

# Human Sound: Hearing test on-line: sensitivity, equal loudness contours and audiometry

**This hearing test measures the relative sensitivity of your ears at different frequencies.** It produces equal loudness contours or hearing sensitivity curves – the frequency response of your own ears. The flash script allows you to play sound files with a range of frequencies and sound levels with the click of a mouse. The total size of all files is approximately 400 k. Because both the chart and the instructions refer to decibels, you may wish to go first to [What is a decibel?](#)

**Warning 1.** Do not start with a panel in the top third of the chart: you might hurt or even damage your ears.

**Warning 2.** Results using this test cannot be regarded as clinical data. Although the sound files have been carefully prepared, the actual sound level and spectral purity depend on the frequency response of your sound card and headphones. They may, however, be helpful for comparison, such as left vs right ear, or for changes in hearing over time, assuming that you use the same hardware. Note, however, that daily fluctuations in hearing are common. **If you are worried about your hearing, consult an audiologist.**

For best results you will need reasonably good quality **headphones that enclose your ears** completely and seal out external noises. Ordinary loudspeakers, and especially the small ones that come with computers, have such poor response, particularly at low frequency and are so much affected by interference effects and resonances that results obtained with them are useless. They may also be damaged by low frequencies.

## How to use this web service to measure equal loudness curves.

- Minimise any background noise: turn off machinery, close windows etc. If your computer has a fan, you may be able to put it under the desk.
- Plug headphones into your soundcard output and put them on, making sure that they seal well around your ears.
- In the 1 kHz column, choose a panel about halfway down. Listen to it and check that (i) it is not uncomfortably loud and (ii) it is considerably louder than the background noise. Go up or down the column if necessary until these conditions are satisfied. Notice that the dB level chosen is now

recorded at the bottom of the chart. Once you have made a choice, this becomes your **reference sound**.

- In the 750 Hz column, click the panel next to your reference panel. If you find that it is less loud than the reference sound, click on the panel that is 3 dB louder, still at 750 Hz. (Conversely, if it is louder, click on the panel below to make it softer. And if it is equally loud, leave it where it is.) Go back to your reference sound and compare. Keeping doing this until you are satisfied that the the 750 Hz and the 1 kHz sounds are equally loud. (You may find it difficult to judge equal loudness for different pitches, but because loudness is by definition subjective, there is no person or machine that can do it for you.)
- Next find a sound at 500 Hz whose loudness equals that of your reference sound **at 1 kHz**.
- Do the same for 375, 250 Hz etc, all the way down to 30 Hz, **at all times using 1 kHz as the reference**.
- Now find a sound at 1.5 kHz that equals the loudness of the 1 kHz reference. Continue to 2, 3 etc up to 16 kHz.
- The chart will now show the sounds that you have chosen as having equal loudness. We repeat that, while this curve roughly approximates the frequency response of your ears, it is modified by the frequency response of your sound card and headphones. You can print this chart by right clicking on the chart, by going to the 'file' menu of your browser and clicking 'print', or you can print the screen electronically.

You might like to compare your curve to the standard equal loudness curves (below) and to the dBA weighting curve given on [What is a decibel?](#) The dBA weighting curve is the response of a filter that is applied to sound level meters to mimic (roughly) the response of human hearing. So a typical human equal loudness curve is somewhat similar to the dBA curve, but inverted. The values on the graph you have made will be arbitrary (unless you calibrate them – see below), because we do not know the properties of your sound card and headphones.

### **What does your hearing curve mean?**

Most people will find that their hearing is most sensitive around 1–4 kHz and that it is less sensitive at high and low frequencies. Children usually hear 16 kHz moderately well. The high frequency hearing of adults depends on age and exposure to loud sounds. It is not uncommon for adults to have very low sensitivity for the highest frequencies. (Your children may be complaining about that 16 kHz tone that you cannot hear.) If you cannot hear the lowest frequencies, it's probably

because you are using loudspeakers. As we mentioned above, you need headphones that enclose your ears for this.

### **How does your hearing response depend on loudness?**

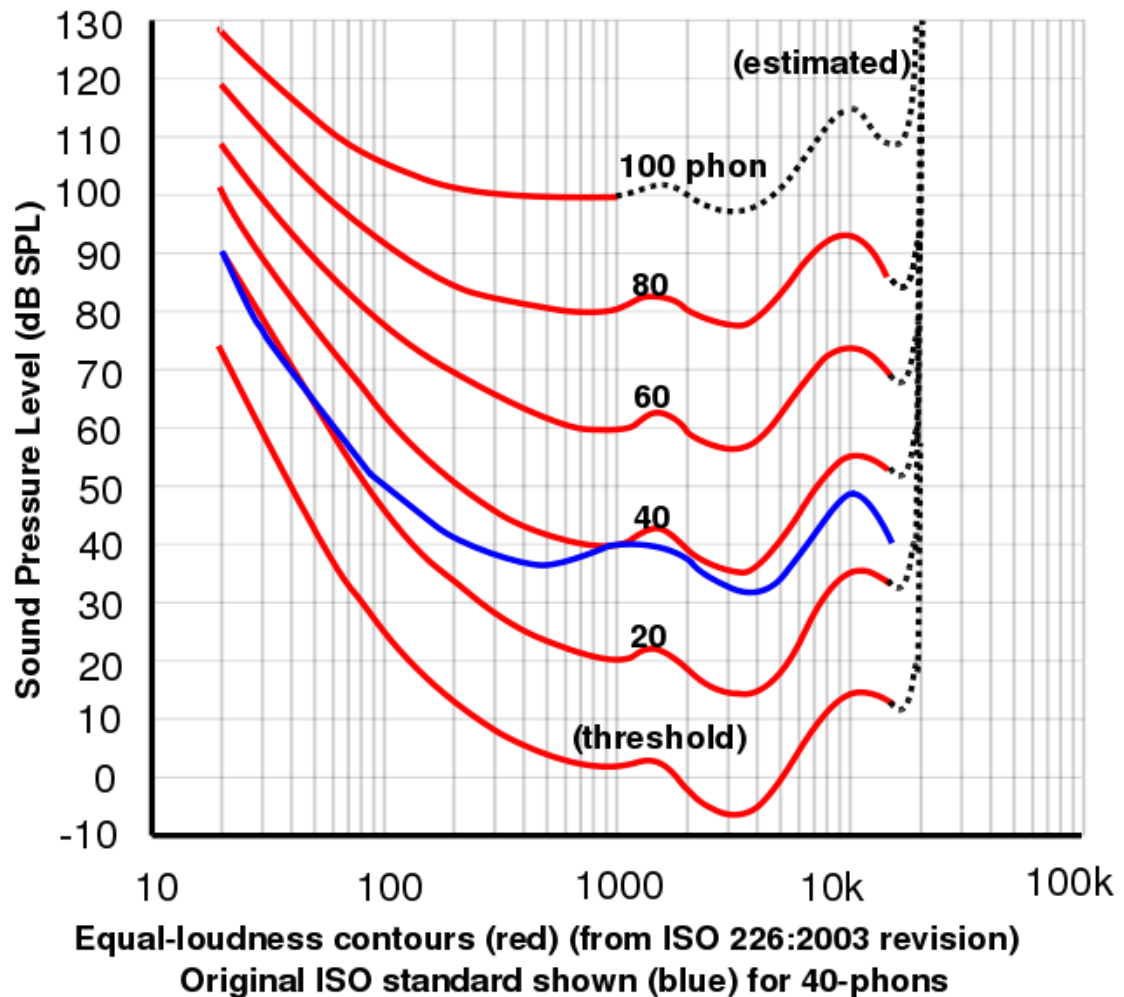
The shape of your hearing response curve probably depends on loudness. For most of us, the curve is flatter at higher sound levels\*. Choose a louder or softer reference signal and obtain a new curve. (If you reload the page it will clear the old curve from the screen.)

### **Can you use this web service to measure hearing threshold curves?**

It is possible, but not likely. Even if your headphones seal really well around your ears, they will probably only give you about 20 to 25 dB insulation from the external sound field. Human hearing thresholds can be around 0 dB in the frequency range 0–4 kHz. It is rare to find an office whose sound level is as low as 20 dB – *i.e.* an office in which 20 dB of insulation would reduce the sound level to near threshold levels. For a start, your computer probably has a fan and a power supply that raise the sound level above 20 dB, even at these frequencies. There may be other background noise as well. However, under very good conditions (a really quiet, still environment, no computer fan or other stray noises) it might be possible.

If so, the method would be to find the lowest sound level audible at each frequency. (How this level relates to the common standard of sound levels (see [What is a decibel?](#)) is something that we cannot tell you: it depends on the gain of your sound card and headphones. However, see the note about calibration below.)

Under normal conditions, if you seek the lowest sound level you can hear at each frequency, what you will find is the lowest level of a sine wave that is not masked by the background noise that you are hearing inside your headphones.



This graph, courtesy of [Lindosland](#), shows the 2003 data from the International Standards Organisation for curves of equal loudness determined experimentally. Plots of equal loudness as a function of frequency are often generically called Fletcher-Munson curves after the original work by Fletcher, H. and Munson, W.A. (1933) *J. Acoust. Soc. Am.* 6:59.

**What does zero dB mean?** It is, by definition, the reference level and is arbitrary. For the hearing curve you make with the gadget above, it is the maximum output of your interface card, amplifier and earphones with the current settings. (We do not know the specifications of your equipment, of course, and we don't know how high you have set the 'volume' knob.) For the graphs shown immediately above, 0 dB is 20  $\mu$ Pa. See [What is a decibel?](#) for an explanation.

**Calibration and improvements.** It is possible to improve the accuracy of measurements made using this service by calibrating the response of your sound card and headphones, using a small microphone with good frequency response. (Microphones usually have much flatter frequency response than do speakers, so even a quite cheap electret microphone can be useful.) Connect the microphone to an oscilloscope or to the input of the sound card of a second computer. Using high but not painful sound levels, play sound files with the same amplitude (i.e. click on panels in the same row) and measure the variation in the recorded AC voltage for different frequencies. This works at low frequencies, but for the highest frequencies the sound level varies considerably within the headphone itself. Microphones often come with a calibration curve, or a sensitivity rating in volts/pascal. Using this you can convert the values measured with the microphone to the standard expressions of sound level, in dB with respect to  $20 \mu\text{Pa}$ .

\* The flattening of the hearing curve at high sound levels is sometimes referred to jokingly as the first law of hifi: if you turn it up it sounds better. If ever you compare hifi systems in a shop, vary the volume controls (and loudness control, if present). The sales staff are usually aware of this law, so, before you buy, make sure that you try turning the expensive one down so that it is slightly softer than the cheap one.

The flash script above was made by George Hatsidimitris with sound files by John Tann of the School of Physics, UNSW. John has posted an [array of sound files](#) over a range of sound levels and frequencies.

**Source:** <http://www.animations.physics.unsw.edu.au/jw/hearing.html>