Hello Fellow Physicists,

I am Aman Patel, the Master Tutor for Physics this semester. To help you on your journey to learn about this wonderful branch of science and the understanding it gives us of the world around us, I will be preparing this resource every week to give you an additional tool to better prepare for your week. I will also be conducting Group Tutoring sessions every week, the information for which will be given below. If you are unable to attend group tutoring, the tutoring center also offers one-on-one tutoring session, so be sure to visit the tutoring center or visit https://baylor.edu/tutoring.

PHY 1408/1420 General Physics 1 Group Tutoring sessions will be held every Wednesday from 6:45-7:45 pm in the Sid Richardson building basement, Room 74. See you there!

In the past two weeks, your professors will have covered sound. This week, you will finish studying temperature and ideal gas law.

**Keywords:** Heat, Thermal Expansion, Specific Heat, Latent Heat

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**Heat:**

Heat is the transfer of energy for one object to another because of a difference in temperature. The important distinction to remember between temperature and heat is that heat can flow from object to object. One of the commonly used quantization’s of heat is calorie. A calorie is the amount of heat required to raise the of water by one degree Celsius. Calorie (with a capital C) is actually kilocalories.

\[
4.186 \text{ J} = 1 \text{ cal};
\]
\[
4.186 \text{ kJ} = 1 \text{ kcal}
\]

The SI unit of heat is Joule.

The total energy of all the molecules of an object is that objects internal or thermal energy. These distinctions are extremely important in thermodynamics.
**Specific Heat**

The specific heat of an object is the energy required per kilogram to change the temperature of the object by 1°C. This is a value that is unique for different substances. This is important because it allows us to find the amount heat that is needed to change the temperature of these substances based on the scenarios of use. We use the following equation to calculate the heat.

\[ Q = mc \Delta T \]

**Calorimetry**

When are looking at these systems, we are considering them to be closed and isolated systems, we assume that no energy passes in and out of the boundary of the system we define. When different parts of the system have different temperatures, heat will flow in the system until it reaches thermal equilibrium. In an isolated system, the energy is conserved. So, the heat out is equal to the heat in. Or \( \sum Q = 0 \) for the isolated system. This is the basis of calorimetry. We use an isolated system where the object is present in water at a known temperature and a calorimeter with a known specific heat. So based on the heat exchanged, unknown objects can be identified.

**Example:**

An engineer wishes to determine the specific heat of a new metal alloy. A 0.150-kg sample of the alloy is heated to 540°C. It is then quickly placed in 0.400 kg of water at 10.0°C, which is contained in a 0.200-kg aluminum calorimeter cup. The final temperature of the system is 30.5°C. Calculate the specific heat of the alloy

**Solution:**

when you first start the problem, begin with the basic premise of isolated systems

Heat out = Heat in

Heat out is the thermal energy lost by the hotter object and heat in is the heat absorbed by the other object.

\[ Q_{\text{alloy}} = Q_{\text{water}} + Q_{\text{calorimeter}} \]

\[ -M_c(T_f - T_i) = M_c(T_f - T_i) + M_{\text{water}}(T_f - T_i) \]

All Images are from Physics: Principles with Applications (7th Edition) by Douglas C. Giancoli
- \( (0.15) c_a(30.5 - 540) = (0.4)(4186)(30.5-10) + (0.2)(900)(30.5 - 10) \)

\[ C_a = \frac{38015.2}{(0.15)(540 - 30.5)} \]

\[ C_a = 497 \text{ J/kg.C°} \]

**Latent Heat**

The increase and decreases in the temperature of a substance is governed by the specific heat of the substance. But when the material undergoes a phase change, it requires heat to break the bonds between the molecules to change the phase of the material. This heat absorbed does not change the temperature of the material, only its phase. This heat is called latent heat. The heat required to go from solid to liquid and liquid to gas are specific to the material. The latent heat required to go from solid to liquid is called the heat of fusion. The latent heat required to go from liquid to gas is called the heat of vaporization. When the object is at its melting point and boiling point, these latent heats are required.

The behavior of the temperature of the material when heated is best represented by the graph above. This behavior relates to other materials as well, just at different temperature and with different heat.
Example

How much energy does a freezer have to remove from 1.5 kg of water at 20°C to make ice at -12°C?

Solution

\[ Q = Q_{0-20°C} + Q_{\text{fusion}} + Q_{0-(-12)°C} \]

\[ = m c_w (T_f - T_i) + mL_f + m c_i (T_f - T_i) \]

\[ = (1.5)(4186)(20 - 0) + (1.5)(333000) + (1.5)(2100)(0-(-12)) \]

\[ = 662880 \text{ J} \]

CHECK YOUR LEARNING

1. To what temperature will 4000 J of heat raise 1 kg of water that is initially at 1°C?
2. What specific heat of a metal substance if 120 kJ of heat is needed to raise 2 kg of the metal form 25 C to 37 C?
3. A cube of ice is taken from the freezer at -20°C and placed in an 100-g aluminum calorimeter filled with 200 g of water at room temperature of 25°C. the final situation is all water at 19°C. what was the mass of the cube?

THINGS YOU MAY STRUGGLE WITH

1. The distinction between temperature, internal energy and heat. Remember, the internal energy describes all the energy of the molecules present in the system. Temperature is the average kinetic energy of the system. Heat is the transfer of energy. That means, whenever energy is moving, it is heat. This is an important distinction.
2. Latent heat is another addition to thermal systems that makes heat confusing. Remember that latent heat applies every time the phase of matter changes, which is whenever the temperature reaching the boiling point and melting point. The heat of fusion applies for the melting point and the heat of vaporization applies for the boiling point. Both of these are dependent on mass. The changes in in temperature has to happen in a range. And breaking points are the melting and boiling points, which is when you get to use the specific heat equation.

I hope you have a wonderful week! Please feel free to reach out to me if you have any questions and check out all the resources the Tutoring Center has to offer at: https://baylor.edu/tutoring.

Answers: 1) 1.96 °C 2) 5000 J/(kg°C) 3) 12.3 kg

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