

GPHYS 515/415 Problem set 1

Due Wednesday Jan 15, 2014

Read Parks Chapters 2 and 3

Problems:

1. **Calculate** the *average velocity, average speed and average energy* of a system of particles in equilibrium with distribution function given by $f(x,y,z,v_x,v_y,v_z) = A \exp(-E/k_B T)$ where E is the kinetic plus potential energy $E = \frac{1}{2} m \mathbf{v}^2 + \Phi$, if
 - a) $\Phi(x,y,z) = 0$, and
 - b) $\Phi(x,y,z) = mgz$ (g is the acceleration of gravity at 1 R_E)
Note $\mathbf{v}^2 = v_x^2 + v_y^2 + v_z^2$ and A is the normalization $(m/2\pi k_B T)^{3/2}$, k_B is the Boltzman constant and T is the temperature
2. **Determine** numerical values for the *average velocity, average speed and average energy* in problem 1a) if
 - a) the particles are electrons, and if
 - b) the particles are oxygen ions (O^+) for $T=0^\circ \text{ K}$, $T=300^\circ \text{ K}$ (86° F), and $T=1000^\circ \text{ K}$. Express the values of average energy both in joules and in electron volts (1 eV = 1 Volt times 1.6×10^{-19} Coul.)
3. Parks Question 5, p. 49 (about a flowing Maxwellian)
4. For a uniform Maxwellian distribution **find** the fraction of the particle density for which particles have speeds greater than the average speed. **Compute** the average speed of those particles which have average speed greater than the average speed of the total system.