Heat Of Fusion Practice Problems


Heat of Fusion and Heat of Vaporization Worksheet

Heat of fusion practice problems are essential in understanding the phase change processes of substances, especially when they transition from solid to liquid states. This concept is crucial in various fields, including chemistry, physics, and engineering, as it provides insights into how materials behave under different temperature and pressure conditions. The heat of fusion is defined as the amount of energy required to change a substance from a solid to a liquid at its melting point without changing its temperature. This article will delve into the fundamentals of heat of fusion, provide illustrative practice problems, and offer solutions to enhance comprehension.

Understanding Heat of Fusion

Before diving into practice problems, it's essential to grasp the concept of heat of fusion.

Definition and Significance

- Heat of Fusion: The heat of fusion (ΔH_{fus}) is the specific amount of energy (usually measured in joules or calories per gram) needed to convert a unit mass of a solid into a liquid at constant temperature and pressure.

- Melting Point: This is the temperature at which a solid becomes a liquid. The heat of fusion is specifically measured at this point.
- Phase Changes: The heat of fusion is crucial for understanding phase changes, which are vital in applications such as:
- Ice melting in warmer environments
- The operation of refrigeration systems
- The behavior of materials in engineering designs

Formula for Heat of Fusion

The formula to calculate the heat absorbed or released during the phase change is:

$$ Q = m \cdot \Delta H_{fus} $$

Where:
- $ Q $ = heat energy (in joules or calories)
- $ m $ = mass of the substance (in grams)
- $ \Delta H_{fus} $ = heat of fusion (in joules/gram or calories/gram)

Practice Problems

Now that we have a solid understanding of the heat of fusion, let's explore some practice problems to solidify this knowledge.

Problem 1: Melting Ice

Problem Statement: How much heat is required to melt 200 grams of ice at 0°C? Given that the heat

of fusion for ice is 334 J/g.

Solution Steps:

1. Identify the mass of ice: $m = 200 \, \text{g}$
2. Identify the heat of fusion for ice: $\Delta H_{fus} = 334 \, \text{J/g}$
3. Use the formula:

$$
Q = m \cdot \Delta H_{fus}
$$

$$
Q = 200 \, \text{g} \cdot 334 \, \text{J/g}
$$

$$
Q = 66800 \, \text{J}
$$

Answer: 66800 J of heat is required to melt 200 grams of ice.

Problem 2: Freezing Water

Problem Statement: If 150 grams of water at 0°C freezes, how much heat is released? The heat of fusion for water is also 334 J/g.

Solution Steps:

1. Identify the mass of water: $m = 150 \, \text{g}$
2. Identify the heat of fusion for water: $\Delta H_{fus} = 334 \, \text{J/g}$
3. Calculate the heat released during freezing:

$$
Q = m \cdot \Delta H_{fus}
$$

$$
Q = 150 \, \text{g} \cdot 334 \, \text{J/g}
$$

$$
Q = 50100 \, \text{J}
$$

Answer: 50100 J of heat is released when 150 grams of water freezes.

Problem 3: Heating a Solid

Problem Statement: A 250-gram block of lead at 327°C is melted. The heat of fusion for lead is 24.7 J/g. How much heat is needed?

Solution Steps:

1. Identify the mass of lead: $m = 250 \, \text{g}$
2. Identify the heat of fusion for lead: $\Delta H_{fus} = 24.7 \, \text{J/g}$
3. Calculate the heat required:

$$
Q = m \cdot \Delta H_{fus}
$$

$$
Q = 250 \, \text{g} \cdot 24.7 \, \text{J/g}
$$

$$
Q = 6175 \, \text{J}
$$

Answer: 6175 J of heat is needed to melt the 250-gram block of lead.

Problem 4: Ice and Water Mixture

Problem Statement: A mixture contains 100 grams of ice at 0°C and 200 grams of water at 0°C. What is the final temperature of the mixture after the ice melts? (Assume no heat loss to the environment and that the heat of fusion for ice is 334 J/g.)

Solution Steps:

1. Calculate the heat required to melt 100 grams of ice:

$$
Q = m \cdot \Delta H_{fus}
$$

$$
Q = 100 \, \text{g} \cdot 334 \, \text{J/g}
$$

$$
Q = 33400 \, \text{J}
$$

2. The water portion has 200 grams at 0°C, which can release heat as the ice melts.

3. The total heat released by the water:

- Since the water doesn't change temperature (it remains at 0°C), all of its heat will go into melting the ice.

- The 200 grams of water can release:

$$
Q = m \cdot c \cdot \Delta T
$$

Where c is the specific heat of water (4.18 J/g°C), and ΔT is the change in temperature, which is initially 0°C.

- Since the water temperature remains the same, it can only provide enough energy to melt the ice.

4. Since the ice requires 33400 J to melt, and the water can provide only a limited amount of energy

at the same temperature, all the ice will melt, and the final temperature of the mixture will remain at 0°C.

Answer: The final temperature of the mixture is 0°C.

Conclusion

In conclusion, heat of fusion practice problems serve as a valuable tool for understanding the energy changes involved in phase transitions. By familiarizing yourself with the concepts of heat of fusion, melting points, and the relevant formulas, you can solve a variety of problems related to the melting and freezing of substances. Through practice, you can develop a deeper comprehension of thermodynamics that will be beneficial in academic and professional settings. Whether you are a student studying chemistry or a professional working in engineering, mastering these concepts will enhance your analytical skills and practical understanding of material properties.

Frequently Asked Questions

What is the heat of fusion?

The heat of fusion is the amount of energy required to change a substance from a solid to a liquid at its melting point without changing its temperature.

How do you calculate the heat absorbed during melting?

To calculate the heat absorbed during melting, use the formula Q = m Lf, where Q is the heat absorbed, m is the mass of the substance, and Lf is the heat of fusion.

What is the heat of fusion for water?

The heat of fusion for water is approximately 334 joules per gram (J/g).

If 50 grams of ice melts, how much heat is absorbed?

The heat absorbed would be Q = 50 g 334 J/g = 16,700 joules.

What happens to the temperature of a substance during the phase change at the heat of fusion?

During the phase change at the heat of fusion, the temperature of the substance remains constant until the entire solid has melted into a liquid.

Can the heat of fusion be negative?

Yes, the heat of fusion can be considered negative when calculating the heat released during the solidification of a liquid.

How does pressure affect the heat of fusion?

Generally, increasing pressure can influence the heat of fusion, but the effect varies depending on the substance. For most solids, a higher pressure increases the heat of fusion.

What is the difference between heat of fusion and heat of vaporization?

The heat of fusion is the energy required to melt a solid into a liquid, while the heat of vaporization is the energy required to convert a liquid into a gas.

How do you determine the mass of a substance from its heat of fusion?

You can determine the mass by rearranging the heat equation: m = Q / Lf, where Q is the heat absorbed and Lf is the heat of fusion.

What are some real-life applications of the heat of fusion?

Real-life applications include ice melting in drinks, the design of thermal energy storage systems, and understanding climate processes like ice cap melting.

Heat Of Fusion Practice Problems

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