Physics CS 31

Set #9 - for **Tuesday** December 3

Fall 2013

Read RHK Ch. 6; Ch. 7; Ch. 12 (skip 12.4), Ch. 13
K&K Ch. 3; Ch. 4 (4.11-4.14)
Feynman V1 Ch. 10

Solve

From RHK	**Ch. 6**	Problems 3, 7, 17
	Ch. 7	Exercise 6, 20
	Ch. 12	Problem 6
From K&K	**Ch. 4**	Problem 4.4, 4.20, 4.23, 4.27 **Extra Credit 1:** 4.11
	Ch. 4	**Problem (4.23+).** Solve the problem in the case when coefficient of restitution for the collision between ball and "superball" is e.

Problem 1. Consider the problem of a water droplet falling in the atmosphere. As the droplet passes through a cloud it acquires mass at a rate proportional to its instantaneous mass $M(t)$. That is, if M is the mass of the droplet at time t, then $\mathrm{d}M/\mathrm{d}t = kM$, where k is a proportionality constant. Consider a droplet of initial mass M_0 that enters a cloud with velocity v_0. Assume no resistive force and find:

a) The mass of the droplet as a function of time.
b) The velocity of the droplet as a function of time.

Problem 2. An electron, mass m, collides head-on with an atom, mass M, initially at rest. As a result of the collision, a characteristic amount of energy E is stored internally in the atom. What is the minimum initial speed v_0 that the electron must have?

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Problem 3. A lunar module of total mass M_0 is at height H above the surface of the Moon and is descending vertically at speed v_0, when a rocket is ignited to produce a soft landing. The mass of the fuel decreases at a constant rate with respect to time, and the gas is ejected at a speed of $2400\ \mathrm{m/s}$ relative to the module. If the module touches the lunar surface with zero velocity and the module's mass at the end of the burn lasting $350\ \mathrm{s}$ is $(2/3)M_0$, evaluate v_0 and H. (Assume that the acceleration due to gravity at the surface of the Moon is $1.62\ \mathrm{m/s^2}$).

http://en.wikipedia.org/wiki/File:Bouncing_ball_strobe_edit.jpg

Problem 4a. Use the ruler and the following picture to estimate coefficient of restitution of the basketball. Neglect air resistance.

Problem 4b. The basketball is dropped from height of $2\ \mathrm{m}$. How long will the basketball bounce of the floor until it will stop?

Problem 5. During last lecture we discussed a paradox that the law of conservation of energy in the inertial frame of reference that is moving with constant velocity v looks wrong: $mgh + \frac{1}{2}mv^2 = 0$. Using direct calculation of energies, show that moving frame of reference could be used and the law of conservation of energy works well in this frame of reference.

Problem 5

Extra Credit 2. Two railway cars of masses m_1 and m_2 are moving along a track with velocities v_1 and v_2 respectively. The cars collide, and after the collision the velocities are u_1 and u_2 respectively. Show that the change in kinetic energy of the system will be a maximum if the cars couple together.

Good Luck, Dr. B