**Temperature and Thermal Expansion**

In the United States, temperatures are often measured in Fahrenheit, while in the rest of the world the Celsius scale is used. In science, it is often useful to use an absolute temperature scale, generally the Kelvin scale. It is useful to know how to go back and forth between the various scales.

Write an equation to show how to convert from a temperature in Kelvin, $T_K$, to the equivalent temperature in Celsius, $T_C$.

$$T_C =$$

Write an equation to show how to convert from a temperature in Celsius, $T_C$, to the equivalent temperature in Kelvin, $T_K$.

$$T_K =$$

Now let’s write down the conversion equations to go between Celsius and Fahrenheit. First let’s see if we know some of the equivalent temperatures. Fill in the table with what you know.

Write an equation to show how to convert from a temperature in Fahrenheit, $T_F$, to the equivalent temperature in Celsius, $T_C$.

$$T_C =$$

Write an equation to show how to convert from a temperature in Celsius, $T_C$, to the equivalent temperature in Fahrenheit, $T_F$.

$$T_F =$$

<table>
<thead>
<tr>
<th>Conversion</th>
<th>$T_F$</th>
<th>$T_C$</th>
<th>$T_K$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water freezes</td>
<td></td>
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<tr>
<td>Water boils</td>
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<td></td>
<td></td>
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<tr>
<td>Human body temperature</td>
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<td></td>
<td></td>
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<tr>
<td>Room temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same reading on Celsius and Fahrenheit scales</td>
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<td></td>
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</tbody>
</table>
Strips of two different metals, which have the same length at room temperature, are bonded together to form a bimetallic strip. When the bimetallic strip is heated it bends into a circular arc. Why?

What is a practical example of a bimetallic strip?

We have a ball and a ring. At room temperature, the ball almost fits through the ring, but it does not quite make it. What should we do to the ring so that the ball will fit through the ring?

[ ] Immerse the ring in liquid nitrogen, cooling it to 77K

[ ] Heat the ring with a propane torch

[ ] Either of the above would work

[ ] Neither cooling nor heating would work

Justify your answer:

What actually happens? Why?

What is the connection between the above and…

Bridges?

Railroad tracks?
One form of the equation for linear thermal expansion is $L = L_i (1 + \alpha \Delta T)$.

Let’s say that a large rectangular window measures exactly 2 m high by exactly 1 m wide when it is installed at 0°C. The coefficient of thermal expansion for glass is approximately $9 \times 10^{-6} / °C$. If the temperature rises to 40°C, by how many millimeters does the window expand in each direction?

For a two-dimensional object, such as the window in the previous example, which initially has an area of $A_i = L_i \times H_i$, what is the equation for the new area when the temperature changes?

Prove that your equation can be approximated by $A = A_i (1 + 2\alpha \Delta T)$.

What do you think the equivalent volume equation is?