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4B Statistical Physics Homework

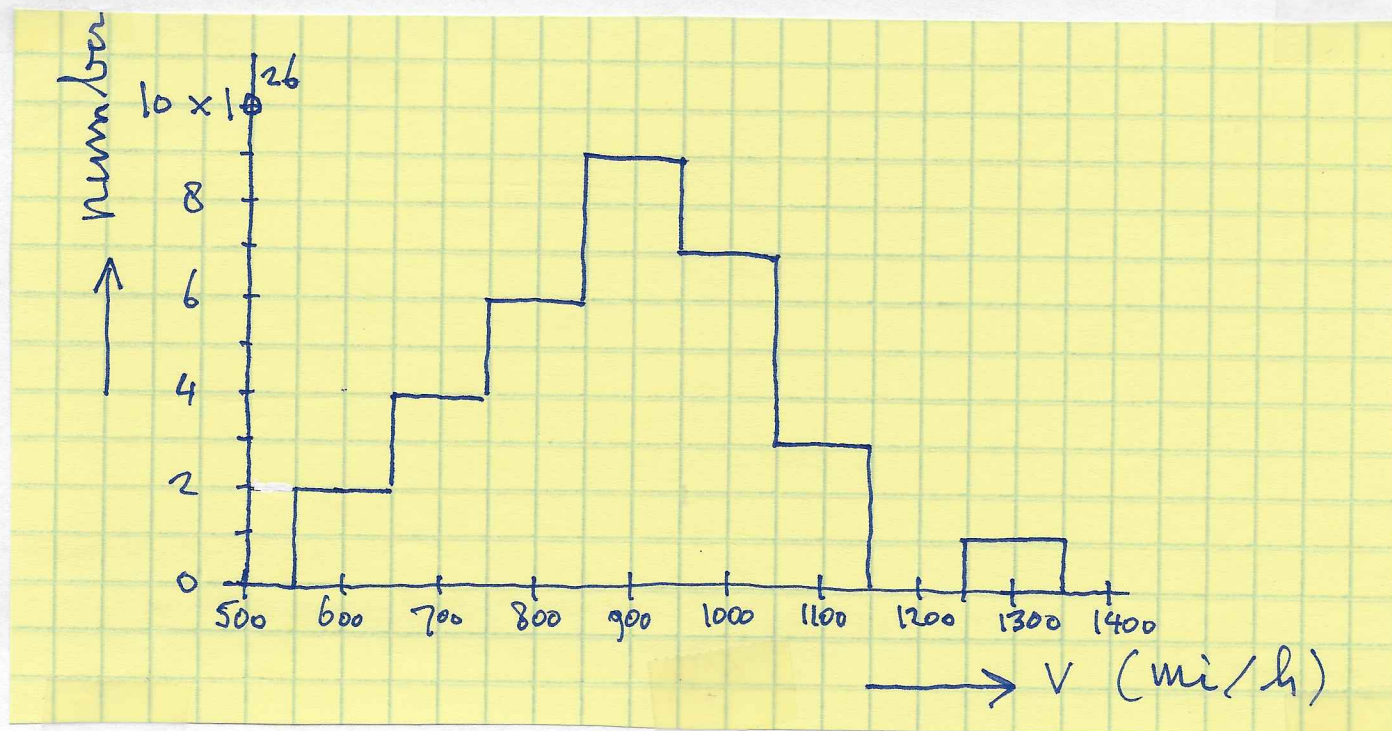
PROBLEM 1

The heights in meters of a number of students are determined as follows:
1.86 1.53 1.75 1.67 1.91 1.63 1.81 1.88 1.78 1.71.

- Calculate the average height from these numbers.
- Make a neat and clean histogram of the heights. Chose a binsize of 0.1 m.
- Calculate the average height using only the histogram.
- What is the probability that someone has a height greater or equal than 1.8 m?
- What are the probabilities for someone's height to fall in each bin?
- What is the sum of all probabilities?

PROBLEM 2

A histogram of the magnitudes of velocities of atoms in a gas is shown below.



- a. What is the total number of atoms in the gas?
- b. What is the average magnitude of the velocities?
- c. What is the average magnitude of the square of the velocities?
- d. What is the rms velocity?
- e. Is the answer in d) equal to the answer in b)? Comment.
- f. What is the probability for an atom to have a velocity between 700 and 800 mi/h?
- g. What is the probability that an atom has a velocity greater than 1500 mi/h?
- h. Find the probabilities that an atom's velocity falls in each bin?

PROBLEM 3

A di-atomic molecule consists of two identical atoms, each with mass m . They are point particles with zero size. They are kept at a fixed distance ℓ . The molecule is rotated with a frequency f .

- a. What is the inertial moment of the di-atomic molecule relative to an axis perpendicular to the line connecting the atoms and through the middle between the atoms?
- b. What is the inertial moment of the di-atomic molecule relative to an axis that coincides with the line connecting the atoms?
- c. What is the kinetic energy in a) above?
- d. What is the kinetic energy in b) above?

PROBLEM 4

A volume contains hydrogen and helium gases. The gases are in equilibrium. What is the ratio of the rms velocities of the atoms or molecules of the helium and the hydrogen gas?

PROBLEM 5

- a. Show with a calculation that the average of the z -component of velocities of atoms or molecules in a gas is zero.
- b. What about the x - and y -components?
- c. So does this mean that the magnitude of the velocity is zero considering your answers in a) and b)?

PROBLEM 6

Gas molecules are in equilibrium in a cube with volume V . The cube is located with its center at the origin of a rectangular coordinate system.

- a. Calculate the average y -position of a molecule. Think carefully about the Boltzmann factor to use.
- b. Where on average will you encounter a molecule within the cube?

WATCH THIS SPACE: MORE PROBLEMS MIGHT APPEAR