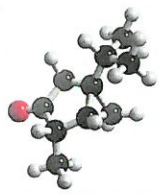
# HESS'S LAW 1 – USING $\Delta H_f$s

Answer Copy



1) The $\Delta H$ for the following reaction is shown.

$$N_2H_4(l) + O_2(g) \rightarrow 2\,H_2O(l) + N_2(g) \qquad \Delta H = -623 \text{ kJ mol}^{-1}$$

Given that the $\Delta H_f$ of $H_2O(g)$ is -286 kJ mol$^{-1}$, calculate the $\Delta H_f$ of $N_2H_4(l)$. +51 kjmol$^{-1}$

2) Calculate the $\Delta H_f$ of ethane, $C_2H_6(g)$, given the enthalpy change for the following reaction and the $\Delta H_f$ of ethene, $C_2H_4(g)$, which is +52 kJ mol$^{-1}$. -85 kjmol$^{-1}$

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g) \qquad \Delta H = -137 \text{ kJ mol}^{-1}$$

3) Use the enthalpies of formation below to calculate the enthalpy change for the following reaction.

$$3\,Fe(s) + 4\,H_2O(g) \rightarrow 4\,H_2(g) + Fe_3O_4(s)$$ -149 kjmol$^{-1}$

$\Delta H_f$: $H_2O(g)$ -242; $Fe_3O_4(s)$ -1117 kJ mol$^{-1}$

4) The $\Delta H$ for the following reaction is shown. Use it and the $\Delta H_f$ values below to calculate the $\Delta H_f$ of $Pb(NO_3)_2(s)$. -452 kjmol$^{-1}$

$$Pb(NO_3)_2(s) \rightarrow PbO(s) + 2\,NO_2(g) + \tfrac{1}{2}\,O_2(g) \qquad \Delta H = +301 \text{ kJ mol}^{-1}$$

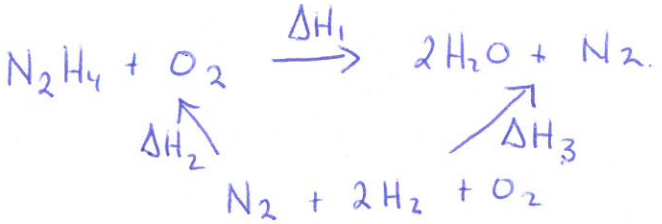
$\Delta H_f$: PbO(S) -217; $NO_2(g)$ +33 kJ mol$^{-1}$

5) Use the enthalpies of formation below to calculate the enthalpy change for the following reaction.

$$CH_3COCH_3(l) + H_2(g) \rightarrow CH_2CH(OH)CH_3(l)$$ -70 kjmol$^{-1}$

$\Delta H_f$: $CH_3COCH_3(l)$ -248; $CH_2CH(OH)CH_3(l)$ -318 kJ mol$^{-1}$

(1)




$\Delta H_1 + \Delta H_2 = \Delta H_3$

$\Delta H_2 = \Delta H_3 - \Delta H_1$

$\Delta H_2 = -572 - (-623)$

$= +51 \text{ kJ mol}^{-1}$

$\Delta H_3 = 2(-286)$

$= -572$

$\Delta H_1 = -623$

② $C_2H_4 + H_2 \xrightarrow{\Delta H_1} C_2H_6$

$\Delta H_2$ ↑ ; $\Delta H_3$ ↑

$2C + 3H_2$

$\Delta H_1 = -137$

$\Delta H_2 = +52$

$\Delta H_1 + \Delta H_2 = \Delta H_3$

$\Delta H_3 = -137 + 52 = \underline{-85 \text{ kJ mol}^{-1}}$

③ $3Fe + 4H_2O \xrightarrow{\Delta H_1} 4H_2 + Fe_3O_4$

$\Delta H_2$ ↑ ; $\Delta H_3$ ↑

$3Fe + 4H_2 + 2O_2$

$\Delta H_3 = -1117$

$\Delta H_2 = 4(-242)$

$= -968$

$\Delta H_1 + \Delta H_2 = \Delta H_3$

$\Delta H_1 = \Delta H_3 - \Delta H_2$

$\Delta H_1 = -1117 - (-968)$

$= \underline{-149 \text{ kJ mol}^{-1}}$

④ $Pb(NO_3)_2 \xrightarrow{\Delta H_1} PbO + 2NO_2 + \frac{1}{2}O_2$

$\Delta H_2$ ↑ ; $\Delta H_3$ ↑

$Pb + 2O_2 + N_2$

$\Delta H_3 = -217 + 2(33)$

$= -151$

$\Delta H_1 = +301$

$\Delta H_2 + \Delta H_1 = \Delta H_3$

$\Delta H_2 = \Delta H_3 - \Delta H_1$

$\Delta H_2 = -151 - (301)$

$= \underline{-452}$

⑤ $CH_3COCH_3 + H_2 \xrightarrow{\Delta H_1} CH_3CH(OH)CH_3$

$\Delta H_2$ ↑ ; $\Delta H_3$ ↑

$3C + \frac{1}{2}O_2 + 4H_2$

$\Delta H_2 = -248$

$\Delta H_3 = -318$

$\Delta H_2 + \Delta H_1 = \Delta H_3$

$\Delta H_1 = \Delta H_3 - \Delta H_2$

$\Delta H_1 = -318 - (-248)$

$= \underline{-70 \text{ kJ mol}^{-1}}$