University of California, Berkeley
Physics H7C Fall 1999 (*Strovink*)

PROBLEM SET 7

1.
Fowles 6.1.

2.
Fowles 6.2.

3.
Fowles 6.6.

4.
Rohlf 2.13.
Note that this problem is more difficult than it first appears to be. You may *not* assume that the *average* number of unexpected events found, per 10^6 interactions, is equal to unity!

5.
Rohlf 2.38.

6.
Assume that the sun is a blackbody of temperature 5800 K and radius 7×10^8 m, located 1.5×10^{11} m from the earth. Assume further that the earth is a gray body which absorbs part of the radiation incident upon it from the sun, and then reradiates it isotropically. Neglect any other effects which could heat the earth. Calculate the surface temperature of the earth under these assumptions.

7.
Greenhouse effect.
Take the sun's blackbody spectrum to have its peak in the yellow ($\lambda = 0.58$ μm). Take $T_{\text{sun}} = 5800$ K and $T_{\text{earth}} = 300$ K.
(a.)
Use Wien's Law ($\lambda_{\text{max}} \propto T^{-1}$) to estimate the wavelength at the peak of the earth's blackbody spectrum.
(b.)
Imagine that the (visible) sun's rays pass through the clear glass of a greenhouse. On the floor of the greenhouse is black dirt with $\epsilon \approx 1$, which absorbs these rays. In contrast, the (infrared) blackbody radiation from the dirt is totally absorbed by the glass and reradiated (half in and half out). Assuming that the temperature outside the greenhouse is 300 K, estimate the temperature inside it.

8.
Nuclear winter (inverse Greenhouse effect).
According to some experts (though this is controversial), after nuclear war a thin layer of dust would remain in the upper atmosphere of the earth. To a first approximation, the dust absorbs all light from the sun, which is near visible in wavelength. The dust then reradiates that energy in the infrared, to which it is transparent: half in toward the earth, half out to space. The dust is nearly transparent to the earth's outward radiation, also in the infrared.

If the peacetime surface temperature of the earth is 300 K, what would that temperature become after nuclear war? To relate to it physiologically, express this latter temperature in °F.