

PHYS1B28: Thermal Physics
Department of Physics and Astronomy, University College London.

Problem Sheet 2 (2005)

Answers to questions 1 – 5 should be handed in by Friday 4 November, 2005. Question 6 is for tutorial discussion.

1. Five gas molecules chosen at random are found to have speeds of 500, 600, 700, 800, 900 m/s. Find the *rms* speed and the average speed. Is the *rms* speed the same as the average speed? Explain the difference.

[5]

2. (a) Obtain expression for the mean free path of molecules in an ideal gas assuming that their speeds are much greater than the *rms* speed. Compare with the exact expression.

(b) Derive expression for collision frequency of molecules in an ideal gas. Estimate the collision frequency of hydrogen molecules in a container containing hydrogen gas at $T = 1000$ K and $P = 1$ atm. (Assume that hydrogen molecules are spherical with the effective diameter equal to twice the diameter of the 1s orbit in the hydrogen atom.)

[10]

3. Calculate the most probable speeds of H_2 and O_2 molecules at $20^\circ C$. On a single diagram sketch the Maxwell-Boltzmann distribution of molecular speeds for H_2 and O_2 molecules at this temperature.

[5]

4. Calculate the probability that a molecule of oxygen in oxygen gas at 1000 K has a speed between 1000 m/s and 1001 m/s.

[5]

5. The proportion of various gases in the earth's atmosphere changes somewhat with altitude. Would you expect the proportion of oxygen at high altitude to be greater or less than at sea level compared to the proportion of nitrogen? Explain your answer.

[5]

6. *For tutorial discussion:* Why is the smell of fried food in a house difficult to get rid of?