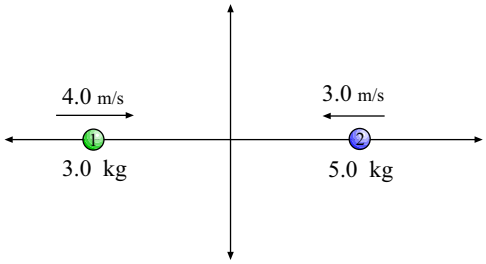
Phys 2112, Spring 2011
Problem Set #4

1. Two particles approach each other along the x axis, as shown at the right. (This is the view of the particles in the "lab" reference frame.) The two particles will make a head-on collision and their final velocities will also be in the x direction.



a) What are the initial velocities of the mass in a reference frame which moves at a speed of 0.375 $\frac{\text{m}}{\text{s}}$ in the $-x$ direction?

b) If *in the reference frame considered in (a)* the velocities simply reverse (change direction by 180°) in the collision, what are the final velocities in the moving frame?

c) Now find the final velocities in the original ("lab") frame.

2. Newton's law of gravity gives the magnitude of the force of gravitational attraction between any two (small) masses. It is

$$F = G\frac{m_1 m_2}{r^2} \qquad \text{where} \quad G = 6.67 \times 10^{-11}\ \tfrac{\text{N}\cdot\text{m}^2}{\text{kg}^2}$$

What is the magnitude of the gravitational force between two 5.0 kg masses separated by 10.0 cm? *(Watch the units!)*

3. If two identical masses separated by 1.0 m have a force of attraction of 1.0×10^{-4} N, what is the value of the mass?

4. What is centripetal acceleration of the earth as it orbits the sun? (The distance from the sun to the earth is $R = 1.50 \times 10^{11}$ m, and the period of the earth's orbit is 1.0 yr = 3.16×10^7 s.)

5. The period of the earth's orbit is 1.0 yr = 3.16×10^7 s and the distance from the sun to the earth is $R = 1.50 \times 10^{11}$ m. If the centripetal force on the earth is due to the gravitational force of the sun, namely

$$F_c = \frac{M_E v^2}{R} = G\frac{M_S M_E}{R^2}$$

solve for the mass of the sun. Note, M_E cancels in this equation, and you might want to use the result of 4.

6. The distance from the earth to the moon (center to center) is 3.84×10^8 m. It takes the moon 27.3 days to go around the earth. Find the centripetal acceleration of the moon.

7. Do as in 5 to get the mass of the earth. (Change "Sun and Earth" in 5 to "Earth and Moon".)

$$F = G\frac{m_1 m_2}{r^2} \qquad G = 6.67 \times 10^{-11}\ \tfrac{\text{N}\cdot\text{m}^2}{\text{kg}^2} \qquad F_c = \frac{mv^2}{r}$$