Kepler's Second Law

Apparatus

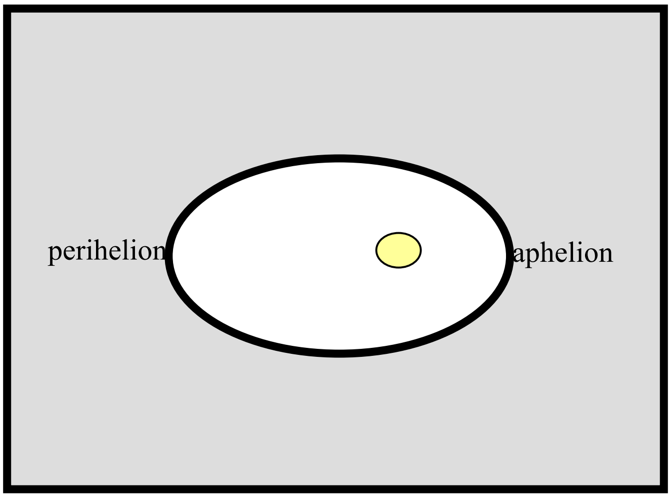
two perspex plates sitting one atop the other, with an ellipse cut out of the top one, with two movable arms attached to one focal point, some ball bearings - see diagram below
The arms should be long enough that they slide around along the upper perspex sheet, the ball bearings should be large enough that they can sit between the two arms without sliding beneath them.

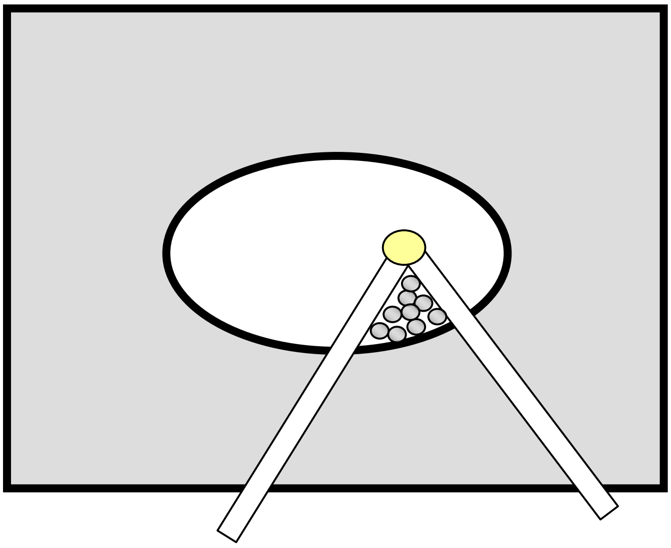
Action

The students move the long arm around, which pushes the ball bearings and other arm along. They should note the relationship between distance from sun, area swept out, and velocity. The area covered by the ball bearings is constant, which can be seen by the lack of gaps between them. The greater the angle between the arms, the greater the angular velocity required to sweep out that area in a given time.

The Physics

The area swept out per unit time by the line joining the planet and the sun is constant. The distance between the sun and planet varies, because the orbit is elliptical, hence the length of this line varies in time. For the area swept out per unit time to be constant the velocity must vary, decreasing as the planet moves further from the sun (towards aphelion) and increasing as it moves closer (towards perihelion). Note that Kepler's second law is identical to conservation of angular momentum, $L = I\omega =$ constant. This can be seen as the angle increases between the arms to give the same area swept out when the planet is near aphelion. The angle, and hence angular velocity, decreases near perihelion.





Accompanying sheet

Kepler's Second Law

Move the "planet" around the sun.
Note the line joining the planet to the sun and observe the area that it sweeps out.

What happens to the velocity of the planet as it moves
further away from the sun (towards aphelion)?

What happens as it moves closer to the sun (towards perihelion)?