

# Hess's Law

We've seen that energy changes can be measured in a calorimeter. But, how can anyone measure all of the energy changes in the world? What if the reaction is unpleasant, or is an explosion, or is very complex – how can we measure the energy change then? .....We use Hess's Law to calculate the energy change from other systems.

Hess's Law:

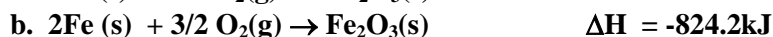
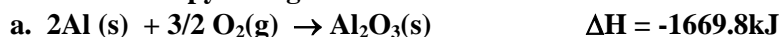
*If a reaction is carried out in a series of steps,  $\Delta H$  for the reaction will be equal to the sum of enthalpy ( $H$ ) changes for the individual steps.*

## Example 1

Calculate the enthalpy change,  $\Delta H$  (in KJ), for the reaction

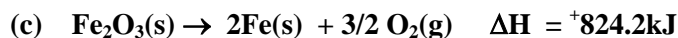


Use the enthalpy changes for the combustion of aluminum and iron:

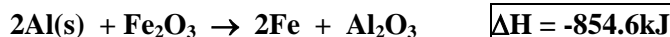
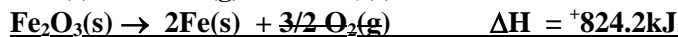
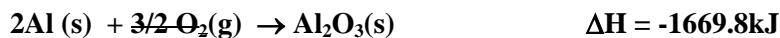


## Solution

Notice that to achieve the desired reaction, equation (b) must be written in reverse. When this is done, be sure to change the sign of  $\Delta H$  since the energy is now flowing in the opposite direction. Call this equation (c)



Now, add equations (a) and (c) to obtain the final answer. As in algebra, like terms cancel out.



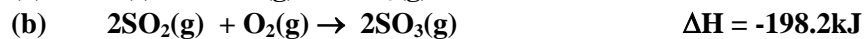
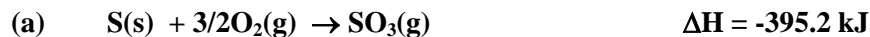
## Key Points

- If a reaction is reversed, the sign of  $\Delta H$  is also reversed.
- The magnitude of  $\Delta H$  is directly proportional to the quantities of reactants and products in a reaction. If the coefficients in a balanced reaction are multiplied by an integer, the value of  $\Delta H$  is multiplied by the same integer.

### Example 2

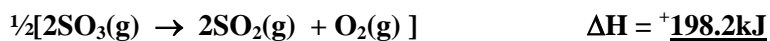
Calculate  $\Delta H$  for the reaction:  $S(s) + O_2(g) \rightarrow SO_2(g)$

From the following information



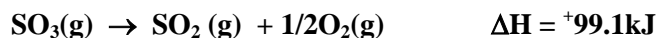
### Solution

To obtain the reactants and products in the desired reaction, we need to reverse equation (b) and multiply it by  $1/2$ . This action reverses the sign and cuts the amount of energy by a factor of 2:



2

OR



Now we add this reaction to the first reaction:

