MEGA LECTURE

Topic 4 Exercise 5 - Hess' Law

Using standard enthalpies of formation

1. Given the following data:

Substance	$H_2O(l)$	$CO_2(g)$	Ethane $C_2H_6(g)$	Ethene $C_2H_4(g)$
ΔH_f/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: $\Delta H_f(CH_4)$ = -74.8 kJmol^{-1}, $\Delta H_f(CH_3Cl)$ = -134.5 kJmol^{-1}, $\Delta H_f(HCl)$ = -92.3 kJmol^{-1};
   Calculate ΔH for the reaction $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

3. Given the data:

Substance	$H_2O(l)$	$NH_3(g)$
ΔH_f/kJmol^{-1}	-286	-46

   Calculate the enthalpy change of the following reaction:

   $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(l)$

4. Given the data:

Substance	$B_2H_6(g)$	$B_2O_3(s)$	$C_6H_6(g)$	$CO_2(g)$	$H_2O(g)$
ΔH_f/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:
$B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(g)$, $C_6H_6(g) + 7.5O_2(g) \rightarrow 6CO_2(g) + 3H_2O(g)$

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 kJmol^{-1} respectively.

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

Enthalpy of combustion of graphite = -393.6 $kJmol^{-1}$
Enthalpy of combustion of hydrogen = -285.9 $kJmol^{-1}$
Enthalpy of combustion of butane = -2877.1 $kJmol^{-1}$

7. Given the following data:

Substance	$CH_3CH_2CH_2CH_3$	$CH_3CH_2CH=CH_2$	H_2
$\Delta H_c/kJmol^{-1}$	-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:

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -890\ kJmol^{-1}$
$CO(g) + 1/2O_2(g) \rightarrow CO_2(g)$ $\Delta H = -284\ kJmol^{-1}$
$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393\ kJmol^{-1}$
$H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$ $\Delta H = -286\ kJmol^{-1}$

Calculate:
a) The enthalpy of formation of methane
b) The enthalpy of formation of carbon monoxide
c) The enthalpy change when methane is burned in limited oxygen to form carbon monoxide and water.