Homework 4

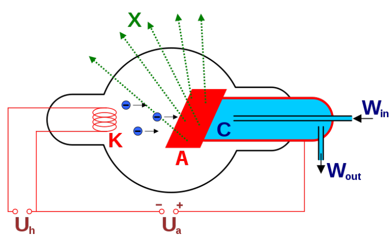
Chapter 28

Problem 1. *In Homework 3, you showed that the sun emits* $3.87 \cdot 10^{26}$ *W of power.* *(a) Use Stefan's law to calculate the surface temperature at the photosphere* ($r = 6.96 \cdot 10^8$ *m). (b) Estimate the power needed to produce the same spectrum with an incandescent light bulb (i.e. to heat the bulb to the same temperature). Model the light bulb's tungsten filament as a cylinder* 58.0 *cm long and* 45 μ*m in diameter with emissivity of* 0.45. *(c) Tungsten melts at* 3695 *K, so we cannot actually operate the filament at the same temperature as the sun. What temperature is the filament from (b) if we only radiate at* 60 *W?*
Because of their long length, tungsten filaments are usually coiled twice. See `http://en.wikipedia.org/wiki/Electrical_filament` *for some nice pictures.*
This problem is similar to P28.2 and P28.55.

Problem 2. *A simple pendulum as a length of* 2.00 *m and a mass of* 3.00 *kg. The amplitude of oscillation is* 5.00 *cm. Assuming that energy is quantized, calculate the quantum number of the pendulum.*

Problem 3. *Sodium has a work function of* 2.46 *eV. (a) Find the cutoff wavelength and cutoff frequency for the photoelectic effect. (b) What is the stopping potential if the incident light has a wavelength of* 440 *nm?*

Problem 4. *X-rays generation (e.g. for medical imaging) can be modeled as an inverse photoelectric effect (basically the regular photoelectric effect played backwards in time). An electron beam is fired into an anode, which absorbs the electrons and emits radiation (the X-rays). If the electrons are accelerated by* 50 *kV towards a Tungsten surface* ($\phi = 4.5$ *eV), find the wavelength of the emitted photons predicted by this model.*



HINT. *Follow the energy flow through the system. Ignore anode heating.*

Problem 5. *(a) What value of* n_i *is associated with the* 94.96 *nm spectral line in the Lyman series of hydrogen? (b) Could this wavelength be associated with the Paschen series or the Balmer series?*

Problem 6. BONUS PROBLEM. *Use Bohr's assumptions in Section 11.5 to derive a formula for the allowed energy levels in singly ionized helium* (He^+).