

EARTH MOTIONS

I. **Two basic motions** (these are regular and predictable, so measurement of **TIME** on earth is based on these earth motions.)

- A. **ROTATION** – spinning on an axis
1. earth – once every 24 hours
- B. **REVOLUTION** – orbiting around something
1. earth – orbits sun once every 365 ¼ days
 2. moon – orbits earth once every 27.3 days

II. **Apparent motion of celestial objects**

- A. How the sun, moon, planets, and stars **APPEAR** to move on the celestial sphere (“dome” of the sky)
1. **Daily motion** – how *all* celestial objects appear to move from east to west in the sky every day(night) due to the earth’s **ROTATION**.
 - a.) The “pivot point” is **POLARIS**, which is directly above the earth’s north pole.
 - b) **ALL** celestial objects appear to rotate at **15° /hour** around Polaris. (Is the basis for our **TIME ZONES**)

$$\begin{array}{l} \text{one whole turn} \rightarrow \frac{360^\circ}{24 \text{ hr}} = \underline{\underline{15^\circ/\text{hr}}} \\ \text{time it takes} \rightarrow \end{array}$$
 2. **Yearly motion** - seasonal changes in apparent positions of constellations (star patterns) provide evidence for earth’s **REVOLUTION**.
 - 3 Planets - (“wanderers”) **appear** to move slowly compared to their background constellations due to their revolution. around the sun
 - a) Apparent diameter and brightness of planets change in a cyclic and predictable fashion as viewed from earth (highest when planet is closest to earth).
 - b) **Retrograde Motion** - looping pattern of outer planets over several weeks/months compared to background stars.
 - 1) due to faster Earth “passing” the slower outer planets
 - 2) is an optical illusion

III. Models of the solar system

1. **Geocentric** - “earth centered”
 - a) ancient model, based on observed “motions” of sun and stars
 - b) explained (*incorrectly*) daily motion as objects circling the earth
 - c) could **NOT** explain planet locations, motions of the Foucault Pendulum, or the Coriolis Effect
2. **Heliocentric** - “sun centered”
 - a) is **correct**, and **simpler**
 - b) explains daily motion as the result of **earth’s rotation**
 - c) explains planet locations based on them orbiting the sun
 - d) explains Foucault Pendulum, Coriolis Effect, and earth’s bulge at equator as the result of **earth’s rotation**.

IV. Motions of the moon

- A. Moon revolves around the earth every 27.3 days.
 1. **Moon phases** (seeing different portions of the lit half of the moon) **are caused by the moon revolving around the earth.**
 - a) one full moon to the next full moon takes **30 days**.
 2. **Eclipses** - occur when the shadow of one objects falls on another
 - a) lunar eclipse - during *full* moon, earth’s shadow falls on moon
 - b) solar eclipse - during *new* moon, moon’s shadow falls on earth
- B. **Tides** - daily rise and fall of sea level due to oceans responding to gravitational attraction of moon (mostly) **and sun** (a little).
 - a) high tide - when moon is above (or opposite) location
 - b) low tide - when moon is at 90° angle to location

V. Apparent path of the sun

- A. Sun’s apparent path through the sky varies with latitude and the season.
- B. **Daily motion** – sun makes an arc across the sky at a rate of 15°/hour due to the earth’s rotation.
 1. This arc is small in the winter (short daylight) and big in the summer (long daylight) **DUE TO THE EARTH’S TILT... 23½°**

- C. Local noon – time of day when the sun is at its highest position in the sky, or the greatest **angle of insolation**.
1. For New York State, is **ALWAYS** to the south (*shadows* at local noon all point north)
 2. Local noon is **lowest** in winter (long shadows)
 3. Local noon is **highest** in summer (short shadows)
- D. Due to the earth's **23½° tilt**, the location on earth where the sun will be directly overhead at noon drifts between 23½° North (in summer) and 23½° South (in winter). It crosses the equator in spring and fall.
1. This is a cyclic change.
 2. This results in the **seasons**.
- E. Time and Earth's rotation
1. **Solar day** - from one local noon till the next (not always 24 hours due to Earth's elliptical orbit)
 2. **Mean solar day** - 24 hours... is the average of all solar days (what the clock shows)

VI. Evidence of earth's rotation

- A. **Foucault Pendulum** – swinging weight on a wire that “appears” to slowly change direction during the day.
- a.) works due to inertia - things in motion tend to stay in motion
- B. **Coriolis Effect** – tendency of winds, ocean currents, etc. to veer off the **RIGHT** in the N. hemisphere (to left in S. Hemisphere).