Physics 141
Problem Set 6

Due Monday, Nov. 10 (hand in in class).

Monday, Nov. 3, 2008

H. J. Frisch; 702-7479

==========

Quiz: There will be the usual quiz in the Tuesday discussion session at 4:30pm. Problems may cover conservative forces, line integrals, calculating $d(Work) - \vec{F} \cdot d\vec{r}$, $\vec{F} = d\vec{p}/dt$, momentum conservation.

==========

2nd Midterm: The second midterm will be given on Tueday, November 11, in the discussion session at 4:30pm. The emphasis will be on material since the first midterm, but you should review all the problem sets and quizzes and make sure there are no holes.

==========

Reading: K&K:
Example 4.10;
Chapter 4, Sections 4.8-4.9, 4.11-4.14;
Chapter 4.
Please read these with a pencil or pen in hand, taking notes (Chapter 5 is quite sophisticated, and very well done. (But see the note on Chapter 5 in the *To the Teacher* (pp. xix- xxii)).

==========

Study Groups You are strongly encouraged to discuss the problems in a study group to save time. However, the work you hand in has to be your own- you must **NEVER** copy anybody else's work! (grounds for severing your connection).

==========

Problem Solving: Please always work in symbols and only plug numbers in at the end where and if required. In general you should start by drawing a careful picture, with labelled axes..

==========

Problem 1: Momentum Conservation: Another Collision, and C of M
K&K Problem 4.23: A small ball of mass m is placed on top of a larger ball of mass M, and the two balls are dropped from a height h (I did this once in class). Assume $m << M$, and all collisions are elastic. How high does the smaller ball go?

Problem 2: Gradients
The gravitational potential from a mass M at a point $\vec{r}$ in space is defined as:

$$\phi(x, y, z) = G_N M/r \tag{1}$$

where G_N is Newton's constant, and $r \equiv |\vec{r}| = \sqrt{x^2 + y^2 + z^2}$. The potential is defined such that a second mass m will be acted upon by a force given by

$$\vec{F}(r) = -m\vec{\nabla}\phi \tag{2}$$

a. Find the expression for the force at the point $\vec{r} = (x, y, z)$.

b. Calculate the force between you and the student sitting closest to you in class. (give the direction as well as the magnitude, and round all numbers so that you don't need a calculator).

Problem 3: Cross-Product and Identities Involving Del

1. Prove:
$$\vec{A} \times \vec{B} \times \vec{C} = (C \cdot A)\vec{B} - (B \cdot A)\vec{C} \tag{3}$$
2. Prove:
$$\vec{\nabla} \times (\vec{A} \times \vec{B}) = (\vec{B} \cdot \vec{\nabla})\vec{A} - (\vec{A} \cdot \vec{\nabla})\vec{B} + (\vec{\nabla} \cdot \vec{B})\vec{A} - (\vec{\nabla} \cdot \vec{A})\vec{B} \tag{4}$$
3. Prove:
$$\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0 \tag{5}$$

Problem 4: Forces from Potentials. K&K Chapter 5, Problem 5.1

Problem 5: Is My Force Conservative? K&K Chapter 5, Problem 5.4

Problem 6: Calculating Work Along a Path. K&K Chapter 5, Problem 5.8

==========