Sound and ultrasound

Introduction

Sounds are carried by waves.

Humans can hear sounds ranging from 20 hertz to 20 000 hertz. This is often referred to as the range of hearing. Not everyone can hear over all of this range - the numbers are only approximate. In particular the high frequency limit reduces with age.

The loudness of a sound is a measure of the **amplitude** of the wave: the greater the amplitude, the louder the sound is.

The pitch of a sound is a measure of the **frequency** of the wave: the higher the frequency, the higher the pitch is.

Sound levels are measured on a scale known as the decibel (dB) scale: the higher the number the greater the sound level is.

Too much noise can damage hearing. Exposure to 90-decibel sound levels for a long time can cause permanent hearing loss. Exposure to a brief sound level of 140 decibels will cause pain and can cause permanent damage to hearing.

Examples of sound levels ranging from 0 decibel to 140 decibels:

Source of sound	Sound level in decibels
Threshold of sound	0
Whispering	20
Background noise at home	40
Normal talking	60
Noise pollution level	90
Pneumatic drill - 5 metres away	100
At a disco - 1 m from a loudspeaker	120
Threshold of pain	140

Ultrasounds are high frequency vibrations beyond the range of human hearing. The frequency of ultrasounds is therefore greater than 20 000 hertz.

Ultrasounds, like audible sounds, are transmitted by means of waves.

Ultrasound is used in medicine to break up kidney stones and gallstones. It is also used, in a process known as medical scanning or imaging, to create images of an unborn baby in a womb.

Medical scanning works as follows. Ultrasound penetrates bodies well but some is reflected off each tissue boundary. The reflected ultrasound pulses are used to build up pictures of inside the body, for example, of an unborn baby. The body absorbs some of the energy of the wave but it is a lot less damaging than other penetrating waves such as X-rays.

You are going to do two types of experiments:

A. Noise pollution
B. Relationship between sound level and distance

Apparatus

Datadisc Au
A Distance sensor for the second experiment
Logbook SE, ML or Logbook XD with a Sound sensor

A serial lead or USB-serial lead

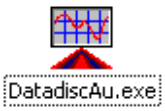
A radio set

Duration

45 min

A. Method

1. Plug the Logbook into the PC using a serial lead or USB-serial lead.
2. Plug the Sound sensor into port 3 if you are using Logbook XD. 

3. Plug in the radio. Check the volume is zero and choose a radio station.
4. Position the Sound sensor towards the loudspeaker, very close to it. It will record the level of noise you would hear if your ear were pressed up to the loudspeaker.
5. Start Datadisc Au. 

6. Click on “Measure”.
7. Click on “Auto time”. Then the Recording window will open.
8. Choose the channel you want to measure on the toolbar if you are using Logbook ML or SE.

9. To make the recording:

   a. Click on the green recording icon on the toolbar: this starts the recording.

   b. Record the background noise for 30 seconds. You can see the time on the X-axis. The sensor does not record noise below 50dB.

   c. Switch on the radio and record for 30 seconds at zero volume.

d. Increase the volume to 60dB. At this sound level, you will notice that you don't need to increase the volume a lot to be at 60dB. Take the time to press your ear up to the loudspeaker. Remember it is the sound level of normal talking.

e. Increase the volume further to 70dB. Once again, take the time to listen up close to the radio.

f. Repeat this operation with 80, 90, 100, 110dB and above. 90dB is the noise pollution level. The sensor does not record noise above 110dB. You will notice that the higher the sound level is, the more you need to increase the volume to go 10dB further.

g. Take note of the different sound level and the noise pollution you create.

h. Stop recording by clicking on the red hand.

10. Click on "Keep this data".

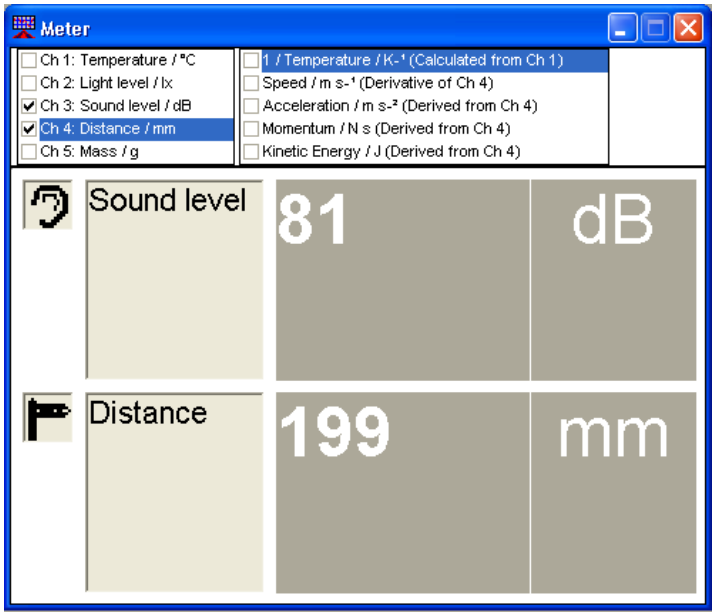
11. Save your recording and amend the graph as explained later.

Between 60 and 90s, the radio was broadcasting the news and then, some music. You can see that, when a person speaks, the sound level changes more and can be very low because there are some breaks in the talking.

B. Method

1. Plug the Distance sensor into port 4. 

2. Position the Sound sensor towards the loudspeaker.
3. Position the Distance sensor on the Logbook, towards the radio set.
4. Check that you will be able to move the radio set to a distance of 1.5 meter away from the sensors.
5. Both sensors must be at the same distance from the radio: 20cm at the beginning of the experiment. The range of the Distance sensor is from 200mm to 1500mm
6. Click on “Measure” and then click on “Meter”. A menu will appear asking you to choose channels to meter.
7. Click on “OK”. You will see the sound and distance readings. Remove the readings you don’t need (Temperature, Light level) if you are using Logbook SE or ML.
8. Switch on the radio and choose a volume of above 80dB. It is easier if the station is broadcasting some music.



9. Switch off.
10.  Close the Meter window.
11. Click on “Measure”.
12. Click on “Auto time”. Then the Recording window will open.
13. Choose the channel you want to measure on the toolbar if you are using Logbook ML or SE.

14. To make the recording:
    a. Switch on the radio.
    b.  Click on the green recording icon on the toolbar: this starts the recording.
    c. Record for 30 seconds.

d. Move the radio to a distance of 400mm away and record for 30s.

e. The radio set must be placed exactly opposite the sensors.

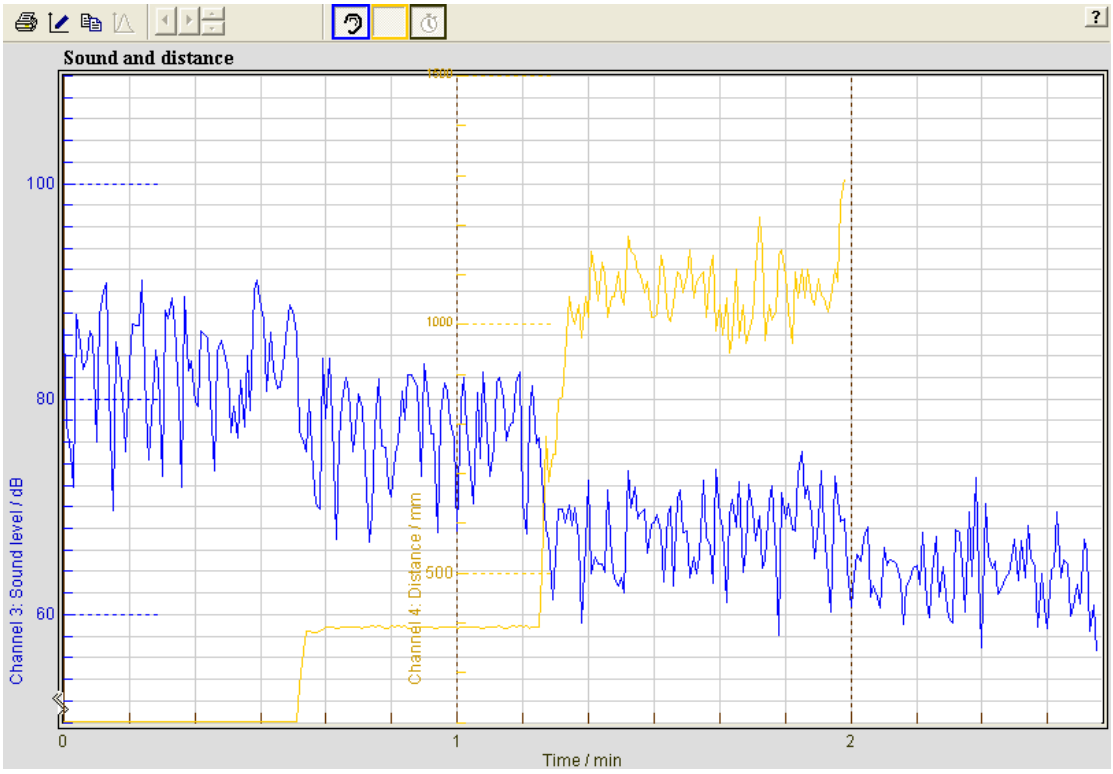
f. Move the radio to a distance of 1000mm away and record for 30s.

g. Repeat this operation at a distance of 1500mm and more.

h. Stop recording by clicking on the red hand.

15. Click on “Keep this data”.

16. Save your recording and amend the graph as explained later.



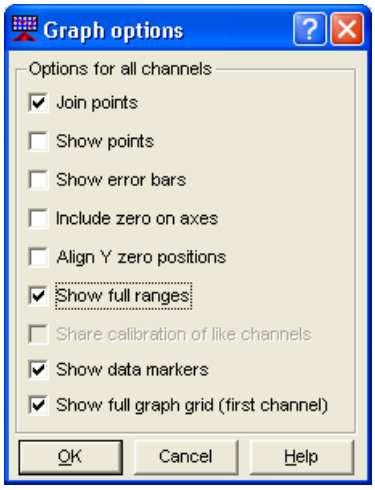
When you move the radio 1.5 meter away, the sound level decreases by about 20dB.

How to save your recording

1. Click on “File”.
2. Click on “Save as…”.
3. Choose the directory you want to save in and type the name of your file.

4. Click on “Save”.

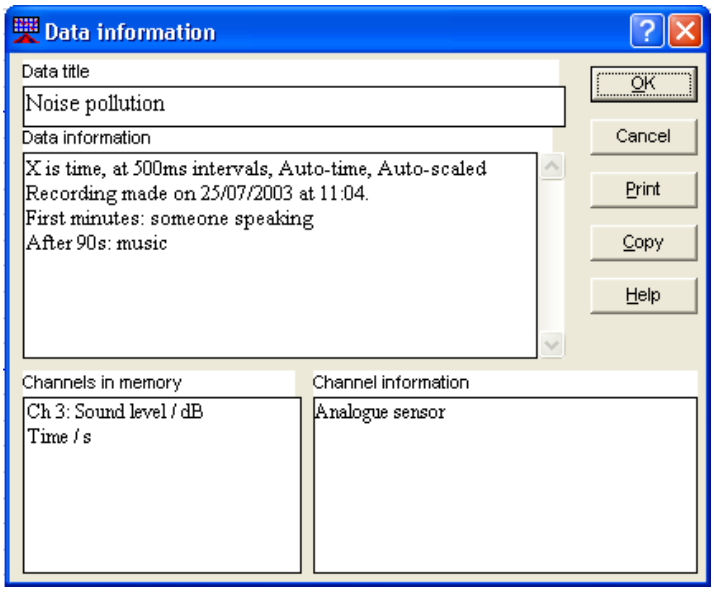
How to amend the graph



1. Click on “Graph”.
2. Click on “Plot options…”. The “Graph options” dialogue will open.
3. Tick “Show full ranges”.
4. Click on “OK”.

How to store information about your recording

1. Click on “Data”.
2. Click on “Data information”.
3. Type all the information you want in “Data title” and “Data information”.



4. Click on “OK”.

How to save your file and exit

1. Click on “File”.
2. Click on “Save”.
3. Click on “File”.
4. Click on “Exit”.