Unit 7 Problem Set

1) $m = 200.\ g$ $\quad q = -11{,}700\ J$

$T_i = 20°C$

$T_f = ?$

$C_s = 4.18\ \frac{J}{g\,°C}$

$q = m \times C_s \times \Delta T$

$-11{,}700\ J = 200g\left(4.18\ \frac{J}{g\,°C}\right) \times (T_f - 20°C)$

$-13.995°C = T_f - 20°C$

$6.0°C = T_f$

2) $9.00g\ Al \times \frac{1\ mol\ Al}{26.98g} \times \frac{-849kJ}{2\ mol\ Al} = -141\ kJ$

3) $\Delta H°_{rxn} = \sum n_p \Delta H°_f (products) - \sum n_r \Delta H°_f (reactants)$

$-1366.8\ kJ = [2\Delta H°_f(CO_{2(g)}) + 3\Delta H°_f(H_2O_{(l)})] - [3\Delta H°_f(O_{2(g)}) + 1\Delta H°_f(C_2H_5OH_{(l)})]$

$= [2(-393.5kJ/mol) + 3(-285.8\ kJ/mol)] - [0 + 1(x\ kJ/mol)]$

$277.6\ \frac{kJ}{mol} = -x\ \frac{kJ}{mol}$

$-277.6\ \frac{kJ}{mol} =$

4) $-450\ kJ \times \frac{1\ mol\ C_2H_4}{-1411\ kJ} \times \frac{28.052\ g\ C_2H_4}{mol} = 8.95\ g\ C_2H_4$

5) [illegible]

$$q_{rxn} = -q_{surr} = -C_{surr} \Delta T$$

$$C_{surr} = C_{H_2O}$$

$$= -(C_{cal} + (m \times C_s))\ \Delta T$$

$$-\frac{26{,}420\ J}{g}(0.7521\ g) = -(C_{cal} + (1000\ g \times \frac{4.18\ J}{g\ ^\circ C}))\ 3.60^\circ C$$

$$-19870.48\ J = -3.60^\circ C\ C_{cal} + 15048\ J$$

$$-4822\ J = -3.60^\circ C\ C_{cal}$$

$$1340\ \frac{J}{^\circ C} = C_{cal}$$

$$1.34\ \frac{kJ}{^\circ C}$$

6) $q = m \times C_s \times \Delta T$

$$q_{metal} = -q_{water}$$

$$m_{metal} \times C_{s,metal} \times \Delta T_{metal} = -m_{water} \times C_{s,water} \times \Delta T_{water}$$

If $m_{metal} = m_{water}$

$$m_{metal} \times C_{s,metal} \times \Delta T_{metal} = -m_{metal} \times C_{s,water} \times \Delta T_{water}$$

$$C_{s,metal} \times \Delta T_{metal} = -C_{s,water} \times \Delta T_{water}$$

$$\left(0.4444 \frac{J}{g\,^\circ C}\right) \times \Delta T_{metal} = \left(4.184 \frac{J}{g\,^\circ C}\right) \times \Delta T_{water}$$

$$\Delta T_{metal} = 9.423\, \Delta T_{water}$$

False

7) $$C = 20.0\,g \times 4.18 \frac{J}{g\,^\circ C} = 83.6 \frac{J}{^\circ C}$$

True

8) a. $$q_{rxn} = -C_{surr}\, \Delta T$$

$$= -(C_{cal} + (m \times C_s))\, \Delta T$$

$$= -\left(4{,}780 \frac{J}{^\circ C} + \left(2000\,g \times \frac{4.180\,J}{g\,^\circ C}\right)\right)[30.2^\circ C - 26.5^\circ C]$$

$$= -\left(4{,}780 \frac{J}{^\circ C} + 8{,}360 \frac{J}{^\circ C}\right)[3.7^\circ C]$$

$$= -48.6\,kJ$$

b. $$\frac{-48.6\,kJ}{2.17\,g \times \frac{1\,mol}{100.1\,g}} = -2.24 \times 10^3 \frac{kJ}{mol}$$

9) $C_2H_{2(g)} + \frac{5}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + H_2O_{(l)}$ $\Delta H^\circ = -1299 \frac{kJ}{mol}$

$\Delta H^\circ = [2_{mol}\Delta H_f^\circ(CO_2) + 1_{mol}\Delta H_f^\circ(H_2O)] - [\frac{5}{2}\overbrace{\Delta H_f^\circ(O_2)}^{0} + 1\Delta H_f^\circ(C_2H_2)]$

$-1299\frac{kJ}{mol} = [2(-393.5\frac{kJ}{mol}) + -285.8\frac{kJ}{mol}] - [\Delta H_f^\circ(C_2H_2)]$

$-1299\frac{kJ}{mol} = -1072.8\frac{kJ}{mol} - \Delta H_f^\circ(C_2H_2)$

$226.2\frac{kJ}{mol} = \Delta H_f^\circ(C_2H_2)$

10) $2B_5H_{9(s)} + 12O_{2(g)} \rightarrow 5B_2O_{3(s)} + 9H_2O_{(l)}$

B ~~2~~ 10	B ~~2~~ 10
H ~~2~~ 18	H ~~2~~ 18
O ~~2~~ 24	O ~~24~~ ~~16~~ 24

$\Delta H^\circ = [5\Delta H_f^\circ(B_2O_3) + 9\Delta H_f^\circ(\overbrace{H_2O}^{})] - [2\Delta H_f^\circ(B_5H_9) + \overbrace{12\Delta H_f^\circ(O_2)}^{0}]$

$= [5(-1273.5\frac{kJ}{mol}) + 9(-285.8\frac{kJ}{mol})] - [2(72.3\ kJ/mol)]$

$\Delta H^\circ = -9084.3\ kJ$ $\quad -9084.3\ kJ : 2\ mol\ B_5H_9$

$1\ mol\ B_5H_9 \times \frac{-9084.3\ kJ}{2\ mol\ B_5H_9} = -4542\ kJ$

11) $Ne_{(g)}$, $I_{2(s)}$

12) $q_{cal} = C_{cal} \times \Delta T$

$= \left(2.47 \frac{kJ}{K}\right)(2.14°C + 273.15)$

$= 679.97\ kJ$

$-q_{rev} = 679.97\ kJ \rightarrow \frac{-679.97\ kJ}{0.105\ g \times \frac{mol}{28.05\ g}}$

$= -1.82 \times 10^5 \frac{kJ}{mol}$

13) $\Delta H° = [1\,\Delta H_f°(N_2H_4) + 1\Delta H_f°(H_2O)] - [1\Delta H_f°(N_2O)] + 3\Delta H_f°(H_2)]$

$-317.25\ kJ = [\Delta H_f°(N_2H_4) + -285.8\ kJ] - [81.6\ kJ + 0]$

$-317.25\ kJ + 81.6\ kJ + 285.8\ kJ = 1\ mol\ \Delta H_f°(N_2H_4)$

$50.15 \frac{kJ}{mol}$

14) a) Heat transfer → Change in temperature
b) Work → Placed force on the ball
c) Work → Gas formation; increase in volume
d) Heat transfer → Vapor is hotter than the person

15) ΔE refers to total energy change.
ΔH refers to only ~~heat~~ the change of the heat component of energy.

16) $C_{(s)} + 2H_{2(g)} \rightarrow CH_{4(g)}$

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\quad \Delta H^\circ = -393.5\,kJ$

$2[H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(\ell)}]$ $\quad (2\Delta H^\circ) = -571.6\,kJ$

$CO_{2(g)} + 2H_2O_{(\ell)} \rightarrow CH_{4(g)} + 2O_{2(g)}$ $\quad \Delta H^\circ = +890.3\,kJ$

$C_{(s)} + 2H_{2(g)} + 2O_{2(g)} + O_{2(g)} + 2H_2O_{(\ell)} \rightarrow CO_{2(g)} + 2H_2O_{(\ell)} + CH_{4(g)} + 2O_{2(g)}$

$\Delta H^\circ = -74.8\,kJ$

17) $2N_{2(g)} + 5O_{2(g)} \rightarrow 2N_2O_{5(g)}$

$2[N_{2(g)} + 3O_{2(g)} + H_{2(g)} \rightarrow 2HNO_{3(\ell)}]$ $\quad (2\Delta H^\circ) = -696.4\,kJ$

$2[2HNO_{3(\ell)} \rightarrow N_2O_{5(g)} + H_2O_{(\ell)}]$ $\quad 2(-\Delta H^\circ) = 147.4\,kJ$

$2H_2O_{(\ell)} \rightarrow 2H_{2(g)} + O_{2(g)}$ $\quad \underline{(-\Delta H^\circ) = 571.6\,kJ}$

$= 22.6\,kJ$

18) $C_2H_{4(g)} + 6F_{2(g)} \rightarrow 2CF_{4(g)} + 4HF_{(g)}$

$2(H_{2(g)} + F_{2(g)} \rightarrow 2HF_{(g)})$ $\quad (2\Delta H^\circ) = -1074\,kJ$

$2(C_{(s)} + 2F_{2(g)} \rightarrow CF_{4(g)})$ $\quad (2\Delta H^\circ) = -1360\,kJ$

$C_2H_{4(g)} \rightarrow 2C_{(s)} + 2H_{2(g)}$ $\quad -\Delta H^\circ = \underline{-52.3\,kJ}$

$-2486\,kJ$

19) $m_{metal} \times C_{s,metal} \times \Delta T_{metal} = -m_{water} \times C_{s,water} \times \Delta T_{water}$

$T_{metal,i} = 100°C$

$T_{metal,f} = 28.8°C$

$150g \times C_{s,metal} \times (100°C - 28.8°C) = -50g \times \left(4.18 \frac{J}{g°C}\right) \times 6.8$

$1068g°C \times C_{s,metal} = -1421.2 \frac{J}{g°C}$

$C_{s,metal} = 0.133 \frac{J}{g°C}$