Astronomy (Schroeder) Name: ______________________

Exercise 4

Due Monday, September 19, 5:00 pm

1. **Strobe diagrams.** On the reverse side of this page, please construct "strobe diagrams" for each of the objects A, B, C, and D. In each case, the diagram already shows the first two dots along the motion; your job is to *carefully* construct at least four more dots for each object (up to dot number 6). Please *use a ruler* to measure out the position of each new dot; don't just estimate the distances by eye. For each new dot, draw arrows showing the inertial motion and the additional motion caused by the force, as in the strobe diagrams discussed in class.

   Object A has no force acting on it. Object B has a continuous downward force acting on it, which you should treat as a succession of discrete "kicks," one acting at dot 2 and at each successive dot. Each kick would, by itself, result in a downward motion of 1/4 inch during a single time step. (This object behaves like a falling apple near earth's surface, pulled downward by gravity.) Object C is subject to the same downward force as B, but is initially moving in the horizontal direction. Object D is subject to a force of the same strength as B and C, but this time the force always points directly toward a fixed point, marked "center of attraction."

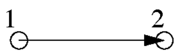
2. As part of a scientific experiment, you simultaneously drop a small apple and a large pumpkin out a second story window. Which object has a greater gravitational force acting on it? Explain why, despite the difference in force, both objects fall at the same rate.

3. The space shuttle typically orbits the earth at an altitude of about 200 miles above the surface. The radius of the earth is 4000 miles. To determine how the weight of an astronaut on the shuttle differs from her weight on earth's surface, calculate $(4000)^2$ and $(4000 + 200)^2$, and determine the percentage by which one is larger than the other. These are the numbers that appear in the denominator of Newton's inverse-square formula for the gravitational force exerted on the astronaut by the earth. Suppose the astronaut's weight on earth is 140 lbs. What is her weight on the shuttle?

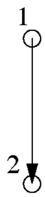
4. Your final answer to the previous question should have been approximately 127 lbs. Does this result surprise you? Explain why, even though they weigh only slightly less than on earth, astronauts on the shuttle have the illusion of being weightless.

Strobe Diagram Worksheet

Object A (no force):



Object B (steady force along motion):



Object C (steady downward force):

Object D (force is always toward a fixed point):

center of attraction