Physics 200 Problem Set 6

Problem 1

a) Estimate how many photons there are at any instant in a volume of one cubic centimeter on a bright sunny day. It will be helpful to look up the flux of energy from the sun at the surface of the Earth.

b) A red laser pointer is turned on for one second. Estimate how many photons are emitted.

Problem 2

A gas of cold atomic hydrogen is illuminated with a diffuse beam of electromagnetic radiation. How small must the wavelength of the radiation be before electrons are observed to be emitted from the gas? It may be useful to know that $M_H - M_p - M_e = 13.6eV/c^2$.

Problem 3

Color-Blind Cathy carries a metal bar around with her to help distinguish electromagnetic radiation of different wavelengths. She heads down to "The Monochrome," a trendy bubble-tea joint with various rooms illuminated by light of a single wavelength. She goes in the $650nm$ room, and notices electrons being emitted from her metal bar. Later, she moves to the $600nm$ room, where electrons are emitted with a maximum kinetic energy that is twice as much as in the first room. Finally, she moves to a third room, where her bar emits electrons whose maximum kinetic energy is three times the energy of the speediest electrons in the first room. What is the wavelength of the light in the third room?

Problem 4

The photoelectric effect simulation that I'll do in class may be found on the "Resources" section of the course website. In the simulation, select the sample labeled ????? in the pull-down menu in the box labeled Target (at the upper right). Using the simulation, determine the work function of this metal.

Problem 5

Typically, photons do not interact much with each other, but with enough energy, two photons can collide and interact to produce massive particles. In a particular event, two photons with equal energy traveling directly toward each other collide to produce an electron and a positron (the antimatter version of an electron, with the same mass and opposite charge) each with total energy $1MeV$. What wavelength did the photons have? Note: the photons completely turn into the electron and the positron in this reaction, which is represented by $\gamma + \gamma \rightarrow e^+ + e^-$.