Heat and Temperature

Please go to the following link to complete this worksheet!

<http://zonalandeducation.com/mstm/physics/mechanics/energy/heatAndTemperature/changesOfPhase/changeOfState.html>

The term 'change of phase' means the same thing as the term '--------------------.

When a substance changes from one state, or phase, of matter to another we say that it has\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or we say that it has undergone a change\_\_\_\_\_\_\_\_\_\_\_\_\_\_. For example, ice melts and becomes water; water evaporates and becomes water vapor.

These changes of phase always occur with a change of\_\_\_\_\_. Heat, which is\_\_\_\_\_\_\_, either comes into the material during a change of phase or heat comes out of the material during this change. However, although the heat content of the material changes, the temperature does\_\_\_\_\_\_.

The five changes of phase are:

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| **Description of Phase Change** | **Term for Phase Change** | **Heat Movement During Phase Change** | **Temperature Change During Phase Change** |
| Solid to liquid | \_\_\_\_\_\_\_\_\_\_\_ | Heat goes \_\_\_\_\_\_ the solid as it melts. | \_\_\_\_\_\_\_\_\_\_ |
| Liquid to soli | \_\_\_\_\_\_\_\_\_\_\_\_ | Heat l\_\_\_\_\_\_\_ the liquid as it freezes. | \_\_\_\_\_\_\_\_\_\_\_ |
| Liquid to gas | \_\_\_\_\_\_\_\_\_\_\_\_\_ | Heat goes \_\_\_\_\_\_ the liquid as it vaporizes. | \_\_\_\_\_\_\_\_\_\_\_ |
| Gas to liquid | \_\_\_\_\_\_\_\_\_\_\_ | Heat \_\_\_\_\_\_\_\_\_ the gas as it condenses. | \_\_\_\_\_\_\_\_\_\_\_\_ |
| Solid to gas | \_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Heat goes \_\_\_\_\_\_the solid as it sublimates. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

How could there be a change in heat during a state change without a change in temperature?

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If heat is coming into a substance during a phase change, then this energy is used to \_\_\_\_\_\_\_\_\_\_ the bonds between the molecules of the substance. The example we will use here is ice melting into water. Immediately after the molecular bonds in the ice are broken the molecules are moving (vibrating) at the same average speed as before, so their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ remains the same, and, thus, their Kelvin temperature remains the same.

In the ice the molecules are strongly bonded to one another, thus forming a rigid solid. When heat is \_\_\_\_\_\_\_\_\_ to the ice these \_\_\_\_\_\_\_\_\_\_ are broken and the ice melts. The molecules afterward bond to one another with less strength and a different geometry, and water is formed.

After the melting the water molecules are still\_\_\_\_\_\_\_\_\_. And they have the same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ as they had before the melting. So, the water is at the same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_at the moment after the melting that the ice was at the moment before the melting.

Heat came into the situation, but it was not used to change the kinetic energy of the molecules. It was used to change the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ between the molecules. Breaking the bonds between the molecules of the ice requires \_\_\_\_\_\_\_\_\_, and this energy is the added \_\_\_\_\_\_\_\_\_.

Heat is not temperature.

Temperature is a \_\_\_\_\_\_\_\_\_\_\_\_. That number is related to energy, but it is not \_\_\_\_\_\_\_\_\_\_\_ itself.

Temperature is a number that is related to the average [kinetic energy](http://zonalandeducation.com/mstm/physics/mechanics/energy/kineticEnergy/kineticEnergy.html) of the molecules of a substance.

Read that last sentence carefully. It does not say that temperature ***is***\_\_\_\_\_\_\_\_\_\_\_\_, nor does it state exactly what the relation between temperature and kinetic energy is.

Here is the relation:

If temperature is measured in Kelvin degrees, then the value of temperature is directly proportional to the average kinetic energy of the molecules of a substance. Note that temperature is not \_\_\_\_\_\_\_\_, it is a number\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_to a type of energy.

Heat, on the other hand, is actual\_\_\_\_\_\_\_\_\_ measured in Joules or other energy units. Heat is a measurement of some of the energy in a substance. When you add heat to a substance, you are adding \_\_\_\_\_\_\_\_\_\_\_ to the substance. This added heat (energy) is ***usually*** expressed as an increase in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of the substance. If the heat (energy) is used to change the state of the substance, say by melting it, then the added energy is used to break the\_\_\_\_\_\_\_\_\_\_\_\_\_ between the molecules rather than changing their kinetic energy.

Heat is \_\_\_\_\_\_\_\_\_. When you add heat to a substance, you are adding energy.

When heat (energy) goes into a substance one of two things can happen:

1.

2.

**For the Student**

**Lesson**

**Background**

The three states of matter are solid, liquid, and gas. To change from one state to another, energy is either added to or removed from the system. In this investigation, you will look at heating up water. Does that involve adding or removing energy? Explain.

In the squares below, draw how you think particles are arranged in the three states. Use spheres to represent the particles and label each box with the state it represents.

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When changing from one state to another, what happens to particles in terms of energy?

**Procedure**

1. Visit [teachchemistry.org/heating-curve](https://www.teachchemistry.org/content/aact/en/periodical/simulations/heating-curve-of-water.html).
2. On the heating curve above, label the states of matter. Include the state changes.
3. Choose an initial point on the graph. This is your starting temperature/state. Choose a second point that is the same state. Draw the two particle diagrams in the squares. Explain why the diagrams look the way they do.

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1. Calculate the energy required to heat up 65.0 mL of the sample. Show your work.  
     
   Verify your answer by clicking “Calculate.”
2. Choose an initial point on the graph. This is your starting temperature/state. Choose a second point that is a different state. Draw the two particle diagrams in the squares. Explain why the diagrams look the way they do.

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1. Calculate the energy required for 30.0 mL of water to undergo this state change.  
     
   Verify your answer by clicking “Calculate.”
2. Pick a point on the ice part of the heating curve. Click on a point about 75 oC warmer. What state is this?\_\_\_\_\_\_\_\_\_ Record the T1 and T2 values. How much energy is required to heat 15.0 g ice to T2? Show your work.

|  |  |
| --- | --- |
| T 1    T 2 | \_\_\_\_\_\_\_\_\_\_\_    \_\_\_\_\_\_\_\_\_\_\_ |

1. Pick a point on the liquid part of the heating curve. Click on a point about 75 oC warmer. What state is this? \_\_\_\_\_\_\_\_\_ Record the T1 and T2 values. How much energy is required to heat 15.0 mL of water to T2? Show your work.

|  |  |
| --- | --- |
| T 1    T 2 | \_\_\_\_\_\_\_\_\_\_\_    \_\_\_\_\_\_\_\_\_\_\_ |

1. Why are your answers to questions 7 and 8 not the same? Explain.

**HEATING CURVE OF WATER LAB: Freezing, Melting, and Boiling of Water**  
  
Freezing temperature, the temperature at which a substance turns from liquid to solid, and melting temperature, the temperature at which a substance turns from a solid to a liquid, are characteristic physical properties. In this experiment, the cooling and warming behavior of a familiar substance, water, will be investigated. By examining graphs of the data, the freezing and melting temperatures of water will be determined and compared.  
  
**OBJECTIVES**  
In this experiment, you will  
• Collect temperature data during the freezing, melting and boiling of water.  
•Analyze graphs to determine the freezing and melting temperatures of water.  
• Determine the relationship between the freezing, melting and boiling temperatures of water.  
  
**Purpose: What happens to temperature when water (or any substance) is going through a phase change?** *What's a phase change?* When a substance gains or loses energy causing it to change from solid, liquid to a gas.  
  
  
**PTT: You know the drill! Do the Prelab of the lab07a,** [**Heating Curve of Water Lab**](https://drive.google.com/a/asfm.edu.mx/?pli=1#folders/0B4l53ZXZaGBWcEM5WFd1MndGYmM)**.**   
  
  
  
**Lesson: Heating Curve of Water Lab.**

**Post Lab:**

**In your notes, answer the following questions:**  
**1. Looking at the data set and graph, what observations can you make about temperature change during the first 4 minutes (how much did temperature change)?**  
**2. Now look at the temperature change during the time between 4 and 10 minutes. How much did the temperature change here?**  
**3. Why do you think there is such a difference in the temperature changes for these specific times?**

***Absolute Zero worksheet and video***

***https://www.youtube.com/watch?v=TNUDBdv3jWI***

***Worksheet***

***http://betterlesson.com/lesson/resource/3141589/absolute-zero-student-worksheet?from=resource\_title***