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A. **Earth's Motions** - Motions of the Earth provide the framework for measuring **time**. The Earth rotates on its axis and revolves around the Sun.

1) **Rotation**– The spinning of a celestial body on its axis is referred to as **rotation**.

- One rotational period takes **24 hours** or 1 day.

a) Angular Rate of Rotation – This measures in degrees how fast the Earth is rotating. This value never changes.

- Earth's angular rate of rotation = _____ °/hr

- Apparent solar day - The time between two successive solar noons is slightly more than 24 hours because we must rotate a little more than 360° due to our position changing during our revolution.
- Mean solar day – The length of a solar day varies slightly, be but it averages 24 hours.

b. **Evidence of Earth's rotation -** There are two main pieces of evidence that we can observe that support the belief that the Earth is rotating.

i) The Foucault pendulum – A pendulum swings back and forth in a straight line. A French scientist Jean Foucault noticed that the pendulum seemed to change direction without being acted upon by an outside force. He reasoned that the base of the pendulum was moving not the pendulum itself. He concluded that the Earth's rotation was causing the base to spin and therefore making the path of the pendulum to change (see diagram).

ii) The Corioles Effect – As free flowing objects move, the Earth rotates beneath them (Ex. Ocean currents and wind patterns). This makes objects curve to the **right of their path** in the Northern Hemisphere (to the left in the Southern Hemi.).

2) **Revolution** – The motion of one celestial body traveling or orbiting around another celestial body is called revolution (it is revolving).

- Orbital period or revolution period – The length of time it takes to make one complete orbit. It takes **365.25 days** for the Earth to complete one revolution around the Sun. This is how we get our year.

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3. Models of the Solar System:

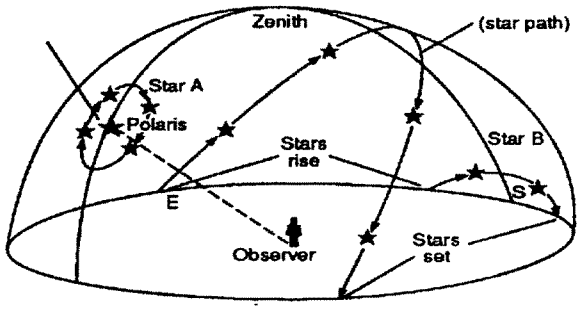
a) Geocentric Model – First proposed by Ptolmy, this model of the solar system placed the Earth in the center with the Sun and planets **revolving** around it.

b) Heliocentric Model – Capernicus proposed this model, which placed the Sun at the center of the solar system and all planets revolving around it.

B. **Celestial Motions –** Celestial motions refers to the movement of objects outside the Earth's atmosphere (a.k.a. celestial). These objects appear to move across our sky from **East to West at 15°/hour** and follow circular paths.

1. **Celestial Sphere** – The celestial sphere is an imaginary dome that surrounds the Earth and celestial objects seem to appear on this dome. It is useful to us because it allows us to "track" the movement of the Sun, stars etc.
   a. **Altitude- Azimuth System** – This is a coordinate system used to locate objects in the sky and on the celestial sphere.
   b. **Altitude** is the height of an object above the horizon.
   c. **Azimuth** is the direction you're facing (north, south, etc). However, we use an angle to represent it, where 0° = north, 90° = east, 180° = south, and 270°= west.

Example: What are the coordinates of Polaris when you're in Kingston, NY? At the equator?



2. **Star Movement** – Celestial objects "appear" to move east to west at a rate of 15°/hr around Polaris (North Star) which appears stationary.
   a. Stars located near to Polaris in the northern sky move in counter clockwise circles around Polaris and are called **circumpolar stars**. Stars that are farther from Polaris "move" in larger **arcs**.
   b. **Constellations** are imaginary figures that people have created that mark the location of stars. The 88 constellations do not change. Each season has its own constellations because the Earth is revolving around the Sun and we see different parts of the sky. At the same time, the Earth is rotating which causes the constellations to appear to move slightly during the night.

*Are **the stars really moving? Why do you think they appear to move?***

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What is our most important star? _____

Does it appear to move east to west? _____

How fast does it move? _____ *(Prove it by making a simple sun dial and measure how fast the Sun is moving)*

3. Planetary Motions - Like stars, planets "appear" to move from east to west on the celestial sphere.
   a. **Daily "apparent" motions** are caused by the **rotation** of the Earth.
   b. **Annual (yearly) "apparent" motions** are caused by the Earth **revolving** around the sun, which makes planets and stars shift Eastward each night.
   c. **Retrograde Motions**- At times, planets appear to be moving "backward". This is an optical illusion caused by planets revolving around the sun at different rates.

Example: Similarly, two cars racing around an oval track. As one car passes the other, the second place car "appears" to be moving backward to an observer in the middle.

   d. **Apparent diameter** – When observed through a telescope, the diameters of the planets appear to change in a cyclic manner. This occurs because the distance to the planets changes and you know that objects closer to you appear larger.

C. The Seasons – There are three (3) causes of the seasons.

1. Revolution of Earth - The revolution of the earth around the sun causes different portions of the earth's surface to be tilted toward the sun during the year.
2. Earth's tilted axis - The tilt (23.5°) of the earth's axis causes seasons because the hemisphere that is tilted toward the sun receives a larger angle of insolation (**AOI**). **The larger the AOI, the more "focused" the energy is, which produces warmer temperatures.**
   - Earth's axis is tilted 23.5° from an imaginary line that is perpendicular to the earth's orbital plane .
3. Parallelism – The earth's axis always "points" in the same direction, which means the axis is always **parallel** with its previous position.
   - See diagram on next page.

Important FACTS about Seasons:

- On only two days a year, the Sun appears to rise due East and sets due West.
- At solar noon, the Sun is at its highest point in the sky for the day and therefore has the greatest angle of insolation (AOI) at that time
- The altitude of the noon Sun varies with the Seasons and the latitude on Earth.
- The noon Sun is **never** directly over head in **NY**. (Only between 23.5°N (Tropic of Cancer) and 23.5°S (Tropic of Capricorn) during the year)
- The duration of insolation (length of daylight) is directly related to the AOI.

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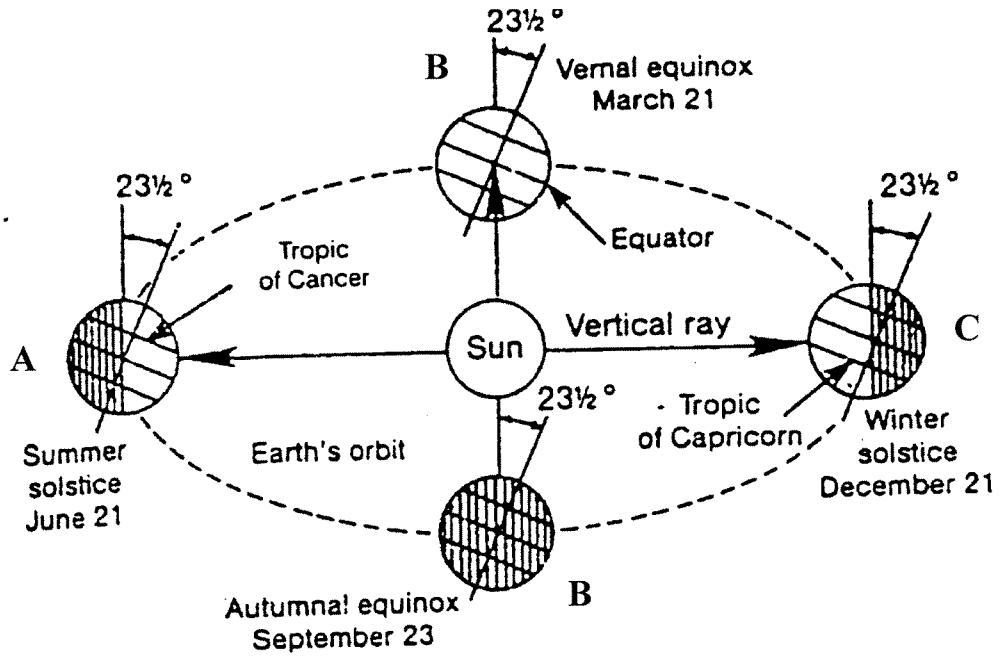


1. At each position, what latitude receives AOI =90?

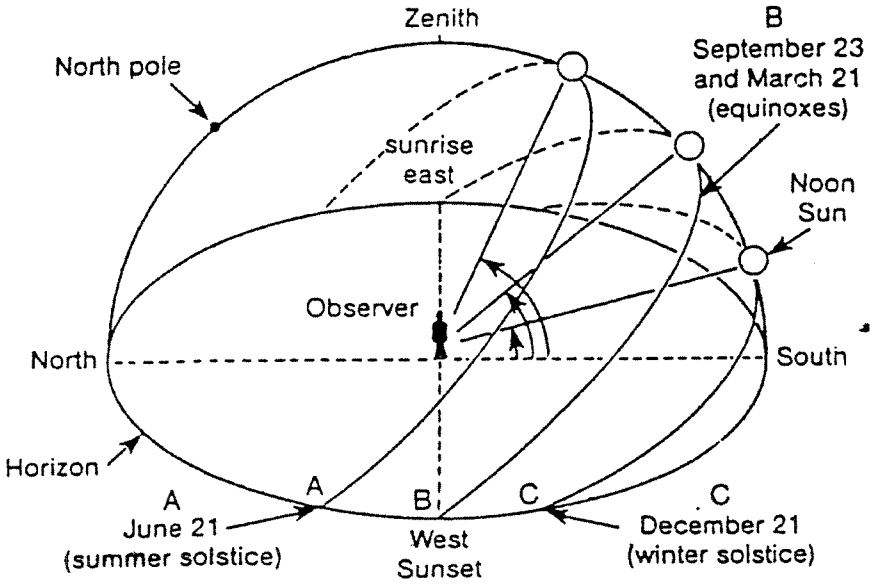
2. On June 21, where is the duration of insolation the longest and shortest.

3. On what date does NY have its shortest duration of insolation?

4. On what date does NY have an AOI = 90?

5. What causes NY to have summer at position A?

6. How would NY's seasons change if Earth's tilt decreased to 10°?



7. What compass direction does sunrise and sunset occur for each path and date.

A. 6/21

B. 3/21, 9/23

C. 12/21

8. Approximately, what is this observers latitude? Explain.

9. Compare and describe the length of each path of the Sun.

10. How does the length of each path indicate the duration of insolation (amount of daylight)?

11. Compare and describe the AOI of the noon sun (solar noon) of each path.