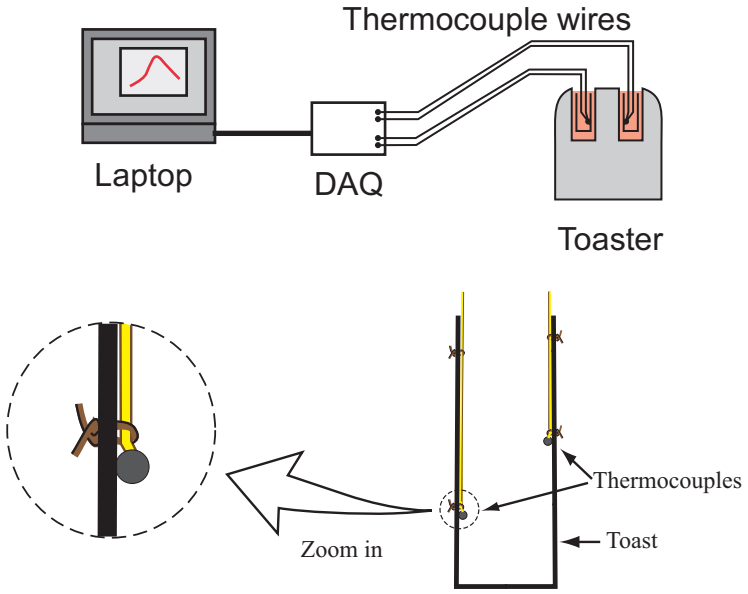
Toaster Demonstration **Spring 2010**

Apparatus

The sketch shows the equipment for this demonstration. The key components are

1. A toaster.
2. A fan.
3. Two pieces of sheet aluminum bent into the shape of a "U".
4. Four thermocouples: two attached to the inside walls of each of the sheet metal pieces.
5. A data acquisition device (DAQ) for digitizing the thermocouple output.
6. A computer to record the output of the thermocouples



In-Class Demonstration

1. The "toast" is placed in the room-temperature toaster.
2. The data acquisition software is started, and the temperature of the system in the ambient condition is displayed.
3. The toaster lever is depressed, sending power to the heating elements. The data acquisition records the temperatures. After one or two minutes the toaster lever is raised, turning off the power to the heating elements.
4. The toast is removed from the toaster (with pliers) and held either in the quiescent laboratory air, or in the air stream from the fan.
5. After waiting for the toast to cool, the data acquisition system is stopped.

See over

Predictions

1. When the toaster is turned on, and the sheet metal pieces are lowered into the toaster,
   a. the two pieces of toast will heat up at the same rate.
   b. the black toast will heat up much faster than the shiny toast.
   c. the black toast will heat up a little faster than the shiny toast.
   d. the black toast will heat up a little slower than the shiny toast.
   e. the black toast will heat up much slower than the shiny toast.

2. After 30 seconds the highest temperature achieved by the toast will be approximately
   a. 30 °C (very warm room temperature)
   b. 50 °C
   c. 100 °C
   d. 500 °C
   e. 1000 °C
   f. > 1000 °C

3. If there is any difference in heating and cooling rate for the toast it is *most likely* due to (choose only one answer)
   a. the insulating effect of the black paint layer.
   b. the difference in energy storage between the two metal pieces
   c. the difference in surface properties.
   d. air currents in the toaster cavity.
   e. uncontrollable variations in temperatures of the heating coils.

4. When the toaster is turned off, the two pieces of metal will be removed and suspended in the air stream from the fan. During the cooling phase
   a. the two pieces of toast will cool down at the same rate.
   b. the black toast will cool down much faster than the shiny toast.
   c. the black toast will cool down a little faster than the shiny toast.
   d. the black toast will cool down a little slower than the shiny toast.
   e. the black toast will cool down much slower than the shiny toast.

5. Which modes of heat transfer are *significant* (i.e., cannot be neglected) during the heating phase?

6. Which *one mode* of heat transfer is *dominant* during the heating phase?

7. Which modes of heat transfer are *significant* (i.e., cannot be neglected) during the cooling phase?

8. Which *one mode* of heat transfer is *dominant* during the cooling phase?