Physics 260 Homework Assignment 7

Chapter 20

1 PSE6 20.P.021

a. Since the heat required to melt the given amount of ice at 0°C exceeds the heat required to cool the temperature of the water to 0°C, the final temperature of the system is 0°C.

b. Assume m grams of ice remains when the system reaches equilibrium, then the amount of ice melt is $(m_{ice} - m)$. We have

$$(m_{ice} - m)L_f = m_{water}c_{water}(T_i - 0°\text{C})$$

2 PSE6 20.P.024

a. The work done on the fluid is equal to the negative of the area under the curve, $W = -\int PdV$.

b. Since the process is reversed, the value you get for this part should be negative of part (a).

3 PSE6 20.P.030

a. Since its is a cyclic process, the internal energy is not changed. So $Q = -W =$ area of the triangle.

b. Negative of the value found in part (a).

4 PSE6 20.P.032

$$E_{int,B} - E_{int,A} = -[(E_{int,A} - E_{int,D}) + (E_{int,D} - E_{int,C}) + (E_{int,C} - E_{int,B})]$$

From point D to point A, the process is isobaric. Energy leaves the system by heat, so Q_{DA} is negative. Therefore,

$$W_{DA} = -P_D(V_A - V_D)$$

and

$$E_{int,A} - E_{int,D} = Q_{DA} + W_{DA}$$

The expression for the change in internal energy from point B to point C is similar except there are energy entering the system by heat. So Q_{BC} is positive. We have

$$W_{BC} = -P_B(V_C - V_B)$$

and

$$E_{int,C} - E_{int,B} = Q_{BC} + W_{BC}$$

From point C to point D, it undergoes isothermal process. T is constant. So

$$E_{int,D} - E_{int,C} = 0$$

5 PSE6 20.P.040

a. Law of conservation of energy tells us that $\Delta E_{int,ABC} = \Delta E_{int,AC}$. From the expression $\Delta E_{int,ABC} = Q_{ABC} + W_{ABC}$ we know that the amount of energy must be added to the system is

$$Q_{ABC} = \Delta E_{int,ABC} - W_{ABC}$$

b.

$$W_{CD} = -P_C \Delta V_{CD}$$

The volume change from point C to point D is negative of the volume change from point A to B. So $\Delta V_{CD} = \Delta V_{AB}$ and $P_A = 5P_C$. Hence,

$$W_{CD} = \frac{1}{5} P_A \Delta V_{AB} = -\frac{1}{5} W_{AB}$$

Since the gas is undergoing isovolumetric process from point B to point C, $W_{BC} = 0$. We have $W_{ABC} = W_{AB} + W_{BC} = W_{AB}$.

c.

$$Q_{CDA} = \Delta E_{int,CDA} - W_{CDA}$$

Again, we have $\Delta E_{int,CDA} = \Delta E_{int,CA} = -\Delta E_{int,AC}$. And $W_{CDA} = W_{CD}$.

d.

$$\Delta E_{int,CD} = \Delta E_{int,CDA} - \Delta E_{int,DA}$$

and

$$Q_{CD} = \Delta E_{int,CD} - W_{CD}$$

6 PSE6 20.P.065

Assume the initial mass of ice is m_i. Suppose energy goes in at a constant rate $\wp$. From $t = 0$ to $t = 50$min, the energy entered into the system goes to melt the ice. The amount of energy enters the system in this time interval is

$$Q = 50\text{min} \times \wp = m_i L_f \tag{1}$$

At $t = 50$ min, all the ice melts. From 50min to 60min, the energy that enters the system raises the temperature from 0°C to 2°C. So

$$Q = 10\text{min} \times \wp = (m_w + m_i)c\Delta T \tag{2}$$

Solve for m_i from the two equations.