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## Solitary Wave Formulas

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## List of 17 Solitary Wave Formulas

Solitary Wave 1) Celerity of Solitary Wave 

$$fx \quad C = \sqrt{[g] \cdot (H_w + D_w)}$$

Open Calculator 


$$ex \quad 24.05395\text{m/s} = \sqrt{[g] \cdot (14\text{m} + 45\text{m})}$$

2) Elevation above Bottom given Pressure Beneath Solitary Wave 

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

Open Calculator 


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

3) Empirical Relationship between Slope and Breaker Height-to-Water Depth Ratio 

$$fx \quad HD_{\text{ratio}} = 0.75 + (25 \cdot m) - (112 \cdot m^2) + (3870 \cdot m^3)$$

Open Calculator 


$$ex \quad 1.23616 = 0.75 + (25 \cdot 0.02) - (112 \cdot (0.02)^2) + (3870 \cdot (0.02)^3)$$

4) Maximum Velocity of Solitary Wave 

$$fx \quad u_{\text{max}} = \frac{C \cdot N}{1 + \cos\left(M \cdot \frac{y}{D_w}\right)}$$

Open Calculator 

$$ex \quad 6.024014\text{m/s} = \frac{24.05\text{m/s} \cdot 0.5}{1 + \cos\left(0.8 \cdot \frac{4.92\text{m}}{45\text{m}}\right)}$$


5) Pressure Beneath Solitary Wave 

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

Open Calculator 

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




6) Total Wave Energy per Unit Crest Width of Solitary Wave 

$$\text{fx } E = \left( \frac{8}{3 \cdot \sqrt{3}} \right) \cdot \rho_s \cdot [g] \cdot H_w^{\frac{3}{2}} \cdot D_w^{\frac{3}{2}}$$

Open Calculator 


$$\text{ex } 2.4E^8 \text{ J/m} = \left( \frac{8}{3 \cdot \sqrt{3}} \right) \cdot 1025 \text{ kg/m}^3 \cdot [g] \cdot (14\text{m})^{\frac{3}{2}} \cdot (45\text{m})^{\frac{3}{2}}$$

7) Volume of Water above Still Water Level per Unit Crest Width 

$$\text{fx } V = \left( \left( \frac{16}{3} \right) \cdot D_w^3 \cdot H_w \right)^{0.5}$$

Open Calculator 


$$\text{ex } 2608.448 \text{ m}^2 = \left( \left( \frac{16}{3} \right) \cdot (45\text{m})^3 \cdot 14\text{m} \right)^{0.5}$$

8) Water Depth given Celerity of Solitary Wave 

$$\text{fx } D_w = \left( \frac{C^2}{[g]} \right) - H_w$$

Open Calculator 


$$\text{ex } 44.98064 \text{ m} = \left( \frac{(24.05 \text{ m/s})^2}{[g]} \right) - 14 \text{ m}$$

9) Water Depth given Total Wave Energy per Unit Crest Width of Solitary Wave 

$$\text{fx } D_w = \left( \frac{E}{\left( \frac{8}{3 \cdot \sqrt{3}} \right) \cdot \rho_s \cdot [g] \cdot H_w^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$

Open Calculator 

$$\text{ex } 44.41991 \text{ m} = \left( \frac{2.4E^8 \text{ J/m}}{\left( \frac{8}{3 \cdot \sqrt{3}} \right) \cdot 1025 \text{ kg/m}^3 \cdot [g] \cdot (14\text{m})^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$


10) Water Depth given Volume of Water within Wave above Still Water Level 

$$\text{fx } D_w = \left( \frac{(V)^2}{\left( \frac{16}{3} \right) \cdot H_w} \right)^{\frac{1}{3}}$$

Open Calculator 

$$\text{ex } 45 \text{ m} = \left( \frac{(2608.448 \text{ m}^2)^2}{\left( \frac{16}{3} \right) \cdot 14 \text{ m}} \right)^{\frac{1}{3}}$$




11) Water Surface above Bottom 

$$\text{fx } y_s = D_w + H_w \cdot \left( \operatorname{sech} \left( \sqrt{\left(\frac{3}{4}\right) \cdot \left(\frac{H_w}{D_w^3}\right)} \cdot (x - (C \cdot t)) \right) \right)^2$$

Open Calculator 


$$\text{ex } 45.00041 = 45\text{m} + 14\text{m} \cdot \left( \operatorname{sech} \left( \sqrt{\left(\frac{3}{4}\right) \cdot \left(\frac{14\text{m}}{(45\text{m})^3}\right)} \cdot (50 - (24.05\text{m/s} \cdot 25)) \right) \right)^2$$

12) Water Surface above Bottom given Pressure Beneath Solitary Wave 

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

Open Calculator 


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

13) Wave Height for Total Wave Energy per Unit Crest Width of Solitary Wave 

$$\text{fx } H_w = \left( \frac{E}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot \rho_s \cdot [g] \cdot D_w^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$

Open Calculator 

$$\text{ex } 13.81953\text{m} = \left( \frac{2.4\text{E}^8\text{J/m}}{\left(\frac{8}{3 \cdot \sqrt{3}}\right) \cdot 1025\text{kg/m}^3 \cdot [g] \cdot (45\text{m})^{\frac{3}{2}}} \right)^{\frac{2}{3}}$$


14) Wave Height given Celerity of Solitary Wave 

$$\text{fx } H_w = \left( \frac{C^2}{[g]} \right) - D_w$$

Open Calculator 


$$\text{ex } 13.98064\text{m} = \left( \frac{(24.05\text{m/s})^2}{[g]} \right) - 45\text{m}$$



15) Wave Height given Volume of Water within Wave above Still Water Level [Open Calculator](#) 

$$\text{fx } H_w = \frac{V^2}{\left(\frac{16}{3}\right) \cdot D_w^3}$$

$$\text{ex } 14\text{m} = \frac{(2608.448\text{m}^2)^2}{\left(\frac{16}{3}\right) \cdot (45\text{m})^3}$$

16) Wave Height of Unbroken Wave in Water of Finite Depth [Open Calculator](#) 

$$\text{fx } H_w = D_w \cdot \left( \frac{\left(0.141063 \cdot \left(\frac{L}{D_w}\right)\right) + \left(0.0095721 \cdot \left(\frac{L}{D_w}\right)^2\right) + \left(0.0077829 \cdot \left(\frac{L}{D_w}\right)^3\right)}{1 + \left(0.078834 \cdot \left(\frac{L}{D_w}\right)\right) + \left(0.0317567 \cdot \left(\frac{L}{D_w}\right)^2\right) + \left(0.0093407 \cdot \left(\frac{L}{D_w}\right)^3\right)} \right)$$

$$\text{ex } 14.01028\text{m} = 45\text{m} \cdot \left( \frac{\left(0.141063 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)\right) + \left(0.0095721 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^2\right) + \left(0.0077829 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^3\right)}{1 + \left(0.078834 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)\right) + \left(0.0317567 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^2\right) + \left(0.0093407 \cdot \left(\frac{90\text{m}}{45\text{m}}\right)^3\right)} \right) \cdot 1.106\text{m}$$

17) Wavelength of Regions of Validity Stokes and Cnoidal Wave Theory [Open Calculator](#) 

$$\text{fx } L_w = D_w \cdot \left( 21.5 \cdot \exp\left(-1.87 \cdot \left(\frac{H_w}{D_w}\right)\right) \right)$$

$$\text{ex } 540.7395\text{m} = 45\text{m} \cdot \left( 21.5 \cdot \exp\left(-1.87 \cdot \left(\frac{14\text{m}}{45\text{m}}\right)\right) \right)$$









## Variables Used

- $a_s$  Solitary Wave Amplitude (Meter)
- $C$  Celerity of the Wave (Meter per Second)
- $D_w$  Water Depth from Bed (Meter)
- $E$  Total Wave Energy per Unit Crest Width (Joule per Meter)
- $H_w$  Height of the Wave (Meter)
- $HD_{ratio}$  Breaker Height-to-Water Depth Ratio
- $L$  Length of Water Wave (Meter)
- $L_w$  Water Wave Length (Meter)
- $m$  Wave Slope
- $M$  Function of Wave Height
- $N$  Function of H/d as N
- $p$  Pressure Under Wave (Pascal)
- $t$  Temporal (Progressive Wave)
- $u_{max}$  Maximum Velocity of Solitary Wave (Meter per Second)
- $V$  Volume of Water per Unit Crest Width (Square Meter)
- $x$  Spatial (Progressive Wave)
- $y$  Elevation above the Bottom (Meter)
- $y_s$  Ordinate of the Water Surface
- $y_s'$  Water Surface Ordinate
- $\rho_s$  Density of Salt Water (Kilogram per Cubic Meter)



## Constants, Functions, Measurements used

- **Constant:** **[g]**, 9.80665  
*Gravitational acceleration on Earth*
- **Function:** **cos**,  $\cos(\text{Angle})$   
*Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- **Function:** **exp**,  $\exp(\text{Number})$   
*n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.*
- **Function:** **sech**,  $\text{sech}(\text{Number})$   
*The hyperbolic secant function is a hyperbolic function that is the reciprocal of the hyperbolic cosine 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:** **Area** in Square Meter (m<sup>2</sup>)  
*Area 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/m<sup>3</sup>)  
*Density Unit Conversion* 
- **Measurement:** **Energy per Unit Length** in Joule per Meter (J/m)  
*Energy per Unit Length Unit Conversion* 



## Check other formula lists

- [Local Fluid and Mass Transport Velocity Formulas](#) 
- [Cnoidal Wave Theory Formulas](#) 
- [Horizontal and Vertical Semi-Axis of Ellipse Formulas](#) 
- [Parametric Spectrum Models Formulas](#) 
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