Physics 203 – Principles of Physics III
Homework Chapters 18 and 19
Assignment #2
February 19, 2008

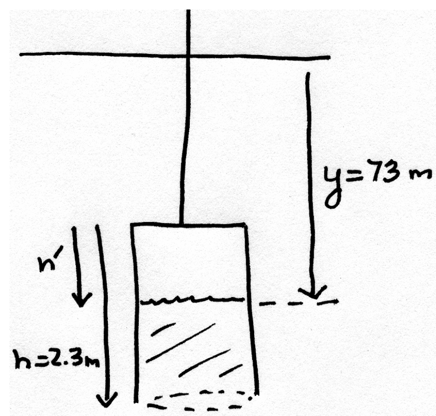
18-15: a) $$T_2 = \frac{p_2 V}{nR} = \frac{(100\,\text{atm})(3.10\,\text{L})}{(11.0\,\text{mol})(0.08206\,\text{L}\cdot\text{atm}/\text{mol}\cdot\text{K})} = 343\,\text{K} = 70.3^{\circ}\text{C}.$$

b) This is a very small temperature increase and the thermal expansion of the tank may be neglected; in this case, neglecting the expansion means not including expansion in finding the highest safe temperature, and including the expansion would tend to relax safe standards.

18-27: $\frac{1000\,\text{g}}{18.0\,\text{g}/\text{mol}} =$ 55.6 mol, which is (55.6 mol)(6.023 x 10^{23} molecules/mol) = 3.35 x 10^{25} molecules.

18-43: a) Using Eq. (16-26), Q = (2.50 mol)(20.79 J/mol·K)(30.0 K) = 1.56 kJ.

b) From Eq. (16-25), $\frac{3}{5}$ of the result of a part (a), 936 J.



18-56: a) The height of water h′ at this depth will be proportional to the reduced volume. From the ideal gas law volume is inversely proportional to the pressure and proportional to the temperature; thus,

$$\frac{PV}{T} = \frac{P'V'}{T'} \quad \Rightarrow \quad \frac{Ph}{T} = \frac{P'h'}{T'}$$

$$h' = h\frac{p}{p'}\frac{T'}{T} = h\frac{p_{atm}}{p_{atm} + pgy}\frac{T'}{T}$$

$$= (2.30\,m)\frac{(1.013x10^5\ Pa)}{(1.013x10^5\ Pa) + (1030\,kg/m^3)(9.80\,m/s^2)(73.0\,m)}\left(\frac{280.15\,K}{300.15\,K}\right)$$

$$= 0.26\,m,$$

so Δh = h - h′ = 2.04 m.

b) The necessary gauge pressure is the term pgy from the above calculation,
P_g – 7.37 x 10^5 Pa.

18-60: (Neglect the thermal expansion of the flask.) At constant volume the ideal gas law says

a) $p_2 = p_1(T_2/T_1) = (1.013 \text{ x } 10^5 \text{ Pa})(300/380) = 8.00 \text{ x } 10^4$ Pa.

b)
$$m_{tot} = nM = \left(\frac{p_2 V}{RT_2}\right) M$$
$$= \left(\frac{(8.00 \text{x} 10^4 \text{ Pa})(1.50 \text{ L})}{(8.3145 \text{ J/mol} \cdot \text{K})(300 \text{ K})}\right)(30.1 \text{ g/mol}) = 1.45 \text{ g}.$$

19-17: The work done is positive from *a* to *b* and negative *b* to *a*; the net work is the area enclosed and is positive around the clockwise path. For the closed path $\Delta U = 0$, so $Q = W > 0$. A positive value for Q means heat is absorbed.

b) $|Q| = 7200$ J, and from part (a), $Q > 0$ and so $Q = W = 7200$ J.

c) For the counterclockwise path, $Q = W < 0$. $W = -7200$ J, so $Q = -7200$ J and heat is liberated, with $|Q| = 7200$ J.

19-36: Equations (19-22) and (19.24) may be re-expressed as

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}, \quad \frac{p_2}{p_1} = \left(\frac{V_1}{V_2}\right)^{\gamma}.$$

a) $\gamma = \frac{5}{3}$, $p_2 = (4.00 \text{ atm})(2/3)^{\frac{5}{3}} = 2.04$ atm, $T_2 = (350 \text{ K})(2/3)^{\frac{2}{3}} = 267$ K.

b) $\gamma = \frac{7}{5}$, $p_2 = (4.00 \text{ atm})(2/3)^{\frac{7}{5}} = 2.27$ atm, $T_2 = (350 \text{ K})(2/3)^{\frac{2}{5}} = 298$ K.

19-44: We are given

$\Delta U_{ab} = U_b - U_a = 240\ J - 150\ J = 90\ J$ $\Delta U_{bc} = U_c - U_b = 680\ J - 240\ J = 440\ J$
$\Delta U_{dc} = U_c - U_d = 680\ J - 330\ J = 350\ J$ $\Delta U_{ad} = U_d - U_a = 330\ J - 150\ J = 180\ J$

No work is done in the processes *ab* and *dc*, and so we know

$W_{ab} = 0$, $W_{dc} = 0$, $W_{bc} = W_{abc} = 450$ J and $W_{ad} = W_{adc} = 120$ J.

For each process, $Q = \Delta U + W$, thus

$Q_{ab} = \Delta U_{ab} + W_{ab} = 90\ J + 0 = 90\ J$
$Q_{bc} = \Delta U_{bc} + W_{bc} = 440\ J + 450 = 890\ J$
$Q_{dc} = \Delta U_{dc} + W_{dc} = 350\ J + 0 = 350\ J$
$Q_{ad} = \Delta U_{aa} + W_{ad} = 180\ J + 120\ J = 300\ J$

Since $Q > 0$ for each process, heat is absorbed in each process. Note that the arrows representing the processes all point in the direction of increasing temperature (increasing U).

19-50: a) $$n = \frac{Q}{C_p \Delta T} = \frac{(-2.5\text{x}10^4\ \text{J})}{(29.07\ \text{J/mol}\cdot\text{K})(-40.0\ \text{K})} = 21.5\ \text{mol.}$$

b) $$\Delta U = nC_V\Delta T = Q\frac{C_V}{C_P} = (-2.5\text{x}10^4\ \text{J})\frac{20.76}{29.07} = -1.79\text{x}10^4\ \text{J.}$$

c) $W = Q - \Delta U = -7.15 \times 10^3$ J.

d) ΔU is the same for both processes, and if $dV = 0$, $W = 0$ and
$Q = \Delta U = -1.79 \times 10^4$ J.