

chapter 17 thermochemistry answer key

Chapter 17 thermochemistry answer key is an essential resource for students and educators studying thermochemistry, a branch of chemistry that focuses on the energy changes that accompany chemical reactions and physical transformations. Understanding the concepts presented in this chapter is crucial for mastering the principles of heat transfer, enthalpy, and the laws governing these processes. This article will provide a comprehensive overview of the key topics covered in Chapter 17, along with explanations of important terms, concepts, and the answer key to typical problems you might encounter.

Understanding Thermochemistry

Thermochemistry is fundamentally concerned with the relationship between chemical reactions and energy changes. It examines how heat is absorbed or released during chemical reactions and physical changes. The study of thermochemistry is grounded in several key concepts:

1. Energy

Energy is the capacity to do work or transfer heat. In thermochemistry, we primarily deal with two forms of energy:

- Kinetic Energy: The energy of motion, which varies with the speed of particles.
- Potential Energy: The energy stored in an object due to its position or arrangement.

2. Heat (q)

Heat is the transfer of thermal energy between systems or objects with different temperatures. It can be measured in joules (J) or calories (cal). Heat is a crucial concept in thermochemistry, as it helps to understand how energy is transferred during reactions.

3. Enthalpy (H)

Enthalpy is a thermodynamic quantity that reflects the heat content of a system at constant pressure. It is defined as:

$$[H = U + PV]$$

Where:

- H is enthalpy
- U is internal energy
- P is pressure
- V is volume

Enthalpy changes (ΔH) during a reaction indicate whether a process is exothermic (releases heat) or endothermic (absorbs heat).

4. Thermodynamic Laws

Thermochemistry is governed by several fundamental laws, including:

- First Law of Thermodynamics: Energy cannot be created or destroyed, only transformed from one form to another.
- Second Law of Thermodynamics: In any energy transfer, some energy becomes unavailable to do work, often lost as heat.
- Law of Conservation of Energy: The total energy of an isolated system remains constant.

Key Concepts in Chapter 17

Chapter 17 typically covers several important areas in thermochemistry. Here are the core topics you may encounter:

1. Calorimetry

Calorimetry is the measurement of heat transfer during chemical reactions or physical changes. There are different types of calorimeters, and they operate based on the principle of conservation of energy. Key formulas include:

- Heat absorbed or released:
 $q = m \cdot c \cdot \Delta T$

Where:

- m is the mass
- c is the specific heat capacity
- ΔT is the change in temperature

2. Enthalpy Changes

Understanding how to calculate and interpret enthalpy changes is crucial. Common types of enthalpy changes include:

- Standard Enthalpy of Formation (ΔH°_f): The heat change when one mole of a compound is formed from its elements in their standard states.
- Standard Enthalpy of Reaction ($\Delta H^\circ_{\text{rxn}}$): The heat change associated with a chemical reaction at standard conditions.

3. Hess's Law

Hess's Law states that the total enthalpy change for a reaction is the sum of the enthalpy changes for individual steps of the reaction. This law is crucial for calculating enthalpy changes for reactions that cannot be measured directly.

4. Bond Energy

Bond energy is the amount of energy required to break a mole of bonds in gaseous molecules. The relationship between bond energies and enthalpy changes of reactions can be expressed as:

$$\Delta H = \sum (\text{bond energies of reactants}) - \sum (\text{bond energies of products})$$

Typical Problems and Their Solutions

In studying thermochemistry, students often encounter various problems related to calorimetry, enthalpy changes, and Hess's Law. Below is an example of a typical problem and its solution.

Problem 1: Calorimetry

Calculate the amount of heat absorbed by 100 g of water when it is heated from 25°C to 75°C. The specific heat capacity of water is 4.18 J/g°C.

Solution:

Using the formula for heat:

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

Where:

- $m = 100 \text{ g}$
- $c = 4.18 \text{ J/g}^\circ\text{C}$
- $\Delta T = 75^\circ\text{C} - 25^\circ\text{C} = 50^\circ\text{C}$

Calculating:

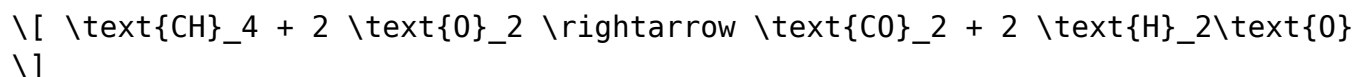
$$q = 100 \text{ g} \cdot 4.18 \text{ J/g}^\circ\text{C} \cdot 50^\circ\text{C} = 20900 \text{ J}$$

\text{J} \]

Thus, the amount of heat absorbed is 20,900 J.

Problem 2: Enthalpy Change

Given the enthalpy of formation of CO₂ is -393.5 kJ/mol and that of H₂O is -285.8 kJ/mol, calculate the enthalpy change for the combustion of methane (CH₄):



Solution:

Using Hess's Law:

1. ΔH for the formation of products:

- CO₂: -393.5 kJ

- H₂O: $(2 \times -285.8 \text{ kJ}) = -571.6 \text{ kJ}$

2. Total ΔH for products:

$$\Delta H_{\text{products}} = -393.5 - 571.6 = -965.1 \text{ kJ}$$

3. ΔH for the formation of reactants (CH₄ and O₂):

- CH₄: +74.8 kJ (standard enthalpy of formation)

- O₂: 0 kJ (elements in their standard state)

4. Total ΔH for reactants:

$$\Delta H_{\text{reactants}} = 74.8 + 0 = 74.8 \text{ kJ}$$

5. Overall reaction:

$$\Delta H = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$$

$$\Delta H = -965.1 - 74.8 = -1039.9 \text{ kJ}$$

Thus, the enthalpy change for the combustion of methane is -1039.9 kJ.

Conclusion

The study of thermochemistry is indispensable for chemistry students and professionals alike. The concepts of heat transfer, enthalpy changes, and the laws of thermodynamics form the backbone of understanding how energy interacts with matter during chemical reactions. The chapter 17 thermochemistry answer key is a valuable tool for reinforcing these concepts and facilitating deeper comprehension of the material. By mastering the principles and practicing problems, students can build a solid foundation in thermochemistry that will serve them well in future studies and applications in the field of chemistry.

Frequently Asked Questions

What is thermochemistry?

Thermochemistry is the study of the heat energy associated with chemical reactions and changes of state.

What is the first law of thermodynamics as it relates to thermochemistry?

The first law of thermodynamics states that energy cannot be created or destroyed, only transformed from one form to another, which is fundamental in understanding heat changes in chemical reactions.

How do you calculate the enthalpy change (ΔH) for a reaction?

The enthalpy change (ΔH) for a reaction can be calculated using the formula $\Delta H = H(\text{products}) - H(\text{reactants})$, where H represents the enthalpy of the respective states.

What is the significance of the heat of formation in thermochemistry?

The heat of formation is the change in enthalpy when one mole of a compound is formed from its elements in their standard states, and it is crucial for calculating the enthalpy changes for reactions.

What is the difference between exothermic and endothermic reactions?

Exothermic reactions release heat into the surroundings, resulting in a temperature increase, while endothermic reactions absorb heat, causing a temperature decrease.

What role do calorimetry experiments play in thermochemistry?

Calorimetry experiments measure the heat exchange during chemical reactions, allowing scientists to determine the enthalpy changes associated with these reactions.

What is Hess's Law and how is it used in

thermochemistry?

Hess's Law states that the total enthalpy change for a reaction is the sum of the enthalpy changes for individual steps, regardless of the pathway taken, and is used to calculate ΔH for complex reactions.

How can bond enthalpies be used to estimate reaction enthalpies?

Bond enthalpies can be used by summing the energies required to break bonds in reactants and subtracting the energies released when new bonds are formed in products to estimate the overall reaction enthalpy.

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