Physics 8.01T   Fall Term 2004

Problem Set 8: Center of Mass, Momentum and Impulse

Available on-line October 22; Due: November 2 at 4:00 p.m.

Please write your name, subject, lecture section, table, and the name of the recitation instructor on the top right corner of the first page of your homework solutions. Please place your solutions in your lecture section table box.

Oct 22
Hour One: Problem Solving Session 12: Conservation of Energy: Restoring Forces and Harmonic Motion
Reading: YF 13.1-13.5

Problem Set 7: Due Tues Oct 26 at 4:00 pm.

Oct 25
Hour One: Center of Mass, Momentum, Impulse and Newton's Second Law
Reading: YF 8.1-8.5

Hour Two: Problem Solving Session 13: Center of Mass, Momentum, Impulse and Newton's Second Law
Reading: YF 8.1-8.5

Oct 27
Hour One: Test Review

Hour Two: **Test Review**

Oct 28   QUIZ TWO: Newton's Laws, Circular Motion, Static Equilibrium, and Conservation of Energy

Oct 29 No Class

Problem Set 8: Due Tues Nov 2 at 4:00 pm.

Nov 1
Hour One: Conservation Laws: Momentum and Collision Theory.
Reading: YF 8.3-8.6

Hour Two: Problem Solving Session 14: Conservation of Momentum
Reading: YF 8.3-8.6

Nov 3
Hour One: Experiment 7: Collisions
Reading: Experiment 7

Hour Two: Rigid Bodies Kinematics
Reading: YF 9.1-9.6

Nov 5
Hour One: Problem Solving Session 15: Moment of Inertia and Rotational Energy
Problem Set 9: Due Tues Nov 9 at 4:00 pm.

Problem 1: Pre-Experiment 07 Concept Questions

a) Cart A is at rest on a straight horizontal track with negligible friction. An identical cart B, moving to the right, collides with cart A. They stick together. After the collision, which of the following is true?

1. Carts A and B are both at rest.
2. Carts A and B move to the right with a speed greater than cart B's original speed.
3. Carts A and B move to the right with a speed less than cart B's original speed.
4. Cart B stops and cart A moves to the right with speed equal to the original speed of cart B.

Explain your reasoning.

b) Cart A is at rest on a straight horizontal track with negligible friction. An identical cart B, moving to the right, collides elastically with cart A. They do not stick together. After the collision, which of the following is true?

1. Carts A and B are both at rest.
2. Cart B stops and cart A moves to the right with speed equal to the original speed of cart B.
3. Cart A remains at rest and cart B bounces back with speed equal to its original speed.

4. Cart A moves to the right with a speed slightly less than the original speed of cart B and cart B moves to the right with a very small speed.

a) Suppose you drop paperclips into an open cart rolling along a straight horizontal track with negligible friction. As a result of the accumulating water, explain whether the momentum and kinetic energy increase, decrease, or stay the same.

Problem 2: *Center of Mass*

The mean distance from the earth to the sun is $r_{e,s} = 1.49 \times 10^{11}\, m$. The mass of the earth is $m_e = 5.98 \times 10^{24}\, kg$ and the mass of the sun is $m_s = 1.99 \times 10^{30}\, kg$. The mean radius of the earth is $r_e = 6.37 \times 10^{6}\, m$. The mean radius of the sun is $r_s = 6.96 \times 10^{8}\, m$. Where is the location of the center of mass of the earth-sun system?

Problem 3: *Impulse and Momentum*

A ball of mass $m_1 = 8.0 \times 10^{-2}\, kg$, starting from rest, falls a height of $3.0\, m$ and then collides with the ground. The ball bounces up to a height of $2.0\, m$. The collision with the ground takes place over a time, $\Delta t_{col} = 5.0 \times 10^{-3}\, s$.

a) What is the momentum of the ball immediately before the collision?

b) What is the momentum of the ball immediately after the collision?

c) What is the average force of the ground on the ball?

d) What impulse is imparted to the ball?

e) What is the change in the kinetic energy during the collision?

Problem 4:

A block of mass m_b on a horizontal table is connected to one end of a spring with spring constant k. The other end of the spring is attached to a wall. The block is set in motion so that it oscillates about its equilibrium point with amplitude A_0.

a) What is the period of the motion?

A lump of sticky putty of mass m_p is dropped onto the block. The putty sticks without bouncing. The putty hits the block at the instant when the velocity of the block is zero.

b) Find the new period, the new amplitude, and the change in mechanical energy of the system.

The putty is removed and the block is set in motion with the same amplitude A_0. This time the putty is dropped and hits the block at the instant the block has its maximum velocity.

- c) Find the new period, the new amplitude, and the change in mechanical energy of the system.