Physics 7b
Spring 1999
Midterm 1
R. Packard

Work all five problems. Introduce and clearly define algebraic symbols to represent numeric quantities. Do not perform numerical work until you have a final algebraic answer within a box. Check the dimensions of your answer before inserting numbers. Work the easiest problem first, and the next hardest, etc. If you do not understand the question ask the proctor for assistance. All problems are weighted equally.

1. At the surface of the Sun the surface temperature is about 6000K and all the substances present are gaseous. All the known elements are present in the gas. What is the range of rms speeds at the surface of the sun if the atoms range from Hydrogen (M_w =1g/mole) to Uranium (M_w=238g/mole)?

2. A cylinder 2.4 m tall is filled with 0.1mol of an ideal gas at standard temperature and pressure (0^{o}C, 1 atm). The top is closed with a tight fitting, frictionless piston of mass 1.4kg and the piston is allowed to drop until it is in equilibrium. A) Find the height of the piston (at equilibrium) assuming that the temperature of the gas does not change as it is compressed. B) Suppose that the piston is pushed slightly below its equilibrium position and then released. Assuming that the temperature of the gas remains constant, find the frequency of small oscillations of the piston.

3. In an isothermal expansion, an ideal gas at an initial pressure P_o expands quasi-statically to twice its volume. Subsequently the gas is compressed adiabatically (and quasi-statically) back to the initial volume, at which point its volume is $1.32P_o$. a) Find c_v for the gas. a) Is the gas monatomic, diatomic or polyatomic?

4. The cooling compartment of a refrigerator and its contents are at 5°C and have an average heat capacity of 84kJ/K. The refrigerator exhausts heat to the room which is at 25°C. What minimum power will be required by the motor that operates the refrigerator if the temperature of the cooling compartment and its contents is to be reduced by 1°C in 1min.

5. A small pond has a layer of ice on the surface that is 1cm thick. If the air temperature is -10^{o}C, find the rate (in m/hr) at which ice is added to the bottom of the layer. the density of ice is 917kg/m^{3}. The thermal conductivity of ice is 0.59 W/m K. The latent heat of fusion is 333kJ/kg. Assume that the underlying water is at 0^{o}C.