Prelim ID Number: ______

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part D, 14:00–17:00, Aug 19, 2011

Instructions

1. You may use a calculator and CRC Math tables or equivalent. No other tables or aids are allowed or required. You may **NOT** use programmable calculators to store formulae.
2. All of the problems will be graded and will be tabulated to generate a final score. Therefore, you should submit work for all of the problems.
3. For convenience in grading please write legibly, use only one side of each sheet of paper, and work **different problems on separate sheets of paper**. The sheets for each problem will be stapled together but separately from the other two problems.
4. You will be assigned a **Prelim ID Number**, *different from your UF ID Number*. The **Prelim ID Number**, the **Problem Number**, and the **Page Number** should appear in the upper right hand corner of **each sheet**. Do **NOT** use your name or UF ID Number anywhere on the Exam.
5. All work must be shown to receive full credit. Work must be clear and unambiguous. Be sure that you hand your completed work to the Proctor.
6. Each problem is worth 10 points.
7. Following the UF Honor Code, your work on this examination must reflect your own independent effort, and you must not have given, nor received, any unauthorized help or assistance. If you have any questions, ask the Proctor.

   University of Florida Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

DO NOT OPEN EXAM UNTIL INSTRUCTED

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part D, 14:00–17:00, Aug 19, 2011

D1.

A neutral pion π^0 with mass m_{π^0} decays into two γ-rays. Suppose a π^0 is moving with a total energy E.

(a) (*4 points*) What are the energies of each of the two γ-rays if the decay process causes them to be emitted in opposite directions along the pion's original line of motion?

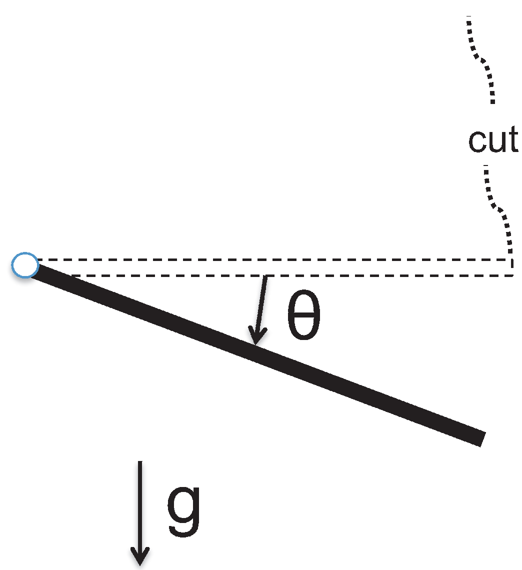
(b) (*4 points*) What angle is formed between the two γ-rays if they are emitted at equal angles to the direction of the pion's motion?

(c) (*2 points*) Taking the mass of the pion to be $m_{\pi^0} = 135\,\mathrm{MeV}/c^2$ and the energy of the pion $E = 1$ GeV, give approximate numerical values for the answers in parts (a) and (b).

PRELIMINARY EXAMINATION
Department of Physics
University of Florida
Part D, 14:00–17:00, Aug 19, 2011

D2. A plank of length l and mass m hangs horizontally from a pivot on one side and supported by a wire on the other. The wire is then cut and the plank swings about the pivot point.

- What is the angular acceleration $\ddot{\theta}$ of the plank at any given angle θ? (2 points)
- Find the x- and y-components of the force on the *pivot* immediately after the wire is cut. (5 points)
- Find the force on the *pivot* when the plank swings through vertical. (3 points)



PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part D, 14:00–17:00, Aug 19, 2011

D3.

$1 \text{ MeV} = 1.6 \times 10^{-13}$ J
$1 \text{ fm} = 10^{-15}$ m
$\hbar = h/2\pi = 1.05 \times 10^{-34}$ J·sec $= 6.58 \times 10^{-22}$ MeV·sec   ($\hbar c = 200$ MeV·fm)
$c = 3 \times 10^8$ m/s
$m_n = m_p = 1.67 \times 10^{-27}$ kg   ($m_n c^2 = 940$ MeV)

A spherical nucleus consists of N nucleons, each having radius $r_0 \simeq 1.0$ fm and mass m_n (We assume that protons and neutrons have approximately the same mass). The volume of the nucleus is approximately N times the volume of a single nucleon. The strong force binds the nucleons within the nucleus.

(a) (*5 points*) Using the uncertainty principle, derive an approximate expression for the minimum kinetic energy per nucleon in terms of N, m_n and r_0, assuming non-relativistic motion confined to the nucleus.

(b) (*2 points*) Using (a), find the approximate kinetic energy (in MeV) per nucleon for a Helium nucleus ($N = 4$). How does this compare to the measured binding energy of ~ 8 MeV/nucleon? (Hint: the evaluation is a little easier if you express your answer from (a) in terms of $\hbar c$ and $m_n c^2$, using their values in the above table of constants.)

(c) (*3 points*) Using the Schrödinger equation, find the ground state energy of a single nucleon in terms of N, m_n and r_0. Assume that the nucleon moves freely within a cube with each side equal to the diameter of the nucleus. (This is a particle in a box in three dimensions.) How does this energy compare to the energy found in part (a)?