1. **Estimation:** Water has a specific heat of 4 J/(g °C) and a density of 1 g/cm^3. If it takes about a minute to boil a glass of water in a microwave, estimate the power of the microwave in Watts (Joules per second). *Clearly state your assumptions and how you came to the numbers you estimate.*

2. **Essay:** An air molecule has mass. Explain why air molecules are not all sitting on the ground like almost all other massive objects on earth.

3. A. The density of air molecules gradually decreases with elevation. Eventually there is just empty space. This layer of gradually thinning air is we call the atmosphere. What mathematical function approximately describes this gradual decrease, and why?

B. A mole of air weighs about 30 grams. Find the mass of an air molecule.

C. Estimate the height at which the gravitational potential energy of an air molecule equals its thermal energy.

D. Explain why this height is also an estimate for the thickness of the atmosphere. Is your value reasonable for the thickness of the atmosphere?

4. Suppose that a system can exist in one of only two energy states, $E_1 = 2$ meV and $E_2 = 30$ meV. An meV (millielectronvolt) is a small unit of energy equal to 1.6×10^{-22} Joules. Suppose that the system is e times (about 2.78 times) as likely to be found in E_1 than in E_2. Find the temperature of the system, in Kelvin.

5. A simple model of a diffusing molecule is a "random walk." Suppose that a molecule is confined to one dimension and takes random steps along a number line. It starts at $x = 0$, and after one step it is either at $x = 1$ with probability 1/2, or $x = -1$ with probability 1/2.
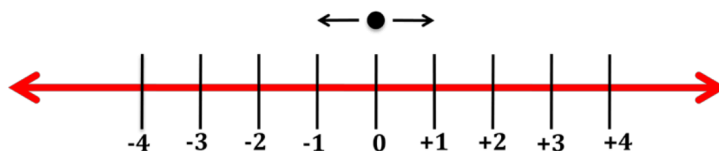
A. Fill in the table below with the probability of being at each position after each number of steps.

	1 step	2 steps	3 steps	4 steps
x = +4				
x = +3				
x = +2				
x = +1				
x = 0				
x = -1				
x = -2				
x = -3				
x = -4				

B. Turn each column of the table into a bar plot of the probability vs. position. Make a rough sketch of what the plot will look like for a large number of steps.