

GCSE CHEMISTRY ENDOTHERMIC REACTIONS EXPERIMENT Study Guide

GCSE Chemistry Endothermic Reactions Experiment: A Comprehensive Guide

GCSE Chemistry Endothermic Reactions Experiment is a fundamental component of the chemistry curriculum, enabling students to understand the energy changes involved in chemical processes. This experiment provides practical insight into the concept of endothermic reactions, which absorb heat from their surroundings, leading to observable temperature drops. Understanding these reactions is essential for grasping broader chemical principles such as energy transfer, reaction enthalpy, and reaction mechanisms. In this article, we will explore the purpose, methodology, safety considerations, and analysis of the GCSE chemistry endothermic reactions experiment, equipping students with the knowledge to perform and interpret this fundamental experiment confidently.

Understanding Endothermic Reactions

What Are Endothermic Reactions?

Endothermic reactions are chemical processes that absorb energy, usually in the form of heat, from their surroundings. This absorption results in a decrease in temperature of the immediate environment, which can be observed through temperature measurements during the reaction. Examples include:

- Photosynthesis
- Dissolving certain salts in water
- Thermal decomposition of compounds

Importance in GCSE Chemistry

Studying endothermic reactions helps students understand:

- Energy transfer during chemical reactions
- The concept of energy profiles and activation energy
- Practical applications like cold packs and cooling systems

Setting Up the Endothermic Reactions Experiment

Objectives of the Experiment

The main objectives are to:

- Observe the temperature change during an endothermic reaction
- Understand how heat absorption affects the surroundings
- Measure and compare energy changes in different reactions

Materials Needed

Ensure all materials are prepared beforehand:

- Test tubes or beakers
- Thermometers (preferably digital for accuracy)
- Stirring rods
- Ice bath or cold water
- Reactants for the experiment (e.g., ammonium chloride, barium hydroxide, hydrated copper sulfate)
- Measuring cylinders or pipettes
- Safety goggles and gloves

Sample Reactions to Test

You can perform the experiment with various endothermic reactions, such as:

- Dissolving ammonium chloride in water
- Dissolving hydrated copper sulfate in water
- Mixing barium hydroxide with ammonium chloride

Each reaction exhibits distinct temperature changes, providing comparative data.

Step-by-Step Procedure

- Preparation:

- Fill a test tube with a known amount of reactant (e.g., 10g of ammonium chloride).
- Prepare a cold water bath or ice pack to immerse the reaction vessel.

- Initial Temperature Recording:
 - Measure and record the initial temperature of the reactant before adding water or initiating the reaction.

- Conducting the Reaction:
 - Add water to the reactant in the test tube.
 - Immediately stir gently with a stirring rod to ensure uniform mixing.
 - Record the temperature at regular intervals (e.g., every 10 seconds) until the temperature stabilizes.

- Observation and Data Collection:
 - Note the maximum decrease in temperature, which indicates heat absorption.

- Repeat for Different Reactions:
 - Perform the same procedure with different reactants to compare the extent of temperature change.

- Cleanup:
 - Dispose of chemicals safely according to your school's safety protocols.
 - Clean all equipment thoroughly.

Safety Tips and Precautions

- Always wear safety goggles and gloves to protect against chemical splashes.
- Conduct the experiment in a well-ventilated area.
- Handle chemicals carefully, especially those that are corrosive or toxic.
- Be cautious when working with hot water or ice baths to prevent burns or cold injuries.
- Dispose of chemicals responsibly, following your school's safety guidelines.

Analyzing and Interpreting Results

Data Presentation

- Create tables to record initial temperatures, temperature drops, and final temperatures.
- Plot temperature versus time graphs for each reaction to visualize heat absorption.

Understanding the Results

- The greater the temperature drop, the more heat the reaction absorbs, indicating a more endothermic process.
- Compare the magnitude of temperature changes across different reactions to assess their relative endothermic nature.

Calculating Enthalpy Change

While detailed calorimetry calculations may be beyond GCSE level, students can estimate the energy absorbed using simplified formulas:

$$Q = mc\Delta T$$

Where:

Q = heat energy absorbed (J)

m = mass of water or reactant (g)

c = specific heat capacity of water ($\sim 4.18 \text{ J/g}^\circ\text{C}$)

ΔT = temperature change ($^\circ\text{C}$)

By calculating Q for each reaction, students gain a quantitative understanding of the energy

involved.

Applications of Endothermic Reactions

Understanding endothermic reactions has practical significance in various industries and everyday life:

- Cold packs: Use of ammonium nitrate or ammonium chloride dissolution to produce cooling effects.
- Chemical manufacturing: Managing heat absorption during reactions.
- Environmental science: Understanding energy flows in natural processes.

Conclusion

The **GCSE Chemistry Endothermic Reactions Experiment** offers invaluable hands-on experience that deepens students' comprehension of energy changes in chemical reactions. By carefully setting up the experiment, observing temperature changes, and analyzing the data, students develop a practical understanding of endothermic processes. This knowledge not only supports their academic development but also enhances their awareness of real-world applications involving heat absorption and energy management. Remember, safety is paramount; always follow proper procedures and use protective equipment. With diligent effort and curiosity, this experiment can be both educational and enjoyable, laying a solid foundation for future studies in chemistry and related sciences.

GCSE Chemistry Endothermic Reactions Experiment: A Comprehensive Guide

GCSE chemistry endothermic reactions experiment is a fundamental component of the curriculum that offers students a hands-on understanding of energy changes during chemical reactions. By exploring these reactions, learners gain insights into how energy is absorbed or released, which is crucial for grasping broader concepts in thermodynamics, safety considerations in chemical processes, and real-world applications such as cold packs and temperature regulation. This article provides a detailed yet accessible overview of how to conduct a GCSE-level endothermic reactions experiment, the scientific principles behind it, and the significance of the findings.

Understanding Endothermic Reactions: The Basics

Before diving into the experimental procedures, it's important to clarify what endothermic reactions are and how they differ from other chemical processes.

What Are Endothermic Reactions?

An endothermic reaction is a chemical process that absorbs energy from its surroundings, typically in the form of heat. This absorption results in a temperature decrease in the immediate environment unless energy is supplied externally.

Key features of endothermic reactions:

- Absorption of heat energy.
- Resulting temperature decrease in the surroundings.
- Often involve bonds breaking rather than forming.
- Require energy input to proceed.

Common real-world examples include:

- The melting of ice.
- Photosynthesis in plants.
- Dissolving ammonium chloride in water.

Understanding these reactions involves measuring the energy change, which is where practical experiments become valuable teaching tools.

The Scientific Principles Behind the Experiment

The core principle guiding the GCSE experiment is the measurement of temperature change when a specific chemical reaction occurs, which indicates whether the reaction is endothermic or exothermic.

Energy change in chemical reactions:

Chemical bonds are either broken or formed during reactions. Breaking bonds requires energy (endothermic), while forming bonds releases energy (exothermic). The net energy change determines whether the reaction absorbs or releases heat.

Enthalpy change (ΔH):

A key thermodynamic quantity, ΔH , measures the heat energy absorbed or released at constant pressure during a reaction.

Why measure temperature?

Monitoring temperature change provides a practical way to determine the nature of the reaction. A decrease in temperature indicates an endothermic process, while an increase suggests exothermic behavior.

Planning and Conducting the Endothermic Reactions Experiment

A well-designed experiment involves selecting suitable reactants, establishing a controlled environment, and accurately recording temperature changes. Here's a step-by-step guide.

Materials Needed

- Beaker (preferably insulated)
- Thermometer or temperature probe
- Stirring rod
- Measuring cylinders
- Chemicals such as ammonium chloride (NH_4Cl), potassium nitrate (KNO_3), or other soluble salts
- Water
- Balance for measuring chemicals
- Safety equipment (goggles, gloves)

Experimental Procedure

- Preparation:
 - Wear safety goggles and gloves.
 - Measure a specific amount of water (e.g., 50 ml) and pour it into the beaker.
 - Record the initial temperature of the water using the thermometer.
- Addition of Reactant:
 - Weigh a known quantity of the chosen salt (e.g., 5 grams of ammonium chloride).
 - Add the salt to the water in the beaker.
- Mixing and Observation:

- Stir the mixture continuously until the salt dissolves completely.
 - Observe the temperature change during dissolution.
 - Record the lowest temperature reached.
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- Repeat for Accuracy:
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- Repeat the process several times to obtain consistent data.
 - Use different salts to compare their endothermic nature.

Data Recording and Analysis

- Record initial and final temperatures for each trial.
- Calculate the temperature change (ΔT).
- Determine the average temperature change for each salt.
- Analyze which salts produce the most significant cooling effect.

Interpreting the Results: What Do They Tell Us?

The primary indicator of an endothermic reaction in this experiment is a notable decrease in temperature during the dissolution process.

Expected observations:

- Ammonium chloride and potassium nitrate typically produce a perceptible cooling effect.
- The larger the temperature drop, the more energy the reaction absorbs, signifying a strongly endothermic process.

Scientific conclusions:

- Dissolving salts like ammonium chloride in water is an endothermic process because it requires energy to break ionic bonds.
- These reactions can be quantitatively characterized by calculating the enthalpy change (if additional data such as heat capacity is known), providing deeper insight into thermodynamic principles.

Applications and Real-World Significance

Understanding endothermic reactions isn't just an academic exercise?they have practical applications in everyday life and industry.

Cold Packs and Medical Uses

- Many instant cold packs utilize endothermic reactions where salts like ammonium nitrate or ammonium chloride dissolve in water to produce cooling effects.
- These are used for reducing swelling and pain in injuries.

Environmental and Industrial Processes

- Endothermic reactions play roles in climate regulation, cooling systems, and energy storage.
- Knowledge of such reactions helps in designing efficient thermal management systems.

Safety and Precautions

While conducting the experiment, safety should always be a priority.

- Always wear personal protective equipment.
- Handle chemicals carefully, following proper disposal protocols.
- Be cautious with hot or cold solutions to prevent burns or frostbite.
- Conduct the experiment in a well-ventilated area.

Troubleshooting Common Issues

- Inconsistent temperature readings: Ensure the thermometer is properly calibrated and stir thoroughly.
- Incomplete dissolution: Use smaller salt particles or stir longer.
- Unexpected temperature rise: Confirm no exothermic reactions are occurring; double-check the chemicals used.

Extending the Experiment: Further Investigations

To deepen understanding, students can:

- Explore the effect of concentration by varying salt amounts.

- Use different salts to compare their endothermic nature.
- Investigate the effect of temperature on the rate of dissolution.
- Measure the amount of heat absorbed using calorimetry techniques for quantitative analysis.

Conclusion: The Value of Practical Chemistry

The **gcse chemistry endothermic reactions experiment** offers students a tangible connection to theoretical concepts. By observing temperature changes during dissolution, learners grasp the abstract idea of energy transfer in chemical reactions, fostering a deeper appreciation for thermodynamics. Additionally, understanding these processes has practical implications, from designing cold packs to managing thermal systems in industry. Conducted safely and accurately, this experiment not only enhances scientific understanding but also cultivates critical thinking and investigative skills—cornerstones of scientific education.

In summary, mastering the GCSE endothermic reactions experiment equips students with essential knowledge about energy absorption in chemical processes, broadening their scientific perspective and preparing them for future studies in chemistry and related fields.

Question What is the purpose of conducting an endothermic reactions experiment in GCSE Chemistry? The purpose is to observe and understand how endothermic reactions absorb heat from their surroundings, which helps students learn about energy changes during chemical reactions. **Answer** What safety precautions should be taken during an endothermic reactions experiment? Safety precautions include wearing safety goggles and gloves, working in a well-ventilated area, handling chemicals carefully, and avoiding direct contact with hot or cold materials. How can you identify an endothermic reaction in a practical experiment? An endothermic reaction can be identified by a temperature decrease in the reaction mixture or surrounding environment, indicating heat absorption during the process. What are common examples of endothermic reactions used in GCSE Chemistry experiments? Common examples include the thermal decomposition of calcium carbonate, the reaction of barium hydroxide with ammonium chloride, and dissolving salts like potassium chloride in water. How do you measure the temperature change accurately in an endothermic reaction experiment? Use a sensitive thermometer or a data logger to record temperature before and after the reaction, ensuring the container is well-insulated to minimize heat exchange with the environment.

Related keywords: GCSE chemistry, endothermic reactions, chemistry experiments, thermal energy, heat absorption, reaction enthalpy, laboratory experiment, chemical reactions, educational chemistry, scientific investigation

EXOTHERMIC AND ENDOTHERMIC REACTIONS EXAMPLES

EVERYDAY LIFE

exothermic and endothermic reactions examples everyday life

Understanding the concepts of exothermic and endothermic reactions is fundamental in chemistry, and these reactions are not confined to laboratories—they are actively happening around us every day. From the warmth of a burning fire to the cool sensation of ice melting, these reactions influence many aspects of our daily lives. Recognizing and understanding these processes can enhance our appreciation of natural phenomena and technological applications. In this article, we will explore numerous examples of exothermic and endothermic reactions that occur in everyday life, providing detailed explanations to help you grasp their significance.

What Are Exothermic and Endothermic Reactions?

Before delving into specific examples, it's essential to define these two fundamental types of chemical reactions.

Exothermic Reactions

An exothermic reaction releases energy, usually in the form of heat, light, or sound, into the surroundings. This release results in an increase in temperature of the environment around the reaction. Examples include combustion, oxidation, and many neutralization reactions.

Endothermic Reactions

An endothermic reaction absorbs energy from its surroundings, often leading to a decrease in temperature around the reaction site. These reactions require energy input to proceed and are common in processes like melting, boiling, and photosynthesis.

Examples of Exothermic Reactions in Everyday Life

Many of the reactions that generate heat or light are exothermic, and they play vital roles in daily activities and natural phenomena.

1. Combustion of Fuels

One of the most prevalent exothermic reactions is combustion, where fuels like wood, gasoline, or natural gas burn in the presence of oxygen.

- **Wood burning:** When you light a campfire or fireplace, the combustion of wood releases heat, light, and gases like carbon dioxide and water vapor.
- **Gasoline engines:** Internal combustion engines in vehicles rely on the exothermic reaction of gasoline with oxygen to produce energy, powering the vehicle.

Key Points:

- Releases large amounts of heat and light.
- Essential for heating, transportation, and electricity generation.

2. Neutralization Reactions

When acids and bases react, they often produce heat.

- **Example:** Mixing hydrochloric acid with sodium hydroxide releases heat, resulting in a warm solution.

Application: This principle is used in antacid tablets, where the neutralization relieves stomach acidity, sometimes producing a slight warming sensation.

3. Respiration

The biological process of respiration, where glucose reacts with oxygen, is exothermic.

- **Reaction:** $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

Significance: The energy released powers our muscles, maintains body temperature, and fuels cellular activities.

4. Fireworks

The spectacular displays of fireworks involve exothermic chemical reactions that release heat, light, and sound, creating vibrant visuals.

5. Oxidation of Metals

When metals like iron rust, an oxidation process occurs, releasing heat slowly over time.

- **Example:** Rusting of iron is an exothermic process, although it releases heat gradually.

Examples of Endothermic Reactions in Everyday Life

Endothermic reactions absorb heat from their surroundings, often resulting in cooling effects or requiring energy input.

1. Melting of Ice

Perhaps the most common example of an endothermic process.

- **Process:** Ice absorbs heat to change from solid to liquid.
- **Observation:** When ice melts, it cools the environment, which is why ice packs feel cold.

Application: Ice packs used in sports injuries rely on endothermic reactions to absorb heat and reduce swelling.

2. Boiling of Water

Heating water to boiling point absorbs a significant amount of heat without a temperature increase during the phase change.

- **Example:** Boiling water in a kettle requires energy input to convert liquid to vapor.

3. Photosynthesis

A vital biological endothermic process where plants absorb sunlight to produce glucose.

- **Reaction:** $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

Importance: This process converts solar energy into chemical energy stored in plants, supporting life on Earth.

4. Evaporation of Water

When water evaporates, it absorbs heat from the surroundings, producing a cooling effect.

- **Example:** Sweating helps cool the body as sweat evaporates, absorbing heat.

5. Dissolving Salt or Sugar in Water

Dissolution often involves endothermic processes, especially when the solute absorbs heat during the process.

Other Everyday Examples Demonstrating the Concepts

In addition to the major reactions, many other common phenomena involve exothermic or endothermic processes.

1. Cold Packs and Heating Pads

- Cold packs: Contain chemicals that undergo endothermic reactions, absorbing heat to reduce inflammation.
- Heating pads: Use resistive heating to produce warmth, exemplifying an energy input (not a chemical reaction but related to heat transfer).

2. Baking and Cooking

- Baking bread involves endothermic reactions like the melting of fats and starch gelatinization.
- The combustion of natural gas in ovens is exothermic, providing the heat necessary for cooking.

3. Photosensitive Reactions

Certain reactions in photography or solar panels depend on light absorption, an endothermic process.

Summary and Practical Implications

Understanding whether a reaction is exothermic or endothermic helps us control and utilize these processes effectively.

Practical Applications:

- Designing better insulation and heating systems by understanding heat transfer.
- Developing cold packs or heat packs for medical use.

- Improving energy efficiency in engines and industrial processes.
- Enhancing agricultural practices through controlled use of energy-dependent reactions like photosynthesis.

Conclusion

Exothermic and endothermic reactions are integral to many aspects of our daily routines, natural phenomena, and technological advancements. Recognizing these reactions' examples such as combustion, respiration, melting, and photosynthesis allows us to appreciate the dynamic nature of chemical processes around us. Whether it's the warmth from a fireplace or the cooling effect of ice, these reactions shape our environment and support life. Understanding their principles enables better application in science, industry, and everyday life, fostering a deeper connection with the natural world and technological innovations.

Remember: The key difference lies in energy transfer: exothermic reactions release energy, warming their surroundings, while endothermic reactions absorb energy, often causing cooling effects.

Exothermic and endothermic reactions examples in everyday life are fascinating phenomena that influence many aspects of our daily routines, from the food we eat to the products we use. Understanding these reactions helps us appreciate the chemistry behind everyday processes and the energy exchanges that occur around us. Whether you're cooking a meal, feeling the warmth of a fire, or experiencing a cold pack, you're witnessing the principles of exothermic and endothermic reactions in action.

Understanding Exothermic and Endothermic Reactions

Before diving into specific examples, it's essential to grasp the basic definitions:

- Exothermic reactions are chemical processes that release energy, usually in the form of heat, light, or sound. These reactions result in a net release of energy to the surroundings.
- Endothermic reactions absorb energy from their surroundings, often leading to a cooling effect. These reactions require an input of energy to proceed.

Both types of reactions are fundamental to countless natural and human-made processes, shaping our environment and technological advancements.

Everyday Examples of Exothermic Reactions

Exothermic reactions are more common in daily life than one might initially think. They often produce

warmth, which is why many heating processes are exothermic at their core.

- Combustion of Fuels

Description: When fuels like wood, coal, gasoline, or natural gas burn, they undergo combustion reactions, which are highly exothermic.

Examples:

- Lighting a wood fire in a fireplace
- Using a gas stove for cooking
- Fueling a car engine

Energy Release: These reactions release large amounts of heat, powering various forms of transportation and heating.

- Respiration

Description: Cellular respiration, the process by which our bodies convert glucose into energy, is an exothermic biological reaction.

Examples:

- Breathing and energy production in cells
- Metabolic processes that keep us alive

Significance: The energy released sustains vital biological functions, and the heat produced helps maintain body temperature.

- Freezing of Water

Description: When water turns into ice, it releases latent heat into the surroundings.

Example:

- Water freezing in a freezer or on a cold day

Note: Although the process involves heat release, it's a phase change, showcasing exothermic behavior.

- Neutralization Reactions

Description: When an acid reacts with a base, such as hydrochloric acid and sodium hydroxide, the process releases heat.

Example:

- Titration in chemistry labs
- Antacid tablets reacting with stomach acid

Application: This principle is used in various industrial and medical processes.

- Fireworks

Description: The combustion reactions in fireworks release energy in the form of heat, light, and sound, creating spectacular displays.

Examples:

- Fireworks displays during celebrations
- Sparklers and firecrackers

Everyday Examples of Endothermic Reactions

Endothermic reactions absorb energy, often resulting in cooling effects, which are equally important in daily life.

- Melting Ice

Description: When ice melts into water, it absorbs heat from the environment.

Examples:

- Ice cubes in a drink cooling the beverage
- Snow melting in sunlight

Impact: This process is a classic example of an endothermic phase change, requiring energy input to break molecular bonds.

- Photosynthesis

Description: Plants absorb sunlight to convert carbon dioxide and water into glucose and oxygen? a quintessential endothermic process.

Examples:

- Growth of plants
- Formation of sugars in leaves

Significance: Without this energy absorption, life on Earth wouldn't be sustainable.

- Boiling Water

Description: Heating water to boiling point requires energy input to change it from liquid to vapor.

Examples:

- Cooking pasta or boiling eggs
- Industrial steam generation

Note: The process absorbs a significant amount of heat, exemplifying an endothermic reaction.

- Dissolving Salt or Sugar

Description: In some cases, dissolving certain salts or sugars in water is endothermic, requiring heat absorption.

Examples:

- Salt dissolving in cold water
- Sugar dissolving in iced tea

Application: This principle is used in cooling packs and refrigeration systems.

- Electrolysis of Water

Description: Splitting water into hydrogen and oxygen gases using electrical energy is an endothermic process.

Applications:

- Hydrogen fuel production
- Electrochemical experiments

How These Reactions Impact Our Daily Lives

Understanding the balance between exothermic and endothermic reactions helps us control and utilize energy efficiently.

Heating and Cooling Applications

- Exothermic reactions are harnessed in hand warmers or chemical heaters, where chemical reactions produce heat.
- Endothermic reactions are used in cooling packs, which absorb heat to provide relief from injuries or to preserve perishable goods.

Cooking and Food Preservation

- Cooking often involves exothermic reactions, such as browning or caramelization, releasing heat.
- Freezing or chilling processes are endothermic, requiring energy to remove heat from food, thus preserving it.

Industrial Processes

- Combustion reactions power engines and generate heat for manufacturing.
- Endothermic reactions like electrolysis and phase changes are essential in producing chemicals, fuels, and materials.

Biological Systems

- Our bodies rely on exothermic respiration to generate energy.
- Photosynthesis is an endothermic process that sustains plant life and, indirectly, all other life forms.

Practical Tips for Recognizing Exothermic and Endothermic Reactions

- Feel for temperature changes: Warmth indicates an exothermic process; cooling suggests endothermic.
- Observe phase changes: Melting, boiling, or evaporation are endothermic; freezing and condensation are exothermic.
- Note energy input or release during reactions: Exothermic reactions often occur spontaneously or with minimal energy input, while endothermic reactions require energy to proceed.

Conclusion

Exothermic and endothermic reactions examples in everyday life demonstrate the dynamic nature of chemical energy exchanges that influence our environment, health, and technology. Recognizing these reactions enhances our understanding of natural processes and helps us harness chemical principles for practical benefits, from cooking and heating to industrial manufacturing and environmental sustainability. By observing these reactions in action, we gain a deeper appreciation for the intricate dance of energy that sustains life and shapes our world.

Question What is an example of an exothermic reaction in everyday life? Burning wood or fuel is an example of an exothermic reaction, as it releases heat and light energy. Can you give an example of an endothermic reaction that occurs daily? Photosynthesis in plants is an endothermic process, as it absorbs sunlight to produce glucose. How is sweating an example of an endothermic reaction? Sweating involves the absorption of heat from the body to evaporate sweat, cooling the skin, which is an endothermic process. What is an everyday example of an exothermic reaction in cooking? Cooking steak involves exothermic reactions, as heat is released during the Maillard reaction, creating flavor and browning. Is dissolving salt in water an exothermic or

endothermic process? Dissolving salt in water is typically an endothermic process, as it absorbs heat to break ionic bonds. What role do exothermic reactions play in hand warmers? Hand warmers use exothermic reactions, such as oxidation of iron, to produce heat and keep hands warm. Why is photosynthesis considered an endothermic reaction? Because it absorbs energy from sunlight to convert carbon dioxide and water into glucose and oxygen. Can combustion be classified as an exothermic or endothermic reaction? Combustion is an exothermic reaction because it releases heat and energy during burning. What is an example of an endothermic reaction used in sports drinks? The absorption of water during hydration can be considered an endothermic process, as it absorbs heat from the body. How do exothermic reactions contribute to the setting of concrete? The chemical reactions during concrete setting release heat, which is an exothermic process aiding in hardening.

Related keywords: chemical reactions, heat transfer, energy change, combustion, cooking, melting, evaporation, condensation, respiration, photosynthesis

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