Unit 5: Thermochemistry

Introduction to Energy

ThIs worksheet will introduce the concept of energy, its diverse forms, and its pivotal role in the behavior of matter. It will cover kinetic and potential energy, their equations and associations with motion and position, alongside units of measurement like joules, kilojoules, calories, and kilocalories. Furthermore, we will explore how energy transfers through work and heat, defining endothermic and exothermic processes crucial for understanding energy dynamics in chemical reactions and physical phenomena.

1. What is the definition of energy?

2. In an exothermic reaction, what is the sign of heat (q)?

3. An object has a potential energy of 500 J and a mass of 10 kg. If it is 5 meters above the ground, what is the gravitational acceleration (g) at that location?

4. A power plant produces 5,000,000 J of energy per second. How many kilojoules (kJ) is this per hour?

5. How does the Law of Conservation of Energy apply to everyday situations?

6. Calculate the kinetic energy (K) of a 2-kilogram object moving at a velocity of 5 meters per second using the kinetic energy formula.

7. Provide an example of an endothermic process and explain why it is classified as endothermic.

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Answer Key:

1. What is the definition of energy?

   Energy can be defined as the capacity to do work or produce heat. It can also be described as the ability to bring about change in a system

2. In an exothermic reaction, what is the sign of heat (q)?

   In an exothermic reaction, heat (q) is released into the surroundings, resulting in a negative value. Therefore, $q<0$

3. An object has a potential energy of 500 J and a mass of 10 kg. If it is 5 meters above the ground, what is the gravitational acceleration (g) at that location?

   Explanation: Using the formula for potential energy ($U = mgh$), we can rearrange it to find 'g', since mass (m) and height (h) and potential energy (U) is given.
   $g = U / (m * h)$
   $= 500\ J / (10\ kg * 5\ m)$
   $= 10\ m/s^2$.

4. A power plant produces 5,000,000 J of energy per second. How many kilojoules (kJ) is this per hour?

   Explanation: This is a multi step conversion problem where both Joules (J) and time (seconds) need to be converted to kiloJoules (kJ) and hours, respectively. To put it simply, convert seconds to hours and joules to kilojoules:

   Energy produced per hour = (5,000,000 J/second) * (3600 seconds/hour) * (1kJ/1000 J) (to convert J to kJ) = 18,000,000 kJ/hours.

   Note: always double check that when you are converting, that the correct units cancel out, leaving only the desired units at the end.

5. How does the Law of Conservation of Energy apply to everyday situations?

   The Law of Conservation of Energy states that energy cannot be created or destroyed but can change forms. In everyday situations, this law is evident when, for example, electrical energy is converted into light and heat in a lightbulb or when potential energy is transformed into kinetic energy when an object falls. It underscores the principle that the

total energy in a closed system remains constant.

6. Calculate the kinetic energy (K) of a 2-kilogram object moving at a velocity of 5 meters per second using the kinetic energy formula.

   The equation to calculate for kinetic energy is: $K = 1/2mv^2$, where velocity is 5m/sec, and mass is 2 kg.
   $= 1/2 * 2\ kg * (5\ m/s)^2$
   $= 25$ joules (J).
   The kinetic energy of the object is 25 joules.

   Note: 1 Joule is equivalent to 1 $(kg*m^2*s^{-2})$, which is why there is no need to convert the mass since we actually want the units to match the SI unit equivalent to Joules. For example, if the mass was given in grams or if velocity was given in other units such as meter/hours, it would need to be converted to the appropriate SI units (as described above).

7. Provide an example of an endothermic process and explain why it is classified as endothermic.

   An example of an endothermic process is the dissolution of ammonium nitrate in water. In this process, heat is absorbed from the surroundings, causing a decrease in temperature. It's classified as endothermic because it requires an input of energy to break the bonds within the ammonium nitrate, resulting in a cooling effect as heat is drawn from the surroundings.