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Cnoidal Wave Theory Formulas

Calculators! Examples! Conversions!

List of 14 Cnoidal Wave Theory Formulas

Cnoidal Wave Theory

1) Complete Elliptic Integral of Second Kind

fx Open Calculator

$$E_k = -\left(\left(\left(\left(\left(\frac{y_t}{d_c}\right) + \left(\frac{H_w}{d_c}\right) - 1\right) \cdot \frac{3 \cdot \lambda^2}{\left(16 \cdot d_c^2\right) \cdot K_k}\right) - K_k\right)\right)$$

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

2) Distance from Bottom to Crest

fx Open Calculator

$$y_c = d_c \cdot \left(\left(\frac{y_t}{d_c}\right) + \left(\frac{H_w}{d_c}\right)\right)$$

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

3) Distance from Bottom to Wave Trough

fx Open Calculator

$$y_t = d_c \cdot \left(\left(\frac{y_c}{d_c}\right) - \left(\frac{H_w}{d_c}\right)\right)$$

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

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

Open Calculator

fx $$y = -\left(\left(\frac{p}{\rho_s \cdot [g]}\right) - y_s\right)$$

ex $$4.92\text{m} = -\left(\left(\frac{804.1453\text{Pa}}{1025\text{kg/m}^3 \cdot [g]}\right) - 5\right)$$

5) Free Surface Elevation of Solitary Waves

Open Calculator

fx $$\eta = H_w \cdot \left(\frac{u}{\sqrt{[g] \cdot d_c \cdot \left(\frac{H_w}{d_c}\right)}}\right)$$

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

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

Open Calculator

fx $$y_s = \left(\frac{p}{\rho_s \cdot [g]}\right) + y$$

ex $$5 = \left(\frac{804.1453\text{Pa}}{1025\text{kg/m}^3 \cdot [g]}\right) + 4.92\text{m}$$

7) Particle Velocities given Free Surface Elevation of Solitary Waves

Open Calculator

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

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

8) Pressure under Cnoidal Wave in Hydrostatic Form

Open Calculator

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

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

9) Trough to Crest Wave Height

Open Calculator

fx $$H_w = d_c \cdot \left(\left(\frac{y_c}{d_c} \right) - \left(\frac{y_t}{d_c} \right) \right)$$

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

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

Open Calculator

fx $$H_w = -d_c \cdot \left(\left(\frac{y_t}{d_c} \right) - 1 - \left(\left(16 \cdot \frac{d_c^2}{3 \cdot \lambda^2} \right) \cdot K_k \cdot (K_k - E_k) \right) \right)$$

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

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

Open Calculator

fx $$H_{w'} = \frac{\Delta P_c}{(\rho_s \cdot [g]) \cdot \left(0.5 + \left(0.5 \cdot \sqrt{1 - \left(\frac{3 \cdot \Delta P_c}{\rho_s \cdot [g] \cdot d_c} \right)} \right) \right)}$$

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

12) Wave Height when Free Surface Elevation of Solitary Waves

Open Calculator

fx $$H_{w'} = \eta \cdot \frac{\sqrt{[g] \cdot d_c}}{u \cdot d_c}$$

ex $$0.99975\text{m} = 25.54\text{m} \cdot \frac{\sqrt{[g] \cdot 16\text{m}}}{20\text{m/s} \cdot 16\text{m}}$$

13) Wavelength for Complete Elliptic Integral of First Kind

Open Calculator

fx $$\lambda = \sqrt{16 \cdot \frac{d_c^3}{3 \cdot H_w}} \cdot k \cdot K_k$$

ex $$32.73897\text{m} = \sqrt{16 \cdot \frac{(16\text{m})^3}{3 \cdot 14\text{m}}} \cdot 0.0296 \cdot 28$$

14) Wavelength for Distance from Bottom to Wave Trough

Open Calculator

fx $$\lambda = \sqrt{\frac{16 \cdot d_c^2 \cdot K_k \cdot (K_k - E_k)}{3 \cdot \left(\left(\frac{y_t}{d_c}\right) + \left(\frac{H_w}{d_c}\right) - 1\right)}}$$

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

Variables Used

- **d_c** Water Depth for Cnoidal Wave *(Meter)*
- **E_k** Complete Elliptic Integral of the Second Kind
- **H_w** Height of the Wave *(Meter)*
- **$H_{w'}$** Cnoidal Wave Height *(Meter)*
- **k** Modulus of the Elliptic Integrals
- **K_k** 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_c** Distance from the Bottom to the Crest *(Meter)*
- **y_s** Ordinate of the Water Surface
- **y_t** Distance from the Bottom to the Wave Trough *(Meter)*
- **ΔP_c** Change in Pressure of Coast *(Pascal)*
- **η** Free Surface Elevation *(Meter)*
- **λ** Wavelength of Wave *(Meter)*
- **ρ_s** 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

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- Wave Celerity Formulas
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