



$$\text{level change} = 20 \log_{10}^{(r)}$$

$$X(t) = a \cos(2\pi f t + \phi)$$

$$f = \frac{1}{\tau} \quad \tau = \frac{1}{f}$$

ex. $\tau = \frac{1 \text{ sec}}{440}$

$$f = 440 \frac{1}{\text{sec}}$$

$$f = \frac{440}{\text{sec}} \cdot \frac{1 \text{ sec}}{1000 \text{ msec}} = \frac{440}{1000} \frac{1}{\text{msec}}$$

$$\tau = 25 \text{ samples}$$

$$f = \frac{1}{25 \text{ samples}} \cdot \frac{44100 \text{ samples}}{1 \text{ sec}}$$

$$\approx 2000 \frac{1}{\text{sec}}$$

$$2000 \text{ Hz} \quad 2000 \text{ cps}$$

			reference frequency				
relative frequency	1/4	1/2	1	2	4		
frequency	110	220	440	880	1760	amplitude	.1 1 10 100
octaves	-2	-1	0	1	2	decades	-1 0 1 2
half steps	-24	-12	0	12	24	decibels	-20 0 20 40
						dB	

$$\text{octaves} = \log_2 \left(\frac{f}{f_{\text{ref}}} \right) \quad \text{relative frequency}$$

$$\text{level-in-dB} = 20 * \log_{10} \left(\frac{a}{a_{\text{ref}}} \right)$$

$$\text{halfsteps} = 12 * \text{octaves} = 12 * \log_2 \left(\frac{f}{f_{\text{ref}}} \right)$$