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A Solution Manual for:  
COMBUSTION, 4th Ed.

by

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CHAPTER 1

**Problem 1**

Calculate the heat of reaction when methane and air in stoichiometric proportions are brought into a calorimeter at 500 K. The product composition is brought to the ambient temperature (298 K) by the cooling water. The pressure in the calorimeter is assumed to remain at 1 atm, but the water formed has condensed.

**Solution:** The heat of reaction can be calculated using Eqn. (10) in the text. However, as also suggested in the textbook, this equation can be simplified for the general case when  $H_{T_1}^o = H_{T_{amb}}^o$ . The modified equation becomes:

$$-Q = \Delta H = \sum_{i=1}^n n_i \left[ (H_{T_2}^o - H_{T_{amb}}^o) + (\Delta H_f^o)_{T_{amb}} \right] - \sum_{j=1}^m n_j \left[ (H_{T_1}^o - H_{T_{amb}}^o) + (\Delta H_f^o)_{T_{amb}} \right] \quad (1)$$

In this Equation,  $T_2$  and  $T_1$  are the temperatures of the products and reactants respectively. The general equation for the complete combustion of one mole of methane in air is:



where  $a_{\text{air}}$  is a coefficient describing how much air is needed for stoichiometric combustion. Balancing the above reaction one has:



In order to apply Eqn. (1) to the above reaction, the following properties from Tables in the textbook are needed (note that for this problem  $T_2 = 298 \text{ K}$  and  $T_1 = 500 \text{ K}$ ):

| gases                      | $\Delta H_f^o$ (kJ/mol) | $H_{T_1}^o - H_{T_{amb}}^o$ (kJ/mol) | $H_{T_2}^o - H_{T_{amb}}^o$ (kJ/mol) |
|----------------------------|-------------------------|--------------------------------------|--------------------------------------|
| $\text{CH}_4$              | -74.90                  | 8.21                                 | 0.0                                  |
| $\text{O}_2$               | 0.0                     | 6.09                                 | 0.0                                  |
| $\text{N}_2$               | 0.0                     | 5.92                                 | 0.0                                  |
| $\text{H}_2\text{O}_{(l)}$ | -286.04                 | 0.0                                  | 0.0                                  |
| $\text{CO}_2$              | -393.77                 | 0.0                                  | 0.0                                  |

Equation (1) then becomes:

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