Thermochemistry Practice Problems – Answers

1. KNOW

	Brass	Water
C	0.385 J/g°C	4.184 J/g°C
d	8.40 g/cm³	m = 138 g
V	14.5 cm³	
T_i	152°C	T_i = 23.7°C
m	121.8 g	

$T_{f(Brass)} = T_{f(H_2O)}$

$q_{Brass} = -q_{H_2O}$

$m \cdot C \cdot (T_f - T_i) = m \cdot C \cdot (T_f - T_i)$

$121.8\,g \cdot 0.385\,J/g°C \cdot (T_f - 152) = -138\,g \cdot 4.184\,J/g°C \cdot (T_f - 23.7)$

$46.893(T_f - 152) = -577.392(T_f - 23.7)$

$46.893T_f - 7127.736 = -577.392T_f + 13684.1904$

$624.285\,T_f = 20811.9264$

$T_f = 33.3°C$

2. a) $1.00 \times 10^6 \cancel{kJ} \times \frac{1\ \cancel{mol}}{890.3\cancel{kJ}} \times \frac{16.04\,\cancel{g}}{1\ \cancel{mol}} \times \frac{1\,kg}{1000\,\cancel{g}} = 18.0\,kg$

b) $1.03 \times 10^3\,\cancel{K} \times \frac{1\ mol}{22.4\,\cancel{L}} \times \frac{-890.3\,kJ}{1\ \cancel{mol}} = -4.09 \times 10^4\,kJ$ (released)

c) $q = m \cdot C \cdot \Delta T \rightarrow m = \frac{q}{C \cdot \Delta T} = \frac{4.09 \times 10^4\,kJ}{4.184 \cdot 38.1} = 256.57\,kg$

$= 256\,L$

3. $1\,\cancel{gal} \times \frac{3.785\,\cancel{L}}{1\,\cancel{gal}} \times \frac{1000\,\cancel{mL}}{1\,\cancel{L}} \times \frac{0.703\,\cancel{g}}{1\,\cancel{mL}} \times \frac{1\ \cancel{mol}}{114.23\,\cancel{g}} \times \frac{-5.48 \times 10^3\,kJ}{1\ \cancel{mol}}$

$= -127650\,kJ$ (released)

4. $0.500\,K \times \frac{7\,mol}{1\,K} \times \frac{-42\,kJ}{1\,mol} = -147\,kJ\ (q)$

$H_2O \Rightarrow \quad q = m \cdot C \cdot \Delta T$

$q = m \cdot C \cdot (T_f - T_i)$

$147\,kJ = 0.5\,kg \cdot 4.184\,J/g^\circ C \cdot (T_f - 21)$

$70.27 = T_f - 21$

$T_f = 91.3^\circ C$

5. Skip

6. $\Delta H_{rxn} = \Sigma H_{f(products)} - \Sigma H_{f(reactants)}$

$-8326\,kJ = [\Delta H_{f(H_2O)} + \Delta H_{f(CO_2)}] - [\Delta H_{f(C_6H_{14})} + \cancel{\Delta H_{f(O_2)}}^{\,0}]$

$2\Delta H_{f(C_6H_{14})} = 8326\,kJ + 14(-285.8) + 12(-393.5)$

$2\Delta H_{f(C_6H_{14})} = -397.2\,kJ \qquad \Delta H_{f(C_6H_{14})} = -198.6\,kJ/mol$

7. $2CH_3CHO + 3O_2 \rightarrow 2CO_2 + 4H_2O(l)$

$\Delta H_{rxn} = \Delta H_{f(prod)} - \Delta H_{f(react)}$

$\Delta H_{rxn} = \Delta H_{f(CO_2)} + \Delta H_{f(H_2O)} - \Delta H_{f(CH_3CHO)}$

$\Delta H_{rxn} = 2(-393.5) + 4(-285.8) - 2(-166)$

$\Delta H_{rxn} = -1598.2\,kJ$

$5.93\,g \times \frac{1\,mol}{44.05\,g} \times \frac{-1598.2\,kJ}{2\,mol} = -215\,kJ$

8. a) $2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$ $\quad \Delta H = -112.16\ kJ$

0.300 L	0.400 L
2 mol/L	1 mol/L
0.6 mol	0.4 mol

$\Delta H_{rxn} = \Sigma H_{f(prod)} - \Sigma H_{f(react)}$

$\Delta H_{rxn} = [\Delta H_{f(H_2O)} + \Delta H_{f(Na_2SO_4)}] - [\Delta H_{f(NaOH)} + \Delta H_{f(H_2SO_4)}]$

$\Delta H_{rxn} = [2(-285.83) + (-1390)] - [2(-470.114) + (-909.27)]$

$-1961.66 \qquad -1849.498$

$\Delta H_{rxn} = -112.162\ kJ$

$0.6\ mol \times \frac{-112.16\ kJ}{2\ mol} = -33.6\ kJ$

b) $q = m \cdot C \cdot \Delta T$ $\qquad 700\ mL \times \frac{1.05\ g}{1\ mL} = 735$

$-33.6\ kJ = 735 \cdot 4.2 \cdot (T_f - 25)$

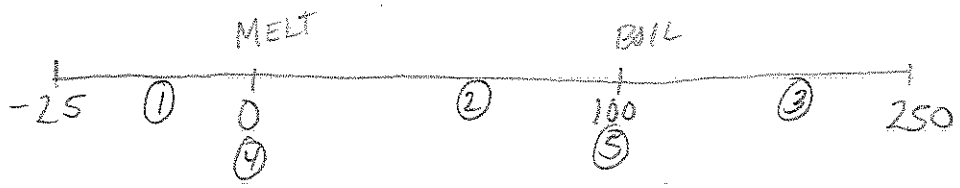
$T_f - 25 = 10.88$

$T_f = 35.8\ °C$

c) $mol_{NaOH} = 2\ mol_{H_2SO_4}$ $\qquad -100 =$

$a = 2b$

9.



① $q = m \cdot C \cdot \Delta T$

$q = 250 \cdot 2.09 \cdot 25 = 13.0625$ kJ

② $q = m \cdot C \cdot \Delta T$

$q = 250 \cdot 4.184 \cdot 100 = 104.6$ kJ

③ $q = m \cdot C \cdot \Delta T$

$q = 250 \cdot 1.84 \cdot 150 = 69$ kJ

④ $q = mol \cdot \Delta H_{fus}$

$q = 250 \times \frac{1 mol}{18 g} \times \frac{6.01 kJ}{1 mol} = 83.47$ kJ

⑤ $q = mol \cdot \Delta H_{vap}$

$q = 250 \cdot \frac{1 mol}{18 g} \times \frac{40.7 kJ}{1 mol} = 565.28$ kJ

TOTAL

835.4 kJ

10. $136 kJ = q_{Hot} + q_{Vap}$

$136 kJ = \frac{m \cdot 4.184 \cdot 75}{1000} + m \times \frac{1 mol}{18 g} \times \frac{40.7 kJ}{1 mol}$

$136 kJ = .3138 m + 2.26 m$

$136 = 2.5738 m$

$m = 52.8 g$ of H_2O.

11. SKIP

12. SKIP

13. a) $N_2 + O_2 \rightarrow 2NO$ $\quad \Delta H = 180.6$

$N_2 + 3H_2 \rightarrow 2NH_3$ $\quad \Delta H = -91.8$ F.

$2H_2 + O_2 \rightarrow 2H_2O$ $\quad \Delta H = -483.7$

$\cancel{2NH_3} + 2O_2 \rightarrow 4NO$ $\quad \Delta H = 180.6 \times 2$

$4NH_3 \rightarrow \cancel{2N_2} + \cancel{6H_2}$ $\quad \Delta H = 2 \times 91.8$

$+ \quad \cancel{6H_2} + 3O_2 \rightarrow 6H_2O$ $\quad \Delta H = 3 \times (-483.7)$

$4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$ $\quad \Delta H = -906.3$ kJ

b) $N_2 + O_2 \rightarrow 2NO$ F.

$N_2 + 3H_2 \rightarrow 2NH_3$

$2H_2 + O_2 \rightarrow 2H_2O$ F

$4NO \rightarrow \cancel{2N_2} + 2O_2$ $\quad \Delta H = -180.6 \times 2$

$\cancel{2N_2} + \cancel{6H_2} \rightarrow 4NH_3$ $\quad \Delta H = -91.8 \times 2$

$+ \quad 6H_2O \rightarrow \cancel{6H_2} + 3O_2$ $\quad \Delta H = 483.7 \times 3$

$\frac{4NO}{4} + \frac{6H_2O}{4} \rightarrow \frac{4NH_3}{4} + \frac{5O_2}{4}$ $\quad \frac{906.3}{4} = \Delta H$

$NO + 1.5H_2O \rightarrow NH_3 + 1.25O_2$ $\quad \Delta H = 226.575$ kJ