

Orbital Mechanics Student Directions and Activity

Computer simulation of gravity and 3 body planetary systems

Simulation directions

- Double-click on the ejs_ITOP_Orbital_Mechanics.jar file to open the simulation.
- When the simulation is running, you will be presented with a space map with three planetary bodies already positioned at some initial position.
- If you go ahead and click on play, you will notice the behavior of these three bodies.
- The three planets and/or stars will move in a way predicted by the universal law of gravitation.
- Try turning on and off the traces option to illustrate the paths that the planets take through space.
- You will notice that the default conditions consist of a very large centrally located object with two smaller objects at different distances away. The two smaller objects also have an initial tangential velocity.
- All mass, position, and velocity data for each object is available on the bottom of the simulation. This data table at the bottom can be used for data inputs or for real time information.
- It is easier to drag the planets to their initial positions instead of inputting the x and y coordinates.
- You will also see that the velocity vectors are present at startup and can also be dragged and resized to set up initial velocities.
- Other checkboxes and controls are available that should help in activity.

Simulation activity

Task: To create a system of 3 planets/stars using a computer simulation program. Explore the effect of changes in mass, distance, and velocity on the orbital motion/period of the planets/stars.

Procedure

1. Open the simulation program and click on play using the initial conditions.
What happens? _____
2. Reset the simulation and decrease the velocity of both small planets to zero and then play the simulation. What happens? _____
3. In order to keep the planets orbiting the central object, it is important to set the initial velocity so that it is (tangent / radial) to the orbit?
4. What velocity must you give the two planets so that their orbits are nearly circular?
5. Sketch the change in the planet's motion as you change the initial velocity of the two smaller planets. Provide 3 different scenarios.
6. Sketch the change in the planet's motion as you change the initial mass of the two smaller planets. Provide 3 different scenarios.
7. Sketch the change in the planet's motion as you change the initial mass of the larger centrally located planet/star. Provide 3 different scenarios.

8. Set both smaller planets so that they have the same mass. (Around 10 is good). Also adjust their distance from the central planet so that 1 planet is twice as far away as the other one. Now adjust the initial velocity of both planets so that their orbits are circular.
9. Calculate the acceleration and period of each planet.

Questions

1. How do the orbits of the planets change when the mass of the sun is increased or decreased? Why? Explain your answer.
2. When is the planet moving fastest? Why?
3. What makes the length of the year increase and decrease? Why?
4. A planet in a circular orbit would always be the same distance from the sun. What do you notice about orbits with the shortest years? Why?
5. How does the year of a planet closer to the sun compare with one that is farther away? Why?
6. How can an orbit be made more circular? Explain your answer.
7. In your own words describe what an orbit is and what factors affect the size, speed and time (period) of an orbit.
8. Which planet in our solar system has the greatest orbital velocity?
9. Which planet in our solar system moves the slowest?