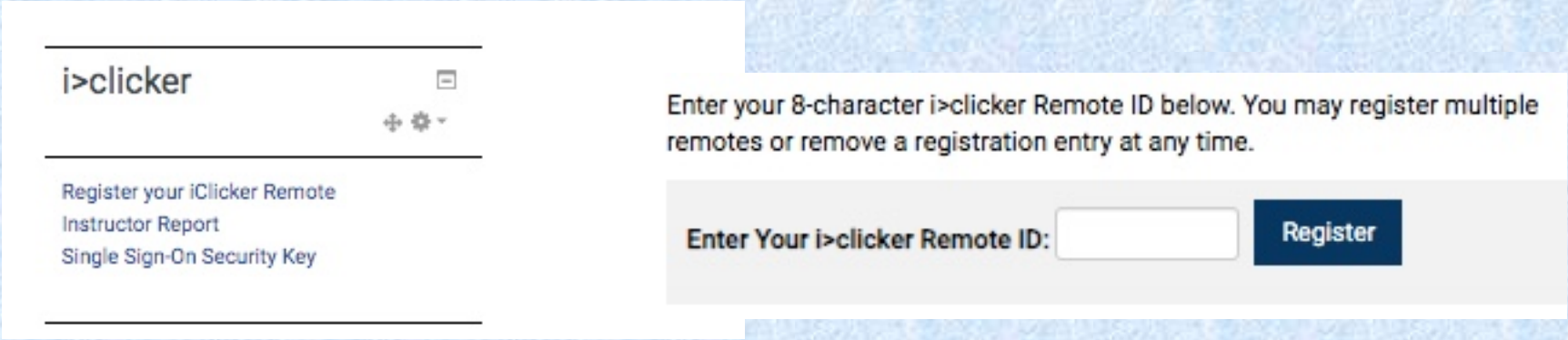
Announcements

Course Website: web.physics.ucsb.edu/~astro1/f2019/

Correction: Homework boxes are NOT in the lobby. They are in front of the Physics Study Room (PSR). **PLEASE write your TA name and section on your homework.**

REGISTER iCLICKERS ONLINE /

You earn class participation points by selecting an answer; the points are the same for right and wrong answers.



Astronomy 1 – Fall 2019

REVIEW OF LECTURE 1

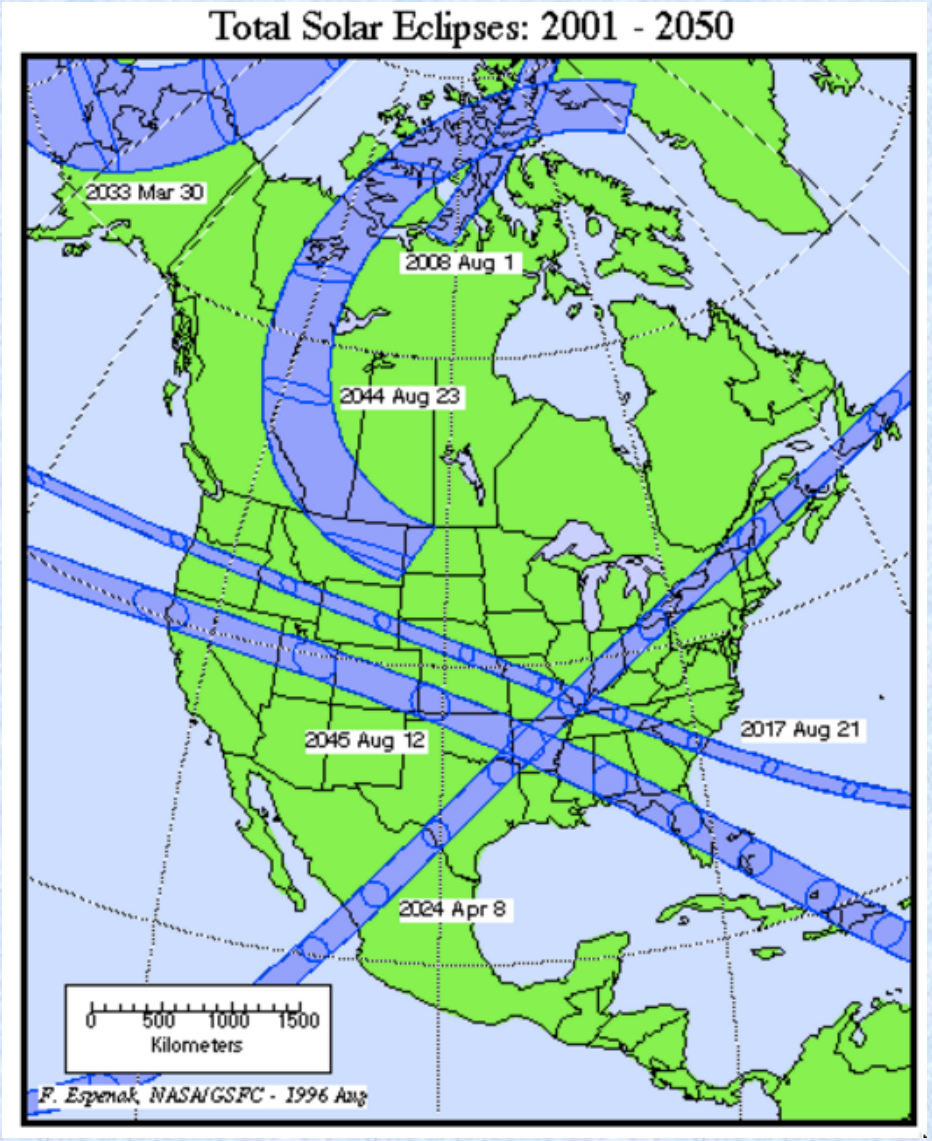
- Science is falsifiable and repeatable..
- Reviewed some scientific language
  - Powers of ten
  - Difference between dimensions and units
  - Small Angle Formula

HOMEWORK

- HW #1 solutions are posted on course webpage.
- Pick up papers from TA at your section; review solutions.
- Start HW #2; due Friday (4:30pm).

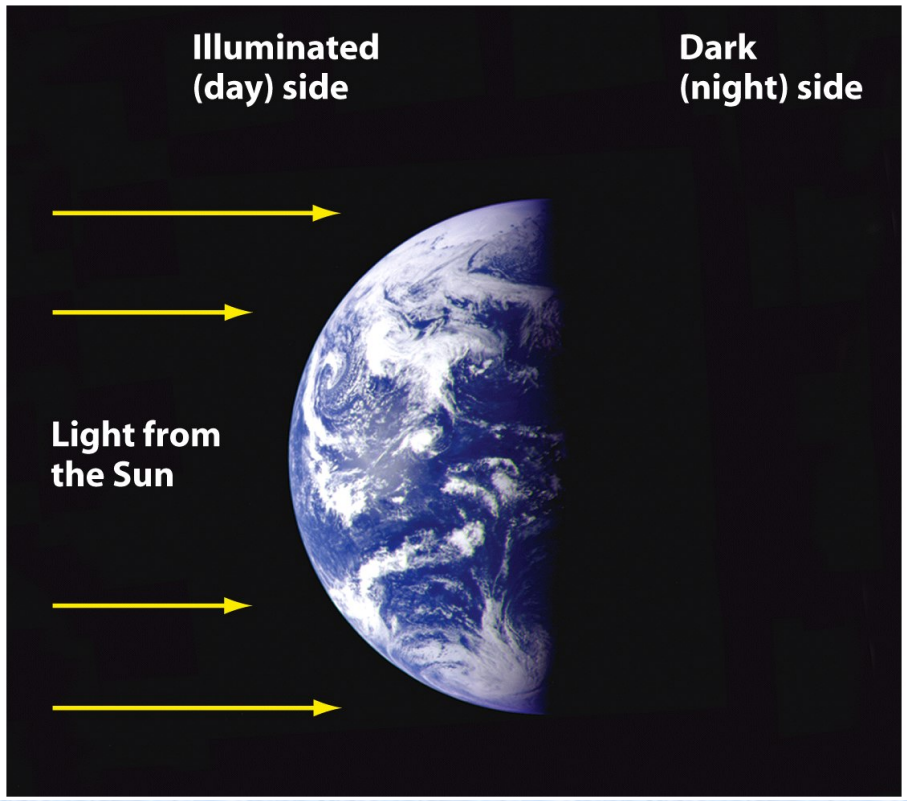
Today on Astro-1

- Earth's Rotation
  - Diurnal motion of stars
  - Moon's rotation
- Earth's Orbit
  - Seasonal motion of stars
  - Defines the ecliptic plane
  - Retrograde motion of planets
- The moon's orbit
  - Lunar eclipses
  - Solar eclipses



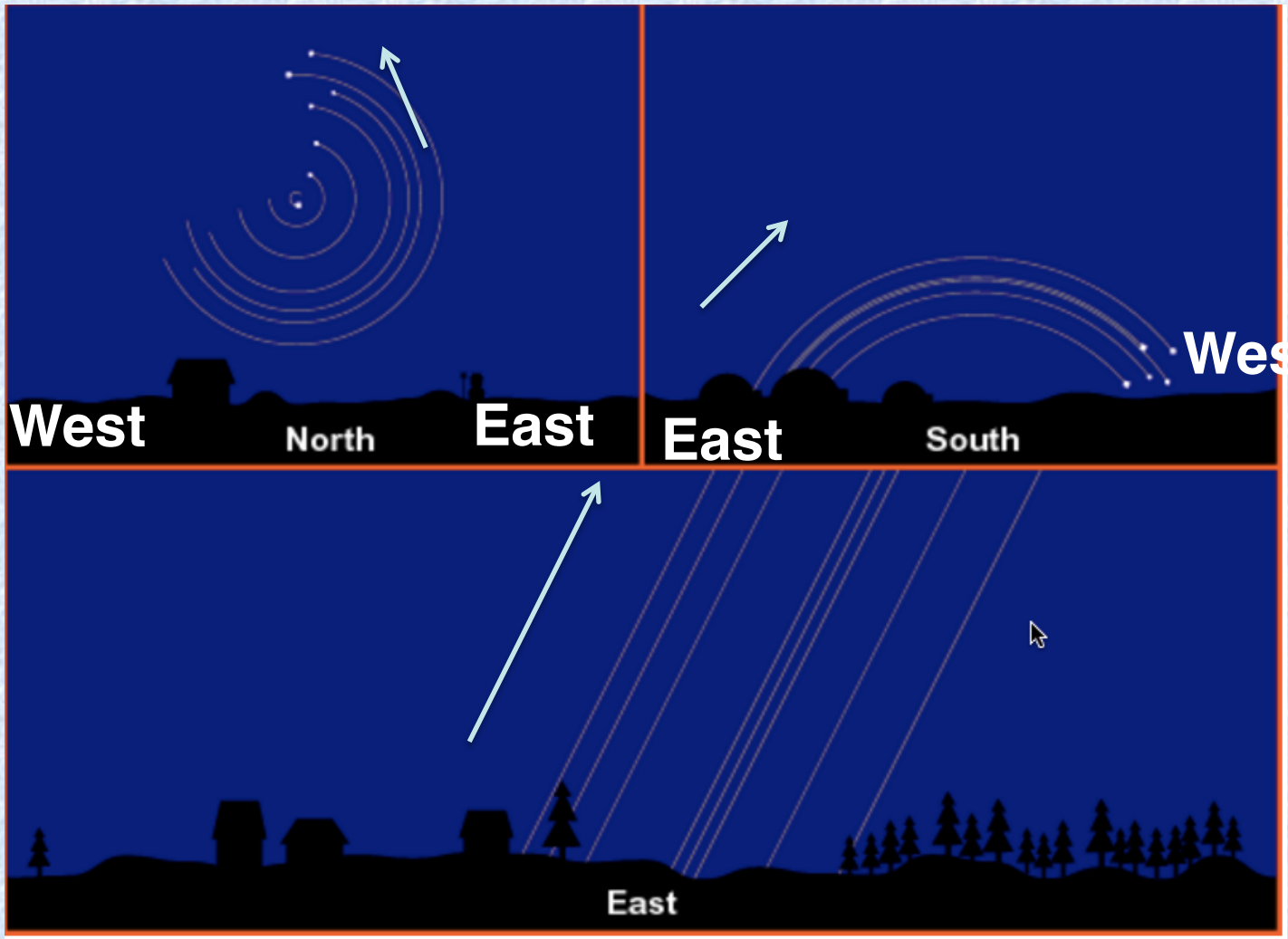
Rotation of Earth and Moon

Daylight Covers Half the Earth

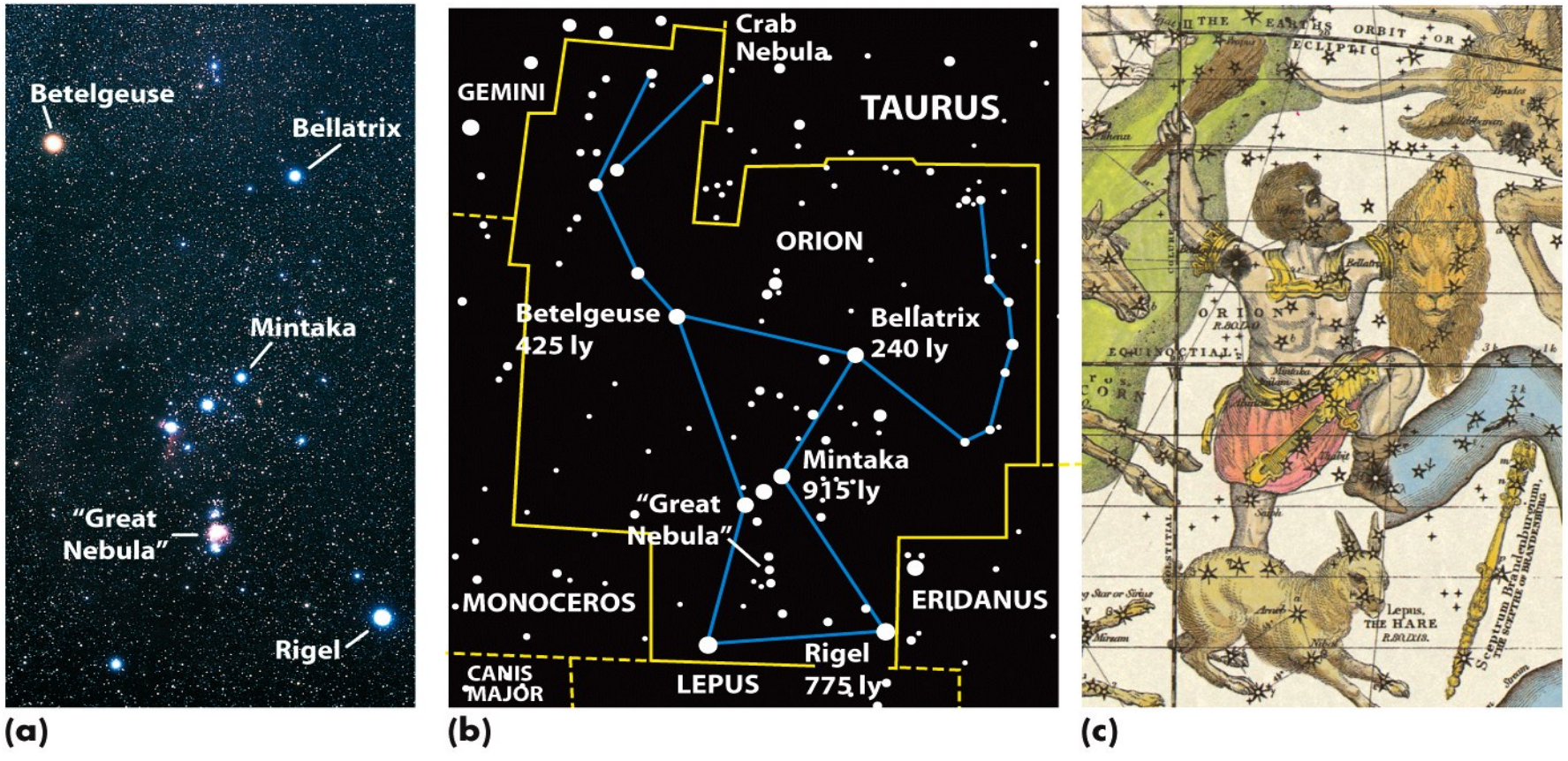


- All the time!
- Picture from Galileo spacecraft in route to Jupiter
- Earth's Rotation (Diurnal Motion) Causes Night & Day
- Earth rotates from west to east
- The dark (night) hemisphere moves into the illuminated (day) hemisphere

Earth's Rotation Causes Stars to Rise and Set During the Night



Constellations: An Ancient Way to Mark Locations on the Celestial Sphere



The sky is divided into 88 constellations, but the stars are at different distances.

Modern Coordinate System

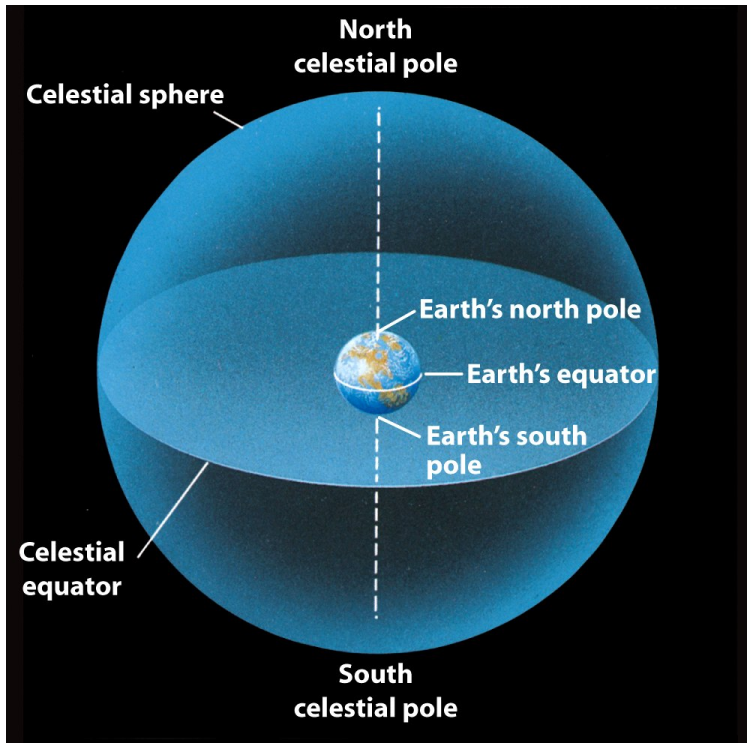
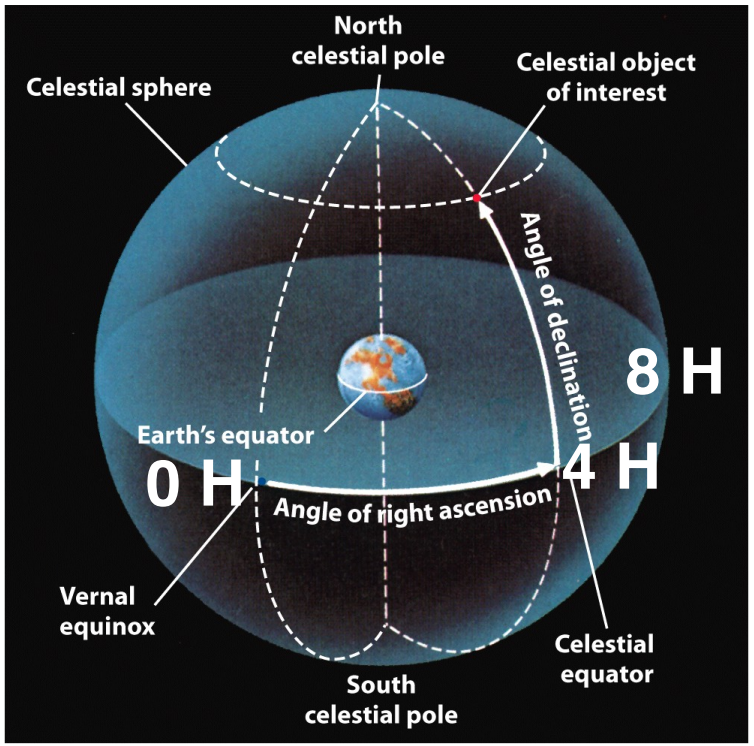


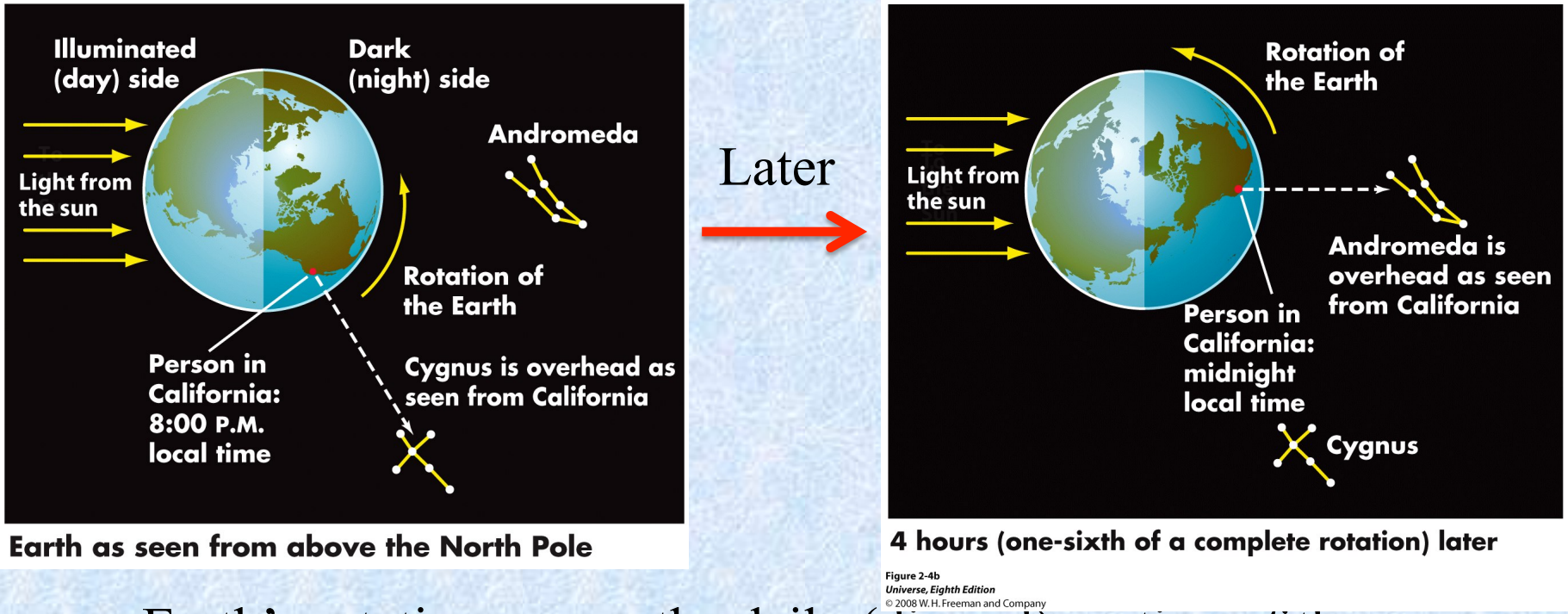
Figure 2-9
Universe, Eighth Edition



Box 2-1
Universe, Tenth Edition

- The celestial equator and poles are projections of the Earth's axis of rotation out into space.
- Astronomers describe the angle of rotation in terms of hours of right ascension (RA) on the sky.
- 1 hour of RA is 15 degrees because earth rotates 360^{o} in 24 hours.

Earth's Rotation Causes Constellations to Rise and Set Every Night



- Earth's rotation causes the daily (diurnal) motion of the stars, Sun, and Moon across the sky.
- How much does the earth rotate in 4 hours?
  [Example: 4 hr / 24 hr × 360° = 60°]
- The entire sky appears to rotate from east to west.

The Moon's Rotation: Daylight Covers Half the Moon

Figure 3-1
Universe, Eighth Edition

- This picture of the Earth and the Moon was taken by the *Galileo* spacecraft on its way toward Jupiter.
- The moon rotates in a special way.
- It spins around exactly once per orbit, so we never see the **far side** of the moon.

Moon's Rotation

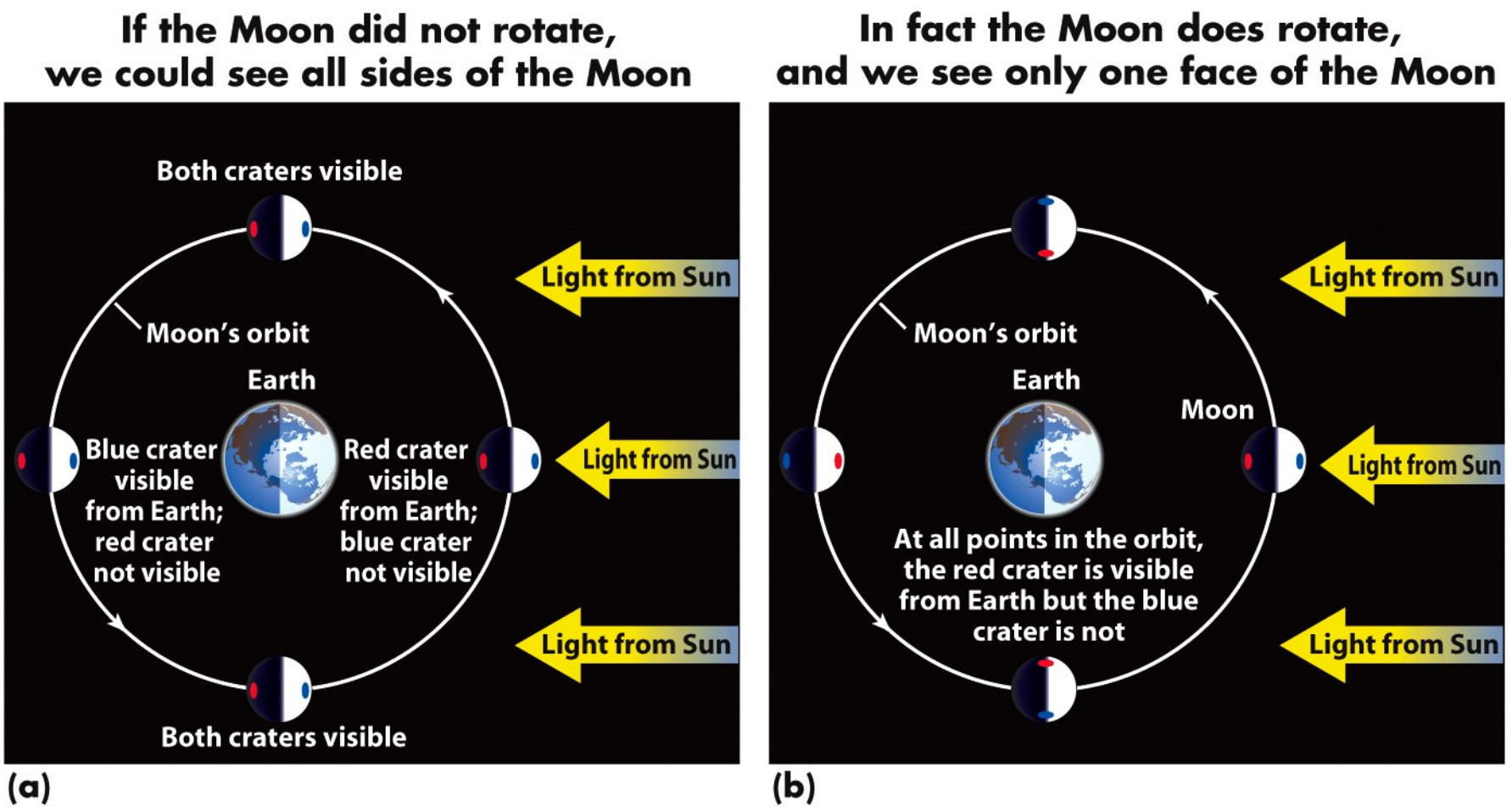


Figure 3-4
Universe, Eighth Edition

iclicker Question

At the time in the diagram, where in the sky would you look for the constellation Cygnus?

A. Directly overhead

B. Towards the east

C. Towards the west

D. Cygnus is below the horizon.

E. I have no idea; please explain.

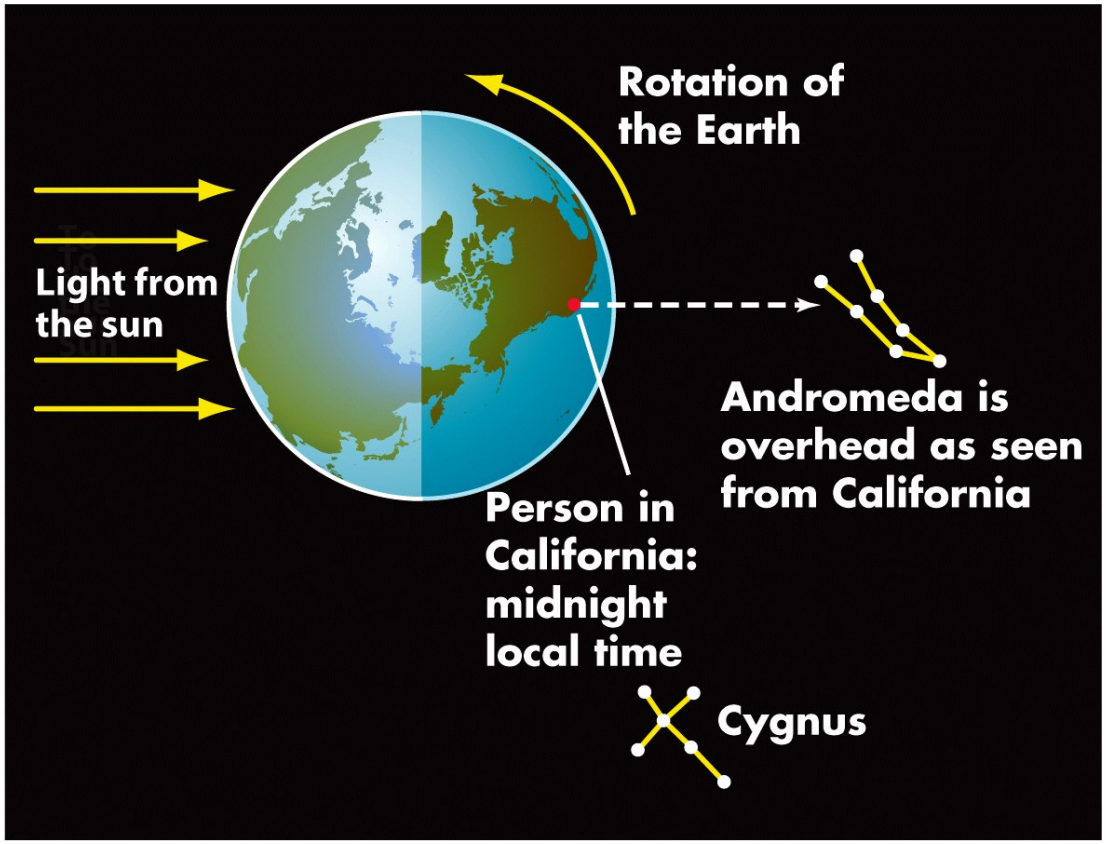


Figure 2-4b
Universe, Eighth Edition

Iclicker Answer

At the time in the diagram, where in the sky would you look for the constellation Cygnus?

A. Directly overhead

B. Towards the east

C. Towards the west

D. Cygnus is below the horizon.

E. I have no idea; please explain.

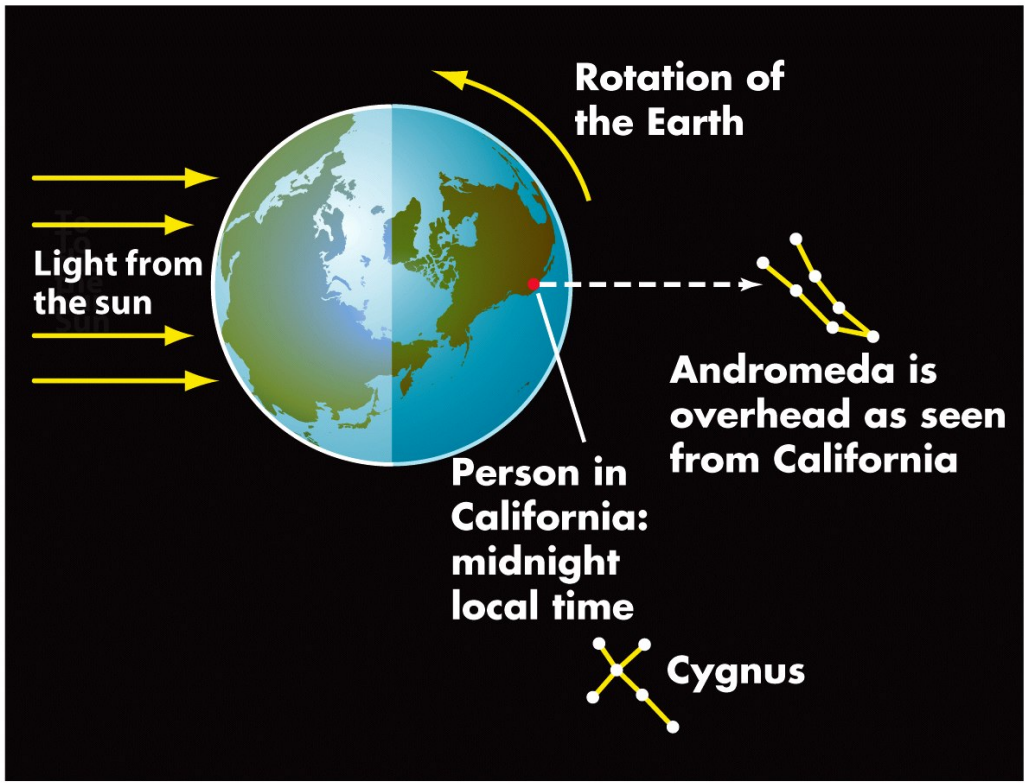


Figure 2-4b
Universe, Eighth Edition

iclicker Question

When is the far side of the moon dark?

A. All the time.

B. Never.

C. For a few days before and after new moon.

D. During a lunar eclipse.

E. During the week before and the week after full moon.

iclicker Question

When is the far side of the moon dark?

A. All the time.

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Orbits of Earth and Moon

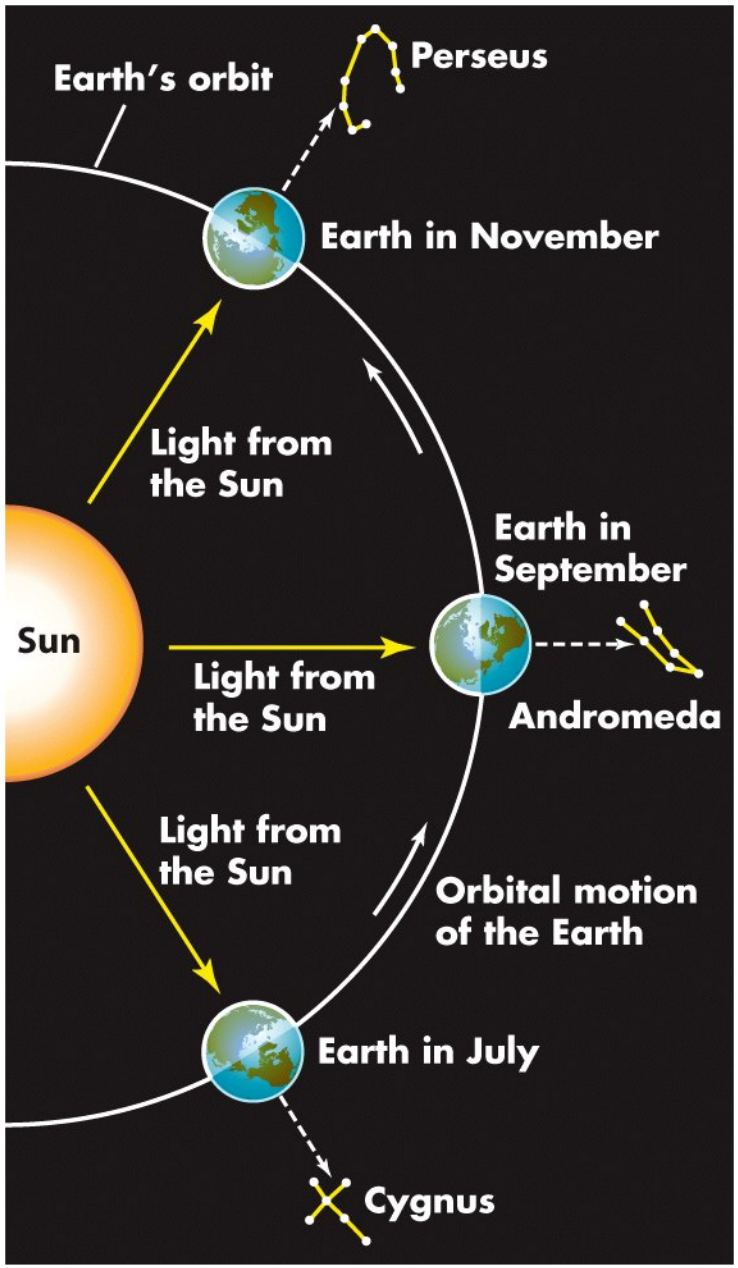


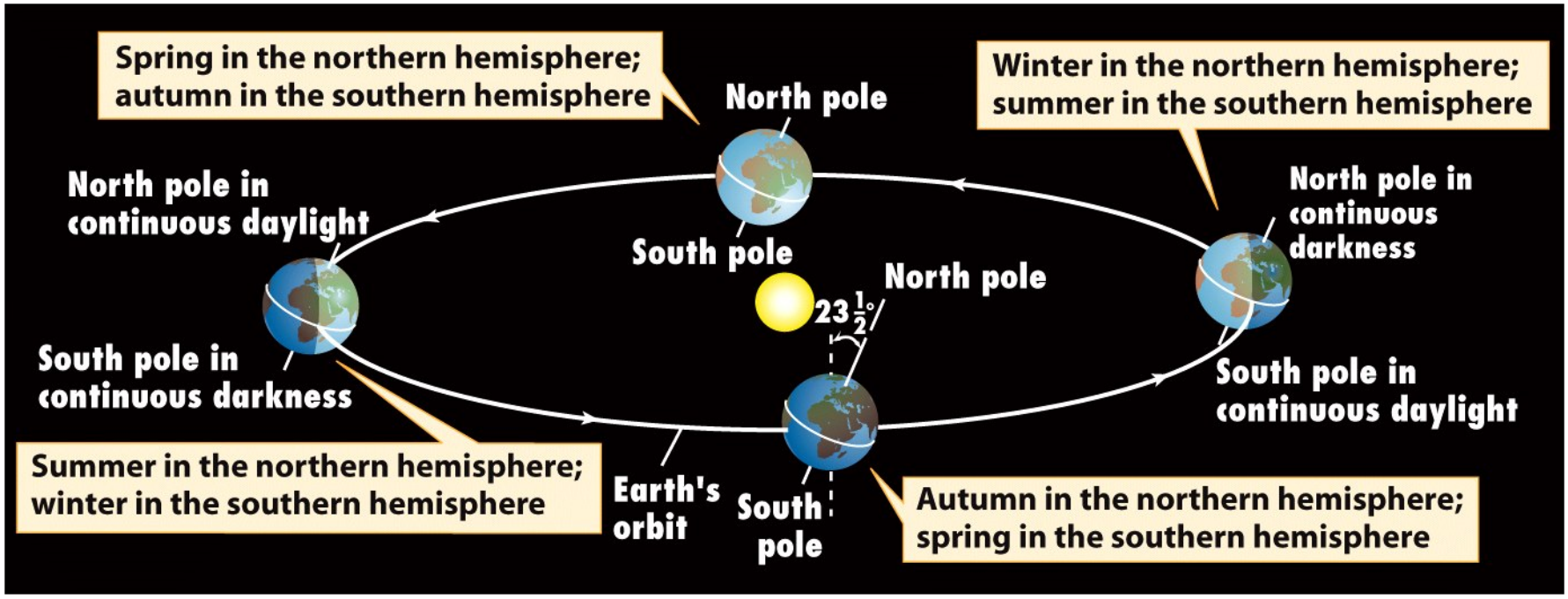
Figure 2-5
Universe, Eighth Edition

Earth's Orbit

- The night sky changes during the year.
- The earth moves [360^o / 12 = 30^o] around the Sun each month.
- The part of the star chart visible shifts by 2 hours of right ascension each month [24 hours / 12 months = 2 hours per month].
- The cycle repeats each year.

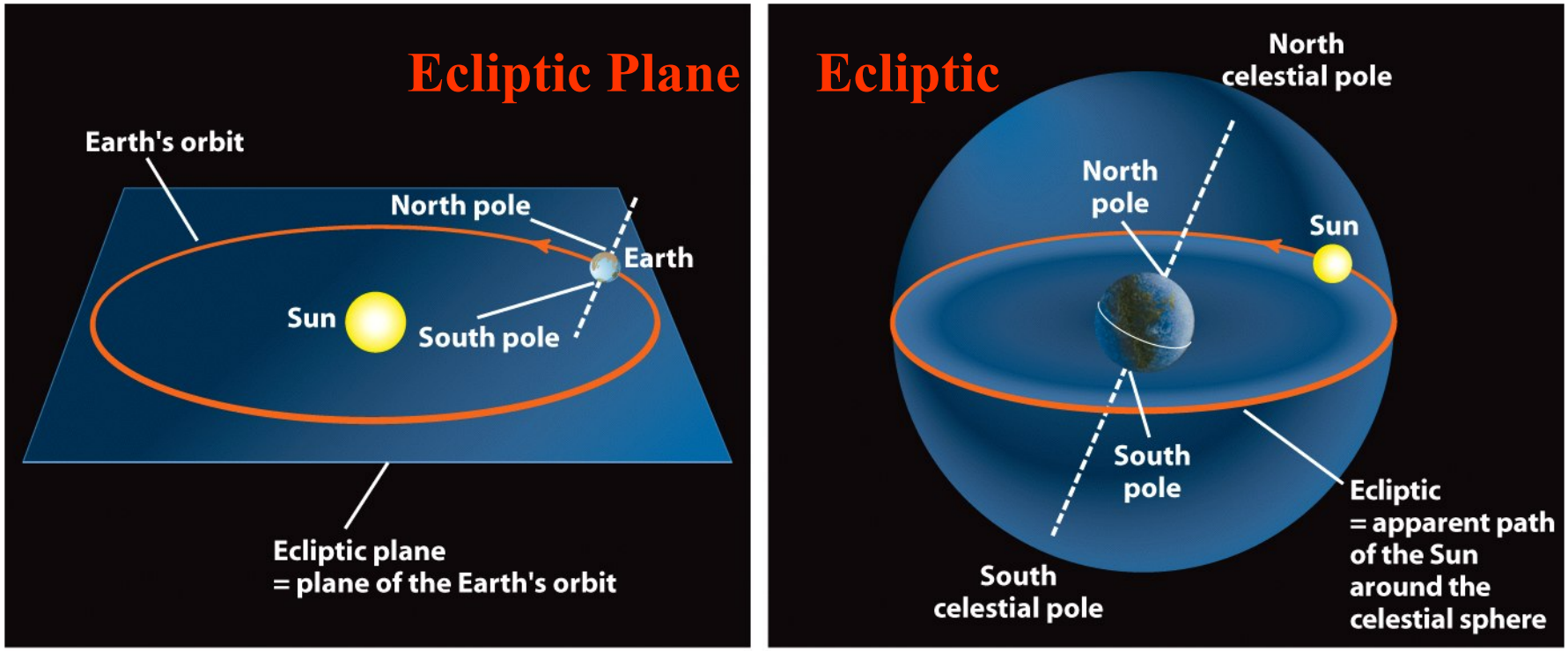
Rotation Axis ≠ Orbital Axis

23.5 Degree Tilt



FUN FACTS: All the planets orbit in the same plane. Most of them have a rotation axis that is nearly aligned with the orbital axis. Uranus is the biggest exception. **Why?**

Earth's Orbit Defines the Ecliptic Plane

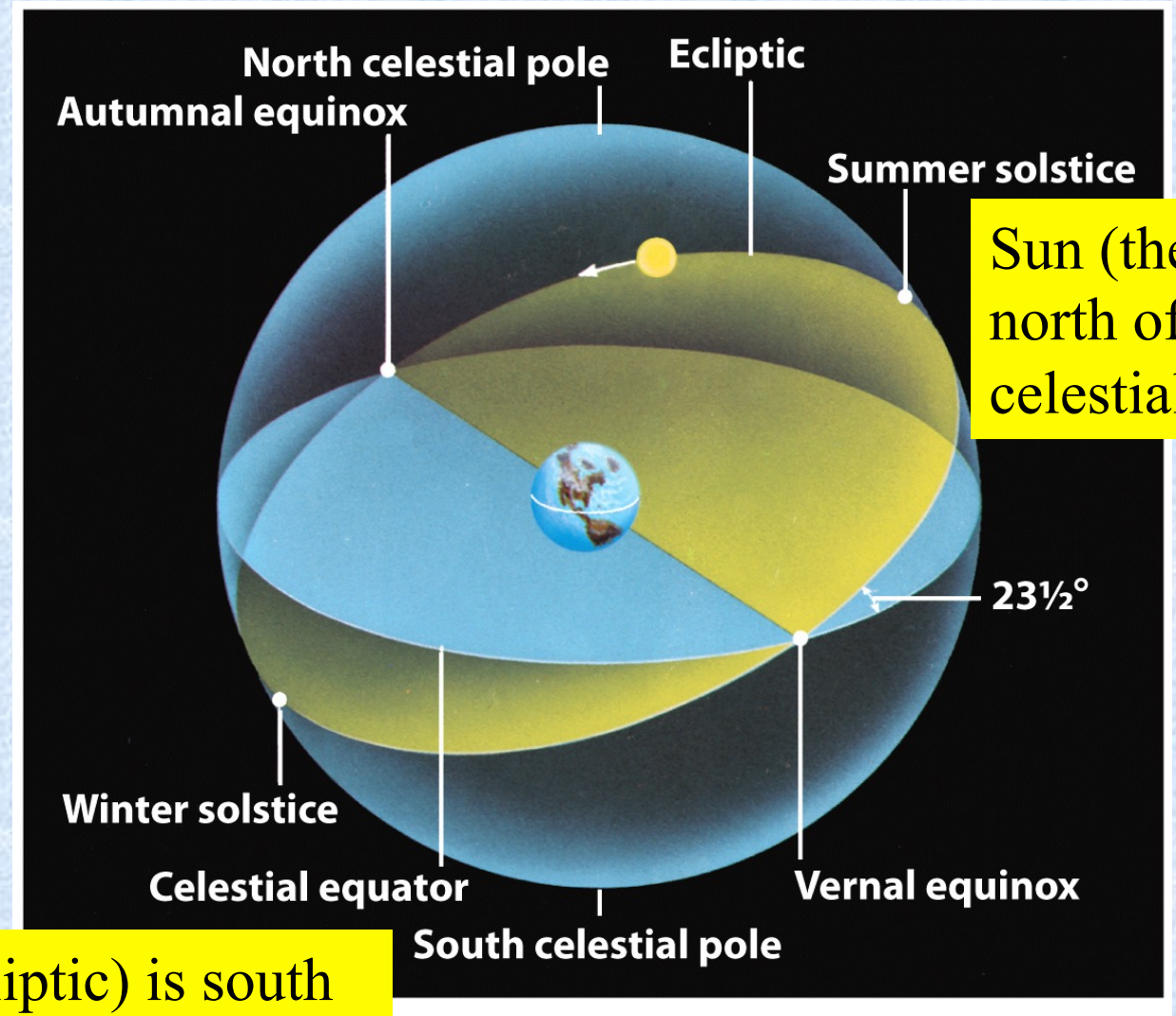


(a) In reality the Earth orbits the Sun once a year

(b) It appears to us that the Sun travels around the celestial sphere once a year

- As seen from the Earth, the Sun appears to move around the celestial sphere along a circular path called the ecliptic.
- Ecliptic plane and the ecliptic: just a matter of perspective

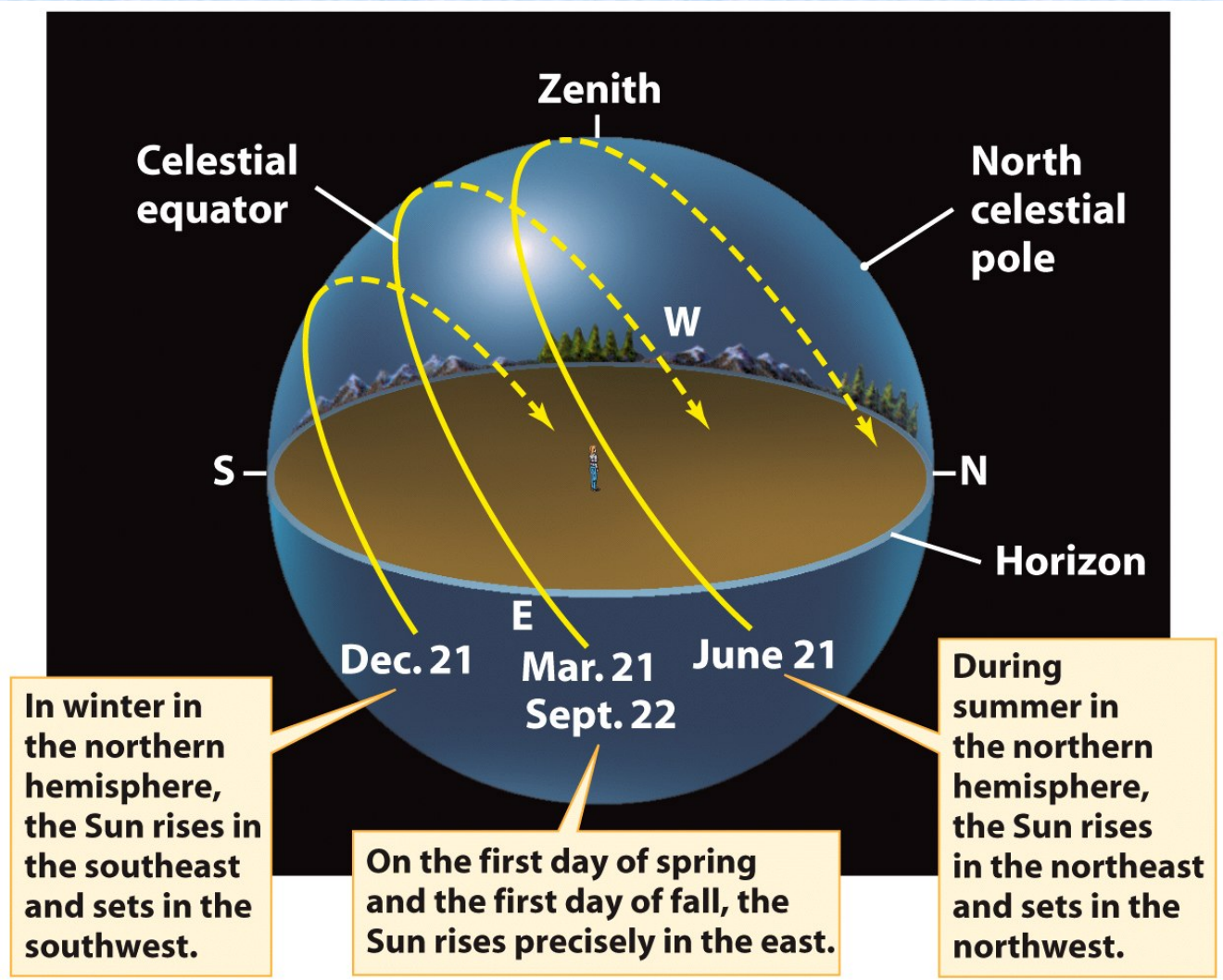
Ecliptic on the Celestial Sphere



Sun (the ecliptic) is north of the celestial equator.

Sun (the ecliptic) is south of the celestial equator.

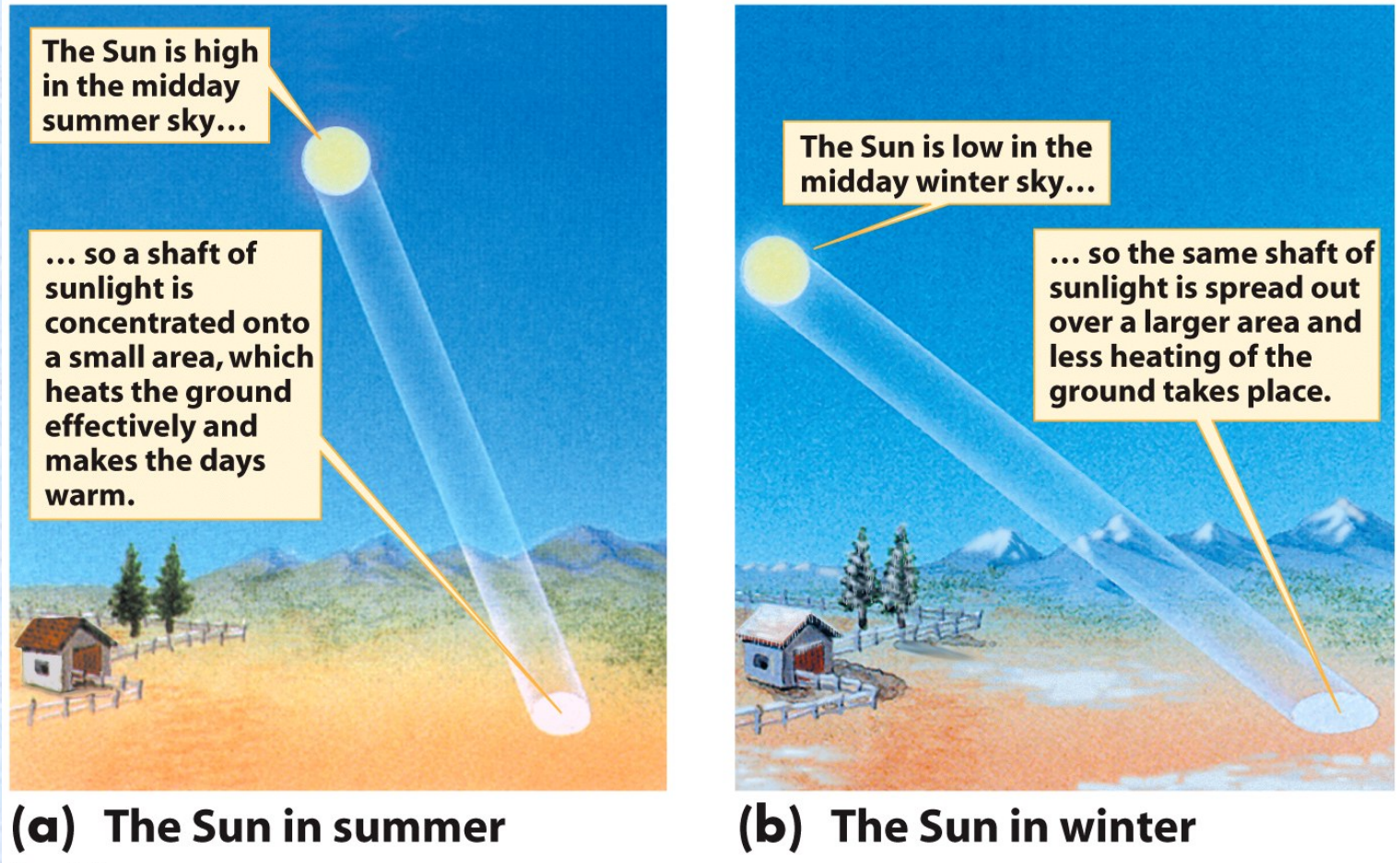
Sun's Diurnal Motion & Seasons



Why the Tilt Causes Seasons

Sun (the ecliptic) is north of the celestial equator.

Sun (the ecliptic) is south of the celestial equator.



(a) The Sun in summer

(b) The Sun in winter

Planets Move Along the Ecliptic

- Their position relative to the stars changes because they are much closer (AU scales vs. light year scales) and because they are moving.
- Direct motion ➔ Planet moves from West to East relative to stars.
- But sometimes the motion of planets is "retrograde", or East to West.
- We will learn why in the next lecture!

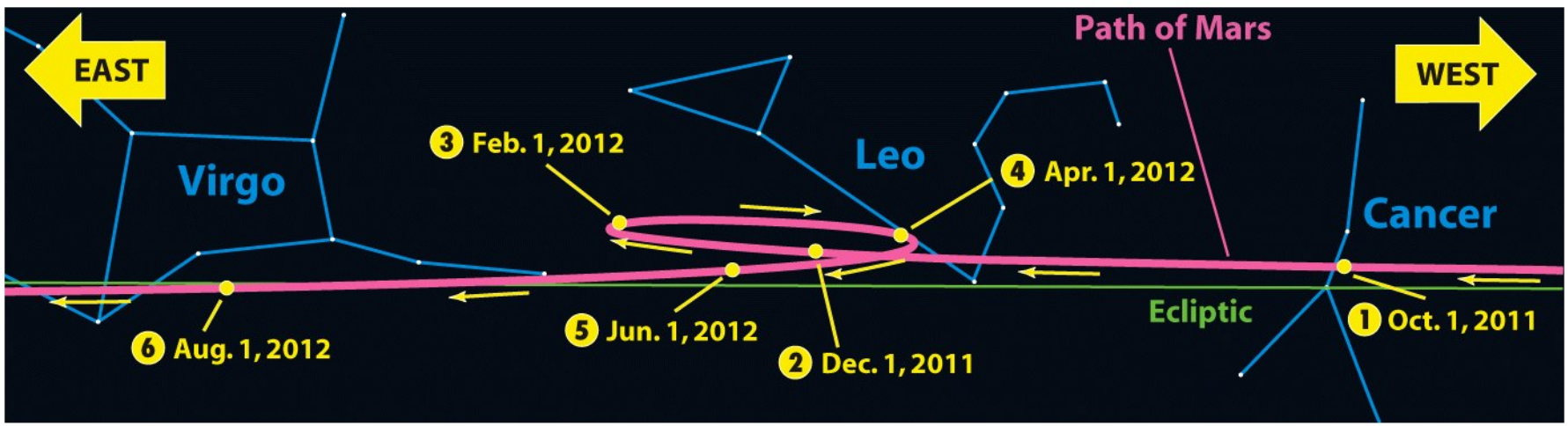


Figure 4-2
Universe, Eighth Edition

Find Venus and Mercury Near the Horizon

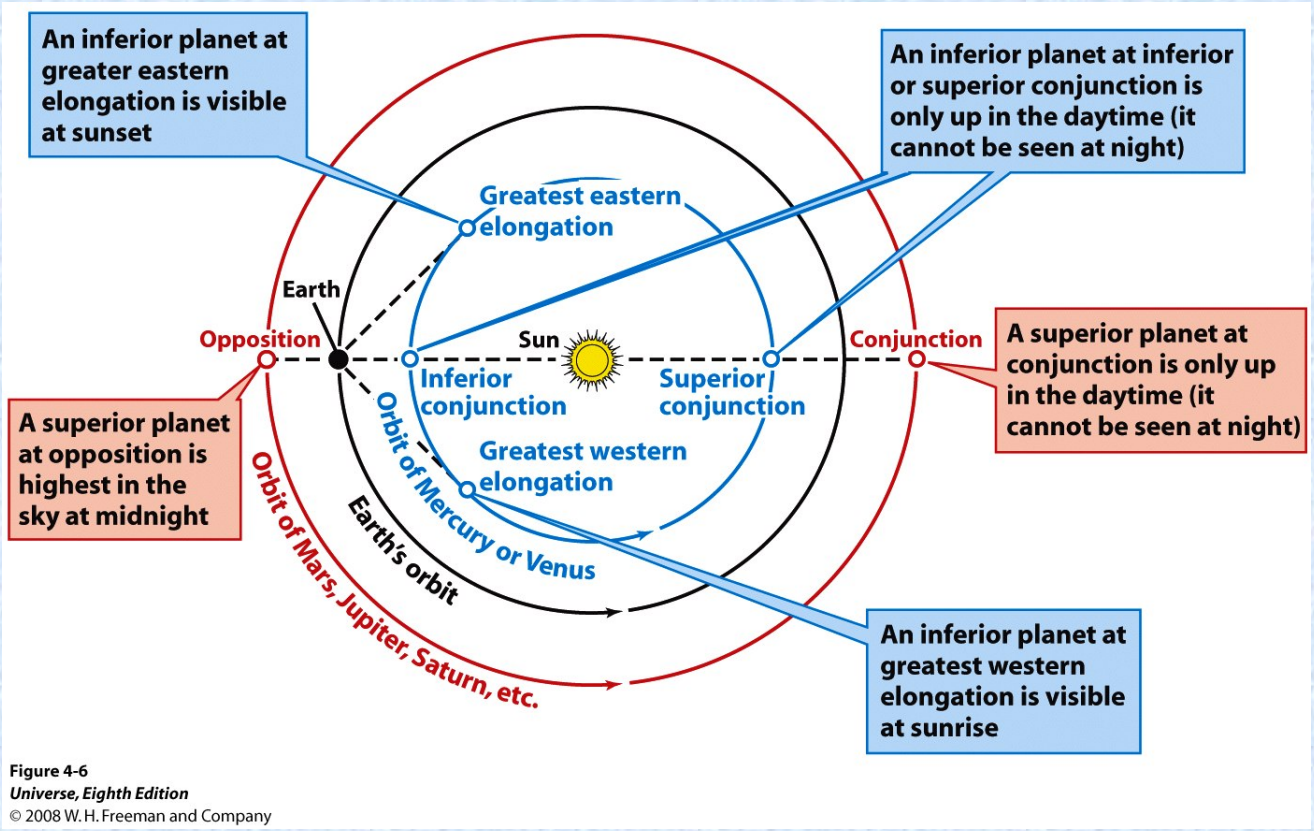
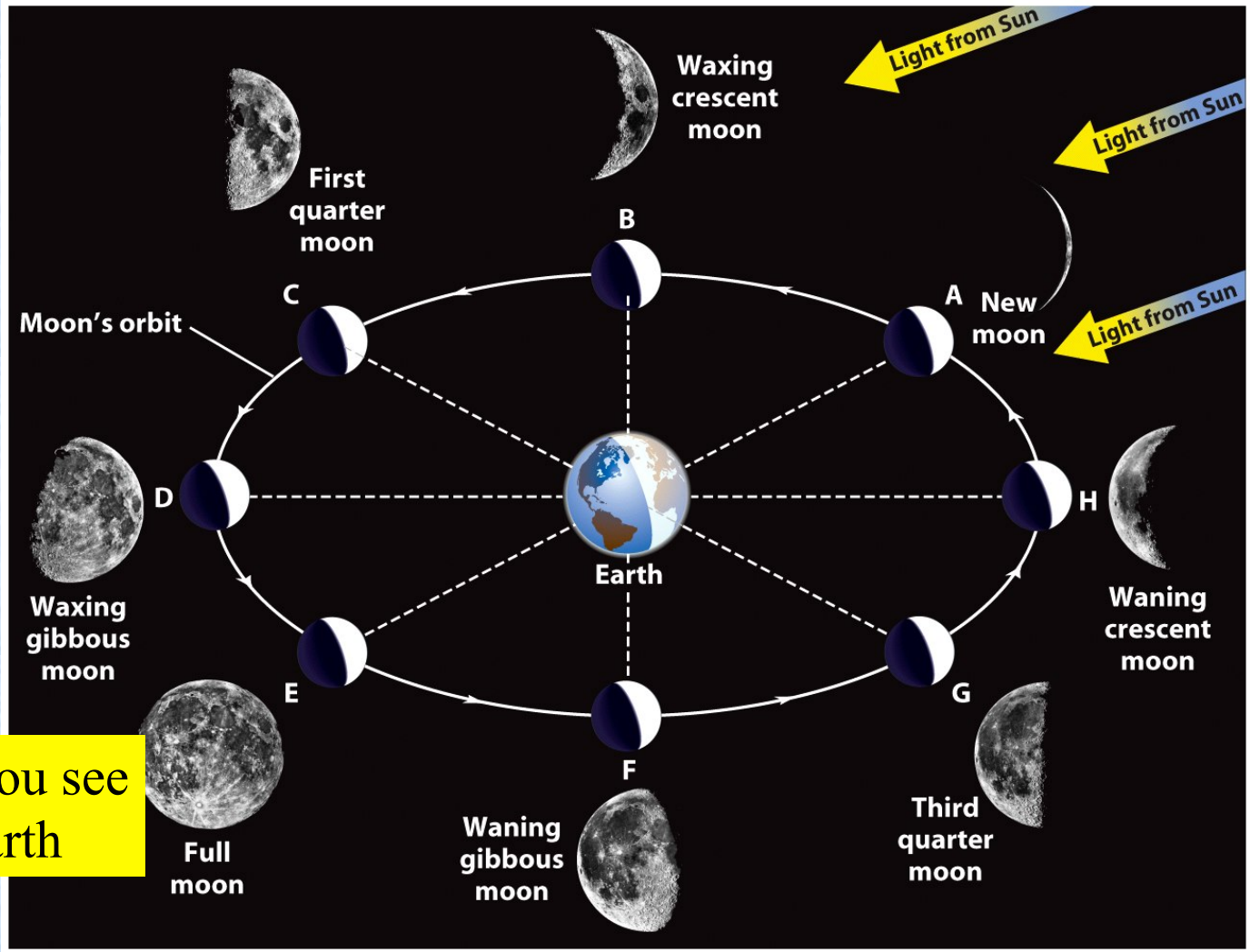


Figure 4-6
Universe, Eighth Edition

Maximum greatest elongation for Venus is 45°, and for Mercury 28°, so they can never be farther than that from the sun.

The Moon's Orbit & Lunar Phases



What you see from earth

Figure 3-2
Universe, Eighth Edition

How Long is a Month?

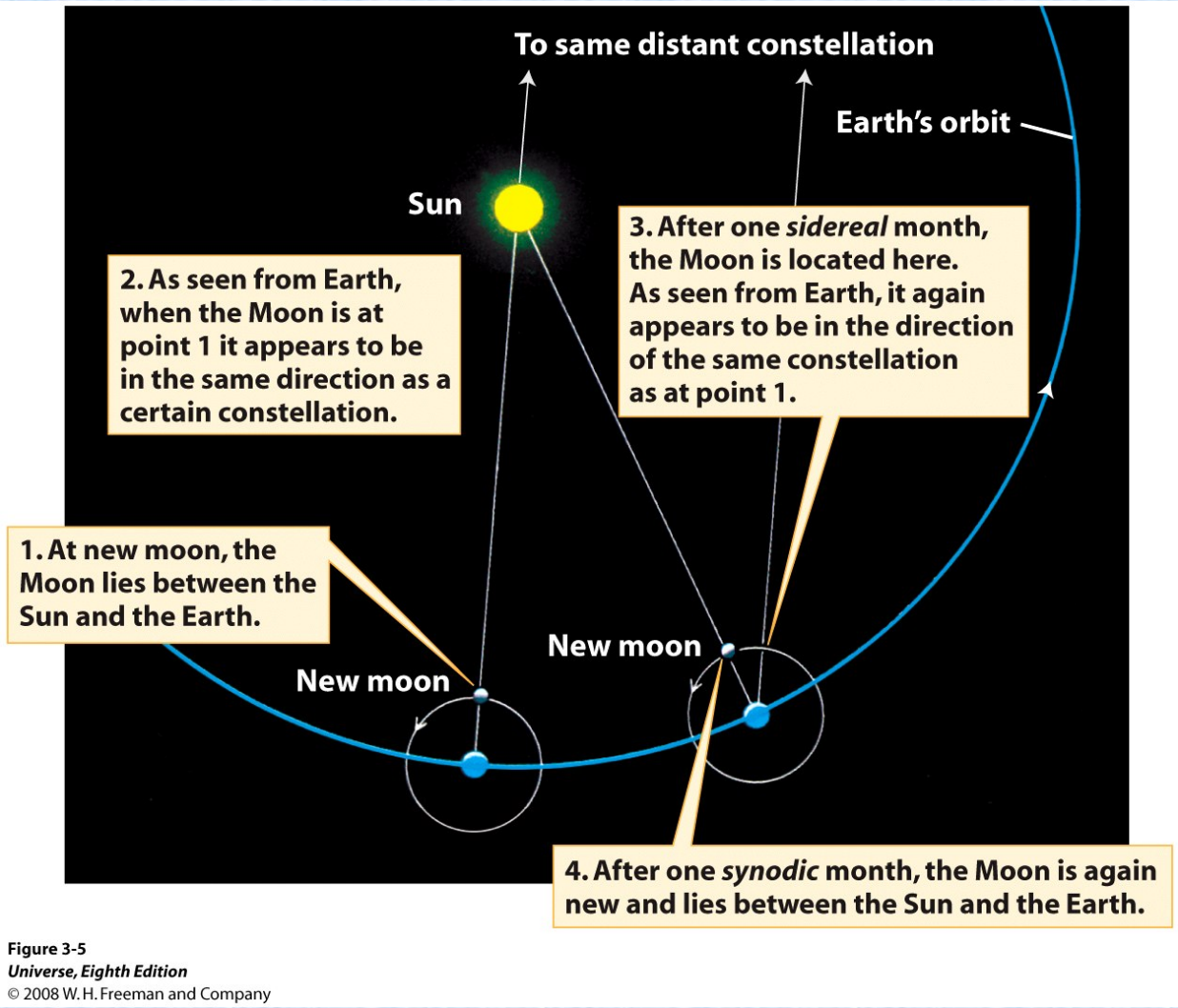


Figure 3-5
Universe, Eighth Edition

Sidereal month: the time the Moon takes to complete one full revolution around the Earth with respect to the background stars: 27.32 days

Synodic (lunar) month: Time from one new moon to the next: 29½ days.

Tilt of Moon's Orbit

- We call the intersection of the two orbital planes the line of nodes.
- This 5 degree tilt makes eclipses rare.

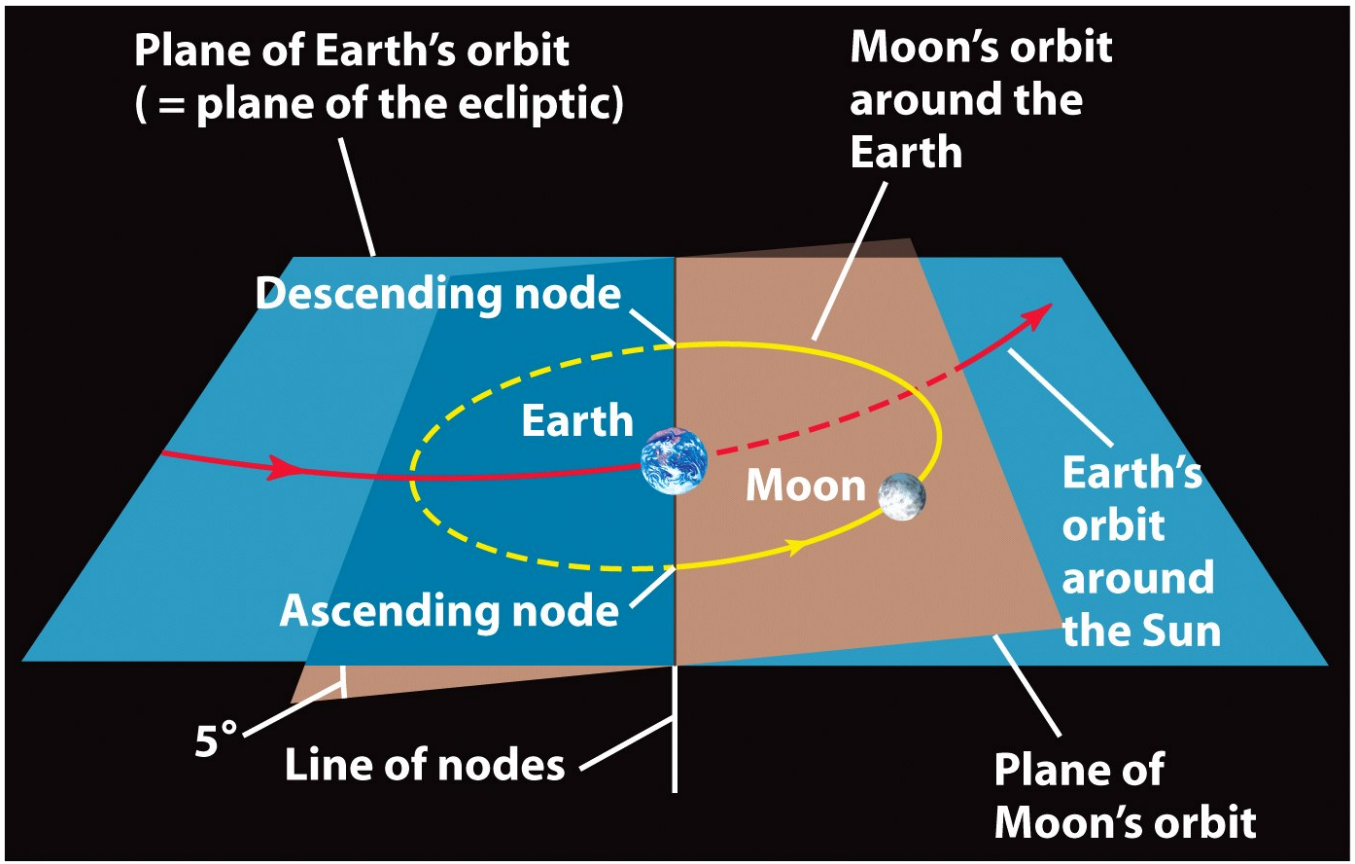


Figure 3-6
Universe, Eighth Edition

iclicker Question

The Santa Barbara coastline faces south. When does the Sun set over the ocean in Santa Barbara?

A. Never because the Sun always sets in the west.

B. In the winter because the ecliptic is south of the celestial equator.

C. In the winter because the ecliptic is north of the celestial equator.

D. In the summer because the ecliptic is north of the celestial equator.

E. In the summer because the ecliptic is south of the celestial equator.

Iclicker Answer

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E. In the summer because the ecliptic is south of the celestial equator.

iclicker Question

Which phases of the moon can you see in the morning sky?

A. Waxing crescent moon

B. Waning crescent moon

C. Third quarter moon

D. Waning gibbous moon

E. Waning crescent, third quarter, and waning gibbous moons

Figure 3-3
Universe, Eighth Edition

Iclicker Answer

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D. Waning gibbous moon

E. Waning crescent, third quarter, and waning gibbous moons

Figure 3-3
Universe, Eighth Edition

iclicker Question

You see a very bright planet at midnight. Is it Venus?

Assume Venus is 45^{o} from the Sun at greatest eastern elongation.

A. Venus will set 45 minutes after sunset. It cannot be seen at midnight.

B. Venus will rise 45 minutes before sunrise. It cannot be seen at midnight.

C. Venus will set 3 hours after sunset. It cannot be seen at midnight.

D. Yes, Venus is visible all night at greatest eastern elongation.

E. Venus will set 3 hours before sunrise. It cannot be seen at midnight.

Note: You know the bright object is a planet because the object does not twinkle like stars do.

Iclicker Answer

You see a very bright planet at midnight. Is it Venus?

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Note: You know the bright object is a planet because the object does not twinkle like stars do.

Eclipses

Conditions Required for Eclipses

Sun, Earth, and Moon lie along a straight line.
(This requires Sun and Moon to be on the line of nodes.)

- We get a solar eclipse if the moon is new.
- We get a lunar eclipse if the moon is full.

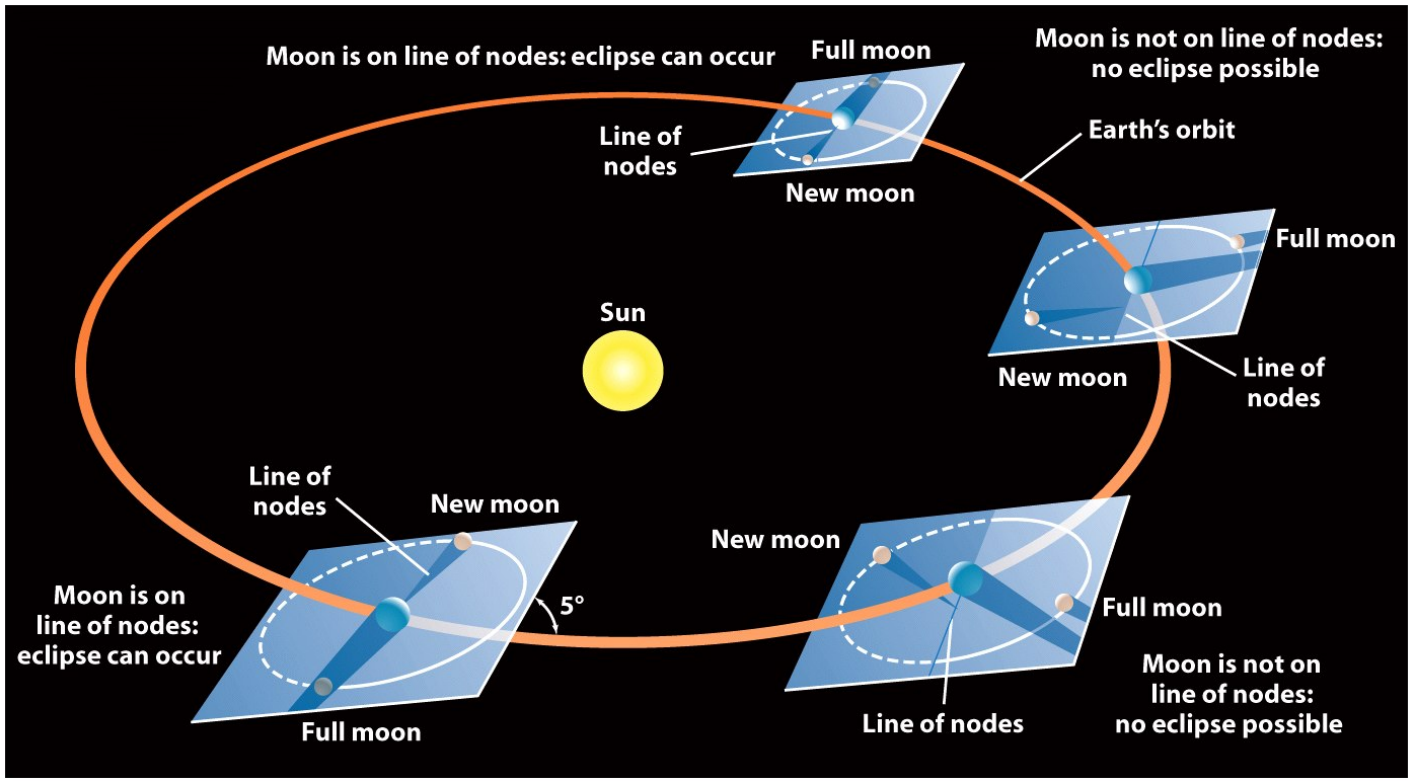

Figure 3-7
Universe, Eighth Edition

Lunar Eclipse

- Moon is in the shadow of the Earth.
- The Moon takes 3 hours to move through the Earth's umbra.

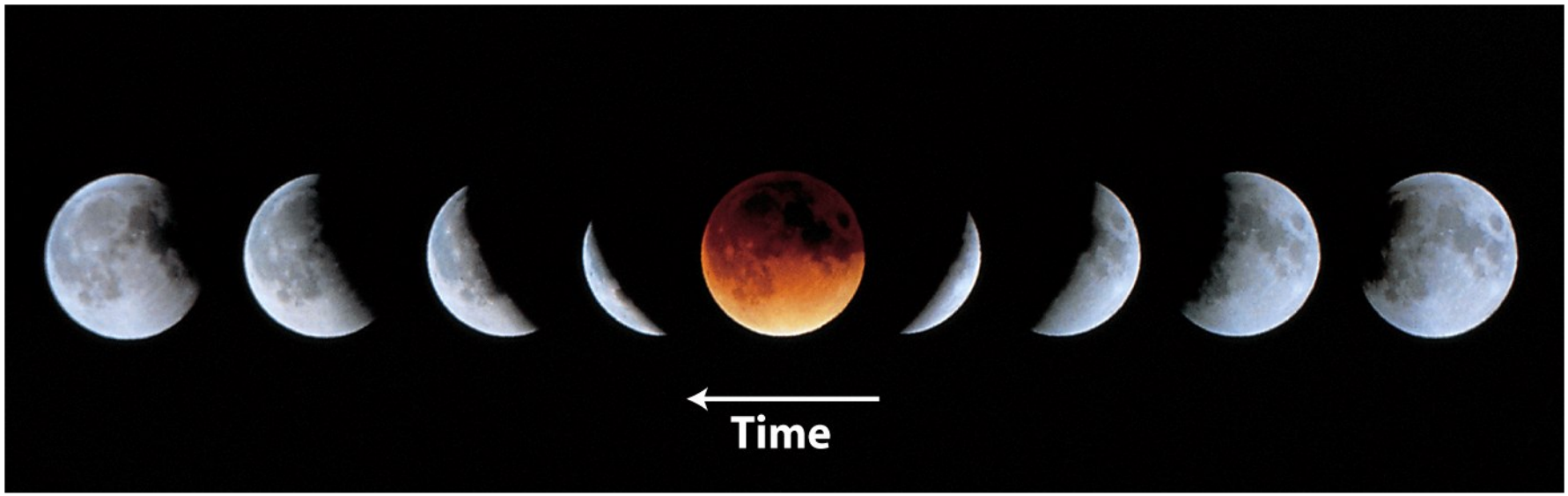

Figure 3-9
Universe, Eighth Edition

Lunar eclipse: three types

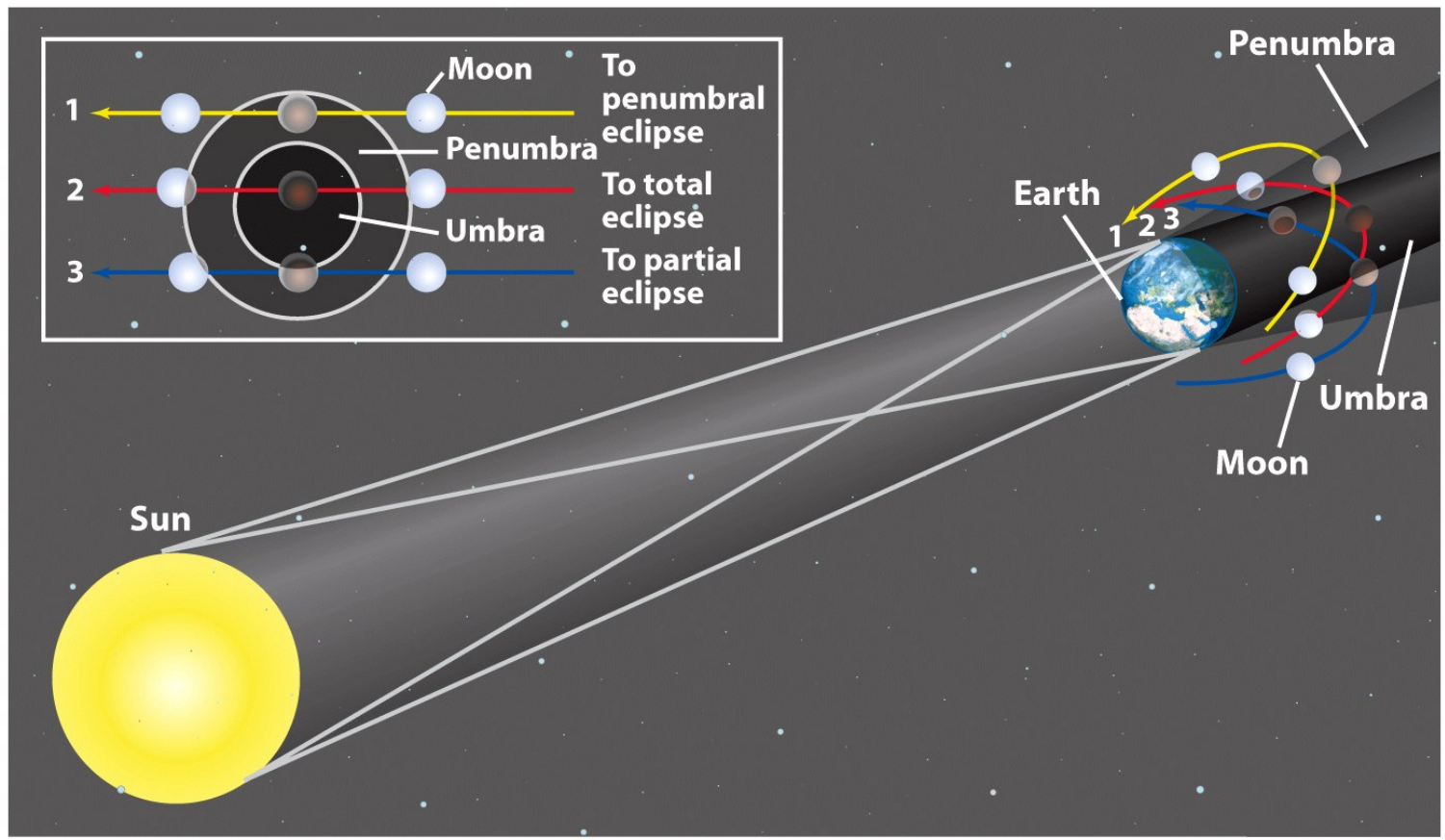

Figure 3-8
Universe, Eighth Edition

Solar Eclipses

- The Moon passes in front of the Sun.
- The Moon's shadow sweeps across the Earth.
- During a total solar eclipse, you can see the solar corona.
- When does an annular eclipse occur?

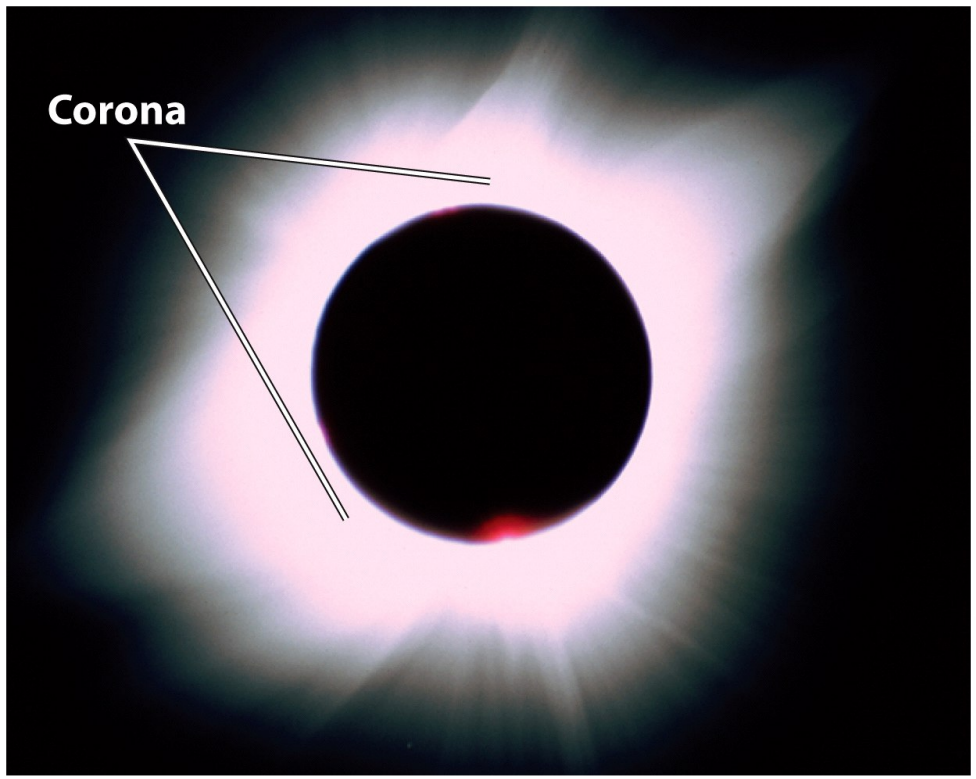

Figure 3-10b
Universe, Eighth Edition

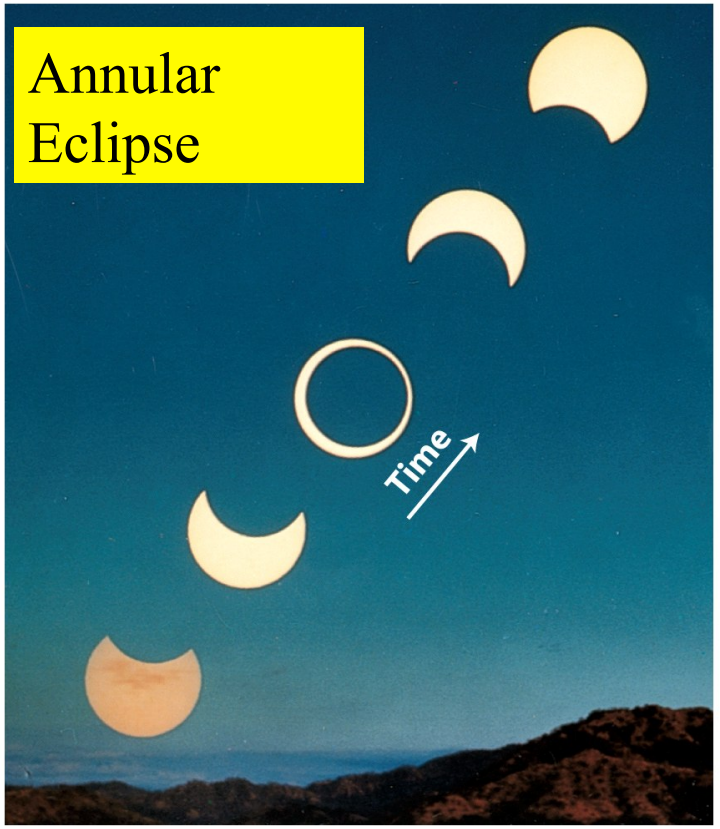

Figure 3-12
Universe, Eighth Edition

Solar Eclipse: Types of Shadows

- Photo from Russian space station Mir (of same eclipse in previous 2 slides).
- People within the umbra see a total solar eclipse.
- Anyone within the penumbra sees only a partial eclipse.

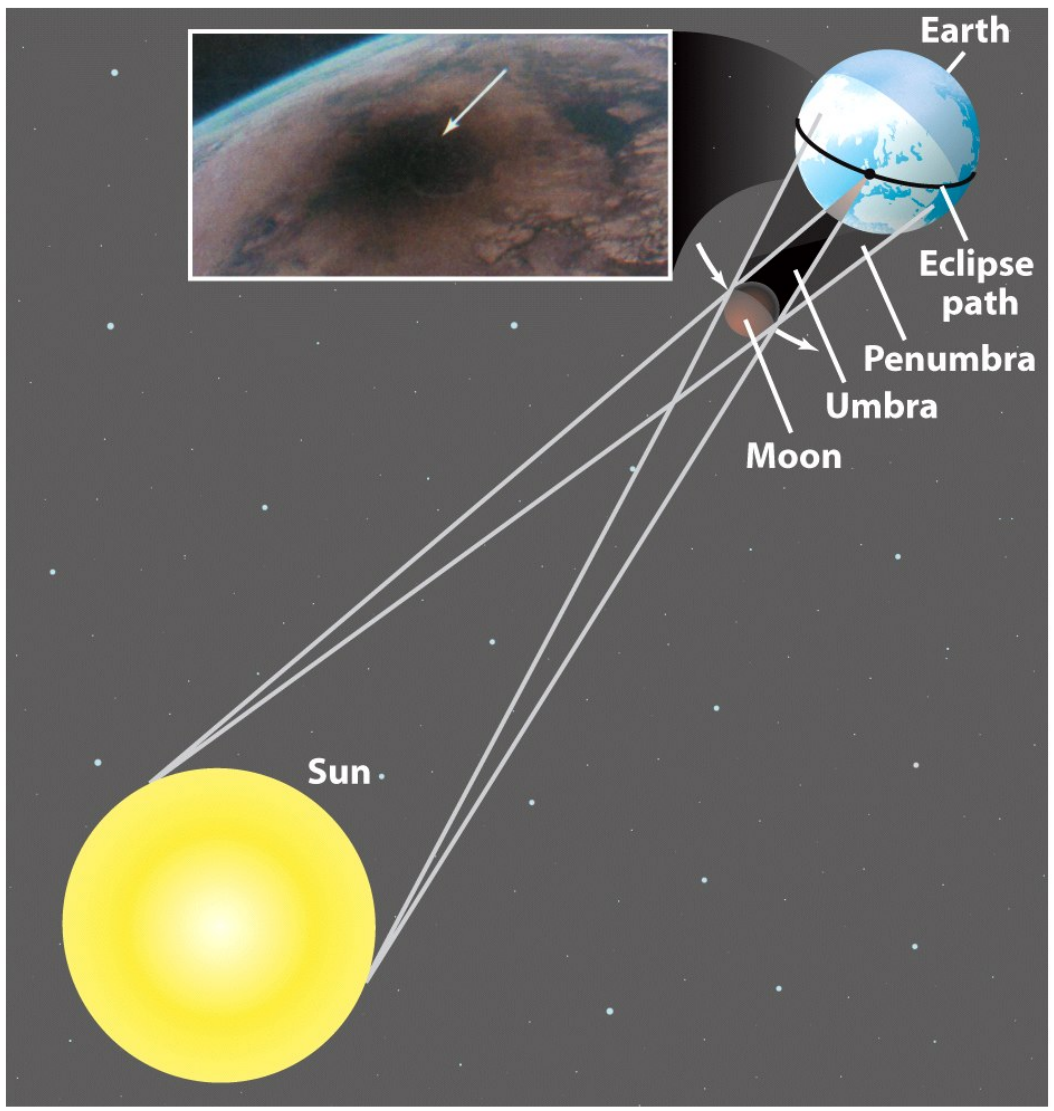

Figure 3-11
Universe, Eighth Edition

Check Yourself

- Know the diurnal motion of stars, Sun, and Moon.
- Know the seasonal motion of stars, Sun, and Moon.
  - Why is it colder in winter?
- Be able to explain why lunar phases arise.
  - How often would an astronaut on the moon see the sun rise?
- Why don't we have eclipses every month?
- What is retrograde motion?

- Practice at Discussion Sections this week!!!
  - Find the ecliptic (and Saturn).
  - Predict what the moon will look like in a week
  - Predict what time of day you'll see the moon in a week