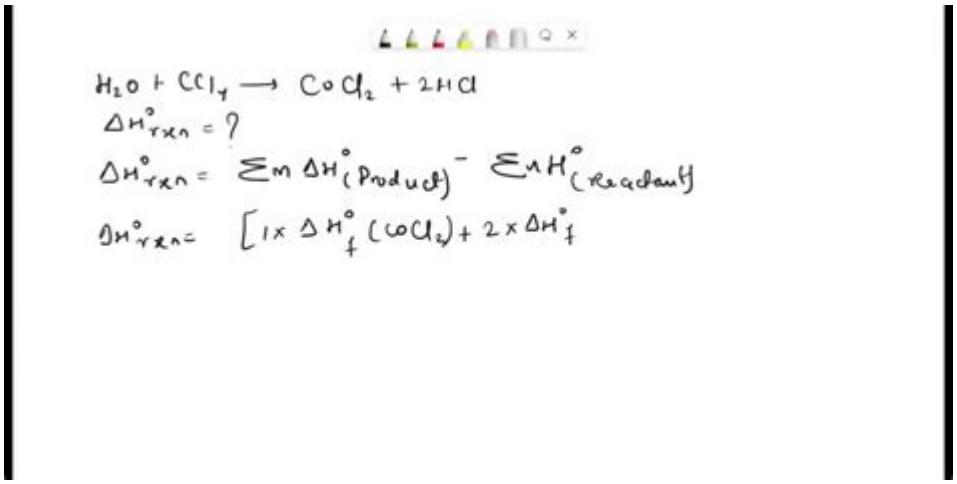
# 174 Calculating Heats Of Reaction Section Review Answers




174 calculating heats of reaction section review answers are essential for understanding thermodynamics in chemistry. The calculation of heats of reaction not only provides insight into energy changes during chemical reactions but also plays a crucial role in various applications, such as industrial processes, environmental science, and research. This article will delve into the concept of heats of reaction, the methodologies used to calculate them, the significance of these calculations, and finally provide a detailed review of the answers to section 174 related to this topic.

## Understanding Heats of Reaction

Heats of reaction, also known as enthalpy changes, refer to the amount of heat absorbed or released during a chemical reaction at constant pressure. The significance of calculating these heats lies in their ability to predict the energy profile of reactions, which is critical for chemists and engineers alike.

### Types of Heats of Reaction

There are several types of heats of reaction that one may encounter in chemistry:

1. Exothermic Reactions: These reactions release heat into the surroundings. The enthalpy change (ΔH) is negative. A common example is the combustion of fuels.

2. Endothermic Reactions: These reactions absorb heat from the surroundings. The enthalpy change is positive. Photosynthesis is a classic example.

3. Standard Heat of Formation (ΔH°f): This is the heat change when one mole of a compound is formed from its elements in their standard states.

4. Standard Heat of Combustion (ΔH°c): This is the heat change when one mole of a substance is completely burned in oxygen.

5. Reaction Enthalpy (ΔH): This is the overall heat change for a chemical reaction based on the stoichiometry of the balanced equation.

# Methods for Calculating Heats of Reaction

There are several methods to calculate the heats of reaction, each suited for different scenarios and types of data available.

## 1. Hess's Law

Hess's Law states that the total enthalpy change for a reaction is the sum of the enthalpy changes for the individual steps of the reaction. This is particularly useful when direct measurement of the heat change is difficult. To apply Hess's Law:

- Identify the desired reaction and its corresponding enthalpy change.
- Break down the reaction into steps for which ΔH values are known.
- Sum the ΔH values to find the total heat of reaction.

## 2. Calorimetry

Calorimetry is the experimental method used to measure the heat of a reaction. A calorimeter is used to isolate a reaction from its surroundings and measure temperature changes. The basic steps include:

- Setting up a calorimeter with known initial conditions.
- Carrying out the reaction and measuring temperature changes.
- Using the specific heat capacity of the substance to calculate the heat absorbed or released.

## 3. Standard Enthalpies of Formation

The heat of reaction can also be calculated using standard enthalpies of formation. The formula is as follows:

$$
\Delta H_{reaction} = \sum (\Delta H^\circ_f \text{ of products}) - \sum (\Delta H^\circ_f \text{ of reactants})
$$

This approach requires knowledge of the standard enthalpies of formation for each substance involved in the reaction.

# Importance of Calculating Heats of Reaction

Calculating the heats of reaction serves several important purposes:

- Predicting Reaction Feasibility: Understanding whether a reaction is exothermic or endothermic helps predict whether it will occur spontaneously.

- Optimizing Industrial Processes: Industries rely on these calculations to design reactors and manage energy consumption efficiently.

- Environmental Impact Assessments: Heats of reaction calculations are essential for understanding the energy changes in natural processes, aiding in the evaluation of their environmental impacts.

- Research and Development: In academic and industrial research, knowing the enthalpy changes can lead to new discoveries and innovations.

# Section Review Answers for 174 Calculating Heats of Reaction

In section 174, students are typically introduced to various problems involving the calculation of heats of reaction. Below are typical questions from this section along with their answers and explanations.

## 1. Problem: Calculate the heat change for the combustion of 1 mole of methane ($CH_4$) given the following data:

- $\Delta H°f$ ($CH_4$) = -74.85 kJ/mol
- $\Delta H°f$ ($CO_2$) = -393.51 kJ/mol
- $\Delta H°f$ ($H_2O$) = -241.82 kJ/mol

Answer:

Using the standard enthalpy of formation approach:

$$
\Delta H_{reaction} = [\Delta H^\circ_f (CO_2) + \Delta H^\circ_f (H_2O)] - [\Delta H^\circ_f (CH_4) + \Delta H^\circ_f (O_2)]
$$

Since the $\Delta H°f$ for $O_2$ is 0 (elements in their standard state):

$$
\Delta H_{reaction} = [-393.51 + (-241.82)] - [-74.85 + 0]
$$

$$
\Delta H_{reaction} = -635.33 + 74.85 = -560.48 \text{ kJ/mol}
$$

Thus, the heat change for the combustion of methane is -560.48 kJ/mol, indicating it is an exothermic reaction.

## 2. Problem: A calorimeter measures a temperature increase of 5.0°C when 0.5 moles of a substance are reacted. If the specific heat capacity of the calorimeter is known to be 4.18 J/g°C, how much heat was absorbed?

Answer:

First, calculate the heat (q) absorbed using the formula:

$$
q = m \cdot c \cdot \Delta T
$$

Assuming the calorimeter has a mass of 100 g:

$$
q = 100 \, \text{g} \cdot 4.18 \, \text{J/g°C} \cdot 5.0 \, \text{°C} = 2090 \, \text{J}
$$

Thus, the heat absorbed is 2090 J.

## 3. Problem: Use Hess’s Law to find the enthalpy change for the following reaction:

$$
A + 2B \rightarrow C + D
$$

Given the following reactions:

1. $B + C \rightarrow A$ ($\Delta H = +100$ kJ)
2. $D + A \rightarrow B$ ($\Delta H = -50$ kJ)

Answer:

Rearranging the first reaction gives:

$$
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$$
A \rightarrow B + C \quad (\Delta H = -100 \, \text{kJ})
$$

Now adding the two reactions:

$$
(A \rightarrow B + C) + (D + A \rightarrow B) \Rightarrow C + D \rightarrow A + B
$$

The overall ΔH will be:

$$
\Delta H = -100 + (-50) = -150 \, \text{kJ}
$$

Thus, the enthalpy change for the reaction $A + 2B \rightarrow C + D$ is -150 kJ.

# Conclusion

The 174 calculating heats of reaction section review answers provide critical insights into the principles of thermochemistry. Understanding how to calculate heats of reaction through various methods, such as Hess's Law, calorimetry, and standard enthalpies of formation, empowers students and professionals to predict energy changes in chemical reactions effectively. Mastery of these concepts is essential for applying thermodynamic principles in real-world scenarios, from industrial applications to environmental assessments. Whether in a classroom setting or a professional laboratory, the ability to accurately calculate and interpret heats of reaction is a fundamental skill for any chemist.

# Frequently Asked Questions

## What is the significance of calculating heats of reaction in thermodynamics?

Calculating heats of reaction is essential in thermodynamics as it helps to understand the energy changes associated with chemical reactions, aiding in predicting reaction feasibility and optimizing conditions for industrial processes.

## How do you calculate the heat of reaction using Hess's law?

Hess's law states that the total heat of reaction is the sum of the heats of reaction for individual steps, allowing one to calculate the overall heat change by adding the enthalpy changes of each step, regardless of the pathway taken.

## What role do standard enthalpies of formation play in

## calculating heats of reaction?

Standard enthalpies of formation provide a reference point for calculating the heat of reaction by allowing the use of the formula: ΔH° = ΣΔH°f(products) - ΣΔH°f(reactants), which gives the overall heat change based on the enthalpy of formation of the substances involved.

## What is the difference between exothermic and endothermic reactions in terms of heat of reaction?

Exothermic reactions release heat to the surroundings, resulting in a negative heat of reaction (ΔH < 0), while endothermic reactions absorb heat, leading to a positive heat of reaction (ΔH > 0).

## Why is it important to consider phase changes when calculating heats of reaction?

Phase changes can significantly affect the heat of reaction because they involve energy changes associated with breaking and forming intermolecular forces, which must be accounted for to accurately determine the total heat change during a reaction.



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