WKst 6c – Hess's Law

① $4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_2O$

-45.5 $+91$ -286

$\Delta H^\circ_{Rxn} = \sum H^\circ_f$ products $- \sum H^\circ_f$ reactants

$= [4(91) + 6(-286)] - [4(-45.5)] = \boxed{-1170\ kJ}$

② $NO + O_3 \rightarrow NO_2 + O_2$ $\quad \Delta H^\circ = -199\ kJ$

$(\frac{3}{2}O_2 \rightarrow O_3)\ \frac{1}{2}$ $\quad \Delta H^\circ = +427\ kJ \cdot \frac{1}{2}$ (Reversed)

$(O_2 \rightarrow 2O)\ \frac{1}{2}$ $\quad \Delta H^\circ = -495\ kJ \cdot \frac{1}{2}$ (Reversed)

$NO + O \rightarrow NO_2$ $\quad \boxed{\Delta H^\circ = -233\ kJ}$

③ form CS_2 $\quad C(s) + 2S(s) \rightarrow CS_2(l)$

$C + O_2 \rightarrow CO_2$ $\quad \Delta H^\circ_f = -393.5\ kJ$

$(S + O_2 \rightarrow SO_2)\ 2$ $\quad \Delta H^\circ_f = -296.1\ kJ \cdot 2$

$CO_2 + 2SO_2 \rightarrow CS_2 + 3O_2$ $\quad \Delta H^\circ = +1072$ Reversed

$C + 2S \rightarrow CS_2$ $\quad \boxed{\Delta H^\circ_f = +86.3\ kJ}$

④ a) $(2CO_2 + 3H_2O \rightarrow C_2H_6 + \frac{7}{2}O_2) \cdot \frac{1}{4}$ $\quad \Delta H = +6240\ kJ \cdot \frac{1}{4}$ Reversed

$(2C + 2O_2 \rightarrow 2CO_2)\ 2$ $\quad \Delta H = -394\ kJ \cdot 2$

$(3H_2 + \frac{3}{2}O_2 \rightarrow 3H_2O) \cdot \frac{3}{2}$ $\quad \Delta H = -572\ kJ \cdot \frac{3}{2}$

$2C + 3H_2 \rightarrow C_2H_6$ $\quad \boxed{\Delta H = -86\ kJ}$

b) yes, as long as other reactions take place at standard conditions

1 mole product formed

⑤ $C_6H_6 + \frac{15}{2}O_2 \rightarrow 6CO_2 + 3H_2O$ $\Delta H° = -3273\ kJ$

$C + O_2 \rightarrow CO_2$ $\Delta H° = -393.5\ kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H° = -285.5\ kJ$

form C_6H_6 from $^6C, ^3H_2$

$3(^3H_2 + \frac{3}{2}O_2 \rightarrow {}^3H_2O)$ $\Delta H° = -285.5kJ \cdot 3$

$6(^6C + {}^6O_2 \rightarrow {}^6CO_2)$ $\Delta H° = -393.5\ kJ \cdot 6$

$6CO_2 + 3H_2O \rightarrow C_6H_6 + \frac{15}{2}O_2$ $\Delta H° = +3273\ kJ$ (reverse)

$6C_{(s)} + 3H_{2(g)} \rightarrow C_6H_{6(\ell)}$ $\boxed{\Delta H_f° = +56\ kJ/mol}$

⑥ $C_6H_{11}OH + \frac{17}{2}O_2 \rightarrow 6CO_2 + 6H_2O$ $\Delta H = -3727\ kJ$

$C + O_2 \rightarrow CO_2$ $\Delta H = -393.5\ kJ$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -285.5\ kJ$

form $C_6H_{11}OH$ from $^6C, ^{12}H, ^1O$

$(^6C + {}^6O_2 \rightarrow {}^6CO_2)6$ $\Delta H = -393.5\ kJ \cdot 6$

$(^6H_2 + \frac{3}{2}O_2 \rightarrow {}^6H_2O)6$ $\Delta H = -285.5\ kJ \cdot 6$

$6CO_2 + 6H_2O \rightarrow C_6H_{11}OH + \frac{17}{2}O_2$ $\Delta H = +3727\ kJ$ (reverse)

$6C_{(s)} + 6H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_6H_{11}OH$ $\boxed{\Delta H = -347\ kJ/mol}$

(7) $4C + 3H_2 \longrightarrow C_4H_6$ $\quad \Delta H_f^\circ = 112.0\ kJ/mol$

$C + O_2 \longrightarrow CO_2$ $\quad \Delta H^\circ = -393.5\ kJ/mol$

$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\quad \Delta H^\circ = -285.5\ kJ/mol$

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combustión $C_4H_6 + \frac{11}{2}O_2 \longrightarrow 4CO_2 + 3H_2O \quad \Delta H^\circ = ?$

$C_4H_6 \longrightarrow 4C + 3H_2$ $\quad \Delta H_f^\circ = -112.0\ kJ/mol$ (Reverse)

$(C + O_2 \rightarrow CO_2)\,4$ $\quad \Delta H^\circ = (-393.5\ kJ/mol)\,4$

$(H_2 + \frac{1}{2}O_2 \rightarrow H_2O)\,3$ $\quad \Delta H^\circ = (-285.5\ kJ/mol)\,(3)$

$C_4H_6 + \frac{11}{2}O_2 \rightarrow 4CO_2 + 3H_2O$ $\quad \boxed{\Delta H^\circ = -2542.5\ kJ/mol}$

(8) $C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$ $\quad \Delta H^\circ = -2877\ kJ/mol$

-124.5

formación $4C + 5H_2 \longrightarrow C_4H_{10}$

$(C + O_2 \rightarrow CO_2)\,4$ $\quad \Delta H^\circ = -393.5\ kJ/mol \cdot 4$

$(H_2 + \frac{1}{2}O_2 \rightarrow H_2O)\,5$ $\quad \Delta H^\circ = -285.5\ kJ/mol \cdot 5$

$4CO_2 + 5H_2O \rightarrow C_4H_{10} + \frac{13}{2}O_2$ $\quad \Delta H^\circ = +2877\ kJ/mol$

$4C + 5H_2 \rightarrow C_4H_{10}$ $\quad \boxed{\Delta H^\circ = -125\ kJ/mol}$