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# Oceanography Formulas

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# List of 36 Oceanography Formulas

## Oceanography

### Dynamics of Ocean Currents

#### 1) Angular Velocity given Pressure Gradient Normal to Current

$$fx \quad \Omega_E = \frac{\left(\frac{1}{\rho_{\text{water}}}\right) \cdot (\delta P / \delta n)}{2 \cdot \sin(L) \cdot V}$$

[Open Calculator](#)

$$ex \quad 7.3E^{-5} \text{rad/s} = \frac{\left(\frac{1}{1000 \text{kg/m}^3}\right) \cdot (4000)}{2 \cdot \sin(20^\circ) \cdot 49.8 \text{mi/s}}$$

#### 2) Coriolis Acceleration

$$fx \quad a_C = 2 \cdot \Omega_E \cdot \sin(L) \cdot V$$

[Open Calculator](#)

$$ex \quad 3.99773 = 2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot \sin(20^\circ) \cdot 49.8 \text{mi/s}$$

#### 3) Current Velocity given Coriolis Acceleration

$$fx \quad V = \frac{a_C}{2 \cdot \Omega_E \cdot \sin(L)}$$

[Open Calculator](#)

$$ex \quad 49.82828 \text{mi/s} = \frac{4}{2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot \sin(20^\circ)}$$



#### 4) Current Velocity given Pressure Gradient Normal to Current

$$\text{fx } V = \frac{\left(\frac{1}{\rho_{\text{water}}}\right) \cdot (\delta p / \delta n)}{2 \cdot \Omega_E \cdot \sin(L)}$$

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

$$\text{ex } 49.82828 \text{mi/s} = \frac{\left(\frac{1}{1000 \text{kg/m}^3}\right) \cdot (4000)}{2 \cdot 7.2921159 \text{E}^{-05} \text{rad/s} \cdot \sin(20^\circ)}$$

#### 5) Latitude given Coriolis Acceleration

$$\text{fx } L = a \sin\left(\frac{a_C}{2 \cdot \Omega_E \cdot V}\right)$$

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

$$\text{ex } 20.01184^\circ = a \sin\left(\frac{4}{2 \cdot 7.2921159 \text{E}^{-05} \text{rad/s} \cdot 49.8 \text{mi/s}}\right)$$

#### 6) Latitude given Pressure Gradient Normal to Current

$$\text{fx } L = a \sin\left(\frac{\left(\frac{1}{\rho_{\text{water}}}\right) \cdot \delta p / \delta n}{2 \cdot \Omega_E \cdot V}\right)$$

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

$$\text{ex } 20.01184^\circ = a \sin\left(\frac{\left(\frac{1}{1000 \text{kg/m}^3}\right) \cdot 4000}{2 \cdot 7.2921159 \text{E}^{-05} \text{rad/s} \cdot 49.8 \text{mi/s}}\right)$$



## 7) Pressure Gradient Normal to Current

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5\_img.jpg\)](#)

$$fx \quad \delta p / \delta m = 2 \cdot \Omega_E \cdot \sin(L) \cdot \frac{V}{\frac{1}{\rho_{water}}}$$

$$ex \quad 3997.73 = 2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot \sin(20^\circ) \cdot \frac{49.8 \text{mi/s}}{\frac{1}{1000 \text{kg/m}^3}}$$

## Eckman Wind Drift

### 8) Angle between Wind and Current Direction

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

$$fx \quad \theta = 45 + \left( \pi \cdot \frac{z}{D_F} \right)$$

$$ex \quad 49.18879 = 45 + \left( \pi \cdot \frac{160}{120m} \right)$$

### 9) Atmospheric Pressure as function of Salinity and Temperature

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

$$fx \quad \sigma_t = 0.75 \cdot S$$

$$ex \quad 24.9975 = 0.75 \cdot 33.33 \text{mg/L}$$

### 10) Density given Atmospheric Pressure whose value of Thousand is reduced from Density Value

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

$$fx \quad \rho_s = \sigma_t + 1000$$

$$ex \quad 1025 \text{kg/m}^3 = 25 + 1000$$



### 11) Depth given Angle between Wind and Current Direction

$$fx \quad D_F = \pi \cdot \frac{z}{\theta - 45}$$

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

$$ex \quad 119.9654m = \pi \cdot \frac{160}{49.19 - 45}$$

### 12) Depth given Volume Flow rate per unit of Ocean Width

$$fx \quad D_F = \frac{q_x \cdot \pi \cdot \sqrt{2}}{V_s}$$

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

$$ex \quad 119.9578m = \frac{13.5m^3/s \cdot \pi \cdot \sqrt{2}}{0.5m/s}$$


### 13) Depth of Frictional Influence by Eckman

$$fx \quad D_{Eddy} = \pi \cdot \sqrt{\frac{\varepsilon_v}{\rho_{water} \cdot \Omega_E \cdot \sin(L)}}$$

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


$$ex \quad 15.40894m = \pi \cdot \sqrt{\frac{0.6}{1000kg/m^3 \cdot 7.2921159E^{-05}rad/s \cdot \sin(20^\circ)}}$$



14) Latitude given Depth of Frictional Influence by Eckman Open Calculator 

$$fx \quad L = a \sin \left( \frac{\varepsilon_v}{\rho_{\text{water}} \cdot \Omega_E \cdot \left( \frac{D_{\text{Eddy}}}{\pi} \right)^2} \right)$$

$$ex \quad 21.12738^\circ = a \sin \left( \frac{0.6}{1000\text{kg/m}^3 \cdot 7.2921159\text{E}^{-05}\text{rad/s} \cdot \left( \frac{15.01\text{m}}{\pi} \right)^2} \right)$$

15) Salinity given Atmospheric Pressure Open Calculator 

$$fx \quad S = \frac{\sigma_t}{0.75}$$

$$ex \quad 33.33333\text{mg/L} = \frac{25}{0.75}$$

16) Velocity at Surface given Velocity Component along Horizontal x Axis Open Calculator 

$$fx \quad V_s = \frac{u_x}{e^{\pi \cdot \frac{z}{D_F}} \cdot \cos \left( 45 + \left( \pi \cdot \frac{z}{D_F} \right) \right)}$$

$$ex \quad 0.479647\text{m/s} = \frac{15\text{m/s}}{e^{\pi \cdot \frac{160}{120\text{m}}} \cdot \cos \left( 45 + \left( \pi \cdot \frac{160}{120\text{m}} \right) \right)}$$



## 17) Velocity at Surface given Velocity detail of Current Profile in Three Dimensions

$$fx \quad V_s = \frac{V}{e^{\pi \cdot \frac{z}{D_F}}}$$

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

$$ex \quad 0.909877m/s = \frac{60m/s}{e^{\pi \cdot \frac{160}{120m}}}$$

## 18) Velocity Component along Horizontal x Axis

$$fx \quad u_x = V_s \cdot e^{\pi \cdot \frac{z}{D_F}} \cdot \cos \left( 45 + \left( \pi \cdot \frac{z}{D_F} \right) \right)$$

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

$$ex \quad 15.6365m/s = 0.5m/s \cdot e^{\pi \cdot \frac{160}{120m}} \cdot \cos \left( 45 + \left( \pi \cdot \frac{160}{120m} \right) \right)$$

## 19) Velocity in Current Profile in Three Dimensions by introducing Polar Coordinates

$$fx \quad V_{Current} = V_s \cdot e^{\pi \cdot \frac{z}{D_F}}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$ex \quad 32.97148m/s = 0.5m/s \cdot e^{\pi \cdot \frac{160}{120m}}$$

## 20) Vertical Coordinate from Ocean Surface given Angle between Wind and Current Direction

$$fx \quad z = D_F \cdot \frac{\theta - 45}{\pi}$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19\_img.jpg\)](#)

$$ex \quad 160.0462 = 120m \cdot \frac{49.19 - 45}{\pi}$$



## 21) Vertical Eddy Viscosity Coefficient given Depth of Frictional Influence by Eckman

$$\text{fx } \varepsilon_v = \frac{D_{\text{Eddy}}^2 \cdot \rho_{\text{water}} \cdot \Omega_E \cdot \sin(L)}{\pi^2}$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107\_img.jpg\)](#)

ex

$$0.569334 = \frac{(15.01\text{m})^2 \cdot 1000\text{kg}/\text{m}^3 \cdot 7.2921159\text{E}^{-05}\text{rad}/\text{s} \cdot \sin(20^\circ)}{\pi^2}$$

## 22) Volume Flow Rates per unit of Ocean Width

$$\text{fx } q_x = \frac{V_s \cdot D_F}{\pi \cdot \sqrt{2}}$$

[Open Calculator !\[\]\(f95dab70c751fda7d824b8b03650f7aa\_img.jpg\)](#)

$$\text{ex } 13.50474\text{m}^3/\text{s} = \frac{0.5\text{m}/\text{s} \cdot 120\text{m}}{\pi \cdot \sqrt{2}}$$

## Forces Driving Ocean Currents

### 23) Angular Speed of Earth for given Coriolis Frequency

$$\text{fx } \Omega_E = \frac{f}{2 \cdot \sin(\lambda_e)}$$

[Open Calculator !\[\]\(e3f255517d37bb309a3a931ec4849e6a\_img.jpg\)](#)

$$\text{ex } 7.3\text{E}^{-5}\text{rad}/\text{s} = \frac{0.0001}{2 \cdot \sin(43.29^\circ)}$$





## 24) Coriolis Frequency

$$fx \quad f = 2 \cdot \Omega_E \cdot \sin(\lambda_e)$$

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

$$ex \quad 0.0001 = 2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot \sin(43.29^\circ)$$

## 25) Coriolis Frequency given Horizontal Component of Coriolis Acceleration

$$fx \quad f = \frac{a_C}{U}$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1\_img.jpg\)](#)

$$ex \quad 0.0001 = \frac{4}{24.85 \text{mi/s}}$$

## 26) Drag Coefficient

$$fx \quad C_D = 0.00075 + (0.000067 \cdot V_{10})$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a\_img.jpg\)](#)

$$ex \quad 0.002224 = 0.00075 + (0.000067 \cdot 22 \text{m/s})$$

## 27) Drag Coefficient given Wind Stress

$$fx \quad C_D = \frac{\tau_o}{\rho \cdot V_{10}^2}$$

[Open Calculator !\[\]\(3342c215b2a8b663596a81468d5dc314\_img.jpg\)](#)

$$ex \quad 0.002397 = \frac{1.5 \text{Pa}}{1.293 \text{kg/m}^3 \cdot (22 \text{m/s})^2}$$



## 28) Horizontal Component of Coriolis Acceleration

$$fx \quad a_C = f \cdot U$$

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

$$ex \quad 3.99922 = 0.0001 \cdot 24.85 \text{mi/s}$$

## 29) Horizontal Speed across Earth's Surface given Coriolis Frequency

$$fx \quad U = \frac{a_C}{f}$$

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

$$ex \quad 24.85485 \text{mi/s} = \frac{4}{0.0001}$$

## 30) Horizontal Speed across Earth's Surface given Horizontal Component of Coriolis Acceleration

$$fx \quad U = \frac{a_C}{2 \cdot \Omega_E \cdot \sin(\lambda_e)}$$

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

$$ex \quad 24.85415 \text{mi/s} = \frac{4}{2 \cdot 7.2921159 \cdot 10^{-5} \text{rad/s} \cdot \sin(43.29^\circ)}$$

## 31) Latitude given Coriolis Frequency

$$fx \quad \lambda_e = a \sin\left(\frac{f}{2 \cdot \Omega_E}\right)$$

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

$$ex \quad 43.28848^\circ = a \sin\left(\frac{0.0001}{2 \cdot 7.2921159 \cdot 10^{-5} \text{rad/s}}\right)$$



### 32) Latitude given Magnitude of Horizontal Component of Coriolis Acceleration

$$fx \quad \lambda_e = a \sin\left(\frac{a_C}{2 \cdot \Omega_E \cdot U}\right)$$

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

$$ex \quad 43.29901^\circ = a \sin\left(\frac{4}{2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot 24.85 \text{mi/s}}\right)$$

### 33) Magnitude of Horizontal Component of Coriolis Acceleration

$$fx \quad a_C = 2 \cdot \Omega_E \cdot \sin(\lambda_e) \cdot U$$

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

$$ex \quad 3.999332 = 2 \cdot 7.2921159E^{-05} \text{rad/s} \cdot \sin(43.29^\circ) \cdot 24.85 \text{mi/s}$$

### 34) Wind Speed at Height 10 m for Drag Coefficient

$$fx \quad V_{10} = \frac{C_D - 0.00075}{0.000067}$$

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

$$ex \quad 26.1194 \text{m/s} = \frac{0.0025 - 0.00075}{0.000067}$$

### 35) Wind Speed at Height 10 m given Wind Stress

$$fx \quad V_{10} = \sqrt{\frac{\tau_o}{C_D \cdot \rho}}$$

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

$$ex \quad 21.54152 \text{m/s} = \sqrt{\frac{1.5 \text{Pa}}{0.0025 \cdot 1.293 \text{kg/m}^3}}$$



### 36) Wind Stress

$$\text{fx } \tau_o = C_D \cdot \rho \cdot V_{10}^2$$

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

$$\text{ex } 1.56453\text{Pa} = 0.0025 \cdot 1.293\text{kg/m}^3 \cdot (22\text{m/s})^2$$



## Variables Used






- $a_C$  Horizontal Component of Coriolis Acceleration
- $C_D$  Drag Coefficient
- $D_{\text{Eddy}}$  Depth of Frictional Influence by Eckman (Meter)
- $D_F$  Depth of Frictional Influence (Meter)
- $f$  Coriolis Frequency
- $L$  Latitude of a Position on Earth Surface (Degree)
- $q_x$  Volume Flow Rates per unit of Ocean Width (Cubic Meter per Second)
- $S$  Salinity of Water (Milligram per Liter)
- $U$  Horizontal Speed across the Earth's Surface (Mile per Second)
- $u_x$  Velocity Component along a Horizontal x Axis (Meter per Second)
- $v$  Current Profile Velocity (Meter per Second)
- $V$  Current Velocity (Mile per Second)
- $V_{10}$  Wind Speed at Height of 10 m (Meter per Second)
- $V_{\text{Current}}$  Velocity in the Current Profile (Meter per Second)
- $V_s$  Velocity at the Surface (Meter per Second)
- $z$  Vertical Coordinate
- $\delta p / \delta n$  Pressure Gradient
- $\epsilon_v$  Vertical Eddy Viscosity Coefficient
- $\theta$  Angle between the Wind and Current Direction
- $\lambda_e$  Earth Station Latitude (Degree)
- $\rho$  Density of Air (Kilogram per Cubic Meter)
- $\rho_s$  Density of Salt Water (Kilogram per Cubic Meter)





- $\rho_{\text{water}}$  Water Density (Kilogram per Cubic Meter)
- $\sigma_t$  Difference of Density Values
- $\tau_o$  Wind Stress (Pascal)
- $\Omega_E$  Angular Speed of the Earth (Radian per Second)



# Constants, Functions, Measurements used

- **Constant: pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Constant: e**, 2.71828182845904523536028747135266249  
*Napier's constant*
- **Function: asin**, asin(Number)  
*The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.*
- **Function: cos**, cos(Angle)  
*Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- **Function: sin**, sin(Angle)  
*Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- **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 Mile per Second (mi/s), Meter per Second (m/s)  
*Speed Unit Conversion* 
- **Measurement: Angle** in Degree ( $^{\circ}$ )  
*Angle Unit Conversion* 
- **Measurement: Volumetric Flow Rate** in Cubic Meter per Second ( $\text{m}^3/\text{s}$ )  
*Volumetric Flow Rate Unit Conversion* 



- **Measurement: Angular Velocity** in Radian per Second (rad/s)  
*Angular Velocity Unit Conversion* 
- **Measurement: Density** in Kilogram per Cubic Meter ( $\text{kg/m}^3$ ), Milligram per Liter (mg/L)  
*Density Unit Conversion* 





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