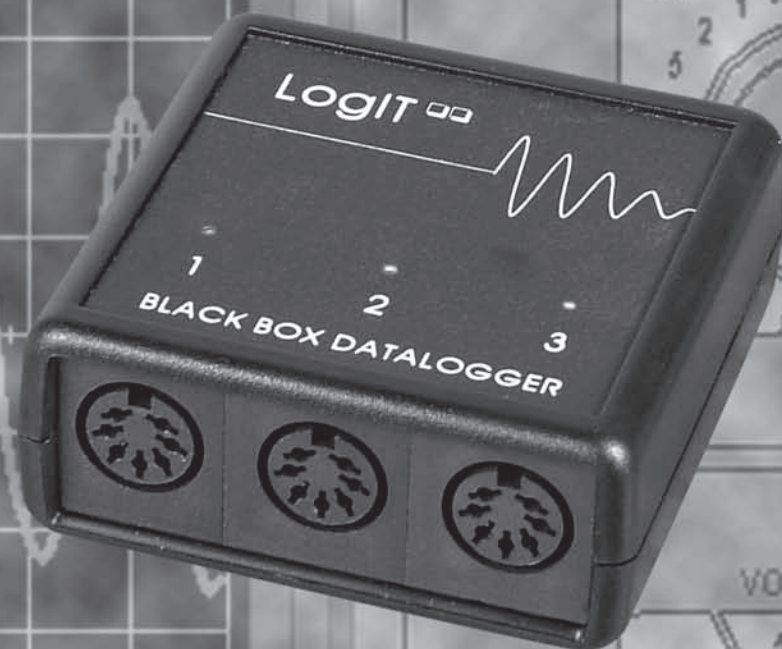


**Black Box**

**LogIT<sup>™</sup>**



**The easiest and most affordable data logging system for Secondary schools**

LogIT



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# Acknowledgements

## Looking after Black Box

LogIT Black Box is designed as an educational tool and although durable requires a reasonable degree of care which any electronic product of this nature needs. Never plug anything into Black Box other than official LogIT Microsense® sensors and accessories. Please read the warning guides throughout this book and in particular do not allow Black Box to get damp, wet or expose it to extremes of temperature or shock unless instructions specifically state. If the unit is accidentally exposed to any of these conditions it could malfunction and serious damage result.

## Safety and risk assessment

It is the responsibility of the user or teacher to have made suitable risk assessments before carrying out any student led experimentation. A teacher has a duty of care towards their students to ensure experiments are carried out within a safe environment. The instructions and experiment ideas contained within this manual highlight particular hazards but are not exhaustive and are not a substitute for your own assessment. Refer to your science departments risk assessment criteria and apply accordingly.

## Acknowledgements and Copyright

LogIT Black Box was developed and designed in Great Britain by Steve Cousins, Mark Finch, David Palmer, Andrew Rouse and Paul Watson. The design team express thanks and acknowledgement to their family, friends, education and commercial colleagues for their support.

This manual was written and designed by Mark Finch and David Palmer.

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The manual was written and designed on Apple Macintosh G5 computers using Adobe Indesign.

LogIT Black Box is designed as an educational tool. The designers and manufacturers cannot be held liable for any special, incidental, consequential, indirect or similar damages due to loss of data, loss of business profits, business interruption or any other reason resulting from the use of LogIT products, even if they have been advised of the possibility of such damages. Not for use in life support applications. DCP accept no responsibility for safety or risk assessment. Statutory rights are not affected.

First Edition April 2007 Published by DCP Microdevelopments Limited, Norfolk, Great Britain. [www.logitworld.com](http://www.logitworld.com)



### Electromagnetic compatibility declaration

The LogIT system and accessories are designed for use as education and training equipment. "The use of this apparatus outside the classroom, laboratory, study area or similar such place invalidates conformity with the protection requirements of the EEC Electromagnetic Compatibility directive (89/336/EEC) and could lead to prosecution".



Waste electrical and electronic products must not be disposed of with household waste. Please recycle where facilities exist. Check with your Local Authority or Retailer for recycling advice.



# Introduction to LogIT Black Box

Thank you for choosing LogIT Black Box which has been designed as an easy to use low cost datalogging solution for Science education at Secondary and College levels.

Black Box takes advantage that most computers are now equipped with USB ports which provide both power and a high speed data link for peripherals such as scanners, cameras etc. USB has made it possible for us to design a powerful yet low cost datalogging solution which is really compact and easy to use, because there are no batteries, buttons or switches - your computer with the datalogging software controls everything!

Because USB is so much faster than most older traditional serial ports we have been able to build in a unique oscilloscope function enabling you to see such fast events as sound waves or dynamics collisions live on your computer screen.

Future reliability and compatibility are assured as both the datalogging software and the firmware inside Black Box are fully upgradable using easy downloads from the [logitworld.com](http://logitworld.com) website.

Most Black Box sets include two versatile sensors for measuring temperature, light level and timing plus there is a wide range of over 50 other Microsense® sensors and adapters available which are all fully compatible - just plug them in and your ready to go.

Although Black Box needs to be connected to a PC to record data, computers are now so much more affordable and compact that a powerful and portable datalogging system can be built around a notebook computer and Black Box datalogger.

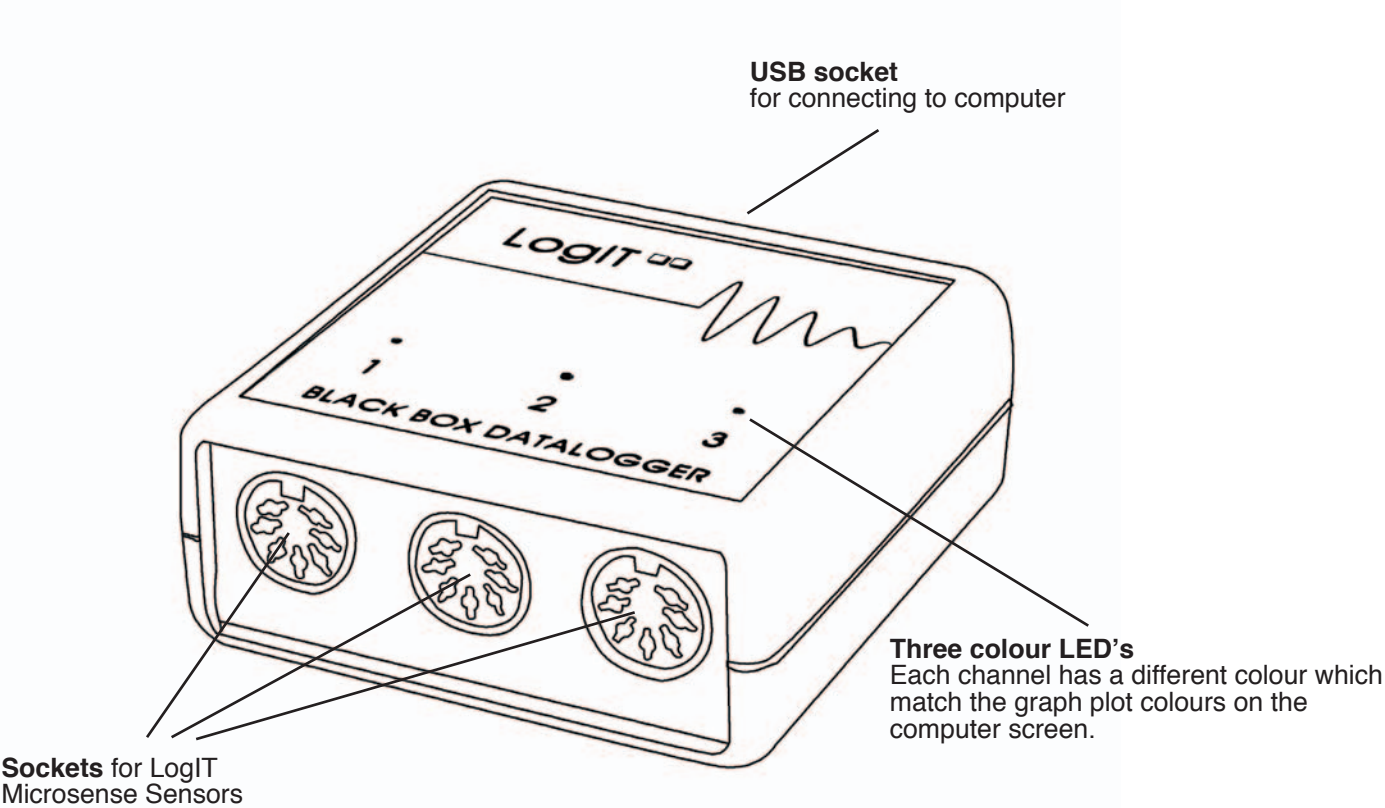
However if you need a fully self contained datalogger other LogIT models are available which record data independently without the need of a computer such as Voyager and DataVision and the great thing is that sensors, cables and software are all compatible with each other making classroom management of a mixture of LogIT's easy and straightforward.

DCP is proud to have been a creator and innovator of sensing and control systems for education for over 25 years but we always welcome feedback so that we can feed the real experience of users directly back into our product development to make future products even better.

So for free help, support or feedback any time visit [www.logitworld.com](http://www.logitworld.com) or email us at [support@dcpmicro.com](mailto:support@dcpmicro.com)

David Palmer  
DCP Microdevelopments Limited  
April 2007

# Black Box Basics



# Black Box Basics - Quick Start

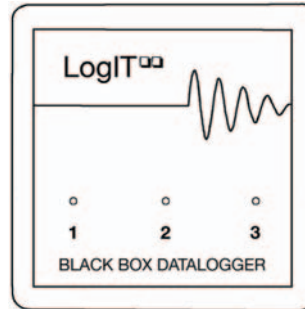
1

- Install datalogging software onto your computer.
- Plug Black Box into a free USB port.
- The LED's should momentarily flash.



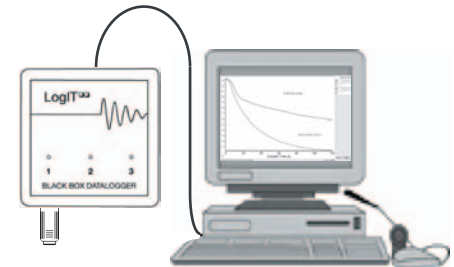
2

- Run the datalogging software - should automatically recognise Black Box.
- Plug LogIT Microsense sensors into Black Box either directly or via an extension cable - sensors are automatically recognised.

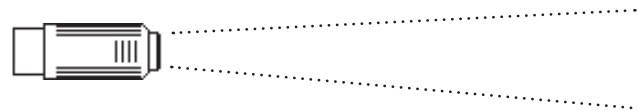


3

- Start logging!



# SmartEye sensor



It is called SmartEye because it is a versatile light sensor which adapts automatically to either measuring light level or timing events, depending on how you use it. SmartEye is different from a conventional light sensor in several ways:

- It has a particularly focused field of view (just  $20^\circ$ ) so that just like a torch you can aim and measure quite accurately. Most light level sensors have a very wide field of view of  $150^\circ$  or more, which is reasonable for measuring the average light levels of large areas (as a camera needs) but not very good when you are trying to measure or compare light from a specific area, as you often need to do in science experiments. You will notice that the sensor also incorporates a shroud to shield the detector from stray or incident light.
- SmartEye measures infrared (IR) as well as visible light. Although not sensitive enough to measure the infrared radiation from a radiator for example, it can detect stronger sources from IR remote controls or the sun and you can use this ability to demonstrate the effectiveness of different materials such as glass as insulators or filters. This makes it a versatile sensor to have in the lab, but always remember that it is also sensitive to infrared, particularly when measuring colours using a strong source of light like a filament lamp which has a high content of infrared light (for colorimetry you can use the new Colorimeter unit which is specifically designed for this function).
- The detector (called a PIN photodiode) inside SmartEye is a very fast reacting device and when used with the special software contained in Black Box it enables the sensor to be used for measuring Time, Frequency, Counts etc. You do this by simply aiming a fairly bright light (eg window or torch) at SmartEye and passing the object you wish to time or count in between the sensor and the light source, effectively breaking the beam - this is further explained in experiments later in this book. This extra digital functionality is selected by the software you are using.

The distance SmartEye can be used away from Black Box can be extended using one of the Microsense extension cables but we recommend it is not extended beyond 3 metres as this may introduce interference or inaccuracies.

The SmartEye sensor reads directly in the range of 0 to 20,000 Lux, the standard SI unit of Light illuminance. Although this is a very wide range, on an extremely bright sunny day the sensor can have too much light. But just as with human eyes, the level can be reduced using a filter (or sunglasses) to cut down the light. Note that although it may be tempting to point the sensor straight at a source of light this is not generally good practice and could cause serious damage if pointed at the sun. So, just as a photographer does with a light meter, the light sensor should be pointed at a surface or 'target' so that you measure the reflected light - a white card is ideal.

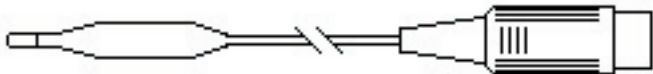
## Care

This sensor is robust but take care to protect it from excessive heat or light and never point any sensor directly at the sun. It is not waterproof so protect from water, rain or high moisture.

## Alternative sensors (also see page 40)

Other light level measuring sensors include the LUX sensor (which has eye response) and SPX LUX (very wide 100,000 Lux range). Alternative sensors for time and speed measurements include Light gate, Reflective switch, Accelerometer and Ultrasonic Ranger sensors.





## HiTemp temperature sensor

HiTemp is a general purpose temperature probe designed for measuring air, liquids (but not acids) and skin temperature within the range of  $-10^{\circ}\text{C}$  to  $+110^{\circ}\text{C}$  with a  $0.1^{\circ}\text{C}$  resolution and a typical accuracy of better than  $1^{\circ}\text{C}$ .

Due to its small size and low thermal mass, HiTemp has a fast response time and the sensor and cable are both lightweight and waterproof making it suitable for suspending in air or liquid and also ideal for measuring low surface or skin temperatures with its small tip.

As with any sensor, if you need to measure with accuracy and repeatability you must carefully control the experiment conditions and consider the effect of where and how the sensor is positioned. For example, if it is put into a beaker the sensor should not touch the glass walls and the liquid should be repeatedly agitated to maintain even heat transfer around the sensor.

The distance HiTemp can be used away from Black Box can be extended using one of the Microsense extension cables but we recommend it is not extended beyond 3 metres as this may introduce interference or inaccuracies.

### Care

The HiTemp tip and cable are waterproof but the connecting plug (and socket) are not. The sensor uses a thin cable to make it very flexible and versatile but you need to take care that the cable is not pulled, twisted or bent sharply as this could fracture wires inside - we suggest it is treated with the same care as you would the flexible wires used for music player headphones. Also take care not to force the sensor into things like hard soil and never expose it to strong acids or alkalis which could attack the plastic or stainless steel tip.

Do not expose the sensor to temperatures outside of its range - for example take special care if measuring the temperature in a heated pot or kettle as the element is at a much higher temperature than the water and will damage the sensor if touched. HiTemp is not suitable for measuring the temperature of anything over  $110^{\circ}\text{C}$  maximum, including flames.

### Alternative sensors (also see page 40)

For frequent experiments more suited to a longer solid probe style and which do not require such fast response times we suggest the LogIT Microsense® ProTemp which has a strong 180mm long stainless steel probe and which can measure a wider span of temperature in the  $-30$  to  $+130^{\circ}\text{C}$  range with a  $0.5^{\circ}$  accuracy and  $0.1^{\circ}$  resolution. The ProTemp can plug directly into Black Box for hand held wire-free monitoring and can also be used further away by using a sensor extension lead.

For higher temperature ranges such as ovens or even flames, a K-type thermocouple adapter is available which works with most of the different styles of K-type thermocouples available and can measure temperatures from  $-50^{\circ}\text{C}$  to  $+1200^{\circ}\text{C}$  with a resolution of  $1^{\circ}\text{C}$ , although bear in mind that thermocouples are generally not as accurate as the precision thermistor devices used in HiTemp and ProTemp.

# Troubleshooting

## Problem

I have purchased a new sensor but it is not recognised by the datalogging software.

I already have LogIT datalogging software installed on my computer but this does not seem to work with my new Black Box datalogger.

My Black box does not seem to always work reliably.

When I plug Black Box into my computer with no sensors connected the red light on channel 1 comes on but nothing else happens.

I need help using my Black Box.

## Solution

*Update your datalogging software by checking [www.logitworld.com](http://www.logitworld.com) or the datalogging software publishers website.*

*Install new software using the CD supplied with Black Box or check with your existing datalogging software publisher to see if there is an update available.*

*Check you do not have other software running at the same time which may conflict with its operation - also check your computer has enough power to run Black Box from the USB socket you are using - some USB ports can provide more power than others (check computer manual).*

*Reinstall the firmware inside Black Box using 'Update loggers system software' in LogIT Lab.*

**24 hour information and support : [www.logitworld.com](http://www.logitworld.com)**

# Experiments with LogIT Black Box

## Introduction to Experiments

The experiments included in this manual have been designed for use with the HiTemp temperature and SmartEye sensors supplied with Black Box. They can also be performed using other LogIT Microsense® sensors such as the ProTemp, LUX sensor or Light gate.

The experiments are designed to provide an understanding of how Black Box can be used within science lessons to teach science based practicals that follow the national curriculum. These experiments could also be adapted to form part of the science coursework for the UK GCSE requirements or used simply as the basis for investigative work within a science framework.

The experiments are only a small fraction of what is possible with the LogIT Black Box and by using additional sensors as listed on page 40, the Black Box can be built into a very powerful datalogging tool.

The experiments have been written from the teachers perspective and can be adapted for the abilities of the students as well as providing a basis for the development of work sheets if required.

As secondary school teachers tend to be science specialists, the experiments are left fairly open ended. This was deliberate to allow teachers to refine the resource to their own teaching style or to integrate easily into departmental schemes of work.

Details of how to set up the datalogging software for each experiment can be found in the manual supplied with the software. Hence, each experiment shows how to connect Black Box and what the software is required to measure.

## Subject contents

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# Capturing Light

**Subject: Physics**

**Sensor: SmartEye sensor**

**Aim:** To show that the apparently continuous light emitted from a fluorescent lamp is not constant but fluctuates.

## Overview:

When you look at light coming from a fluorescent or standard lamp, it appears to be constant in terms of its output. What actually happens can be quite surprising. Using the SmartEye sensor, LogIT Black Box and the fast triggered function of the logging software, the output of a fluorescent lamp can be captured.

**Equipment required:** LogIT Black Box.  
SmartEye light sensor.  
Light source such as a fluorescent lamp.  
Black card or human finger.  
Infrared remote control (Extension activity).

## Hazards:

Students should be supervised at all times.  
Do not look directly into the light from the lamp.  
Allow the lamp to cool before handling in any way.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

## Setup:

1. Connect Black Box to the computer using the USB cable.
2. Plug the SmartEye sensor into any channel of Black Box.
3. Start LogIT Lab software.
4. Click 'Setup' then select 'Fast with trigger (one sensor only)' and click 'Next'
5. Select '500 microseconds for 0.1 seconds' as the log rate and interval then click 'Next' followed by 'Finish'.

Note: Depending on the brightness of the lamp you may find that the finger over the end of the sensor is sufficient to keep the logger from triggering early. If not, use a thick piece of black card. If using other datalogging software, set the logging interval to 500 microseconds. The photo shows an energy saving fluorescent lamp being used which worked well using a 500 microsecond logging interval. Note that some energy saving bulbs have complex electronics which can remove the flicker and may not be suitable.



## Method:

1. Place either the finger or hold a piece of black card over the end of the SmartEye sensor.
2. Place the sensor about 30cm from the fluorescent lamp.
3. Uncover the end of the sensor allowing the light to enter the sensor.

Note: This method should produce some very repeatable results but needs a little practise in where exactly to aim the sensor. Make sure that the sensor is pointing directly at the edge of the lamp so as not to reduce the amount of light entering the sensor. This shouldn't however affect the frequency however.

## Results:

Are the results surprising? Why can the human eye not see this effect?

Can the frequency of the lamp be calculated from the results? What is surprising about this result?

What factors do you think may have contributed to any incorrect results?

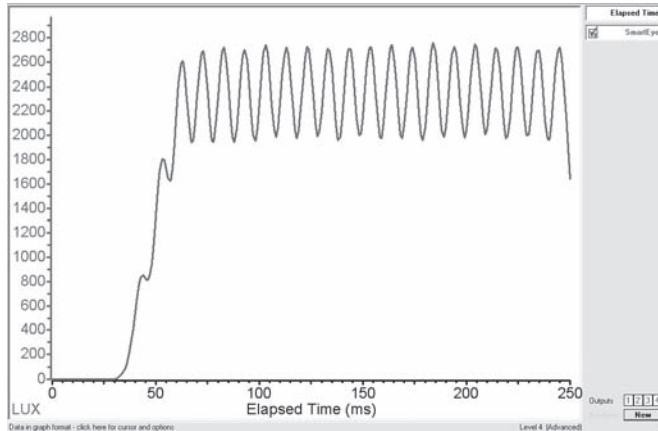
What would you do to improve the accuracy of the experiment?

## Going further:

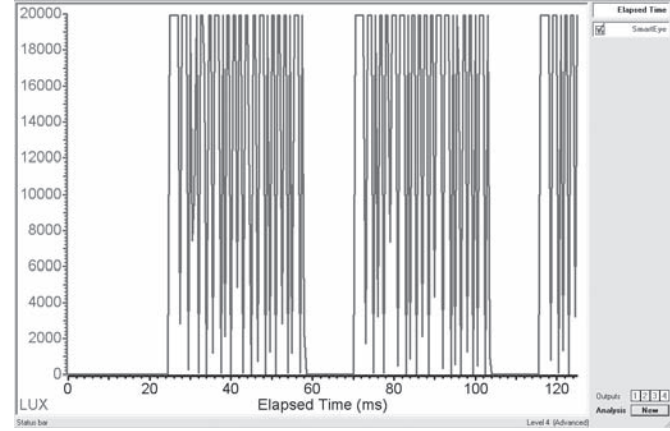
A television infrared remote control can give interesting results. Use the same method but instead of holding a finger or card over the sensor, simply aim the remote directly at the end of the sensor (about 1 cm away) and press one of the remote control's buttons.

From the results, you can show how different controls produce different shaped signals in order to operate the different functions of the remote. This can be achieved by using the 'Overlay' function to compare the signals directly.

Try using the 'scope' mode in LogIT Lab changing the 'Time/Div' and 'Volts/Div' to obtain a larger trace.



*Fluorescent Lamp.*



*Television remote control.*

# Friction

**Subject: Physics**

**Sensor: SmartEye sensor**

**Aim:**  
To test the effect of friction on the speed/time of a 'vehicle' travelling down a ramp.

**Overview:**  
The choice of using speed or time is partly dependent on the abilities and knowledge of the students. Because only one SmartEye sensor is used a known length of card is required so that the speed can be calculated. Black Box starts timing when the front edge of the card passes the sensor and stops timing when the back edge passes i.e. it times how long it takes the card to pass in front of the sensor. By knowing the length of the card and how long it took to pass, the speed can be calculated.

**Equipment required:** LogIT Black Box.  
SmartEye light sensor.  
Dynamics trolley, toy car or similar.  
20cm matt black card.  
Light source such as torch, lamp or similar.  
Test track which can be raised to form a ramp.  
Different materials to be placed on the track.

**Hazards:**  
Students should be supervised at all times  
Ensure the datalogger cannot come into contact with water or damp.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Cut out a 20cm long piece of matt black card and attach it to the test vehicle.
2. Place Black Box about three quarters of the way down the track ensuring the card passes in front of the SmartEye sensor.
3. Place the light source opposite the SmartEye sensor forming a light 'gate'.
4. Connect Black Box to the computer, start the datalogging software and select the timing function. Set up the software so that it knows you are using a single light 'gate'.



Note: Black Box can be used with a clamp stand or simply placed on text books. If using clamp stands, do not clamp Black Box too tightly. Ensure that the light source shines into the SmartEye as this change in contrast between the light source and black card will allow Black Box to 'see' the card go past.

## Method:

1. Run the vehicle down the ramp passed Black Box without a material on the ramp's surface. (Does the ramp's surface count?)
2. Choose a piece of material and write down its description. Place it securely onto the ramp's surface.
3. Run the vehicle down the ramp again.
4. Repeat this for each piece of material.
5. When finished the results can be printed, saved or transferred to a spreadsheet for more analysis.

Note: If you obtain some strange results, this can usually be attributed to a false trigger of the light 'gate'. This can happen if a hand or other object inadvertently passes through the gate. You can also get false triggers if the ambient light changes suddenly, for example bright sunlight falling on the sensor part way through an experiment.

## Results:

There are a number of factors which affect the outcome of this experiment and can be used to form the basis of a 'fair test' discussion relating to the results. For example, the height of the track, starting point of the vehicle or whether the vehicle is pushed or simply released.

Was the method chosen a fair test?

Which material slowed the vehicle the most (largest friction)?

Which material slowed the vehicle the least (smallest friction)?

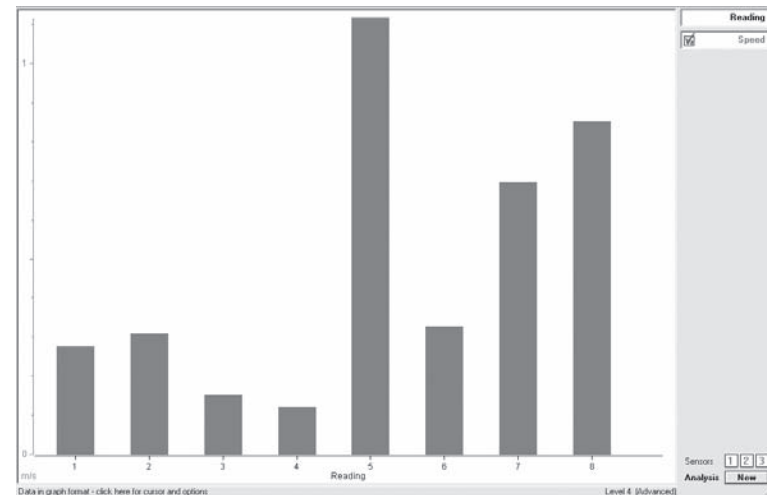
## Going further:

What effect would different size tyres have on the results.

Does the mass of the vehicle change the results?

Does the shape of the vehicle affect the outcome?

How does the angle of the ramp affect the results?



# Induced EMF

**Subject: Physics**

**Sensor: 100mV signal adapter**

**Aim:** To show how induced voltages can be created using a magnet and to see what effect the speed of the magnet has on the induced EMF.

## Overview:

For this investigation, the induced voltage is to be plotted against time as a magnet passes through the middle of a coil of wire. The resultant graph will show how the voltage varies as the magnet travels through the coil.

**Equipment required:** LogIT Black Box.  
100mV signal adapter  
A coil of wire  
A strong magnet (which must pass through the middle of the coil)  
Cloth or similar to catch the magnet  
Wires to connect to the adapter.

## Hazards:

Students should be supervised at all times.

A set of soft cloths in a box might be used to catch the magnet as it falls to prevent injury.

Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

## Setup:

1. Connect Black Box to the computer using the USB cable.
2. Connect the signal adapter into Black Box and connect the coil to the adapter.
3. Start LogIT Lab software.
4. Click 'Setup' then select 'Fast with trigger (one sensor only)' and click 'Next'
5. Select '2 milliseconds for 0.4 seconds' as the log rate and interval then click 'Next' followed by 'Finish'.

Note: You will need to trial your combination of magnet and coil as with more turns or a more powerful magnet you will obtain a greater or lesser induced voltage. The height the magnet is dropped will also result in a greater induced voltage. In our example we used a readily available school magnet and a coil of some 200 turns.





## Method:

1. Drop the magnet through the coil.
2. Repeat using 'overlay' and drop the magnet from a greater height.
3. When finished, stop the datalogging software.
4. Save and print the results.

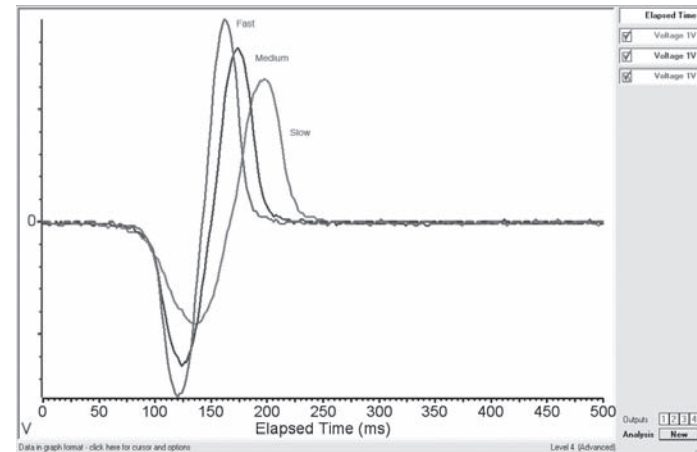
Note: Whilst the procedure on paper seems quite straight forward, it can take a bit of practice to get the magnet to pass cleanly through the coil. Also, its important that the magnet does not hit hard objects and is caught by a soft cloth as continual impacts will weaken the magnet or indeed break it completely.

## Results:

Why does the voltage go first one way then the other?  
 Are the results what you expected?  
 What was done to ensure accuracy of readings?  
 How would you make the experiment a fair test?

## Going further:

How might the graph change if more coils were added or a stronger magnet used?  
 What happens if the magnet is reversed and dropped through the coil?  
 Can the speed of the magnet be calculated from the graph?  
 What happens if two magnets are placed together (north to south) and dropped through?



# Cooling by evaporation

**Subject:** Physics

**Sensor:** Temperature

**Aim:**

This simple procedure can be used to show the heat being absorbed by an evaporating liquid and the subsequent drop in temperature plotted.

**Overview:**

Latent heat is the heat absorbed or released by a substance as it changes state ie. liquid to gas at a constant temperature and pressure. The latent heat needed for evaporation is taken from the liquid itself which subsequently cools and as a result cools its surroundings.

The method provides scope for students to expand their thinking about heat absorption, evaporation and how the body might keep cool.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Clamp stand or similar  
Paper towels, pipettes drip tray or mat  
Distilled water  
Methylated spirit/alcohol/mineral spirit

**Hazards:**

Students should be supervised at all times.

Ensure the datalogger cannot come into contact with water or damp.

Goggles should be worn and avoid skin contact with samples.

Always check your local regulations or a school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Cut strips of a paper towel about 3 cm long and the width of the temperature sensors stainless tip. (About 7 mm)
2. Mount the temperature sensor horizontally in the clamp stand.
3. Fold the strip of paper in half and by slightly squashing it, place it onto the end of the mounted temperature sensor. (see picture)
4. Connect the temperature sensor to Black Box and connect Black Box to the computer.
5. Start the datalogging software and if necessary set the time span to 3 minutes.

Note: If using a clamp stand to hold the temperature sensor, do not clamp too tightly.

You can use cotton wool instead of paper but be aware that placing the cotton wool on the temperature sensor is difficult and if covered in methylated spirit can be a handling hazard. By tightly squeezing the paper you should find it sits securely on the probe tip.



## Method:

1. Start the datalogging software.
2. Using a pipette, drop water onto the paper wrapped around the temperature sensor until it is saturated.
3. Continue logging the temperature for about 3 minutes.
4. Remove the paper from the probe and wipe dry using a paper towel.
5. Allow the temperature of the probe to reach the starting temperature of the water sample.
6. Fold another strip of paper in half and place it onto the end of the mounted temperature sensor as before.
7. Start the datalogging software again and use the 'overlay' function to plot over the top of the previous graph.
8. Repeat step 1 above using the spirit in place of water.

## Results:

What do the results show?

How do the two traces differ?

What can be concluded about the latent heat of the two samples?

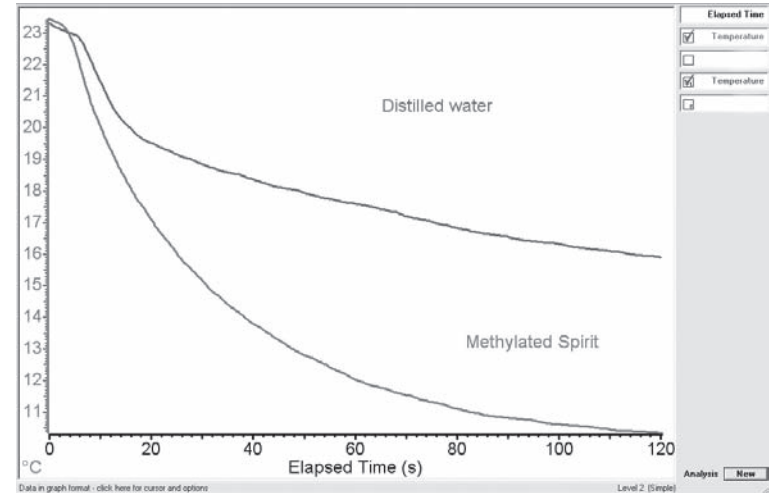
## Going further:

What other liquid could you try?

What would happen to the latent heat if a fan was used to blow air continuously over the sample?

This can also make an interesting demonstration:

On a sunny day, invert a clay plant pot. Insert a temperature probe into the middle of the pot and place a temperature sensor outside the pot. Pour water onto the pot until it is fairly well saturated and log the temperature over a few hours. Direct sunlight is best. What might be found? You can also place a few ice cubes inside the pot and a few outside the pot.



# Where does the heat go?

**Subject:** Physics

**Sensor:** Temperature

**Aim:** This investigation is designed to show what happens to the heat (energy) from a liquid when it cools.

## Overview:

It is designed to show that objects cool or warm to the temperature of their surroundings. It is also a good introduction to making a prediction to an investigation. Students can predict what will happen to the two temperatures if left for a long period of time.

Note: This experiment is shown with an additional temperature sensor being used. However, by using the 'Overlay' function in the datalogging software it can be performed with a single sensor.

**Equipment required:** LogIT Black Box  
2 Temperature sensors  
Hot water (No hotter than 50°C), Cold water  
2 containers - 1 large, 1 small  
Tray and paper towels to catch spillage

Note: Make sure that the small container fits safely inside the larger one.

## Hazards:

Students should be supervised at all times.

Ensure the datalogger cannot come into contact with water or damp.

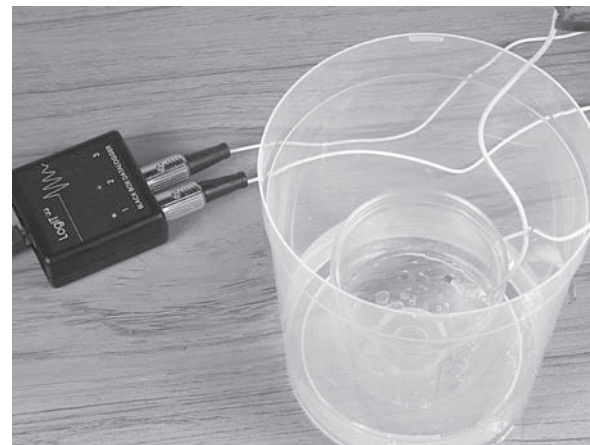
Hot water above 55°C should be avoided as this can scold.

Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

## Setup:

1. Connect the temperature sensors to Black Box and connect Black Box to the computer.
2. Start the datalogging software and if necessary set the time span to at least 20 minutes.
3. Place the smaller container into the larger one.

Note: If using small containers, you might like to fix the smaller of the two containers to the bottom of the larger one using a piece of modelling clay. Alternatively you could use a large stopper. This also aids in keeping the two containers insulated from each other.



## Method:

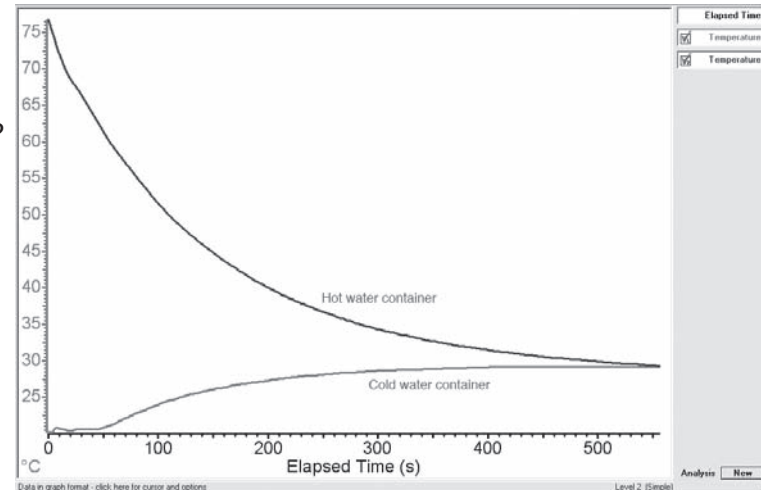
1. Carefully pour hot water into the inner small container.
2. Carefully pour cold water into the larger outer container to the same level as the inner container.
3. Place the temperature sensors into the two containers making sure they do not touch the sides.
4. Start the datalogging software.
5. While logging the experiment can be discussed with students asked to predict what will happen. Students could sketch a graph.
6. Once the temperatures no longer rise or fall, stop the datalogging software and save or print the results.

## Results:

Looking at the two traces, where did the heat energy appear to go?  
 What would happen to the two temperatures if the experiment was left for a few hours?  
 When did the cold water gain heat energy and then lose it?  
 What happens to the heat energy lost by the cold water in the outer container?  
 Why is it important not to let the temperature sensors touch the sides?

## Going further:

Leave the cooling process over a longer period of time.  
 Put lids on the containers. What effect might this have?  
 What about the shape and volume of the containers?  
 Try insulating the outer container. What effect might this have?



# Sound Wave analysis

**Subject: Physics**

**Sensor: Sound Wave sensor**

**Aim:**

To study Amplitude and Frequency of sound waves.

**Overview:**

Sound waves are longitudinal waves which consist of particles oscillating in the same plane as the direction that the sound wave is travelling. These waves can be examined using an oscilloscope and a microphone. By using a Sound Wave sensor, sound waves can be examined and the changes in frequency and amplitude demonstrated easily.

**Equipment required:** LogIT Black Box  
Sound Wave sensor  
Selection of tuning forks (we used two)

**Hazards:**

Students should be supervised at all times.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Connect Black Box to the computer using the USB cable.
2. Connect the Sound wave sensor into any channel of Black Box.
3. Start LogIT Lab software.
4. Click 'Setup' then select 'Fast with trigger (sensor 1 only)' and click 'Next'
5. Select '100 microseconds for 20 milliseconds' as the log rate and interval then click 'Next' followed by 'Finish'.

Note: When you click 'Finish' the software will wait until an event occurs which will trigger the recording of data. If you find that the readings are not smooth and are a little spiky, try decreasing the timing interval to 50 microseconds as the spikes are caused by missing data. If you find the readings are too rounded with not enough peak's, then increase the logging interval.



## Method:

1. Strike the first tuning fork. (You will get a false reading on the screen as the strike is picked up)
2. Hold the vibrating tuning fork in front of the sound wave sensor and press 'R' to re-record the sound.
3. Click on the green icon to start the next recording.
4. Select 'Overlay' from the pop up menu.
5. Strike the tuning fork and place in front of the sound wave sensor as before.
6. Click the green icon to collect the readings and overlay the original graph.
7. Repeat from step 3 for additional tuning forks.

Note: In this experiment we used two tuning forks which were an octave apart. One of 256 Hz and one at 512 Hz. From the results, students can see the difference in frequency as one is twice the other. The amplitude can be investigated by using one tuning fork but striking it harder to increase the amplitude.

## Results:

What do the results show?

How can you tell one tuning fork has a higher frequency than the other?

Are the readings accurate? How can you check this from the graph?

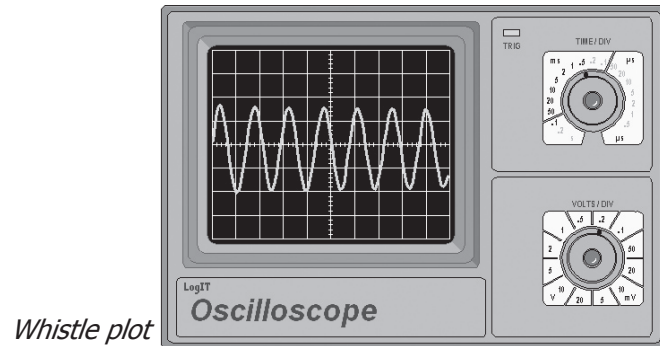
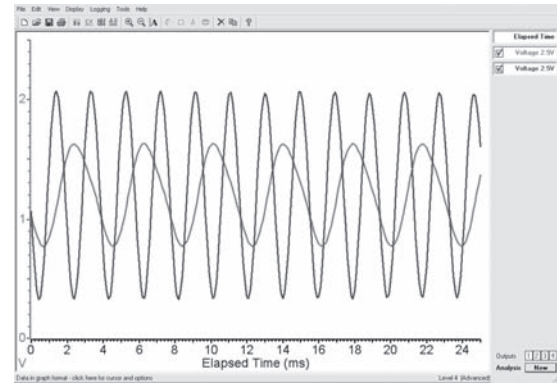
## Going further:

How might you investigate how as amplitude increases, frequency stays the same?

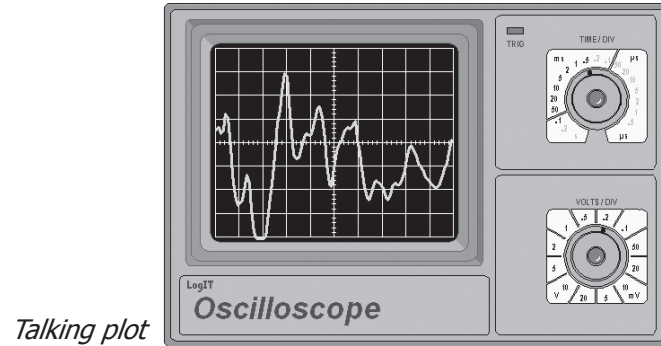
Try using two tuning forks of different frequency at the same time.

Try using the oscilloscope function in 'LogIT Lab' to show how different sounds make different sound wave patterns.

You can also use the oscilloscope mode to very quickly demonstrate the differences in amplitude and frequency of different sounds by whistling or talking.



*Whistle plot*



*Talking plot*

# Endothermic Reactions

**Subject:** Chemistry

**Sensor:** Temperature

**Aim:**

To show the difference between a chemical or physical change and to also show a reaction has taken place.

**Overview:**

There are a few reactions in Chemistry where energy is absorbed from the surroundings during the reaction. When this happens, the temperature of the reactants drops and an endothermic reaction has taken place. The experiment is also a simple rate of reaction experiment in that you can vary the starting temperature of the water, size or shape of the antacid.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Small vessel, beaker or boiling tube  
Antacid such as Alka-seltzer® (Sodium Bicarbonate and Citric Acid)  
Water

**Hazards:**

If using warm water, make sure the water is not too hot for the ability of the students.  
Water temperature above 55°C will scold students.  
Allow the temperature to cool before use. Place the tubes over a tray to catch any spilt water.  
Alka-seltzer® or similar can contain aspirin.

**Setup:**

1. Connect the Temperature sensor to Black Box and then connect Black Box to the computer.
2. You can use a clamp stand to hold the sensor if required.
3. Place the water into the small vessel, beaker or boiling tube.

Note: In the picture we have used a Micro Science kit with the Alka-Seltzer® about to be introduced to the water. This allows for the use of small amounts of water and Alka-Seltzer® (2.0 ml of water and 0.3 g of Alka-Seltzer® in this example). You can use boiling tubes, about 10ml of water and half a tablet which is about 1.5 g.  
Be careful of using too much water as this will cause only a small drop in temperature due to the volume of water being reacted with the tablet.





**Method:**

1. Set your software ready to start taking readings.
2. When the temperature has reached a stable value start logging.
3. Add the Alka-Seltzer® tablet. (You can add a marker to the graph either by pressing the Red button if logging remotely, or selecting the down arrow from the icons at the top of LogIT Lab)
4. Record until the temperature no longer falls.
5. Stop logging.
6. Repeat for different temperatures of water, different size or different shape of Alka-Seltzer.

Note: If you are varying the temperature of the water, you could use more channels and record the temperature changes on the same graph. This could also be achieved by using the 'Overlay' feature found in datalogging software.

You may also need to use the zoom facility of the software to show the results more clearly. You can also use the smoothing function to produce a cleaner curve from the gathered results.

**Results:**

How much of a temperature change was there?

How does this show that a reaction has taken place?

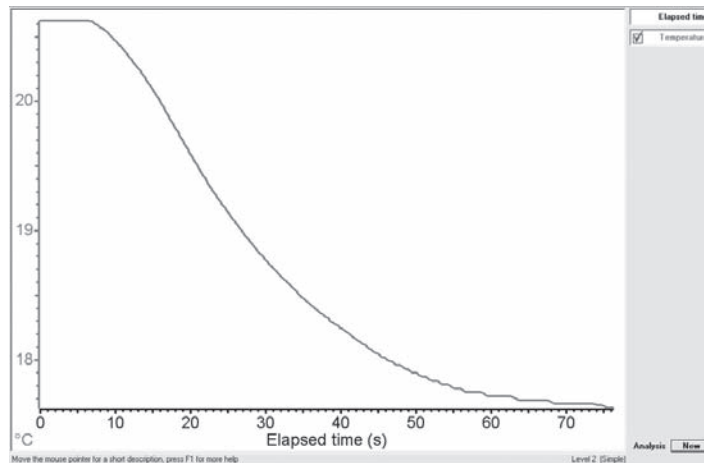
**Going further:**

How would the shape and size of the Alka-Seltzer affect the graph?

Try using vinegar instead of water. What might happen to the speed of the reaction and shape of graph this time?

How might the investigation be changed to calculate the rate of reaction?

What other factors could you investigate using this method?



# Cooling curves

**Subject:** Chemistry

**Sensor:** Temperature

**Aim:**

To show the technique for recording a cooling curve and subsequent freezing point for tap, distilled and salty water.

**Overview:**

A change of state is a change from one physical state to another eg. solid to liquid or liquid to gas. While this change of state is occurring, there is no change in temperature as all of the energy is used to make or break molecular bonds. In practice this can be quite difficult to show.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Small vessel, beaker or boiling tube  
Freezer  
Salt (Sodium Chloride)  
Tap water (No hotter than 40°C)  
Distilled water (No hotter than 40°C)

**Hazards:**

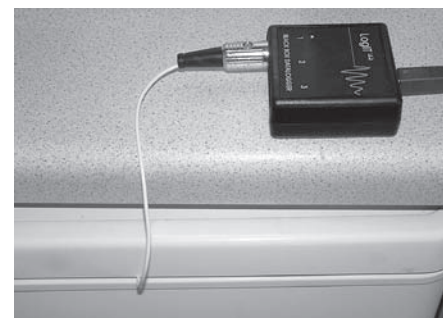
If warming the water first, make sure the water is not too hot for the ability of the students. Water temperature above 55 °C will scold Students. It is sometimes useful to use hot water from the schools water supply.

Care must be taken if using kettles to heat the water. Allow the temperature to cool before use. To avoid cross contamination, do not use a freezer which contains food for human consumption. Do not put very hot water into a freezer as damage to the freezer may result.

**Setup:**

1. Connect the Temperature sensor to Black Box and then connect Black Box to the computer.
2. Start the logging software.
2. Place the water into the small vessel, beaker or boiling tube.

Note: For good results it is necessary to make sure that the Temperature probe does not touch the sides of the container. This can be achieved either by passing the probe through thick card and suspend the probe in the middle of the water or by carefully 'hooking' the probe on the edge of the vessel using the probe's cable. (Do not bend the cable at a tight angle as this can damage the cable)



**Method:**

1. Place the vessel into the freezer. (Make sure that the cable cannot get 'trapped' in the door)
2. Start logging.
3. Allow the water to freeze. (the time needed depends on the amount of water used)
4. Stop logging.
5. Repeat the experiment using distilled water or salty water.
6. When finished the results can be saved and printed.

**Results:**

Did the cooling curve give the expected result?

What factors might have affected the final curve?

What is significant about the shape of the cooling curve?

How do the distilled, salty and tap waters compare? Why is this so?

Why might the tap water not freeze at 0°C?

**Going further:**

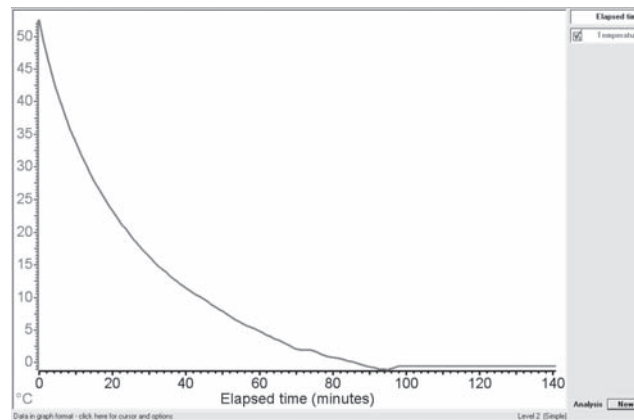
Try different starting temperatures of water.

Try using more than one temperature sensor and have different concentrations of salt.

Calculate the rate of temperature change for the cooling curves.

Try other liquids such as pure orange juice or squash.

Why might this experiment be useful to freezer manufacturers or food companies?



# Rates of reaction

**Subject:** Chemistry

**Sensor:** SmartEye sensor

**Aim:**

To show that concentration of reactants affects the reaction time.

**Overview:**

When Sodium Thiosulphate and Hydrochloric Acid are reacted together, a precipitation of sulphur is produced and the solution becomes cloudy. By measuring the light intensity through the solution, timing how long the precipitate takes to form, the rate of reaction can be found. The use of Black Box and the SmartEye sensor has some distinct advantages over the traditional cross and observation method in that the plotted graph shows at what point light is no longer reduced. Thus the time of the reaction can be more accurately observed. The products of this reaction are Sodium Chloride, Sulphur, Water and Sulphur Dioxide.

**Equipment required:** LogIT Black Box  
SmartEye sensor  
Small test-tube and cotton wool (used to seal the tube)  
Pipette or small burette  
0.15 Molar Sodium Thiosulphate  
1 Molar Hydrochloric Acid  
Distilled water  
Paper towels or tissue paper to dry the test tube  
Light source such as a torch  
Piece of black card

**Hazards:**

Students must be supervised at all times.  
Goggles must be worn.  
Avoid inhalation of any gas given off if not contained in the test-tube.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous materials or chemicals.



## Setup:

In this procedure the amount of Acid was kept constant at 1 ml. You can increase/decrease the amount of acid depending on time. The concentration of Sodium Thiosulphate was altered by adding varying amounts of distilled water.

Sodium Thiosulphate (ml)	3	2.5	2.0	1.5	1.0
Distilled water (ml)	0	0.5	1.0	1.5	2.0
Hydrochloric Acid (ml)	1	1	1	1	1
<hr/>					
Total volume of liquid (ml)	4	4	4	4	4

For this experiment, you need to make a tube of cardboard to channel the light to the SmartEye sensor. In this example, we cut the profile of the test tube into one end of the tube so that the light has to pass through the test tube.

## Method:

1. Connect Black Box to the computer.
2. Set up the datalogging facility of the software. (For LogIT Lab use 'Autolog' otherwise set the time span between 5 and 15 minutes.)
3. Carefully measure out 3 ml of Sodium Thiosulphate and place it into the test-tube.
4. Start logging.
5. After about 15 seconds, add 1 ml of Hydrochloric Acid. (The dropping of the acid should be enough to mix the reactants.)
6. Keep collecting data until the light levels no longer drop ie. the reaction has finished.
7. Stop logging and then repeat for the different concentrations by adding distilled water shown in the above table.

Note: It is important to clean the test-tube thoroughly with distilled water between readings.

The reaction time can be obtained from the graph from where the plot starts to fall to where the plot levels off again. The rate of the reaction can be determined by calculating how much sulphur was produced in the recorded time.

Since we can assume that the amount of sulphur obtained is the same, the rate of reaction can be expressed as:-  $\text{Rate of reaction} = 1 / \text{Time taken}$

## Results:

What do the results show about how the rate of reaction can be changed?

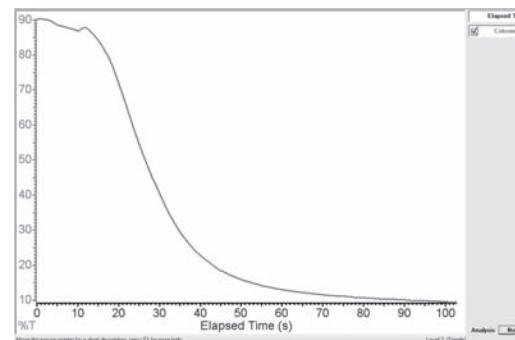
How does this method ensure it was a fair test?

Why was it important to ensure the test-tube was thoroughly cleaned each time?

## Going further:

How might the temperature affect the reaction rate?

How might this experiment relate to reactions at home?



# Combustion of fuels

**Subject:** Chemistry

**Sensor:** Temperature sensor

**Aim:**

To find out how much energy is released per gram of fuel burnt.

**Overview:**

By using a temperature sensor, the temperature rise of a known volume of water can be measured and the amount of energy released by the fuel can be calculated.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Spirit burner  
Conical flask or boiling tube  
Measuring cylinder and balance (to record the mass of the fuel burnt)  
Clamp stand  
Methylated spirit/alcohol/Mineral spirit or similar fuel

**Hazards:**

Students should be supervised at all times.  
Goggles should be worn and heat proof mats also used.  
Ensure the datalogger cannot come into contact with water or damp.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Clamp the conical flask into the clamp stand and insert the temperature probe.
2. Plug the temperature probe into Black Box and connect Black Box to the computer.
3. Put 100 ml of water into the flask/boiling tube.
4. Find the mass of the spirit burner and methylated spirit.
5. Start the datalogging software and if necessary set the time of the experiment to 10 minutes.

**Note:** If you are using LogIT Lab, you can make use of the 'Autolog' function. It is important to make sure that the temperature probe does not touch the sides of the conical flask. It is also good practise to wrap the cable away from the flame around the clamp stand.



**Method:**

1. Start the datalogging software.
2. Place the spirit burner under the conical flask.
3. Ignite the spirit burner.
4. Stop logging after 10 minutes or a rise in temperature greater than 40°C is observed. Extinguish the spirit burner.
5. Using the plotted graph obtain the temperature change from the start of the experiment to the end.
6. Obtain the mass of the burnt fuel.

Hint: You can repeat the experiment and take an average.

**Results:**

4.2 joules of energy will raise 1 gram of water by 1°C. To calculate the amount of energy released, use the following formulae. Remember that 100 ml of water has a mass of 100 grams

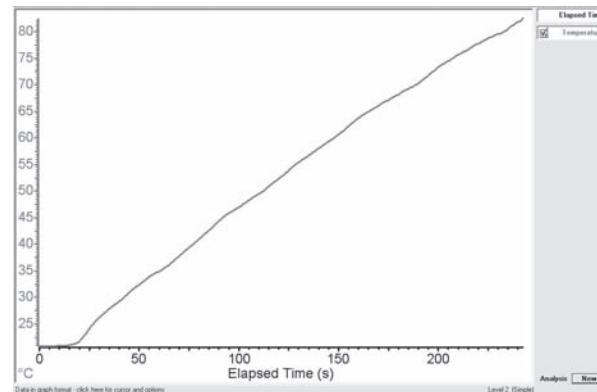
$$\text{Energy released (kJ)} = \frac{\text{mass of water (g)} \times \text{temperature rise (}^{\circ}\text{C)} \times 4.2}{1000}$$

$$\text{Energy released per gram} = \frac{\text{Energy released (kJ)}}{\text{Amount of fuel burnt (g)}}$$

How accurate do you think the results are?

Has all of the heat energy released by the fuel been used to heat the water?

What effect does heat loss have on the results? How could you prevent this?

**Going further:**

What factor could you vary in this investigation in order for it to be a fair test? How would you investigate this factor?

How about investigating other fuels?

Why are there so many different fuels for different applications? What properties of these fuels make them appropriate for the application involved?

How might you investigate the energy released by gaseous fuels such as butane?

How important is this test on fuels that might be used in the home?

# States of matter

**Subject:** Chemistry

**Sensor:** Temperature sensor

**Aim:**

To record any change in temperature of ice during the change of state.

**Overview:**

This classic datalogging experiment presents students with a challenge as to the position of the temperature sensor whilst the ice is melting. This procedure can be used to show that no change in temperature is observed at the melting and boiling point of ice/distilled water.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Spirit burner  
Boiling tube  
Clamp stand  
Finely crushed ice

**Hazards:**

Students should be supervised at all times.

Goggles should be worn and heat proof mats also used.

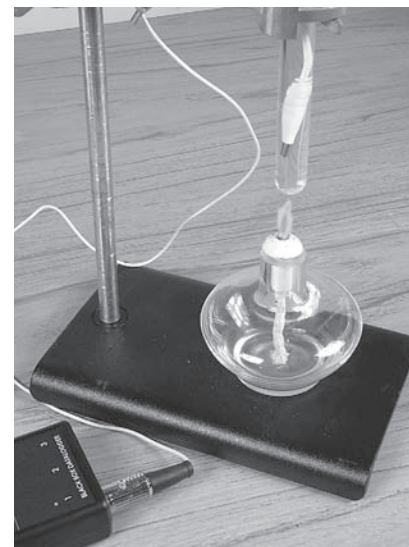
Water over 55°C can scold so extra care must be taken if investigating the change of state at the boiling point. (Teachers may decide to perform this as a demonstration)

Ensure the datalogger cannot come into contact with water or damp.

Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Clamp the boiling tube into the clamp stand and insert the temperature probe.
2. Put the sensor cable around the back of the clamp stand to prevent burning.
3. Plug the temperature probe into Black Box and connect Black Box to the computer.
4. Set your software ready to start taking readings.





**Method:**

1. Fill the boiling tube with finely crushed ice.
2. Make sure the temperature probe does not touch the bottom or sides of the tube.
3. When the temperature reaches freezing, start logging.
4. Light the spirit burner.
5. When the temperature reaches 100°C, keep logging for a minute and then stop logging. (If it is not required that the temperature reaches boiling point for reasons of safety, the readings can be stopped before this point is reached.)

Hint: The real trick with getting a good change of state graph is to make sure that the temperature sensor remains in the melting ice and does not touch the sides. If the sensor is moved too much, then strange results can occur due to convection effects in the tube.

**Results:**

Was there a flat area of the graph?

Was the water pure? How might you tell from the graph?

Did the results match the students prediction?

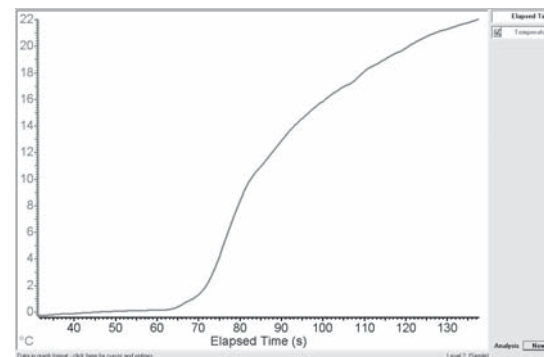
Discuss the change of state from Solid to liquid and then liquid to gas or demonstrate the liquid to gas change of state if this was not performed by the students themselves.

**Going further:**

Look at how the state can be reversed (see 'Cooling Curves').

How might the change of state of gas back to liquid be shown?

When talking about water turning into a gas it should be pointed out that the steam is in fact colourless and that the 'white cloud' we normally say is the steam, is in fact water vapour as the steam (gas) turns back to liquid. This can be observed at a boiling kettle, there is a little gap between the kettle spout and the cloud of water vapour, this gap is the colourless gas.



# Classroom environment studies

**Subject: Biology/Environmental studies**

**Sensor: SmartEye sensor and HiTemp temperature sensor**

## Overview:

Environmental studies are becoming more and more important in every day life. The environment we work in is also important and this simple procedure shows how to obtain temperature and light readings from the classroom.

This procedure also can be used as a simple introduction to the use of scientific equipment, ICT and how to analyse results and draw conclusions from collected data.

**Equipment required:** LogIT Black Box  
SmartEye light sensor  
Temperature sensor  
Computer.

## Hazards:

Students should be supervised at all times  
Ensure the datalogger cannot come into contact with water or damp.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

## Setup:

1. Find a secure place for Black Box and the sensors.
2. Plug the sensors into two channels of Black Box.
3. Connect the Black Box to the computer using the USB cable and start the datalogging software.
4. Decide if you are going to log data either first thing in the morning, last thing in the afternoon or for just the lesson.

Note: This simple procedure can be set up and allowed to log for either 30 mins during which time the environment in the room can be discussed or allowed to run for 12 or 24 hours and discussed during the next lesson. Make sure that the screen saver for the computer is deactivated to prevent the logging from being interrupted which can happen on some computers.



### Method:

1. Start logging with the datalogging software.
2. Allow the data to be collected for the predetermined length of time.
3. Stop logging.
4. Save or print the results.

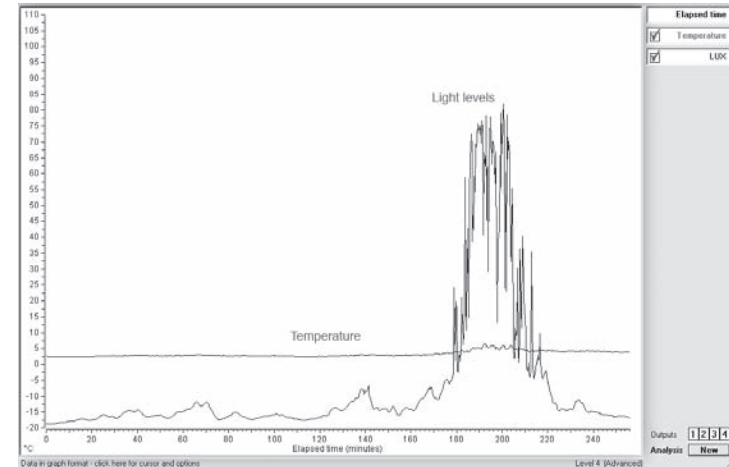
Hint: During a short environmental study, you can discuss the effects of opening windows or indeed closing them (during the summer) to see what effect this has. You could even close/open a window without drawing this to the students attention and see if this can be detected on the resultant graph.

### Results:

- Did the temperature change?
- Did the light level change?
- Did the changes take place at the same time.
- When was it the coldest ?
- Did anything happen after you left school or before you arrived ?
- Was it always hot or cold at certain times ?

### Going further:

- Try the experiment on different days in the week.
- Try the experiment at different times of the year e.g. Autumn, Spring, Summer and Winter.
- Move the Black Box somewhere else in the class and see if this effect the results - if it did, why ?
- Monitor outside the school or in other rooms such as the hall or gym.
- Produce a display of results showing pictures of what happened at certain times along the graph and link this to the school timetable.



# The Greenhouse Effect

**Subject:** Biology/Environmental studies

**Sensor:** HiTemp temperature sensor

**Aim:**  
To study the heating effect of Carbon Dioxide in relation to the earth's atmosphere.

**Overview:**  
Most students will have heard of the 'greenhouse effect'. This investigation sets out to find out if high levels of Carbon Dioxide gas could cause a 'warming up' of the atmosphere. It makes use of readily available household chemicals and items such as small plastic bottles. By dropping an Alka-seltzer® into one of the bottles, Carbon Dioxide will be produced inside the bottle and will simulate an increase in CO<sub>2</sub> levels within the bottles 'atmosphere'. The other bottle will contain simply air and will remain as the constant in the experiment.

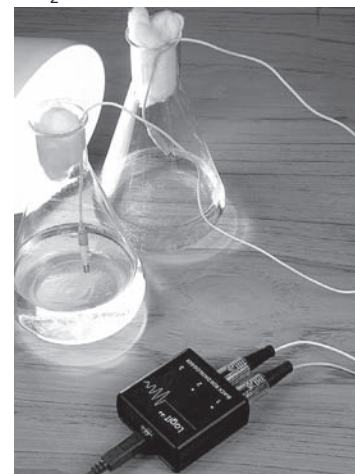
**Equipment required:** LogIT Black Box  
Temperature sensor (An additional sensor is preferable)  
2 small bottles or flasks (the small drinks bottles are ideal)  
Cotton wool  
Alka-seltzer® or similar to produce the CO<sub>2</sub> gas  
Lamp (100 watt bulb) to act as the sun

**Hazards:**  
Students should be supervised at all times  
Ensure the datalogger and lamp cannot come into contact with water or damp.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source. Alka-seltzer® or similar can contain aspirin.

**Setup:**

1. Pour the same amount of water into each bottle. We used 50ml in each bottle for this example.
2. Plug the Temperature sensors into Black Box and place in the top of the bottles. Make sure they are near the top and not touching the sides and if using one sensor, make the position the same for both experiments.
3. Connect Black Box to the computer using the USB cable.
4. Seal one bottle using the cotton wool being careful to leave the temperature probe in place at the top of the bottle.
5. Have an Alka-seltzer® tablet ready for one of the bottles.

**Note:** The photo shows the Black Box and the two flasks during the experiment with the cotton wool sealing each of the flasks. The use of the cotton wool offers a good insulated seal against heat loss and also allows any pressure created by the tablet to be safely vented.



## Method:

1. Place the lamp close to the two bottles.
2. Add the Alka-seltzer® tablet to the open bottle and then seal the bottle with the cotton wool. Make sure the temperature sensor is correctly positioned.
3. Start the datalogging software.
4. Record the data for a period of half an hour. (If using one sensor at a time, use 'overlay' within the software to plot the second bottle over the first. Make sure the starting temperatures are the same and that the lamp is the same distance from the bottle.)

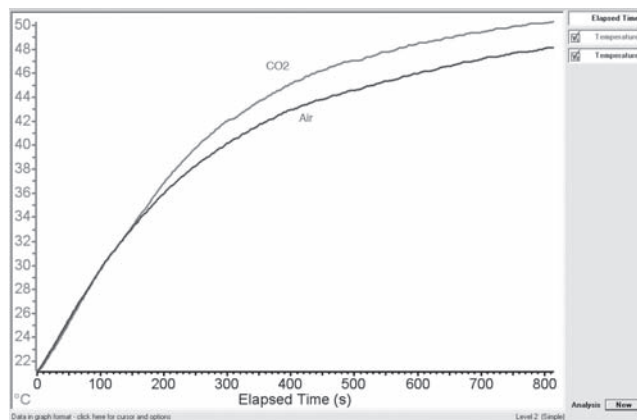
Hint: If the temperature does not appear to rise by a significant amount, try repositioning the lamp a little closer to the bottles.

## Results:

Does the temperature in the bottle containing carbon dioxide rise more than the bottle containing air?

Are these results reliable?

How could you alter the investigation to ensure that the difference in temperature at the end was due to the two different gases and not that the bulb was closer to one of the bottles?



## Going further:

What factor could you vary in this investigation in order for it to be a fair test? Could you for instance vary the volume of gas by increasing or decreasing the amount of water added?

What effect does different coloured light have on the temperature change? Try using felt tips to colour the plastic bottles or use thin coloured plastic to wrap around the bottles. You could also look at the effects caused by using coloured card on the outside of the bottles.

# Energy in food

**Subject: Biology**

**Sensor: Temperature sensor**

**Aim:**

To investigate how much energy is released per gram of a food sample.

**Overview:**

By using a temperature sensor, the temperature rise of a known volume of water can be measured and the amount of energy released by the food can be calculated.

**Equipment required:** LogIT Black Box  
Temperature sensor  
Combustion wire or mounted needle  
Boiling tube, Measuring cylinder and balance (to record the mass of the food burnt)  
Clamp stand  
Spirit burner (a Bunsen could be used) and heat proof mat  
Food sample (examples might be Weetabix® or Shreddies®)

**Hazards:**

Students should be supervised at all times. Avoid using a peanut (traditional) to prevent any nut allergy problems.

Stress that any food used in science labs is not to be eaten.

Goggles should be worn and heat proof mats also used.

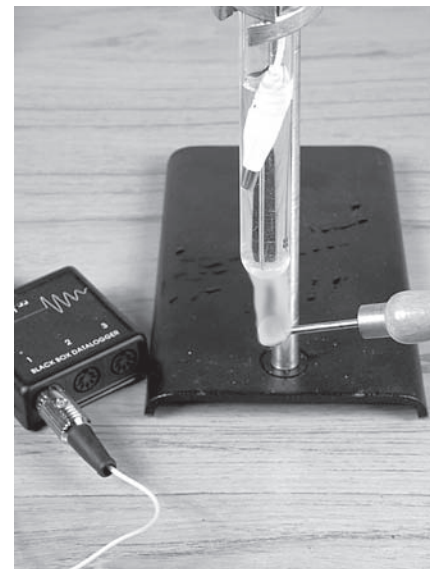
Ensure the datalogger cannot come into contact with water or damp.

Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Clamp the boiling tube into the clamp stand and insert the temperature probe.
2. Plug the temperature probe into Black Box and connect Black Box to the computer.
3. Pour 25 ml of water into the boiling tube.
4. Start the datalogging software and if necessary set the time of the experiment to 5 minutes.

Note: The time of the experiment depends on the food sample used as cereals can burn for different amounts of time. If you are using LogIT Lab, you can make use of the 'Autolog' function. It is important to make sure that the temperature probe does not touch the sides of the boiling tube. It is also good practice to wrap the cable away from the flame around the clamp stand.



### Method:

1. Obtain the mass of the unburnt food.
2. Place the food sample onto the combustion wire or needle (Place the food on the table and push the wire into the food. Do not use the fingers to hold the food as injury may occur)
3. Start the datalogging software.
4. Ignite the food sample using the spirit burner.
5. Hold the food under the boiling tube and allow the food to fully burn and extinguish.
6. Stop the datalogging software and using the plotted graph obtain the temperature change.
7. Obtain the mass of the burnt food.

Hint: You can repeat the experiment and take an average but remember to use the same mass of food each time.

### Results:

To obtain the energy released per gram of food burnt, substitute your values into the following:

Energy transferred (J) = mass of water (kg) x specific heat capacity of water (J/kg°C) x rise in temperature (°C)

So Energy transferred (J) = 0.025 x 4200 x rise in temperature (°C) (Note: 25 ml of water has a mass of 25 g (0.025kg))

Therefore the energy transferred by each gram of food burnt is given by:

Energy transferred by each gram (J/g) =  $\frac{[0.025 \times 4200 \times \text{rise in temperature (}^{\circ}\text{C)}]}{\text{mass of food burnt (g)}}$

How accurate do you think the results are?

Has all of the heat energy released by the food been used to heat the water?

What effect does heat loss have on the results?

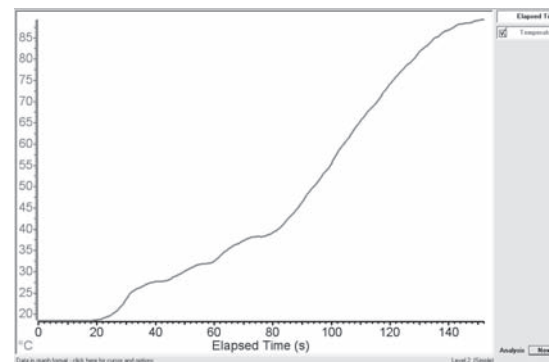
### Going further:

What factor could you vary in this investigation in order for it to be a fair test?

How important is the amount of energy in food to different people such as athletes?

What about the food industry. How is this process useful in food production?

Where might this information be found for different foods?



# Heat absorption of different soils.

**Subject:** Biology/Environmental studies

**Sensor:** HiTemp temperature sensor

**Aim:**

To study how different soil types affect heat absorption using the same mass of sample.

**Overview:**

Soil temperature is affected by the intensity of radiation from solar radiation from the sun. As a result, the temperature of soil close to the surface can fluctuate during the day and night. Different types of soil can also show different characteristics in the amount of heat they absorb from the sun. This simple procedure describes how you can use the HiTemp temperature sensor with Black Box to monitor the temperature of different types of soil. This should enable students to see how datalogging can be used for environmental studies and to also perform an important ecological study since soil temperature is an important factor in plant growth and water loss in the soil.

**Equipment required:** LogIT Black Box.  
Temperature sensor (2 were used for this example)  
Plastic cups or beakers.  
Soil samples such as sandy, clay or peat.  
Heat source (60 watt lamp was used for this example)

**Hazards:**

Ensure the datalogger cannot come into contact with water or damp.  
Always check your local regulations or the school advisory service such as CLEAPSS or SSERC for guidance on the use of any hazardous material or source.

**Setup:**

1. Place the same mass of soil into the two plastic beakers.
2. Push the temperature sensors into each beaker.
3. Place the heat source next to the two beakers.
4. Plug the sensors into Black Box.
5. Plug Black Box into the computer.
6. Start the datalogging software and set the time to 30 minutes if necessary.

Note: We used 100 grams of each soil sample and placed the temperature sensor in the centre of the sample. This should give the temperature rise of the soil as it absorbs the heat energy.





### Method:

1. Start the datalogging software.
2. Switch on the heat source.
3. Allow the experiment to run for 30 minutes.
4. When finished, save or print the results.

Hint: The length of time required for the experiment depends on the amount of soil used.

### Results:

What do the results show?

Are the results a surprise?

How does the density of the soil relate to the results?

What might happen to the results if you kept heating the samples?

### Going further:

Why is soil temperature such an important issue in plant growth?

Try switching off the heat source and log how quickly the soil cools down. What might this show?

How might you show heat flowing through the soil using three temperature sensors? What does this show?

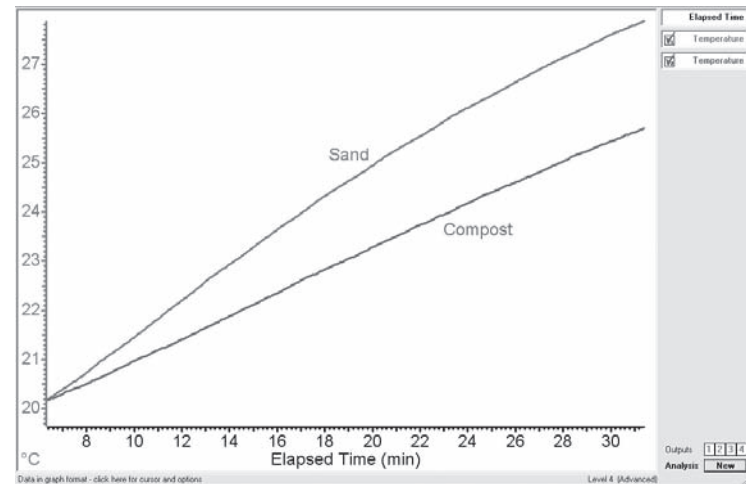
How is soil temperature used in heat pumps that heat houses?

What environmental impact does soil temperature have on the earth and its eco-systems?

What additional factors might you investigate?

What about the difference between wet and dry soils?

How might you investigate soil density and the relationship with temperature absorbtion?



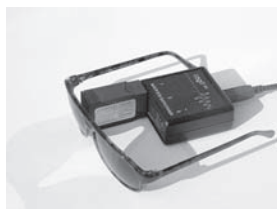
# Sensors and cables for Black Box

## Temperature and Light sensing

HiTemp Temperature sensor	Basic General purpose wire type (-10 to +110°C max) as in LogIT packs
ProTemp temperature sensor	Robust stainless steel probe for chemistry, soil temp etc (-30 to +130°C)
Infrared sensor	Measure radiated energy in W/m <sup>2</sup> and °C
K-Type Thermocouple adapter	For use with any standard K-type thermocouple -50 to +1200°C range
General Light Level sensor	Basic light sensor as supplied in LogIT packs for general use
Light Level sensor with lens	With lens system & coloured filter set for optics & general use
LUX sensor	Wide range of 0-25000 LUX with eye response filter for ambient light studies
SPX LUX Sensor	Designed for monitoring changes of outdoor natural light (0-100,000 LUX)
Ultraviolet light sensor	UVA & UVB radiation - to show effectiveness of sunglasses, sunblock etc



Pulse monitor



UV sensor



Stream flow sensor

## Electrochemistry, Air Pressure and Environmental Sensing

Sound Level sensor	Measures sound level calibrated Range 50-100dBA
Sound Wave Sensor	Display & records Sound Waveforms - for new LogIT DataVision CX only
pH amplifier	Compact pH amplifier with BNC socket for standard pH electrodes
pH electrode	High Quality pH electrode with BNC plug & cable for use with pH amplifiers
Stream flow sensor	Flow in rivers & streams; includes 1 metre wading rod.
pH electrode & amplifier pack	Complete set with pH electrode, cable and amplifier
Adjustable pH Amplifier	For pH work requiring high accuracy - calibrates most standard pH electrodes.
Adjust. pH Amp & Electrode	Complete set with pH electrode, cable and adjustable amplifier
Submersible DO2 probe set	Needs no battery and easy to set up (0-200% SAT)
Spare membrane set	With 3 membranes and KCl solution for Submersible DO2 set
Conductivity probe set	Liquid Conductivity set with probe and adapter
Colorimeter	Easy to use Colorimeter using three colour LED and powered from LogIT
HumiPro Sensor	Professional Humidity sensor for fast response & high accuracy (1-100% RH)
Humidity Sensor	Standard Humidity sensor for general indication of relative humidity (10-90%)
Radioactivity Probe	Radioactivity sensor to measure the intensity of alpha, beta & gamma sources.
Air Pressure Sensor	For measuring absolute air pressure in general lab experiments
Barometric Air Pressure	Designed for barometric measurements - range 800-1100 Bar
Weather Station adapter set	For Davis Weather Stations: Temperature, Wind speed & direction
CO2 sensor	Measures environmental Carbon Dioxide.



Radiativity probe



## Voltage, Current, Movement and Timing

Magnetic Field sensor	Flexible probe for electro-field experiments +/- 90mT range
Voltage Measurement set	Range -25 to +25V dc complete with cable & set of probes & clips
Current Measurement probe	Range of -1 to +1A dc complete with cable and set of probes & clips
100mV signal adapter	Adapter containing amplifier for +/- 100mV range
Movement & position sensor	Angular low friction movement for pendulum, plant growth etc
Ultrasonic Ranger sensor	Ultrasonic position and speed of sound sensor for physics & maths
Linear Accelerometer	Solid state accelerometer which measures horizontal or vertical acceleration.
Force Sensor	Designed for multi purpose Physics dynamics investigations and demos
Light Gate set	Pair of Light gates for Time, acceleration & velocity experiments
Single Light Gate	One Light gate for Timing experiments
Pressure mat set	Set of 2 Pressure mats for timing races, exercise etc
Light Switch sensor	New design with integral light guide to make wide light gate etc
Infra Red Source	Focused IR Light source for Light switch above
Reflective Light Switch	Suitable for optical tachometry or timing/counting close objects
Start/Mark Switch	Hand held button- use with extension cable to remotely mark events
ElectroSmog sensor	Detects high frequency radiation & radio freq noise. 100MHz to 2.5 GHz
Magnetic Switch	Supplied with small magnet to detect, count & time passing objects

## Heart Monitoring

Wireless Heart Receiver	Works with POLAR Pulse transmitters for rate display (not LIVE compatible)
Pulse Monitor	Intelligent pulse monitor for rate & waveform - clips on stationary ear or finger

**Computer Link & Sensor extension cables** - many others available. See [www.logitworld.com](http://www.logitworld.com)

USB to Serial adapter cable	Connects a serial LogIT datalogger to USB port:PC (Win98SE+) or Mac (OS9+)
Sensor extension lead 1	Professional 1 metre long with serviceable metal cased connectors
Sensor extension lead 2	Professional 3 metre long with serviceable metal cased connectors
Sensor extension lead 3	Economy 1 metre long with moulded connectors - non-serviceable

Sensor extension cables



**For more information**  
**[www.logitworld.com](http://www.logitworld.com)**



Colorimeter



**LogIT is a joint British development between  
DCP Microdevelopments and SCC Research**



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