Thermochemical Equations & Calorimetry #2

1. $2Ca_{(s)} + 2C_{(s)} + 3O_{2(g)} \rightarrow 2CaCO_{3(s)} + 1207\,kJ$

   $Ca_{(s)} + C_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow CaCO_{3(s)} + 1207\,kJ$

2. $C_3H_{8(l)} + 5\,O_{2(g)}$

   $\Delta H_{comb} = -5720.2$

   $3CO_{2(g)} + 4H_2O_{(g)}$

3. a) $C_3H_{8(g)}$ 10.0 g

   C $3 \times 12.01 = 36.03$

   H $8 \times 1.01 = 8.08$

   $44.11\ g/mol$

   $10.0\,g\ C_3H_{8(g)} \times \frac{1\,mol}{44.11\,g}$

   $= 0.2267\,mol \times \frac{104\,kJ}{mol}$

   $= 23.58\,kJ \rightarrow 23.6\,kJ$

   OR

   $10.0\,g\ C_3H_{8(g)} \times \frac{1\,mol}{44.11\,g} \times \frac{104\,kJ}{mol} = 23.58\,kJ$ → 23.6 kJ

   The heat released by the formation of 10.0g of propane from its elements is 23.6 kJ

3b) $C_3H_{8(g)}$ 10.0g = 0.2267 mol

complete combustion −2324 kJ/mol

$$0.2267 \text{ mol} \times \frac{2324 \text{ kJ}}{\text{mol}}$$

$$= 526.85 \text{ kJ}$$

$$527 \text{ kJ}$$

The heat released during the complete combustion of 10.0g $C_3H_{8(g)}$ is 527 kJ.

4.a) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)} + 890 kJ$

b) $18.5 g\ CH_{4(g)} \times \frac{1 \text{ mol}}{16.05 g} = 1.1526 \text{ mol}$

1×12.01
4×1.01
16.05

$$1.1526 \text{ mol} \times \frac{890 \text{ kJ}}{\text{mol}} = 1025 \text{ kJ}$$

$$= 1.03 \times 10^3 \text{ kJ}$$

OR

$$18.5 g\ CH_4(g) \times \frac{1 \text{ mol}}{16.05 g} \times \frac{890 kJ}{\text{mol}} = \underset{1.03 \times 10^3 \text{ kJ}}{1025 \text{ kJ}}$$

Burning 18.5 of methane released 1.03×10^3 kJ

5. Butane C_4H_{10}

a) $25.0\,g\ C_4H_{10(g)} \times \frac{1\ mol}{58.14\,g} = 0.42999\ mol$

$4 \times 12.01 = 48.04$
$10 \times 1.01 = 10.10$
58.14

$0.42999\ mol \times \frac{126\,kJ}{mol} = 54.179\,kJ$
$54.2\,kJ$

OR

$25.0\,g\ C_4H_{10(g)} \times \frac{1\ mol}{58.14\,g} \times \frac{126\,kJ}{mol} = 54.179\,kJ$
$54.2\,kJ$

The heat released by the formation of 25.0g of butane from its elements is 54.2 kJ

b) $25.0\,g\ C_4H_{10} = 0.42999\ mol$

$0.42999\ mol \times \frac{3003\,kJ}{mol} = 1291.259\,kJ$

$= 1.29 \times 10^3\,kJ$

The heat released by the combustion of 25.0g of butane is 1.29×10^3 kJ

6. $Ca = 1.13\,g$

$H_2O = 250.0\,g$

$T_I = 15.9°C$

$T_F = 23.8°C$

$\Delta T = 23.8°C - 15.9°C$

$= 7.9°C$

$1.13\,g\,Ca(s) \times \frac{1\,mol}{40.08\,g}$

$= 0.028193\,mol$

$$\Delta H_r = \frac{m \times C \times \Delta T}{mol}$$

$$= \frac{250.0\,g \times 4.18\,J/g.°C \times 7.9°C}{0.028193\,mol}$$

$= 29820\,J/mol$

$= 29.8\,kJ/mol$

$29\,kJ/mol$

The enthalpy change for the reaction of calcium in water is 29 kJ/mol.

7.a) HCl 50.0mL of 4.77 mol/L 50.0mL = 0.0500L x 4.77 mol

NaOH 50.0mL

$C = 4.18\ J/g \cdot °C$

$\Delta T = 33.4°C$

$= 0.2385\ mol$

$m = 50.0mL + 50.0mL$

$= 100.0\cancel{mL} \times \frac{1.00g}{\cancel{mL}}$

$= 100.0g$

$\Delta H_r = \frac{m \times C \times \Delta T}{mol}$

$= \frac{100.0g \times 4.18\ J/g°C \times 33.4°C}{0.2385\ mol}$

$= 58537.52\ J/mol$

$58.5\ kJ/mol$

The heat neutralization of HCl is 58.5 kJ/mol

b) $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(s)} + H_2O +$

or

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl + H_2O$

$\Delta H = -62.5\ kJ$