Thermodynamics & Statistical Mechanics PSet 3

1. **Book Problems:** 2.17, 2.19, 2.26, 2.35, 2.36

2. **Box of Gas in Space:** Astronauts place a box full of N atoms of monatomic gas with molecular mass m in empty space. At time $t = 0$ the box itself is perfectly at rest, and it (ignoring the gas) has mass M. The box is structurally perfect, ie it does not deform or absorb energy from the gas, which is in a typical state at temperature T. After a long time t, how far would you expect the box to have drifted? Reasoning much like what you need for this problem was employed by Einstein in one of his 'miracle year' papers.

3. **Book Problem Extra Credit:** 2.25

4. **Another Extra Credit Problem:** Let's say we have a general probability distribution $p(x)$ with support on (it's only non-zero on) the interval $[-1, 1]$. Let's also assume the mean of x drawn from $p(x)$ is 0. (This all implies that if we randomly select an x, the probability that x lies in the interval $[a, b]$ is $\int_a^b dx\, p(x)$. Our assumptions also imply that $\int_{-1}^{1} dx\, p(x) = 1$, since the distribution is normalized, and $\int_{-1}^{1} dx\, x\, p(x) = 0$, since the mean is zero, and further since $p(x)$ is a probability, we know that $p(x) \geq 0$ everywhere.)

   Say we draw $N \gg 1$ random values of x from our distribution, and we take the sum of these values. What can you say about the probability distribution of the sum of the randomly chosen x at large N?