quency is twice the lower frequency of the band as shown in the following table.

Band Number	Usual Frequency Limits	Approximate Geometric Mean Frequency
1	20 to 75 cps*	40
2	75 to 150	105
3	150 to 300	210
4	300 to 600	425
5	600 to 1200	850
6	1200 to 2400	1700
7	2400 to 4800	3400
8	4800 to 10,000*	6900

* The highest and lowest bands as usually used, contain somewhat more than one octave as indicated.

Decibel db is a dimensionless unit for expressing the ratio of two numerical values (usually electrical or mechanical power) on a logarithmic scale. The number of decibels is ten times the logarithm to the base 10 of the numerical ratio of the two quantities. For example, let W_1 and W_2 designate two powers; or, I_1 and I_2 designate two sound intensities, and let M designate the number of corresponding decibels, then

$$M = 10 \log_{10} \frac{W_1}{W_2} \text{ decibels} \tag{1}$$

or,

$$M = 10 \log_{10} \frac{I_1}{I_2} \text{ decibels} \tag{2}$$

Alternatively, the ratio of two sound pressures squared is expressed in the same units,

$$M = 10 \log_{10} \frac{p_1^2}{p_2^2} = 20 \log_{10} \frac{p_1}{p_2} \text{ decibels} \tag{3}$$

These relations tacitly assume that: $W = p^2/Z$, which means that Z, the acoustic impedance is real, and that for p_1 and p_2, $Z_1 = Z_2$. This is not usually the case, but because sound pressure is the easiest variable to measure in a sound field, the relation:

$$M = 20 \log_{10} \frac{p_1}{p_2} \text{ decibels} \tag{4}$$

is commonly used. Thus, in a sense when used in this way, the decibel is redefined on the basis of a pressure squared ratio rather than a power ratio.

Sound Power Level PWL is ten times the logarithm to the base ten of the ratio of the sound power to the reference power of 10^{-13} watt. Thus, Power Level in the English system:[2]

$$\text{PWL} = 10 \log_{10} \frac{W}{10^{-13}} \text{ dbe} \tag{5}$$

where

W = sound power, watts.

The unit is the *dbe*. The symbol *dbe* means that the sound power level

is convenient to use in the English system and that 10^{-13} watt is the reference power.

Sound Intensity Level (L_I) is ten times the logarithm to the base ten of the ratio of the sound intensity I to the reference intensity of 10^{-16} watt per sq cm (or its equivalent 1 picowatt per sq m). Thus

$$L_I = 10 \log_{10} \frac{I}{10^{-16}} \text{ dbi} \tag{6}$$

where

I = watts per square centimeter.

or

$$L_I = 10 \log_{10} \frac{I}{10^{-12}} \text{ dbi} \tag{7}$$

where

I = watts per square meter.

The unit is the *dbi*. Either formula gives the same numerical result.

Sound Pressure Level L_p is twenty times the logarithm to the base 10 of the ratio of the sound pressure p to the reference sound pressure of 0.0002 microbar, *i.e.*,

$$L_p = 20 \log_{10} \frac{p}{0.0002} \text{ dbc} \tag{8}$$

where

p = sound pressure, microbars (dynes per square centimeter).

The unit is the *dbc*, where *c* stands for the C scale or flat scale on the sound level meter.

Loudness N is the intensive subjective attribute of an auditory sensation, in terms of which sounds may be ordered on a scale extending from soft to loud. The unit is the sone. The number of sones is directly proportional to the loudness. By definition, a 1000 cps pure tone with a sound pressure level of 40 dbc has a loudness of 1.0 sone.

Loudness Level (L_N) of a sound is numerically equal to the sound pressure level L_p of a simple tone of frequency 1000 cps that is judged by the listeners to be equivalent in loudness. The unit is the phon. In this text, for a 1000 cps tone, L_N in phons is assumed to be related to N in sones by the formula

$$L_N = 33 \log_{10} N + 40 \text{ phons} \tag{9}$$

This approximation is assumed valid[3] for $N > 1$.

Sound Level at a point in a sound field is the reading in decibels of a sound level meter constructed and operated in accordance with the latest edition of American Standard Sound Level Meters for the Measurement of Noise and Other Sounds.[4] The reading is taken with the proper weighting network switched into the circuit. The unit is dba, if the reading is taken on the A scale; dbb if taken on the B scale, and dbc if taken on the C or flat scale. The use of these scales is discussed later.

Attenuation is ten times the logarithm to the base ten of the ratio of the sound intensities at any two points along any continuous acoustic path in the direction away from the source. The unit is the decibel. For a signal