Student ID Number: _____

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part B, January, 2013, 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.

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. 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.

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 B, January, 2013, 14:00–17:00

B1. A conductor at potential $V = 0$ has the shape of an infinite plane except for a hemispherical bulge of radius R. A charge Q is placed above the center of the bulge at a distance $D(> R)$ from the plane. Find the force on the charge Q. Hint: you may want to use the method of images.

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part B, January, 2013, 14:00–17:00

B2. Three noninteracting particles of mass m move inside a 1-dimensional square well of size a.

(a) **[4 points]** Assume that the particles are distinguishable. Write down the general time-independent wavefunctions, properly normalized. Label the wavefunctions with any appropriate quantum numbers.

(b) **[2 points]** Using (a), find the lowest 6 energy eigenvalues in units of $E_0 = \pi^2\hbar^2/2ma^2$ and show which wavefunctions they correspond to. Identify any degeneracies.

(c) **[2 points]** Assume now that the particles are indistinguishable bosons. What is the ground state wavefunction and its energy in units of E_0?

(d) **[2 points]** Assume now that the particles are indistinguishable fermions. What is the ground state wavefunction and its energy in units of E_0?

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part B, January, 2013, 14:00–17:00

B3. Consider a system whose Helmholtz free energy is given by

$$F = -cT^3 \ln(V/V_0),$$

where T and V are temperature and volume. c and V_0 are positive constants.

(a) **[2 points]** The dimension of V_0 is obviously (length)^3. What is the dimension of c?

(b) **[4 points]** Express the pressure (P) of the system as a function of T and V.

(c) **[4 points]** Express the constant-volume heat capacity (C_v) of the system as a function of T and V.