The Motion of Planets

History of Astronomy

Scientific Method

1. __________
2. __________
3. __________
4. __________
_________ = Why something happens
_________ = How something happens

Assumptions of Early Models

- __________ - Earth in the middle
- Everything orbits the Earth
- Stars are located on the Celestial Sphere
- Everything moves in __________ motions

The Dark Ages

Nicolaus Copernicus (1473-1543)

Errors building up
Must be a better way!
Let’s try a __________ system!
Not any better though
Tycho Brahe (1546-1601)

Naked eye observations of planets
Accuracy through ______________
Best observations of planetary positions
Hired “nerd” to help calculate model
Died….

Johannes Kepler (1571-1630)

Worked for Brahe
Took data after his death
Spent years figuring out the motions of the planets
Came up with…

Three Laws of ______________

1. Planets move in __________ orbits with the Sun at one foci

2. Planets move ______ at perihelion than at aphelion.

3. Period is related to average distance

\[ P = \frac{k}{a} \]

Longer orbits - greater average distance
Need the value of \( k \) to use the formula
\( k \) depends upon the situation
Can be used for anything orbiting anything else
Special version of Kepler’s third Law –
If the object is orbiting the Sun
P – measured in years,
a – measured in A. U., then....

\[ P^2 = a^3 \]

Galileo Galilei
(1564-1642)
Knew of Copernicus’s & Kepler’s work
Used a telescope to look at the sky
What did he see?

The Moon was an ________ object

Venus has ________

Jupiter has objects around it

Saturn is imperfect

The Sun is imperfect

Isaac Newton
(1642-1727)
The ultimate “nerd”
Able to explain Kepler’s laws
Had to start with the basics -
The Three Laws of ______

1. Law of ______ - Objects do whatever they are currently doing unless something messes around with them.
2. Force defined
   \[ F = ma \]
   \( F = \text{force} \)
   \( m = \text{_______} \)
   \( a = \text{_________} = \text{change in motion} \)

3. For every action there is an __________________________.
   The three laws of motion form the basis for the most important law of all (astronomically speaking)
   Newton’s Universal Law of Gravitation

\[ F = \frac{GM_1 M_2}{R^2} \]
\( F = \text{force of gravity} \)
\( G = \text{constant} \)
\( M_1, M_2 = \text{masses} \)
\( R = \text{distance from “centers”} \)
Gravity is the most important force in the Universe

Planetary Configurations
Superior Planets (beyond Earth’s orbit)

Planetary Configurations
Inferior Planets (inside Earth’s orbit)