

# Modern Physics

## Problem Set 5

### JC-25) Green Light Bulb

A certain green light bulb emits at a single wavelength of 550 nm. It consumes 55 W of electrical power and is 75% efficient in converting electrical energy into light.

- (10 points) How many photons does the bulb emit in one hour?
- (10 points) Assuming the emitted photons to be distributed uniformly in space, how many photons per second strike a 10 cm by 10 cm paper held facing the bulb at a distance of 1.0 m?

### JC-26) The Compton Effect

Gamma rays emitted by radioactive decay also exhibit measurable Compton scattering. Suppose a 0.511 MeV photon from a positron-electron annihilation scatters at  $110^\circ$  from a free electron.

- (10 points) What are the energies of the scattered photon and the recoiling electron?
- (10 points) Relative to the initial direction of the 0.511 MeV photon, what is the direction of the recoiling electron's velocity vector

### JC-27) Dental X-rays

(10 points) The x-ray tubes used by dentists often have accelerating voltages of 80 keV. What is the minimum wavelength of the x-rays they produce?

### JC-28) Pair Production

(10 points) A positron collides head on with an electron at the SLAC National Accelerator Facility. The positron and electron are both annihilated producing 2 photons. Each particle had a kinetic energy of 1.0 MeV. Find the wavelength of the resulting photons.