Student ID Number: _____

PRELIMINARY EXAMINATION
DEPARTMENT OF PHYSICS
UNIVERSITY OF FLORIDA
Part B, 6 January 2003, 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

1

B1. An electron, mass m, moves in a potential of form

$$V(x) = \begin{cases} \infty & x < 0 \\ 0 & 0 \leq x \leq a \\ \infty & x > a \end{cases}$$

(a) (3 points) What is the ground state wave function and energy?

(b) (2 points) What is the first excited state wave function and energy?

Assume that the electron has spin up, and now a second spin up electron, which does not interact with the first, is added to the well.

(c) (3 points) What are the wave function and energy of the ground state of the two-electron system as described?

(d) (2 points) What are the energy and wave function of the first excited state? (still with both spins up!)

B2. A certain amount of water of heat capacity C is at a temperature of 0°C. It is placed in contact with a heat reservoir at 100°C and the two come into thermal equilibrium.

(a) (5 points) What is the entropy change of the universe?

(b) (2 points) The process is now divided into two stages: first the water is placed in contact with a heat reservoir at 50°C and comes into thermal equilibrium; then it is placed in contact with the heat reservoir at 100°C. What is the entropy change of the universe?

(c) (3 points) If we were to continue this subdivision into an infinite number of heat baths, what would be the entropy change of the universe?

B3. A metal sphere of radius a carries a charge Q. It is surrounded, out to radius b, by linear dielectric material of permittivity ϵ.

(a) (3 points) Find the potential at the center relative to infinity.

(b) (3 points) Give an expression for the surface polarization charge at the interface between the metal and the dielectric.

(c) (4 points) Compute the total electrostatic energy of the system.