

Instructions:

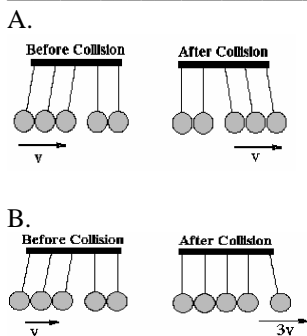
1. Do all of your work on this sheet.
2. **Show all of your steps** in problems for full credit.
3. **Be clear and neat** in your work. Any illegible work, or scribbling in the margins, will not be graded.
4. Place your **answers in a box**. Do not forget **units!**
5. If you need more space, you may use the back of the page and write **On back** in the problem space.

1. **Multiple Guess (3 pts)** Find the answer which best fits the question and write it in the space provided.

- a. Impulse is equal to  
 a)  $F\Delta x$ . b) change in kinetic energy.  
 c) the change in momentum. d)  $\frac{dp}{dt}$ .
- b. The momentum of a system of objects is conserved if  
 a) the force acting on the system is conservative;  
 b) there is an unbalanced external force acting on the system;  
 c) there are no net external forces acting on the system;  
 d) the mechanical energy is conserved.
- c. The center of mass of which of the following objects would not lie within the body itself?  
 a) baseball b) solid brick c) Frisbee d) paperback book

2. **Definition/Principle (3 pts)**

A popular toy exhibiting elastic collisions is shown below. There are five identical masses suspended from a supporting bar. Let three balls enter with a speed  $v$ . Based on conservation principles, determine which of the following two scenarios is most likely. [Explain your answer for full credit!]

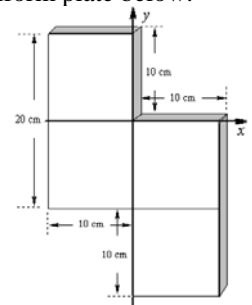


**Bonus:** At one end of a train car is a crate of oranges. A monkey tosses each orange 15 m/s to the opposite end of the car, where it hits the wall and falls straight down to the floor. Describe the position and velocity of the car after the monkey has thrown the oranges?

Position:  
 Velocity:

3. **Problems (14 pts)**

- a. A top tennis player serves a 0.060 kg tennis ball horizontally at 65.0 m/s during a serve.  
 i. If the contact time with the racket is 0.030 s, then what is the average force on the ball?  
 ii. If the ball rebounds horizontally from a wall at 50.0 m/s, what is the impulse delivered by the wall?
- b. A 5.00 g pellet strikes a 200.0 g block of wood that is free to move and sticks to it. What was the original speed of the pellet if the block's speed is 3.00 m/s after impact?
- c. (3 pts) Find the center of mass of the uniform plate below.



- d. An 1100 kg van is stopped at a light. It is hit directly by a 750 kg car traveling with velocity 2.50 m/s. Assuming the van is in neutral and the collision is elastic, what is the final velocity of the van after the collision?
- e. (3 pts) A ball of mass  $2m$  on a string ( $L = 45$  cm) swings down and strikes a similar ball of mass  $m$  as shown. How high does the small mass rise after the collision? Assume the collision is elastic or inelastic. State which you used: \_\_\_\_\_

