Chapter 12 Homework

3. $P_1 = 1.5 atm (1.013\times10^5 Pa/atm) = 1.52\times10^5 Pa$

$V_1 = 4.0 m^3$

a) $P_2 = P_1$ and $V_2 = 2V_1$ The gas does positive work when it expands. $W = P(V_2 - V_1) = P_1(2V_1 - V_1) = P_1V_1$

$W = 1.52\times10^5 Pa (4.0 m^3) = 6.1\times10^5 J$

∴ "on" the gas is $-6.1\times10^5 J$

b) compressed: $P_2 = P_1$ and $V_2 = \frac{1}{4}V_1$

∴ work is done "on" the gas

The gas does negative work.

$W = 1.52\times10^5 Pa \left(\frac{1}{4}V_1 - V_1\right) = (1.52\times10^5)\left(-\frac{3}{4}\right)(4.0) J$

$= -4.6\times10^5 J$

∴ on gas would be $+4.6\times10^5 J$

5. Graph on page 420 Calculate the work by gas and ∴ "on gas" is opposite sign

a) $W_{IAF} \Rightarrow IA$ $W = P\Delta V = (4 atm)(1.013\times10^5 Pa/atm)(2 \ell)(10^{-3} m^3/\ell)$

since $W_{AF} = 0$ $W_{IAF} = 810 J$ ∴ on gas $(-810 J)$

b) $W_{IF} \Rightarrow$ Area ① $= \frac{1}{2}bh = \frac{1}{2}(2\ell)(3 atm) = 3 \ell.atm$

Area ② $= (1 atm)(2\ell) = 2 \ell.atm$

Total $= 5 \ell.atm (10^{-3} m^3/\ell)(1.013\times10^5 Pa/atm) = 507 J$

∴ on gas $(-507 J)$

c) $W_{IBF} \Rightarrow W_{IB} = 0$ since $\Delta V = 0$

$W_{BF} \Rightarrow W = (1 atm)(2\ell) = 203 J$ ∴ on gas is $-203 J$

13. $Q_{IF} = 418 J$ (enters gas) a) $\Delta U = Q - W = 418 J - 507 J = -89 J$

$W_{IF} = 507 J$ (by gas) Note: W done by gas ∴ it used some energy and ΔU is $(-)$

b) $\Delta U = -89 J$

$W_{IAF} = 810 J$ (by gas) ∴ $Q = \Delta U + W = -89 J + 810 J$

$= 721 J$ (added to gas)

15. $P_1 = P_2 = 0.800$ atm
$V_1 = 9.00$ L
$V_2 = 2.00$ L
$\Delta Q = -400$ J ← leaves the system

a) Find W on gas ∴ opposite of W by gas

$\therefore W = -P\Delta V$
$= -(.800 \text{ Atm})(2.00\text{ L} - 9.00\text{ L})$
$= +5.6 \text{ L}\cdot\text{atm}\left(10^{-3}\frac{m^3}{L}\right)\left(\frac{1.013\times10^5 \text{ Pa}}{\text{atm}}\right)$
$= 567$ J

b) $\Delta U = Q - W$
$= -400 \text{ J} - (-567 \text{ J})$
$= 167$ J

sign convention, W by gas is −567 J ∴ internal energy is increased.

26. Graph on p. 421

$n = 1.00$ mole
$P_I = 2.00$ atm
$V_I = .300$ L
$U_I = 91.0$ J
$P_F = 1.50$ atm
$V_F = 0.800$ L
$U_F = 180$ J

Path IAF

a) W_{IA} 0 since $\Delta V = 0$
W_{AF} (by gas) $= (1.50 \text{ Atm})(.500 \text{ L}) = .750 \text{ Atm}\cdot\text{L} = 76.0$ J
$\therefore W_{on\ gas} = -76.0$ J

b) $\Delta U = U_F - U_I = 180 \text{ J} - 91.0 \text{ J} = 89.0$ J
$Q_{IAF} = \Delta U + W = 89.0 \text{ J} + 76.0 \text{ J} = 165$ J

Path IBF

a) $W_{BF} = 0 + W_{IB} = (2.00 \text{ atm})(.500 \text{ L})$
$W_{IB} = 101$ J (by gas, ∴ on gas −101 J)

b) $Q_{IAF} = 89.0 \text{ J} + 101 \text{ J} = 190$ J

Path IF

a) $W_{IF} = \frac{1}{2}(.500 \text{ L})(.500 \text{ Atm}) + (1.50 \text{ atm})(.500 \text{ L})$
$= .875 \text{ L}\cdot\text{atm} = 88.6$ J by Gas
∴ −88.6 J on gas

b) $Q_{IF} = 89.0 \text{ J} + 88.6 \text{ J}$
$= 178$ J

31. $T_c = 25^\circ C = 298\,K$ $\quad e_c = 1 - \frac{T_c}{T_H} = 1 - \frac{298}{648} = 1 - .46$

$T_H = 375^\circ C = 648\,K$

$\therefore e_c = .54$ or 54 %

37. $Q_H = 1700\,J$ $\quad$ a) $e = 1 - \frac{Q_c}{Q_H} = 1 - \frac{1200\,J}{1700\,J} = .294 \therefore 29.4\%$

$Q_c = 1200\,J$

b) $W = Q_H - Q_c = 1700\,J - 1200\,J = 500\,J$

~~c) $P = \frac{W}{t} = \frac{500\,J}{.300\,s} = 1.67 \times 10^3$ Watt~~

41. $Q_H = 500\,J$ $\quad e = 1 - \frac{Q_c}{Q_H} = 1 - \frac{300\,J}{500\,J} = 0.40$

$Q_c = 300\,J$

$e = 0.60\,e_c$ $\quad .60\,e_c = .40 \therefore e_c = \frac{.40}{.60} = \frac{2}{3}$

$\frac{2}{3} = 1 - \frac{T_c}{T_H} \therefore \frac{T_c}{T_H} = \frac{1}{3}$

47. $T = 0^\circ C$

$V_w = 1.0\,L = 1.0 \times 10^{-3}\,m^3$ $\quad \therefore m_w = \rho_w V_w = 1.0\,kg$

$\rho_w = 1.0 \times 10^3\,kg/m^3$ $\quad \Delta S = \frac{\Delta Q}{T} = \frac{m L_f}{T}$

(⊖ leaving water)

$\Delta S_{water} = \frac{(1.0\,kg)(-3.33 \times 10^5\,J/kg)}{273\,K} = -1.2 \times 10^3\,J/K$

$\therefore \Delta S_{Freezer} = +1.2 \times 10^3\,J/K$

49. $m = 70\,kg$ $\quad Q = PE$ given up by the log $= mgh$

$h = 25\,m$ $\quad Q = mgh = (70\,kg)(9.8\,m/s^2)(25\,m)$

$T = 300\,K$ $\quad Q = 1.72 \times 10^4\,J \approx 1.7 \times 10^4\,J$

$\therefore \Delta S = \frac{\Delta Q}{T} = \frac{1.72 \times 10^4\,J}{300\,K} \approx 57\,J/K$