Motions in the Sky (Part I)

1. Practice Quiz
2. Introduction
3. Earth Spins Around Its Axis
4. Earth Revolves Around the Sun
5. Summary

Review

- Astronomy is the study of objects outside of the Earth's atmosphere
- This is a science class
- The scientific method always tests and retests hypotheses and develops new theories if old ones fail
- Powers of 10 are used for big and small numbers
- We are going to study lots of interesting stuff this semester

Wait a moment...

LOTS of Motion

- Earth Spins Around Its Axis
  - Once per ???
- Earth and Moon Revolve Around Each Other
  - Once per ???
- Earth Revolves Around the Sun
  - Once per ???
- Solar System is Revolving Around the Center of the Milky Way
- The Milky Way is Moving Through Space
- Whew, do you feel dizzy?

Earth Spins

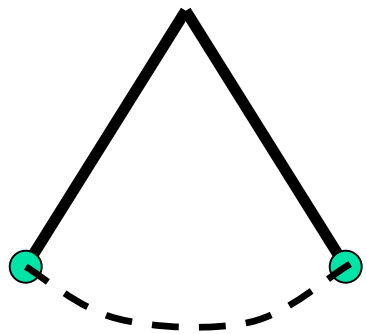
- The Earth spins around its axis once per day (24 hr)
- This axis runs through the Earth from the North Pole to the South Pole
- When viewed from above the North Pole, the Earth rotates counterclockwise.
- This spin causes the rising and setting of the Sun (and the Moon and the stars)
- This effects many of our weather patterns including hurricanes

North Celestial Pole

- The Earth revolves around an axis that runs from the north celestial pole to the south celestial pole
  - Currently, the north celestial pole points towards Polaris, otherwise known as the North Star
  - There is no corresponding "South Star"
  - The Earth tilt moves some so eventually the north celestial pole won't point towards Polaris

Foucault's Pendulum

- A pendulum swings back and forth because of gravity and its mass

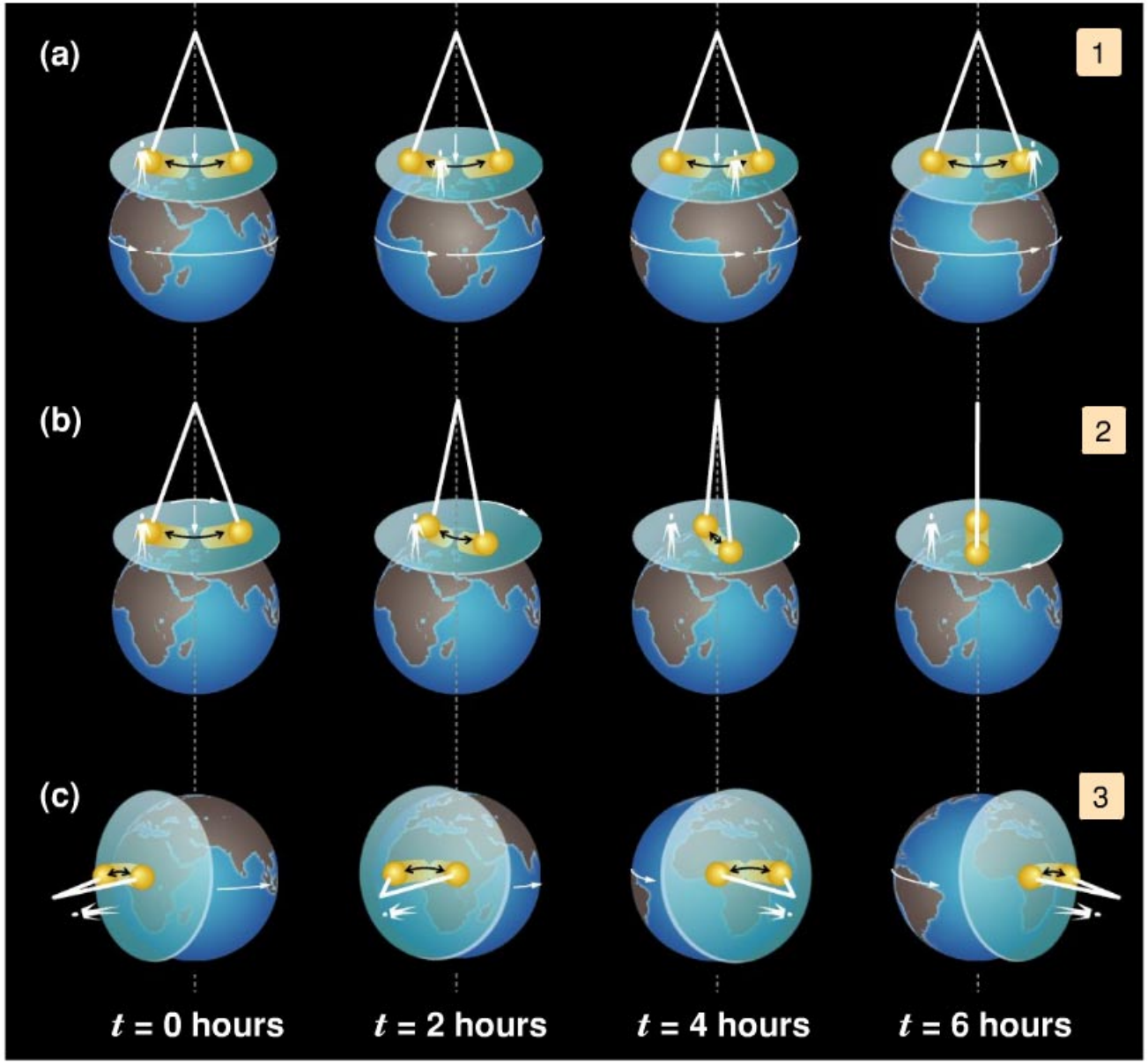


- Without friction and air resistance, it will do this forever
- In 1851, Jean-Bernard-Leon Foucault developed a test to demonstrate the Earth's rotation

Foucault's Pendulum (cont)

- Imagine the pendulum is at the North Pole
- It will continue to swing back and forth in the same plane. However, the Earth will rotate underneath it.
- So to someone standing nearby the pendulum will appear to rotate, completing one revolution per day
- Now consider a pendulum at the equator which is swinging along the east-west line
- This pendulum will not rotate
- At latitudes in the middle, the pendulum will rotate with a period more than 24 hours

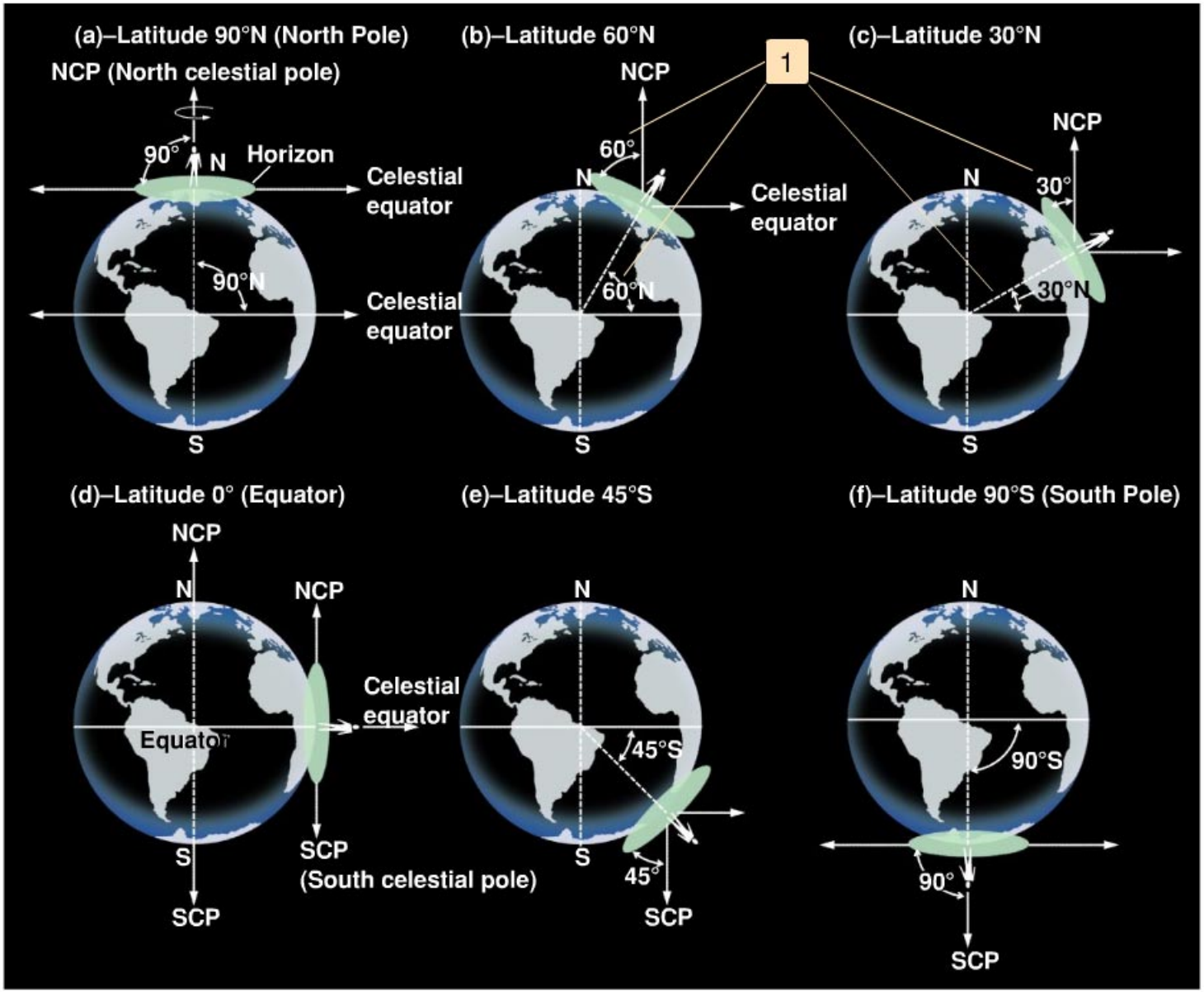
Figure 2.9



The Horizon

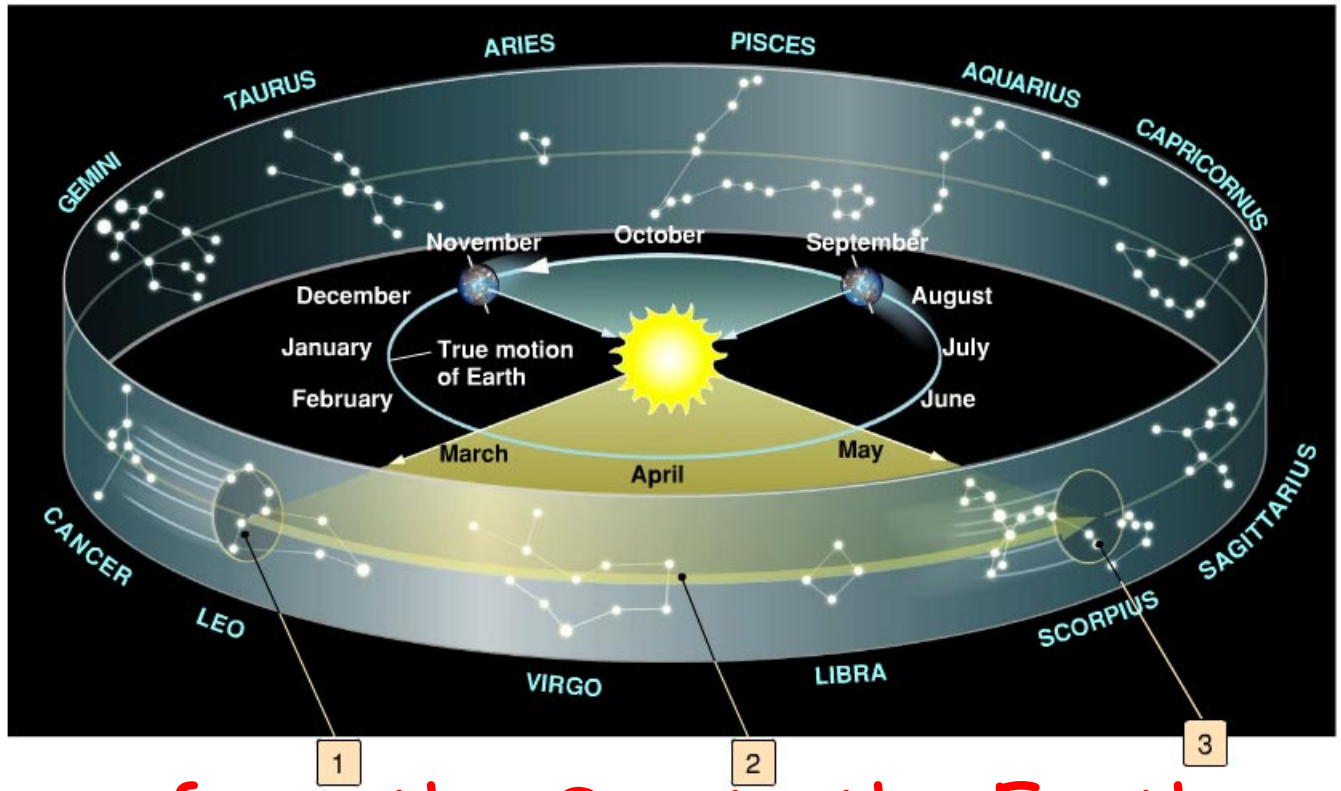
- We can only see half the sky at any given moment (the half above us)
  - The other half is blocked by the Earth
- If we are on the North or South Pole, we will always see the same half of the sky
  - It does rotate around itself
- If we are on the equator, we will see the whole sky once per day
- In between, we see part of the sky all day long and part of the sky only some of the day

Figure 2.4



The Earth Revolves Around the Sun

- The Earth revolves around the sun once per year



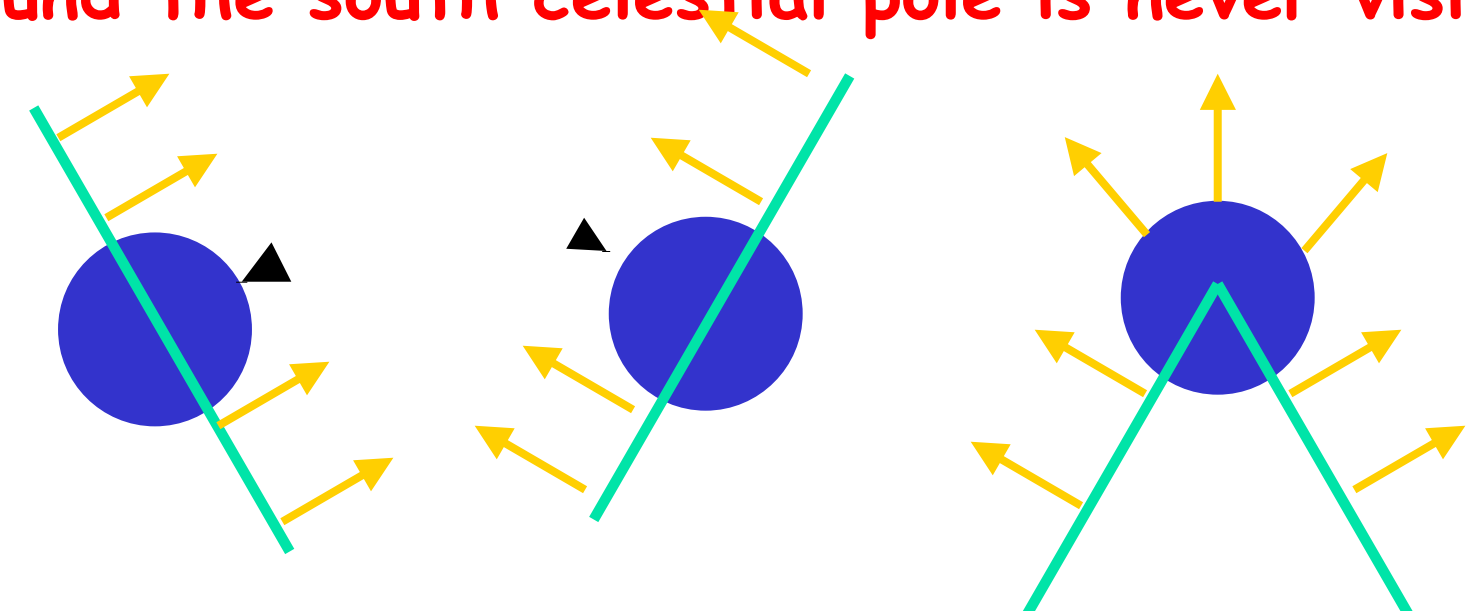
- The distance from the Sun to the Earth changes by about 3% over a year

What Can I See?

- Earth's rotation and motion around the Sun determine what we can see in the sky
- Rotation
  - During the day, you only see the Sun and maybe a bit of the Moon
  - At night you see the portion of the sky above you with stars "rising" in the east and "setting" in the west
- Motion around the Sun
  - Six months from now the current sky will be hidden by the Sun and we will see part which is now behind the Sun

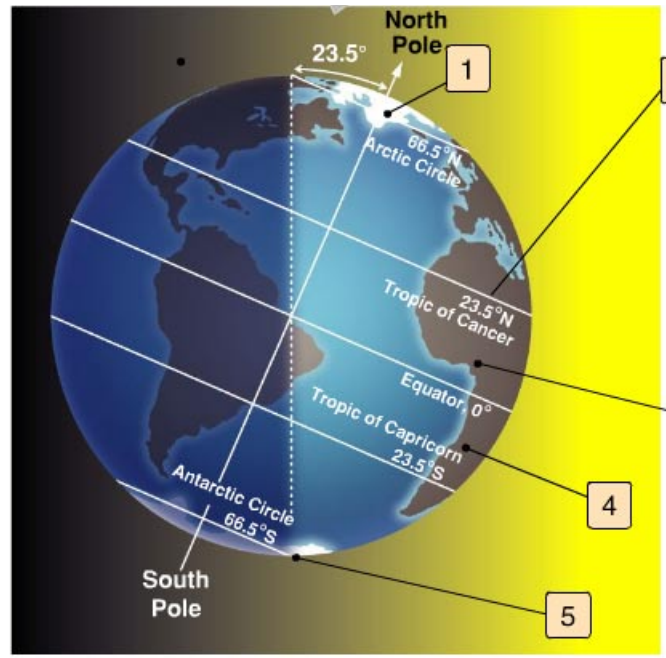
What Can I See? (cont.)

- In the northern hemisphere, the North Star is above the horizon all day long
  - The angle of the North Star above the horizon equals your latitude
- In the northern hemisphere, part of the sky around the south celestial pole is never visible



The Earth is Tilted

- The Earth's axis is tilted 23.5° with respect to its orbit around the Sun
  - Axis always points in the same direction, toward the north celestial pole
    - It actually moves very slowly over time, precessing like a top

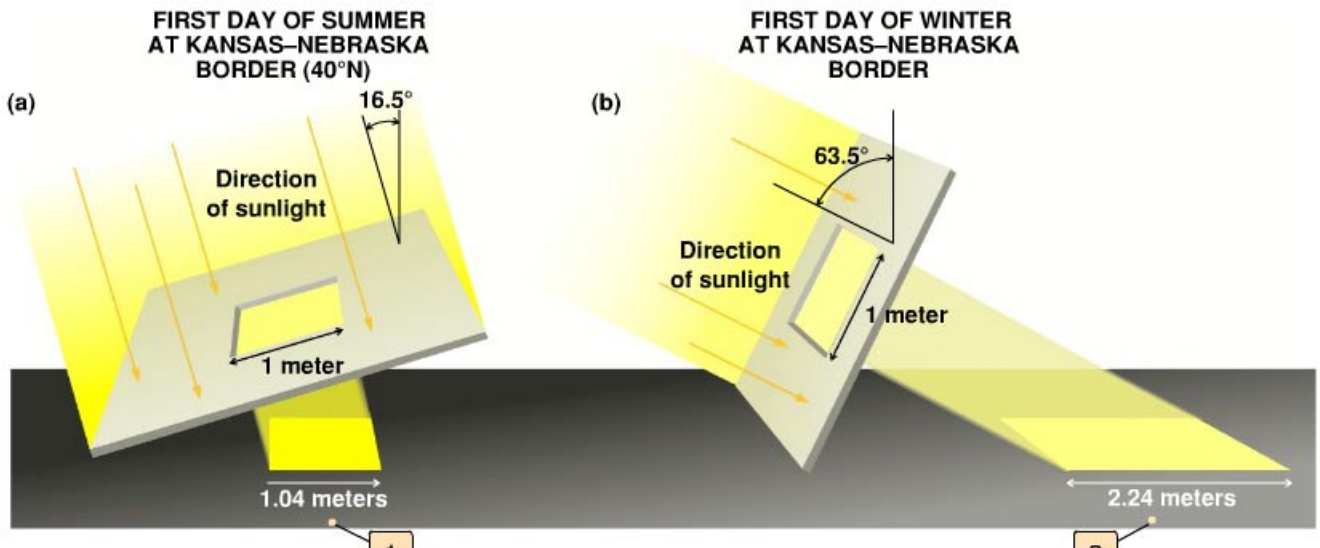


Seasons

- Seasons are caused by the tilt of the Earth combined with motion around the Sun
- During our summer, the north celestial pole is pointed towards the Sun
  - The Sun is above the horizon longer
  - We receive more intense light
- During our winter, the south celestial pole is pointed towards the Sun

Intensity of Sunlight

- The amount of light per square meter depends on the angle at which the light hits the surface
- The amount of light determines the "heating" of the Earth
- In the summer, the light is more direct and provides more heat



Summer Solstice

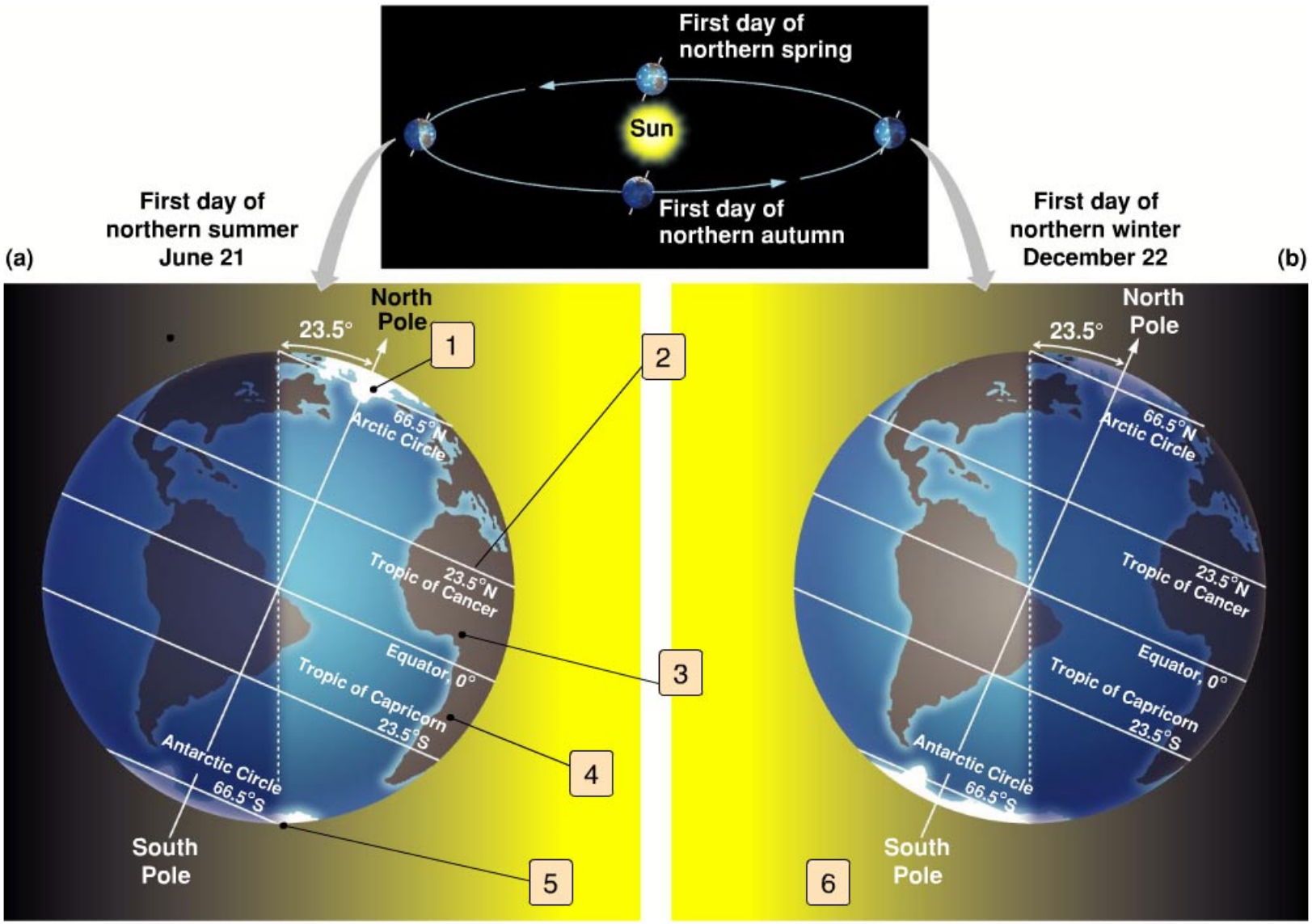
- **First day of summer, about June 22**
  - Sun appears to be 23° north of the equator
    - Passes through the zenith (straight above) of places that are 23° N latitude at noon
    - 23° N latitude is called the Tropic of Cancer
  - All regions within 23° of the North Pole see the sun for the full day
    - 90° - 23° = 67° N latitude is called the Artic Circle
  - All regions within 23° of the South Pole see no sunlight for the full day
    - 67° S latitude is called the Antarctic Circle
    - It stays dark at the North and South Poles for 6 months each year

Winter Solstice and Equinoxes

- First day of winter, about December 22
  - Everything is reversed
  - Sun passes through the zenith along the Tropic of Capricorn at noon (23° S latitude)
- Equinoxes
  - Twice a year, the sun passes through the zenith along the equator at noon (0° latitude)
  - Vernal Equinox, around March 21
  - Autumnal Equinox, around September 21
  - 12 hours of light and 12 hours of darkness everywhere

Real World

- Earth's atmosphere fuzzes the edges (figuratively and literally)
- Atmosphere bends light coming from the Sun, allowing us to "see over the horizon" about 18°
  - Sun appears to rise earlier and set later
  - It's light out (twilight) in the morning when the Sun is 18° below the horizon and stays light in the evening until the Sun is 18° below the horizon
  - Effect is most noticeable at the poles – complete darkness for only 3 months (rather than 6 months)
    - Last week the scientific station in Antarctica starting receiving flights after the winter break
- June 22 is the longest day, but not the hottest, why?



Length of the Year

- It takes the Earth 365.242199 days to go from one vernal equinox to the next
  - NOT an integer number
  - But the extra is close to $\frac{1}{4}$ = 0.25
- So every 4 years (leap year) we add an extra day to the calendar (Feb. 29)
  - But this is too much (we've added 0.25!)
- So every 100 years (on the century) we don't add the extra day (no leap year)
- But this isn't right either, so every 4th 100 years, we do include the leap year
- This is why 2000 was a leap year

Summary

- The Universe has lots of motion
- The spinning of the Earth causes the rising and setting of the Sun and stars
- The revolution of the Earth around the Sun determines the year
- The tilt of the Earth determines the seasons
- The spinning, revolution and tilt determine the part of the sky which is visible
- You want/need to understand these motions
- Next time, we will look at how the Moon behaves