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

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**Problem Sheet 1 (2005)**

Answers to questions 1 – 5 should be handed in by Friday, 21 October, 2005. Question 6 is for tutorial discussion.

1. An ideal gas exerts a pressure of 1.52 MPa when its temperature is 25 $^{o}$C and its volume is $10^{-2}$ $m^3$.
   (a) How many moles of gas are there?
   (b) What is the mass density if the gas is molecular hydrogen, $H_2$?
   (c) What is the mass density if the gas is oxygen, $O_2$?

[5]

2. (a) The average kinetic energy of the molecules of the ideal gas at 15 $^{o}$C has the value KE. At what temperature will the average kinetic energy of the same gas double this value, i.e. become 2 KE?

(b) Find a root-mean-square (RMS) speed of a mist particle of mass $1\times10^{-15}$ kg would have at room temperature according to kinetic theory.

[5]

3. A beam of particles, each of mass m and speed $\upsilon$, is directed along the *x* axis. The beam strikes the area of 1 $mm^2$ with $10\times10^{15}$ particles striking per second. Find the pressure on the area due to the beam if the particles stick to the area when the hit. Evaluate for an electron beam in a television tube where m = $9.1\times10^{-31}$ kg and v = $8\times10^{7}$ m/s.

[5]

4. The pressure of a gas in a 100 mL container is 200 kPa and the average translational kinetic energy of gas particles is $6.0\times10^{-23}$ J. Find the number of gas particles in the container. How many moles of gas are in the container?

[5]

5. A piston pump having a barrel of effective volume 100 $cm^3$ is used to exhaust a vessel of volume $2.5\times10^{3}$ $cm^3$. If the initial pressure of the air in the vessel is 1 atm, estimate the reduction in pressure produced by two strokes of the pump, assuming that all processes are isothermal and that air behaves as an ideal gas. Further, estimate the number of strokes needed to reduce the pressure in the vessel from 1 atm to 0.02 atm.

[10]

6) *For tutorial discussion*: Explain on both microscopic and macroscopic level, why a bicycle pump gets hot when you pump a tire with it?

1 bar = $10^5$ Pa = $10^5$ $Nm^{-2}$ = 75 cm of Hg = 0.987 atm

1 L = $10^{-3}$ $m^3$

R = 0.083143 L bar $K^{-1}$ $mol^{-1}$ = 8.315 J $K^{-1}$ $mol^{-1}$; $N_A = 6.022\times10^{23}$ $mol^{-1}$; $k_B = R/N_A = 1.38\times10^{-23}$ J/K