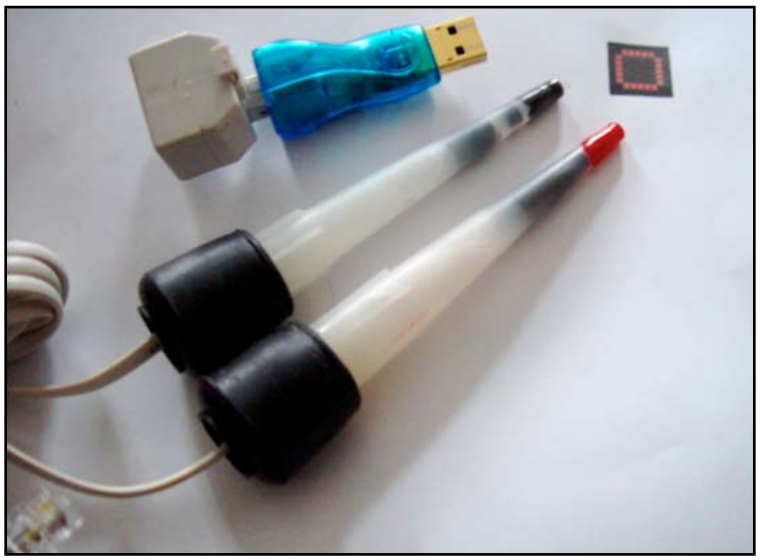
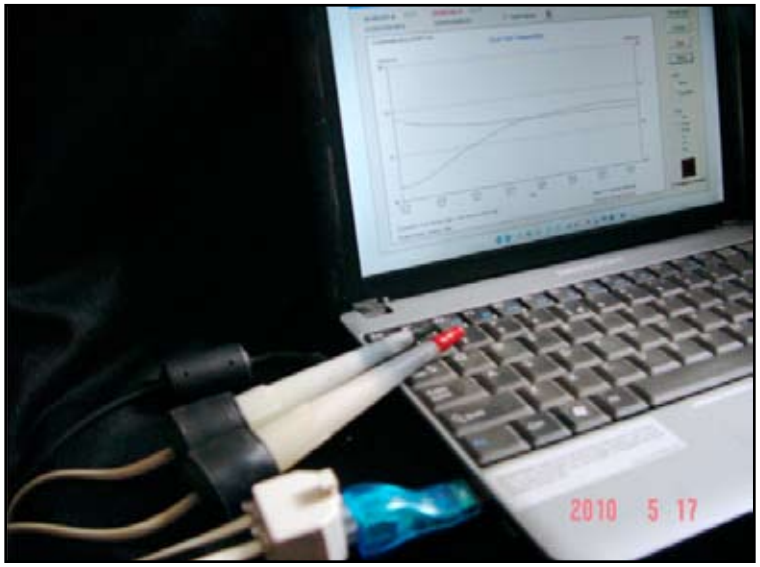
Conduction, Convection & Radiation

This experiment requires you to have the following:-
(i) The ThermoSense Mk1 hardware connected to your Windows USB port.
Hardware look like this:-



(ii) The Free ThermoSoft Mk1 Running on your Windows PC.
Software Display should look similar to this :-



Experiment Objectives:-
These experiments are easy and fast to do.

They are concerned with three methods by which Heat Energy transfers from one object to another.

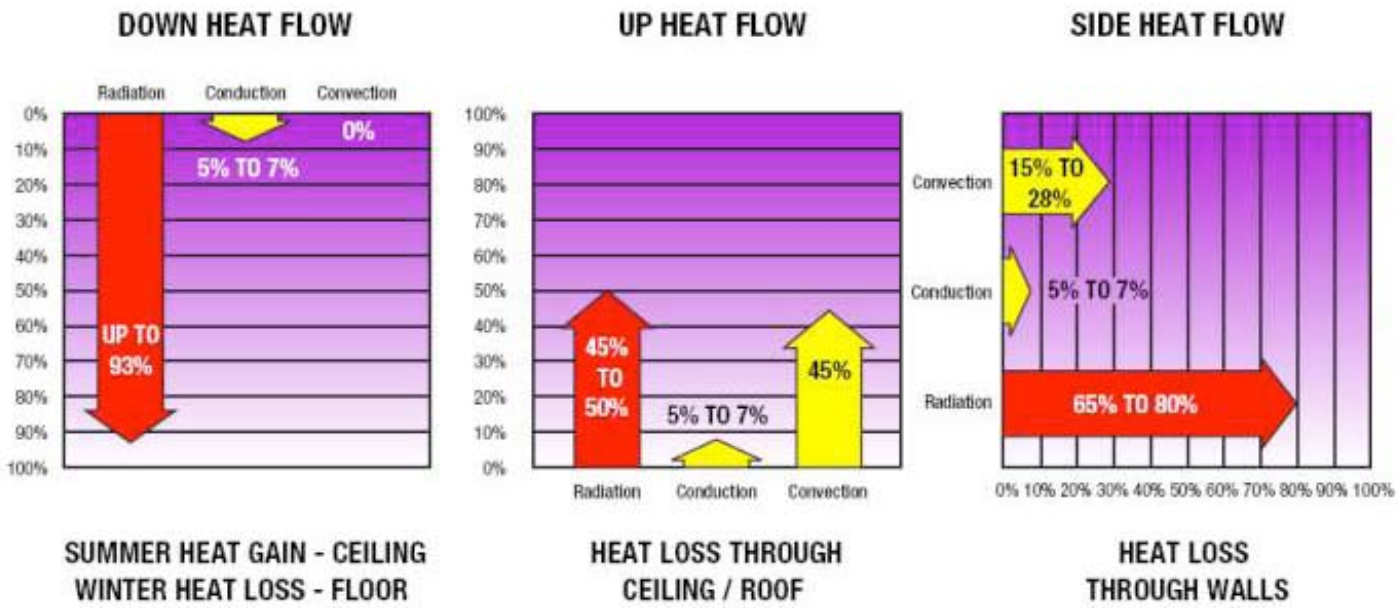
To help put these simple experiments using the ThermoSense Mk1 and the Free supporting Software ThermoSoft Mk1 in context we need to remind ourselves that Heat and Temperature are Different but Linked.

So one of our old Educational Notes is reprinted below on the following pages for fast revision:-
Remember for Heat Energy to transfer from One object to another there must be a temperature difference between the two objects.

Consider some of the other experiments we will do soon when we are familiar how Heat Energy flows. For instance:-

HOW BUILDINGS LOSE / GAIN HEAT

BY RADIATION, CONDUCTION & CONVECTION



ThermoSense Mk1

Temperature and Heat are different but linked.

Temperature (T) is a measurement of the average kinetic energy of the molecules which vibrate in an object and can be measured by a thermometer.

ThermoSense Mk1 is a thermometer which measures from two temperature sensors Hot and Cold changes. These are displayed on your computer in Graphical and Numerical ways with the information available for personal investigation.

Temperature can be used to determine the **Internal Energy(U)** contained within an object.

Heat Energy(Q) always refers to the **transfer** of **Internal Energy** between objects, **not to the Internal Energy(U) contained within the objects.**

Two objects: say two baked potatoes, one large (A), one small (B) could be at the same temperature or have different temperatures.

A) At Same Temperatures

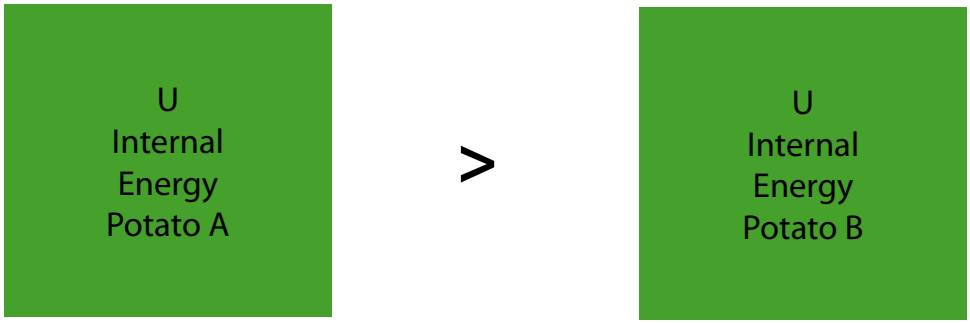
* If potato (A -large) and potato (B-small) are **at the same temperature** then **potato (A)** will have **more Internal Energy(U)** than **potato (B)**

Potato A

Potato B

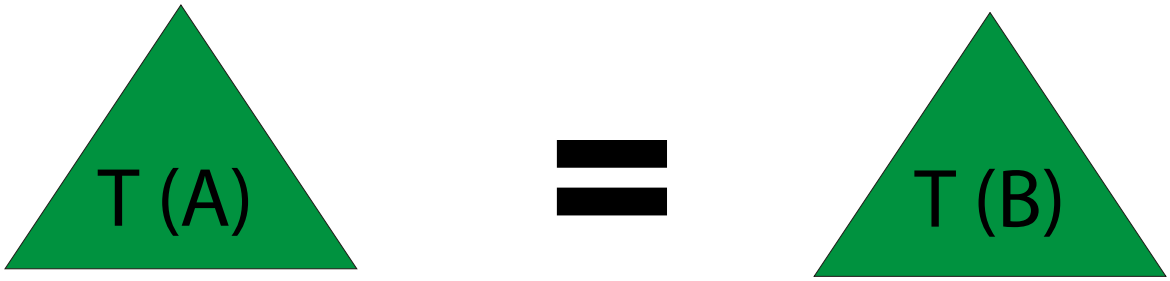
That is the:-

Internal Energy of Potato (A) is greater than Internal Energy of potato (B)



even though

TEMPERATURE of Potato(A) = TEMPERATURE of Potato (B)



Heat Energy Transfer (Q)

*** Requires a Temperature difference between two objects.**

So if TEMPERATURE of Potato(A) = TEMPERATURE of Potato (B)

and

They touch each other, so as to be in thermal contact

There is no **Heat Energy** conduction

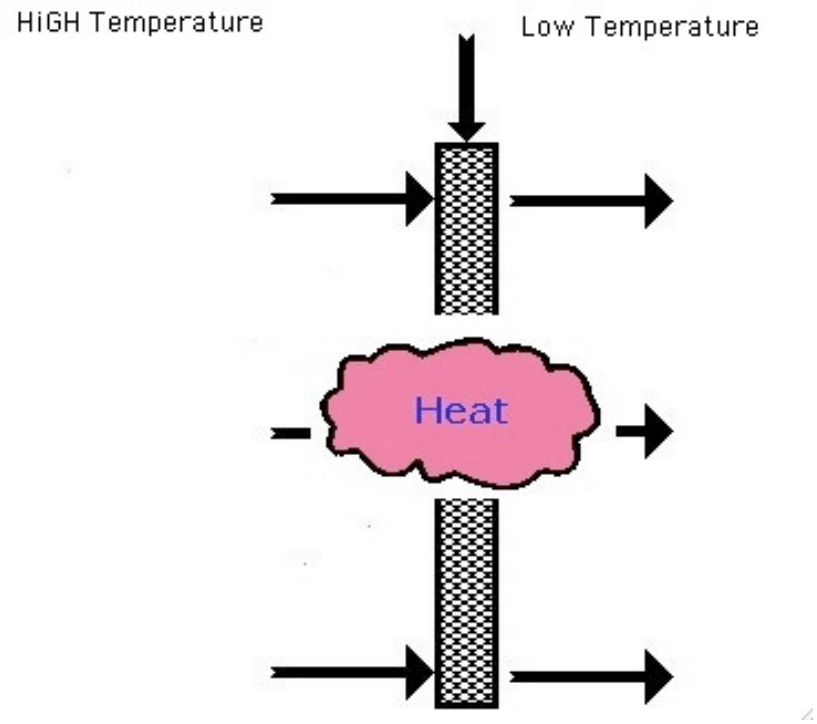
SO

Heat Energy Transfer between Potato(A) & Potato (B)

is zero.

B) At different Temperatures.

*** for Heat Energy (Q) to transfer from one object to another there must be a Temperature difference.**



* Heat Energy (Q) transfers from an object at a High Temperature

*** Heat Energy (Q) may transfer by three means:-**

To Illustrate

a) Conduction ---Finger touch on a hot surface.

b) Convection --- Draft from a gap in a wall.

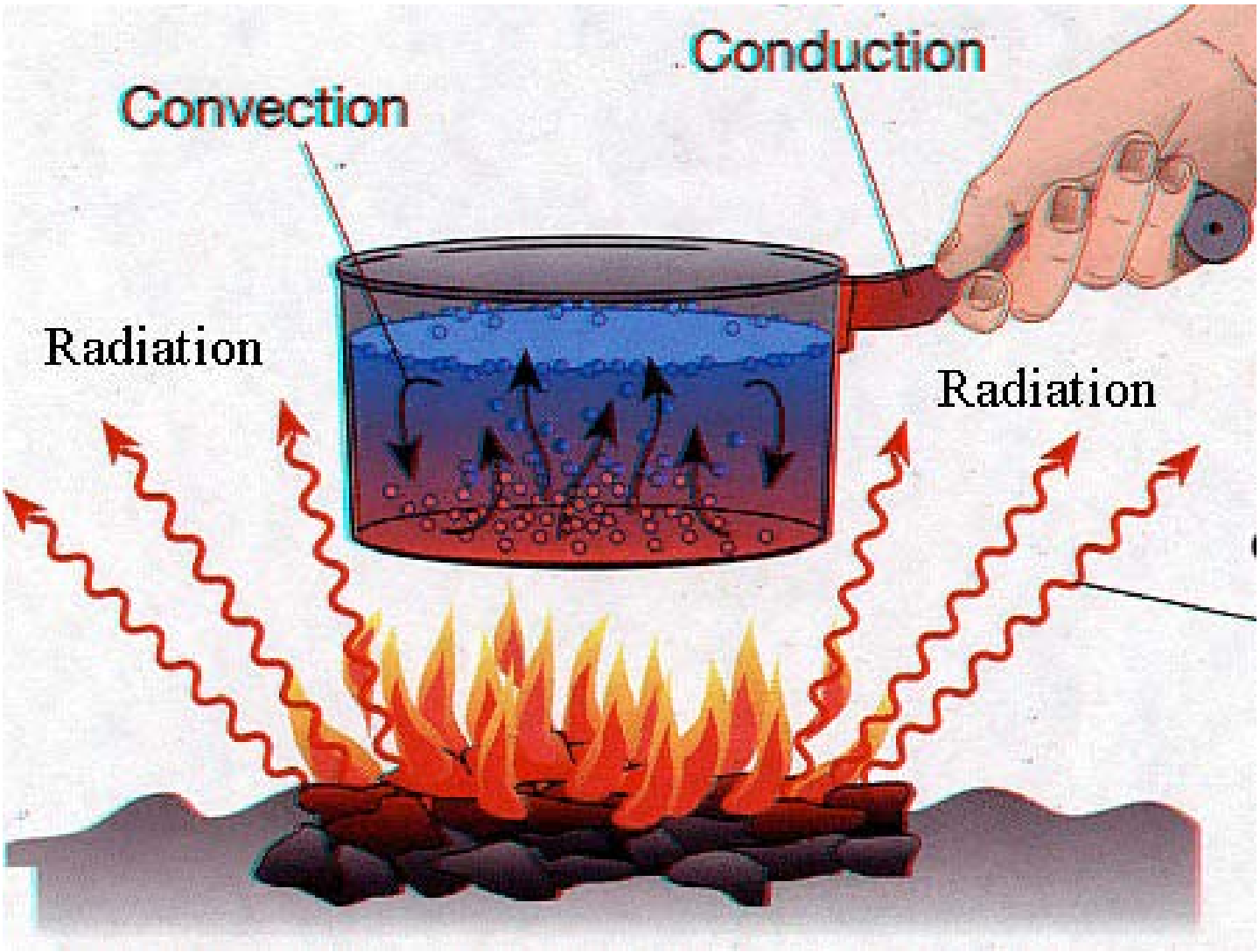
c) Radiation --- Heat from the Sun on your face.

WITH THIS IN MIND WE CAN HAVE FUN AND LEARN USING IMAGING ASSOCIATES INTERNATIONAL'S THERMOSENSE MK1

ThermoSense Mk1 will enable you to make easy Temperature and Heat Transfer Measurements and help you investigate Sustainable Environmental issues involving ENERGY. Practical Measurements will increase your insight into many scientific and political Issues including GLOBAL WARMING!

End Educational Note.

Method for our Simple introductory Experiments.:-
They must try to isolate the three Heat Energy transfer methods illustrated below from a heating water situation.

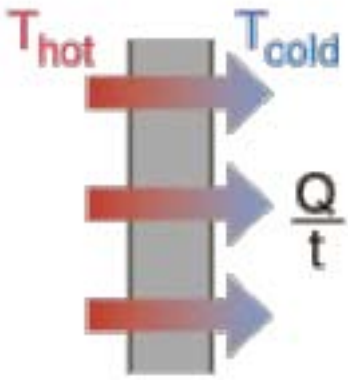


When doing our experiments:-

Note: Cone Sensors are Robust but of course sensitive to temperature.
Try to handle them by the Black Rubber Insulating Handles.

Action:-
If you want the Cone Sensors to start from some arbitrary Temperature put the two Cone Sensors in to a Glass of Tap Water, and dry them with a Tissue.

A. Simple **Heat Energy Conduction** Experiment.
Conduction is Heat Energy Transfer (Q) by means of molecular agitation within a material without the material Moving.
Heat Energy Transfer per unit time (Q/t) is a Heat Energy Transfer Rate and depends upon a Temperature difference between a Hot Temperature position(T-hot) and a Cold Temperature position (T-cold) in the material or two different materials in Physical Contact.



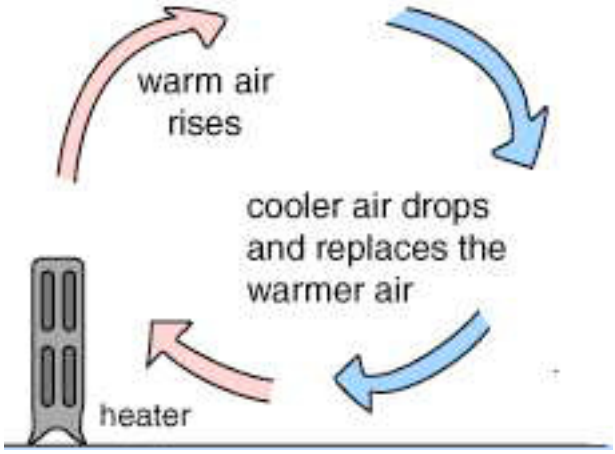
The Temperature Difference is (T-hot minus T-cold)

If (T-hot minus T-cold) is Large then the Heat Energy Transfer Rate (Q/t) will be Large.
If (T-hot minus T-cold) is Small then the Heat Energy Transfer Rate (Q/t) will be Small.
When (T-hot minus T-cold) is Zero then there will be no Heat Energy Transfer so (Q/t=0).
With this in mind we will set up our Conduction Experiment using ThermoSense Mk1 and ThermoSoft Mk1.
Our Experiment in Heat Energy Conduction will be between a Teacher or Students Hand and the ThermoSense Cone Temperature sensor.
Note: Cone Sensors should not be put in the mouth of a person.
As we have two sensors two students can take part.

This Image illustrates.

Set the ThermoSoft Mk1 Experiment Time settings as you see fit.

B. Simple **Heat Energy Convection** Experiment.
Convection is when the Heat Energy Transfer is caused by the mass movement of a fluid such as air.
There are different types of Convection.
Natural Convection --- this Heat Energy transfer occurs as Hot Air is Lighter than Cold Air. Convection above a hot surface occurs because hot air expands, becomes lighter than cold air, and rises causing convection currents which transport energy.

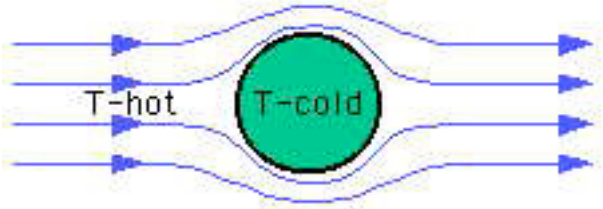


Note: In another Experiment we will measure air temperature near the floor and temperature near the ceiling.
Forced Convection --- is usually concerned with the Heat Energy Transfer between a moving fluid and a solid surface.

In the Two Images shown below:-
The Blue Lines represent a Forced Air Flow --- the green circle represents an end on view of a ThermoSense Mk1 cone sensor.

Case A.

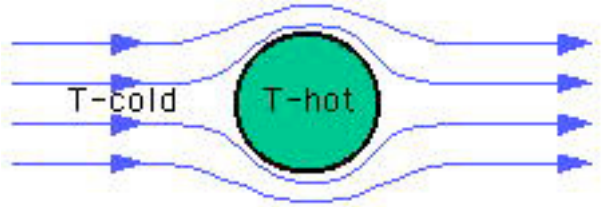
Hot Air Cooler Air



Heat Energy Gained by Cone Sensor.
Measured Temperature T-cold Rises.

Case B.

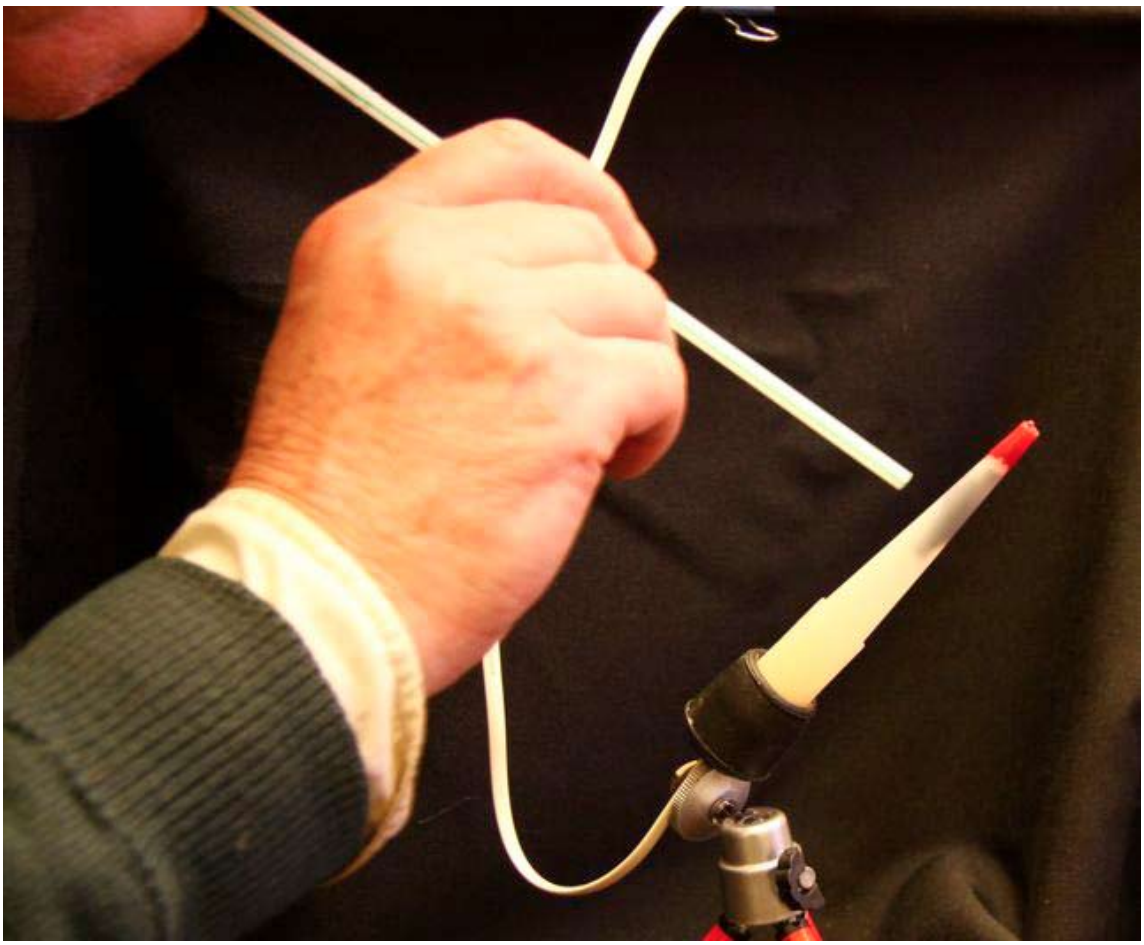
Cold Air! Hotter Air



Heat Energy lost by the Cone Sensor.
Measured Temperature T-hot Falls.

Our experiment will be concerned with Forced Convection as the results will be shown quickly on ThermoSoft Mk1.

For this Experiment all that is required is a Drinking Straw and of course ThermoSense Mk1 and ThermoSoft Mk1.
This image illustrates the method of Forced Convection :-

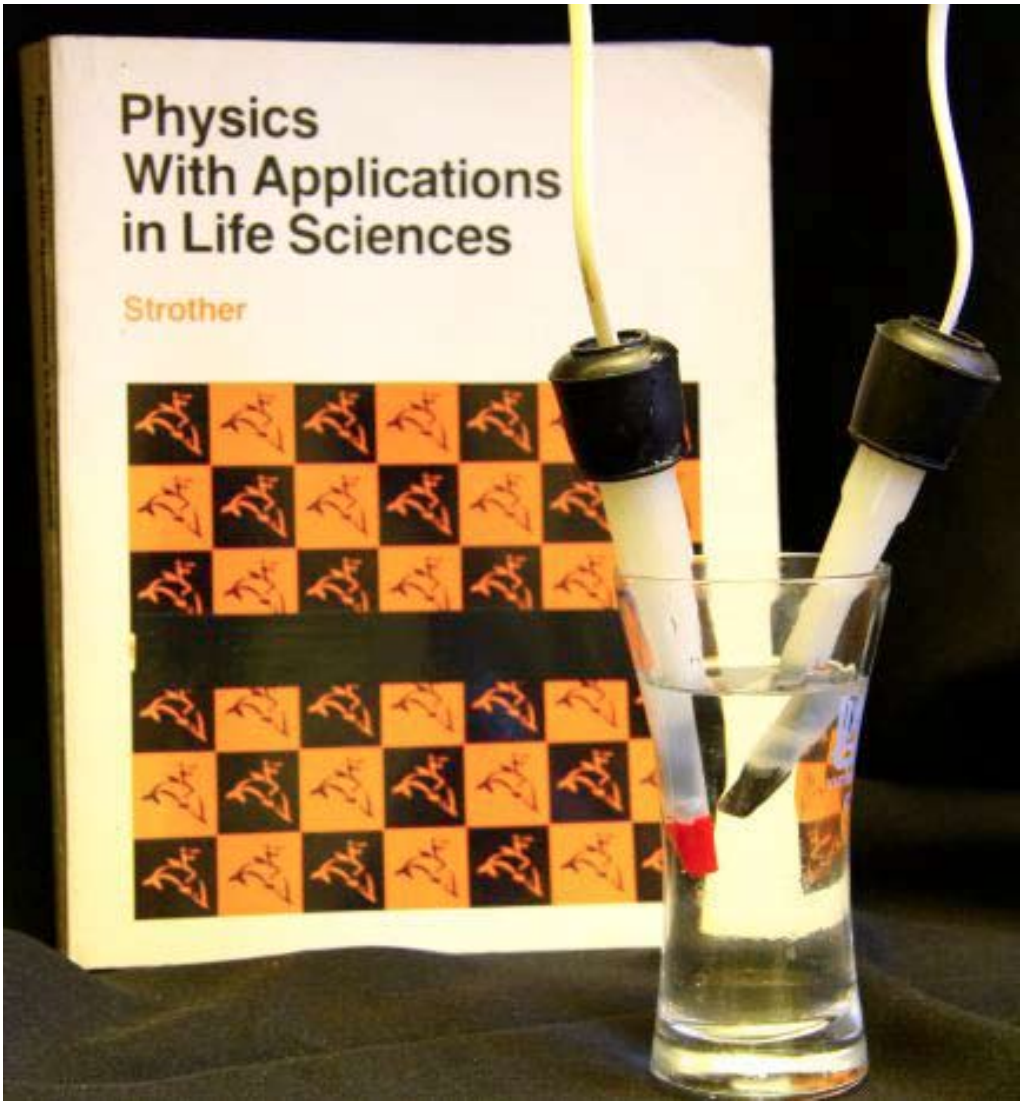


Using a New Fresh Drinking Straw we blow the warm air from our lungs across the Cone Temperature as shown below.

Results will show quickly on ThermoSoft Mk1 software.
1) If your Breath is hotter than the ThermoSense Mk1 sensor we have Case A illustrated above. This means the Temperature Measured and Displayed on ThermoSoft Mk1 will rise on the Graphical Display.

2) If your Breath is colder than the ThermoSense Mk1 sensor we have Case B illustrated above. This means the Temperature Measured and Displayed on ThermoSoft Mk1 will decrease on the Graphical Display.

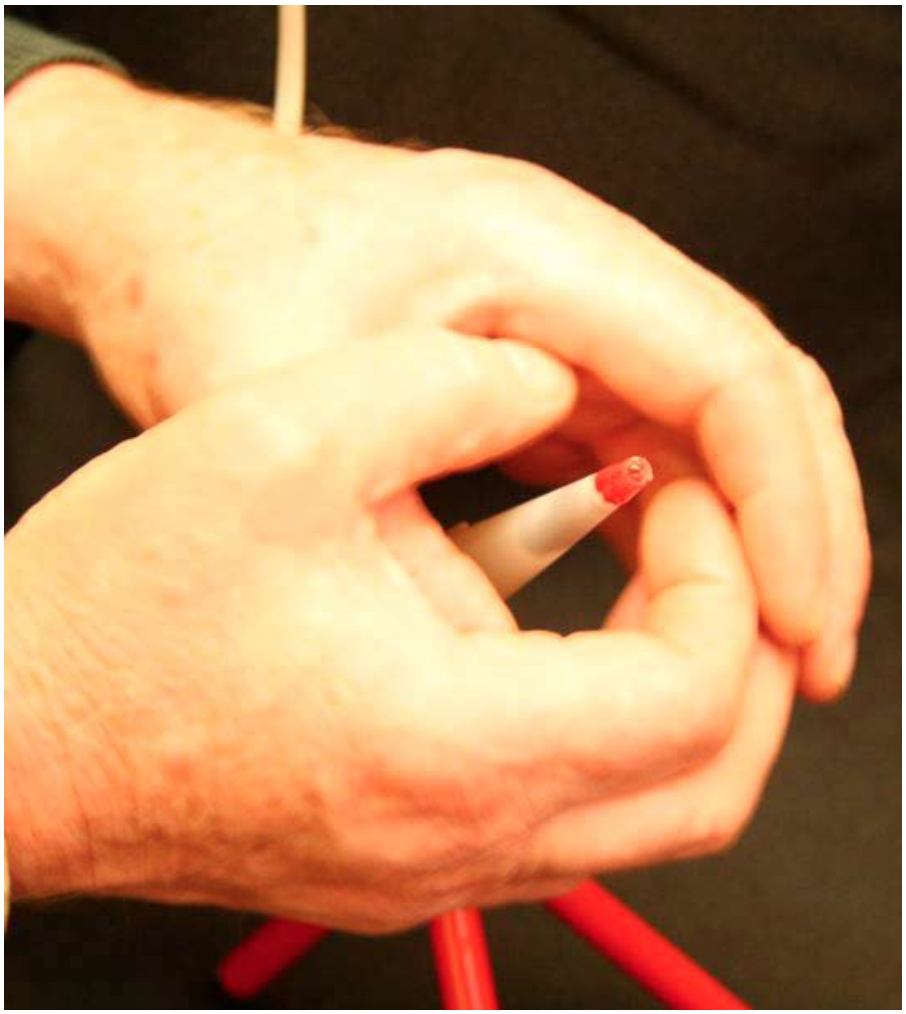
3) If your Breath is at the same temperature as the Cone Sensor there will be no change in Temperature and no Heat Energy transfer.
Note: Cone Temperature Sensors are water proof and should be immersed in a glass of water to which an antiseptic such as Dettol has been added and then dried with a tissue before the next experiment.



C. **Simple Heat Energy Radiation Experiment.**

Radiation is Heat Transfer Energy by electromagnetic waves which carry energy away from the emitting object, a familiar source of Radiant Heat Energy for us is the Sun.
Radiant Energy Reaches Earth from the Sun because the Sun is hotter than the Earth.

Again the Heat Energy Transfer requires a temperature Difference --- the Sun is Hotter than the Earth ---------- so electromagnetic energy travels from the Sun to Earth.
Experiment: Radiation from our hands transmitted To or From the Cone temperature Sensor.



You may have to rub your hands together to heat them by friction and adjust the Thermosoft Mk1 temperature scale for maximum sensitivity .