Specific Heat Practice Problems Worksheet

Answers

$Q = mc\Delta T$, where Q = heat energy, m = mass, and ΔT = change in temp.
Remember, **$\Delta T = (T_{final} - T_{initial})$**. Show all work and proper units.

1. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.

$$C = \frac{Q}{m(T_f - T_i)} = \frac{1086.75}{15.75(175-25)} = 0.46\ J/g°C$$

2. How many joules of heat are needed to raise the temperature of 10.0 g of aluminum from 22°C to 55°C, if the specific heat of aluminum is 0.90 J/g°C?

$$Q = mC(T_f - T_i) = 10.0g\ (0.90J/g°C)(55-22) = 297\ J$$

3. Calculate the specific heat capacity of a piece of wood if 1500.0 g of the wood absorbs 67,500 joules of heat, and its temperature changes from 32°C to 57°C.

$$C = \frac{Q}{m(T_f - T_i)} = \frac{67500\ J}{(1500\ g)(57-32)} = 1.8\ J/g°C$$

4. 100.0 g of 4.0°C water is heated until its temperature is 37°C. Calculate the amount of heat energy needed to cause this rise in temperature.

$$Q = mC(T_f - T_i) = 100g(4.184J/g°C)(37 - 4) = 14000\ J$$

5. 25.0 g of mercury is heated from 25°C to 155°C, and absorbs 455 joules of heat in the process. Calculate the specific heat capacity of mercury.

$$C = \frac{Q}{m(T_f - T_i)} = \frac{455\ J}{(25g)(155-25)} = 0.14\ J/g°C$$

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Specific heat practice problems worksheet are essential tools for students and educators alike, helping to reinforce the fundamental concepts of heat transfer in physical science. Understanding specific heat capacity is crucial for students studying physics and chemistry as it lays the groundwork for more advanced topics. This article will delve into the importance of specific heat, provide a variety of practice problems, and offer solutions to help solidify your understanding of this vital concept.

What is Specific Heat?

Specific heat, often denoted as c, is the amount of heat required to raise the temperature of one gram of a substance by one degree Celsius (°C). It varies from substance to substance, which is why different materials respond differently to heat.

Formula for Specific Heat

The relationship between heat transfer, specific heat, mass, and temperature change is expressed by the formula:

$$
Q = mc\Delta T
$$

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

Why Practice with Specific Heat Problems?

Practicing specific heat problems is vital for various reasons:

- **Reinforcement of Concepts:** Regular practice helps solidify theoretical knowledge.
- **Problem-Solving Skills:** Working through problems enhances critical thinking and analytical skills.
- **Application of Knowledge:** Applying formulas in real-world scenarios helps students understand practical applications.
- **Exam Preparation:** Practicing problems prepares students for exams and quizzes, where such questions are common.

Types of Specific Heat Problems

There are several types of specific heat problems that students can encounter. Here are a few categories:

1. Calculating Heat Transfer

These problems involve calculating the heat absorbed or released by a substance when its temperature changes.

2. Finding Specific Heat Capacity

In these problems, students are given heat transfer, mass, and temperature change, and they must solve for the specific heat capacity.

3. Applying Specific Heat in Mixtures

These problems may involve two or more substances reaching thermal equilibrium, requiring students to set up equations based on conservation of energy.

4. Phase Changes

Some problems may delve into situations where substances undergo phase changes, requiring students to account for the heat associated with these transformations.

Sample Specific Heat Practice Problems

Here are some practice problems for students to work on, along with their solutions.

Problem 1: Calculating Heat Transfer

A 100 g sample of water is heated from 25°C to 75°C. Calculate the heat absorbed by the water. (Specific heat of water = 4.18 J/g°C)

Problem 2: Finding Specific Heat Capacity

A metal block weighing 200 g absorbs 5000 J of heat and its temperature increases from 20°C to 80°C. Calculate the specific heat capacity of the metal.

Problem 3: Mixtures

You mix 150 g of water at 80°C with 100 g of water at 20°C. Assuming no heat loss to the surroundings, what is the final temperature of the mixture?

Problem 4: Phase Change

If 50 g of ice at 0°C is added to 200 g of water at 80°C, what will be the final temperature of the system? (Specific heat of water = 4.18 J/g°C, heat of fusion of ice = 334 J/g)

Solved Problems with Explanations

Now, let's go through the solutions to the problems presented above.

Solution to Problem 1

Given:
- Mass (m) = 100 g
- Specific heat (c) = 4.18 J/g°C
- Initial temperature (T_i) = 25°C
- Final temperature (T_f) = 75°C

Calculate the change in temperature (ΔT):
$$
\Delta T = T_f - T_i = 75°C - 25°C = 50°C
$$

Now, using the formula $Q = mc\Delta T$:
$$
Q = (100 \text{ g})(4.18 \text{ J/g°C})(50°C) = 20900 \text{ J}
$$

The heat absorbed by the water is 20900 J.

Solution to Problem 2

Given:

- Mass (m) = 200 g
- Heat (Q) = 5000 J
- Initial temperature (T_i) = 20°C
- Final temperature (T_f) = 80°C

Calculate ΔT:

$$
\Delta T = T_f - T_i = 80°C - 20°C = 60°C
$$

Using the formula $Q = mc\Delta T$:

$$
5000 = (200)(c)(60)
$$

$$
c = \frac{5000}{200 \times 60} = \frac{5000}{12000} \approx 0.417 \text{ J/g°C}
$$

The specific heat capacity of the metal is approximately 0.417 J/g°C.

Solution to Problem 3

Let T_f be the final temperature.

Using the formula for heat transfer:

$$
Q_{\text{lost}} = Q_{\text{gained}}
$$

$$
m_1c(T_i - T_f) = m_2c(T_f - T_i)
$$

For water:
- $m_1 = 150$ g, $T_i = 80°C$
- $m_2 = 100$ g, $T_i = 20°C$

Setting the equations:

$$
150(80 - T_f) = 100(T_f - 20)
$$

$$
12000 - 150T_f = 100T_f - 2000
$$

$$
14000 = 250T_f
$$

$$
T_f = \frac{14000}{250} = 56°C

The final temperature of the mixture is 56°C.

Solution to Problem 4

The heat required to melt the ice is:

$$
Q_{\text{melt}} = m_{\text{ice}} \times \text{heat of fusion} = (50 \text{ g})(334 \text{ J/g}) = 16700 \text{ J}
$$

The heat lost by the water is:

$$
Q_{\text{water}} = m_{\text{water}} \times c \times \Delta T = (200 \text{ g})(4.18 \text{ J/g°C})(80°C - T_f)
$$

Setting the heat lost equal to the heat gained:

$$
200 \times 4.18 \times (80 - T_f) = 16700
$$

$$
836 \times (80 - T_f) = 16700
$$

$$
80 - T_f = \frac{16700}{836} \approx 19.98
$$

$$
T_f \approx 60.02°C
$$

The final temperature of the system is approximately 60.02°C.

Conclusion

Specific heat practice problems worksheets are invaluable resources for mastering the principles of heat transfer. By engaging with a variety of problems ranging from calculating heat transfer to understanding phase changes, students can enhance their comprehension and application of specific heat. Regular practice not only builds a solid foundation in physical science but also equips students with the problem-solving skills necessary for more advanced studies in the field.

Frequently Asked Questions

What is specific heat capacity?

Specific heat capacity is the amount of heat required to raise the temperature of one gram of a substance by one degree Celsius.

How do you calculate the heat energy absorbed or released?

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

What units are used for specific heat capacity?

The specific heat capacity is typically expressed in units of joules per gram per degree Celsius (J/g°C) or calories per gram per degree Celsius (cal/g°C).

Why is it important to understand specific heat in real-world applications?

Understanding specific heat is crucial in fields like cooking, material science, and environmental science, as it helps predict how substances will react to heat and temperature changes.

What is the specific heat capacity of water?

The specific heat capacity of water is approximately 4.18 J/g°C, making it one of the highest specific heat capacities of any substance.

How would you set up a specific heat practice problem involving metals?

To set up a specific heat practice problem involving metals, you would need the mass of the metal, its specific heat capacity, and the initial and final temperatures to calculate the heat absorbed or released.

Can the specific heat capacity vary with temperature?

Yes, the specific heat capacity can vary with temperature, especially for gases and some solids, so it's important to use the specific heat value that corresponds to the temperature range of interest.

What is a common mistake when solving specific heat

problems?

A common mistake is forgetting to convert units appropriately, such as mass from grams to kilograms or temperature from Celsius to Kelvin, which can lead to incorrect calculations.

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The words "special" and "specific" are often used interchangeably, but there are some subtle differences in meaning between them. Both words can be used to describe people or things that are unique, but "special" usually refers to something that is positive or desirable, while "specific" can be either positive or negative.

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