Class 37 – old exam #2, T7.: B1, M4 M5 M7

B1 $H_2 \rightarrow 2\,g/mole \rightarrow \frac{1}{2}\,6\times10^{23} = 3\times10^{23}$ molecules

assume $f=5$ $\quad U = \frac{5}{2} n R T \leftarrow 293 = 3.04\ kJ$

(n: $1/2$; R: 8.32)

$$P = \frac{nRT}{V} = \frac{1/2 \cdot 8.31 \cdot 293}{.02} = 6.09\times10^4\ Pa$$

M4 net work = area $= +\frac{1}{2} \cdot 2m^3 \cdot 20kPa = 20\ kJ$

($2m^3$: ΔV; $20kPa$: ΔP)

	Q	W	ΔU
A→B	+	−	+
B→C	+	0	+
C→A	−	+	−

M5

A→B	0	−	−
B→C	−	+	0
C→A	+	0	+

M7 "air" → $\gamma = 7/5$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$3(25)^{7/5} = 1\, V_2^{7/5}$$

$$3^{5/7}\,25 = V_2 = 55\ cm^3$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)\left(\frac{V_2}{V_1}\right)$$

$$= (281)\left(\frac{1}{3}\right)\left(\frac{55}{25}\right) = 205\ K$$

Answer 5 of the following 6 questions

Physical Constants

$\sigma = 5.6705 \times 10^{-8}\ \mathrm{W \cdot m^{-2} \cdot K^{-4}}$
$R = 8.3145\ \mathrm{J/(K \cdot mol)}$
$N_A = 6.0221 \times 10^{23}$
$k_B = 1.3807 \times 10^{-23}\ \mathrm{J/K}$
$1\ \mathrm{eV} = 1.6022 \times 10^{-19}\ \mathrm{J}$
$1\ \mathrm{atm} = 1.0133 \times 10^{5}\ \mathrm{Pa}$

Properties of H_2O

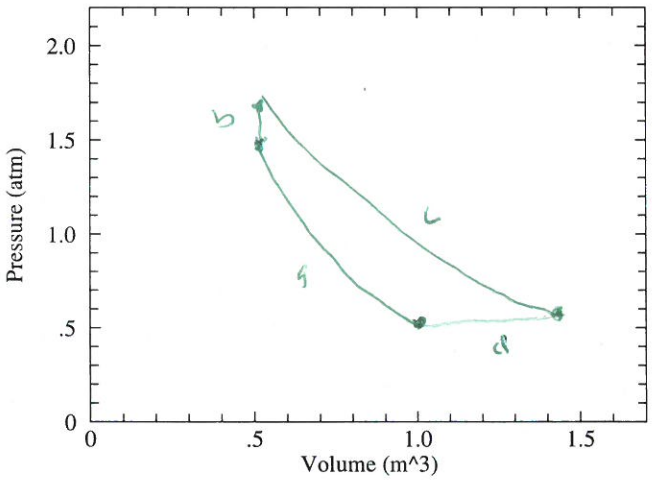
$L_V = 2256\ \mathrm{J/g}$
$c_w = 4.19\ \mathrm{J/(g \cdot K)}$
$L_f = 333\ \mathrm{J/g}$
$c_i = 2.22\ \mathrm{J/(g \cdot K)}$
$\rho_w = 1000\ \mathrm{kg/m^3}$

1. In an insulated container, 250 g of water at 35°C is mixed with 75 g of ice at −20°C. The final state consists of 100% liquid water. What will be the equilibrium temperature of this system?

2. Consider the following cycle starting with 1 $\mathrm{m^3}$ of a diatomic ideal gas at a pressure of 0.5 atm and a temperature of 300 K.

   (a) The gas is adiabatically compressed until the temperature reaches 400 K.
   (b) With the volume held constant, the temperature is increased to 450 K.
   (c) The gas is then isothermally expanded until the pressure reaches 0.5 atm.
   (d) In a constant-pressure (a.k.a., isobaric) process, the volume is returned to 1 $\mathrm{m^3}$.

   On the below graph, accurately plot and label each leg of this cycle. This will require calculating various pVT values at the end of some cycles. Fill in the below table giving the sign $(+, -, 0)$ of the quantity for each leg of the cycle.



path:	a	b	c	d
ΔT	+	+	0	−
ΔE_{int}	+	+	0	−
Q	0	+	+	−
W	+	0	−	+
ΔS	0	+	+	−