Astr 1050 Mon. Feb. 2, 2015

- **Finish Ch. 3: Discovering the Universe**
  - **Seasons**
  - **Angular Size formula**
  - **Eclipses**
  - **Phases of the moon**

Reading:

For Today: **Begin Chapter 3**

For Friday: **Finish Chapter 3**

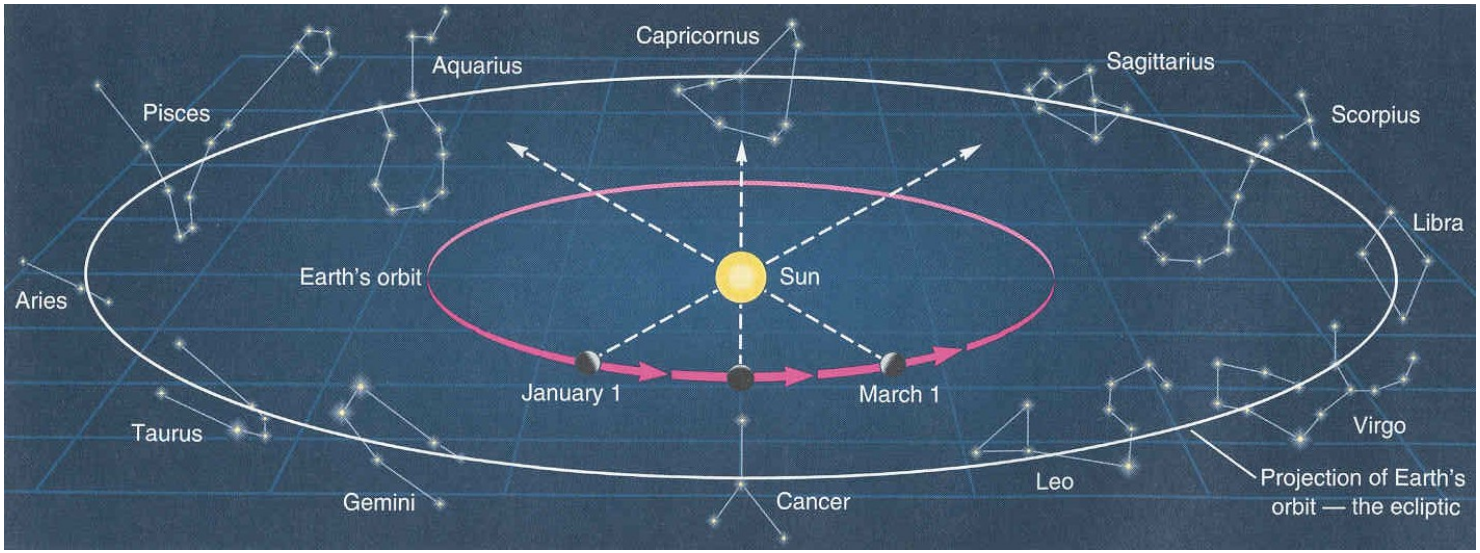
Homework on Mastering Astronomy (Due Next Monday)

Effect of Elliptical Orbit on Climate

- **Seasons almost entirely due to TILT of Earth**
  - **Seasons opposite (not the same) in N & S Hemispheres**
- **Earth's orbit slightly elliptical**
  - **Slightly closer to the sun in N. Hemisphere Winter**
    - **But this changes as tilt precesses in 26,000 yr cycle**
  - **Expect N. Hemisphere winter to be slightly milder**
    - **Positions of continents and oceans actually more important**
    - **Effect is important for Mars -- more elliptical orbit**
- **Cyclic variations in climate as tilt precesses (and tilt and ellipticity also gets slightly larger and smaller**
- **VERY IMPORTANT TOPIC (Re: Global Warming)**

Why are the planets found near the ecliptic?

- The ecliptic is defined by the *plane* of the Earth's orbit
- If the other planets are always found near the ecliptic, they must always be located near the plane of the Earth's orbit – at most slightly above or below it.
  - The planes of their orbits around the sun must almost match the Earth's
  - Their slight motions above and below the ecliptic means the match isn't exact. (Their orbits are slightly tilted relative to ours.)

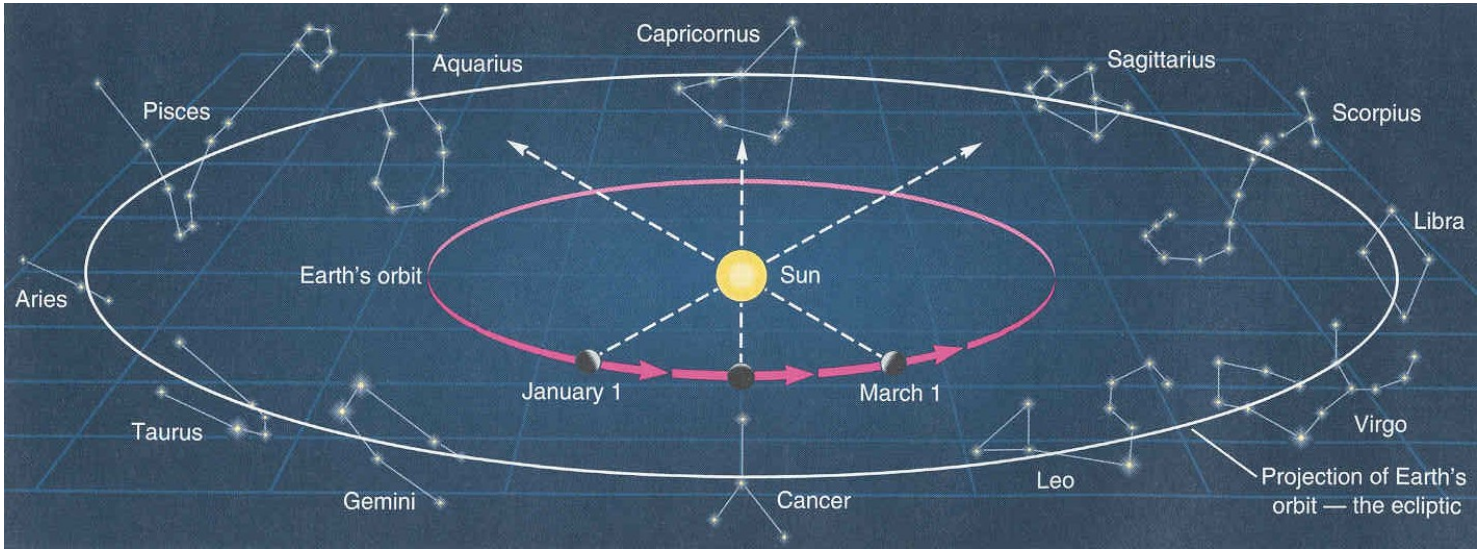


From our text: Horizons, by Seeds

Superior vs. Inferior Planets

•**Superior planets** (Mars, Jupiter, Saturn, Uranus, Neptune, Pluto) have orbits larger than the earth and *can* appear opposite the sun in the sky. They can be up at midnight. Never show phases.

•**Inferior planets** (Mercury, Venus) have orbits smaller than earth and can never appear far from the Sun. They form "morning stars" or "evening stars" visible a little before sunrise or after sunset. Show phases.



From our text: Horizons, by Seeds

Inferior Planets

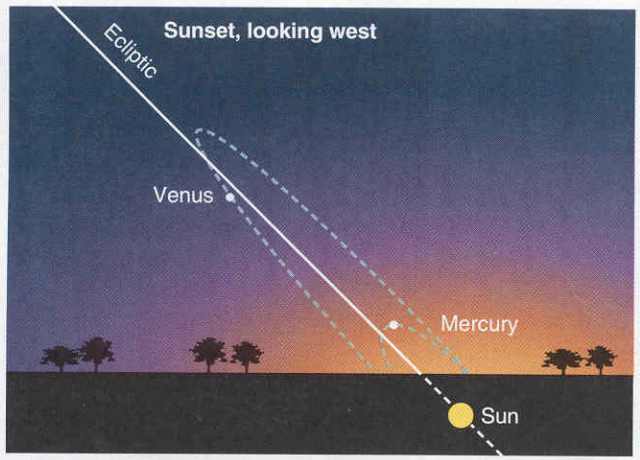
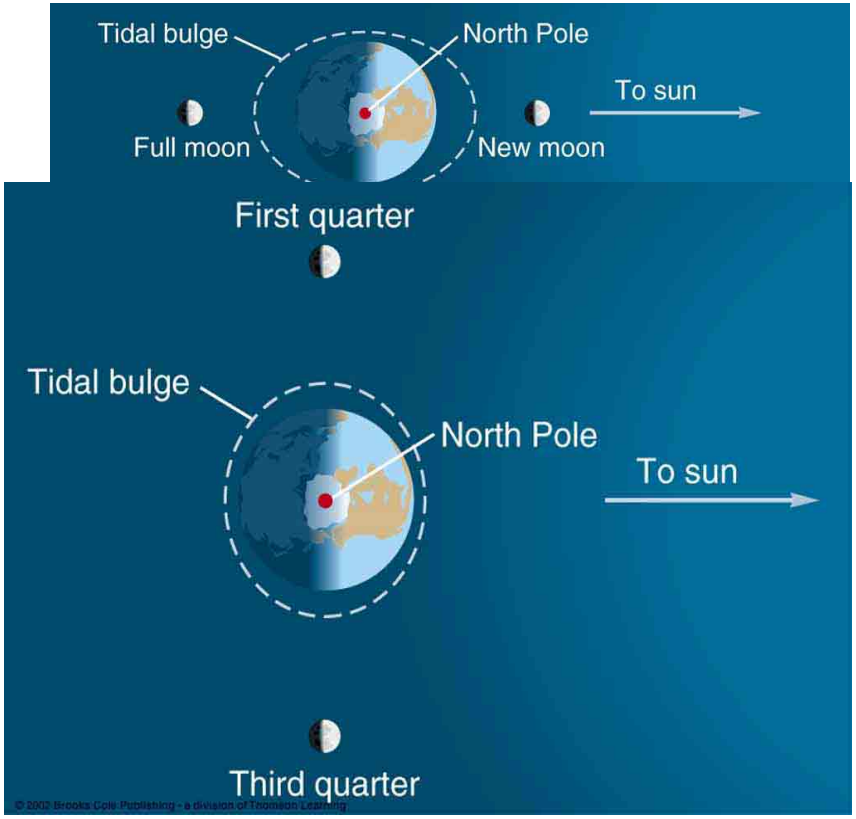


Figure 3-2
Mercury and Venus are sometimes visible in the western sky just after sunset (a) or in the eastern sky just before sunrise (b).

- **Inferior planets (Mercury, Venus) have orbits smaller than earth and can never appear far from the Sun. They form "morning stars" or "evening stars" visible a little before sunrise or after sunset.**

From our text: Horizons, by Seeds

Lunar/Solar Tides (exaggerated!)



What are tides? More complex than what you see on Baywatch!

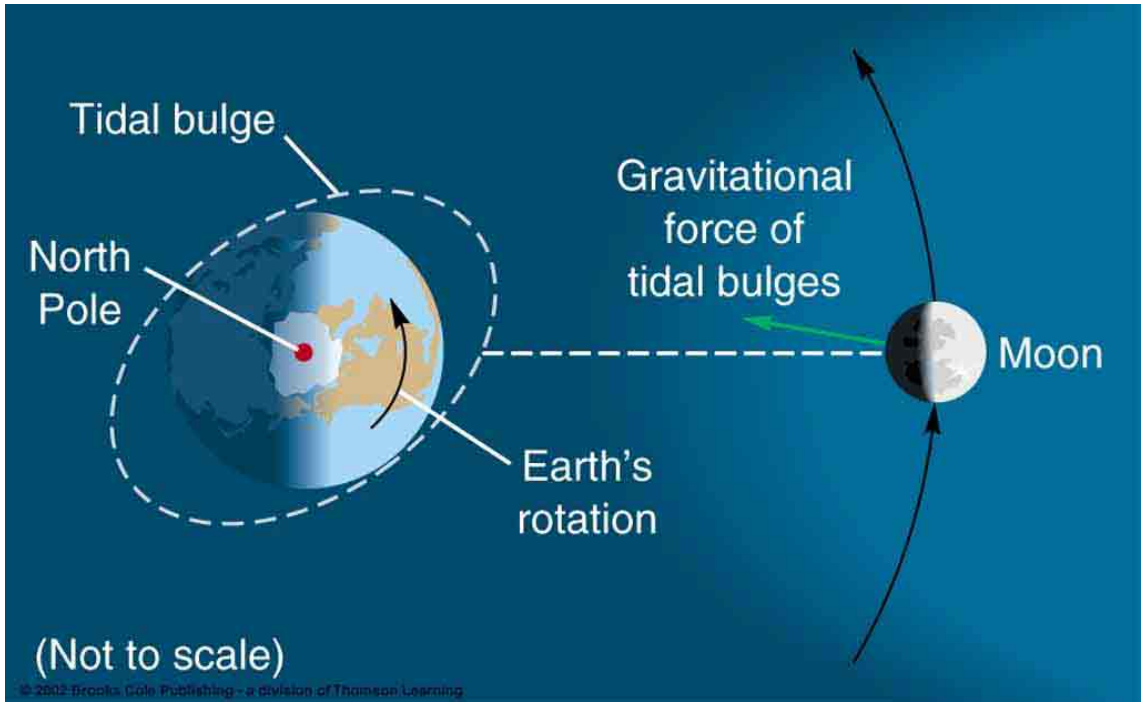
Gravity from the moon and sun pull on Earth. Gravity weakens with distance, so the pull is strongest on the near side, weakest on the far side.

The sun is more massive than the moon, but farther away, so its tidal effect is smaller.

Actual flow of water around the world is very complex and not fully understood!

From the text, Horizons by Seeds

More on tides

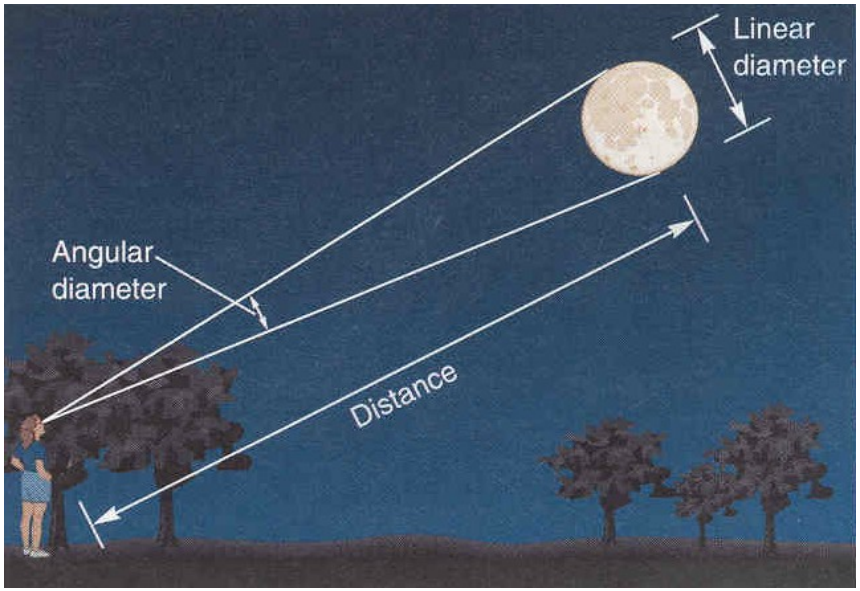


1. **Tidal friction leads to energy loss.**
2. **Earth's rotation drags the tidal bulge forward, helping pull the moon (its orbit is increasing in radius).**
3. **The energy comes from Earth's rotation, which is slowing.**
4. **The extraction of energy from the moon's rotation led to phase-locking.**

Tidal forces will appear later in the semester in other astrophysical contexts. Watch for them.

Angular sizes

From our text: Horizons, by Seeds



•Quite often we will need to find linear size of some object, given its distance and its angular size

$$\frac{\text{angular diameter}}{206265\,\text{arcsec}} = \frac{\text{linear diameter}}{\text{distance}}$$

Note – the book leaves out the units of "arcsec". Do not make that mistake yourself.

An example different than the one in the book: How large is the sun?
The angular diameter of the sun is about 0.5^0. To convert that to arcseconds use:
0.5 deg × 60 arcmin/deg × 60 arcsec/arcmin = 1800 arcsec
The sun is 1.5×10^8 km away (= 1 astronomical unit). So

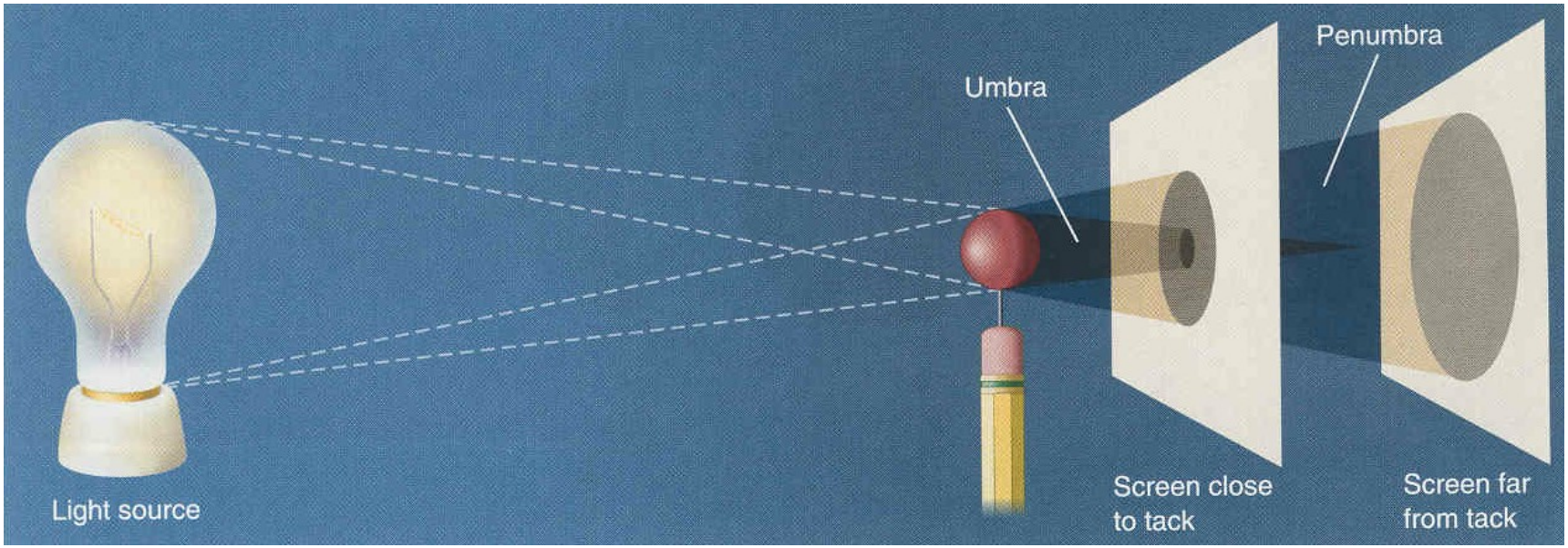
$$\text{linear diameter} = \text{distance} \times \frac{\text{angular diameter}}{206265\,\text{arcsec}} = 1.5 \times 10^8\ \text{km} \times \frac{1800\,\text{arcsec}}{206265\,\text{arcsec}} = 1.3 \times 10^6\ \text{km}$$

The Angular Size of the Moon

- **How big is the moon? Have you ever seen the moon near the horizon? Has it looked huge, much larger than when it is high in the sky?**

- **Last full moon was Aug. 29. Next one is Sept. 27. Have a look. After we do phases (next time) will know where and when to look!**

Shadows and Eclipses



From our text: Horizons, by Seeds

Both the Earth and the Moon will cast shadows. If the Sun, Earth, and Moon are all lined up, then the shadow from one can fall on the other.

Because the Earth is ~4 times bigger, it will cast a shadow 4 times bigger.

Umbra — **Portion of shadow where it is completely dark.**

(for a person in the shadow, the light bulb would be completely blocked out)

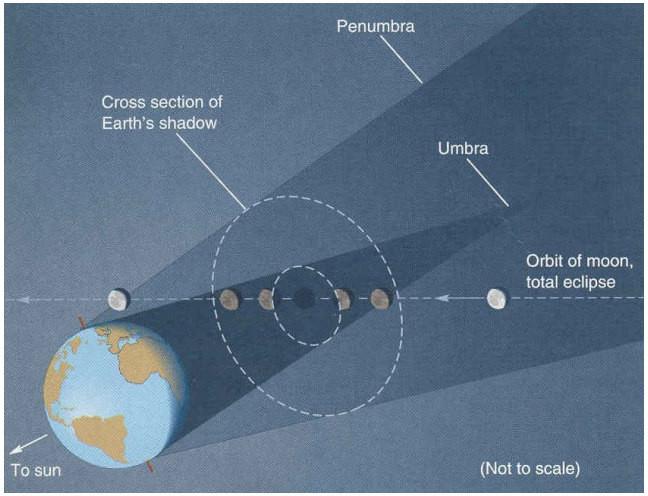
Penumbra — **Portion of shadow where it is only partially dark.**

(for a person in the shadow, the light bulb would be partially blocked out)

(To remember the names, think of "ultimate" and "penultimate")

Types of eclipses

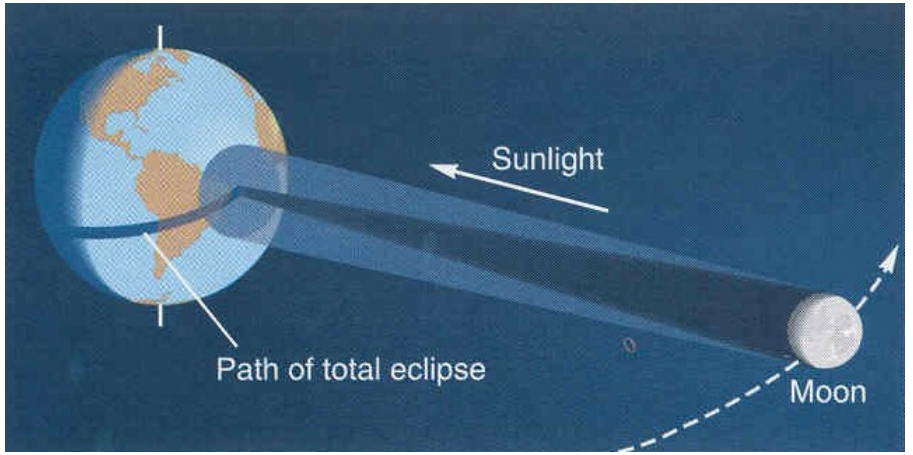
Lunar Eclipse



We view the illuminated object and watch it go dark.

Everyone on one side of the Earth can see the Moon – so a given lunar eclipse is visible to many people.

Solar Eclipse

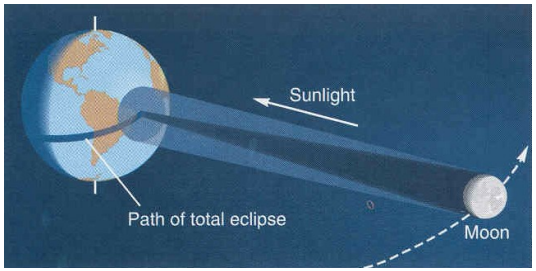


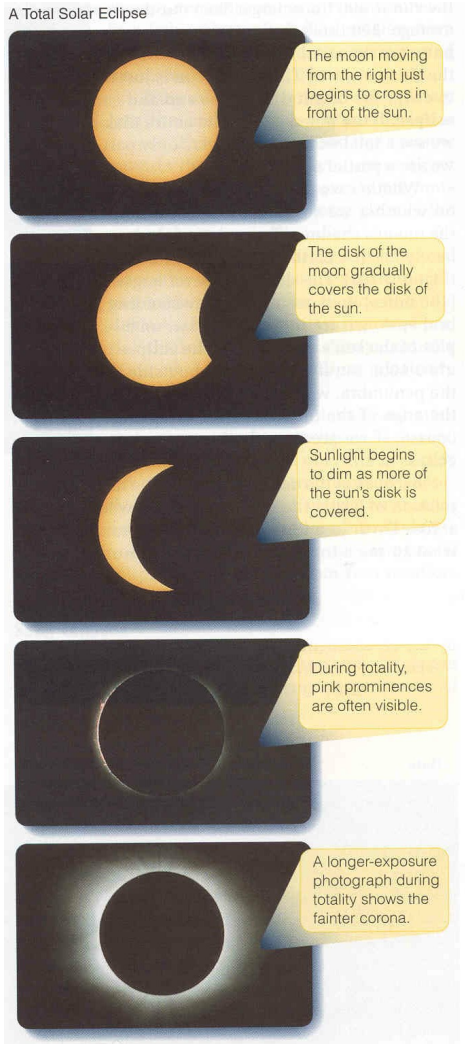
From our text: Horizons, by Seeds

We view the illuminating object (the Sun) and see it blocked out.

Only a few people are in the right place to be in the shadow.

It is "coincidence" that the umbra just barely reaches earth.





From our text: Horizons, by Seeds

Solar eclipses

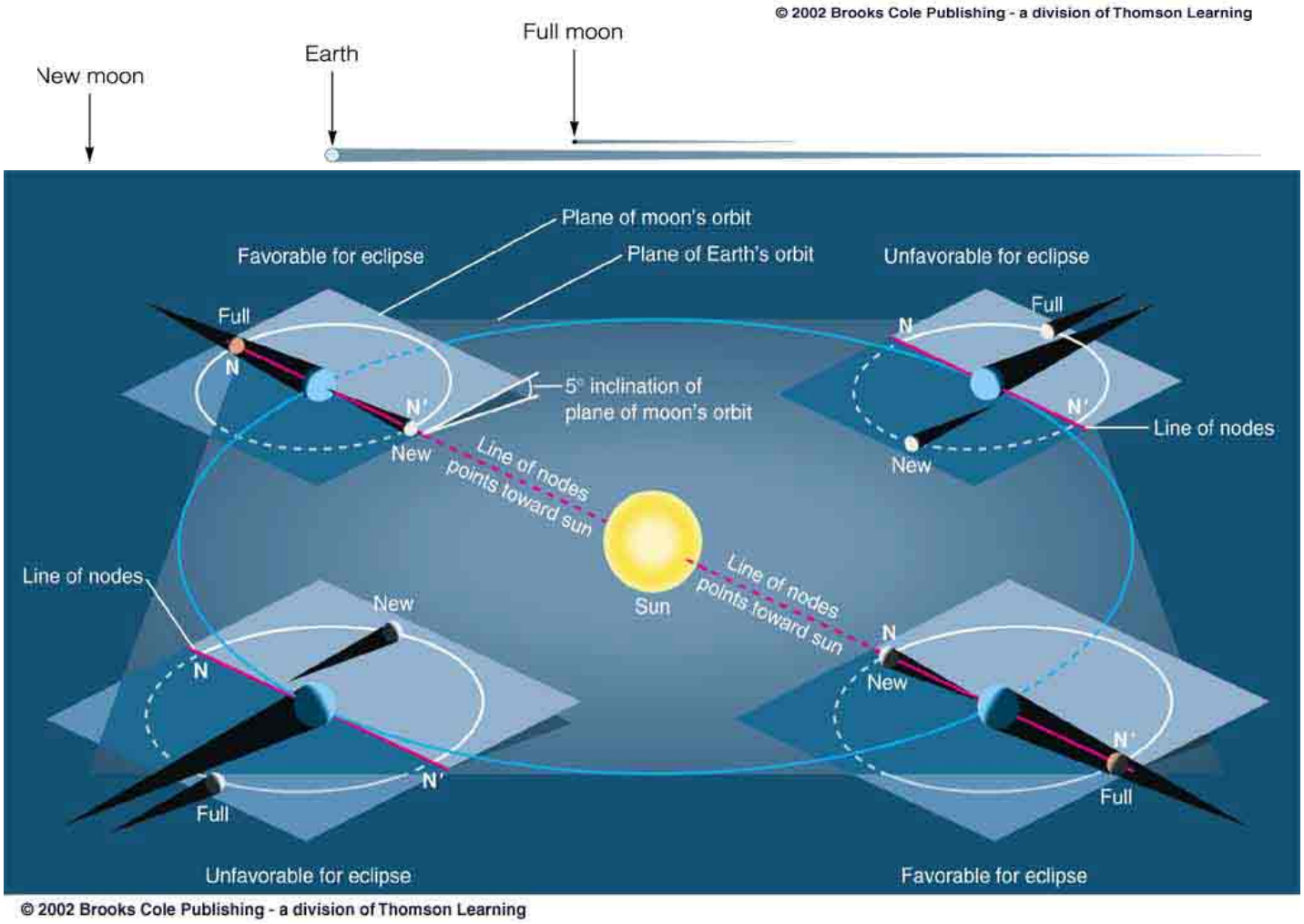
- **If you are outside the penumbra you see the whole sun.**
- **If you are in the penumbra you see only part of the sun.**
- **If you are in the umbra you cannot see any of the sun.**

- **The fact that the moon is just barely big enough to block out the sun results from a coincidence:**
  - **The sun is 400 times bigger than the moon, but also almost exactly 400 times further away.**
  - **The orbit of the moon is elliptical.**
    - **At perigee it can block out the full sun**
    - **At apogee it isn't quite big enough, giving an annular eclipse.**

Eclipse Facts

- **Longest possible total eclipse is only 7.5 minutes. Average is only 2-3 minutes.**
- **Shadow sweeps across Earth @ 1000 mph!**
  - **(Compare with scene in *The Mummy Returns*!)**
- **Birds will go to roost in a total eclipse. The temperature noticeably drops.**
- **Totally predictable (even in ancient times, e.g., the Saros Cycle, eclipse pattern repeats every 6585.3 days or 18 years, 11 1/3 days).**

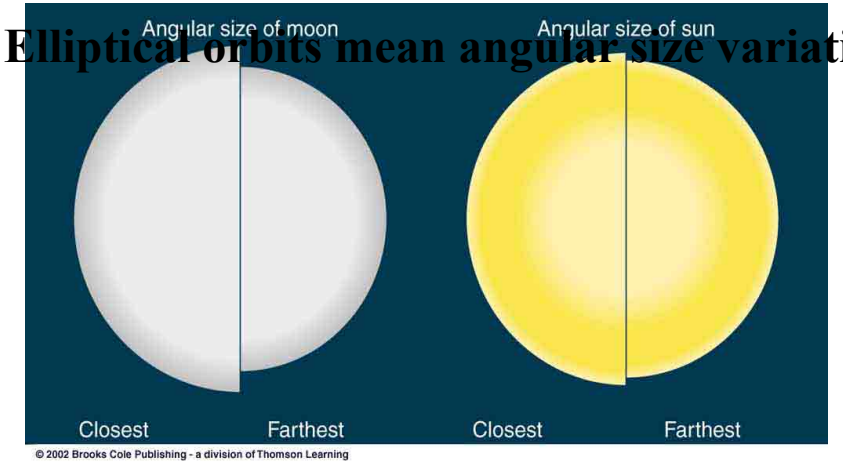
Eclipses and Nodes



From our textbook, Horizons by Seeds.

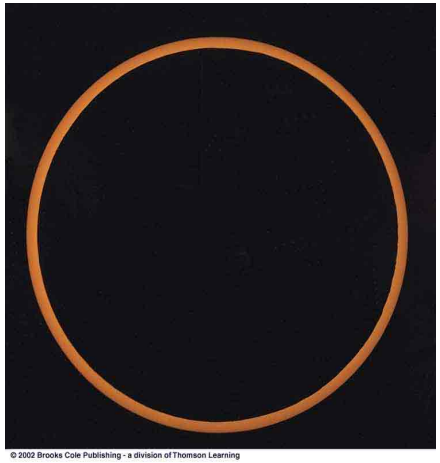
Variations in Solar Eclipses

Elliptical orbits mean angular size variation.



Total Solar Eclipse

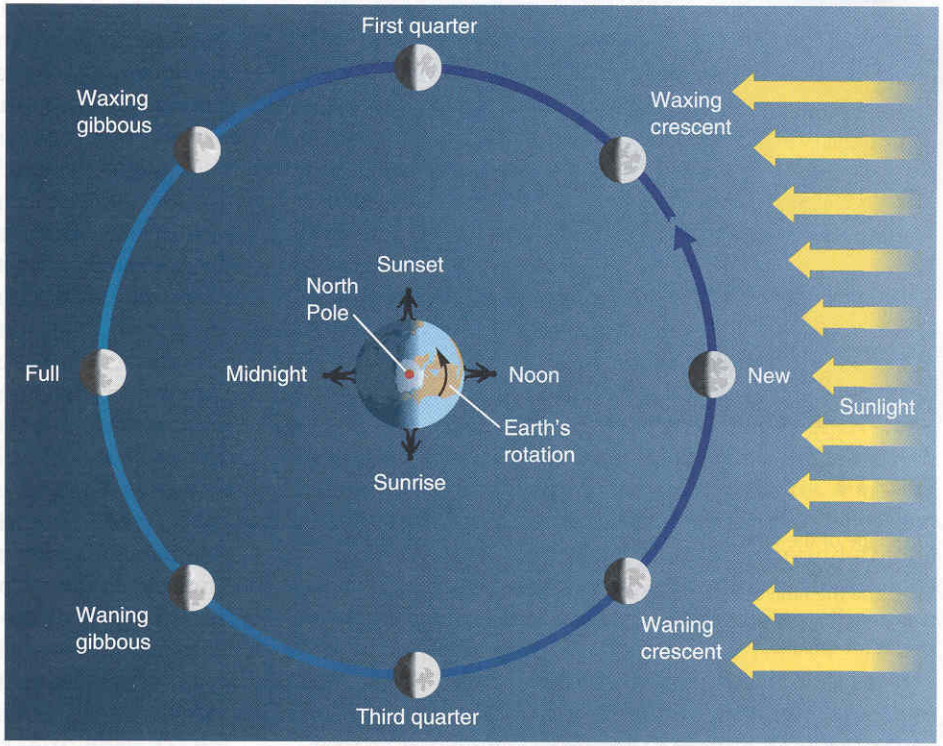
Diamond-Ring Effect



Annular Eclipse

Phases of the Moon and its orbit around the Earth (1).

a

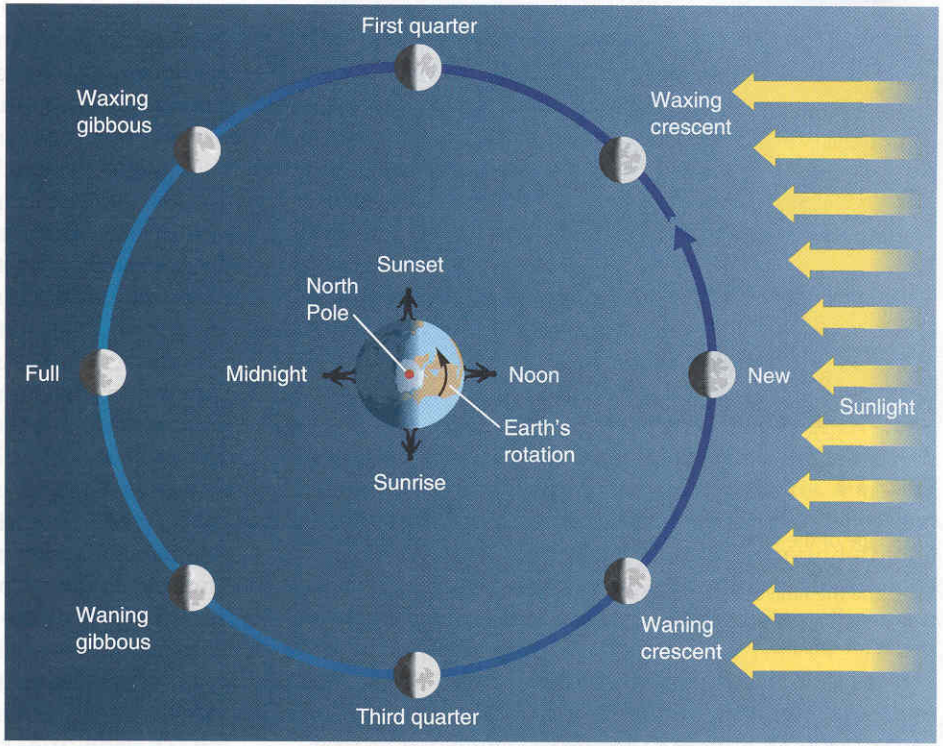


1. Everything (almost) in the solar system rotates or orbits counterclockwise, as seen from the North.
2. The illumination of the Earth and the moon will be almost the same, since the sun is so far away that both receive light from (almost) the same direction.
3. It takes 4 weeks for the moon to complete an orbit of the earth.
4. The moon is *phase-locked*. In other words, we always see the same face, although the illumination pattern we see changes. How long is a lunar day?

From our text: Horizons, by Seeds

Phases of the Moon and its orbit around the Earth (2).

a



From our text: Horizons, by Seeds

Suppose you are asked when the first quarter moon will rise, when it will be overhead, and when it will set. Which side will be illuminated?

- **If it is first quarter, it has moved ¼ revolution around from the new moon position, so it is at the top of the diagram.**
- **For a person standing on the earth, the moon would rise at noon, be overhead at 6 pm, and would set at midnight.**
- **It has to be the side towards the sun which is illuminated. Imagine yourself lying on the ground at 6 pm, head north, right arm towards the west. That west (right) arm points towards the sun. That must be the side which is illuminated.**

Before Friday:

- **Finish Ch. 3: Discovering the Universe**
  - **Start Mastering Astronomy HW**
  - **Begin Reading Chapter #3**
  - **Learn the Math in Lab!**

Homework on Mastering Astronomy

(Due Next Monday)