Ch. 13 ex

STP = 1 atm, 0°C

13.1 98.6 °F

$T_c = \frac{5}{9}(t_f - 32)$

$= \frac{5}{9}(98.6 - 32) = 37.0\,°C$

$37.0°C + 273.15 K = 310.2\ K$

13.2) $\Delta l = \alpha l \Delta T$

$= 12 \times 10^{-6}\ K^{-1} \cdot 1.25 \times 10^{7}\ m \times 30\ K$

$= 0.46\ m$

13.3) $\Delta A = 2\alpha A \Delta T$

$= 2(12 \times 10^{-6}\ K^{-1})(6.00\ m)(30\ K)$

$= 0.0043\ m^2$

13.4) $\Delta V = 3\alpha V \Delta T$

$= 3(9.6 \times 10^{-4}\ \frac{1}{K})(10\ m^3)(30\ K)$

$= 0.864\ m^3$

$\Delta V = 3\alpha V \Delta T = (9.6 \times 10^{-4}\ \frac{1}{K})(10)(30)$

$= 0.29\ m^3$

13.5) a) $\Delta V = 3\alpha V \Delta T$

$= 3(12 \times 10^{-6}\ \frac{1}{K})(80\ L)(30K)$

$= 0.0864\ L$

b) $\Delta V = 3\alpha V \Delta T$

$= 3(9.6 \times 10^{-4}\ K^{-1})(80\ L)(30\ K)$

$= 2.3\ L$

c) $V_0 = 80\ L$

$V_f = 2.3\ L + 80\ L - 0.0864\ L$

$= 82.21\ L$

$\Delta V = 2.21\ L$

13.6) $PV = nRT$

$V = \frac{nRT}{P} = \frac{(1.00)(8.314\ J/mol\,K)(273.15K)}{101325\ Pa}$

$= 0.022\ m^3$ [22.4 L]

13.7) $V_0 = 4.00\ L \quad \Delta T = 50.0K$

$V_f = 3.00\ L$

$P_1 V_1 = nRT_1 \quad P_2 V_2 = nRT_2$

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

$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2} = \frac{(101325\ Pa)(4.00\ L)(273 + 50K)}{(273\ K)(3.00\ L)}$

$= 160.\ kPa$

$160\ kPa \times \frac{1\ atm}{101.325\ kPa} = 1.58\ atm$

13.8) a) $0.100\ kg\ CO_2$

$CO_2 \rightarrow 12.001\ g/mol + 32\ g/mol$

$= 44.01\ g/mol$

$100\ g \times \frac{1\ mol}{44.01\ g} = 2.27\ mol$

b) $N = nN_A = (2.27\ mol)(6.022 \times 10^{23}\ molec/mol)$

$= 1.37 \times 10^{24}\ molecules$

13.9) $Q = mc\Delta T = (4.50\ kg)(385\ J/kgK)(130\ K)$

$= 226\ kJ$

13.10) a) $Q = mL = (3.00kg)(22.57 \times 10^5\ J/kg)$

$= 6.77\ MJ$

b) $P = \frac{Q}{t} \quad t = \frac{Q}{P} = \frac{6.77 \times 10^6\ J}{1000\ J/s} = 6771\ s$

(3.11) ice $-10.0$ C  $m_1$=?  $m_2 = 4.00$ kg water, $T_2 = 20$ C, $T_f = 5$ C

$Q_1 = m_1 c_{ice}(10\text{K}) + m_1 L_{fus} + m_1 c_{water}(5\text{K})$

$Q_2 = m_2 c_{water}(15\text{K})$

$Q_1 + Q_2 = 0$

~~$m_1(c_{ice}(10\text{K}) + L_{fus}) = m_2 c_{water}$~~

$m_1(c_{ice}(10\text{K}) + c_{water}(5\text{K}) + L_{fus}) = m_2 c_{water}(15\text{K})$

$$m_1 = \frac{(4\text{kg})(4186\ \text{J/kgK})(15\text{K})}{(2050\ \text{J/kgK})(10\text{K}) + (4186)(5) + 3.34\times10^5\ \text{J/kg}}$$

$= 0.669$ kg ice

(3.12) $m_{ice} = 20$ kg, $T_{ice} = 0$C

$m_{water} = 1$ kg $T_{water} = 100$C

heat to melt the ice: $Q = mL = (20)(3.335\times10^5) = 6.67$ MJ

heat to bring all the water to 0C: $Q = mc\Delta T$

$= (1\text{kg})(4186)(100\text{K}) = 0.419$ MJ

ice doesn't melt, so the final temp is 0C

$Q = mL$

$$m_{melted} = \frac{Q}{L} = \frac{2118600\ \text{J}}{3.35\times10^5\ \text{J/kg}} = 1.26\ \text{kg melted}$$

remaining $= 20 - 1.26 = 18.7$ kg

(3.13) $Q = mc\Delta T$

$$m = \frac{Q}{c\Delta T} = \frac{1.50\times10^6\ \text{J}}{4186\cdot 2\text{e-}3\ \text{K}} = 1792\ \text{kg}$$

(3.14) $$\frac{dQ}{dt} = \frac{(T_H - T_c)A}{R_{total}} = \frac{(100.\text{m}\times150\text{m})(37 - -20\text{C})}{0.21\ \text{m}^2\text{K/W}}$$

$= 121$ W

(3.15) $$\frac{dQ}{dt} = \frac{(2.5\ \text{m}^2)(45\text{K})}{(0.1 + 2.53 + 0.14)} = 162\ \text{W}$$

(3.16) $$\frac{dQ_1}{dt} = \frac{(2\times3.5 - 0.75\times1.2)(80\text{K})}{(2.10\ \text{m}^2\text{K/W})} = 87\ \text{W}$$

$$\frac{dQ_2}{dt} = \frac{(0.75\times1.2)(30\text{K})}{0.21\ \text{m}^2\text{K/W}} = 129\ \text{W}$$

$$\frac{dQ_{total}}{dt} = 129 + 87 = 216\ \text{W}$$

(3.17) $dm = \rho_{ice} A\,|dx|$

a) $dQ = -L_f\,dm$

$= -L_f \rho_{ice} A\,|dx|$

$dQ = -L_f \rho_{ice} A(-dx) = L_f \rho_{ice} A\,dx$

$$\frac{dQ}{dt} = \frac{kA\Delta T}{x}$$

$$L_f \rho_{ice} A \frac{dx}{dt} = \frac{kA\Delta T}{x}$$

$$x\,dx = \frac{k\Delta T}{L_f \rho_{ice}}\,dt$$

$$\int_0^x x\,dx = \frac{k\Delta T}{L_f \rho_{ice}} \int_0^t dt$$

$$x = \sqrt{\frac{2k\Delta T}{L_f \rho_{ice}}\,t}$$

b) $$x^2 = \frac{2k\Delta T}{L_f \rho_{ice}}\,t$$

$$t = \frac{x^2 (L_f \rho_{ice})}{2k\Delta T} = \frac{(0.01\ \text{m})^2 (3.335\times10^5\ \text{J/kg})(917\ \text{kg/m}^3)}{2(2.1\ \text{W/mK})(10\text{K})}$$

$= 728$ s

(3.18) $$\frac{dQ}{dt} = -eA\sigma T^4$$

$e = 1$

$= -4\pi r^2 (5.67\times10^{-8}\ \text{W/m}^2\text{K}^4)(5800\ \text{K})^4$

$= -3.91\times10^{26}$ W

(3.19) $\frac{dQ}{dt} = e A \sigma \left( (T_{obj} + \Delta T)^4 - T_{obj}^4 \right)$

$= e A \sigma \left( T_{obj}^4 \left( 1 + \frac{\Delta T}{T_{obj}} \right)^4 - T_{obj}^4 \right)$

$\left( 1 + \frac{\Delta T}{T_{obj}} \right)^4 \approx 1 + 4 \frac{\Delta T}{T_{obj}}$

$= e A \sigma \left( T_{obj}^4 \left( 1 + 4 \frac{\Delta T}{T_{obj}} \right) - T_{obj}^4 \right)$

$= e A \sigma \left( 4 T_{obj}^3 \Delta T \right)$

(3.20) $\frac{dQ}{dt} = e A \sigma \left( -T_{obj}^4 + T_{sur}^4 \right)$

$= (1.9\ m^2) \left( (293\ K)^4 - (273 + 37)^4 \right)$

$= -3.5 \times 10^9\ W$

$\frac{dQ}{dt} = (2.5\ m^2) \left( 5.67 \times 10^{-8} \frac{W}{m^2 K^4} \right) \left( 4 (273 + 37)^3 (17\ K) \right)$

$= 2.9 \times 10^2\ W$ (→)

$-2.9 \times 10^2\ W$

(3.21) $W = nRT \ln \frac{V_f}{V_0}$

& $PV = nRT$

$n = \frac{PV}{RT} = \frac{(101325\ Pa)(0.0005\ m^3)}{(8.314\ J/mol\ K)(300\ K)}$

$W = \frac{PV}{RT} \cdot RT \ln \frac{V_f}{V_0}$

$= PV \ln \frac{V_f}{V_0} = (101325\ Pa)(0.0005\ m^3) \cdot \ln \left( \frac{0.25}{0.5} \right)$

$= -35\ J$

work is done on the gas

(3.22) $W_{total} = \text{enclosed area}$

$W = \pi r^2 = \pi (0.004\ m^3)(2 \times 101325\ Pa)$

$= 25473$

$W = \pi (2.00\ atm \times 1.0013 \times 10^5 \frac{Pa}{atm}) \cdot (3.00\ L \times 10^{-3}\ m^3/L)$

$= 1910\ J$