Exam practice

#1 b

$$Q_{system} = 0 = Q_{water} + Q_{ice}$$

$$m_{water} c_{water} \Delta T_{water} + m_{ice} c_{ice} \Delta T_{ice} + m_{ice} L_{f_{ice}} + m_{ice} c_{water} \Delta T_{ice \to water} = 0$$

$$\to m_{ice} = - \frac{m_{water} c_{water} \Delta T_{water}}{c_{ice} \Delta T_{ice} + L_{f_{ice}} + c_{water} \Delta T_{ice \to water}}$$

$$= \frac{-1.0 \; 4190 (27-77)}{2100(0--23) + 334 \cdot 10^3 + 4190(27-0)} = 0.423 \text{ kg}$$

1st Law Question

a) $1 \to 2$, $2 \to 3$: $W = 0$, $\Delta p = 0 \to W = p\Delta V = p(V_3 - V_2) = 3P_0(4V_0 - 2V_0) = 6P_0V_0$

$3 \to 4$: $W = 0$

$4 \to 1$: $W = p\Delta V = 2P_0(2V_0 - 4V_0) = -4P_0V_0$

b) $1 \to 2$: $Q = \Delta U = nC_v\Delta T = nC_v\left(\frac{P_2V_2}{nR} - \frac{P_1V_1}{nR}\right) = \frac{5}{2}(3P_0 2V_0 - 2P_0 2V_0)$

$$= \frac{10}{2} P_0V_0$$

$2 \to 3$: $Q = \Delta U + W = nC_v\Delta T + W = nC_v\left(\frac{P_3V_3}{nR} - \frac{P_2V_2}{nR}\right) = \frac{5}{2}(3P_0 4V_0 - 3P_0 2V_0) + W$

$$= \frac{30}{2} P_0V_0 + 6P_0V_0 = \frac{42}{2} P_0V_0$$

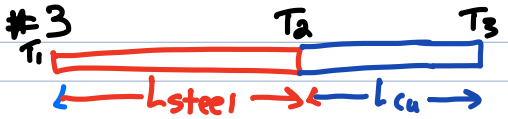
$$\left[Q = nC_p\Delta T = \frac{42}{2} P_0V_0\right]$$

$3 \to 4$: $Q = \frac{-20}{2} P_0V_0$ $\qquad$ $4 \to 1$: $Q = \frac{-28}{2} P_0V_0$

$W_{tot} = 6P_0V_0 - 4P_0V_0 = 2P_0V_0$ which checks out according to Hailee

$\Delta U = 0$ for complete cycle (since $\Delta T = 0$) $\Rightarrow Q = W$

#3



$P_{St} = P_{Cu} \Rightarrow \frac{k_{St} A (T_2 - T_1)}{L_{steel}} = \frac{k_{Cu} (A\ T_3 - T_2)}{L_{Cu}}$

$\Rightarrow L_{Cu} = L_{St} \frac{k_{Cu}}{k_{St}} \frac{(T_3 - T_2)}{(T_2 - T_1)}$

$= 1.0\,m \frac{390 \frac{W}{m \cdot K}}{80 \frac{W}{m \cdot K}} \frac{(0° - 50°)}{(50° - 100°)} = 4.875\,m$

#4 a) $\frac{P_A}{P_B} = \frac{n_A R T_A / V}{n_B R T_B / V}$ don't know

b) don't know

c) $\frac{1}{2} m v_{av}^2 \propto T \Rightarrow$ K.E. $_A >$ K.E. $_B$ ✓

d) $v \sim \sqrt{\frac{3kT}{m}}$ since we don't know $\frac{m_A}{m_B} \Rightarrow$ can't answer

HW ch3, #54

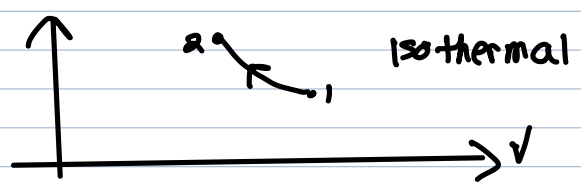
Practice example

$V_1 = 40 \cdot 10^{-3} m^3$ $P_1 = 62\,kPa$

$V_2 = 10 \cdot 10^{-3} m^3$ $T_1 = 300K$

$n = 1.0$ mol

monatomic



a) Qualitative changes in $\Delta U, Q, W$

$\Delta U = 0$ $Q < 0$ $W < 0$

$\rightarrow Q = W$

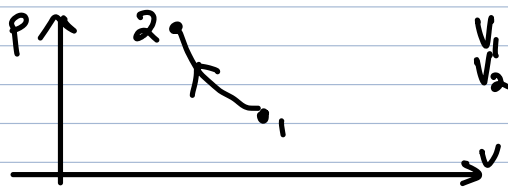
b) How does the product PV change? Doesn't!

c) $W = ?$ $\quad W = \int p\,dV = nRT\int \frac{dV}{V} = nRT \ln \frac{V_2}{V_1} = -3458\ J$

d) $Q = \Delta U + W_{\text{by gas}} = 0 + -3458\ J$

e) If T were instead 250 K, what would happen to curve? drops in PV diagram!

Adiabatic



$V_1 = 40\cdot10^{-3}\ m^3$ $\quad P_1 = 42\ kPa$
$V_2 = 10\cdot10^{-3}\ m^3$ $\quad T_1 = 200\ K$

a) $Q = 0$
$W = < 0$
$\Delta U = > 0$

b) $T_2 = ?$ $\quad P_2 = P_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 42kPa\left(\frac{40}{10}\right)^{1.67} = 423\ kPa$

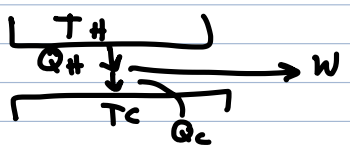
$T_2 = T_1 \frac{P_2}{P_1}\frac{V_2}{V_1} = 504\ K$

c) $\Delta U = \frac{3}{2} nR\Delta T = 3791\ J$

d) $W = -\Delta U = -3791\ J$ $\quad$ OR $W = \frac{1}{\gamma - 1}(P_1V_1 - P_2V_2) = -3825\ J$

~~$W = \int p\,dV = \int \frac{nRT}{V} dV$~~

ch 04 #22



$e = \frac{W}{Q_H} \rightarrow Q_H = \frac{W}{e} = 500\ J$

$W = |Q_H| - |Q_C| \rightarrow |Q_C| = |Q_H| - W = 500 - 200 = 300\ J$