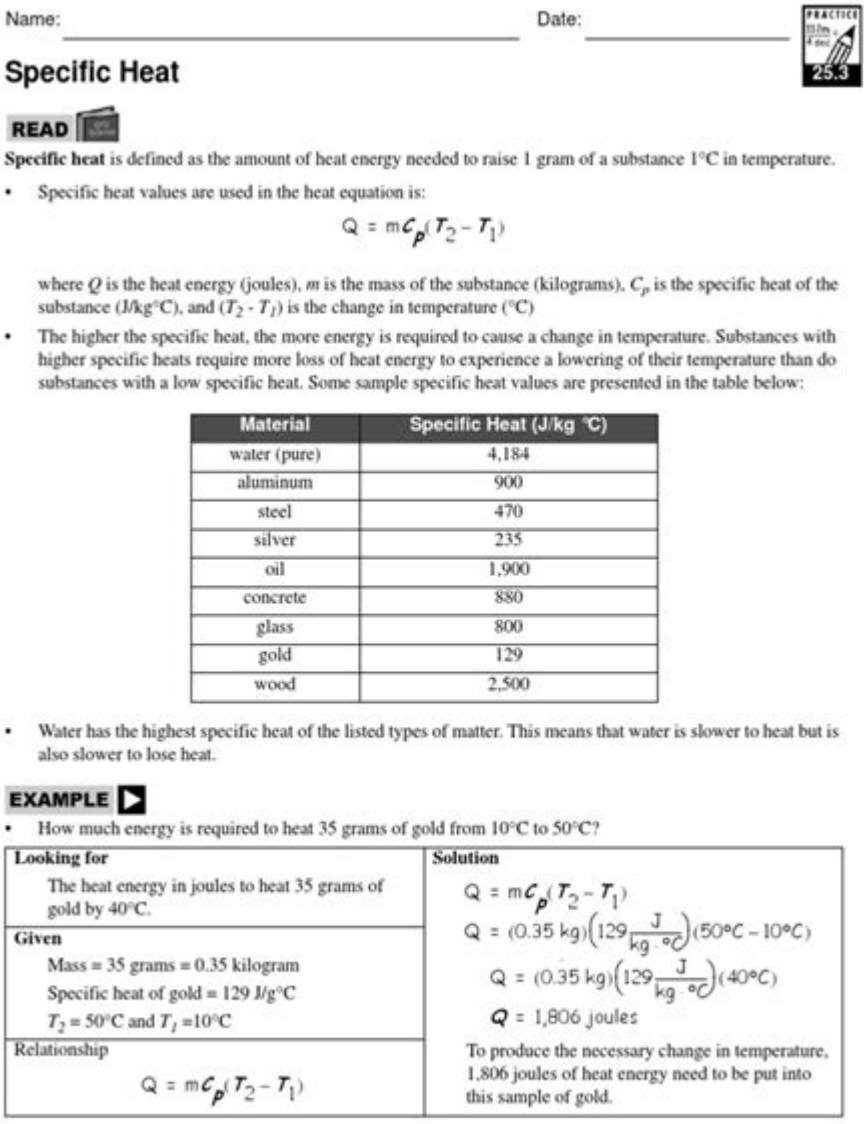
Specific Heat Lab Answer Key



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PRACTICE 25.3

Specific Heat

READ

Specific heat is defined as the amount of heat energy needed to raise 1 gram of a substance 1°C in temperature.

- Specific heat values are used in the heat equation is:

$$Q = mC_p(T_2 - T_1)$$

where Q is the heat energy (joules), m is the mass of the substance (kilograms), C_p is the specific heat of the substance (J/kg°C), and $(T_2 - T_1)$ is the change in temperature (°C)

- The higher the specific heat, the more energy is required to cause a change in temperature. Substances with higher specific heats require more loss of heat energy to experience a lowering of their temperature than do substances with a low specific heat. Some sample specific heat values are presented in the table below:

Material	Specific Heat (J/kg °C)
water (pure)	4,184
aluminum	900
steel	470
silver	235
oil	1,900
concrete	880
glass	800
gold	129
wood	2,500

- Water has the highest specific heat of the listed types of matter. This means that water is slower to heat but is also slower to lose heat.

EXAMPLE

- How much energy is required to heat 35 grams of gold from 10°C to 50°C?

Looking for	Solution
The heat energy in joules to heat 35 grams of gold by 40°C.	$Q = mC_p(T_2 - T_1)$ $Q = (0.35\ kg)\left(129\frac{J}{kg \cdot °C}\right)(50°C - 10°C)$ $Q = (0.35\ kg)\left(129\frac{J}{kg \cdot °C}\right)(40°C)$ $Q = 1{,}806$ joules
Given Mass = 35 grams = 0.35 kilogram Specific heat of gold = 129 J/g°C $T_2 = 50°C$ and $T_1 = 10°C$	To produce the necessary change in temperature, 1,806 joules of heat energy need to be put into this sample of gold.
Relationship $Q = mC_p(T_2 - T_1)$	

Specific heat lab answer key is an essential resource for students and educators engaged in the study of thermodynamics and heat transfer. Understanding the concept of specific heat is crucial for various scientific applications, as it describes how much energy is required to raise the temperature of a substance. This article will delve into the fundamentals of specific heat, provide guidelines for conducting specific heat experiments, and present a comprehensive answer key to common specific heat lab questions.

Understanding Specific Heat

Specific heat, often denoted as c, is defined as the amount of heat energy required to raise the temperature of one gram of a substance by one degree Celsius (°C). This property

varies among different materials and is a critical factor in thermal management and energy efficiency.

Formula for Specific Heat

The formula to calculate specific heat is:

$$
c = \frac{q}{m \Delta T}
$$

Where:
- c = specific heat capacity (J/g°C)
- q = heat energy (joules)
- m = mass of the substance (grams)
- ΔT = change in temperature (°C)

The Importance of Specific Heat in Experiments

Understanding specific heat is vital for numerous scientific experiments, especially those involving thermal energy transfer. Some key reasons include:

- **Material Identification:** Specific heat can help identify unknown substances based on their thermal properties.
- **Energy Calculations:** Knowing the specific heat of materials allows for precise calculations in energy transfer processes.
- **Environmental Studies:** Specific heat plays a role in understanding heat capacities of oceans, atmospheres, and ecosystems.

Conducting a Specific Heat Lab

To effectively measure the specific heat of a substance, a structured lab experiment is necessary. Here is a step-by-step guide to conducting a specific heat lab:

Materials Needed

- Calorimeter
- Heat source (e.g., hot plate)

- Thermometer
- Stopwatch
- Sample materials (e.g., metal, water)
- Balance (for measuring mass)
- Insulating materials (to minimize heat loss)

Experimental Procedure

1. Preparation:
- Measure and record the mass of the sample material using the balance.
- Fill the calorimeter with a known mass of water and record its initial temperature.

2. Heating the Sample:
- Heat the sample material to a specific temperature using the heat source.
- Use the thermometer to monitor and record the temperature of the sample.

3. Combining the Samples:
- Quickly transfer the heated sample into the calorimeter with water.
- Stir gently and continuously measure the temperature of the water until it stabilizes.

4. Record Data:
- Note the final temperature of the water and the sample.
- Calculate the temperature change (ΔT) for both the water and the metal.

Calculating Specific Heat

Using the data collected during the experiment, apply the specific heat formula:

1. Calculate the heat gained by the water (q_{water}):
$$
q_{water} = m_{water} \cdot c_{water} \cdot \Delta T_{water}
$$

2. Calculate the heat lost by the sample (q_{sample}):
$$
q_{sample} = m_{sample} \cdot c_{sample} \cdot \Delta T_{sample}
$$

3. Set $q_{water} = -q_{sample}$ to find the specific heat of the sample.

Specific Heat Lab Answer Key

Here are the answers to common questions and problems that arise during specific heat experiments:

Sample Calculation Questions

1. If 50g of water at 25°C is heated to 75°C, what is the heat gained?
- Given: $m_{water} = 50g$, $c_{water} = 4.18 J/g°C$, $\Delta T_{water} = 75°C - 25°C = 50°C$
- Calculation:
$$
q_{water} = 50g \cdot 4.18 J/g°C \cdot 50°C = 10450 J
$$

2. If a metal sample (mass = 100g) cools from 80°C to 30°C, and the heat lost is calculated to be 10450 J, what is its specific heat?
- Given: $q_{sample} = -10450 J$, $m_{sample} = 100g$, $\Delta T_{sample} = 30°C - 80°C = -50°C$
- Calculation:
$$
-10450 J = 100g \cdot c_{sample} \cdot (-50°C)
$$
$$
c_{sample} = \frac{10450 J}{100g \cdot 50°C} = 2.09 J/g°C
$$

Common Misconceptions and Errors

- Neglecting Heat Loss: One common mistake is not accounting for heat loss to the environment, which can skew results.
- Incorrect Temperature Readings: Always ensure that the thermometer is calibrated and placed correctly in the sample.
- Using Incorrect Units: Ensure that mass is in grams and temperature in degrees Celsius to maintain consistency.

Conclusion

In summary, the **specific heat lab answer key** serves as an invaluable guide for students and educators. Understanding specific heat and its calculation is foundational in the fields of physics and chemistry. By following structured procedures and learning from both calculations and common errors, students can effectively grasp the concepts of heat transfer and energy dynamics. As you conduct your experiments, remember to validate your results with this answer key and continuously refine your approach for accurate and reliable findings.

Frequently Asked Questions

What is specific heat and why is it important in experiments?

Specific heat is the amount of heat required to raise the temperature of a unit mass of a substance by one degree Celsius. It is important in experiments to understand how different materials absorb and transfer heat.

What materials are typically used in a specific heat lab experiment?

Common materials include water, metals like copper or aluminum, and sometimes non-metals, each chosen for their distinct specific heat capacities.

How do you calculate the specific heat of a substance in a lab setting?

The specific heat can be calculated using the formula: $Q = mc\Delta T$, where Q is the heat added, m is the mass, c is the specific heat, and ΔT is the change in temperature.

What is the role of a calorimeter in a specific heat lab?

A calorimeter is used to measure the amount of heat transferred during a reaction or phase change, providing an isolated environment to accurately determine specific heat.

How can errors in measurements affect the specific heat calculation?

Errors in measurements, such as inaccuracies in temperature readings or mass, can lead to incorrect values for heat capacity, resulting in skewed specific heat calculations.

What is the expected outcome of a specific heat lab experiment?

The expected outcome is to determine the specific heat of a substance and compare it with known values to verify the accuracy of the experiment.

What safety precautions should be taken during a specific heat lab?

Safety precautions include wearing goggles and gloves, handling hot materials with care, and ensuring proper ventilation when necessary.

Why might different substances have different specific heats?

Different substances have varying atomic or molecular structures, which affect how they store and conduct thermal energy, leading to different specific heats.

What is the significance of specific heat in real-world applications?

Specific heat is significant in various fields such as meteorology, cooking, engineering, and environmental science, as it influences temperature regulation and energy efficiency.

Specific Heat Lab Answer Key

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