**Sample Test 1: Thermodynamics**

1. Two moles of a diatomic ideal gas are in an initial **state 1** with temperature **25 oC** and

pressure **5.0 atm**. (1 atm = 101 kPa.) The gas expands **adiabatically** to **state 2**, in which the gas

has twice its initial volume. The gas is then compressed **isobarically** to **state 3**, in which its

volume equals its initial value. Finally, the gas undergoes an **isometric** process in which it returns to its initial **state 1**.

(a) Make a rough sketch of the cycle on a PV diagram.

(b) The diatomic ideal gas may reasonably be assumed to have 5 degrees of freedom. Explain.

(c) What is the internal energy of the gas in state 1, U1?

(d) What is the initial volume of the gas, V1?

(e) What is the pressure in the gas in state 2, P2?

(f) What is the temperature of the gas in state 3, T3?

(g) What work was done *on* the gas during process 2–3?

(h) What work was done *by* the gas during process 1–2?

2. An aluminum metal plate at a temperature of 25 oC has a 3.000 cm diameter hole through it. An aluminum metal rod has a diameter of 3.002 cm at 25 oC.

(a)To what temperature must the rod be cooled in order to insert it into the hole in the plate? (Al=22.2 x 10-6 m/K.m)

(b) If the rod is 6 cm long, what is the change in volume of the cooled rod compared to the volume of the rod at 25 oC?

3. A cup of tea contains 120 g of water at 97 oC. How many ice cubes each of mass 2 g from a freezer at a temperature of -12 oC must be added to cool the tea below 79 oC? [cice=2050 J/kg.K LfIce=334 kJ/kg cwater = 4186 J/kg.K]

4. A house has a total window area of 9.5 m2. The windows are single panes of glass 8.5 mm thick. Calculate the rate of heat loss per second through the windows when the indoor temperature is 68 oF and the outdoor temperature is 28 oF. The thermal conductivity of glass is 1.05 W/m.K.

5. A Carnot cycle is illustrated in the PV diagram below. The isothermal legs are at 600 K and 300 K. If the cycle is run as a heat engine the cycles goes in the sequence a, b, c, d. The engine when run in the perfect reversible cycle produces 120 Watts of work.

(a) What is the efficiency of this Carnot cycle?

(b) What is Qin the heat energy input into the system?

(c) Calculate the change in entropy for each of the 4 legs of the cycle a→b, b→c, c→d, d→a. Does the sum of the total entropy change agree with what you expect for a reversible cycle?

(d)What is the value of Qout?

