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# Waves And Sound Formulas

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# List of 49 Waves And Sound Formulas

## Waves And Sound

### 1) Frequency of Progressive Wave

$$fx \quad f_w = \frac{\omega_f}{2 \cdot \pi}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$ex \quad 1.636113Hz = \frac{10.28Hz}{2 \cdot \pi}$$

### 2) Frequency of Wave using Time Period

$$fx \quad f_w = \frac{1}{T_w}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$ex \quad 0.384615Hz = \frac{1}{2.6s}$$

### 3) Frequency of Wavelength using Velocity

$$fx \quad f_w = \frac{V_w}{\lambda}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$ex \quad 150Hz = \frac{60m/s}{0.4m}$$



#### 4) Intensity of Sound

$$\text{fx } I_s = \frac{P}{A}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 20\text{W/m}^2 = \frac{900\text{W}}{45\text{m}^2}$$

#### 5) Length of Closed Organ Pipe

$$\text{fx } L = (2 \cdot n + 1) \cdot \frac{\lambda}{4}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 0.5\text{m} = (2 \cdot 2 + 1) \cdot \frac{0.4\text{m}}{4}$$

#### 6) Length of Open Organ Pipe

$$\text{fx } L = \frac{n}{2} \cdot \frac{V_w}{f_w}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } 0.666667\text{m} = \frac{2}{2} \cdot \frac{60\text{m/s}}{90\text{Hz}}$$

#### 7) Loudness

$$\text{fx } Q = 10 \cdot \log_{10} \left( \frac{I_s}{I_{\text{ref}}} \right)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$\text{ex } 48.75061\text{dB} = 10 \cdot \log_{10} \left( \frac{75\text{W/m}^2}{0.001\text{W/m}^2} \right)$$



## 8) Mass per Unit Length of String

$$fx \quad m = \frac{T}{V_w^2}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 0.027778\text{kg/m} = \frac{100\text{N}}{(60\text{m/s})^2}$$

## 9) Tension in String

$$fx \quad T = V_w^2 \cdot m$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$ex \quad 43200\text{N} = (60\text{m/s})^2 \cdot 12\text{kg/m}$$

## 10) Time Period given Velocity

$$fx \quad T_w = \frac{\lambda}{V_w}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$ex \quad 0.006667\text{s} = \frac{0.4\text{m}}{60\text{m/s}}$$

## 11) Time Period using Angular Frequency

$$fx \quad T_w = \frac{2 \cdot \pi}{\omega_f}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b\_img.jpg\)](#)

$$ex \quad 0.611205\text{s} = \frac{2 \cdot \pi}{10.28\text{Hz}}$$



## 12) Time Period using Frequency

$$fx \quad T_w = \frac{1}{f_w}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$ex \quad 0.011111s = \frac{1}{90Hz}$$

## 13) Velocity of Sound in Liquid

$$fx \quad V_w = \sqrt{\frac{K}{\rho}}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$ex \quad 1.41634m/s = \sqrt{\frac{2000Pa}{997kg/m^3}}$$

## 14) Velocity of Sound in Solids

$$fx \quad V_w = \sqrt{\frac{E}{\rho}}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd\_img.jpg\)](#)

$$ex \quad 0.10015m/s = \sqrt{\frac{10Pa}{997kg/m^3}}$$



15) Wave Number 

$$fx \quad k = \frac{2 \cdot \pi}{\lambda}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)


$$ex \quad 15.70796 = \frac{2 \cdot \pi}{0.4m}$$

16) Wave Number using Angular Frequency 

$$fx \quad k = \frac{\omega_f}{V_w}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5\_img.jpg\)](#)

$$ex \quad 0.171333 = \frac{10.28Hz}{60m/s}$$

Angular Frequency 17) Angular Frequency given Velocity 

$$fx \quad \omega_f = \frac{2 \cdot \pi \cdot V_w}{\lambda}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7\_img.jpg\)](#)

$$ex \quad 942.4778Hz = \frac{2 \cdot \pi \cdot 60m/s}{0.4m}$$

18) Angular Frequency using Frequency 

$$fx \quad \omega_f = 2 \cdot \pi \cdot f_w$$

[Open Calculator !\[\]\(21226b58c700e5231ab98d27101bac58\_img.jpg\)](#)

$$ex \quad 565.4867Hz = 2 \cdot \pi \cdot 90Hz$$



## 19) Angular Frequency using Time Period

$$fx \quad \omega_f = \frac{2 \cdot \pi}{T_w}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$ex \quad 2.41661\text{Hz} = \frac{2 \cdot \pi}{2.6\text{s}}$$

## 20) Angular Frequency using Wave Number

$$fx \quad \omega_f = k \cdot V_w$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$ex \quad 13.8\text{Hz} = 0.23 \cdot 60\text{m/s}$$

## Frequency of Organ Pipe

### 21) Frequency of 1st Harmonic Closed Organ Pipe

$$fx \quad f_w = \frac{1}{4} \cdot \frac{V_w}{L}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e\_img.jpg\)](#)

$$ex \quad 20\text{Hz} = \frac{1}{4} \cdot \frac{60\text{m/s}}{0.75\text{m}}$$


### 22) Frequency of 2nd Harmonic Open Organ Pipe

$$fx \quad f_w = \frac{V_w}{L}$$

[Open Calculator !\[\]\(683dba75afe26e28cd4de5730b776760\_img.jpg\)](#)

$$ex \quad 80\text{Hz} = \frac{60\text{m/s}}{0.75\text{m}}$$




23) Frequency of 3rd Harmonic Closed Organ Pipe 

$$fx \quad f_w = \frac{3}{4} \cdot \frac{V_w}{L}$$

Open Calculator 


$$ex \quad 60Hz = \frac{3}{4} \cdot \frac{60m/s}{0.75m}$$

24) Frequency of 4th Harmonic Open Organ Pipe 

$$fx \quad f_w = 2 \cdot \frac{V_w}{L}$$

Open Calculator 

$$ex \quad 160Hz = 2 \cdot \frac{60m/s}{0.75m}$$

25) Frequency of Closed Organ Pipe 

$$fx \quad f_w = \frac{2 \cdot n + 1}{4} \cdot \frac{V_w}{L}$$

Open Calculator 

$$ex \quad 100Hz = \frac{2 \cdot 2 + 1}{4} \cdot \frac{60m/s}{0.75m}$$

26) Frequency of Open Organ Pipe 

$$fx \quad f_w = \frac{n}{2} \cdot \frac{V_w}{L}$$

Open Calculator 

$$ex \quad 80Hz = \frac{2}{2} \cdot \frac{60m/s}{0.75m}$$





## 27) Frequency of Open Organ Pipe for Nth Overtone

$$fx \quad f_w = \frac{n - 1}{2} \cdot \frac{V_w}{L}$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0\_img.jpg\)](#)

$$ex \quad 40Hz = \frac{2 - 1}{2} \cdot \frac{60m/s}{0.75m}$$

## Observed Frequency

### 28) Observed Frequency when Observer and Source Move Away from Each Other

$$fx \quad F_o = \left( \frac{c - V_o}{c + V_{source}} \right) \cdot f_w$$

[Open Calculator !\[\]\(faf942dc3e59ce8eb64b4ac481eca7e0\_img.jpg\)](#)

$$ex \quad 41.06383Hz = \left( \frac{343m/s - 150m/s}{343m/s + 80m/s} \right) \cdot 90Hz$$

### 29) Observed Frequency when Observer and Source Move towards Each Other

$$fx \quad F_o = \left( \frac{c + V_o}{c - V_{source}} \right) \cdot f_w$$

[Open Calculator !\[\]\(95b425611cbd2b8716a140cf67c81822\_img.jpg\)](#)

$$ex \quad 168.7072Hz = \left( \frac{343m/s + 150m/s}{343m/s - 80m/s} \right) \cdot 90Hz$$



### 30) Observed Frequency when Observer Moves Away from Source

$$f_x \quad F_o = c - V_o$$

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a\_img.jpg\)](#)

$$ex \quad 193\text{Hz} = 343\text{m/s} - 150\text{m/s}$$

### 31) Observed Frequency when Observer Moves Away from Source using Wavelength

$$f_x \quad F_o = \frac{c - V_o}{\lambda}$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010\_img.jpg\)](#)

$$ex \quad 482.5\text{Hz} = \frac{343\text{m/s} - 150\text{m/s}}{0.4\text{m}}$$

### 32) Observed Frequency when Observer Moves towards Source

$$f_x \quad F_o = \left( \frac{c + V_{obj}}{c} \right) \cdot f_w$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd\_img.jpg\)](#)

$$ex \quad 103.1195\text{Hz} = \left( \frac{343\text{m/s} + 50\text{m/s}}{343\text{m/s}} \right) \cdot 90\text{Hz}$$

### 33) Observed Frequency when Observer Moves towards Source and Source Moves Away

$$f_x \quad F_o = \left( \frac{c + V_o}{c + V_{source}} \right) \cdot f_w$$

[Open Calculator !\[\]\(235bfe13ebf007ce2eea9e689707fac7\_img.jpg\)](#)

$$ex \quad 104.8936\text{Hz} = \left( \frac{343\text{m/s} + 150\text{m/s}}{343\text{m/s} + 80\text{m/s}} \right) \cdot 90\text{Hz}$$



### 34) Observed Frequency when Observer Moves towards Source using Wavelength

$$fx \quad F_o = \frac{c + V_{obj}}{\lambda}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 982.5\text{Hz} = \frac{343\text{m/s} + 50\text{m/s}}{0.4\text{m}}$$

### 35) Observed Frequency when Source Moves Away from Observer

$$fx \quad F_o = \frac{c \cdot f_w}{c + V_{source}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 72.97872\text{Hz} = \frac{343\text{m/s} \cdot 90\text{Hz}}{343\text{m/s} + 80\text{m/s}}$$

### 36) Observed Frequency when Source Moves towards Observer

$$fx \quad F_o = \frac{c \cdot f_w}{c - V_{source}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 117.3764\text{Hz} = \frac{343\text{m/s} \cdot 90\text{Hz}}{343\text{m/s} - 80\text{m/s}}$$



### 37) Observed Frequency when Source Moves towards Observer and Observer Moves Away

$$f_x \quad F_o = \left( \frac{c - V_o}{c - V_{\text{source}}} \right) \cdot f_w$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$ex \quad 66.04563\text{Hz} = \left( \frac{343\text{m/s} - 150\text{m/s}}{343\text{m/s} - 80\text{m/s}} \right) \cdot 90\text{Hz}$$

### Velocity of Wave

#### 38) Velocity of Progressive Wave

$$f_x \quad V_w = \frac{\lambda}{T_w}$$

[Open Calculator !\[\]\(aa53ad6fea213b8b2226d3077e30533a\_img.jpg\)](#)

$$ex \quad 0.153846\text{m/s} = \frac{0.4\text{m}}{2.6\text{s}}$$

#### 39) Velocity of Progressive Wave given Angular Frequency

$$f_x \quad V_w = \frac{\lambda \cdot \omega_f}{4 \cdot \pi}$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a\_img.jpg\)](#)

$$ex \quad 0.327223\text{m/s} = \frac{0.4\text{m} \cdot 10.28\text{Hz}}{4 \cdot \pi}$$


#### 40) Velocity of Progressive Wave using Frequency

$$f_x \quad V_w = \lambda \cdot f_w$$

[Open Calculator !\[\]\(c1168d6a8b365d11e842ece304635fa7\_img.jpg\)](#)

$$ex \quad 36\text{m/s} = 0.4\text{m} \cdot 90\text{Hz}$$




41) Velocity of Wave given Wave Number 

$$fx \quad V_w = \frac{\omega_f}{k}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)


$$ex \quad 44.69565m/s = \frac{10.28Hz}{0.23}$$

42) Velocity of Wave in String 

$$fx \quad V_w = \sqrt{\frac{T}{m}}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)


$$ex \quad 2.886751m/s = \sqrt{\frac{100N}{12kg/m}}$$

Wavelength 43) Change in Wavelength due to Movement of Source 

$$fx \quad \lambda = V_{source} \cdot T_w$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3\_img.jpg\)](#)

$$ex \quad 208m = 80m/s \cdot 2.6s$$


44) Change in Wavelength given Angular Frequency 

$$fx \quad \lambda = 2 \cdot \pi \cdot V_{source} \cdot \omega_f$$

[Open Calculator !\[\]\(e50091943b385fe16d3277389202856f\_img.jpg\)](#)

$$ex \quad 5167.292m = 2 \cdot \pi \cdot 80m/s \cdot 10.28Hz$$



45) Change in Wavelength given Frequency 

$$fx \quad \lambda = \frac{V_{\text{source}}}{f_w}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0\_img.jpg\)](#)


$$ex \quad 0.888889m = \frac{80m/s}{90Hz}$$

46) Effective Wavelength when Source Moves Away from Observer 

$$fx \quad \lambda = \frac{c + V_{\text{source}}}{f_w}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5\_img.jpg\)](#)


$$ex \quad 4.7m = \frac{343m/s + 80m/s}{90Hz}$$

47) Effective Wavelength when Source Moves towards Observer 

$$fx \quad \lambda = \frac{c - V_{\text{source}}}{f_w}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60\_img.jpg\)](#)

$$ex \quad 2.922222m = \frac{343m/s - 80m/s}{90Hz}$$

48) Wavelength given Frequency 

$$fx \quad \lambda = \frac{V_w}{f_w}$$

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487\_img.jpg\)](#)

$$ex \quad 0.666667m = \frac{60m/s}{90Hz}$$



## 49) Wavelength of Wave using Velocity

**fx**  $\lambda = V_w \cdot T_w$

Open Calculator 

**ex**  $156\text{m} = 60\text{m/s} \cdot 2.6\text{s}$



## Variables Used

- **A** Normal Area (Square Meter)
- **c** Velocity of Sound (Meter per Second)
- **E** Elasticity (Pascal)
- **F<sub>O</sub>** Frequency Observed (Hertz)
- **f<sub>w</sub>** Wave Frequency (Hertz)
- **I<sub>ref</sub>** Reference Intensity (Watt per Square Meter)
- **I<sub>s</sub>** Sound Intensity (Watt per Square Meter)
- **k** Wave Number
- **K** Bulk Modulus (Pascal)
- **L** Length of Organ Pipe (Meter)
- **m** Mass per Unit Length (Kilogram per Meter)
- **n** Number of Nodes
- **P** Power (Watt)
- **Q** Loudness (Decibel)
- **T** Tension of String (Newton)
- **T<sub>w</sub>** Time Period of Progressive Wave (Second)
- **V<sub>O</sub>** Velocity Observed (Meter per Second)
- **V<sub>obj</sub>** Velocity of Object (Meter per Second)
- **V<sub>source</sub>** Velocity of Source (Meter per Second)
- **V<sub>w</sub>** Velocity of Wave (Meter per Second)
- **λ** Wavelength (Meter)
- **ρ** Density (Kilogram per Cubic Meter)

















- $\omega_f$  Angular Frequency (Hertz)



## Constants, Functions, Measurements used









- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **log10**,  $\log_{10}(\text{Number})$   
*The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.*
- **Function:** **sqrt**,  $\text{sqrt}(\text{Number})$   
*A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- **Measurement:** **Length** in Meter (m)  
*Length Unit Conversion* 
- **Measurement:** **Time** in Second (s)  
*Time Unit Conversion* 
- **Measurement:** **Area** in Square Meter ( $\text{m}^2$ )  
*Area Unit Conversion* 
- **Measurement:** **Pressure** in Pascal (Pa)  
*Pressure Unit Conversion* 
- **Measurement:** **Speed** in Meter per Second (m/s)  
*Speed Unit Conversion* 
- **Measurement:** **Power** in Watt (W)  
*Power Unit Conversion* 
- **Measurement:** **Force** in Newton (N)  
*Force Unit Conversion* 
- **Measurement:** **Frequency** in Hertz (Hz)  
*Frequency Unit Conversion* 



- **Measurement: Density** in Kilogram per Cubic Meter ( $\text{kg/m}^3$ )  
*Density Unit Conversion* 
- **Measurement: Sound** in Decibel (dB)  
*Sound Unit Conversion* 
- **Measurement: Linear Mass Density** in Kilogram per Meter ( $\text{kg/m}$ )  
*Linear Mass Density Unit Conversion* 
- **Measurement: Intensity** in Watt per Square Meter ( $\text{W/m}^2$ )  
*Intensity Unit Conversion* 



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