TFY4275 Classical Transport Theory
Problemset 4 Spring 2013

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Problem 1.
We consider a gas of non-interacting particles (molecules). The velocity distribution of the particles is given by the Maxwell (velocity) distribution

$$p_M(\mathbf{v}) = \left(\frac{m}{2\pi kT}\right)^{3/2} \exp\left(-\frac{m\mathbf{v}^2}{2kT}\right), \tag{1}$$

where m denotes the mass of the particles, k the Boltzmann constant, T the temperature (in Kelvin), and $\mathbf{v} = (v_1, v_2, v_3)$ is the 3-dimensional velocity vector.
For this system, show that the distribution of (kinetic) energy, $E = (1/2)m\mathbf{v}^2$, can be expressed as

$$p(E) = \frac{2}{\sqrt{\pi}} \frac{E^{1/2}}{(kT)^{3/2}} \exp\left(-\frac{E}{kT}\right). \tag{2}$$

This distribution is known as the gamma or χ^2-distribution.
[Hint: Use the method of transformation of variables, and the properties of the Dirac delta function.]