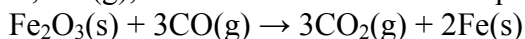


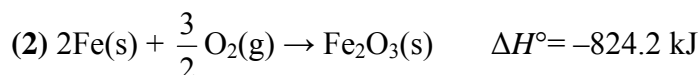
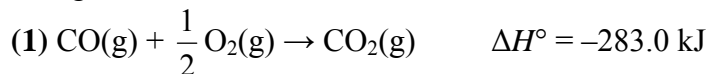
Using Hess's Law to Determine Enthalpy Change

Sample Problem

One of the methods that the steel industry uses to obtain metallic iron is to react iron(III) oxide, $\text{Fe}_2\text{O}_3(\text{s})$, with carbon monoxide, $\text{CO}(\text{g})$, as shown in the balanced equation below:

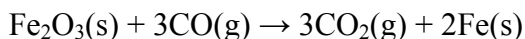


Determine the enthalpy change of this reaction, given the following equations and their enthalpy changes.



What Is Required?

You need to manipulate equations (1) and (2), along with their enthalpy changes, so they add up to the overall equation:



What Is Given?

You know the chemical equations for reactions (1) and (2), and you know their corresponding enthalpy changes.

Plan Your Strategy

Step 1 Examine equations (1) and (2) to see how they compare with the overall equation. Decide how you need to manipulate equations (1) and (2) so that they add to the overall equation. (Reverse the equation, multiply the equation by a coefficient, do both, or do neither.) Remember to adjust ΔH° accordingly for each equation.

Step 2 Write the manipulated equations so that their equation arrows line up. Add the reactants and products on each side, and cancel substances that appear on both sides in equal amounts.

Step 3 Ensure that you have obtained the overall equation. Add ΔH° for the combined equation.

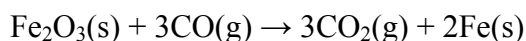
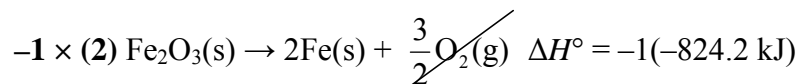
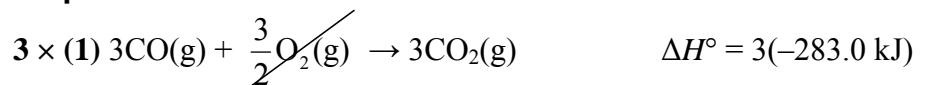
CHAPTER 10	Using Hess's Law to Determine Enthalpy Change (continued)	BLM 10.1.2
OVERHEAD		

Act on Your Strategy

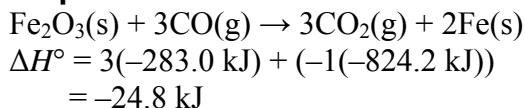
Step 1

- Equation (1) has CO(g) as a reactant and CO₂(g) as a product, as does the overall equation. The stoichiometric coefficients do not match the coefficients of the overall equation, however. To achieve the same coefficients, you must multiply equation (1) by 3.
- Equation (2) has the required stoichiometric coefficients, but Fe(s) and Fe₂O₃(s) are on the wrong sides of the equation. You need to reverse equation (2) and, therefore, change the sign of the ΔH° .
- Note:** Since oxygen gas, O₂(g), is present in both equations that you are manipulating, do not use O₂(g) to decide on how to manipulate the equations. Always start with a chemical species that is present in only one of the equations and is also present in the overall equation.

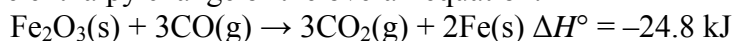
Step 2



Step 3



The manipulated equations add to the overall equation. Therefore, the sum of the manipulated enthalpy changes is the enthalpy change of the overall equation:



Check Your Solution

The equations added correctly to the overall equation. Check to ensure that you adjusted ΔH° accordingly for each equation. Because you added the ΔH° values, the final answer will be as precise as the least precise number used in the calculation. The final answer has one digit after the decimal point, which is correct.