

# VOL SCALE

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## VOL SCALE

**Primary Disciplinary Field(s):** Psychoacoustics, Auditory Science, Experimental Psychology

### 1. Core Definition

The **Vol Scale** is a specialized measurement system designed to quantify **subjective volume**, often referred to synonymously with perceived loudness. Unlike physical measures of sound intensity, such as the decibel (dB), which measures sound pressure level (SPL), the Vol Scale attempts to assign a numerical value to the magnitude of auditory sensation experienced by a human listener. This distinction is crucial in psychoacoustics, the study of the relationship between physical stimuli and psychological response, because the relationship between objective physical energy and subjective perception is highly non-linear and frequency-dependent. The scale utilizes a specific unit of measure known as the **vol**.

The definition establishes a clear, standardized reference point for one vol. Specifically, **one vol** is defined as the volume of a 1000-Hertz (Hz) tone presented at 40 decibels (dB). This reference tone--a pure tone at a frequency where the human ear is highly sensitive and at a moderate intensity--serves as the anchor for all subsequent subjective measurements on the scale. When a sound stimulus is said to have a volume of 2 vols, it implies that the perceived loudness of that stimulus is subjectively twice as great as the standard reference tone. Conversely, a stimulus rated at 0.5 vols is perceived as half as loud. This structured definition allows researchers to translate complex auditory experiences into a relative, quantitative metric rooted in human perception, although the source material itself emphasizes the inherent variability in individual perception, noting that "Every individual has their own perception of vol. scale and what is considered by them to be loud and quiet."

### 2. Psychoacoustic Context: Loudness Perception

Understanding the Vol Scale requires placing it within the broader psychoacoustic study of **loudness**. Loudness is a psychological attribute, not a physical one. If sound intensity were perfectly correlated with perception, no specialized subjective scale would be necessary; the decibel system alone would suffice. However, early psychoacoustic research, notably the work of Harvey Fletcher and Wilden A. Munson in the 1930s, demonstrated that the ear's sensitivity varies dramatically across the audible frequency spectrum. A sound presented at 40 dB at 1000 Hz sounds significantly louder than a sound presented at 40 dB at 50 Hz. Furthermore, the rate at which loudness increases or decreases relative to changes in physical intensity (dB) is non-linear, following established psychophysical laws.

Scales like the Vol Scale were developed specifically to address this perceptual complexity. They

are designed to measure **loudness magnitude**, meaning they aim to quantify how much louder or quieter one sound is compared to another, independent of the underlying physical parameters like SPL or frequency, except for the initial standardization reference. In practice, this means that different stimuli--say, a complex noise spectrum or a pure tone at a very low frequency--can all be assigned the same "vol" rating if they are perceived as equally loud by a listener, even if their dB levels differ drastically. This focus on magnitude distinguishes the Vol Scale and related subjective metrics from loudness level scales (like the phon), which only quantify equal loudness without representing the magnitude relationship directly.

### 3. The Unit of Measurement: The Vol

The unit **vol** is the core metric of this scale, serving as the arbitrary yet standardized unit of subjective volume. Its precise definition (1000 Hz at 40 dB) anchors it directly to the concepts developed for standardized psychoacoustic measurement. In the international system of psychoacoustics, the standard measure of loudness magnitude is the sone. While the term 'vol' is less common in modern standardized literature than 'sone', the numerical definition (40 dB at 1 kHz) strongly suggests that the Vol Scale operates identically to, or is an early variant of, the Sone scale. The standard definition of 1 sone is conventionally set at the loudness of a 1 kHz tone presented at 40 phons, which typically equates to 40 dB for a standard young listener.

The significance of the vol, therefore, lies in its adherence to the principle that doubling the physical sound pressure level (a 10 dB increase) approximately doubles the perceived loudness magnitude. If a sound is measured at 2 vols, and another sound is measured at 4 vols, the 4-vol sound is perceived to be twice as loud as the 2-vol sound. This linear relationship in the subjective realm (vols) contrasts sharply with the logarithmic nature of the physical measurement (decibels). This characteristic allows researchers and engineers to perform meaningful arithmetic operations on perceived loudness, which is impossible using only dB measurements. The reference point of 40 dB at 1 kHz also places the 1-vol measurement well above the typical absolute threshold of hearing (0 dB), ensuring it represents a clearly audible, moderate sound level.

### 4. Historical Development and Relation to Other Scales

The genesis of the Vol Scale, or similar subjective magnitude scales, stems from the efforts in the mid-20th century to create standardized methods for quantifying human hearing experience. Before the development of the Sone and Vol scales, the primary means of quantifying subjective sound intensity was the **Phon Scale**. The phon scale measures the **loudness level**, where sounds are judged to be equally loud to a reference 1 kHz tone. While useful for establishing equal loudness contours, the phon scale is an interval scale, meaning a sound of 80 phons is not necessarily perceived as twice as loud as a sound of 40 phons.

The need for a true **ratio scale**, where numerical ratios correspond to perceived ratios (e.g., a magnitude of 4 is twice a magnitude of 2), led to the development of scales like the Sone and, by extension, the Vol Scale. The Sone scale was largely formalized by Stanley Smith Stevens, who employed techniques like magnitude estimation to derive the mathematical function relating SPL to perceived loudness. This Sone scale established the critical principle that a 10 dB increase (above the reference) results in a doubling of perceived loudness. Given the specific definition provided for the vol (1 vol = 40 dB at 1 kHz), it is highly probable that the Vol Scale represents a local or specialized nomenclature for the standardized Sone scale, used perhaps in an instructional or non-international context to emphasize the concept of subjective volume scaling using the ratio principle. Thus, the history of the Vol Scale is intertwined with the successful establishment of the Sone scale as the international standard for loudness magnitude, detailed in standards such as ISO 532.

## 5. Methodology of Subjective Volume Measurement

The establishment and calibration of any subjective scale, including the Vol Scale, rely heavily on sophisticated psychoacoustic experimental methodology. These methods are designed to bypass the limitations of simple physical measurements by directly eliciting quantitative judgments from human participants. The two most common techniques utilized are **magnitude estimation** and **magnitude production**.

**Magnitude Estimation:** In this technique, a listener is presented with the reference tone (1 vol) and then presented with a sequence of different test stimuli (varying in frequency, intensity, or complexity). The listener is instructed to assign a numerical value to each test stimulus corresponding to its perceived loudness relative to the reference. If a sound is perceived as three times louder than the reference, the listener assigns it the value '3'. This allows experimenters to map the entire psychoacoustic space onto the numerical vol scale.

**Magnitude Production:** Conversely, in magnitude production, the listener is presented with a standard sound and asked to adjust the intensity of a test sound until it reaches a specified numerical volume, for instance, half the loudness (0.5 vols) or four times the loudness (4 vols). By averaging results across numerous subjects and diverse stimuli, researchers can construct the complex non-linear curves necessary to convert physical measurements into subjective vol units.

These experimental frameworks are essential for capturing the variability inherent in human hearing and establishing a statistically representative average scale. However, they also serve to confirm the source content's observation regarding inherent subjectivity, as individual results invariably show significant variance before aggregation.

## 6. Key Characteristics of Vol Scale Measurement

The Vol Scale, as a measure of subjective loudness, exhibits several fundamental characteristics that govern its utility and application in auditory science:

**Ratio Properties:** Unlike the phon scale (interval), the Vol Scale possesses ratio properties, allowing direct comparison of magnitudes. A ratio of 2:1 in vols corresponds directly to a perceived doubling of volume. This is the scale's primary advantage over earlier methods.

**Frequency Dependence:** Measurement on the Vol Scale is highly dependent on the frequency content of the sound. Because the human auditory system is maximally sensitive in the 2 kHz to 5 kHz range, a sound at a low frequency (e.g., 100 Hz) requires significantly higher SPL (more dB) to achieve the same vol rating as a sound at 1000 Hz. The Vol Scale integrates the complexities of the equal-loudness contours into its final calculation.

**Dynamic Range:** The scale must accommodate the vast dynamic range of human hearing, from the threshold of audibility (approximately 0 dB SPL) up to the threshold of pain (around 120 dB SPL). This necessitates a robust mathematical model (often a power law) that accurately translates the logarithmic nature of physical energy into the linear nature of perceived volume across this massive range.

**Subjectivity and Variability:** The intrinsic definition of volume requires acknowledging inter-subject variability. Factors such as age, hearing health, attention, and immediate auditory context can influence an individual's volume judgment. While standardization (e.g., ISO 532) attempts to define the "average normal ear," application of the Vol Scale inherently contains a measure of error derived from the individual listener's perception, aligning with the concept that every individual maintains a unique frame of reference for loud and quiet.

## 7. Applications in Audiology and Engineering

While the specific nomenclature "Vol Scale" may be less common than "Sone Scale," the underlying principles of measuring subjective loudness magnitude have vital applications across various fields:

In **Acoustic Engineering and Noise Control**, the Vol Scale principles are indispensable. Engineers dealing with environmental noise (e.g., aircraft, traffic, machinery) cannot rely solely on dB meters, as these often poorly correlate with how annoying or intrusive the noise is perceived to be. For instance, high-frequency noise is often perceived as significantly louder than low-frequency noise at the same dB level. By converting physical measurements into vol (sone) units, engineers can design noise reduction strategies that target the sounds perceived as most voluminous, thereby optimizing auditory comfort and compliance with noise pollution regulations based on human experience rather than pure physics.

In **Audiology and Communication Science**, subjective volume measurement assists in evaluating hearing loss and setting appropriate amplification levels. Calibrating hearing aids

requires knowledge of how a sound's physical intensity translates to a perceived volume magnitude for a hearing-impaired individual. Since the recruitment phenomenon (abnormal growth of loudness perception) often complicates volume judgments in impaired ears, subjective scales help practitioners tailor amplification settings to ensure sounds are audible without being excessively loud, maintaining a natural perceived volume progression for the user.

## 8. Debates on Subjectivity and Standardization

Despite the rigor applied to its development, any scale based on subjective perception, including the Vol Scale, is subject to ongoing academic debate regarding its standardization and limitations. The primary challenge, as noted in the source material, is the inherent variability among listeners. While scales like the Sone (and Vol) are based on the averaged responses of young, healthy listeners, these averages do not perfectly capture the perceptual reality of every individual.

Furthermore, debates persist regarding the applicability of the 1000 Hz, 40 dB reference tone across all populations and listening conditions. For example, loudness perception can be affected by factors such as duration of the sound, spatial location, and whether the sound is presented monaurally or binaurally. While standardized measurement procedures account for many of these variables, subtle contextual effects continue to challenge the notion of a perfectly universal, standardized volume scale. Critics often point out that while the scale provides a necessary psychological metric, its utility is highest in controlled laboratory settings and its practical application in highly complex, real-world noise environments requires continuous refinement and contextual adjustment.

### Further Reading

[Loudness \(Wikipedia\)](#)

[Sone \(Wikipedia\)](#)

[Psychoacoustics \(Wikipedia\)](#)

[Phon \(Wikipedia\)](#)