



Topic 4 Exercise 5 - Hess' Law

Using standard enthalpies of formation

1. Given the following data:

Substance	H ₂ O(l)	CO ₂ (g)	Ethane C ₂ H ₆ (g)	Ethene C ₂ H ₄ (g)
$\Delta H_f/\text{kJmol}^{-1}$	-286	-393	-84	+52

a) Write equations for the complete combustion of

- i) ethane
- ii) ethene

b) Calculate the enthalpy of combustion in each case using the above data.

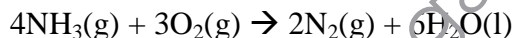
2. Given the following data: $\Delta H_f(\text{CH}_4) = -74.8 \text{ kJmol}^{-1}$, $\Delta H_f(\text{CH}_3\text{Cl}) = -134.5 \text{ kJmol}^{-1}$, $\Delta H_f(\text{HCl}) = -92.3 \text{ kJmol}^{-1}$;

Calculate ΔH for the reaction $\text{CH}_4(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{CH}_3\text{Cl}(\text{g}) + \text{HCl}(\text{g})$

3. Given the data:

Substance	H ₂ O(l)	NH ₃ (g)
$\Delta H_f/\text{kJmol}^{-1}$	-286	-46

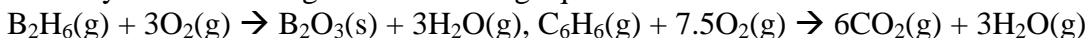
Calculate the enthalpy change of the following reaction:



4. Given the data:

Substance	B ₂ H ₆ (g)	B ₂ O ₃ (s)	C ₆ H ₆ (g)	CO ₂ (g)	H ₂ O(g)
$\Delta H_f/\text{kJmol}^{-1}$	+31.4	-1270	+83.9	-393	-242

Calculate the enthalpy of combustion of gaseous diborane and gaseous benzene given that they burn according to the following equations:



5. The enthalpy of combustion of ethanol is -1380 kJmol^{-1} . Calculate the enthalpy of formation of ethanol, given that the enthalpies of formation of carbon dioxide and water are -393.7 and $-285.9 \text{ kJmol}^{-1}$ respectively.



Using standard enthalpies of combustion

6. Calculate the enthalpy of formation of butane (C_4H_{10}) from the following data:

Enthalpy of combustion of graphite = $-393.6 \text{ kJmol}^{-1}$

Enthalpy of combustion of hydrogen = $-285.9 \text{ kJmol}^{-1}$

Enthalpy of combustion of butane = $-2877.1 \text{ kJmol}^{-1}$

7. Given the following data:

Substance	$CH_3CH_2CH_2CH_3$	$CH_3CH_2CH=CH_2$	H_2
$\Delta H_c/\text{kJmol}^{-1}$	-2877	-2717	-286

Calculate ΔH for the following reaction: $CH_3CH_2CH=CH_2 + H_2 \rightarrow CH_3CH_2CH_2CH_3$

8. Given the following data:

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -890 \text{ kJmol}^{-1}$

$CO(g) + 1/2O_2(g) \rightarrow CO_2(g)$ $\Delta H = -284 \text{ kJmol}^{-1}$

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393 \text{ kJmol}^{-1}$

$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286 \text{ kJmol}^{-1}$

Calculate:

- The enthalpy of formation of methane
- The enthalpy of formation of carbon monoxide
- The enthalpy change when methane is burned in limited oxygen to form carbon monoxide and water.