15-64

Combustion with 30% excess, and 92% of carbon burns to CO_2, the remaining 8% forming CO.

$$C_6H_6 + 9.75(O_2 + 3.76N_2) \rightarrow 5.52CO_2 + 0.48CO + 3H_2O + 2.49O_2 + 36.66N_2$$

	$\bar{h}_f$	$\bar{h}_{298K}$	$\bar{h}_{100K}$
C_6H_6	82,930	–	–
O_2	0	8682	31,389
N_2	0	8669	30,129
H_2O	−241,820	9904	35,882
CO	−110,530	8669	30,355
CO_2	−393,520	9364	42,769

$$\begin{aligned} -Q_{out} = {} & (5.52)(-393,520 + 42,769 - 9364 - 8.314 \times 1000) \\ & + (0.48)(-110,530 + 30,355 - 8669 - 3.314 \times 1000) \\ & + (3)(-241,820 + 35,882 - 9904 - 8.314 \times 1000) \\ & + (2.49)(0 + 31,389 - 8682 - 8.314 \times 1000) \\ & + (36.66)(0 + 30,129 - 8669 - 8.314 \times 1000) \\ & - 1 \cdot (82,930 - 8.314 \times 298) \\ & - (9.75)(4.76)(-8.314 \times 298) \\ = {} & -2,200,529.302 \end{aligned}$$

$$\Rightarrow Q_{out} = \underline{2,200,529.302\ kJ} \quad \text{... Ans}$$

15-96 (part b)

if pure O_2 are used to burn C_8H_{18},

$$C_8H_{18} + 12.5O_2 \rightarrow 8CO_2 + 9H_2O$$

	$\bar{h}_f^\circ$	$\bar{h}_{298K}$
C_8H_{18}	−249,950	−
O_2	0	8682
N_2	0	8669
H_2O	−241,820	9904
CO_2	−393,520	9364

$$(8)(-393,520 + \bar{h}_{CO_2} - 9364) + (9)(-241,820 + \bar{h}_{H_2O} - 9904) = (1)(-249,950)$$

$$\Rightarrow 8\bar{h}_{CO_2} + 9\bar{h}_{H_2O} = 5,238,638 \text{ kJ}$$

$$\frac{5,238,638}{(8+9)} = 308,155 \text{ kJ/kmol} \rightarrow \text{higher than the highest enthalpy value listed for } H_2O \text{ and } CO_2$$

At 3200 K: $8\bar{h}_{CO_2} + 9\bar{h}_{H_2O} = (8)(174,695) + (9)(147,457)$

$= 2,724,673$ kJ

At 3250 K: $8\bar{h}_{CO_2} + 9\bar{h}_{H_2O} = (8)(177,895) + (9)(150,727)$

$= 2,775,024$ kJ

By extrapolation,

$$\frac{T_p - 3200}{3250 - 3200} = \frac{5,238,638 - 2,724,673}{2,775,024 - 2,724,673} \Rightarrow T_p = \underline{\underline{5696 \text{ K}}}$$