# Physics 1302, Exam 4 Review

The following is a list of things you should *definitely* know for the exam, however, the list *is not* exhaustive. You are responsible for all the material covered in the assigned readings, lectures, and homework assignments.

- Use Wein's Law and the Stefan-Boltzmann law to determine basic quantities for a blackbody radiator.
- Describe Planck's quantization condition.
- Determine the energy and momentum of a photon, and perform basic calculations using these quantities.
- Describe what the photoelectric effect is, and explain how it lead Einstein to conclude that photon's existed.
- Describe the plum pudding model for the structure of the atom.
- Describe the Rutherford experiment, and explain what it tells us about the structure of the atom.
- Describe Bohr's model for the atom, and perform basic calculations regarding the structure of the hydrogen atom.
- Describe what the De Broglie hypothesis is, and perform basic calculations concerning De Broglie waves.
- Describe what the Heisenberg uncertainty principle is, and perform basic calculations using it.
- Perform basic calculations regarding the decay of radioactive nuclei.
- Perform basic calculations about nuclear binding energy.
- Perform basic dose calculations for radiation.

# Exam 4 Multiple Choice Problems

**Sample** **Dr. Andersen**

On the scantron sheet provided, *write* and *bubble in* your name. In the *identification number* field, write and bubble in the 7 digits from your student id number from your black cougar 1 card, or from your fee bill (do not try to fill the first two characters, which are letters.) Each of the following multiple choice questions is worth seven points. Mark the correct answer on the scantron sheet provided.

1. in the Rutherford gold foil experiment (i.e. the experiment where a beam of alpha particles was directed at a thin foil of gold), the expected result of the experiment if the plum pudding model for the structure of the atom had been correct would have been:

   (a) most of the alpha particles would be absorbed in the foil.

   (b) most alpha particles would go through undeflected, but a few would get deflected at large angles.

   (c) most of the alpha particles would be deflected back in the direction from which they had come.

   (d) the alpha particles would be spread out by a few degrees from their original direction of motion.

   (e) the alpha particles would not be deflected at all.

2. A photon has an energy of 2.6 eV. What is its wavelength?

   (a) $4.8 \times 10^{-7}\ m.$

   (b) $6.3 \times 10^{-7}\ m.$

   (c) $2.6 \times 10^{-7}\ m.$

   (d) $7.2 \times 10^{-7}\ m.$

   (e) $1.1 \times 10^{-7}\ m.$

3. A proton and an electron are both traveling at the same speed. What can we conclude about their De Broglie wavelengths?

   (a) It is impossible to determine the relative sizes of their wavelengths from the information given.

   (b) They will both have the same wavelength.

   (c) The wavelength of the proton will be shorter than that of the electron.

   (d) The wavelength of the electron will be shorter than that of the proton.

   (e) Because both the electron and the proton are particles, they do not have wavelengths.

4. An electron in a hydrogen atom is in the ground state. It absorbs a photon, and moves to the $n = 3$ state. What was the energy of the absorbed photon?

   (a) 1.5 eV.

   (b) 12.1 eV.

   (c) 10.2 eV.

   (d) 13.6 eV.

   (e) 3.4 eV.

5. A cosmonaut whose mass is 54.0 kg absorbs 2.0 Joules of energy from high energy protons in the Van Allen radiation belt. What is the biologically equivalent dose this cosmonaut has received?

   (a) 3.7 $REM$.

   (b) 108 $REM$.

   (c) 37 $REM$.

   (d) 27 $REM$.

   (e) 10.8 $REM$.

6. After 26 days, a radioactive source has its activity drop to 17.1 mCi from an initial activity of 34.2 mCi. What is the half-life of this source?

(a) 26 days.

(b) 13 days.

(c) 18 days.

(d) 9.7 days.

(e) 20 days.

7. what experimental result did Albert Einstein cite as evidence that light has particle-like properties?

   (a) The orbits of electrons within the hydrogen atom could have only certain radii.

   (b) The fact that electrons posses both particle and wave-like properties.

   (c) The ejection of electrons from a metal surface by light depends only on the frequency of the light used.

   (d) Mass being converted to energy by fusion reactions in the core of the sun.

   (e) The pattern of light and dark bands produced when light was passed through a pair of narrow slits.

8. The total energy of an electron in the $n^{th}$ orbit of a hydrogen atom is given by the formula $E_n = -13.6\ eV/n^2$. What does the negative energy for an electron indicate?

   (a) Electrons have both wave and particle-like properties.

   (b) The electron has a negative charge.

   (c) The electron is in a bound orbit.

   (d) The orbits are quantized.

   (e) The electron is a fundamental particle in nature.

9. An electron in a hydrogen atom makes a transition from the $n = 8$ orbit to the $n = 4$ orbit. The wavelength of the photon emitted by the electron is:

   (a) $3.89 \times 10^{-7}\ m$.

   (b) $4.86 \times 10^{-7}\ m$.

(c) $6.56 \times 10^{-7}\ m.$

(d) $7.29 \times 10^{-7}\ m.$

(e) $9.72 \times 10^{-7}\ m.$

10. An electron passes through a slit of width $x = 0.32\ mm.$ What is the minimum uncertainty in the x-component of its momentum after it has passed through the slit?

(a) $6.6 \times 10^{-31}\ mkg/s.$

(b) $1.2 \times 10^{-31}\ mkg/s.$

(c) $4.2 \times 10^{-31}\ mkg/s.$

(d) $3.3 \times 10^{-31}\ mkg/s.$

(e) $2.3 \times 10^{-31}\ mkg/s.$

# Exam 4 Worked Problems

## Sample Dr. Andersen

Both problems are worth 15 points, and will be graded in a manner similar to the assigned homework problems in the book; up to 6 points possible for the description of your solution method, up to 6 points for your algebra and other work *(available only if you receive the full 6 points for the description)*, and three points for the correct answer *(available only if you receive the full 6 points for your work)*, including units.

1.) a) At what frequency does the human body radiate the most electromagnetic radiation? b) What is the energy of these photons, in electron volts? (A normal, healthy human will have a body temperature of approximately $37^\circ\ C$.)

2.) Find the energy released in the fusion reaction ${}^1_1H + {}^2_1H \longrightarrow {}^3_2He + \gamma$. ( The mass of ${}^1_1H$ is $1.007825u$, of ${}^2_1H$ is $2.014102u$, and of ${}^3_2He$ is $3.016029u$, where $u = 1.66 \times 10^{-27}\ kg$.)