Quantum Physics, Preparation for Tuesday, Jan. 30

Study Q5 from *Six Ideas*

This is the last chapter in our accumulation of "bizarre phenomena" that are unexplainable by classical theory.

In Q6, we will launch into the quantum theory, which manages to explain every bizarre phenomenon that you have seen. Developing and understanding the theory will take us many weeks.

Presentations / Review for Exam

The exam will cover all of Q1 to Q5. It was suggested on Friday that Tuesday's presentations relate to the exam. Therefore, while you are busting your brain cells understanding Q5, let's have four detailed and careful presentations on Q1 to Q4.

NB: To make Tuesday interesting, these problems are lots harder than typical exam problems would be. Sorry if that defeats the purpose of the review. Also, I assigned you alphabetically. If you want to trade with someone, you can (provided you give them lots of lead time and they agree).

Emma and Ethan: Q1R.1, a slightly tricky Doppler shift problem
Hexi and Miles: Q2R.2, p. 32, pulsation frequency of variable stars
Rebecca and Ren: Q3R.1, p. 51, passing by foghorns
Trey (and Jay if she wants to join in): We are out of "rich context" problems from Moore for Q4. So here is a rich context problem for Q4 from me...

The energy levels of the hydrogen atom are of the form

$E_n = -1\ \text{Ry} / n^2$

with $n = 1,\ 2,\ 3,$ etc.

Like the eV, the Rydberg, abbreviated Ry, is a useful unit. $1\ \text{Ry} = 13.6\ \text{eV} = 2.178 \times 10^{-18}\ \text{J}$.

If a single photon is liberated when Hydrogen goes from energy level n to Hydrogen energy level m, and energy is conserved, then the photon must carry away the energy (continued on reverse):

$-1\,\text{Ry}\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$

Make a table of these energies in eV for

$n = 5,\ 4,\ 3,$ or $2,$ with $m = 1,$

and

$n = 6,\ 5,\ 4,$ or $3,$ with $m = 2,$

and

$n = 7,\ 6,\ 5,$ or $4,$ with $m = 3$.

Also make a second table that converts the above energies to wavelengths in nm. Finally, categorize the photons. Are they infrared, visible, ultraviolet? For any that are visible, what color are they?

If you are feeling expository, explain to your fellow physicists why there is a minus sign in E_n.

For Problem Set 5

Interference Patterns

1. Q5T.8, p. 82, matching interference patterns to cases

The de Broglie Wavelength

2. Q5B.2, p. 83, the de Broglie wavelength of an electron with 3.2keV of energy
3. Q5B.6, p. 83, the de Broglie wavelength of a thermal neutron

Interference patterns and the de Broglie wavelength

4. Q5M.3, p. 84, interference pattern using 50 keV electrons.
5. Q5R.1, p. 85, a world in which h is more than 10^{33} times to its actual value