Answer on Question #80953, Chemistry/ Organic Chemistry

In the calibration of a calorimeter, an electrical resistance heater supplies 80.0J of heat and a temperature increase of 1.20°C is observed. What is the initial temperature of 8.50 g of gasoline (C8H18) with molar heat capacity of 39.36 J mol1 K-1 after heating in the same calorimeter? The initial temperature of the calorimeter is 28.0°C and the final temperature of the system is 50.0°C.

Solution

Find c_{cal}

$$q_{cal} = c_{cal} \times \Delta T \, , then \; c_{cal} = \frac{q_{cal}}{\Delta T}$$

$$c_{cal} = \frac{80\,J}{(273.15 + 1.20)K} = 0.292\,\frac{J}{K}$$

Heat absorbed by gasoline is:

$q_1 = nc_p\Delta T$

$n(C_8H_{18}) = m/M = 8.50\ g/\ 114\ g/mol = 0.0756\ mol$

$T_{final} = 273{,}15 + 50 = 323.15\ K$

$q_1 = 0.0756\ mol \times 39.36\ J/(mol \times K) \times (323.15 - T_1)$

Heat absorbed by calorimeter:

$q_2 = c_{cal} \times \Delta T$

$T_1 = 28 + 273.15 = 301.15\ K$

$T_2 = 273{,}15 + 50 = 323.15\ K$

$q_2 = 0.292\ J/K \times (323.15\text{-}301.15)K = 6.424\ J$

q, supplied by electrical resistance heater , is 80.0J

q, absorbed by gasoline and calorimeter is $q_1 + q_2$

$0.0756\ mol \times 39.36\ J/(mol \times K) \times (323.15 - T_1) + 6.424\ J = 80\ J$

$0.0756\ mol \times 39.36\ J/(mol \times K) \times (323.15 - T_1) = 73.576\ J$

$323.15 - T_1 = 24.73$

$T_1 = 298.42$

$T\ (^0C) = 298.42 - 273.15 = 25.27^OC$

Answer: 25.27 ^{0}C