**Heating and Cooling Curve and Heat Transfer Problems**

Directions: Read carefully!

1. Sketch a heating or cooling curve for each of the following problems. Curve should include:

* the highest temperature mentioned in the problem
* the lowest temperature mentioned in the problem
* the boiling point
* the melting point

You must determine if the curve is a heating curve or a cooling curve. Pay attention to the initial temperature and the final temperature. These problems may have anywhere from 1-5 steps!

2. Solve for the **total amount of energy** that is needed to make the change in each problem. Remember that each step on the graph requires a different formula. Number the steps on the graph and number the steps of your math work.

 Temperature change q = mc△T

 Phase change q = △Hvap x moles (vaporization)

 q = △Hfus x moles (melting)

Below are the constants that you will need to draw the curves and solve for the total heat. Please use correct sig figs and units for all calculations.

If you need some help or a better explanation than I gave yesterday, you can watch these videos. The first is background info and the second walks you through a problem including the making of the graph. There are links to these on the website.

Heating Curve and Cooling Curve of Water – Enthalpy of Fusion and Vaporization (Background Information)

<https://www.youtube.com/watch?v=ys2RHRiRc88>

How Much Thermal Energy is Required to Heat Ice into Steam – Heating Curve Problem Explained

<https://www.youtube.com/watch?v=AhKRUA4_viY>

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| **Sample** | **Melting point (˚C)** | **Boiling point (˚C)** | **Specific heat (s)****(J/g˚C)** | **Specific heat (l)****(J/g˚C)** | **Specific heat (g)****(J/g˚C)** | **Heat of Fusion****(kJ/mol)** | **Heat of Vaporization****(kJ/mol)** |
| **Water** | 0.0 | 100.0 | 2.06 | 4.184 | 1.87 | 6.009 | 40.79 |
| **Aluminum** | 660.37 | 2517 | 0.9025 | 0.869 | 1.05 | 10.71 | 290.8 |
| **Copper** | 1085 | 2570 | 0.3845 | 0.2987 | 0.3986 | 13.38 | 304 |
| **Iron** | 1536 | 2860 | 0.4494 | 0.4223 | 0.4882 | 13.807 | 350 |
| **Cesium** | 28.4 | 687.0 | 0.246 | 0.252 | 0.156 | 15.7 | 514 |
| **Phosphorus** | 44.2 | 280.5 | 0.7697 | 0.898 | 0.973 | 0.659 | 49.8 |

**Heating and Cooling Curve Problems** – See previous page for data.

1. How much heat energy is released when 90.0 grams of water vapor at 110.0°C is changed to liquid water at 0.0°C? (3 step problem)

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| Graph | Heat calculations |

2. Calculate the heat necessary to raise the temperature of 40.0 grams of cesium from 20.0°C to 600.0°C. (3 step problem)

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| Graph | Heat calculations |

3. Calculate the heat released when 45.0 grams of liquid iron at 1750.0°C is changed to solid iron at 45°C. (3 step problem)

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| Graph | Heat calculations |

4. How much heat is required to completely melt a 30.0 gram ice cube if the ice cube has an initial temperature of -10.0˚C?

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| Graph | Heat calculations |

5. How much energy is released when 42.5 grams of aluminum vapor is cooled from 4750.0°C to 25.0°C?

(5 step problem). Show graph and math.

**Heat Transfer Problems**

These problems do not require a graph, but drawing a sketch of the situation can be very helpful!

Specific heat constants you may need:

Water 4.184 J/g ˚C Aluminum 0.9025 J/g ˚C Copper 0.3845 J/g ˚C

Iron 0.4494 J/g ˚C Nickel 0.4492 J/g ˚C Cadmium 0.2311 J/g ˚C

1. A piece of unknown metal with a mass of 23.8 g is heated to 100.0 ˚C and dropped into 50.0 mL of water at 24.0 ˚C. The final temperature of the system is 32.5 ˚C. What is the specific heat of the metal?
2. A blacksmith heated an iron bar to 1455 ˚C. The blacksmith then tempered the metal by dropping it into 42,800 mL of water that had a temperature of 22.0 ˚C. The final temperature of the system was 45 ˚C. What was the mass of the iron bar?
3. A 752.0 mL sample of water was placed in a 1.00 kg aluminum pan. The initial temperature of the pan was 26.0 ˚C and the final temperature of the system was 39.0 ˚C. What was the initial temperature of the water?
4. The color of many ceramic glazes comes from cadmium compounds. If a piece of cadmium with a mass of 65.6 g and a temperature of 100.0 ˚C is dropped into 25.0 mL of water at 23.0 ˚C, what will be the final temperature of the system?
5. 50.00 g of copper at 950.0 C is immersed in a cold water bath containing 200.0 mL of water at 10.0 C. What is the final temperature of the system?
6. A 45 gram sample of an alloy was heated to 90.0 C and then dropped into a beaker containing 82.0 g of water at 23.50 C. The temperature of the water rose to a final 26.25 C. What is the specific heat of the alloy?
7. Charlie Brown wants to give Snoopy a bath. Charlie Brown heats 200 kg of water to 50.0 C, but this is too hot for Snoopy. Snoopy will only bath in water if it is 44.7 C. how many kg of water at 18.0 C will Charlie have to add to the tub in order for Snoopy to take a bath?