Prelim ID Number: ________

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part A, 09:00–12:00, Aug 18, 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.

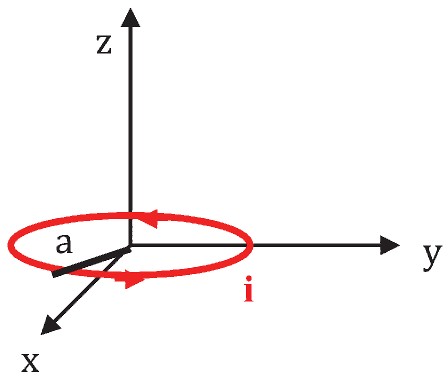
   University of Florida Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"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 A, 09:00–12:00, Aug 18, 2011

A1.



A circular current loop of radius a lies in the x-y plane ($z = 0$) with its center pierced by the z-axis as shown in the figure. The current i moves in the counter-clockwise direction in the x-y plane.

(a) (*4 points*) Calculate the magnitude and direction of the magnetic field at a point $z = d$ along the z-axis.

(b) (*3 points*) How much work must be done by an external force to bring a second identical current loop with the same current, current direction, and orientation (parallel to the x-y plane) from $z = \infty$ to the position $z = d$ along the z-axis? Assume that $d \gg a$ such that each loop can be approximated as a magnetic dipole and that the current i is maintained constant.

(c) (*3 points*) What force (magnitude and direction) acts on the second current loop at position $z = d$, assuming that $d > 0$ and $d \gg a$ and also that the central axes are aligned and the loops are in the same orientation with the same current?

PRELIMINARY EXAMINATION
Department of Physics
University of Florida
Part A, 09:00–12:00, Aug 18, 2011

A2.

For the angular momentum operator $\vec{L}$:

(a) (*7 points*) Prove that the operator L^2 commutes with the Cartesian components of the operator $\vec{L}$.

(b) (*2 points*) Among L^2, L_x, L_y, L_z, which pairs have values which can be simultaneously determined?

(c) (*1 points*) Is there any situation where all three components of $\vec{L}$ be determined simultaneously? Explain.

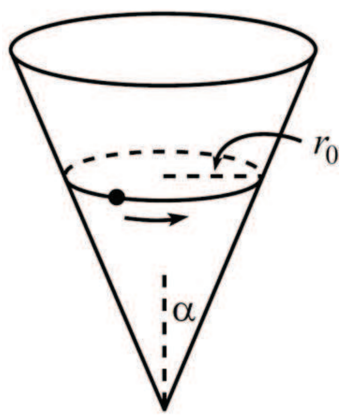
PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part A, 09:00–12:00, Aug 18, 2011

A3.



A particle slides on the inside surface of a frictionless cone. The cone is fixed with its tip on the ground and its axis vertical. The half-angle at the tip is α (see the figure). Let $r(t)$ be the distance from the particle to the vertical axis, and let $\theta(t)$ be the angle around the cone.

(a) (*2 points*) Write the Lagrangian for the particle.

(b) (*2 points*) Derive the equations of motion for the particle.

(c) (*2 points*) If the particle moves in a circle of radius r_0, find the frequency, ω, of this motion.

(d) (*3 points*) If the particle is then perturbed slightly from this circular motion, find the frequency, Ω, of the oscillations about the radius r_0.

(e) (*1 point*) Find the conditions for $\Omega = \omega$.