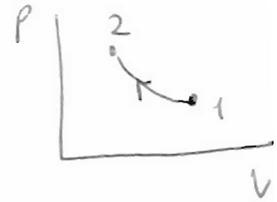
PHYSICS 2 - SUMMER 08
HOMEWORK 6

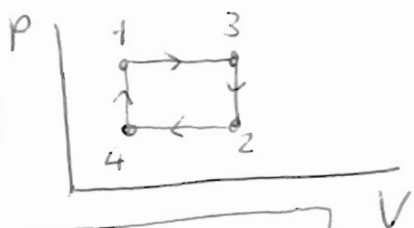
19.3 (a) $pV = \text{constant}$



(b)
$W = nRT \log \frac{P_1}{P_2}$ (see example 19.1 on page 649

$P_1V_1 = P_2V_2 \quad P_2 = 3P_1$ $\quad W = nRT \log \frac{1}{3} = -nRT\log 3$ $\quad W = -6540\,J$

19.7 (a)



$W = P_1(V_1 - V_2) - P_2(V_1 - V_2)$ $\boxed{W = (P_1 - P_2)(V_1 - V_2)}$

(b) $\boxed{W = -(P_1 - P_2)(V_1 - V_2)}$

19.15 (a) Volume constant $\rightarrow W = 0$

(b) $pV = nRT$ since $V = \text{constant}$ and P doubles, T also doubles
ie. $T_b = 2T_a$

(c) since $W = 0$, $\Delta U = Q = +400\,J \Rightarrow U_b = U_a + 400\,J$

19.16 (a) $a \rightarrow b$ greatest work on path 1
smallest work on path 3

(b) $\Delta U = Q - W$ $\quad \Delta U > 0$ and path independent. $Q = \Delta U + W$
$W > 0$ for all paths
$\Rightarrow$ Q greatest when W is greatest and
$Q > 0$ (ie, heat is absorbed)

19.24 $pV = nRT \Rightarrow p\Delta V = nR\Delta T$ (at constant P)

$\Rightarrow \Delta T = \frac{p\Delta V}{nR} > 0$

$Q = nC_p\Delta T \Rightarrow$ heat absorbed $(Q>0)$

19.30 $C_p = C_v + R$ and $\gamma = \frac{C_p}{C_v} \Rightarrow C_p = \gamma C_v$

$\gamma C_v = C_v + R \Rightarrow$ $\boxed{C_v = \frac{R}{\gamma - 1}}$ $\quad c_v = 65.5 \frac{J}{mol\,k}$

$C_p = C_v + R = \frac{R}{\gamma-1} + R = \frac{R + \gamma R - R}{\gamma - 1}$ $\quad \boxed{C_p = \frac{\gamma}{\gamma-1} R}$ $\quad C_p = 73.8 \frac{J}{mol\,k}$

19.48 $W_{acb} = W_{a\to c} + W_{c\to b} + W_{b\to a}$ (1)

$W_{a\to c} = P_A(V_c - V_A)$

$W_{a\to c} = nR(T_c - T_a) = 3 \cdot 8.3145 \cdot (492-300)\,J = 4.789\ 10^3\,J$

$W_{c\to b} = Q - \Delta U = -\Delta U = -nC_v\Delta T = -n(C_p - R)(T_b - T_c)$

$W_{c\to b} = -3 \cdot (29.1 - 8.3145)(600 - 492)\,J = -6.735\ 10^3\,J$

$W_{b\to a} = 0$

Adding all up according to eqtn (1), $W_{acb} = -1.95\ 10^3\,J$

20.3 (a) $e = \frac{\text{Work output}}{\text{heat input}} = \frac{3700}{16,100} = 23\%$

(b) $W = |Q_H| - |Q_c| \Rightarrow |Q_c| = |Q_H| - W = 16,100 - 3700 = 12,400\,J$

(c) $Q_H = m L_c$ where L_c = latent heat of combustion

$m = \frac{Q_H}{L_c} = \frac{16,100\,J}{4.6\,10^4\,J/g} = 0.350\,g$

(d) $W = 3700$ J/cycle, 60 cycles/sec $\Rightarrow$ Power $= 60 \times 3700 =$ ③

Power $= 222\ 10^3$ W

$222\ 10^3 W = 222\ 10^3\ W \frac{1\ hp}{746 W} = 298\ hp$

20.6 $e = 1 - \frac{1}{r^{\gamma-1}}$ $e = 1 - \frac{|Q_c|}{|Q_H|}$

(a) $e = 1 - \frac{1}{9.50^{0.40}} = 59\%$

(b) $|Q_c| = |Q_H|(1-e) = 4060\ J$

20.14 (a) $Q_c = -Q_H \frac{T_c}{T_H} = -6.45\ 10^3 J\ \frac{300}{520} = -3.7\ 10^3 J$

(b) $|W| = |Q_H| - |Q_c| = 2.73\ 10^3 J$

(c) $e = \frac{W}{Q_H} = 42.3\%$

20.26 $Q_{system} = 0$ $Q = mc\Delta T$.

Example 20.6 shows $\Delta S = mc \log \frac{T_2}{T_1}$ for temp change

(a) Heat transfer 100°C $\rightarrow$ 30°C is irreversible

(b) $270\ kg\ c\,(T_2 - 30°C) + 5\ kg\ c\,(T_2 - 100°C) = 0$ gives $T_2 = 31.27°C$

$c = 4190\ J/kg\,K$

(c) $\Delta S = mc \log \frac{T_2}{T_1}$ gives

$\Delta S = 270\ kg \cdot c\ \log \frac{304.42}{303.15} + 5\ kg\ c\ \log \frac{304.42}{373.15}$

$\Delta S = +470\ J/K$