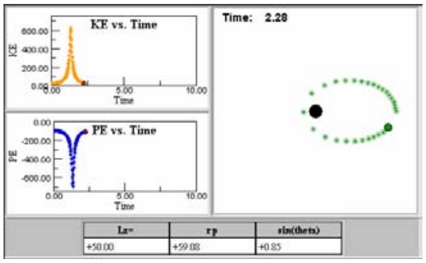
Worksheet for Exploration 12.2: Set Both x_o and v_o for Planetary Orbits



This Exploration shows a planet orbiting a star. The initial position in the x direction and the initial velocity in the y direction of the planet can be set at t = 0 **time units** when the planet is on the x axis. The difference in orbital trajectory, therefore, is due to the planet's initial position and velocity (**in this animation GM = 1000**). Restart.

a. As you vary the initial velocity of the planets how do the orbital trajectories change?

b. What happens to the orbit when x_0 gets really small (keep $v_{0y} = 10$)?

c. What happens to the orbit when x_0 gets really large (keep $v_{0y} = 10$)?

d. What happens to the orbit when v_{0y} gets really small (keep $x_0 = 5$)?

e. What happens to the orbit when v_{0y} gets really large (keep $x_0 = 5$)?

f. Find the condition for circular motion.

g. For circular motion, what is the period?

h. During each of your investigations, what was happening to the angular momentum as time passed? Why?

i. Make $x_0 = 10$. Then for small v_0 what type of orbit occurs?

j. For $x_0 = 10$ what v_0 makes the orbit circular?

k. As you increase v_0 (x_0 = 10) the orbit changes shape. What shape does it have just beyond the speed required for circular orbit?

l. As you increase v_0 (x_0 = 10) even further, you eventually reach a condition of “escape”. Use energy considerations to predict what this escape velocity should be.

m. For any circular orbit predict (and then check on the graphs) how the magnitude of potential energy compares to kinetic. Likewise for escape velocity.

n. For a given orbit you should note that the angular momentum remains constant. How does this relate to the other quantities in the table (under the simulation window), and discuss what is meant by the angle “theta”?