Physics 237, Midterm Exam #1

Tuesday February 21, 2012
8.00 am – 9.30 am

Do not turn the pages of the exam until you are instructed to do so.

Exam rules: You may use *only* a writing instrument while taking this test. You may *not* consult any calculators, computers, books, nor each other.

1. Problems 1 and 2 must be answered in booklet # 1.

2. Problems 3 and 4 must be answered in booklet # 2.

3. The answers need to be well motivated and expressed in terms of the variables used in the problem. You will receive partial credit where appropriate, but only when we can read your solution. Answers that are not motivated will not receive any credit, even if correct.

At the end of the exam, you need to hand in your exam, your equation sheet, and the two blue exam booklets. **All** items must be clearly labeled with your name, your student ID number, and the day/time of your workshop.

Name: _____

ID number: _____

Workshop Day/Time: _____

Problem 1 (30 points) **ANSWER IN BOOKLET 1**

Consider a particle with charge e and rest mass m_0. The particle is accelerated to relativistic speeds by an accelerating potential V.

a) What is the de Broglie wavelength of this particle as function of V?

b) Show that the expression obtained in a) is consistent with assumption de Broglie made in the non-relativistic limit expressed in terms of the rest mass of the particle and its velocity.

Problem 2 (30 points) **ANSWER IN BOOKLET 1**

The Wilson-Sommerfeld quantization rule states that

> *For any physics system in which the coordinates are periodic functions of time, there exists a quantum condition for each coordinate. These quantum conditions are*
>
> $$\oint p_q \, dq = n_q h$$
>
> *where q is the one of the coordinates, p_q is the momentum associated with that coordinate, n_q is a quantum numbers which taken on integral values, and $\oint$ means that the integration is taken over one period of the coordinate q.*

a) Show how the Bohr quantization of angular momentum follows from the Wilson-Summerfeld rule.

b) Show how Planck's quantization law follows from the Wilson-Summerfeld rule.

Note: the area of the ellipse $x^2/a^2 + y^2/b^2 = 1$ is πab.

Problem 3 (35 points) **ANSWER IN BOOKLET 2**

The energy of a linear harmonic oscillator is equal to $E = p_x^2 / 2m + Cx^2 / 2$. The angular frequency of this oscillator is $\omega = \sqrt{C / m}$.

a) Show, using the uncertainty relations, that the energy of the linear harmonic oscillator can be written as

$$E = \frac{h^2}{32\pi^2 m x^2} + \frac{Cx^2}{2}$$

b) Show that the minimum energy of the oscillator is $hv/2$ where

$$v = \frac{1}{2\pi}\sqrt{\frac{C}{m}}$$

Problem 4 (5 points) **ANSWER IN BOOKLET 2**

Please include the proper answer for part a and b in your exam booklet.

a) (2 points) Which of the following New York baseball teams have moved from their old stadiums into new stadiums during the last four years?
   1. Only the NY Yankees.
   2. Only the NY Mets.
   3. Both the NY Yankees and the NY Mets.

b) (3 points) This stadium is also known as (more than one answer may be correct)

   1. The house that Ruth built.
   2. Yankee stadium.
   3. Fenway Park.
   4. Frontier field.