

**Teacher’s Guide**

**Hot and Cold Therapies**

***December 2023***

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Activate students’ prior knowledge and engage them before they read the article.

[***Reading Comprehension Questions***](#_3znysh7) ***3***

These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[***Graphic Organizer***](#_9f8azrtnp6p5) ***5***

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

[***Answers***](#_djipzn7z1r1b) ***6***

Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

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Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Cold therapy is used to treat a chronic injury. |
|  |  | 2. Both hot and cold therapy are effective in reducing damage after exercise. |
|  |  | 3. Cold therapy was used in ancient Egypt. |
|  |  | 4. Plunging the body into cold water causes blood to acquire more oxygen. |
|  |  | 5. Only cold therapy increases norepinephrine that controls your body’s flight or fight response. |
|  |  | 6. Heat therapy increases release of dopamine, a neurotransmitter that elevates mood, energy, and the ability to focus. |
|  |  | 7. Heat therapy increases blood flow to injured areas. |
|  |  | 8. Heat therapy affects metabolism and thinking ability. |
|  |  | 9. Many instant hot and cold packs work by dissolving a salt into water. |
|  |  | 10. Breaking bonds releases energy. |

# Student Reading Comprehension Questions

**Directions**: Use the article to answer the questions below.

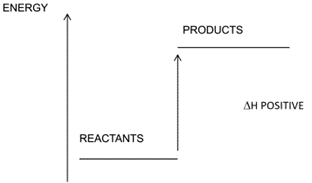
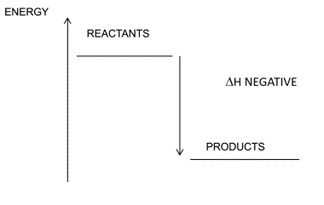
1. Define and explain the differences between thermotherapy and cryotherapy.
2. Explain what happens to blood vessels in the body during thermotherapy and cryotherapy.
3. Give some examples and uses for dry heat and moist heat.
4. Define exothermic in your own words. Give a few examples. Define endothermic in your own words. Give a few examples.
5. What is enthalpy? What is the symbol for enthalpy?
6. The breaking of chemical bonds between atoms in a molecule is typically an endothermic process. Explain why this is the case.
7. Explain some similarities and differences between ultrasound heating and the heat generated from traditional heat packs.
8. When you hold an ice cube, you say it feels “cold”. In terms of heat transfer, what is happening?
9. In a heat pack, heat is released when the chemicals react. In terms of potential energy of the reacting chemicals and the resulting products, explain where the heat energy comes from.
10. In a cold pack, heat is absorbed from the surroundings when the chemicals react (it feels cold). In terms of potential energy of the reacting chemicals and the resulting products, explain why the chemicals are absorbing the heat.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Consider the two energy diagrams below. Determine which one is a diagram for an exothermic process, and which one is for an endothermic process. Explain your reasoning. Also, explain why the ΔH is negative or positive in each of the diagrams.



1. Give a few reasons why heat therapy and cold therapy are good alternatives over drugs to treat illnesses and injuries.

# Graphic Organizer

**Directions**: As you read, complete the graphic organizer below to compare hot and cold therapy.

|  |  |  |
| --- | --- | --- |
|  | **Hot Therapy** | **Cold Therapy** |
| **Used in ancient times** |  |  |
| **Examples** |  |  |
| **When to use it** |  |  |
| **What it does in your body** |  |  |
| **Chemicals produced in your body when used** |  |  |
| **Chemicals in instant packs** |  |  |

**Summary:** On the back of this sheet, write a short email (3-4 sentences) to a friend about treating injuries with thermotherapy and cryotherapy.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. Define and explain the differences between thermotherapy and cryotherapy.  
   Thermotherapy uses heat to help alleviate injuries and/or illnesses. Cryotherapy is the process of using cold to do the same thing. Both processes can be used for a variety of ailments.
2. Explain what happens to blood vessels in the body during thermotherapy and cryotherapy.  
   During thermotherapy, blood vessels will dilate, which allows blood flow to increase to the injured area. This extra blood will help heal any injuries to joints, muscles, and tissues. In cryotherapy, the blood vessels contract, which lessens the amount of blood flow to the injured area. The lower blood flow will reduce swelling. Additionally, the restricted vessels push the blood back to the organs, which absorbs more oxygen to bring to the affected area.
3. Give some examples and uses for dry heat and moist heat.  
   Dry heat is called conductive heating. Examples of this are heat packs, hot water bottles, and heating pads. Moist heat, called convection, includes heating baths and steamed cloths or towels.
4. Define exothermic in your own words. Give a few examples. Define endothermic in your own words. Give a few examples.  
   Exothermic means to release heat into the surroundings. When something burns, such as burning wood or a gas stove fire, this is exothermic. Endothermic means to absorb heat. When you hold something cold, such as an ice cube, or when a freezer cools water into an ice cube, an endothermic process is happening because something is absorbing heat to make the other object feel cold.
5. What is enthalpy? What is the symbol for enthalpy?  
   Enthalpy is the amount of heat energy in a chemical. The symbol for enthalpy is H.
6. The breaking of chemical bonds between atoms in a molecule is typically an endothermic process. Explain why this is the case.  
   The bonds between chemicals consist of a set amount of potential energy. For these bonds to be broken, an amount of energy greater than the bond’s stored energy must be added to the chemical. The energy must come from an outside source, the surroundings; therefore, it is an endothermic process to break a chemical bond.
7. Explain some similarities and differences between ultrasound heating and the heat generated from traditional heat packs.  
   Ultrasound heating is not like traditional style heating. With ultrasound heating, sound waves cause vibrations in tissues in the body. These vibrations create friction, which causes heat. With traditional heating, the substances in hot packs are already vibrating quickly, which produces the heat. The heat is then transferred to the body.
8. When you hold an ice cube, you say it feels “cold”. In terms of heat transfer, what is happening?  
   Heat is being transferred from your hand to the ice cube to warm the ice and as a consequence your hand feels cold. The ice cube is absorbing the heat (an endothermic process), so what you feel is the heat leaving your hand. Heat always flows from hot to cold.
9. In a heat pack, heat is released when the chemicals react. In terms of potential energy of the reacting chemicals and the resulting products, explain where the heat energy comes from.  
   The initial chemicals (reactants) have higher energy than the final chemicals (products). The difference in energy between where the start of the reaction and the end of the reaction is the energy released to the surroundings. Measuring the temperature of the reaction will show an increase in temperature indicating a loss of energy.
10. In a cold pack, heat is absorbed from the surroundings when the chemicals react (it feels cold). In terms of potential energy of the reacting chemicals and the resulting products, explain why the chemicals are absorbing the heat.   
    If the products of a reaction have more energy than the reactants, then heat is absorbed by the reaction. An observed decrease in temperature during the reaction is an indicator that the chemicals are absorbing energy and that the products are gaining heat, rather than giving off heat. The energy needed to complete the reaction must come from the surroundings. So the reaction absorbs the heat energy in order to make the products.
11. Consider the two energy diagrams below. Determine which one is a diagram for an exothermic process, and which one is for an endothermic process. Explain your reasoning. Also, explain why the ΔH is negative or positive in each of the diagrams.  
    The diagram on the left represents an exothermic reaction. An exothermic reaction releases heat. According to the energy diagram, the reactants have more potential energy than the products. Therefore, the extra unneeded energy is given off into the surroundings as heat. The enthalpy value is negative because the system is losing heat.   
    The diagram on the right represents an endothermic reaction. An endothermic reaction absorbs heat. According to the energy diagram, the reactants have less potential energy than the products. Therefore, for the products to be formed, the system needs to get more energy from another source. This source would be the surroundings, so the system absorbs the surroundings heat energy. The enthalpy value is positive because the system is gaining heat.
12. Give a few reasons why heat therapy and cold therapy are good alternatives over drugs to treat illnesses and injuries.  
    (Answers may vary). Heat and cold therapy can be used to reduce swelling and increase blood flow to injuries. They are inexpensive and can be applied immediately to non-emergent injuries. They can reduce recovery time and can mean that pain medications are not needed. They are a non-addictive method for treating aches and pains.

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# 

# Additional Resources and Teaching Strategies

**Additional Resources**

* **Labs and demos**
* Handwarmer Design Challenge  
  <https://teachchemistry.org/classroom-resources/handwarmer-design-challenge>

# Less Than Zero <https://teachchemistry.org/classroom-resources/less-than-zero>

* Energy in Hot and Cold Packs  
  <https://teachchemistry.org/classroom-resources/energy-in-hot-and-cold-packs>
* **Lessons and lesson plans**
* Thermochemistry and Thermodynamics Unit Plan

<https://teachchemistry.org/classroom-resources/thermochemistry-and-thermodynamics-unit-plan>

* **Projects and extension activities**
  + Thermodynamics Escape Room

<https://teachchemistry.org/classroom-resources/thermodynamics-escape-room>

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* **Alternative to Anticipation Guide:** Before reading, ask students if they have used hot or cold therapy, and when. Ask if they have used instant hot or cold packs and if they know how they work. Their initial ideas can be collected electronically via Jamboard, Padlet, or similar technology.
  + As they read, students can find information to confirm or refute their original ideas.
* After they read, ask students what they learned about hot and cold therapy and treating injuries. Ask how they might use the information in the future.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Enthalpy
* Exothermic and endothermic
* Heat
* Molecular structure

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-4.** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends on the changes in total bond energy.

**HS-LS1-3.** Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

**HS-ETS1-2.** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* LS.1.A: Structure and Function
* ETS.1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Cause and effect
* Energy and matter

**Science and Engineering Practices:**

* Constructing explanations (for science) and designing solutions (for engineering)

**Nature of Science:**

* Scientific knowledge assumes an order and consistency in natural systems.

See how *ChemMatters* correlates to the[**Common Core State Standards** online](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html).