SCI1130: Mechanics: A Theoretical Approach

Spring 2014

Homework Assignment 8

Issued: Monday, April 7th, 2014 **Due: Saturday, April 12th, 2014 by 11 pm**

Enthusiasm is the energy and force that builds literal momentum of the human soul and mind.

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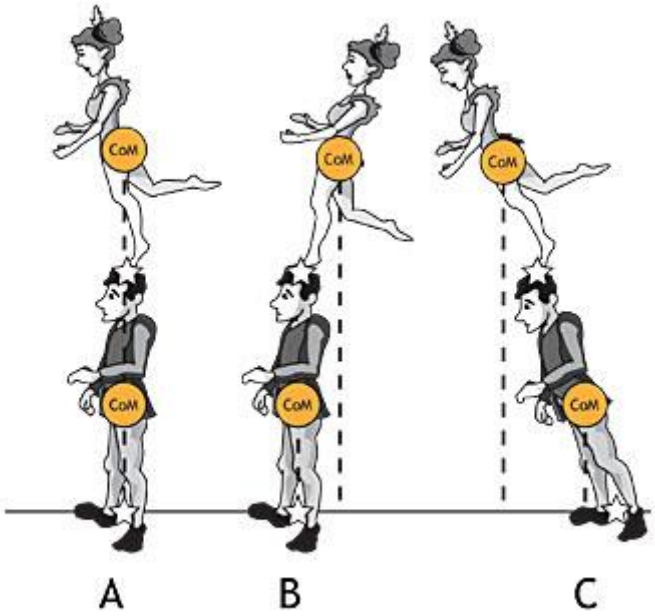

http://www.pbs.org/opb/circus/classroom/circus-physics/center-mass/

Important Concepts:

(a) Impulse and Collisions
(b) Conservation of Momentum
(c) Impulse-Momentum Theorem
(d) Collisions: Elastic and Inelastic
(e) Center of Mass
(f) Center of Mass Motion

Textbook Reading:

(a) Chapters 10 – 11

Questions and Problems:

1. Experiment and its Analysis:

Perform an experiment with two balls, say a softball and a basketball, one balanced on the top of another and drop them to the floor. I hypothesize that the basketball would stop dead on the floor and the softball would rebound high into the air. Please, check my hypothesis. This peculiar behavior occurs because of the specific ratio of the masses of the basketball and softball. What must that ratio be?

HINT: Assume that the basketball first rebounds elastically from the floor and then the softball and (upward moving) basketball collide. What height does the softball reach compared to the initial height of the balls?

2. Center of Mass:

Ohanian and Markert, Ch. 10, Problem 55, p. 334

3. Center of Mass -- Harder Stuff!

Ohanian and Markert, Ch. 10, Problem 56, p. 334

4. Motion of the Center of Mass:

Romeo and Juliet are sitting at opposite ends of a rowboat in still water. Romeo entertains Juliet by strumming his guitar and reciting a list of physics formulas that he has attempted to memorize just for this occasion. He draws a blank when trying to remember the definition of the center of mass of an extended object and begins to blush. Juliet carefully moves to Romeo and whispers the formula into his ear. Juliet's mass is 60 kg and Romeo's mass is 70 kg; the boat has a mass of 50 kg and is 3 m long. If the boat is oriented so that Juliet moves away from shore, how far does the boat move toward the shore during this episode of physics-induced romance? (Assume that the water exerts no net horizontal force on the boat.)

5. Interesting Geometry and Center of Mass Motion:

The curved inclines of two identical wedge-shaped masses *M* smoothly merge with a horizontal, frictionless surface as indicated in the Figure 1 below. The curved surfaces of the inclines also are frictionless. Another mass *m* is released at rest from a height *h* on one of the curved, smooth surfaces of the wedges.

a) Consider first the motion of *m* from its initial height *h* down to the horizontal plane. Is the total mechanical energy of *m* and *M* conserved in the descent? If so, write an equation representing this. Is the total momentum of the system of *m* and *M* conserved in the descent? If so, write an appropriate equation expressing this conservation when *m* reaches the horizontal surface.

b) After *m* reaches the horizontal plane, it then encounters the right-hand wedge and ascends it to some height *h'*. Is the total mechanical energy of the system of *m* and the right-hand wedge conserved in the ascent? If so, write an equation expressing

this relationship. Is the total momentum of *m* and the right-hand wedge *M* conserved in the ascent? If so, write and equation expressing this relationship.

c) Show that the height h' to which *m* ascends the right-hand wedge is

$$h' = [M^2/(M + m)^2]\, h.$$

d) What mass ratio M/m results in h' = h/4?