Exam & Solution

Physics 7b
Spring 2000
Midterm 1
R. Packard

Work all four 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. $K_B=1.38\times10^{-23}$J/K, $N_A=6.02\times10^{23}$

Name_____

SID_____

Sect. # or day and time _____

TA name (if known)_____

1._____

2._____

3._____

4._____

Total_____

1. Rubidium atoms, (atomic weight 85), can be cooled to 1nK (10^{-9}K) Estimate how long it takes one of these cold Rubidium atoms to travel 1 meter.

2. 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 $1.32P_o$. Find c_v for the gas.

3. A building has walls and roof with a total area of 600m^2. The walls and roof are 0.1m thick made from material with thermal conductivity k=0.1J/smK. The average inside temperature is 21°C and the average outside temperature is 10°C.

a. How much power $\dot{Q}$ (in Watts) is required to maintain the inside temperature?

b. We may heat the building using a heat pump which operates at 75% of the Carnot performance coefficient. The heat pump is operated electrically. Find the annual cost to heat the building using the heat pump. Assume the cost of electricity is $0.14/kW hr. If you didn't get the answer to part a, express your answer in part b in terms of the symbol $\dot{Q}$.

4. A clock uses a brass pendulum made as a thin brass rod of negligible mass terminated in a large pendulum "bob". The clock gives accurate time when the ambient temperature is 20°C. At 30°C, how much time (in seconds) does it gain or loose in one day? Thermal expansion coefficient of brass is 19×10^{-6}/K. (hint: $period = \sqrt{\frac{l}{g}}$)