

## Audible Sound

Usually “sound” is used to mean sound which can be perceived by the human ear, i.e., “sound” refers to audible sound unless otherwise classified. A reasonably standard definition of audible sound is that it is a pressure wave with frequency between 20 Hz and 20,000 Hz and with intensity above the standard threshold of hearing. Since the ear is surrounded by air, or perhaps under water, the sound waves are constrained to be longitudinal waves. Normal ranges of sound pressure and sound intensity may also be specified.

Frequency:	20 Hz - 20,000 Hz	corresponds to pitch
Intensity:	$10^{-12}$ - $10$ watts/m <sup>2</sup>	0 to 130 decibels
Pressure:	$2 \times 10^{-5}$ - 60 Newtons/m <sup>2</sup>	$2 \times 10^{-10}$ – 0.0006 atm

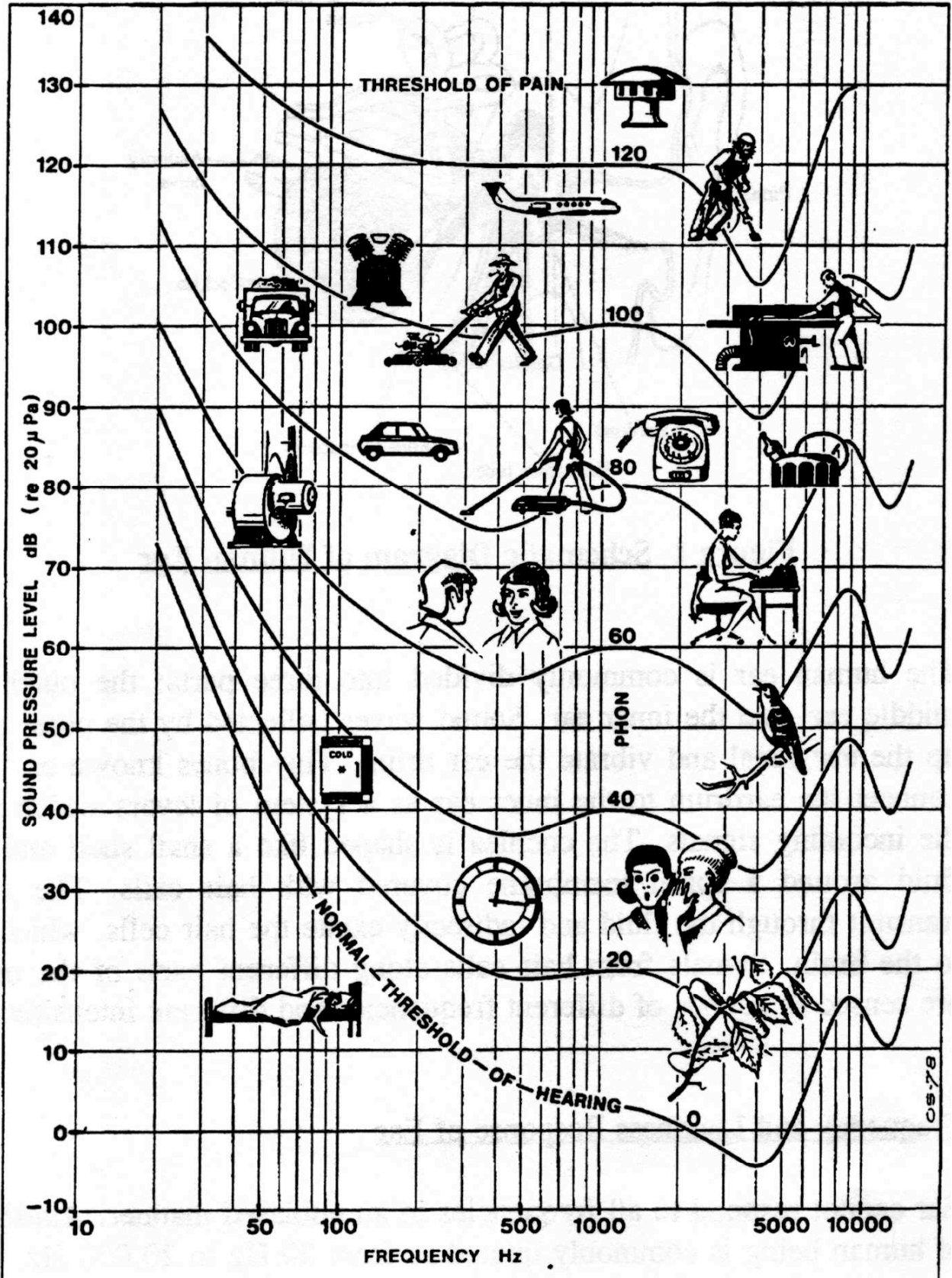
For an air temperature of 20°C where the sound speed is 344 m/s, the audible sound waves have wavelengths from 0.0172 meters (0.68 inches) to 17.2 meters (56.4 feet).

The ear has incredible sensitivity

**Threshold of hearing**      $I_0$      **less than one billionth of atmospheric pressure.**

And an incredible power range of operation!

**Threshold of pain**      $10^{13} I_0 = 10,000,000,000,000 I_0$



140

130

120

110

100

90

80

70

60

50

40

30

20

10

0

-10

THRESHOLD OF PAIN

NORMAL THRESHOLD OF HEARING

PHON

120

100

80

60

40

20

0

10

50

100

500

1000

5000

10000

FREQUENCY Hz

09-78