QUANTUM OPTICS PROBLEMS

More difficult problems are indicated with an asterisk.

1. At what wavelength does the peak of the black body radiation curve occur at (a) 1000°K; (b) 3000°K; (c) 5000°K; (d) 7000°K; and (e) 9000°K?

2. A light bulb emits 10 watts of power when the filament burns at 3000°K. How much power will be emitted when the power is turned up so that the filament burns at 4500°K? Assume the filament obeys the black body radiation curve.

3.* A woman weighing 50 kg climbs to the top of a 2 m ladder. How much potential energy does she have in joules and electron volts?

4. What is the energy of photons of wavelength (a) 350 nm; (b) 450 nm; (c) 550 nm; (d) 650 nm; (e) 750 nm?

5. A metal cathode has a 2.1 ev work function. What is the longest light wavelength that can generate a photoelectric current?

6. (a) Assuming a polarizer absorbs no light, what are the odds that a photon in a beam of light polarized 30° to the polarizer will get through the polarizer? (b) What determines whether a particular photon gets through the polaroid?

7.* No one buys black cars in Arizona. Why?

8. As an ingot of iron is heated it begins to glow. As it becomes hotter it becomes brighter and its color changes. Through what sequence of colors does it go as it heats up? What law governs this change in color?

ANSWERS to SELECTED PROBLEMS

1. (a) 2898 nm; (b) 966 nm; (c) 580 nm; (d) 414 nm; (e) 322 nm.

2. 50.6 watts

3. potential energy=V=mgh where m=50 kg, g=9.8 m/sec^2, and h=2 m, so that V=(50 kg)(9.8 m/sec^2)(2 m)=980 joules. Since 1 ev=1.60x10^{-19} joules, the energy in electron volts is (980 joules)/(1.60x10^{-19} joules/ev)=6.12x10^{21} ev. Clearly the electron volt is an unwieldy unit for ordinary mechanics calculations.

4. (a) Using E=(1.2396x10^3 ev-nm)/λ, if λ=350 nm, then E=3.5 ev.

5. 590 nm

6. (a) The odds are 0.75=3/4, so three out of four photons will traverse the polaroid. (b) Quantum mechanics doesn't tell which photons get through the polaroid—it only gives the odds; so this is unanswerable.

7. Black bodies are perfect radiators *and* perfect absorbers of radiation. Black cars get awfully hot under the Arizona sun.

8. By Wien's displacement law, there will initially be a red glow which changes through orange, yellow, green, and blue-white.