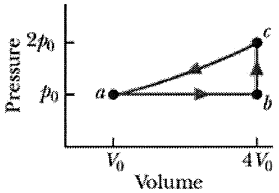
Name: KEY

Phys.115 Practice Exam III
Fall 2004

Please do not turn the page until you are told to do so. When you do so, make sure the you have all six problems on your copy of the test. In order to get credit on a problem, you must show your work. If you only write down an answer without the work leading up to it, you will get no credit for it, even if it is the right answer.

1. One mole of an ideal monatomic gas (C_V=3/2 R) is taken through the cycle in the figure. Express all the answers to the following questions in terms of the pressure p_0, volume V_0, and temperature T_0 of state *a*.



a. (7 points) How much work is done by the gas in going from state *a* to state *c* along path *abc*?

$$W_{a\to b} = P_0(4V_0 - V_0) = 3P_0V_0$$

$$W_{b\to c} = 0$$

$$W_{a\to b\to c} = 3P_0V_0$$

b. (7 points) What is the change in internal energy in going from *b* to *c*?

$$\Delta U = nC_V(T_c - T_b) = n\frac{3}{2}R\left(\frac{(2P_0)(4V_0)}{nR} - \frac{(P_0)(4V_0)}{nR}\right) = 6P_0V_0$$

c. (6 points) What is the change in internal energy through one complete cycle?

$\Delta U = 0$ *for a complete cycle.*

2. (20 points) A small electric immersion heater is used to heat 100 g of water for a cup of instant coffee. The heater is labeled "200 watts," which means that it converts electrical energy to thermal energy at this rate. Calculate the time required to bring all this water from 23 °C to 100 °C, ignoring any heat losses ($c_{water} = 4185$ J/kg K).

$$P = \frac{Q}{t} = \frac{mc\Delta T}{t}$$

$$t = \frac{mc\Delta T}{P} = \frac{(0.1\,\mathrm{kg})(4185\,\mathrm{J/kg \cdot K})(77\,\mathrm{K})}{200\,\mathrm{W}} = 161\,\mathrm{sec}$$

3) (20 points) A block of ice, at its melting point and of initial mass 50.0 kg, slides along a horizontal surface of thermally insulated material, starting at a speed of 5.38 m/s and finally coming to rest after traveling 28.3 m. Compute the mass of ice melted as a result of friction between the block and the surface. (Assume that all the energy lost by mechanical energy due to friction is transferred to thermal energy of the block of ice.) (L_{Fwater}=333 kJ/kg, c_{water}=4190 J/kg K, c_{ice}=2220 J/kg K)

The work done by the friction force is converted into the heat that melts part of the ice.

$$W_f = \Delta KE$$

$$\frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2 = m_{melted}L_{F_{water}}$$

$$m_{melted} = \frac{mv_i^2}{2L_{F_{water}}} = \frac{(50.0\,\text{kg})(5.38\,\text{m/s})^2}{2(333\times10^3\,\text{J/kg})} = \frac{4.35\,\text{grams}}{2} = \boxed{2.18\,\text{g}}$$

$$P = \frac{F}{A}$$

$$\rho = \frac{m}{V}$$

$$P_2 = P_1 + \rho g h$$

$$F_B = W_{fluid\ displaced}$$

$$\rho A v = \text{const}$$

$$\mathrm{P} + \frac{1}{2}\rho v^2 + \rho g y = \text{const}$$

$$\mathrm{T} = \mathrm{T_C} + 273.15$$

$$Q = mc\Delta T$$

$$Q = Lm$$

$$PV = nRT = NkT$$

$$\Delta U = Q - W$$

$$W = P\Delta V$$

$$W = nRT \ln\left(\frac{V_f}{V_i}\right)$$

$$\Delta U = nC_V \Delta T$$

$$Q = nC_P \Delta T$$

$$P_i V_i^\gamma = P_f V_f^\gamma$$

$$\gamma = \frac{C_P}{C_V}$$

$$C_P = C_V + R$$

$$e = \frac{W}{Q_H}$$

$$\Delta S = \frac{Q}{T}$$

...constants...

$$g = 9.8\,\mathrm{m/s^2}$$

$$1\,\mathrm{atm} = 1.013 \times 10^5\ \mathrm{Pa}$$

$$R = 8.314\ \mathrm{J/(mol \cdot K)}$$

$$k = 1.38 \times 10^{-23}\ \mathrm{J/K}$$

$$C_V = \frac{3}{2}R$$