Student ID Number: _____

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part D, August, 2014, 14:00–17:00

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.

   (a) 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.

   (b) 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.

   (c) Your assigned student **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 anywhere on the Exam.

   (d) 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.

   (e) Each problem is worth 10 points.

   (f) 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

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D1. A particle with mass M at rest decays into three particles with masses m_1, m_2 and m_3.

All quantities in the answers should be expressed in terms of the known masses M, m_1, m_2 and m_3. You can work in natural units with $c = 1$.

(a) **[2 points]** What is the minimum energy of the particle m_1?

(b) **[4 points]** What in this case (when m_1 has a minimum energy) are the energies of the particles m_2 and m_3?

(c) **[4 points]** What is the maximum possible energy of m_1?

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D2. A body is composed of a cylinder of radius R and length L and a hemisphere also of radius R. Assume both are of the same density. The circular cross-section of the hemisphere is attached to one circular end of the cylinder. The body is balanced on the hemisphere with the cylinder section being vertical.

(a) **[5 points]** Find the center of mass of the whole system.

(b) **[2 points]** For what value of L is the center of mass at the center of the hemisphere (*i.e.,* at the cylinder-hemisphere interface).

(c) **[3 points]** What will happen to the body if it is tipped slightly away from equilibrium, in the case when:

1) L is equal to the value found in (b)?
2) L is (much) larger than the value found in (b)? (Hint: what if $L = \infty$?)
3) L is (much) smaller than the value found in (b)? (Hint: what if $L = 0$?)

PRELIMINARY EXAMINATION

DEPARTMENT OF PHYSICS

UNIVERSITY OF FLORIDA

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D3. A block of wood of initial mass M_0 slides on a horizontal frictionless surface. A machine gun begins shooting a steady horizontal stream of of bullets into the block. The bullets, each of mass m, are fired at a rate of n per second and with velocity v_0. You may assume that n is very large and that m is very small, *i.e.*, you can take the limit $n \to \infty$ with nm fixed. The block absorbs the bullets and thus becomes heavier with time with a mass $M(t)$, including all the bullets it has absorbed up to that point, and velocity $V(t)$. Ignore friction and gravity and assume that the block is at rest at $t = 0$.

(a) **[2 points]** Find the mass $M(t)$ as a function of time.

(b) **[3 points]** Show that $M(t)(v_0 - V(t)) = v_0 M_0$ at all times.

(c) **[3 points]** Solve for the motion of the block, *i.e.*, obtain $x(t)$ traveled by the block as a function of time t.

(d) **[2 points]** What is the acceleration of the block at $t = 0$?