Physics 250

Problem Set #3

1. You are given the following group of particles (N_i represents the number of particles that have a speed v_i.)

N_i	v_i(cm/s)
2	1.0
4	2.0
6	3.0
8	4.0
2	5.0

Compute (a) the average speed $\langle v \rangle$, (b) the root-mean-square speed v_{rms}, and (c) the most probable speed v_p of this distribution.

2. N Molecules of a certain gas are found to have the speed distribution

$$P(v) = \begin{cases} Cv^2 & \text{if } 0 < v \le v_0; \\ 0 & \text{if } v > v_0. \end{cases}$$

Find (a) an expression for C in terms of N and v_0, (b) the average speed of the particles, and (c) the rms speed of the particles.

3. The lowest possible temperature in outer space is 2.7K. What is the root-mean-square speed of hydrogen molecules at this temperature?

4. The sun is a huge ball of hot ideal gas. The temperature and pressure in the sun's atmosphere are 2.00×10^6K and 0.0300Pa. Calculate the rms speed of free electrons (mass = 9.11×10^{-31}kg) there.

5. At what temperature can you drive faster than the average velocity of a He atom if your race car can go 150mph?

6. Calculate the energy of a photon whose frequency is (a) 5×10^{14} Hz, (b) 10 GHz, (c) 30MHz. Express your answers in electron volts.

7. An FM radio transmitter has a power output of 100 kW and operates at a frequency of 94 MHz. How many photons per second does the transmitter emit?

8. A sodium-vapor lamp has a power output of 10 W. Using 589.3 nm as the average wavelength of the source, calculate the number of photons emitted per second.

9. When cesium metal is illuminated with light of wavelength 300 nm, the photoelectrons emitted have a maximum kinetic energy of 2.23 eV. Find (a) the work function of cesium and (b) the stopping potential if the incident light has a wavelength of 400 nm.

10. A light source of wavelength λ illuminates a metal and ejects photoelectrons with a maximum kinetic energy of 1.00 eV. A second light source with half the wavelength of the first ejects photoelectrons with a maximum kinetic energy of 4.00 eV. What is the work function of the metal?

11. Photons of wavelength 450 nm are incident on a metal. The most energetic electrons ejected from the metal are bent into a circular arc of radius 20 cm by a magnetic field whose strength is equal to $2.0\times10^{-5}\ \mathrm{T}$. What is the work function of the metal?