



# **Cnoidal Wave Theory Formulas**

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# **List of 14 Cnoidal Wave Theory Formulas**

# Cnoidal Wave Theory

1) Complete Elliptic Integral of Second Kind

fx  $\mathrm{E_k} = - \left( \left( \left( \left( rac{\mathrm{y_t}}{\mathrm{d_c}} 
ight) + \left( rac{\mathrm{H_w}}{\mathrm{d_c}} 
ight) - 1 
ight) \cdot rac{3 \cdot \lambda^2}{\left( 16 \cdot \mathrm{d_c^2} 
ight) \cdot \mathrm{K_k}} 
ight) - \mathrm{K_k} 
ight)$ 

$$27.96819 = -\left( \left( \left( \left( \frac{21\text{m}}{16\text{m}} \right) + \left( \frac{14\text{m}}{16\text{m}} \right) - 1 \right) \cdot \frac{3 \cdot \left( 32\text{m} \right)^2}{\left( 16 \cdot \left( 16\text{m} \right)^2 \right) \cdot 28} \right) - 28 \right)$$

# 2) Distance from Bottom to Crest

$$\mathbf{x} \mathbf{y}_{\mathrm{c}} = \mathrm{d}_{\mathrm{c}} \cdot \left( \left( \frac{\mathrm{y}_{\mathrm{t}}}{\mathrm{d}_{\mathrm{c}}} \right) + \left( \frac{\mathrm{H}_{\mathrm{w}}}{\mathrm{d}_{\mathrm{c}}} \right) \right)^{\mathrm{r}}$$

Open Calculator

Open Calculator

$$\boxed{\textbf{ex}} \ 35 \text{m} = 16 \text{m} \cdot \left( \left( \frac{21 \text{m}}{16 \text{m}} \right) + \left( \frac{14 \text{m}}{16 \text{m}} \right) \right)$$

3) Distance from Bottom to Wave Trough

$$\mathbf{x} \mathbf{y}_{\mathrm{t}} = \mathbf{d}_{\mathrm{c}} \cdot \left( \left( rac{\mathbf{y}_{\mathrm{c}}}{\mathbf{d}_{\mathrm{c}}} 
ight) - \left( rac{\mathbf{H}_{\mathrm{w}}}{\mathbf{d}_{\mathrm{c}}} 
ight) 
ight)$$

Open Calculator

$$21 ext{m} = 16 ext{m} \cdot \left( \left( rac{35 ext{m}}{16 ext{m}} 
ight) - \left( rac{14 ext{m}}{16 ext{m}} 
ight) 
ight)$$



# 4) Elevation above Bottom given Pressure under Cnoidal Wave in Hydrostatic Form

$$\mathbf{f}_{\mathbf{z}} \mathbf{y} = -\left(\left(rac{\mathbf{p}}{
ho_{\mathbf{s}} \cdot [\mathbf{g}]}
ight) - \mathbf{y}_{\mathbf{s}}
ight)$$

Open Calculator

ex 
$$4.92$$
m =  $-\left(\left(\frac{804.1453$ Pa}{1025kg/m³ · [g]}\right) - 5\right)

# 5) Free Surface Elevation of Solitary Waves

$$\eta = H_w \cdot \left( rac{u}{\sqrt{[g] \cdot d_c} \cdot \left( rac{H_w}{d_c} 
ight)} 
ight)$$

Open Calculator

$$25.5464\mathrm{m} = 14\mathrm{m} \cdot \left(\frac{20\mathrm{m/s}}{\sqrt{[\mathrm{g}] \cdot 16\mathrm{m}} \cdot \left(\frac{14\mathrm{m}}{16\mathrm{m}}\right)}\right)$$

# 6) Ordinate of Water Surface given Pressure under Cnoidal Wave in Hydrostatic Form

$$\mathbf{f}_{\mathbf{z}} \mathbf{y}_{s} = \left(\frac{\mathbf{p}}{\mathbf{p}_{s} \cdot [\mathbf{g}]}\right) + \mathbf{y}$$

Open Calculator

$$5 = \left( rac{804.1453 ext{Pa}}{1025 ext{kg/m}^3 \cdot [ ext{g}]} 
ight) + 4.92 ext{m}$$

# 7) Particle Velocities given Free Surface Elevation of Solitary Waves

$$u = \eta \cdot \sqrt{[g] \cdot d_c} \cdot rac{rac{H_w}{d_c}}{H_w}$$

Open Calculator 🗗

ex 
$$19.99499 ext{m/s} = 25.54 ext{m} \cdot \sqrt{[g] \cdot 16 ext{m}} \cdot rac{rac{14 ext{m}}{16 ext{m}}}{14 ext{m}}$$





### 8) Pressure under Cnoidal Wave in Hydrostatic Form

 $p = \rho_s \cdot [g] \cdot (y_s - y)$ 

Open Calculator

 $= 804.1453 Pa = 1025 kg/m^3 \cdot [g] \cdot (5 - 4.92 m)$ 

## 9) Trough to Crest Wave Height

 $\mathbf{H}_{\mathrm{w}} = \mathrm{d}_{\mathrm{c}} \cdot \left( \left( \frac{\mathrm{y}_{\mathrm{c}}}{\mathrm{d}_{\mathrm{c}}} \right) - \left( \frac{\mathrm{y}_{\mathrm{t}}}{\mathrm{d}_{\mathrm{c}}} \right) \right)$ 

Open Calculator

 $= 14 \text{m} = 16 \text{m} \cdot \left( \left( \frac{35 \text{m}}{16 \text{m}} \right) - \left( \frac{21 \text{m}}{16 \text{m}} \right) \right)$ 

10) Wave Height given Distance from Bottom to Wave Trough and Water Depth

fx Open Calculator  $egin{split} H_{
m w} = - {
m d_c} \cdot \left( \left( rac{{
m y_t}}{{
m d_c}} 
ight) - 1 - \left( \left( 16 \cdot rac{{
m d_c^2}}{3 \cdot \lambda^2} 
ight) \cdot {
m K_k} \cdot ({
m K_k} - {
m E_k}) 
ight) 
ight) \end{split}$ 

ex  $14.11467m = -16m \cdot \left( \left( \frac{21m}{16m} \right) - 1 - \left( \left( 16 \cdot \frac{(16m)^2}{3 \cdot (32m)^2} \right) \cdot 28 \cdot (28 - 27.968) \right) \right)$ 

# 11) Wave Height Required to Produce Difference in Pressure on Seabed

 $\left( 
ho_{
m s} \cdot [
m g] 
ight) \cdot \left( 0.5 + \left( 0.5 \cdot \sqrt{1 - \left( rac{3 \cdot \Delta 
m P_c}{
ho_c \cdot [
m g] \cdot d_c} 
ight)} 
ight) 
ight)$ 

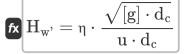
Open Calculator

9500Pa ex 0.991152m = - $\left(1025 \mathrm{kg/m^3 \cdot [g]}\right) \cdot \left(0.5 + \left(0.5 \cdot \sqrt{1 - \left(rac{3.9500 \mathrm{Pa}}{1025 \mathrm{kg/m^3 \cdot [g] \cdot 16 \mathrm{m}}}
ight)}
ight)
ight)$ 



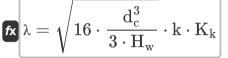


### 12) Wave Height when Free Surface Elevation of Solitary Waves



Open Calculator

## 13) Wavelength for Complete Elliptic Integral of First Kind



Open Calculator

### 14) Wavelength for Distance from Bottom to Wave Trough

$$\lambda = \sqrt{rac{16 \cdot ext{d}_{ ext{c}}^2 \cdot ext{K}_{ ext{k}} \cdot ( ext{K}_{ ext{k}} - ext{E}_{ ext{k}})}{3 \cdot \left( \left( rac{ ext{y}_{ ext{t}}}{ ext{d}_{ ext{c}}} 
ight) + \left( rac{ ext{H}_{ ext{w}}}{ ext{d}_{ ext{c}}} 
ight) - 1 
ight)}}$$

$$\mathbf{ex} \ 32.09642 \mathrm{m} = \sqrt{\frac{16 \cdot \left(16 \mathrm{m}\right)^2 \cdot 28 \cdot \left(28 - 27.968\right)}{3 \cdot \left(\left(\frac{21 \mathrm{m}}{16 \mathrm{m}}\right) + \left(\frac{14 \mathrm{m}}{16 \mathrm{m}}\right) - 1\right)} }$$



### Variables Used

- dc Water Depth for Cnoidal Wave (Meter)
- Ek Complete Elliptic Integral of the Second Kind
- **H**<sub>w</sub> Height of The Wave (*Meter*)
- Hw Cnoidal Wave Height (Meter)
- **k** Modulus of the Elliptic Integrals
- Kk Complete Elliptic Integral of the First Kind
- **p** Pressure Under Wave (Pascal)
- u Particle Velocity (Meter per Second)
- **y** Elevation above the Bottom (*Meter*)
- y<sub>c</sub> Distance from the Bottom to the Crest (Meter)
- y<sub>s</sub> Ordinate of the Water Surface
- yt Distance from the Bottom to the Wave Trough (Meter)
- ΔP<sub>c</sub> Change in Pressure of Coast (Pascal)
- η Free Surface Elevation (Meter)
- **\( \lambda \)** Wavelength of Wave (Meter)
- ρ<sub>S</sub> Density of Salt Water (Kilogram per Cubic Meter)





# Constants, Functions, Measurements used

- Constant: [g], 9.80665
   Gravitational acceleration on Earth
- Function: sqrt, sqrt(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: Pressure in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: Speed in Meter per Second (m/s)
   Speed Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
   Density Unit Conversion





### **Check other formula lists**

- Cnoidal Wave Theory Formulas
- Zero-Crossing Method Formulas

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