Kepler’s Laws & Orbits

In this activity students will be exploring Kepler’s Laws and Orbital Motion using the “Gravity and Orbits” PhET simulation.

Open the simulation by clicking on the link:


Take a look at the explanatory video via YouTube:

https://youtu.be/m6e2y4fef1l

Learning Objectives

By the end of these activities it is hoped that students will have acquired the following skills:

• Following explicit instructions to gain acquired knowledge

• Investigate the shape of planetary orbits

• Relate how planetary orbits link to Kepler’s first two laws of planetary motion.
1. Is the orbit of a planet circular?
   - Press the **TO SCALE** option at the bottom of the screen with the star and planet chosen, see opposite image.
   - Turn on the path/grid option ON, see green circle.
   - Allow the planet to move through 360°.
   - Turn on the measuring tape from the tool bar, green circle.
   - 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.

<table>
<thead>
<tr>
<th></th>
<th>Distance (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left side from path to star</td>
<td></td>
</tr>
<tr>
<td>Right side from star to path</td>
<td></td>
</tr>
</tbody>
</table>

• What do you notice about the distances?

• What does this data say about the orbit of the planet, discuss?
2. Linking planetary orbits to Kepler’s Laws?

- Go to model
- Click sun and planet
- Press **PLAY**, blue circle (with path/gravity/velocity/grid **ON**, green circle) and leave for one cycle then **PAUSE**.
  
  - Screen shot trajectory

  ![Screenshot of the trajectory](image)

  - **What holds the planet in the orbit?**

  What shape is the orbit use the screenshot to explain this?

  - **Turn ON** gravity force button, green circle above.
    
    - **What direction do the forces face**, screenshot this as proof?

    ![Screenshot of the trajectory](image)

  - **Turn the gravity OFF**, green circle above.
    
    - **What happens to the planet & why**, screenshot this as proof?

    ![Screenshot of the direction](image)
- Now increase slightly the velocity of the plant by extending the red ‘v’ arrow of the planet, green circle.
  
  • What happens to the planet in the orbit?

  • What is the shape of the orbit when increased?

- Now increase the velocity of the plant to a large extent by extending the red ‘v’ arrow.
  
  • What happens to the planet in the orbit?

- Now decrease slightly the velocity of the plant by diminishing the red ‘v’ arrow, green circle.
  
  • What happens to the planet in the orbit?

  • What is the shape of the orbit when increased?

- Now decrease the velocity of the plant to a large extent by moving the ‘v’ arrow in.
  
  • What happens to the planet in the orbit?

  • Now try to explain this in terms of v and gravity?

  •
• Is the velocity constant throughout the journey?


• Which one of Kepler’s law does this relate to?

- With the star and planet chosen and path/grid on, increase the size of the star by sliding the controller to 1.5/1.75/2.0, green circle.
  • What do you notice about the orbit?
  
  • What happens to the velocity on the path?

- Now do the same but change the planets mass 1.5/1.75/2.0, blue circle.
  • What do you notice about the orbit?

  • Why do you think the observation for your previous answer occurs?