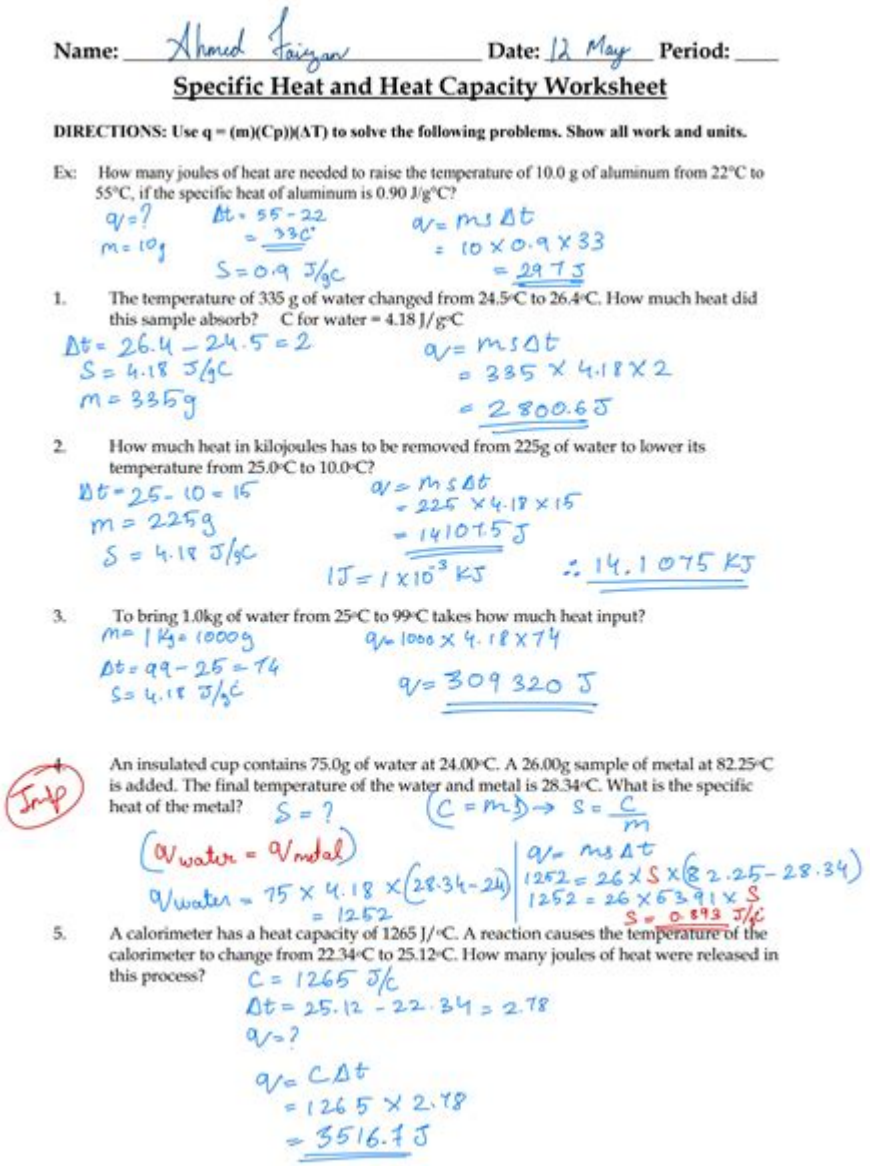
Specific Heat And Heat Capacity Worksheet



Name: Ahmed Faizan Date: 12 May Period: ____

Specific Heat and Heat Capacity Worksheet

DIRECTIONS: Use q = (m)(Cp)(ΔT) to solve the following problems. Show all work and units.

Ex: 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=? Δt = 55-22 = 33°C q = mSΔt = 10 × 0.9 × 33 = 297 J
m = 10g S = 0.9 J/g°C

1. The temperature of 335 g of water changed from 24.5°C to 26.4°C. How much heat did this sample absorb? C for water = 4.18 J/g°C

Δt = 26.4 − 24.5 = 2 q = mSΔt = 335 × 4.18 × 2 = 2800.6 J
S = 4.18 J/g°C
m = 335g

2. How much heat in kilojoules has to be removed from 225g of water to lower its temperature from 25.0°C to 10.0°C?

Δt = 25 − 10 = 15 q = mSΔt = 225 × 4.18 × 15 = 14107.5 J
m = 225g
S = 4.18 J/g°C
1J = 1 × 10⁻³ KJ ∴ 14.1075 KJ

3. To bring 1.0kg of water from 25°C to 99°C takes how much heat input?

m = 1Kg = 1000g q = 1000 × 4.18 × 74
Δt = 99 − 25 = 74 q = 309320 J
S = 4.18 J/g°C

Imp

An insulated cup contains 75.0g of water at 24.00°C. A 26.00g sample of metal at 82.25°C is added. The final temperature of the water and metal is 28.34°C. What is the specific heat of the metal? S = ? (C = mS → S = C/m)

(q water = q metal)
q water = 75 × 4.18 × (28.34 − 24) = 1252
q = mSΔt
1252 = 26 × S × (82.25 − 28.34)
1252 = 26 × 53.91 × S
S = 0.893 J/g°C

5. A calorimeter has a heat capacity of 1265 J/°C. A reaction causes the temperature of the calorimeter to change from 22.34°C to 25.12°C. How many joules of heat were released in this process?

C = 1265 J/°C
Δt = 25.12 − 22.34 = 2.78
q = ?
q = CΔt = 1265 × 2.78 = 3516.7 J

Specific heat and heat capacity worksheet serve as essential educational tools in understanding the fundamental concepts of thermodynamics, particularly how substances absorb and transfer heat. This worksheet is instrumental in helping students grasp the principles of specific heat and heat capacity, which play significant roles in various scientific applications, from climate science to engineering. In this article, we will delve into the definitions, formulas, and applications of specific heat and heat capacity, along with practical examples and exercises to reinforce learning.

Understanding Specific Heat and Heat Capacity

Definitions

- Specific Heat (c): Specific heat is defined as the amount of heat required to raise the temperature of a unit

mass of a substance by one degree Celsius (°C) or Kelvin (K). It is an intrinsic property of the material and varies from substance to substance. The formula is expressed as:

$$
Q = mc\Delta T
$$

where:
- Q = heat added or removed (in joules)
- m = mass of the substance (in kilograms)
- c = specific heat (in J/kg°C)
- ΔT = change in temperature (in °C or K)

- Heat Capacity (C): Heat capacity is the amount of heat energy required to change the temperature of an entire object by one degree Celsius (°C) or Kelvin (K). It is dependent on both the mass and the specific heat of a substance. For an object, the heat capacity can be expressed as:

$$
C = mc
$$

where C is the heat capacity (in joules per degree Celsius) and m is the mass.

Units of Measurement

The units of specific heat and heat capacity are crucial for calculations:

- Specific Heat: Typically measured in joules per kilogram per degree Celsius (J/kg°C).
- Heat Capacity: Measured in joules per degree Celsius (J/°C).

The Importance of Specific Heat and Heat Capacity

Understanding specific heat and heat capacity is vital for several reasons:

1. Thermal Management: In engineering, specific heat is essential for designing systems that manage heat, such as heating and cooling systems in buildings or engines.
2. Environmental Studies: In climate science, the specific heat of water plays a critical role in regulating Earth's temperature and climate patterns.
3. Material Selection: In material science, knowledge of specific heat helps engineers select appropriate materials for thermal insulation or heat exchangers.
4. Energy Storage: Understanding specific heat is also crucial in developing materials for energy storage systems, such as batteries and thermal energy storage.

Calculating Specific Heat and Heat Capacity

Example Calculations

Let's consider a practical example to illustrate how to calculate specific heat and heat capacity.

Example 1: A 2 kg piece of aluminum is heated from 25°C to 75°C. Given that the specific heat of aluminum is

900 J/kg°C, calculate the heat absorbed by the aluminum.

1. Identify the values:
- Mass (m) = 2 kg
- Specific Heat (c) = 900 J/kg°C
- Initial Temperature (T_i) = 25°C
- Final Temperature (T_f) = 75°C
- Change in Temperature (ΔT) = $T_f - T_i = 75°C - 25°C = 50°C$

2. Use the formula $Q = mc\Delta T$:
$$
Q = 2 \, \text{kg} \times 900 \, \text{J/kg°C} \times 50°C = 90,000 \, \text{J}
$$

Thus, the aluminum piece absorbs 90,000 Joules of heat.

Example 2: Calculate the heat capacity of a 5 kg iron block with a specific heat of 450 J/kg°C.

1. Use the formula $C = mc$:
$$
C = 5 \, \text{kg} \times 450 \, \text{J/kg°C} = 2250 \, \text{J/°C}
$$

This means the heat capacity of the iron block is 2250 Joules per degree Celsius.

Practice Problems

To reinforce your understanding of specific heat and heat capacity, try solving the following problems:

1. A 3 kg block of copper is heated from 20°C to 80°C. The specific heat of copper is 385 J/kg°C. Calculate the heat absorbed by the block.

2. Determine the heat capacity of a 10 kg piece of water, knowing that the specific heat of water is 4186 J/kg°C.

3. If a substance with a specific heat of 2000 J/kg°C absorbs 3000 J of heat, and its mass is 1 kg, what is the change in temperature?

4. A 2.5 kg piece of glass is heated from 15°C to 45°C. The specific heat of glass is 840 J/kg°C. How much heat is required?

Common Misconceptions

While studying specific heat and heat capacity, students often fall prey to several misconceptions:

- Specific Heat vs. Heat Capacity: Many confuse these two terms. Remember that specific heat is per unit mass, while heat capacity refers to the entire object.
- Higher Mass Means Higher Heat Capacity: While it's true that larger mass results in higher heat capacity, specific heat remains an intrinsic property, regardless of mass.
- Assuming All Materials Have the Same Specific Heat: Different materials have unique specific heats, which affect how they respond to heat.

Conclusion

A specific heat and heat capacity worksheet provides students and educators a structured approach to understanding thermodynamic principles. By exploring definitions, calculations, and real-world applications, learners can develop a comprehensive grasp of these essential concepts. Through practice problems and addressing common misconceptions, students can enhance their knowledge and readiness for advanced studies in physics, chemistry, and engineering. Understanding these principles is crucial not just in academics, but also in real-life applications across various fields, from environmental science to engineering practices.

Frequently Asked Questions

What is the difference between specific heat and heat capacity?

Specific heat is the amount of heat required to raise the temperature of a unit mass of a substance by one degree Celsius, while heat capacity is the total amount of heat required to raise the temperature of a substance by one degree Celsius, independent of its mass.

How do you calculate the specific heat of a substance using a worksheet?

To calculate specific heat using a worksheet, you typically use the formula: specific heat (c) = Q / (m ΔT), where Q is the heat added, m is the mass of the substance, and ΔT is the change in temperature.

What units are used for specific heat and heat capacity?

Specific heat is usually expressed in joules per gram per degree Celsius (J/g°C) or calories per gram per degree Celsius (cal/g°C), while heat capacity is expressed in joules per degree Celsius (J/°C) or calories per degree Celsius (cal/°C).

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

Understanding specific heat is crucial in various applications such as climate science, cooking, material selection, and thermal management in engineering, as it helps predict how substances will react to heat changes.

What is the significance of a substance having a high specific heat?

A substance with a high specific heat can absorb a lot of heat without a significant increase in temperature, which makes it effective for temperature regulation, like in the case of water in climate control.

How can a specific heat and heat capacity worksheet help students?

A worksheet on specific heat and heat capacity helps students practice calculations, reinforces concepts through problem-solving, and enhances their understanding of thermal properties of materials.

What common mistakes should students avoid when completing a specific heat worksheet?

Students should avoid common mistakes such as confusing specific heat with heat capacity, neglecting the correct units, and miscalculating the temperature change (ΔT) by not using the final minus initial temperature correctly.

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