Student ID Number: ________

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part D, 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

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D1. Two Level Systems: Consider a system of N particles that has only two possible states with energies: $E_1 = 0$ and $E_2 = \epsilon$. The Boltzmann distribution function $f_i = Ae^{-E_i/k_bT}$ provides the appropriate description of this system.

(a) [**2 points**] What is the value of A for this system?
Express your answer in terms of ϵ, k_B, T.

(b) [**2 points**] What is the average energy per particle $\langle E \rangle$?
Express your answer in terms of ϵ, k_B, T.

(c) [**1 point**] In the limit as $T \to 0$ what value does the average energy $\langle E \rangle$ go to?

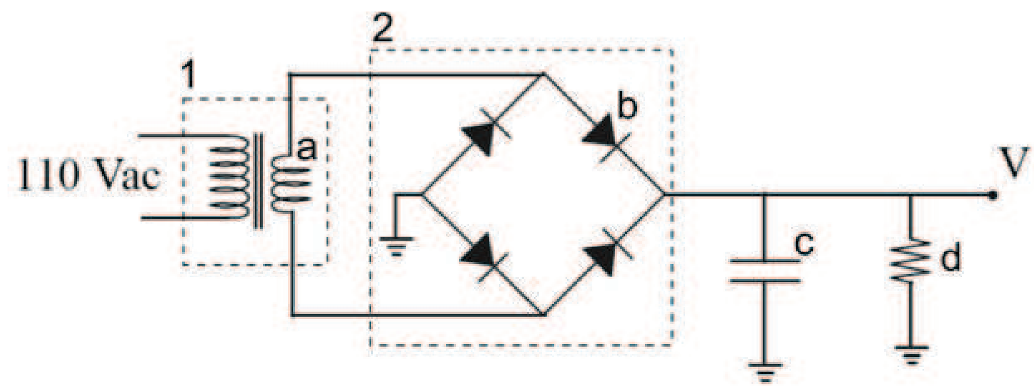
(d) [**1 point**] In the limit as $T \to \infty$ what value does the average energy $\langle E \rangle$ go to?

(e) [**2 points**] Show that the heat capacity is

$$C_V = Nk_B \left(\frac{\epsilon}{k_B T} \right)^2 \frac{e^{-\epsilon/k_B T}}{(1 + e^{-\epsilon/k_B T})^2}$$

(f) [**2 points**] Approximately at what temperature is the heat capacity maximized?

D2. For the circuit shown below



(a) **[1 point each]** Name the individual components indicated by the letters:
a:
b:
c:
d:

(b) **[2 points each]** Name the numbered device formed by the components surrounded by the dotted squares and their function in the circuit.
1:
2:

(c) **[2 points]** Give the name and function of the entire circuit, component d is the load.

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D3. A particle X is moving with speed v/c in the positive direction. The particle decays into two π-mesons, each of the rest mass = 140 MeV/c^2. One of them (particle 1) with kinetic energy 282 MeV, moves in the positive direction, and the other (particle 2), with kinetic energy 25 MeV, moves in the negative direction. Find the rest mass (in MeV/c^2) of the original particle X, and its speed v/c.