TABLE I: Noble Gases.

stuff	σ A^o	ϵ Kelvin	m amu	η $\times 10^{-4} gm/cm/sec$
helium	2.56	10	4	1.94
neon	2.78	36	20	3.10
argon	3.40	120	40	2.21
krypton	3.64	170	84	2.47
xenon	3.96	231	131	2.25

P740.HW2.tex

Due 02/12/07

1. Table I has information about the noble gases.Use the viscosity data to find the "diffusion constant for transverse velocity" (called the "kinematic viscosity"). [These data are for a gas at $P = 1$ atm and $T = 300$ K.] From the results in **P740.4** find the mean free path and the cross section. The Lennard Jones form of the pair interaction is

$$V(r) = 4\epsilon \left(\left[\frac{\sigma}{r} \right]^{12} - \left[\frac{\sigma}{r} \right]^{6} \right), \tag{1}$$

   where ϵ is the strength of the interaction and σ sets the length scale of the interaction. Make a plot of the cross section as a function ϵ.

2. (a) Complete the calculation at the bottom of page 2 of the **Boltzmann Equation** notes, i.e., find the relationship of P to Q.

   (b) Show that

$$f_0 \propto exp\left(-\beta \left(\frac{p^2}{2m} - pQ \right) \right), \tag{2}$$

   and

$$f_0 \propto exp\left(-\frac{\beta}{2m} \left[v - u \right]^2 \right), \tag{3}$$

   are equally good for finding $P \neq 0$.

   (c) Relate P to u.

3. When normed to 1 over v

$$f_0 \propto exp\left(-\frac{\beta}{2m}v^2\right) \tag{4}$$

is $P(v)$, the probability of v.

   (a) Find $|\overline{v}|$, the average of $|v|$.

   (b) Find $P_> = P(v > |\overline{v}|)$, the probability that $v > |\overline{v}|$.

4. Biased random walk. Return to problem 3 of HW.1. Suppose the random walker has a bias to go right instead of left: $\mathbf{R} \leftrightarrow p$ and $\mathbf{L} \leftrightarrow q$, $p + q = 1$. Unbiased walk, $p = q = 1/2$. Choose $p = 1/2(1 + \epsilon)$ and $q = 1/2(1 - \epsilon)$. Make a choice of ϵ. When the walker has a bias the quantites of interest are $< x >$ and $< (x - < x >)^2 >$.

   (a) How does $< x >$ depend on time?, ϵ?,

   (b) How does $< (x - < x >)^2 >$ depend on time?, ϵ?