

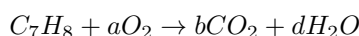
JQ.2.16.soln

September 19, 2014

(2.16) Determine the heat of combustion of toluene and express it in proper thermodynamic form. The heat of formation is 11.95 kcal/mole.

This is essentially the same type of analysis as problem 2.8.

Step 1: Balance the chemical reaction using elemental balances:

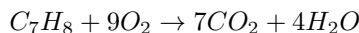


Find the stoichiometric coefficients a, b, & d.

C: $7 = b$

H: $8 = 2d$ or $d = 4$

O: $2a = 2b + d$ or $a = 7 + 2 = 9$



Step 2: Use equation 2.25 to express the heat of combustion in terms of the heats of formation

$$\Delta \tilde{h}_c = \left(\sum_i \nu_i \Delta \tilde{h}_{f,i}^o \right)_{React} - \left(\sum_j \nu_j \Delta \tilde{h}_{f,j}^o \right)_{Prod}$$

$$n_{C_7H_8} = 1.; n_{CO_2} = 7.; n_{H_2O} = 4.; \Delta h_{f,CO_2}^o = -393.5 kJ/\tilde{m}; \Delta h_{f,H_2O_{lower}}^o = -241.8 kJ/\tilde{m}; \Delta h_{f,C_7H_8} = 11.95 \times 4.2 kJ/\tilde{m}$$

In [9]: n_C7H8=1.; n_CO2=7.; n_H2O=4.; hfC7H8= 11.95*4.2; hfCO2=-393.5; hfH2O_lower= -241.8;

In [10]: Dhcmol=hfC7H8 - (n_CO2*hfCO2 + n_H2O*hfH2O_lower); Dhcmol

Out[10]: 3771.89

The molar heat of combustion for toluene is $3772 kJ/mole$. We divide by the molecular weight to get the heat of combustion on a mass basis. We divide by the mass of oxygen to get this on a oxygen basis.

In [10]: