

HW 7

Due November 16, 2007

Please answer all questions clearly and concisely. While you need not transcribe the question completely, it should be clear from your answer alone what you are talking about.

You are strongly encouraged to discuss the homework with your classmates, but you must complete the written homework by yourself, and of course, the material you submit must be your own.

Remember, show all of your work!

1. Consider a system with 3 energy states:

- $E_1 = 2 \text{ eV}$
- $E_2 = 4 \text{ eV}$
- $E_3 = 8 \text{ eV}$

The system is in the $n = 2$ state. Please describe all possible transitions, for each tell me:

- (a) Whether the transition involves absorption or emission of a photon.
 - (b) What the “name” of the transition is (e.g. Balmer β or whatever).
 - (c) The energy of the emitted or absorbed photon.
 - (d) The wavelength of the emitter or absorbed photon.
 - (e) What range the photon is in (visible, UV, IR, etc.). If in the visible, approximately what color is it?
 - (f) The frequency of the photon.
2. What is the de Broglie wavelength of a proton moving at 20 m/s? If a photon had this wavelength, what type (UV, Visible, Radio, etc.) would it be?
3. A particle of mass, m , trapped in a 1-d box of length, L , has energies with:

$$E_n = \frac{\hbar^2 \pi^2}{2mL^2} n^2 \quad (1)$$

- (a) What is the ground state energy if the length of the box is 10^{-10} m (roughly the size of a hydrogen atom) and the particle in question is an electron? Express your answer in eV.
You should find that the energy is of the same order (a factor of a few) the energy of a Hydrogen atom. This is not a coincidence.
 - (b) What is the energy of the first excited state of this system?
 - (c) What is the wavelength corresponding to the “Lyman-Alpha” transition of this system?
 - (d) What type of radiation is this?
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