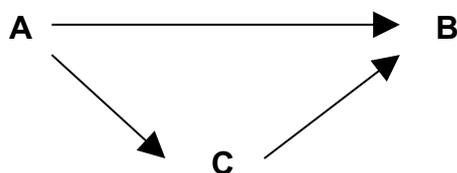




HESS'S LAW 2 - COMBUSTION

Hess's Law: The enthalpy change for a reaction is independent of the route taken

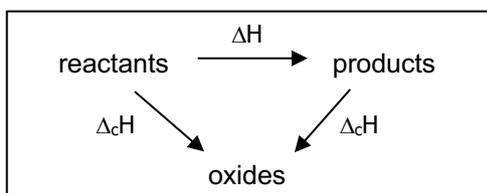


e.g. the enthalpy change to go from A → B direct is the same as going from A → C → B

- This method is for questions involving enthalpies of combustion (some people called these “type 2 questions”).

Best method for most students (uses a cycle)

- Questions that involve enthalpies of combustion can usually be done using the cycle shown below.
- The reaction involved across the top is often an enthalpy of formation (from elements to a compound).
- The sum of the clockwise arrows equals the sum of the anticlockwise arrows.
- Be careful when drawing your cycle to ensure that arrows are going in the right direction and the number of moles is correct.



- If you use a cycle like this, there is no need to worry about getting the number of oxygen molecules in the downward arrows.

Simpler method if you are struggling

- This is a simpler method that works for most simple questions.

$$\Delta H = [\text{SUM of } \Delta_c H \text{ reactants}] - [\text{SUM } \Delta_c H \text{ products}]$$

- Note that this is *reactants* – *products* which is the opposite of the equation that uses enthalpies of formation.

Example 1

Calculate the enthalpy of formation of ethanol (C₂H₅OH) given the following enthalpies of combustion.

$\Delta_c H$ C(s) = -393, H₂(g) = -286, C₂H₅OH(l) = -1371 kJ/mol

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Example 2

Calculate the enthalpy of combustion of propane, $C_3H_8(g)$, given the following enthalpy changes

$\Delta_c H$: $C(s)$ -393 ; $H_2(g)$ -286 $kJ\ mol^{-1}$, $\Delta_f H$: $C_3H_8(l)$ -103 $kJ\ mol^{-1}$

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1) Calculate the enthalpy change for this reaction given the following data. $C(s) + 2 H_2(g) \rightarrow CH_4(g)$
 $\Delta_c H$ $C(s) = -393$, $H_2(g) = -286$, $CH_4(g) = -890$ $kJ\ mol^{-1}$

2) Calculate the enthalpy change for the following reaction using the enthalpies of combustion given.
 $C(\text{graphite}) \rightarrow C(\text{diamond})$
 $\Delta_c H$: $C(\text{graphite}) -393$; $C(\text{diamond}) -395$ $kJ\ mol^{-1}$

3) Calculate the enthalpy change during the fermentation of glucose using the enthalpies of combustion given.
 $C_6H_{12}O_6(s) \rightarrow 2 C_2H_5OH(l) + 2 CO_2(g)$
 $\Delta_c H$: $C_6H_{12}O_6(s) -2820$; $C_2H_5OH(l) -1368$ $kJ\ mol^{-1}$

4) Calculate the enthalpy of formation of pentane, $C_5H_{12}(l)$, given the following enthalpies of combustion.
 $\Delta_c H$: $H_2(g) -286$; $C(s) -393$; $C_5H_{12}(l) -3509$ $kJ\ mol^{-1}$

5) Calculate the enthalpy of combustion of propanone, $CH_3COCH_3(l)$, given the information below.
 $\Delta_c H$: $H_2(g) -286$; $C(s) -393$ $\Delta_f H$: $CH_3COCH_3(l) -217$ $kJ\ mol^{-1}$

6) Calculate the enthalpy of combustion of $CS_2(l)$ given the following enthalpy changes.
 $\Delta_c H$: $C(s) -393$; $S(s) -297$ $kJ\ mol^{-1}$, $\Delta_f H$: $CS_2(l) +88$ $kJ\ mol^{-1}$

7) Calculate the standard enthalpy change for the following reaction using the enthalpy changes given.
 $SO_2(g) + 2 H_2S(g) \rightarrow 3 S(s) + 2 H_2O(l)$
 $\Delta_c H$: $S(s) -297$ $kJ\ mol^{-1}$ $\Delta_f H$: $H_2O(l) -286$; $H_2S(g) -20$ $kJ\ mol^{-1}$