Unit 5: Thermochemistry

Introduction to Thermochemistry & Terminology

This worksheet will introduce thermochemistry, exploring its focus on heat and energy changes during chemical reactions. It covers concepts like heat flow, enthalpy, and temperature variations, offering insights into engines, chemical processes, and environmental shifts, driving technological advancements and a deeper understanding of the natural world. As you progress through the worksheets, you'll be able to define key terms that relate to thermochemistry.

1. Describe the differences between an "open", "closed", and "isolated" system.

2. Define the following terms in relation to thermochemistry, providing equations if necessary:
    a. Surroundings
    b. Heat
    c. Work

3. Describe a scenario in which an isolated system is a useful concept in thermodynamics.

4. Explain how the concept of open systems is relevant in the context of a biological organism, like the human body.

5. How does thermodynamics contribute to our understanding of climate change and environmental processes?

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Answer Key:

1. Describe the differences between an “open”, “closed”, and “isolated” system.

   In thermodynamics, systems are categorized as open, closed, or isolated based on their interactions with the surroundings. An open system allows the exchange of both matter and energy with its surroundings, while a closed system permits the exchange of energy but not matter. On the other hand, an isolated system completely restricts both matter and energy transfer. These distinctions are fundamental for understanding thermodynamic processes and applying principles like the conservation of energy in various scenarios.

2. Define the following terms in relation to thermochemistry, providing equations if necessary:
   a. Surroundings
   b. Heat
   c. Work

   a. The term surroundings refer to everything outside the system under consideration. The system and its surroundings together make up the universe. The interactions between the system and its surroundings involve the exchange of **heat** and **work**, where the surroundings provide the boundary within which these interactions occur.
   b. Heat (q) is a form of energy transfer between a system and its surroundings due to a temperature difference. The quantity of heat transferred is typically measured in joules (J) or Calories. It can be added to or extracted from a system. Heat transfer occurs in 3 ways:
      1. Conduction - transfer through direct contact
      2. Convection- transfer through fluid movement
      3. Radiation - transfer through electromagnetic waves

   c. Work is another form of energy transfer between a system and its surroundings. In thermochemistry, work is often associated with mechanical processes, such as expansion or compression of gasses. The general equation for work done is $w = -P*\Delta V$, where P is pressure and ΔV is the change in volume ($V_{final} - V_{initial}$). The negative sign in the equation indicates that work done on the system is considered positive, while work done by the system is negative.

3. Describe and give an example of an application of an isolated system.

An example of an application of an isolated system is a thermos bottle. They are used to keep the contents inside, either hot or cold. The contents inside a thermos is well-insulated from the outside surroundings, thus making it an isolated system. A thermos is composed of a double walled substance (such as glass or metal), in which the air between these two walls is sucked out –creating a vacuum. The thermos keeps things hot by not allowing heat to escape.

So therefore, an isolated system prevents both heat (energy) and matter exchange, allowing the beverage to stay hot or cold (depending on the usage) for an extended period without losing heat to the surroundings (or vice versa).

4. Explain how the concept of open systems is relevant in the context of a biological organism, like the human body.

The human body can be considered an open system because it interacts with its surroundings by exchanging both matter (through consumption of food and excretion of waste) and energy (through metabolism and heat exchange). The human body also does work on its surroundings, such as walking, breathing, moving and talking. This concept of open systems is essential for understanding how the body maintains its energy balance and internal conditions in a dynamic equilibrium with the external environment.

5. How does thermodynamics contribute to our understanding of climate change and environmental processes?

Thermodynamics is critical for understanding climate change because it provides insights into energy transfers and transformations in Earth's atmosphere. It helps scientists analyze the energy balance between incoming solar radiation and outgoing heat, which is essential for predicting temperature changes and climate patterns.