Physics 309 Homework

Experimental Foundations

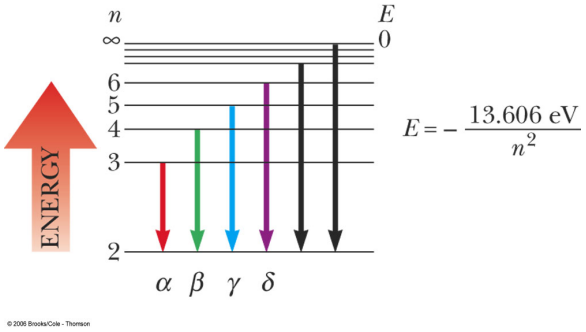
1. The Balmer series for the hydrogen atom corresponds to transitions that end in the $m = 2$ state as shown in the figure and are described by

$$\frac{1}{\lambda} = R_H \left(\frac{1}{2^2} - \frac{1}{n^2} \right)$$

where $R_H = 1.09737 \times 10^7\ m^{-1}$ is the Rydberg constant. The hydrogen atom energy levels are described by

$$E_n = -\frac{13.6\ eV}{n^2}$$

where n is the principle quantum number. What is the energy and wavelength of the photon with the longest wavelength?



2. Consider the following numbers: 2, 2, 3, 1, 1, 2, 0, 1, 0 representing the number of hits obtained by each starter for the Cleveland Indians in a recent game.

   (a) Calculate the average number of hits per batter.

   (b) Let x represent the number of hits obtained by a batter and let $f(x)$ be the number of batters who had x hits. Do you get the same results as the previous question using the following expression?

$$\bar{x} = \frac{\sum_0^4 x f(x)}{\sum_0^4 f(x)}$$

   (c) Let $p(x)$ be the probability of x hits occurring. Show $\bar{x}$ is given by the following.

$$\bar{x} = \sum_0^4 x p(x)$$

3. Consider the function

$$f(x) = \frac{1}{10}(10 - x)^2 \qquad 0 \leq x \leq 10$$
$$f(x) = 0 \qquad \text{all other} x$$

The general definition of the average is

$$\bar{x} = \frac{\int_{-\infty}^{\infty} x f(x) dx}{\int_{-\infty}^{\infty} f(x) dx} \quad .$$

(a) What is the average value of x?

(b) Suppose x were discrete instead of continuous. Assume $x = 0, 1, 2, ..., 10$. What is $\bar{x}$ and how does it compare with the previous result?

(c) Now assume $x = 0, 5, 10$. What is $\bar{x}$? How does it compare to the two previous results?

4. The work function of zinc is 3.6 eV. What is the energy of the most energetic electron emitted by ultraviolet light of wavelength 1900$\mathring{A}$?

5. Photoelectrons are observed when a metal is illuminated by light with a wavelength less than 388 nm. What is the metal's work function?

6. What is the de Broglie wavelength of a neutron that has fallen a distance of 1.0 m in a vacuum chamber, starting from rest?