Earth’s Motions

What evidence do we have to provide evidence of Earth’s motions and how do calculate its elliptical orbit?
Earth’s Motions

- **Rotation** - the movement of an object in a circular motion around a line of axis

- **Period of Rotation** - amount of time to make one complete rotation
  
  - Example: Earth rotates 360° in 24 hours
Earth’s Rotation
Earth’s Motions

- Earth’s axis of rotation is tilted 23.5°
Earth’s Motions

Evidence of Rotation

- **Foucault Pendulum** - large pendulum that when allowed to swing freely changes its path due to Earth’s rotation
Foucault Pendulum
Evidence of Rotation

- **Coriolis Effect** - the tendency of all particles on Earth’s surface to be deflected from a straight line
  - N. Hemisphere to the right
  - S. Hemisphere to the left
Coriolis Effect
Coriolis Effect in the Northern Hemisphere
Coriolis Effect in the Southern Hemisphere
Hurricanes in the Northern Hemisphere
Earth’s Motions

- **Revolution** - the motion of one body around another in an orbit
- **Period of Revolution** - the amount of time required to orbit the Sun one time
  - Example: Earth orbits the Sun in 365.25 days
Earth’s Revolution
Earth’s Motions

Evidence of Revolution

- **Parallelism of Earth’s Axis** - Earth’s tilted axis of 23.5° is always pointed to the same location in the sky giving us our different seasons.
Earth’s Motions

Evidence of Revolution
Earth’s Motions

- **Winter Solstice** - first day of winter [N. Hemisphere] when the Earth leans away from the Sun
  - Approximate Date: December 21
- **Summer Solstice** - first day of summer [N. Hemisphere] when the Earth leans towards the Sun
  - Approximate Date: June 21
Earth’s Motions

- **Vernal Equinox** - first day of spring [N. Hemisphere] when there are equal amounts of day and night
  - Approximate Date: March 21
- **Autumnal Equinox** - first day of fall [N. Hemisphere] when there are equal amounts of day and night
  - Approximate Date: September 21
Autumnal Equinox

Vernal Equinox

147 million km

152 million km

Sun
Kepler
Earth’s Motions

- **Ellipse** - the oval shape of a planet’s orbits
- **Perihelion** - the point in the orbit of Earth at which it is closest to the sun
  - Distance: 147,000,000 km
- **Aphelion** - the point in the orbit of Earth at which it is farthest from the sun
  - Distance: 152,000,000 km
Earth’s Motions

Parts of an Ellipse

- **Eccentricity** - the degree of “ovalness” of an ellipse
  - Eccentricity of a perfect circle is 0
  - Eccentricity of a flat line is 1
- **Foci** - two fixed center points of an ellipse
- **Major Axis** - the longest straight line distance across an ellipse
Earth's Motions
Earth’s Motions

Calculate Eccentricity

- Use the formula from the E.S.R.T

\[
\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}
\]
Earth’s Motions

Calculate the eccentricity

\[
\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}
\]
## Earth’s Motions

<table>
<thead>
<tr>
<th>Celestial Object</th>
<th>Mean Distance from Sun (million km)</th>
<th>Mean Period of Revolution (d=days) (y=years)</th>
<th>Period of Rotation at Equator</th>
<th>Eccentricity of Orbit</th>
<th>Equatorial Diameter (km)</th>
<th>Mass (Earth = 1)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUN</td>
<td>—</td>
<td>—</td>
<td>27 d</td>
<td>—</td>
<td>1,392,000</td>
<td>333,000.00</td>
<td>1.4</td>
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<tr>
<td>MERCURY</td>
<td>57.9</td>
<td>88 d</td>
<td>59 d</td>
<td>0.206</td>
<td>4,879</td>
<td>0.06</td>
<td>5.4</td>
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<tr>
<td>VENUS</td>
<td>108.2</td>
<td>224.7 d</td>
<td>243 d</td>
<td>0.007</td>
<td>12,104</td>
<td>0.82</td>
<td>5.2</td>
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<tr>
<td>EARTH</td>
<td>149.6</td>
<td>365.26 d</td>
<td>23 h 56 min 4 s</td>
<td>0.017</td>
<td>12,756</td>
<td>1.00</td>
<td>5.5</td>
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<tr>
<td>MARS</td>
<td>227.9</td>
<td>687 d</td>
<td>24 h 37 min 23 s</td>
<td>0.093</td>
<td>6,794</td>
<td>0.11</td>
<td>3.9</td>
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<tr>
<td>JUPITER</td>
<td>778.4</td>
<td>11.9 y</td>
<td>9 h 50 min 30 s</td>
<td>0.048</td>
<td>142,984</td>
<td>317.83</td>
<td>1.3</td>
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<tr>
<td>SATURN</td>
<td>1,426.7</td>
<td>29.5 y</td>
<td>10 h 14 min</td>
<td>0.054</td>
<td>120,536</td>
<td>95.16</td>
<td>0.7</td>
</tr>
<tr>
<td>URANUS</td>
<td>2,871.0</td>
<td>84.0 y</td>
<td>17 h 14 min</td>
<td>0.047</td>
<td>51,118</td>
<td>14.54</td>
<td>1.3</td>
</tr>
<tr>
<td>NEPTUNE</td>
<td>4,498.3</td>
<td>164.8 y</td>
<td>16 h</td>
<td>0.009</td>
<td>49,528</td>
<td>17.15</td>
<td>1.8</td>
</tr>
<tr>
<td>EARTH’S MOON</td>
<td>149.6 (0.386 from Earth)</td>
<td>27.3 d</td>
<td>27.3 d</td>
<td>0.055</td>
<td>3,476</td>
<td>0.01</td>
<td>3.3</td>
</tr>
</tbody>
</table>