

**Labdisc Activity Book  
Supporting Labdisc Data Logger,   
GlobiWorld and GlobiLab Software**

***For Elementary School Science***



**Rev-01 August 2011**

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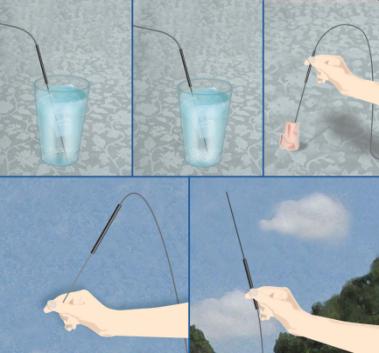
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# Activity Brief and Sensor Correlation

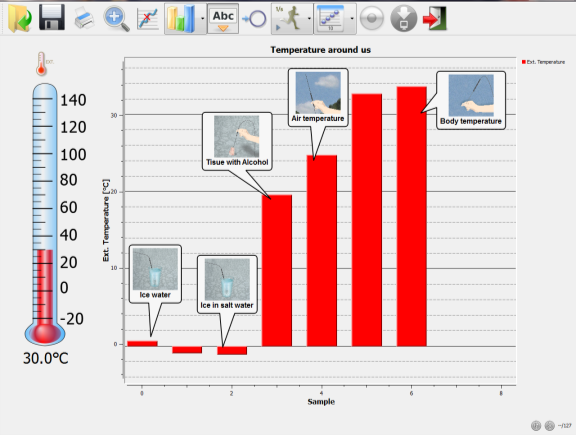
|  |  |  |
| --- | --- | --- |
| 1air.jpg | TempExt.PNG  External Temperature | ***The Temperature Around Us*** Measuring the temperature of common materials: Air, the human body and water |
| 5.jpg | Light.PNG  Light | ***Light Absorbance***  Measuring the light absorbance of different sunglasses to establish which provide better protection |
| 6.jpg | Sound.PNG  Sound Level | ***How Loud is Sound?*** Measuring the decibel level of different sounds at variant distances from the source |
| 7.jpg | Distance.PNG  Distance | ***What is Distance?***   The relationship between speed, time and distance |
| 8.jpg | Pulse.PNG  Heart Rate | ***Our Heart Rate***  Measuring heart rates before and after exercise |
| 12.jpg | TempInt.PNG  Ambient Temperature | ***Day and Night***  Temperature and Light changes over a 24 hour period |
| 11.jpg | GPS.PNG  Global Positioning Sensor | ***Walk in the Park***  Noise and temperature changes in the city |

# Activity 1: The Temperature Around Us



|  |
| --- |
| **Introduction**  Temperature is the degree of hotness or coldness of any substance. Temperature is also a measure of how fast the atoms and molecules of that substance move and does not depend on the size of the substance. For example, the temperature of a small cup of boiling water is the same as a large pot of boiling water. Even if the pot is much bigger than the cup and has millions more water molecules. Temperature is measured in degrees on the Fahrenheit, Celsius, and Kelvin scales.  We experience temperature every day. We feel hot when it is a hot day or we have a fever and we feel cold when we are in the snow or a cold wind. When we boil water we wait for the water temperature to increase and when we make popsicles we wait for the liquid to become very cold and freeze.  Let’s check the temperature around us.  **The Experiment**  In this activity we will record the temperature of different substances.  **Equipment Needed**   * Plastic cup * Ice cubes * Salt * Alcohol * Small piece of tissue paper   **Quick Investigation**   * Turn on the Labdisc by pressing the On/Off key On-off.jpg * Rotate the Labdisc plastic ring to expose the sensors * Connect the external temperature probe DSC_0038.JPGto the input located under the external temperature key. TempExt.PNG * Press this key and you should observe the temperature probe.   **Now you are ready for a quick investigation:**   1. Place the probe tip in a cup of ice water, wait for the reading on the Labdisc screen to stabilize and write down the temperature. 2. Close your hand on the probe tip. Wait for the temperature to stabilize and write down your skin temperature. 3. Investigate the air temperature in your classroom and in the school yard.   Using the Labdisc software we can have the Labdisc recorded measurements displayed. Please follow the steps below.  **Labdisc Setup**   1. Connect the Labdisc to the computer, either with the USB cable or through the wireless Bluetooth channel. 2. Click the Lab icon btn_lab.pngto open the Lab software. 3. Click on the sensor icon input_icon.png and select External Temperature. Make sure that this is the only selected sensor. 4. Click on the sampling rate icon triangle and select manual sampling. 5. Click on the Display option triangle  then select the Bar Graph option. Bar.png   **Experiment procedure**   1. Click on the Record icon REC_icon.png to start the experiment. 2. Place the external sensor in the ice water and wait for the temperature reading to stabilize. Then take a manual sample by pressing the Labdisc SCROLL key.Scroll.jpg Each time the SCROLL key is pressed, the software will display another red bar. The bar height represents the measured temperature level. 3. Repeat the above for measuring:    1. Tap water    2. Your own skin temperature, by closing your hand on the sensor tip    3. The skin temperature of one of your classmates    4. Ice water with 2 spoons of salt added to it (make sure to stir the cup so that all the salt melts in the water).    5. Cover the external temperature sensor tip with a paper tissue soaked in alcohol. Blow air on the covered sensor and observe the temperature change.   When you have finished recording click on the STOP icon.    **Data Analysis**  Double click on the graph title and a dialog box will open. Write “Temperature around us” and click ok. The software will display the following screen.    Use annotation to add text and pictures to the Bar graph. Click on the Annotation icon. Annotate.png Move the mouse over one of the red bars and make a left click. A dialog box will open, allowing you to type text and even add pictures to the graph. In the dialog box text window type the material temperature you have measured. Click OK and use the mouse to drag the annotation to any point on the graph. You can also click on the annotation tip and move it over the graph window. |

After annotation you’ll see the graph below.



**Investigation and Questions**

Observe the measurements you’ve collected and answer the following questions:

1. Which material was the coldest and which material was the hottest?

**** Ice water was the coldest material and a human hand was the hottest

**** Salty ice water was the coldest material and a human hand was the hottest

**** Air temperature was the hottest and the tissue soaked alcohol was the coldest

1. In cold winters city municipalities use salt to melt the ice on the main roads. In view of the above experiment can you explain this?

**** Car metal parts exposed to salty ice will not rust

**** Salt prevent car tiers from slipping on icy roads

**** Salt reduces the melting temperature of water and prevents ice accumulation on roads

1. Why did the alcohol soaked tissue drop in temperature?

**** Alcohol is colder than air

**** When alcohol starts to evaporate it “takes” the heat needed for evaporation from the tissue - reduces its temperature

**** Any wet material is colder than air

1. Are our body and skin temperatures the same?

**** Yes, body and skin temperature are the same

**** Skin temperature is always lower than body temperature

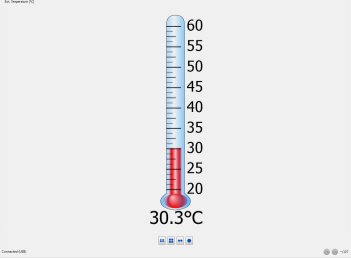
**** Our body temperature must be kept between 36 °C and 41 °C, while our skin temperature, exposed to the ambient temperature, can reach temperatures as low as 5 °C, or as high as 50 °C

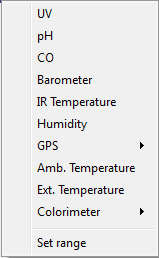
**Further Suggestions**

Do a fun activity in the classroom to verify who has the warmest hand.

Use the same Labdisc setup. Connect it to the computer.   
Press the Meter icon.The software will open with 4 meters on the screen.

Use the bottom single meter icon 1meters.png to see only one meter on the screen. With a right mouse click on the meter body you can change it to digital meter, analog gauge, bar graph, color changing display or thermometer.



Changing the range of the meter, or the type of sensors displayed by the meter is done with a right click on the sensor name located at the top left corner of the meter. The right click opens a dialog box where the sensor type and new range can be changed.

# Activity 2: Light Absorbance



**Introduction**

Our world is filled with light. We need light in order to see - it carries information from all around us to our eyes and brains. Seeing colors and shapes is second nature to us and yet when we take a closer look, light is a perplexing phenomenon.

Here are some things to think about:

* Sunlight causes plant growth - the sun's energy is stored in plants. In fact, ancient plant life provided the earth's supply of fossil fuels: All the coal, natural gas, and oil deposits that we use until today.
* Our brains and eyes act together to make extraordinary things happen in our perception. Movies are simply sequences of still pictures. Magazine pictures are just an array of dots.
* Light acts like particles - little light bullets called photons - that stream from the light source. This explains how shadows work.
* Light also acts like waves - ripples in space, rather than bullets. This explains how rainbows work.
* In fact, light is both a particle and wave. This "wave-particle duality" is one of the most confusing and wonderful principles of physics.

Despite the fact that the sun is over 93 million miles away, its rays also pose important health and ocular dangers to our eyes. Sunlight photon absorbed in our eye lens reduces its transparency and create diseases like Cataract.

Sunglasses play a major role in protecting our eyes and absorbing dangerous sunlight radiation such as UV and blue light.

What is light absorbance? Light absorption occurs when atoms or molecules of the sunglass lens take up the energy of a photon of light, thereby reducing the transmission of light as it is passed through the lens to reach our eye.

**The Experiment**

In this activity we will check and compare the absorbance of different pairs of glasses and sunglasses to discover which one provides the highest protection for our eyes.

**Equipment Needed**

* Flash lamp (not needed if working in direct sunlight)

**Labdisc Setup**

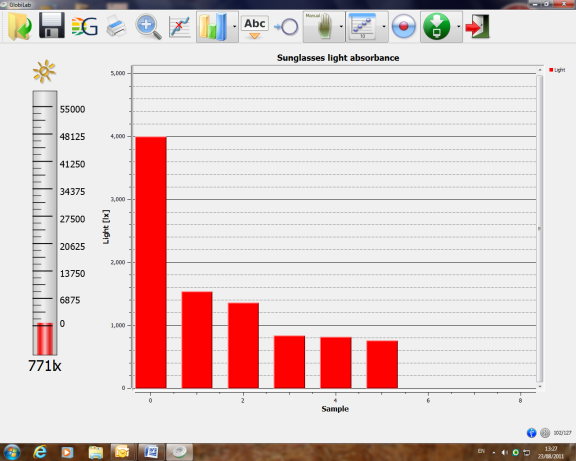
1. Turn on the Labdisc by pressing the On/Off key On-off.jpg
2. Rotate the Labdisc plastic ring to expose the light sensor
3. Place a flash lamp 25 cm away from the Labdisc facing the light sensor.
4. Connect the Labdisc to the computer, either with the USB cable or through the wireless Bluetooth channel.
5. Click the LAB icon btn_lab.pngto open the Lab software.
6. Click on the SENSOR icon input_icon.png and select Light sensor.Light_icon.png Make sure that this is the only selected sensor.
7. Click on the SAMPLING RATE icon triangle and select manual sampling. 
8. Click on the DISPLAY OPTION triangle  then select the Bar Graph option. 
9. Click on the RECORD icon REC_icon.png to start the experiment.

**Experiment Procedure**

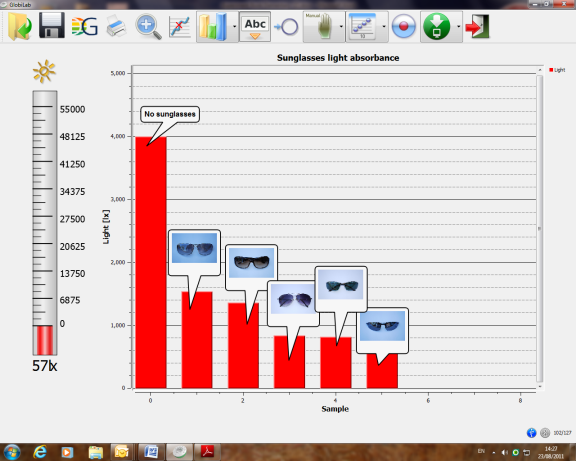
1. Place a flash lamp 25 cm away from the Labdisc facing the light sensor.
2. Take a manual sample by pressing the Labdisc SCROLL key.Scroll.jpg
3. Place one of the pairs of sunglasses as close as possible to the light sensor and press the SCROLL key again.
4. Each time the SCROLL key is pressed, the software will display another red bar. The bar height represents the measured light level.
5. Repeat the above to measure many different pairs of sunglasses.
6. When you have finished recording click the STOP icon. STOP_icon.png

**Data Analysis**

1. Double click on the graph title and a dialog box will open. Write “Sunglasses light absorbance” and click ok. The software will display the following screen.



|  |
| --- |
| 1. You can take pictures of the different pairs of sunglasses with a digital camera and then use annotation to add them above the relevant bar graph. Click on the ANNOTATION icon. Annotate.png Move the mouse over one of the red bars and make a left click. A dialog box will open, allowing you to type text and add pictures to the graph.   After adding text and the picture, click OK and use the mouse to drag the annotation to any point on the graph. You can also click on the annotation tip and move it over the graph window.  After annotation you’ll see the graph below: |



1. Save your project by clicking on the SAVE icon. 

**Investigation and Questions**

View your measurements and try to answer the questions below.

1. When did you measure the maximum light absorbance?

**** When using the darkest pair of sunglasses

**** All the sunglasses absorbed the same amount of light

**** The highest light absorbance was measured without any sunglasses

1. If we repeat the experiment using two sets of sunglasses placing one pair after the other, we will measure:

**** More light at the light sensor

**** The highest light absorbance

**** The lowest light absorbance

1. When using funny glasses with blue lenses:

**** The lenses absorb all other colors and only pass the blue

**** The lenses absorb the blue color

**** The lenses are painted blue, but absorb all the colors

1. What light levels would you measure if the flash lamp was placed 50 cm from the Labdisc?

**** The light level would be twice as high

**** The light level would be half the amount

**** The light level would be four times lower

**Further Suggestions**

1. Compare the light absorbance of sunglasses and reading glasses
2. Place the flash lamp at a 90 degree angle to the Labdisc. Use different shiny materials (e.g. metal foil, mirror) to measure light reflections.
3. Repeat the same experiment while using a simple color filter (also known as gel) to measure the different absorbance of various light colors
4. Repeat the experiment and instead of using the flash lamp, perform it outdoors in direct sunlight, for best results compare sunlight in both the winter and summer.

# Activity 3: How Loud is Sound?



We are surrounded by sound. Sound sources vary from speech and music, to motorcycle engines. If sound can be caused by so many different things then what is sound really? How is it created? And how does it reach our ears?

An object produces sound when it vibrates. When something vibrates in the atmosphere it moves the air particles around it and in turn those air particles move the air particles around them. In this way the pulse of vibration is carried through the air - a vibrating object sending a wave of pressure fluctuation through the atmosphere. These waves are called sound waves. Sound waves spread in every direction, similar to the pressure waves created by a drop of milk falling into a milk jar, travelling at the speed of sound (340 meter per second in air) until they reach our ears.

The **decibel** (abbreviated **dB**) is the unit used to measure the intensity of a sound. The decibel scale is a little strange because the [human ear](http://www.howstuffworks.com/hearing.htm) is incredibly sensitive. Your ears can hear a really wide range of sounds, from a leaf falling on grass to a loud [jet engine](http://www.howstuffworks.com/turbine.htm) - the sound of the jet engine is about 1,000,000,000,000 times more powerful than the smallest audible sound. That's a big difference!

On the **decibel scale**, the smallest audible sound (near total silence) is 0 dB. A sound 10 times more powerful is 10 dB. A sound 100 times more powerful than near total silence is 20 dB. A sound 1,000 times more powerful than near total silence is 30 dB. Here are some common sounds and their decibel ratings:

|  |  |
| --- | --- |
| ***Sound Sources  examples with distance*** | ***Sound pressure level in decibels*** |
| Jet aircraft 50 m. away | 140 |
| Threshold of pain | 130 |
| Threshold of discomfort | 120 |
| Chainsaw 1 m. distance | 110 |
| Disco, standing 1 m. from the speaker | 100 |
| Diesel truck 10 m. away | 90 |
| Curbside of a busy road 5 m. | 80 |
| Vacuum cleaner 1 m. distance | 70 |
| Conversational speech 1 m. distance | 60 |
| Average home | 50 |
| Quiet library | 40 |
| Quiet bedroom at night | 30 |
| Background in TV studio | 20 |
| Rustling leaves in the distance | 10 |
| Threshold of hearing | 0 |

**The Experiment**

Sound level is affected by distance. The closer we are to the sound source, the louder we will hear it. In this activity we will measure the decay of sound level over distance.

**Equipment Needed**

* 30 cm ruler

**Labdisc Setup**

1. Turn on the Labdisc by pressing the On/Off key.On-off.jpg
2. Rotate the Labdisc plastic ring to expose the sensors.
3. **SENSORS:**

Press the SCROLL key Scroll.jpgto open the Labdisc menu. Select the SETUP iconsetup_icon.bmp and then the SET SENSOR icon.input_icon.bmp Press the Sound sensorSound.PNG and make sure that this is the only selected sensor for the activity.

1. **SAMPLING RATE:**

Press the ESC key On-off.jpg to leave the previous menu and then select the SAMPLING RATE icon.rate_icon.bmp Use the SCROLL key Scroll.jpgto choose Manual sampling rate. Press the SELECT key Enter.jpgto confirm.

1. **AMOUNT OF SAMPLES:**

Press the ESC key On-off.jpg to leave the previous menu and then select the NUMBER OF SAMPLES icon.samples_icon.bmp Use the SCROLL key Scroll.jpgto choose 10 samples. Press the SELECT key Enter.jpgto confirm.

**Experiment Procedure**

1. Use your computer speaker to create a constant sound of source:
   1. Set the speaker volume to between 80-90%
   2. You need to work with only one speaker, thus set the speaker balance to either L (left) or R (Right).
   3. The [www.freesound.org](http://www.freesound.org) WEB site offers a variety of sound sources, one example is: <http://www.freesound.org/samplesViewSingle.php?id=28636>

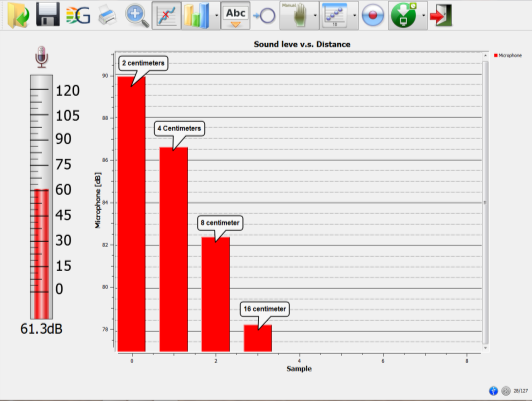
This sound source was created by Mr. Pete Chapman.

* 1. Press the small play button on the WEB and your speaker will produce a pure tone for 30 seconds.

1. Press the SELECT key Enter.jpgto start recording.
2. Place the Labdisc with the sound sensor facing your speaker at a 2 cm distance.
3. Take a manual sample by pressing the Labdisc SCROLL key.Scroll.jpg
4. Repeat the above actions for measuring while moving away from the speaker:
   1. Place the Labdisc 4 cm away and press the SCROLL key.Scroll.jpg
   2. Place the Labdisc 8 cm away and press the SCROLL key.Scroll.jpg
   3. Place the Labdisc 16 cm away and press the SCROLL key.Scroll.jpg
5. Press the SELECTEnter.jpgand then the SCROLL key Scroll.jpgto stop recording.

**Data Analysis**

1. Open the software.
2. Connect the Labdisc to the computer either via wireless communication or through the USB port.
3. Click on the DOWNLOAD iconDownload.png to retrieve the sound measurements from the Labdisc.
4. Use the annotation tool to mark the distance for every measurement as seen in the graph below:



As is clearly shown in the graph – the sound declines by 3 dB per doubling of distance. We can conclude that the sound level decay is directly proportional to the distance.

**Investigation and Questions**

View your measurements and try to answer the questions below.

1. When moving away from a sound source, the sound volume we hear?

**** Decreases over distance

**** Stays the same regardless of the distance to the sound source

**** Increases with the distance

1. How can we protect our hearing?

**** Clean our ears daily

**** Keep away from loud sounds of over 130dB

**** Avoid exposure to sounds of over 100 dB for periods of 15 minutes or more

1. Can we hear a person whispering while at a loud rock concert?

**** No, because in a loud environment our ear sensitivity is low and we cannot hear weak sounds

**** Yes, because our ears can ignore the background music

**** No, because when our ears listen to music we cannot process the sound of a voice.

1. Can we hear music or a person’s voice in outer space?

**** Yes, outer space is very quiet and we can easily hear music or voices

**** In space we have a vacuum and thus sound, which travels via the movement of particles, cannot be formed

**** No, because space is a vast place and sound simply disappears in it

**Further Suggestions**

1. Find the quiet and noisiest place in your school.
2. Make a contest between students, to find out who has the loudest whistle.
3. Using both the GPS and sound sensors - check the noise level difference between a busy city street, a quiet residential area, or a park.

# Activity 4: What is Distance?



**Introduction**

Some of your class mates live within walking distance from your school, but some need to be driven to school every morning because their homes are quite far. We measure distance by meters. Walking distances cover a few meters to a few thousand meters – called kilo-meters (km). Driving distance can range from a few kilometers to many.

Let’s start with some typical distances to help get orientated:

* Our neighbor lives a few meters from us
* Our school can be a few kilometers away
* The nearby city may be 50 kilometers away
* A neighboring country can be a thousand kilometers away

Now consider these amazing distance facts:

* The moon is 384 thousands kilometers away from earth
* Mars is 56 million kilometers away from earth.
* The sun is 150 million kilometers from earth.
* The distance between atoms is only 3 billionth of a meter…

If we want to reach any of the destinations described above we need to walk, run, drive, fly, sail or even use a fast spaceship. Speed is measured by meter per second or kilometer per hour and different modes of transport help us cross distances at different speeds.

We can:

* Walk to our neighbor or our school at a speed of four to six kilometers per hour, or run at 12 kilometer per hour.
* Drive to our school at 50 kilometer per hour
* Fly to a neighboring country at 1000 kilometers per hour
* Fly to another planet at 30,000 kilometer per hour

The most fundamental equation describing distance, time and speed states that: Distance is equal to speed multiplied by time.

Distance = Speed x Time

It means that the faster we travel; we will cover larger distances over the same period of time.

**The Experiment**

In this activity we will examine the relationship between speed time and distance. We will also explore graphs of distance versus time.

For the experiment we will use the Labdisc distance sensor which measures distances between 0.4 m to 10 m. The sensor works as sonar, transmitting an ultra sonic sound, which travels through air, hits a body and then echoes back to the sensor. The Labdisc measures the time passed from transmitting the sound, to the reception of its echo and then calculates the distance.

**Equipment Needed**

* No equipment is needed

**Labdisc Setup**

The best way to perform this experiment is by using wireless communication with the computer.

Setup the Labdisc from the Labdisc menu.

1. Make sure that the Labdisc is fully charged before starting this experiment.
2. Turn on the Labdisc by pressing the On/Off key. On-off.jpg
3. Make sure the BLUETOOTH icon bluetooth_20px.bmpappears on the Labdisc screen. If not enable Bluetooth communication:
   1. Press SCROLL key Scroll.jpgto open the Labdisc menu.
   2. Select the CONFIGURATION icon. config_icon.bmp
   3. From that menu select the BLUETOOTH iconbluetooth_icon.bmp, then SCROLL to “BT Enabled” option and press SELECT.
   4. Press the ESC key twice On-off.jpg to return to the main menu.
4. **SENSORS:**

Press SCROLL key Scroll.jpgto open the Labdisc menu. Select the SETUP iconsetup_icon.bmp and then SET SENSOR iconinput_icon.bmp. Press the distance sensor keyDistance.PNG and make sure that this is the only selected sensor for the activity.

1. **SAMPLING RATE:**

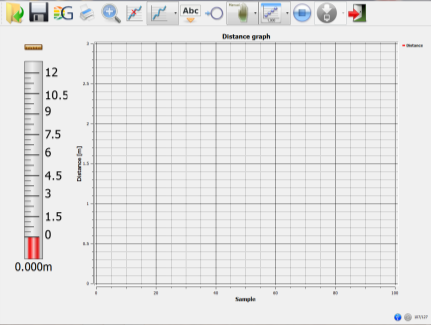
Press the ESC key On-off.jpg to leave the previous menu and then select the SAMPLING RATE icon.rate_icon.bmp Use the SCROLL key Scroll.jpgto choose 10/sec. Press the SELECT key Enter.jpgto confirm.

1. **AMOUNT OF SAMPLES:**

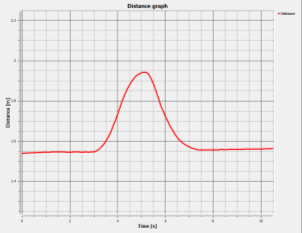
Press the ESC key On-off.jpg to leave the previous menu and then select the NUMBER OF SAMPLES icon.samples_icon.bmp Use the SCROLL key Scroll.jpgto choose 1000. Press the SELECT key Enter.jpgto confirm.

**Experiment Procedure**

1. Your teacher will use a projector to project the software graph window onto the classroom white board.
2. Your teacher will manually draw a graph on the screen. As shown below:



1. If you are using wireless communication - make sure that the computer bottom right BLUETOOTH icon  is turned on indicating that the computer is wirelessly connected to your Labdisc.
2. Stand 1.5 m from the classroom white board.
3. Open the distance sensor plastic cap and aim it at the white board.
4. Press the distance sensor key and verify that the Labdisc LCD shows a 1.5 m distance.
5. Press the SELECT key Enter.jpg to start recording.
6. Try to repeat the graph drawn by your teacher, while walking with the Labdisc and changing the distance between the Labdisc and the classroom wall.
7. When you’ve finished, press the SELECT key Enter.jpgand then the SCROLL key Scroll.jpgto stop recording.
8. Repeat this experiment to imitate the distance graphs below:

**Data Analysis**

A

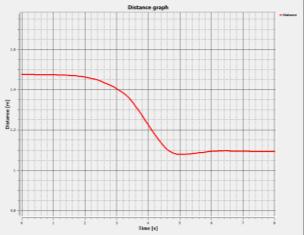
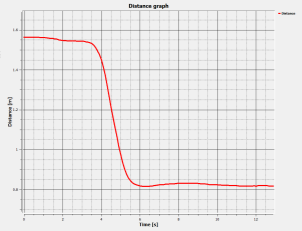
A

A

B

C

B

****

Activity - 1

Activity - 2

A

A

D

A

Activity - 3

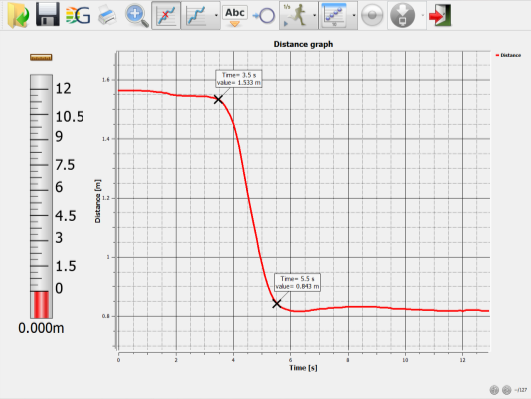
A graph is a “mathematical” way of describing our experiment.

Viewing the graphs on the previous page we can draw the following conclusions:

1. A flat graph (marked A) describes when we were standing still and the distance between us to the classroom wall (or white board) wasn’t changing.
2. A straight falling graph (marked B) describes when we were moving at a constant speed, walking toward the classroom wall.
3. In the same way, the straight rising graph (marked C) describes when we were moving away from the wall, increasing our distance from it.
4. The section marked D on the graph, also describes when we were moving towards the classroom wall. However, while section B represented walking at a constant speed, section D describes walking at a variable speed: starting fast and then slowing down.

Let’s analyze what distance we crossed, our speed and our final position at the end of each activity.

1. Open Activity - 1
2. Place the markers as shown below:



1. The first marker shows that when we started our recording we were 1.5 m away from the classroom wall; Then we moved towards the wall reaching a distance of 0.8 m - as we see on the 2nd marker.

Therefore:

* 1. We traveled: 1.5 - 0.8 = 0.7 m
  2. Our final position was 0.8 m away from the wall

1. Speed is defined as distance divided by time. From the markers above we can get the following information:
   1. We started walking after 3.5 seconds
   2. We stopped walking after 5.5 seconds
   3. Our initial position was 1.5m
   4. Our final position was 0.8m

Thus our speed was:

**Investigation and Questions**

View your measurements and try to answer the questions below.

1. In the activities above, a flat graph means?

**** We are moving very slowly towards the wall.

**** We are moving quickly away from the wall.

**** We are standing still.

1. In the activities above, a rising graph means?

**** We are moving towards the wall.

**** We are moving away from the wall.

**** We are standing still.

1. A steeper distance graph means:

**** We traveled faster.

**** We traveled slower.

1. What is the distance between your initial and final position in Activity 2?

**** Initial and final positions are the same

**** 1.5 m

**** 0.7 m

1. How much time will it take to move 20 meters, if our speed is two meters per second?

**** 20 seconds.

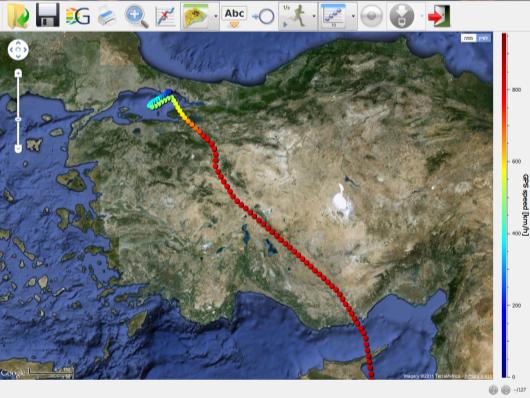
**** 10 seconds.

**** 11 seconds.

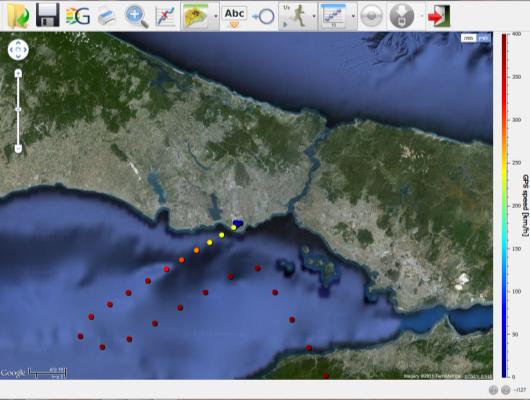
**Further Suggestions**

The GPS sensor built into the Labdisc measures our global position and our traveling speed. The recording below was taken during a flight to Istanbul – the capital of Turkey, where the Labdisc with GPS was held by a passenger on board the airplane.

The color points on the Google map represent the airplane’s speed during the flight. Using the color speed scale to the left of the map, try to determine the cruising speed of the airplane.



Focus on the airplane’s decent to landing; Try to guess the landing speed.



# Activity 5: Our Heart Rate



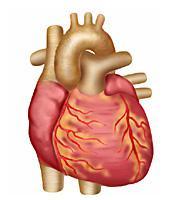
**Introduction**

The heart is a powerful muscle, pumping blood and oxygen all around our body and yet we use this amazing organ to describe many other experiences and feelings too. When people say their heart is broken, they’re really saying they feel very sad. Or if they place a hand on their heart they want you to know their words are absolutely true and almost everyone has drawn a picture of a heart to say they love someone.

When we are frightened, nervous or excited our hearts beat really fast and loud – sometimes we even hear our hearts beating inside our ears. People also say when they get a shock that their heart skipped a beat!

Our brain may process our thoughts and emotions, but our hearts are clearly responding to our feelings.

**Muscle Power**

Clench your fist and put it slightly to the left of the middle of your chest. That’s about the size and position of your heart inside your body. Now squeeze your fist really tight and then release it. That’s exactly how the heart muscle works - like a pump - filling with blood and then contracting to push the blood along. Your heart is one of the most important muscles in the body, working without a break, together with the lungs and blood vessels, to carry away waste and deliver oxygen and nutrients to every single cell.

The left side of the heart pumps blood full of oxygen from the lungs, taken in with every breath. At the same time, the right side of the heart is busy receiving all the blood that’s been around the body delivering all of its oxygen. This blood gets pumped into the lungs where it is refilled with oxygen, ready to start the whole journey again.

**Heart Beat**

A complete cycle of pumping blood around our body is called heart beat. At rest, our heart beats between 60 to 80 times per minute. Although we go to sleep, our heart doesn’t, and keeps beating throughout our entire life time – about 3 bilion times!

Our heart rate, or pulse is the number of beats per minute. The table below shows the normal heart rate of people at different ages.

|  |  |
| --- | --- |
| Heart Rate Chart: Babies to Adults | |
| **AGE** | **Beats Per Minute (BPM)** |
| Babies up to one year | 100 – 160 |
| Children aged 1-10 | 60 – 140 |
| Children aged 10+ and adults | 60 – 100 |
| Athletes: | 40 – 60 |

**The Experiment**

In this activity we will record our heart rate before and after exercise using an ear clip probe. This probe measures how our ear lobe, or even our finger, changes its light transparency when blood flows through it.

**Equipment Needed**

* No equipment is needed

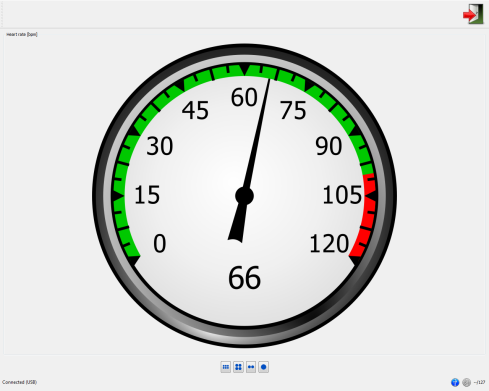
**Labdisc Setup**

1. Turn on the Labdisc by pressing the On/Off key On-off.jpg
2. Rotate the Labdisc plastic ring to expose the sensors
3. Connect the ear-clip to the Labdisc input located under the HEART RATE key. Pulse.PNG
4. Connect the ear-clip to your pointing finger or ear lobe. Press the HEART RATE key Pulse.PNGon the Labdisc and wait three seconds. The Labdisc should beep at the same rate as your heart beat. Then after eight seconds your heart rate will be displayed on the LCD screen.
5. If the Labdisc doesn’t beep, make sure the ear clip is well positioned on your finger or ear lobe – as in the pictures below:





1. Connect the Labdisc to the computer either with the USB cable or through the wireless Bluetooth channel.
2. Click on the METER icon btn_meters.pngto open the METER view.
3. Use the bottom single METER icon 1meters.png to see only one meter on the screen.
4. A right mouse click on the body of the meter changes it to a digital meter, analog gauge or bar graph.
5. With a right mouse click over the sensor name select the Pulse -> heart rate sensor. The meter will show your current heart rate:



1. Connect the ear-clip to other students in your class, and compare their different heart rates.

**Note**: Don’t forget the Labdisc takes up to eight seconds to pick up your heart rate. For stable readings make sure not to move your finger or ear while measuring your heart rate

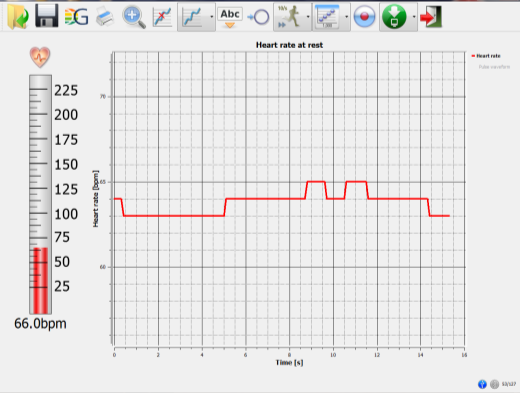
1. Click on the EXIT icon Exit.png to close the METER view.
2. Now, let’s investigate the changes in heart rate.

**Experiment Procedure**

1. Click the LAB iconbtn_lab.pngto open the Lab software.
2. Click on the SENSOR icon input_icon.png and select the heart rate sensor. EKG_active_icon.png Make sure that this is the only selected sensor.
3. Click on the sampling rate icon triangle and select 10 samples per second.rate_10sec_icon.png
4. Click on the amount of samples and select 1000 samples. samples1000_icon.png
5. Click on the Display option triangle  and then select the line graph option. viewGraph.png
6. Click on the RECORD icon REC_icon.png to start the experiment.

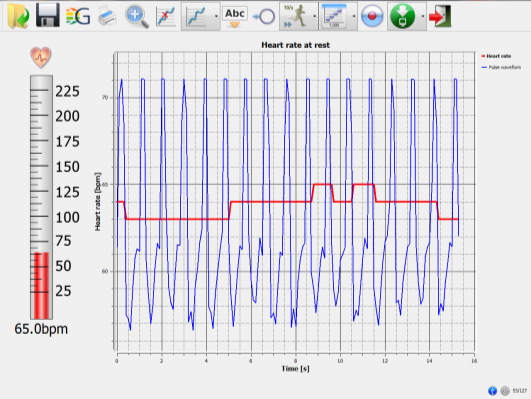
**Data Analysis**

The software displays the graph below.

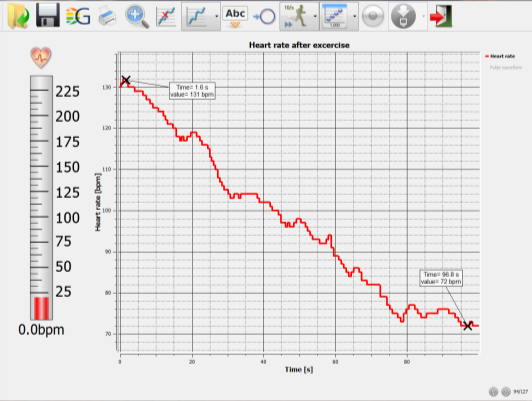


A steady graph is shown on the screen describing your heart rate at rest. In this example the heart rate recorded was between 64 and 66 bpm (beat per minute).

1. To stop recording press the STOP icon. STOP_icon.png
2. With a right mouse click over the pulse waveform you can view the heart beats and their magnitude.



1. When we exercise our muscles need more oxygen which makes us breathe more quickly, as well our heart beating faster. Try it for yourself by performing a few minutes of exercise, such as running on the spot or doing star jumps.
2. Then stand still, connect the ear-clip to your finger or ear lobe and press the RECORD icon.REC_icon.pngWait for your heart beat to stabilize and then stop the recording, by pressing the STOP icon.STOP_icon.png
3. The graph on the screen should show a constant decrease in the rate of your heart beat so that eventually it is close to your rest rhythm.
4. In the example below the heart beat was decreased from 130 bpm to 72 bpm after 95 seconds.



1. Click the MARKER icon.viewGraph.png In this mode a left mouse click, near any of the graphs will place a marker on the graph with the coordinates (time and value) displayed in a small pop-up window. Place markers at the minimum and maximum heart rate levels.
2. Double click on the graph title and change the title to “Heart Rate After Exercise”
3. Save your project by clicking on the SAVE icon 

**Investigation and Questions**

View your measurements and try to answer the questions below.

1. What was your heart rate at rest?

**** Between 90 – 120 bpm

**** Between 100 – 140 bpm

**** Between 60 – 85 bpm

1. What was your heart rate right after exercising?

**** Less than 70 bpm

**** Between 60 – 80 bpm

**** Above 120 bpm

1. How much time did it take your heart beat to decrease to below 90 bpm after exercising?

**** More than two minutes

**** Less than one minute

**** Between one to two minutes

1. If after exercising, your heart rate returned to between 60 to 80 bpm over a short period of time, it means that:

**** You are in good physical shape

**** You need to drink more water

**** Your muscles needs more oxygen

1. Athletes’ heart rates at rest are:

**** Lower compared to other people of the same age

**** Higher compared to other people of the same age

**** The same as other people of the same age

1. When do you think your heart rate will be the lowest?

**** While eating breakfast

**** While sitting in the classroom

**** While sleeping

**Further Suggestions**

1. While recording your heart beat at rest, try to relax yourself and reduce your heart beat.
2. Check your heart rate after lunch and compare it to your heart rate at rest. Is it higher, lower or the same?
3. Try to compare your heart rate measured in both your ear lobes or fingers. Is it the same?
4. Heart rate is also a good indication of when we feel frightened or nervous. Try to create an activity that demonstrates that.

# Activity 6: Day and Night



**Introduction**

Winter nights can be very cold, while summer days can be really hot. Why does temperature change so much from night to day? And why does it change throughout the different seasons during the year. It all has to do with the distance between the earth and the sun - our only heat source.

Our globe has two hemispheres: northern and southern, divided by the equator. In the northern hemisphere we can find continents such as: Europe and North America; while South America, Australia and South Africa – all belong to the southern hemisphere.



Equator

Northern hemisphere

Southern hemisphere

Latitude Affects Temperature

While the amount of heat coming from the sun stays the same, it is spread over a greater area during the winter than during the summer. This is due to the earth’s tilt. In summer, the sun shines almost directly overhead when the northern hemisphere faces toward the sun. In winter, the sun appears to be much lower in the sky and the same amount of sunlight has to cover a much larger area.

|  |  |
| --- | --- |
| **SUMMER in the Northern Hemisphere**  **sun.jpg**  cartoon_earth.gif  Sunlight  Sunlight | |
|  |  |
| Here, the top part of the earth (the northern hemisphere) is leaning  towards the sun, receiving more heat energy  from the sunlight.  **WINTER in the Northern Hemisphere**  cartoon_earth.gif  Sunlight  Sunlight  sun.jpg  Here, the top part of the earth is leaning away from the sun,  meaning it receives less energy from the sunlight. | |
|  |  |

Day Length Affects Temperature

Another important factor that has a direct impact on how earth is heated is the length of a day. The longer that a day lasts, the more time there is for Earth to absorb energy from the Sun. It makes sense then that longer summer days typically are warmer, while shorter winter days are colder.   
  
If you lived in a country that was situated along the equator then the length of your days would change very little throughout the year. You’ll have daylight and darkness for almost exactly 12 hours each. The further away that we travel from the equator however, the greater the variation we’ll see in day length. Summer days get stretched out, becoming much longer than the nights, while the opposite happens in winter - it gets darker earlier and the nights lasts much longer.

**The Experiment**

In this activity we will examine the temperature and light changes during the day.

**Equipment Needed**

* No equipment is needed

**Labdisc Setup**

Setup the Labdisc from the Labdisc menu.

1. For this activity you’ll need your Labdisc to run for more than 24 hours – so make sure that the Labdisc is fully charged before starting.
2. Turn on the Labdisc by pressing the On/Off key. On-off.jpg
3. To enable the Labdisc to record for a long period of time, we must turn off the GPS and Bluetooth modules, due to their high power consumption:
   1. Press SCROLL key Scroll.jpgto open the Labdisc menu.
   2. Select the CONFIGURATION icon. config_icon.bmp
   3. From that menu select the BLUETOOTH icon,bluetooth_icon.bmpthen SCROLL Scroll.jpgto the “BT disabled” option and press SELECT. Enter.jpg
   4. Press the ESC key On-off.jpg to leave the Bluetooth menu
   5. SCROLL Scroll.jpg to the GPS menu GPS_icon.bmpand press SELECT,Enter.jpgthen SCROLL Scroll.jpgto “GPS Disabled” and press   
      SELECT.Enter.jpg
   6. Press the ESC key On-off.jpgtwice to return to the main menu.
4. **SENSORS:**

Press the SCROLL key Scroll.jpgto open the Labdisc menu. Select the SETUP iconsetup_icon.bmp and then the SET SENSOR icon.input_icon.bmp Press the Light Light.PNGand Internal Temperature TempInt.PNGsensor keys and make sure that these are the only selected sensors for the activity.

1. **SAMPLING RATE:**

Press the ESC key On-off.jpg to leave the previous menu and then select the SAMPLING RATE icon.rate_icon.bmp Use the SCROLL key Scroll.jpgto choose 1/min. Press the SELECT key Enter.jpgto confirm.

1. **AMOUNT OF SAMPLES:**

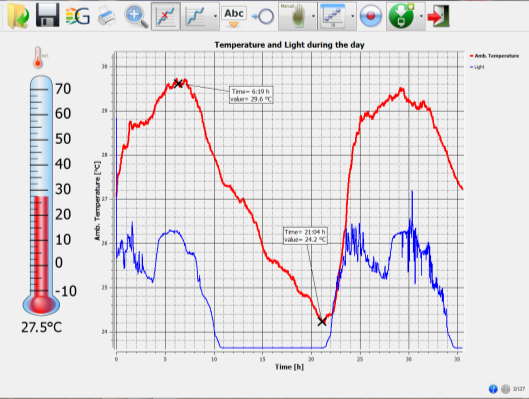
Press the ESC key On-off.jpg to leave the previous menu and then select the NUMBER OF SAMPLES icon.samples_icon.bmp Use the SCROLL key Scroll.jpgto choose 10000. Press the SELECT key Enter.jpgto confirm.

**Experiment Procedure**

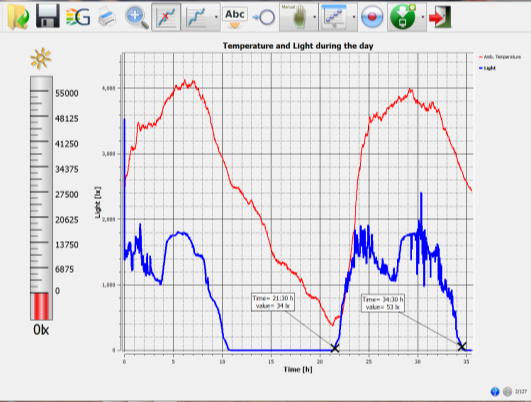
1. Place the Labdisc in a shaded place in an open place with the light sensor facing towards the outdoor sky.
2. Press the SELECT key to start recording temperature and light level
3. Leave the Labdisc for one to two days, to record data, and then stop recording by pressing the SELECTEnter.jpgand then the SCROLL keys.Scroll.jpg

**Data Analysis**

1. Open the software
2. Connect the Labdisc to the computer either via wireless communication or through the USB port
3. Click on the download iconDownload.png to retrieve all measurements from the Labdisc and display them in the graph window as shown below:



1. Use the markers to verify the minimum and maximum temperature and light levels during your recording. In the above example – the maximum recorded temperature was 29.6 °C and the minimum temperature 24.2 °C.
2. Observe that the minimum temperature occurs at night time and the maximum temperature during the day.
3. This recording was done during summer in the northern hemisphere. Use the markers to measure the length of day time and night time as measured by the Light sensor. In the below example the day was 13 hours long.



**Investigation and Questions**

View your measurements and try to answer the questions below.

1. In the northern hemisphere the summer nights:

**** Are shorter than the days

**** Last for 12 hours exactly

**** Last for 14 to 16 hours

1. How many seasons are there in the equator area?

**** 4 seasons: Summer, autumn, winter and spring

**** The equator is the closest place on earth to the sun and so only has one hot season

**** 2 seasons: Summer and winter

1. Can it snow in Australia at Christmas?

**** Yes, especially in the northern parts of Australia

**** It is very cold, but it doesn’t snow

**** Australia is in the southern hemisphere and experiences summer during Christmas and so it never snows at Christmas

1. Why are summer nights warmer than winter nights?

**** Because the earth is still tilted towards the sun

**** Because the ground absorbed a lot of heat during the long day and releases it at night

**** Because we still get sun heat radiation reflected from the moon

1. Why are rainy winter nights warmer than cloudless winter nights?

**** The clouds absorb sunlight and radiate heat to the ground

**** The rain clouds act as a blanket, preventing ground heat from radiating back into space

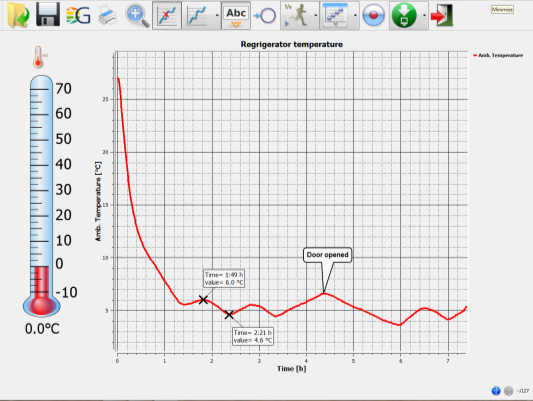
**** The water in the clouds is exposed to the sun and heats the air when falling to the ground

**Further Suggestions**

We can use the internal temperature sensor to monitor home appliances such as our refrigerator.

1. Set the Labdisc to record internal temperature, at one sample per minute and for 1000 samples.
2. Insert the Labdisc into a sealed plastic bag, and place it on the vegetable shelf of your refrigerator.
3. Make sure no one opens the Refrigerator door during the recording. The best time to conduct this activity is at night.
4. After recording for five to ten hours, stop recording and download the measurements.

An example of a refrigeration graph is shown below:



1. Change the graph scale to show between 3 °C to 7 °C
2. The cooling cycles of the refrigerator are clearly demonstrated. When the temperature rises above 6 °C the refrigerator compressor is turned on and starts cooling the refrigerator chamber. This continues until the temperature drops to 4.6 °C. The compressor is turned off and the chamber starts to heat again.

# Activity 7: A Walk in the Park



**Introduction**

We can find green parks in almost every city. Going to the park is a lot of fun, but is this the only reason why we should create parks?

Cities are crowded with people but also with cars and industrial plants. All these elements increase air pollution in the city and can even change the city’s weather conditions.

Parks are called green lungs. Their main role is to consume air pollution, mainly carbon dioxide (CO₂) and produce oxygen! This is done by the parks’ trees and other vegetation through a process called photosynthesis. In addition, parks reduce the heat created by cars, and industrial plants.

**The Experiment**

In this activity we will record temperature changes at a city’s busy intersection and in a nearby park or garden.

**Equipment Needed**

No equipment is needed for this activity.

**Labdisc Setup**

For this experiment we will setup the Labdisc from the Labdisc menu.

1. Turn on the Labdisc by pressing the On/Off key On-off.jpg
2. Rotate the Labdisc plastic ring to expose the sensors
3. **SENSORS:**Press SCROLL key Scroll.jpgto open the sensor menu. Then select the SETUP iconsetup_icon.bmp and the SET SENSOR icon.input_icon.bmp Using the sensor keys select both the External Temperature and GPS.
4. **SAMPLING RATE:**

Press the ESC key On-off.jpg to leave the previous menu and then select the SAMPLING RATE icon.rate_icon.bmp Use the SCROLL key Scroll.jpgto choose 1/sec. Press the SELECT key Enter.jpgto confirm.

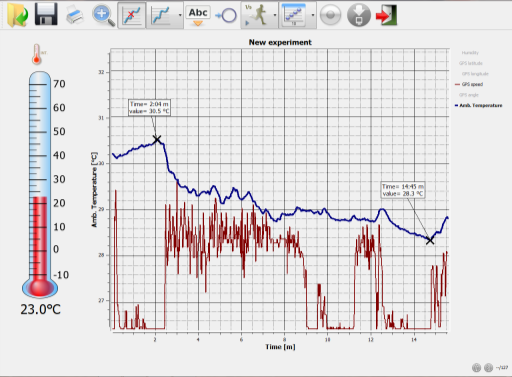
1. **AMOUNT OF SAMPLES:**Press the ESC key On-off.jpg to leave the previous menu and then select the NUMBER OF SAMPLES icon.samples_icon.bmp Use the SCROLL key Scroll.jpgto choose 1000. Press the SELECT key Enter.jpgto confirm.

**Experiment Procedure**

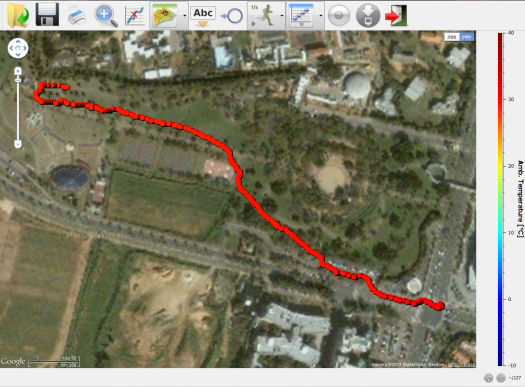
1. Select a park full of vegetation and located within walking distance from a busy intersection in the city.
2. Make sure the Labdisc battery is charged.
3. Start the experiment when located close to the busy intersection.
4. Connect the external temperature sensor, hold it in the air and wait for the reading to stabilize.
5. Make sure the GPS icon shows the 3 arcs, GPP3_20px.bmp indicating that the GPS is working properly.
6. Press the SELECT key Enter.jpg to start recoding.
7. Slowly walk to the center of the park.
8. Wait for the temperature reading to stabilize and stop recording by pressing the SELECT key Enter.jpgand then the SCROLL key.Scroll.jpg

**Data Analysis**

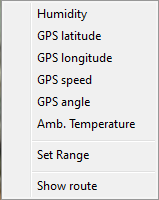
1. Make sure your computer is connected to the Internet.
2. Connect the Labdisc to the computer, either with the USB cable or through the wireless Bluetooth channel.
3. Click the Lab icon btn_lab.pngto open the Lab software.
4. Click on the download icon Download.pngto transfer the last recording from the Labdisc memory to the software. After the download is complete, the software displays the graphs of the temperature at GPS speed.
5. Using the software markers you can observe the minimum and maximum temperatures reached during this recording. In the example below the maximum measured temperature was 30.5 °C and the minimum measured temperature was 28.3 °C.



1. Press the right triangle on the Display Option icon.viewGraph.png Select the Map icon.viewMap.png The software will automatically open the Google Map application and display a satellite picture of the area where you conducted your recording. In addition it will plot the temperature recorded during the experiment as a layer of color-coded data over the map.

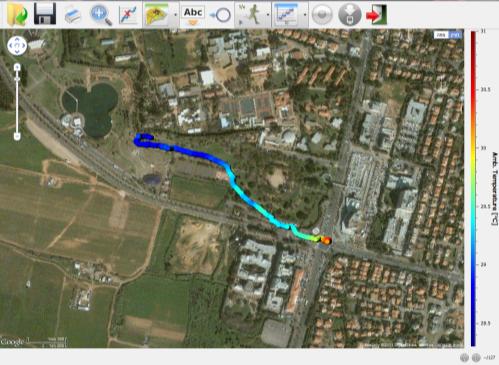


The colors represent the different temperatures measured at each location. You may move your mouse over any point to get a numeric value of the temperature.

1. As the temperature change is only by a few degrees, you should set the color scale minimum and maximum values accordingly, in order to see the color scale more clearly representing the range of temperature measured during the trip.

A right mouse click over the color scale bar will open the Google Map dialog box. This dialog box allows you to view other sensors over the Google Map and also set the range of each sensor. Select the range and enter the minimum and maximum temperature values recorded during the trip.

Press OK and you’ll receive the plot below.



It is very clear from the recording above that the park has a lower temperature than the nearby intersection.

1. Save your project by clicking on the SAVE icon 

**Investigation and Questions**

Try to answer the questions below using your collected data and software.

1. What were the hottest and the coldest areas?

**** The hottest area was the intersection and the coldest area was the park

**** The hottest area was the park and coldest area was the intersection.

1. Can you explain the temperature change?

**** The temperature in the park was lower because of the shade from the trees

**** The temperature in the park was lower because of cold winds

**** The temperature in the park was lower because of water evaporation from the park’s trees and grass

1. Explain the difference between climate and microclimate?

**** Microclimate and climate are the same

**** Microclimate describes the weather in the city and climate describes the weather in the country

**** Climate is an average weather condition measured in a certain area. Microclimate is a local zone where the climate differs from the surrounding area.

1. Would the temperature difference in the park and at the intersection change if this experiment was conducted at the weekend?

**** The temperature difference would be smaller due to less traffic

**** The temperature difference would be the same

****  The temperature difference would increase since many more people would be in the park

**** The temperature difference would decrease since there would be fewer people in the park

**Further Suggestions**

1. While in map view, right click with your mouse to the left of the color scale and choose GPS speed. Verify your walking speed along the trip.
2. Repeat the activity while recording both temperature and sound level.
3. Repeat the activity at different seasons of the year.