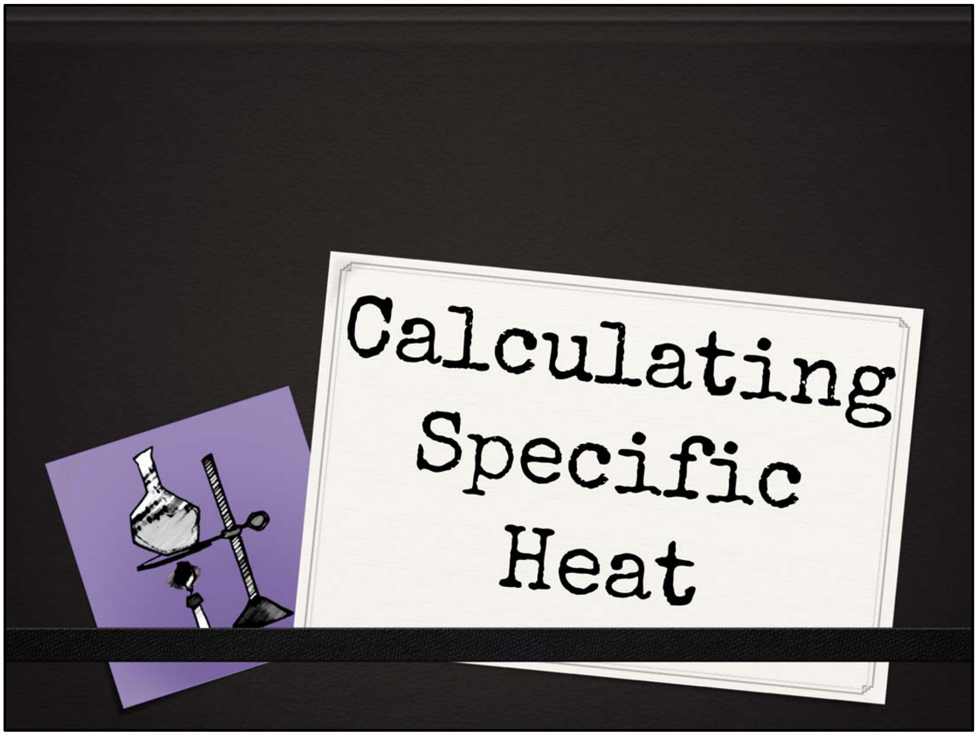
Module 8: Thermochemistry
Topic 8 Content: Calculating Specific Heat



Calculating Specific Heat

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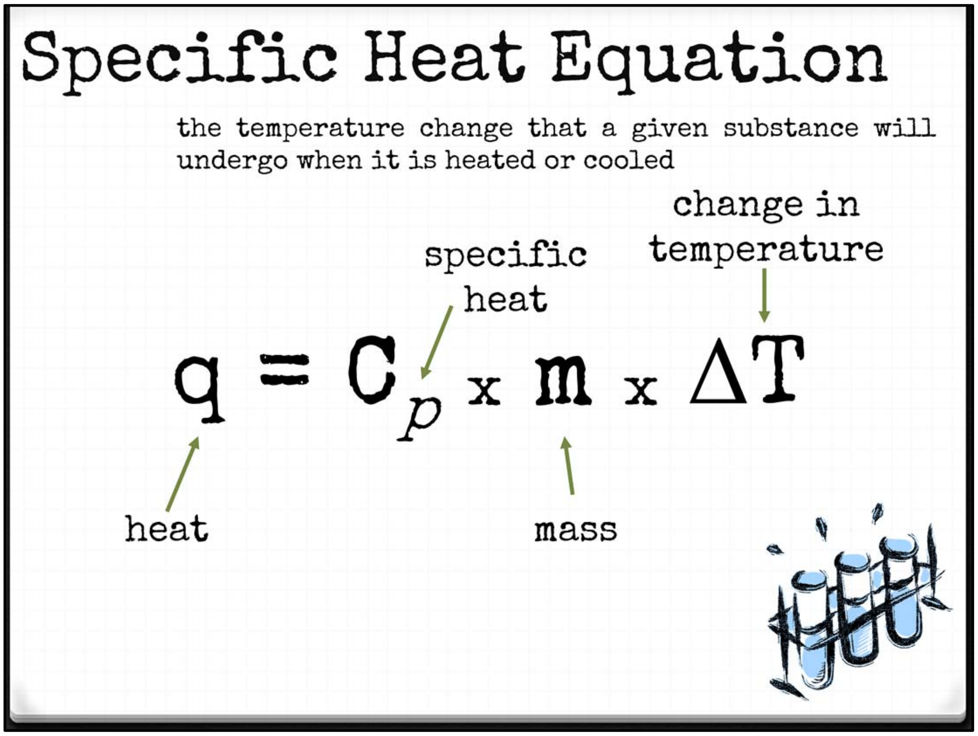

In a chemistry laboratory, the specific heat of a substance is used to calculate the temperature change that a given substance will undergo when it is heated or cooled. This equation relates heat, represented by *q*, to specific heat, represented by C_p, mass, represented by *m*, and temperature change, represented by ΔT. The equation is written so that heat equals specific heat times mass times temperature change, as shown here.

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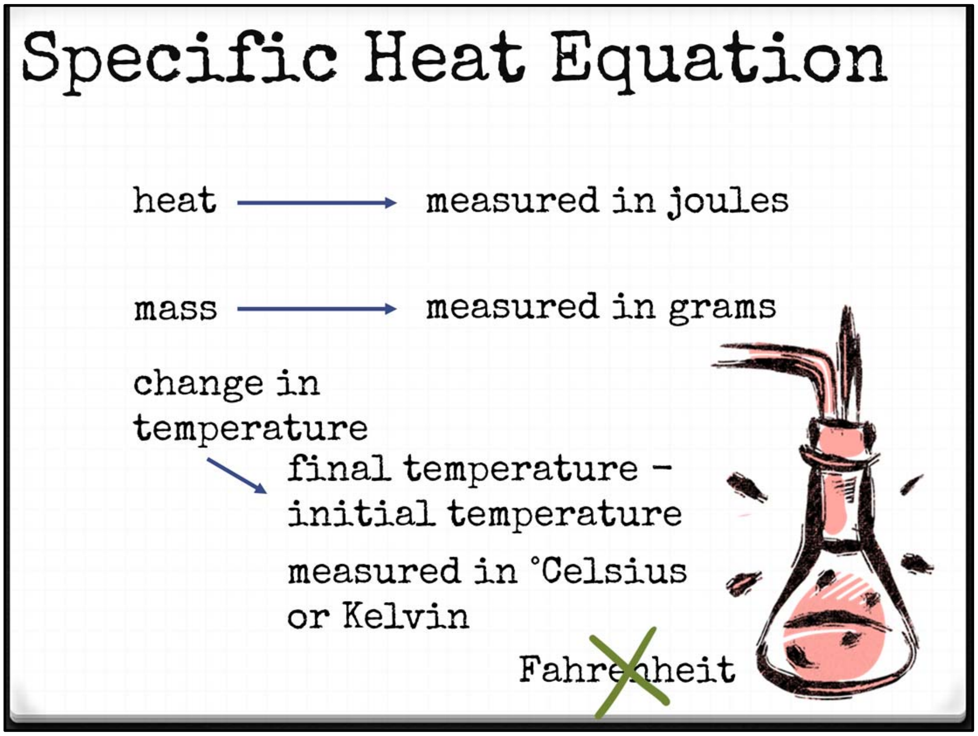
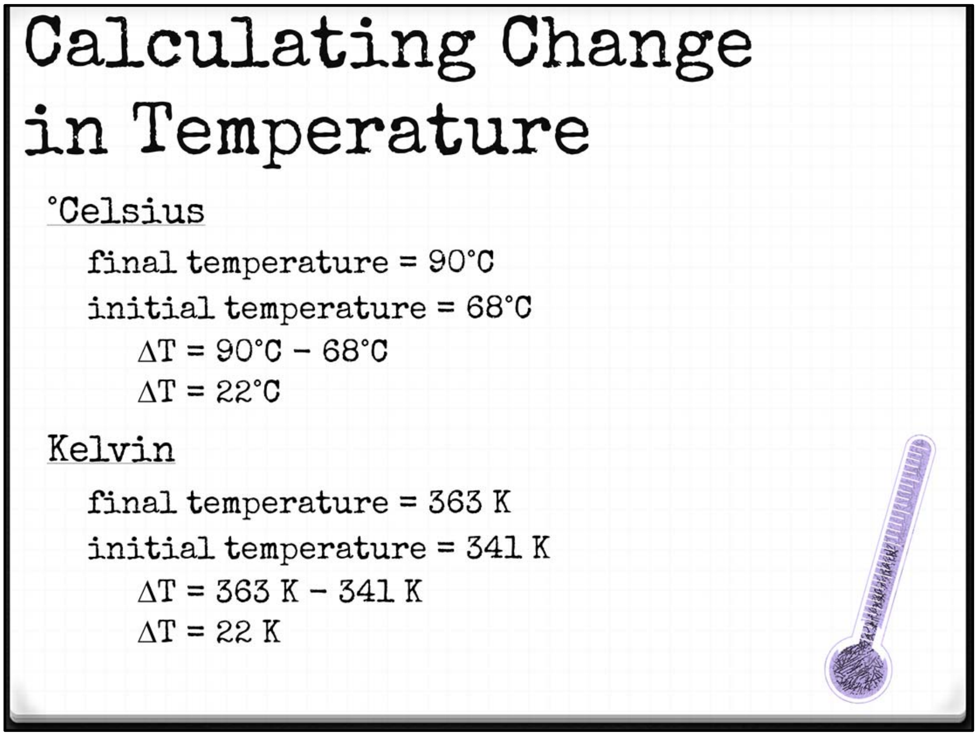


In a reaction, the heat that is either absorbed or released is measured in joules. The mass is measured in grams. The change in temperature, or ΔT equals the final temperature minus the initial temperature. With temperature, it does not matter if you complete the problem in degrees Celsius or Kelvin. Although the numerical values for a temperature given in Celsius and Kelvin are different, $\Delta °C$ and ΔK for two given temperatures are the same. This means that you do not need to convert temperature to correlate with your units for specific heat during this calculation, if you are working with Celsius or Kelvin. If you are working with Fahrenheit, you will still need to perform a temperature conversion.



Now, take a look at an example. You can see how temperature is converted in both Celsius and Kelvin. How would you solve for change in temperature, or ΔT if you were given a final temperature value of 90°C and an initial temperature value of 68°C? You would simply subtract 68°C from 90°C to arrive at 22°C. The same subtraction will take place if you are given values in Kelvin. If you were given a final temperature value of 363K and an initial temperature of 341K, you would subtract the initial temperature from the final temperature. In this example, the change in temperature still equals 22, only the unit is Kelvin.

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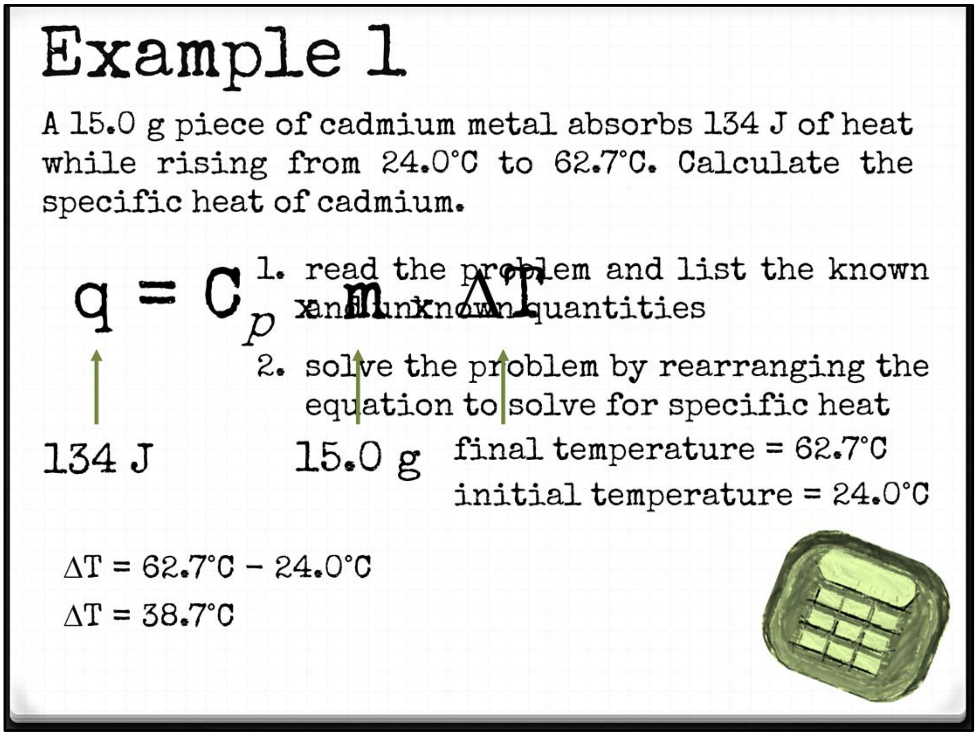

How do you calculate the specific heat in a given problem? You will need to complete this problem in two steps. First, read the problem and list the known and unknown quantities. Second, solve the problem by rearranging the equation to solve for specific heat. Take a moment to consider this example.

A 15.0 g piece of cadmium metal absorbs 134 J of heat while rising from 24.0°C to 62.7°C. Calculate the specific heat of cadmium.

In this problem, you are given a heat value of 134 J. You are given a mass value of 15.0 g, and you are given both final temperature and initial temperature values. You will need to solve for change in temperature by subtracting the initial temperature from the final temperature. After you have preformed this step, you will find that change in temperature equals 38.7°C.

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Example 1

A 15.0 g piece of cadmium metal absorbs 134 J of heat while rising from 24.0°C to 62.7°C. Calculate the specific heat of cadmium.

$$q = \boxed{C_p} \times m \times \Delta T$$

$$C_p = \frac{q}{m \times \Delta T}$$

$$\frac{134\ \text{J}}{150\text{g} \times 38.7°\text{C}} = 0.231\ \text{J/g°C}$$

specific heat of Cadmium

The unknown variable in this example is the specific heat of cadmium. You will need to rearrange the equation to solve for specific heat. The new equation reads; specific heat equals heat divided by mass times change in temperature. All that is left to do is plug in the known variables and solve using mathematics. You will find that 134 J divided by 150 g times 38.7°C equals 0.231 J/g°C. What can you conclude from the answer to this problem? The specific heat of cadmium, which is a metal, is fairly close to the specific heats of other metals.

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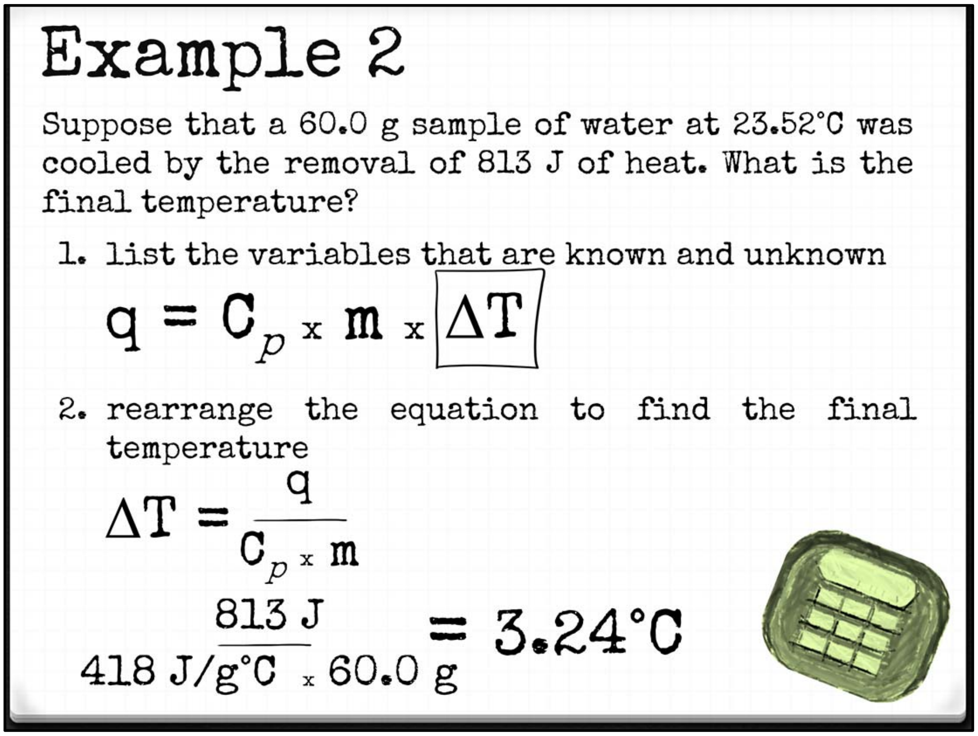
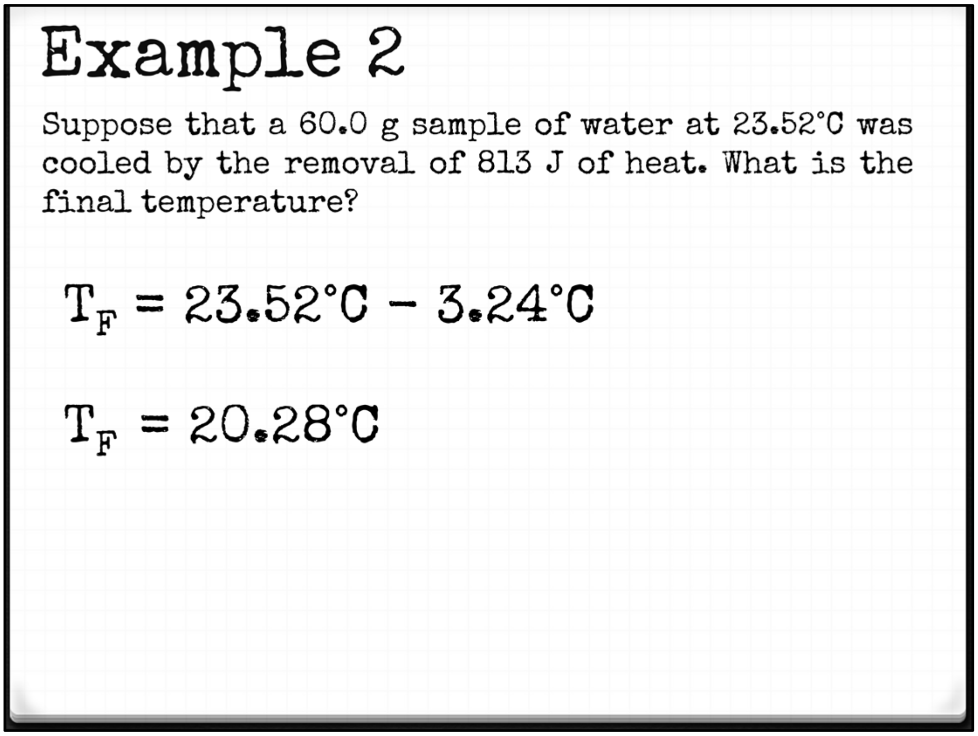


How do you calculate the final temperature in a given problem if you are given the other variables, such as mass, specific heat, and initial temperature? Take a moment to read the example problem.

Suppose that a 60.0 g sample of water at 23.52°C was cooled by the removal of 813 J of heat. What is the final temperature?

You will need to complete this problem in three steps. First, list the variables that are known and unknown. In this example, you were given the known variables of heat, mass, specific heat, and initial temperature. The unknown variables in this example are change in temperature and final temperature. Next, in order to find the final temperature, you will need to find the change in temperature. You will need to rearrange the equation to read: change in temperature equals heat divided by specific heat times mass. Plugging in your known variables, you will find that 813 J divided by 418 J/g°C times 60.0 g equals 3.24°C.



In the third step, you must solve for the final temperature. In order to solve for final temperature, you must subtract the change in temperature from the initial temperature. You will find the final temperature in this example to be 20.28°C. You can see from the solution that the temperature decreased, since the water was cooled.