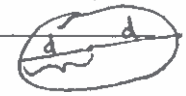
1. Elliptical orbits
2. closer to sun = faster v
farther from sun = slower v (1 planet)
3. Dist. planets take longer to orbit than closer planets (compares 2+ planets)

• 1609 published Laws 1 & 2
• 1619 published law 3

Kepler's Laws and Orbits: PhET Simulation **Name:** Key 2019
Google "Gravity and Orbits Phet"

Objective 4: Explain each of Kepler's Laws and apply them quantitatively.
Define Key Terms:

A. Eccentricity: measure of how elliptical an orbit is
B. Semi-major axis: half of the longest diameter



1. Is the orbit of a planet circular?
   - Press the TO SCALE option at the bottom of the screen with only the star and planet chosen
   - Turn on the path/grid option ON
   - Allow the planet to move through one full orbit
   - Turn on the measuring tape from the tool bar
   - Measure the horizontal distance from the path line on the left of the star. Write the measurement in the table below
   - Now do the same from the star to the path line on the right hand side.

	Distance (miles)
Left side from path to star	94,976
Right side from path to star	91,517

What do you notice about these distances?
they are not equal

Which of Kepler's Laws does this relate to? State the law.
1st Law - orbits are elliptical

2. Linking planetary orbits to Kepler's Laws
   - Leave the TO SCALE and open MODEL
   - Click on sun and planet
   - Turn path, gravity, and velocity ON
   - Press play and immediately pause after one full orbit

What holds the planet in the orbit? gravity

   - Turn ON the gravity force button

What direction do the forces face? toward each other

   - Turn the gravity (not gravity force) OFF

What happened to the planets and why?
the planet continued in a straight line tangent to the orbit

   - Turn the gravity (not gravity force) back ON
   - Increase the red velocity arrow very slightly in length
   - Run simulation and observe

Did the planets orbit change in any way? If so, how?

As $v \uparrow$ the orbit becomes more elliptical

- Increase the red velocity arrow substantially
- Run simulation and observe

What happened to the planet in orbit?

the planet did not remain in orbit

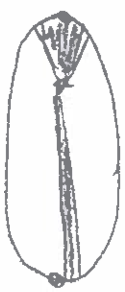
- Decrease the red velocity arrow substantially
- Run simulation and observe

How did the orbit of the planet change?

the planet crashed into the Sun

Can this be explained in terms of velocity and gravity?

- If a planet's v is too high ⇒ g would have to increase in order to keep it in orbit
- if a planet's v is too ↓ ⇒ g would take over & swallow the planet



a line joining a planet & the Sun sweeps out equal areas during equal intervals of time

- Make sure the only thing selected is the path and grid
- Hold the graph paper to the screen and draw the sun in the center of the paper
- Run in slow motion, pausing every 30 days and indicating the placement of the planet
- Once each month has been marked, mark the orbit path and draw a straight line from each planet to the sun
- Count the grid boxes within each month period

How do the areas covered during each month compare?

each month covers the same amount of space.

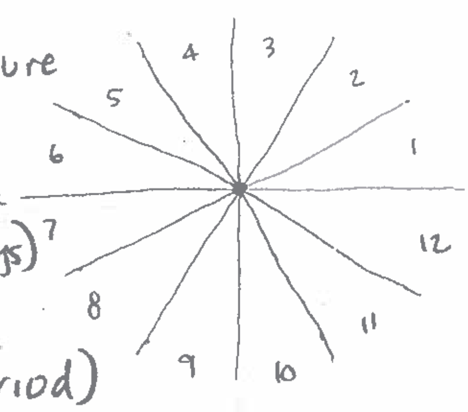
Which of Kepler's Laws does this pertain to? State the law.

2nd Law - planets speed up in their orbit when they are closer to the Sun & slow down when they are farther away

Is it possible to see Kepler's 3rd Law using this PhET? Explain.

Move the planet close to Sun & measure # Earth days (Ex: 236 Earth days)

& move farther from Sun & measure # of Earth days (Ex: 540 Earth days)



Planets that are closer to Sun take less time to orbit (shorter orbital period)

Planets that are farther from Sun take more time to orbit (longer orbital period)