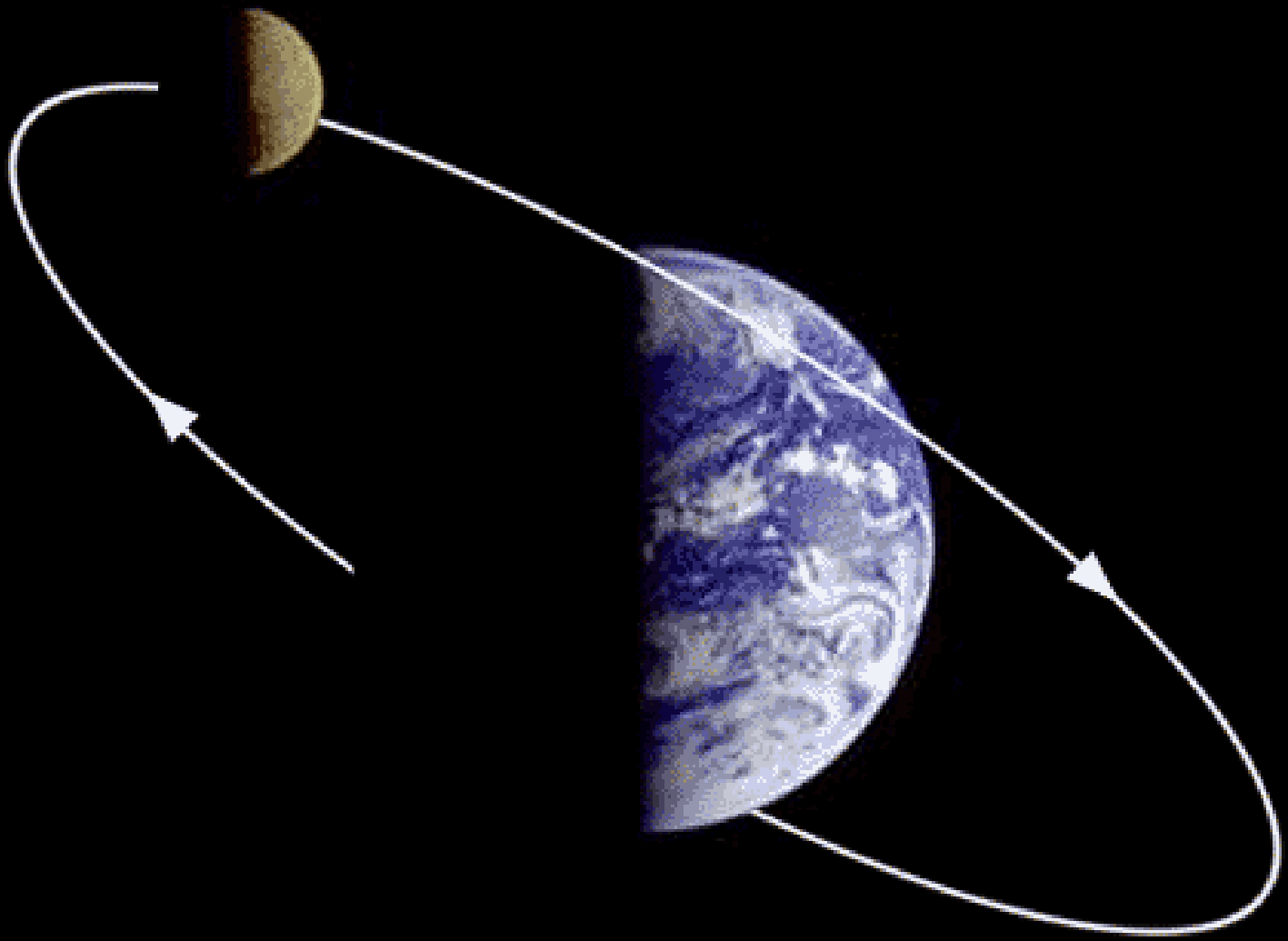
- The phases of the Moon are caused by the orbit of the Moon around the Earth, but how does this work?
- Any thoughts?

on’s Orbit

Moo

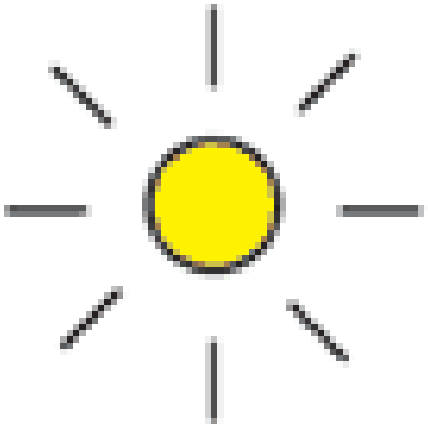
- Relative to the Sun, the Moon orbits the Earth once every 29.5 days (relative to the stars the orbit is 27.3 days)

Phases of the Moon

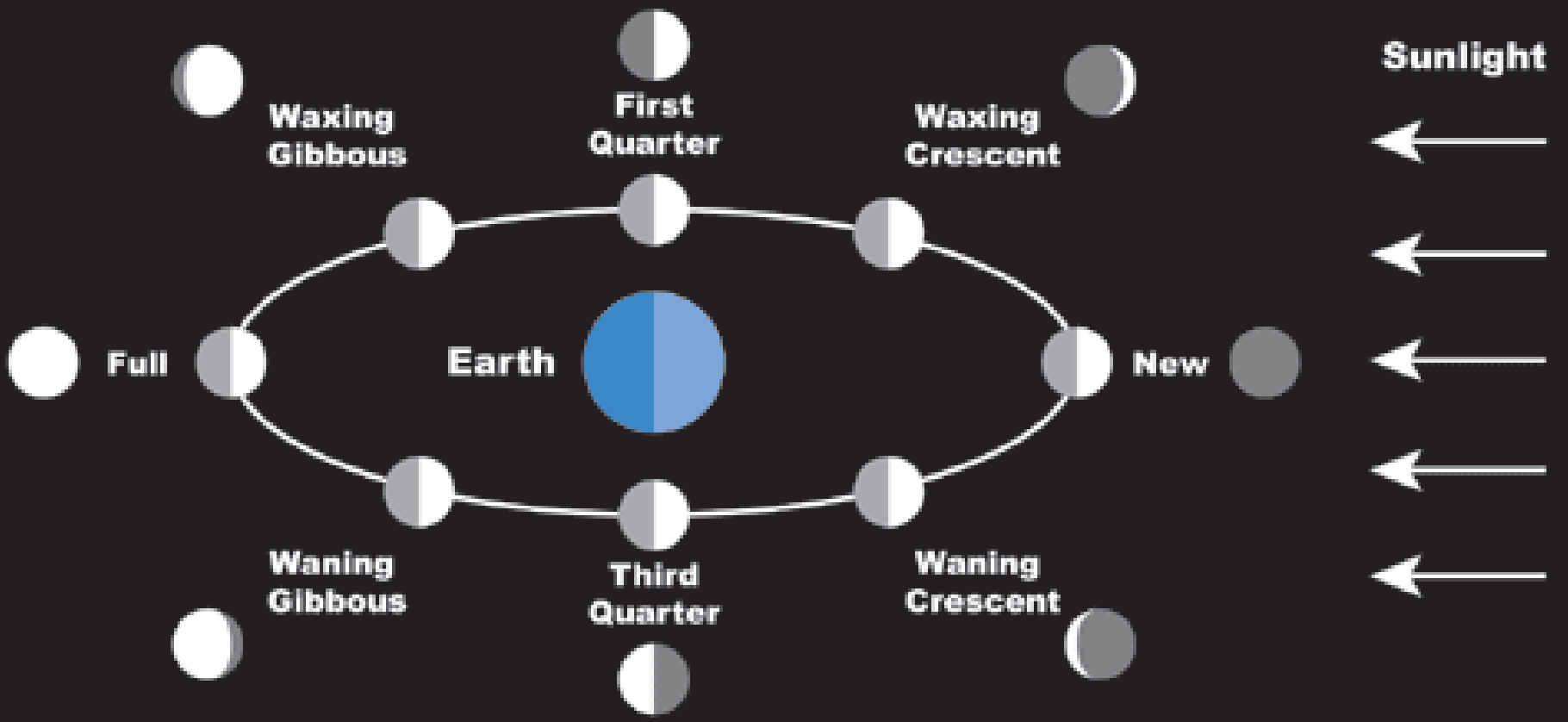


Picture taken by Galileo spacecraft from 4 million miles away

Phases of the Moon

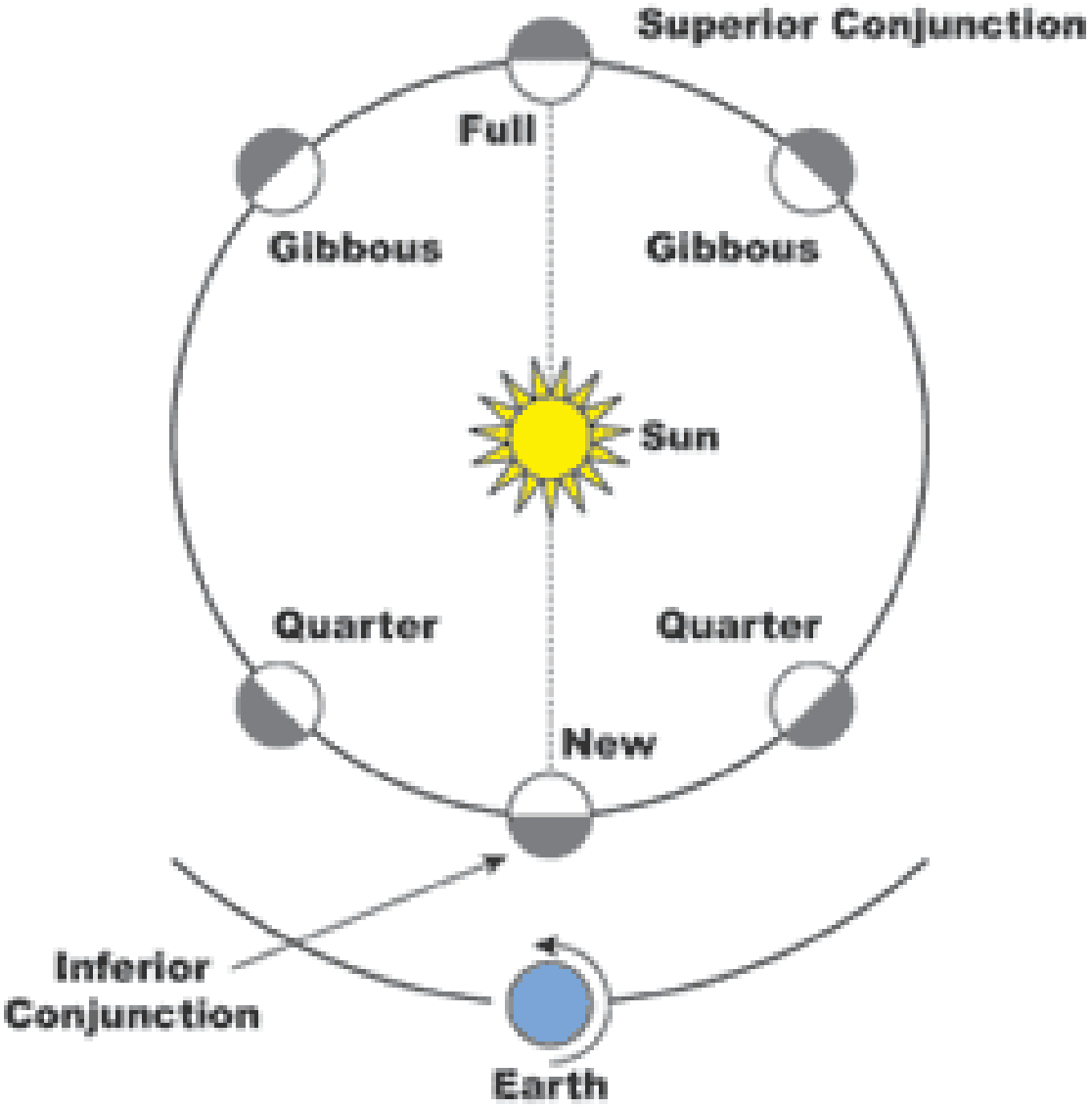


Lamp

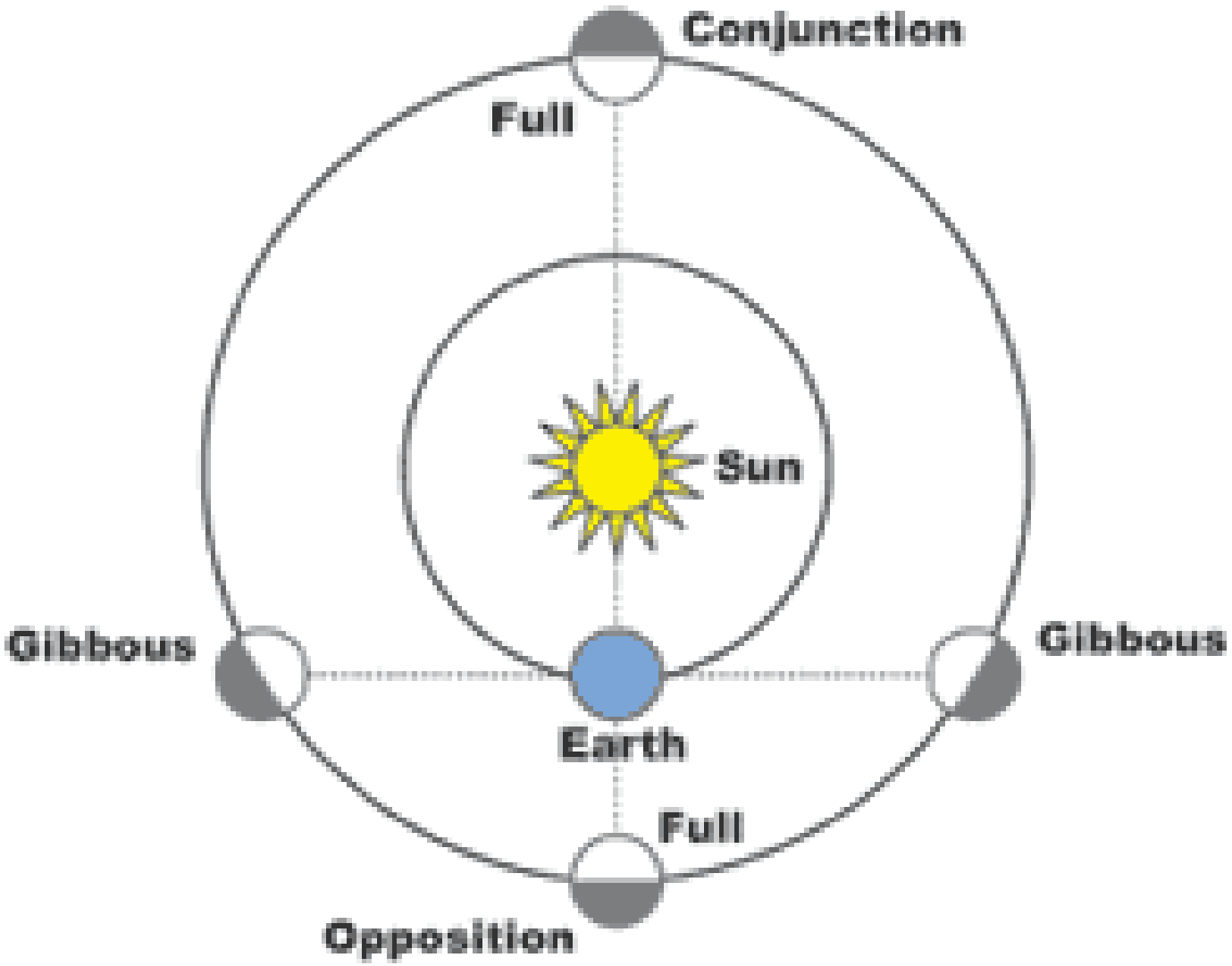

Sunlight
Waxing Gibbous
First Quarter
Waxing Crescent
Full
Earth
New
Waning Gibbous
Third Quarter
Waning Crescent

Seen from the Moon, does the Earth have phases? (A=yes, B=no)

Do the planets have phases?

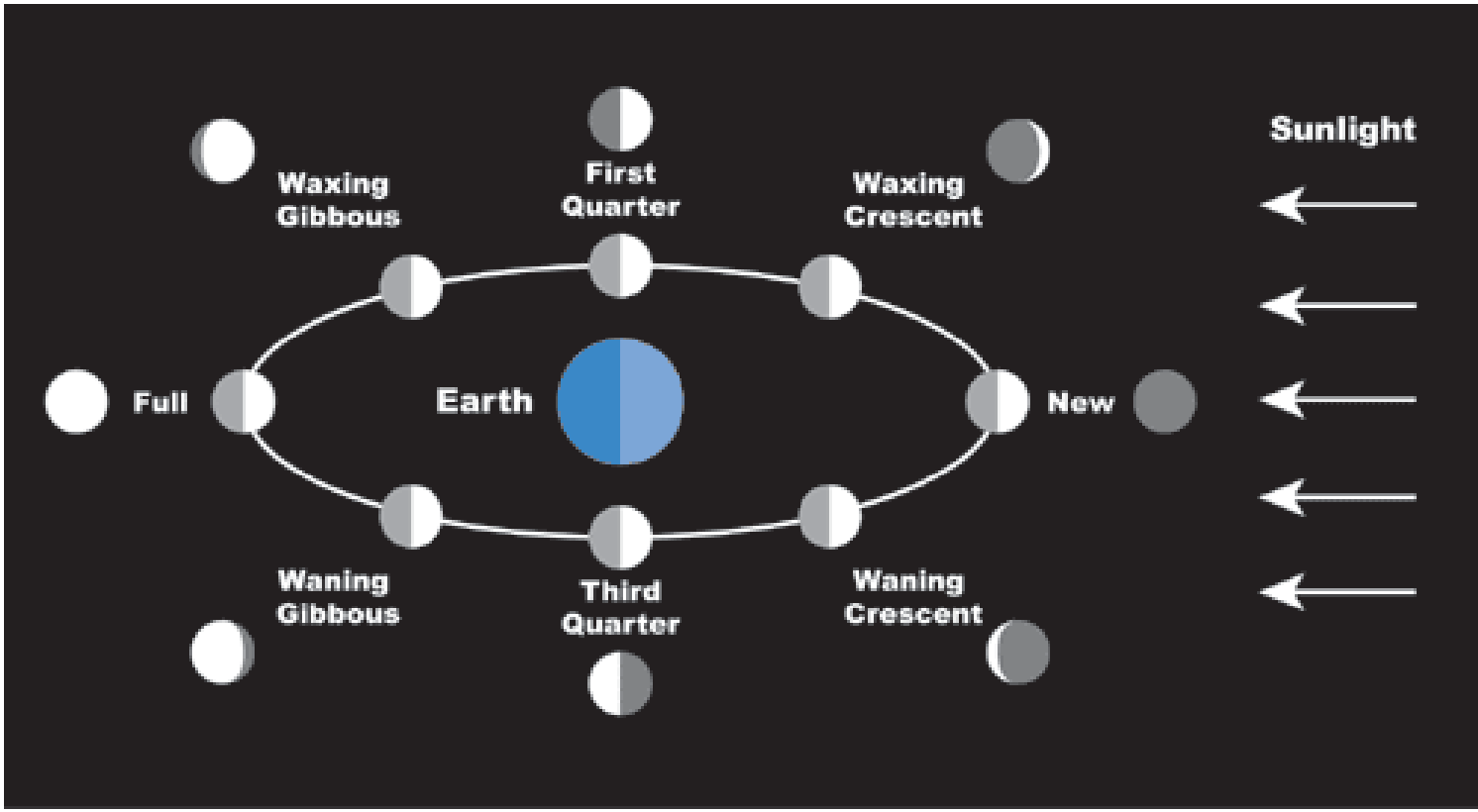


Phases of the Planets



At approximately what time does the new moon rise?

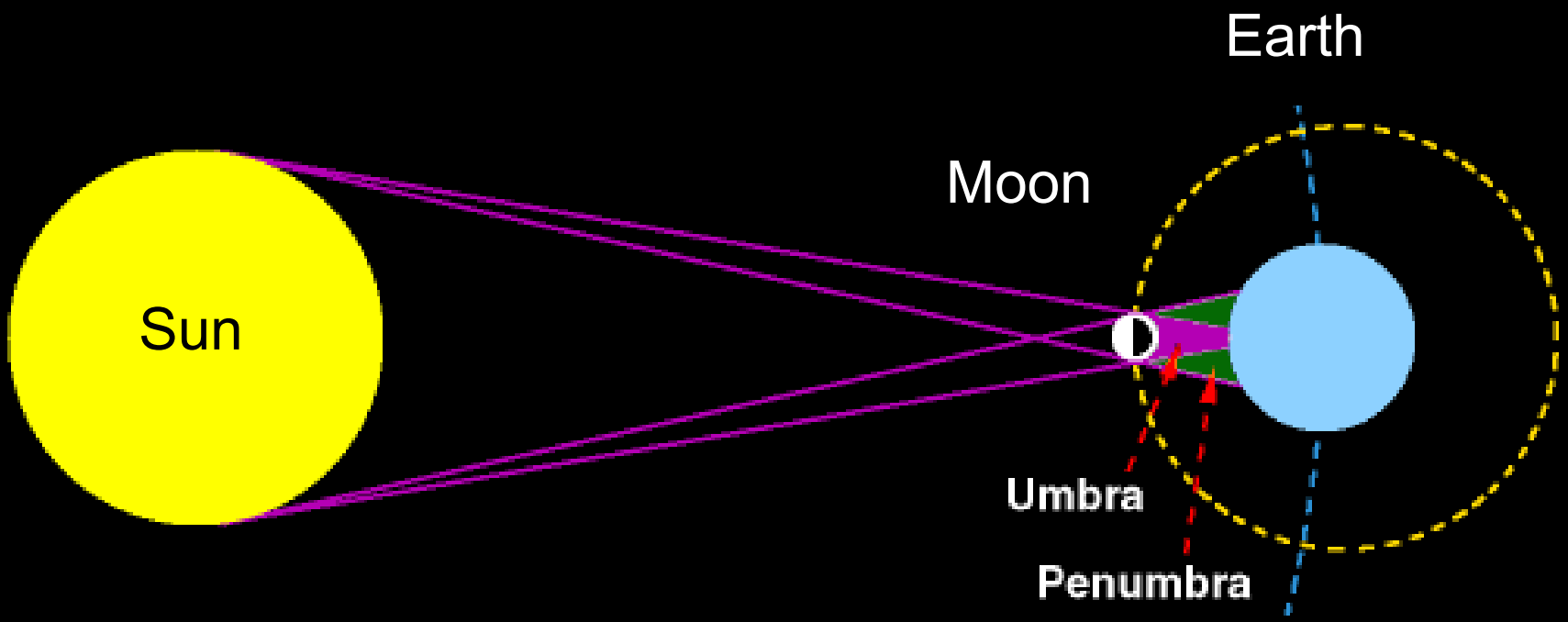
A) Sunset
B) Midnight
C) Sunrise
D) Noon
E) No clue

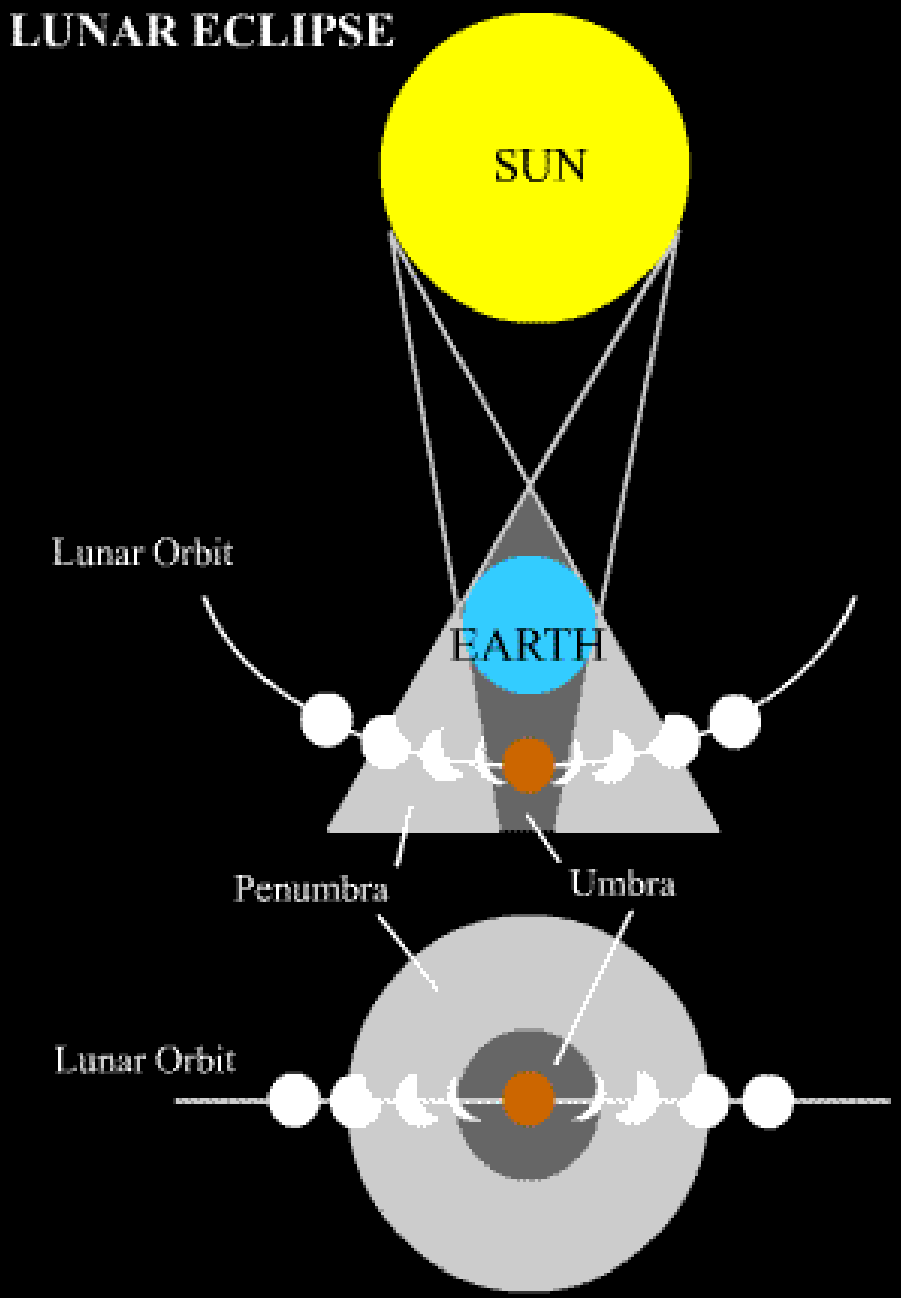


Solar and Lunar eclipses

- What causes a solar eclipse?
- How about a lunar eclipse?

A solar eclipse




LUNAR ECLIPSE
SUN
Lunar Orbit
EARTH
Penumbra
Umbra
Lunar Orbit

What is the phase of the moon during a solar eclipse?

A) First quarter
B) Full
C) Third quarter
D) New
E) Still no clue

Review questions

- How many coordinates are needed to locate a star on the sky?
- What are the names of the coordinates on the celestial sphere?
- What causes the seasons?
- Does the sun rise higher in the summer or winter?
- How long does it take the Earth to make one full rotation?

Review questions

- Draw a diagram of the positions of the Earth, Sun, and Moon at new moon, first quarter moon, and full moon.
- Draw a diagram of the positions of the Earth, Sun, and Moon during a lunar eclipse.