Student ID Number: ________

PRELIMINARY EXAMINATION
Department of Physics
University of Florida
Part C, August, 2013, 09:00–12:00

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

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C1. A quantum system has only two energy eigenstates, $|1>$, $|2>$, corresponding to the energy eigenvalues E_1, E_2. Apart from the energy, the system is also characterized by a physical observable whose operator $\wp$ acts on the energy eigenstates as follows:

$$\wp|1>=|2>, \ \wp|2>=|1>$$

The operator $\wp$ can be regarded as a type of parity operator.

(a) [**points**] Assuming that the system is initially in a positive-parity eigenstate, find the state of the system at any time.

(b) [**points**] At a particular time t a parity measurement is made on the system. What is the probability of finding the system with positive parity?

(c) [**points**] Imagine that you make a series of parity measurements at the times Δt, $2\Delta t$, ..., $N\Delta t = T$. What is the probability of finding the system with positive parity at time T?

(d) [**points**] Assume that the parity measurements performed in (c) are not instantaneous but each take a minimal time $\delta\tau$. What is the survival probability of a state of positive parity if the above measurement process is carried out in the time interval T?

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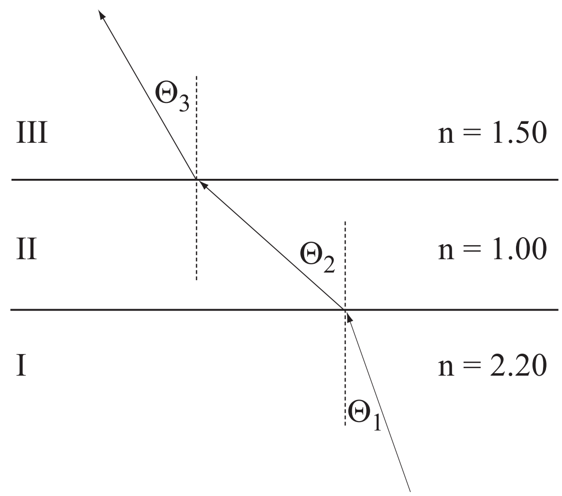
C2. An incident light ray from below in Region I in the n=2.20 material, angle Θ_1 from the perpendicular, undergoes refraction at the interface between Region I and Region II as shown.



(a) **[4 points]** What is the critical angle Θ_1 above which there is total internal reflection of the incident ray from Region I back into Region I?

(b) **[3 points]** What is the speed of light in the higher index of refraction material?

(c) **[3 points]** Now consider the third layer, just above the n=1.00 layer, where the new added layer has $n = 1.50$. If the exiting ray in Region III has angle $\Theta_3 = 30°$, what is the incident angle, Θ_1?

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C3. Consider a random walk, which starts at point **0** on the **x** - axis. At each step it moves randomly one unit distance to the right (**+1**) or to the left (**-1**).

(a) [**2 points**] Calculate probability that after **5** steps it will be at the point **+3**.

(b) [**2 points**] Calculate probability that it will return to **0** after **10** steps.

(c) [**3 points**] How many different trajectories returning to **0** after **10** steps cross point **+3** at step **5**?

(d) [**3 points**] Estimate the probability that after **10000** steps walk returns to **0**.

Hint 1: For parts 1-3, it is convenient to use binomial distribution coefficients.

Hint 2: For part 4, you can use Central Limit Theorem, or (in worst case) dimensional estimate.