

## Hess's Law

**SUMMARY****Enthalpy of Reaction and Hess's Law**

To determine an enthalpy change of a reaction by using Hess's law, follow these steps:

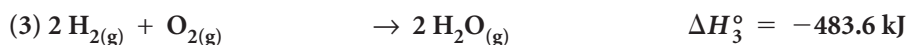
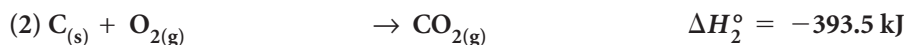
1. Write the net reaction equation if it is not given.
2. Manipulate the known equations so they will add to yield the target equation.
3. Cancel and add the remaining reactants and products.
4. Add the component enthalpy changes to obtain the net enthalpy change.
5. Determine the molar enthalpy, if required.

**Example**

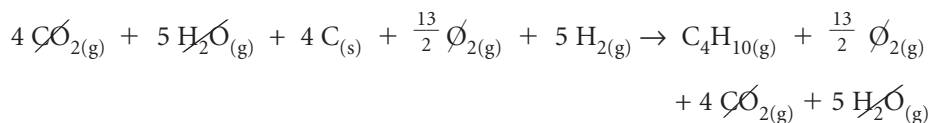
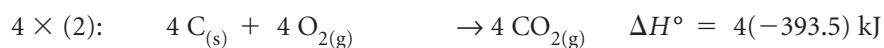
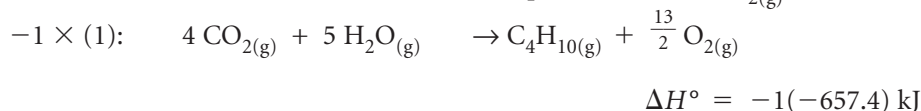
What is the enthalpy change for the formation of one mole of butane ( $C_4H_{10}$ ) gas from its elements? The reaction is:



The following known equations, determined by calorimetry, are provided:



Reversing known equation (1), which will require multiplying its  $\Delta H$  by  $-1$ , will make  $C_4H_{10(g)}$  a product; multiplying known equation (2) by 4 will provide the required amount of  $C_{(s)}$  reactant; and multiplying known equation (3) by  $5/2$  will provide the required amount of  $H_{2(g)}$  reactant. Cancellation when the equations are added will determine whether the required amount of  $O_{2(g)}$  remains.



(continued)

## LSM 5.4-1

If the known equations can be added together to form the target equation, *then* their enthalpy changes can be added together. In this case,

$$\Delta H_{\text{total}}^{\circ} = (+2657.4) + (-1574.0) + (-1209.0) \text{ kJ}$$

$$\Delta H_{\text{total}}^{\circ} = -125.6 \text{ kJ}$$

The enthalpy change for the formation of one mole of butane is  $-125.6 \text{ kJ}$ .