Package 'sonar'

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Type Package

Title Fundamental Formulas for Sonar

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Description Formulas for calculating sound velocity, water pressure, depth, density, absorption and sonar equations.

License GPL (>= 3)

Depends R (>= 2.7.0)

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Repository CRAN

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R topics documented:

`AbsorptionAlphaAinslieMcColm` *Calculation of absorption in sea water from Ainslie and McColm 1998*

Description

Returns the absorption in sea water from Ainslie and McColm 1998

Usage

```
AbsorptionAlphaAinslieMcColm(f, temperatureC, S, D, pH)
```

Arguments

`f,`	frequency (kHz)
`temperatureC,`	temperature in degrees C
`S,`	salinity in %
`D,`	depth in meters
`pH,`	pH

Value

the absorption

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Calculation of absorption of sound in seawater http://resource.npl.co.uk/acoustics/techguides/seaabsorption/

References

Ainslie and McColm 1998 J. Acoust. Soc. Am., Vol. 103, No. 3

Examples

```
AbsorptionAlphaAinslieMcColm(20, 0, 30, 0, 7)
```

AbsorptionAlphaFisherSimmons

Calculation of absorption in sea water from Fisher and Simmons 1977

Description

Returns the absorption in sea water from Fisher and Simmons 1977

Usage

```
AbsorptionAlphaFisherSimmons(f, temperatureC, D)
```

Arguments

f,	frequency (kHz)
temperatureC,	temperature in degrees C
D,	depth in meters

Value

the absorption

Author(s)

Jose Gama

Source

Fisher and Simmons, 1977 J. Acoust. Soc. Am., Vol. 62, No. 3, September 1977

Examples

```
AbsorptionAlphaFisherSimmons(20, 0, 1)
```

`AbsorptionSoundFreshWaterFrancoisGarrison`
Calculation of absorption of sound in fresh water From Francois & Garrison 1982

Description

Returns the absorption of sound in fresh water From Francois & Garrison 1982 Total absorption = Pure Water Contrib.

Usage

```
AbsorptionSoundFreshWaterFrancoisGarrison(SonarFreq, temperatureC, D)
```

Arguments

`SonarFreq,`	sonar frequency (kHz)
`temperatureC,`	temperature (degC)
`D,`	depth in meters

Value

the absorption of sound

Author(s)

Jose Gama

Source

Echoview, 2016 Sonar calculator algorithms `http://support.echoview.com/WebHelp/Reference/Algorithms/Sonar_calculator_algorithms.htm`

References

Francois & Garrison 1982 Sound absorption based on ocean measurements: Part I:Pure water and magnesium sulfate contributions J. Acoust. Soc. Am., Vol. 72, No. 6

Examples

```
AbsorptionSoundFreshWaterFrancoisGarrison(50, 0, 0)
```

AbsorptionSoundSeaWaterFrancoisGarrison

Calculation of absorption of sound in sea water From Francois & Garrison 1982

Description

Returns the absorption of sound in sea water From Francois & Garrison 1982 Total absorption = Boric Acid Contrib. + Magnesium Sulphate Contrib. + Pure Water Contrib.

Usage

```
AbsorptionSoundSeaWaterFrancoisGarrison(SonarFreq, temperatureC, Salinity, D,
  pH)
```

Arguments

SonarFreq,	sonar frequency (kHz)
temperatureC,	temperature (degC)
Salinity,	Salinity (ppt)
D,	depth in meters
pH,	pH

Value

the absorption of sound

Author(s)

Jose Gama

Source

NPL, 2016 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/seaabsorption/

References

Francois & Garrison 1982 Sound absorption based on ocean measurements: Part I:Pure water and magnesium sulfate contributions J. Acoust. Soc. Am., Vol. 72, No. 6

Examples

```
AbsorptionSoundSeaWaterFrancoisGarrison(50, 0, 35, 0, 6)
```

BandLevelFlatSpectrum *band level (BL) for flat spectrum*

Description

Returns the total intensity of the sound in a band for flat spectrum

Usage

```
BandLevelFlatSpectrum(SpL, deltaf)
```

Arguments

SpL	spectrum level
deltaf	band frequency

Value

band level (BL)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 10.

Examples

```
BandLevelFlatSpectrum( 3, 2 )
```

BandLevelFromCompleteBand *band level (BL) from complete band*

Description

Returns the band level from integrating the intensity over the complete band

Usage

```
BandLevelFromCompleteBand(I0, f1, f2)
```

Arguments

`I0`	spectrum level
`f1`	lower frequency
`f2`	upper frequency

Value

band level (BL)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 10.

Examples

```
BandLevelFromCompleteBand( 10000, 40000, 50000 )
```

BasicActiveSonarEquation

basic active sonar equation

Description

Returns the basic active sonar equation SE = (SL + TS - 2 * PL) - N - DT

Usage

```
BasicActiveSonarEquation(SL, TS, PL, N, DT)
```

Arguments

`SL`	is the source level of the target
`TS`	target strength
`PL`	propagation loss
`N`	noise
`DT`	detection threshold

Value

SE signal excess (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 120.

`BasicPassiveSonarEquation` *basic passive sonar equation*

Description

Returns the basic passive sonar equation SE = (SL - PL) - N = DT

Usage

```
BasicPassiveSonarEquation(SL, PL, N)
```

Arguments

`SL`	is the source level of the target
`PL`	propagation loss
`N`	noise

Value

SE signal excess (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 120.

`BasicSonarEquation` *basic sonar equation*

Description

Returns the basic sonar equation SE = S - N + DT

Usage

```
BasicSonarEquation(S, N, DT)
```

Arguments

`S`	signal
`N`	noise
`DT`	detection threshold

Value

SE signal excess (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 120.

`CavitationThresholdEstimateFunctionOfDepth` *Cavitation threshold estimate as a function of depth*

Description

Returns the Cavitation threshold estimate as a function of depth line passing by (5, 2) and (50, 50)

Usage

```
CavitationThresholdEstimateFunctionOfDepth(d)
```

Arguments

`d,`	depth (meters)

Value

Cavitation threshold

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 6.

Examples

```
CavitationThresholdEstimateFunctionOfDepth( 1 )
```

`CavitationThresholdEstimateFunctionOfRadiatedAcousticPowerIntensity` *Cavitation threshold estimate as a function of radiated acoustic power intensity*

Description

Returns the Cavitation threshold estimate as a function of radiated acoustic power intensity line passing by (2, 5) and (50, 50)

Usage

```
CavitationThresholdEstimateFunctionOfRadiatedAcousticPowerIntensity(Ir)
```

Arguments

`Ir,`	radiated acoustic power intensity

Value

Cavitation threshold

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 6.

Examples

```
CavitationThresholdEstimateFunctionOfRadiatedAcousticPowerIntensity ( 1000 )
```

`CorrectiveTermsDepthFromPressure`
Corrective terms to be added for obtaining depth from pressure

---

Description

Corrective terms to be added for obtaining depth (m) from pressure (MPa)

Usage

```
CorrectiveTermsDepthFromPressure
```

Format

dataframe with 13 rows and 5 columns:

No Number

Area.of.applicability Area of applicability

Expression.for.deltaf Expression for deltaf

Latitude Latitude in degrees

Accuracy Accuracy

Author(s)

Jose Gama

References

C. C. Leroy and F Parthiot, 1998 Depth-pressure relationship in the oceans and seas. J. Acoust. Soc. Am. 103(3) pp 1346-1352

`CorrectiveTermsPressureFromDepth`
Corrective terms to be subtracted for obtaining pressure from depth

---

Description

Corrective terms to be added for obtaining pressure (MPa) from depth (m)

Usage

```
CorrectiveTermsPressureFromDepth
```

Format

dataframe with 14 rows and 5 columns:

No Number

Area.of.applicability Area of applicability

Expression.for.deltaf Expression for deltaf

Latitude Latitude in degrees

Accuracy Accuracy

Author(s)

Jose Gama

References

C. C. Leroy and F Parthiot, 1998 Depth-pressure relationship in the oceans and seas. J. Acoust. Soc. Am. 103(3) pp 1346-1352

`CutoffFrequencyShallowWater` *Calculation of cutoff frequency in shallow water from Jensen et Al 2011*

Description

Returns the cutoff frequency in shallow water from Jensen et Al 2011

Usage

```
CutoffFrequencyShallowWater(Cw, Cb, D)
```

Arguments

`Cw,`	velocity of sound in water
`Cb,`	velocity of sound in homogeneous bottom
`D,`	depth in meters

Value

the cutoff frequency (Hz)

Author(s)

Jose Gama

Source

Finn B. Jensen, William A. Kuperman, Michael B. Porter, Henrik Schmidt, 2011 Computational Ocean Acoustics, 2nd Edition. Springer. pp. 29

Examples

```
CutoffFrequencyShallowWater(3000, 2500, 1)
```

CutoffFrequencyWater *Calculation of cutoff frequency in water from Jensen et Al 2011*

Description

Returns the cutoff frequency in water from Jensen et Al 2011

Usage

```
CutoffFrequencyWater(Cw, D)
```

Arguments

`Cw,`	velocity of sound in water
`D,`	depth in meters of isothermal surface layer

Value

the cutoff frequency (Hz)

Author(s)

Jose Gama

Source

Finn B. Jensen, William A. Kuperman, Michael B. Porter, Henrik Schmidt, 2011 Computational Ocean Acoustics, 2nd Edition. Springer. pp. 26

Examples

```
CutoffFrequencyWater(3000, 1)
```

`DepthToPressureLeroyParthiot`
Depth To Pressure from Leroy Parthiot 1998

Description

Returns the Depth To Pressure from Leroy Parthiot 1998

Usage

```
DepthToPressureLeroyParthiot(D, latitude, CorrectiveTerm = NA)
```

Arguments

`D,`	depth in meters
`latitude,`	latitude in degrees
`CorrectiveTerm,`	optional corrective term

Value

the Pressure

Author(s)

Jose Gama

Source

C. C. Leroy and F Parthiot, 1998 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

C. C. Leroy and F Parthiot, 1998 Depth-pressure relationship in the oceans and seas (1998) J. Acoust. Soc. Am. 103(3) pp 1346-1352

Examples

```
DepthToPressureLeroyParthiot(0, 0)
```

DetectionIndex *Detection index*

Description

Returns the Detection index

Usage

```
DetectionIndex(S, N)
```

Arguments

S	signal
N	noise

Value

Detection index

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 120.

fuelStabilizer *Number of milliliters or drops of stabilizer are needed to stabilize a certain amount of fuel*

Description

Returns the number of milliliters or drops of stabilizer are needed to stabilize a certain amount of fuel

Usage

```
fuelStabilizer(Lfuel, mLstabilizer = 25, Lstabilizer2fuel = 20,
  dropml = 0.05)
```

Arguments

`Lfuel`	numeric, liters of fuel to stabilize
`mLstabilizer`	numeric, manufacturer's recommended milliliters of stabilizer per liters of fuel
`Lstabilizer2fuel`	numeric, manufacturer's recommended liters of fuel per mms of stabilizer
`dropml`	numeric, how many milliliters per drop

Value

the number of milliliters or drops of stabilizer

Author(s)

Jose Gama

Examples

```
# liqui moly, petrol stabilizer CNG/LPG gasoline stabilizer
# 25ml of stabilizer are the recommended amount for 20 litres of gasoline
# stabilizer for 1l of gasoline
fuelStabilizer(1)
# stabilizer for 0.5l of gasoline
fuelStabilizer(0.5)
```

`HydrophoneSensitivity` *Hydrophone Sensitivity*

Description

Returns the Hydrophone Sensitivity

Usage

```
HydrophoneSensitivity(p, v)
```

Arguments

`p`	sound pressure in micropascals at the hydrophone
`v`	voltage at the open circuit terminals

Value

Hydrophone Sensitivity (dB/V)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 9.

Examples

```
HydrophoneSensitivity( 1000, 2 )
```

`InternationalFormulaForGravity` *International Formula For Gravity*

Description

Returns the average gravity at certain latitude

Usage

```
InternationalFormulaForGravity(latitude, CorrectiveTerm = NA)
```

Arguments

`latitude,`	latitude in degrees
`CorrectiveTerm,`	optional corrective term

Value

the average gravity

Author(s)

Jose Gama

Source

Fofonoff and R.C. Millard, 1983 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

Saunders P.M., Fofonoff N.P., 1976 Conversion of pressure to depth in the ocean. Deep Sea Research 23:109-111.

Examples

```
InternationalFormulaForGravity(0)
```

`MaximumRadiatedPowerToAvoidCavitation`
Maximum radiated power to avoid cavitation

Description

Returns the Maximum radiated power to avoid cavitation

Usage

```
MaximumRadiatedPowerToAvoidCavitation(radiatingSurfaceArea, cavitationThreshold)
```

Arguments

`radiatingSurfaceArea,`
Radiating surface area

`cavitationThreshold,`
Cavitation threshold

Value

Maximum radiated power

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 5.

Examples

```
MaximumRadiatedPowerToAvoidCavitation( 50, 0.7 )
```

`MolecularRelaxationAttenuationCoeficient`
Molecular relaxation attenuation coeficient (alpha)

Description

Returns the attenuation coeficient of absorption losses due to molecular relaxation

Usage

```
MolecularRelaxationAttenuationCoeficient
```

Format

dataframe with 3 rows and 11 columns:

temperatureC numeric, temperature in degrees Celsius

0.5 attenuation coeficient for 0.5 kHz

1 attenuation coeficient for 1 kHz

2 attenuation coeficient for 2 kHz

5 attenuation coeficient for 5 kHz

10 attenuation coeficient for 10 kHz

20 attenuation coeficient for 20 kHz

50 attenuation coeficient for 50 kHz

100 attenuation coeficient for 100 kHz

200 attenuation coeficient for 200 kHz

500 attenuation coeficient for 500 kHz

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 47.

`MolecularRelaxationAttenuationCoeficientApproximation`
Molecular relaxation attenuation coeficient approximation

Description

Returns the Molecular relaxation attenuation coeficient approximation

Usage

```
MolecularRelaxationAttenuationCoeficientApproximation(f)
```

Arguments

`f,`	frequency (Hz)

Value

alpha Molecular relaxation attenuation coeficient

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 47.

Examples

```
MolecularRelaxationAttenuationCoeficientApproximation( 1000 )
```

`PeakTS` *peak pressure of the incident and reflected pulses*

Description

Returns the peak pressure of the incident and reflected pulses

Usage

```
PeakTS(Pr, Pi)
```

Arguments

`Pr`	pressure of the reflected pulse
`Pi`	pressure of the incident pulse

Value

Target Strength (TS)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 68.

Examples

```
PeakTS( 900, 1000 )
```

PlaneWaveIntensity *Plane wave intensity*

Description

Returns the intensity

Usage

```
PlaneWaveIntensity(p, rho, C)
```

Arguments

`p,`	pressure (Pa or N/m2)
`rho,`	fluid density = 10^3kg/m^3 for sea water
`C,`	velocity of sound wave propagation = 1.5 x 10^3m/s in sea water

Value

intensity of the wave (power / unit area) (Watt / m^2)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 3.

Examples

```
PlaneWaveIntensity( 1e3, 1.5e3,  1)
```

PlaneWavePressure *Plane wave pressure*

Description

Returns the pressure

Usage

```
PlaneWavePressure(rho, C, u)
```

Arguments

`rho,`	fluid density = 10^3kg/m^3 for sea water
`C,`	velocity of sound wave propagation = 1.5 x 10^3m/s in sea water
`u`	particle velocity (m/s)

Value

pressure (Pa or N/m2)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 2.

Examples

```
PlaneWavePressure( 1e3, 1.5e3,  1)
```

PLcylindricalSpreadingLaw

PL to range r cylindrical spreading law in logarithmic form

Description

Returns the PL to range r cylindrical spreading law in logarithmic form

Usage

```
PLcylindricalSpreadingLaw(r)
```

Arguments

`r`	radius (meters)

Value

Propagation loss (PL) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 45.

Examples

```
PLcylindricalSpreadingLaw( 1000 )
```

PLSphericalSpreadingAndAbsorption *PL Spherical Spreading and Absorption*

Description

Returns the PL Spherical Spreading and Absorption

Usage

```
PLSphericalSpreadingAndAbsorption(r, alpha)
```

Arguments

r	radius (meters)
alpha	Molecular relaxation attenuation coeficient

Value

Propagation loss (PL) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 48.

Examples

```
PLSphericalSpreadingAndAbsorption( 1000, 0.9 )
```

`PLsphericalSpreadingLaw` *PL to range r spherical spreading law in logarithmic form*

Description

Returns the PL to range r spherical spreading law in logarithmic form

Usage

```
PLsphericalSpreadingLaw(r)
```

Arguments

`r`	radius (meters)

Value

Propagation loss (PL) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 44.

Examples

```
PLsphericalSpreadingLaw( 1000 )
```

`PowerCylindricalSpreadingLaw` *Power cylindrical spreading law*

Description

Returns the Power cylindrical spreading law

Usage

```
PowerCylindricalSpreadingLaw(r, h, Ir)
```

Arguments

`r`	radius (meters)
`h`	distance between 2 planes (meters)
`Ir`	intensity at radius r

Value

total power (Watts)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 45.

Examples

```
PowerCylindricalSpreadingLaw( 1000, 100, 500 )
```

PowerSphericalSpreadingLaw *Power spherical spreading law*

Description

Returns the Power spherical spreading law

Usage

```
PowerSphericalSpreadingLaw(r, Ir)
```

Arguments

`r`	radius (meters)
`Ir`	intensity at radius r

Value

total power (Watts)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 44.

Examples

```
PowerSphericalSpreadingLaw( 1000, 500 )
```

`PressureBalticSimplifiedLeroy` *Calculation of pressure in the Baltic from Leroy 1969*

Description

Returns the pressure in the Baltic from Leroy 1969

Usage

```
PressureBalticSimplifiedLeroy(Z, lat)
```

Arguments

`Z,`	depth in meters
`lat,`	latitude n degrees

Value

the pressure

Author(s)

Jose Gama

Source

Leroy C. C. 1969 Development of simple equations for accurate and more realistic calculations of the speed of sound in sea water J. Acoust. Soc. Am. 46, 216-226.

Examples

```
PressureBalticSimplifiedLeroy(0, 0)
```

`PressureBlackSeaSimplifiedLeroy` *Calculation of pressure in the Black Sea from Leroy 1969*

Description

Returns the pressure in the Black Sea from Leroy 1969

Usage

```
PressureBlackSeaSimplifiedLeroy(Z, lat)
```

Arguments

`Z,`	depth in meters
`lat,`	latitude n degrees

Value

the pressure

Author(s)

Jose Gama

Source

Leroy C. C. 1969 Development of simple equations for accurate and more realistic calculations of the speed of sound in sea water J. Acoust. Soc. Am. 46, 216-226.

Examples

```
PressureBlackSeaSimplifiedLeroy(0, 0)
```

`PressureModifiedSimplifiedLeroy` *Calculation of pressure in water (Leroy modified) from Lovett 1978*

Description

Returns the pressure in water (Leroy simplified modified) from Lovett 1978

Usage

```
PressureModifiedSimplifiedLeroy(Z, lat)
```

Arguments

`Z,`	depth in meters
`lat,`	latitude n degrees

Value

the pressure

Author(s)

Jose Gama

Source

Lovett, J.R. 1978 Merged seawater sound-speed equations J. Acoust. Soc. Am., 63, 1713-18.

Examples

```
PressureModifiedSimplifiedLeroy(0, 0)
```

`PressureSimplifiedLeroy` *Calculation of pressure in water simplified from Leroy 1969*

Description

Returns the pressure in water simplified from Leroy 1969

Usage

```
PressureSimplifiedLeroy(Z, lat)
```

Arguments

`Z,`	depth in meters
`lat,`	latitude n degrees

Value

the pressure

Author(s)

Jose Gama

Source

Leroy C. C. 1969 Development of simple equations for accurate and more realistic calculations of the speed of sound in sea water J. Acoust. Soc. Am. 46, 216-226.

Examples

```
PressureSimplifiedLeroy(0, 0)
```

PressureToDepthLeroyParthiot — *Pressure To Depth from Leroy Parthiot 1998*

Description

Returns the Pressure To Depth from Leroy Parthiot 1998

Usage

```
PressureToDepthLeroyParthiot(P, latitude, CorrectiveTerm = NA)
```

Arguments

`P,`	pressure in MPa (relative to atmospheric pressure)
`latitude,`	latitude in degrees
`CorrectiveTerm,`	optional corrective term

Value

the depth

Author(s)

Jose Gama

Source

C. C. Leroy and F Parthiot, 1998 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

C. C. Leroy and F Parthiot, 1998 Depth-pressure relationship in the oceans and seas (1998) J. Acoust. Soc. Am. 103(3) pp 1346-1352

Examples

```
PressureToDepthLeroyParthiot(0.1, 0)
```

PressureToDepthSaundersFofonoff
Pressure To Depth from Saunders and Fofonoff 1976

Description

Returns the Pressure To Depth from Saunders and Fofonoff 1992 CHECKVALUE: DEPTH = 9712.653 M FOR P=10000 DECIBARS, LATITUDE=30 DEG ABOVE FOR STANDARD OCEAN: T=O DEG. CELSIUS; S=35 (PSS-78)

Usage

```
PressureToDepthSaundersFofonoff(P, latitude)
```

Arguments

`P,`	pressure in MPa (relative to atmospheric pressure)
`latitude,`	latitude in degrees

Value

the depth

Author(s)

Jose Gama

Source

Unesco, 1983 Algorithms for computation of fundamental properties of seawater, 1983. Unesco Tech. Pap. in Mar. Sci., No. 44, 53 pp.

References

Saunders P.M., Fofonoff N.P., 1976 Conversion of pressure to depth in the ocean. Deep Sea Research 23:109-111

Examples

```
PressureToDepthSaundersFofonoff(0.1, 0)
```

`ProjectorSensitivityPower` *Projector Sensitivity Power*

Description

Returns the Projector Sensitivity Power

Usage

```
ProjectorSensitivityPower(I1, Ir, P)
```

Arguments

I1	intensity of source at standard range
Ir	reference intensity
P	power (Watt)

Value

response Sv (dB/V)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 9.

Examples

```
ProjectorSensitivityPower( 10000, 15000, 0.7 )
```

`ProjectorSensitivityVoltage` *Projector Sensitivity Voltage*

Description

Returns the Projector Sensitivity Voltage

Usage

```
ProjectorSensitivityVoltage(I1, Ir, v)
```

Arguments

`I1`	intensity of source at standard range
`Ir`	reference intensity
`v`	Voltage

Value

response Sv (dB/V)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 9.

Examples

```
ProjectorSensitivityVoltage( 10000, 15000, 0.7 )
```

`PropagationLoss` *Propagation loss (PL)*

Description

Returns the Propagation loss (PL)

Usage

```
PropagationLoss(I0, Ir)
```

Arguments

`I0`	intensity of the source to a point one metre from its acoustic centre
`Ir`	is the intensity at the receiver

Value

Propagation loss (PL) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 43.

Examples

```
PropagationLoss( 1000, 500 )
```

RangeResolutionCHIRP *Sonar Range Resolution CHIRP*

Description

Returns the Sonar Range Resolution CHIRP

Usage

```
RangeResolutionCHIRP(SonarBandwidth, Cw)
```

Arguments

`SonarBandwidth,`	Sonar Bandwidth
`Cw,`	Velocity of sound

Value

the Sonar Range Resolution

Author(s)

Jose Gama

Examples

```
RangeResolutionCHIRP(1, 343)
```

RangeResolutionMonotonic *Sonar Range Resolution for monotonic acoustic systems*

Description

Returns the Sonar Range Resolution for monotonic acoustic systems

Usage

```
RangeResolutionMonotonic(SonarPulseDuration, Cw)
```

Arguments

`SonarPulseDuration,`	Sonar Pulse Duration
`Cw,`	Velocity of sound

Value

the Sonar Range Resolution

Author(s)

Jose Gama

Examples

```
RangeResolutionMonotonic(1, 343)
```

SLdirectionalProjector   *SL of a directional projector*

Description

Returns the SL of a directional projector

Usage

```
SLdirectionalProjector(P, DIt)
```

Arguments

`P,`	power output (watts)
`DIt,`	transmit directivity index (dB)

Value

SL of a directional projector

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 4.

Examples

```
SLdirectionalProjector( 700, 0.7 )
```

SLomnidirectionalProjector *SL of an omnidirectional projector*

Description

Returns the SL of an omnidirectional projector

Usage

```
SLomnidirectionalProjector(P)
```

Arguments

`P,`	omnidirectional power output (watts)

Value

source level (SL)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 4.

Examples

```
SLomnidirectionalProjector( 1000 )
```

SonarEquation *sonar equation*

Description

Returns the sonar equation EL = SL - 2PL + TS

Usage

```
SonarEquation(SL, PL, TS)
```

Arguments

`SL`	source level
`PL`	propagation loss
`TS`	target strength

Value

EL echo level

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 68.

`SourceLevel` *source level (SL)*

Description

Returns the source level (SL)

Usage

```
SourceLevel(I1, Ir)
```

Arguments

`I1,`	intensity of source at standard range
`Ir,`	reference intensity

Value

source level (SL)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 4.

Examples

```
SourceLevel( 1000, 1100)
```

SourceLevelToAvoidCavitation

source level to avoid cavitation

Description

Returns the source level to avoid cavitation

Usage

```
SourceLevelToAvoidCavitation(f, DIt)
```

Arguments

`f,`	frequency (Hz)
`DIt,`	transmit directivity index (dB)

Value

source level SL (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 5.

Examples

```
SourceLevelToAvoidCavitation( 20000, 0.7 )
```

SpeedAlgorithmParameterRanges

Data on Speed of Sound Algorithm Parameter Ranges

Description

Data on Speed of Sound Algorithm Parameter Ranges

Usage

```
SpeedAlgorithmParameterRanges
```

Format

dataframe with 10 rows and 10 columns:

Reference Reference

TemperatureRangeMin Temperature Range (C) Min

TemperatureRangeMax Temperature Range (C) Min

SalinityRangeMin Salinity Range (ppt) min

SalinityRangeMax Salinity Range (ppt) max

PressureOrDepthRangeMin Pressure or Depth Range min

PressureOrDepthRangeMax Pressure or Depth Range max

PressureOrDepthRangeUnits Pressure or Depth Range units

StandardError Standard Error

NumberOfTerms Number of Terms

Author(s)

Jose Gama

References

Paul C. Etter, 2013 Underwater Acoustic Modeling and Simulation, Fourth Edition pp. 28. CRC Press

---

`SpeedOfSound` *Speed of sound*

Description

Returns the speed of sound from wavelength and frequency

Usage

```
SpeedOfSound(lambda, f)
```

Arguments

`lambda`	numeric, wavelength (meters)
`f`	numeric, frequency (Hz)

Value

the speed of sound (m/s)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 1.

Examples

```
SpeedOfSound( 5,  70)
```

`SpeedOfSoundAir` *speed of sound in humid air at sea level air density and known atmospheric pressure*

Description

Returns the speed of sound in humid air at sea level air density and known atmospheric pressure

Usage

```
SpeedOfSoundAir(temperatureC, Hr, pressurekPa)
```

Arguments

`temperatureC`	numeric, temperature in degrees Celsius in the range -30 C to 43 C
`Hr`	numeric, relative humidity, accurate to within 0.1% for temperatures
`pressurekPa`	numeric, atmospheric pressure in kPa

Value

the speed of sound (m/s)

Author(s)

Jose Gama

References

Kleeman L. & Kuc R., 2008 Springer Handbook of Robotics, Bruno Siciliano, Oussama Khatib (Eds.) Springer-Verlag Berlin Heidelberg, pp.496 eq (21.8).

Examples

```
#Speed of sound (Humid air, at sea level air density)
#temperature 20 C, 90\% relative humidity, 101 kPa atmosphere pressure
SpeedOfSoundAir(20, 0.9, 101)
```

`SpeedOfSoundDryAir` *Speed of sound in dry air at sea level air density and one atmosphere pressure*

Description

Returns the speed of sound in dry air at sea level air density and one atmosphere pressure

Usage

```
SpeedOfSoundDryAir(temperatureC)
```

Arguments

`temperatureC`	numeric, temperature in degrees Celsius accurate to within 1%

Value

the speed of sound (m/s)

Author(s)

Jose Gama

References

Kleeman L. & Kuc R., 2008 Springer Handbook of Robotics, Bruno Siciliano, Oussama Khatib (Eds.) Springer-Verlag Berlin Heidelberg, pp.496 eq (21.6).

Examples

```
#Speed of sound (dry air, at sea level air density, one atmosphere pressure)
#temperature 20 C
SpeedOfSoundDryAir(20)
```

`SpeedOfSoundFreshWaterGrossoMader` *speed of sound (m/s) in fresh water from Grosso and Mader*

Description

Returns the speed of sound (m/s) Range of validity: 0-95C, D = 0, error +-0.015

Usage

```
SpeedOfSoundFreshWaterGrossoMader(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://support.echoview.com/WebHelp/Reference/Algorithms/Sonar_calculator_algorithms.htm

References

Del Grosso, VA and Mader C.W., 1972 Speed of sound in pure water. J. acoust. Soc. Am., 52, 1442-6.

Examples

```
SpeedOfSoundFreshWaterGrossoMader(25)
```

SpeedOfSoundHumidAir *Speed of sound in Humid air at sea level air density and one atmosphere pressure*

Description

Returns the speed of sound in Humid air at sea level air density and one atmosphere pressure

Usage

```
SpeedOfSoundHumidAir(temperatureC, Hr)
```

Arguments

`temperatureC`	numeric, temperature in degrees Celsius in the range -30 C to 43 C
`Hr`	numeric, relative humidity, accurate to within 0.1% for temperatures

Value

the speed of sound (m/s)

Author(s)

Jose Gama

References

Kleeman L. & Kuc R., 2008 Springer Handbook of Robotics, Bruno Siciliano, Oussama Khatib (Eds.) Springer-Verlag Berlin Heidelberg, pp.496 eq (21.7).

Examples

```
#Speed of sound (Humid air, at sea level air density, one atmosphere pressure)
#temperature 20 C, 90\% relative humidity
SpeedOfSoundHumidAir(20, 0.9)
```

SpeedOfSoundKinslerEtal

Speed of sound (m/s) from Kinsler et al

Description

Returns the speed of sound (m/s) from Kinsler et al accurate to within 0.05% for 0<=T<=100 C and 0<=P<=200 bar

Usage

```
SpeedOfSoundKinslerEtal(PressureBar, temperatureC)
```

Arguments

`PressureBar,`	Pressure in bars (1 bar = 100 kPa)
`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

References

L. Kinsler, A. Frey, A. Coppens, J. Sanders, 1982 Fundamentals of Acoustics, Third Edition New York: John Wiley & Sons. pp. 121 (5.6.8)

Examples

```
SpeedOfSoundKinslerEtal(1, 20)
```

SpeedOfSoundPureWaterBelogolskiiSekoyanEtal

speed of sound (m/s) from Belogolskii, Sekoyan et al

Description

Returns the speed of sound (m/s) Range of validity: 0-40C, 0.1 - 60 MPa

Usage

```
SpeedOfSoundPureWaterBelogolskiiSekoyanEtal(temperatureC, pressureMegaPascals)
```

Arguments

`temperatureC,`	temperatureC in Celsius
`pressureMegaPascals,`	pressure in mega Pascals

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

Belogolskii, Sekoyan et al, 1999 Pressure dependence of the sound velocity in distilled water, Measurement Techniques, Vol 42, No 4, pp 406-413.

Examples

```
SpeedOfSoundPureWaterBelogolskiiSekoyanEtal(25, 1)
```

`SpeedOfSoundPureWaterBilaniukWong112`
speed of sound (m/s) from Bilaniuk and Wong 112 point equation

---

Description

Returns returns the speed of sound (m/s) Range of validity: 0-100 OC at atmospheric pressure

Usage

```
SpeedOfSoundPureWaterBilaniukWong112(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

Bilaniuk and Wong 1993 Speed of sound in pure water as a function of temperature, J. Acoust. Soc. Am. 93(3) pp 1609-1612 Bilaniuk and Wong 1996 Erratum: Speed of sound in pure water as a function of temperature [J. Acoust. Soc. Am. 93, 1609-1612 (1993)], J. Acoust. Soc. Am. 99(5), p 3257.

Examples

```
SpeedOfSoundPureWaterBilaniukWong112(20)
```

`SpeedOfSoundPureWaterBilaniukWong148` *speed of sound (m/s) from Bilaniuk and Wong 148 point equation*

Description

Returns returns the speed of sound (m/s) Range of validity: 0-100 OC at atmospheric pressure

Usage

```
SpeedOfSoundPureWaterBilaniukWong148(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

Bilaniuk and Wong 1993 Speed of sound in pure water as a function of temperature, J. Acoust. Soc. Am. 93(3) pp 1609-1612 Bilaniuk and Wong 1996 Erratum: Speed of sound in pure water as a function of temperature [J. Acoust. Soc. Am. 93, 1609-1612 (1993)], J. Acoust. Soc. Am. 99(5), p 3257.

Examples

```
SpeedOfSoundPureWaterBilaniukWong148(20)
```

SpeedOfSoundPureWaterBilaniukWong36
speed of sound (m/s) from Bilaniuk and Wong 36 point equation

Description

Returns returns the speed of sound (m/s) Range of validity: 0-100 OC at atmospheric pressure

Usage

```
SpeedOfSoundPureWaterBilaniukWong36(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

Bilaniuk and Wong 1993 Speed of sound in pure water as a function of temperature, J. Acoust. Soc. Am. 93(3) pp 1609-1612 Bilaniuk and Wong 1996 Erratum: Speed of sound in pure water as a function of temperature [J. Acoust. Soc. Am. 93, 1609-1612 (1993)], J. Acoust. Soc. Am. 99(5), p 3257.

Examples

```
SpeedOfSoundPureWaterBilaniukWong36(20)
```

`SpeedOfSoundPureWaterLubbersandGraaffSEa`
speed of sound (m/s) from Lubbers and Graaff's simplified equations a and b

---

Description

Returns returns the speed of sound (m/s) temperature interval 15-35 C at atmospheric pressure, maximum error 0.18 m/s Lubbers and Graaff's simplified equation a)

Usage

```
SpeedOfSoundPureWaterLubbersandGraaffSEa(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

J. Lubbers and R. Graaff, 1998 A simple and accurate formula for the sound velocity in water, Ultrasound Med. Biol. Vol 24, No 7, pp 1065-1068.

Examples

```
SpeedOfSoundPureWaterLubbersandGraaffSEa(20)
```

SpeedOfSoundPureWaterLubbersandGraaffSEb

speed of sound (m/s) from Lubbers and Graaff's simplified equations a and b

Description

Returns returns the speed of sound (m/s) temperature interval 10-40C at atmospheric pressure, maximum error 0.18 m/s Lubbers and Graaff's simplified equation b)

Usage

```
SpeedOfSoundPureWaterLubbersandGraaffSEb(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

J. Lubbers and R. Graaff, 1998 A simple and accurate formula for the sound velocity in water, Ultrasound Med. Biol. Vol 24, No 7, pp 1065-1068.

Examples

```
SpeedOfSoundPureWaterLubbersandGraaffSEb(20)
```

SpeedOfSoundPureWaterMarczak
speed of sound (m/s) from Marczak

Description

Returns returns the speed of sound (m/s) Range of validity: 0-95C at atmospheric pressure

Usage

```
SpeedOfSoundPureWaterMarczak(temperatureC)
```

Arguments

`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

National Physical Laboratory, 2015 Underwater Acoustics Technical Guides - Speed of Sound in Pure Water http://resource.npl.co.uk/acoustics/techguides/soundpurewater/content.html#LUBBERS

References

Marczak, 1997 Water as a standard in the measurements of speed of sound in liquids J. Acoust. Soc. Am. 102(5) pp 2776-2779.

Examples

```
SpeedOfSoundPureWaterMarczak(20)
```

`SpeedOfSoundSeaWaterChenAndMillero`
speed of sound (m/s) in sea water from Chen and Millero 1977

Description

Returns the speed of sound (m/s) Range of validity: temperature 0 to 40 C, salinity 0 to 40 parts per thousand, pressure 0 to 1000 bar

Usage

```
SpeedOfSoundSeaWaterChenAndMillero(S, temperatureC, P)
```

Arguments

`S,`	salinity in parts per thousand
`temperatureC,`	temperature in degrees Celsius
`P,`	pressure in kg/cm^2

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

C-T. Chen and F.J. Millero, 1977 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

C-T. Chen and F.J. Millero, 1977 Speed of sound in seawater at high pressures J. Acoust. Soc. Am. 62(5) pp 1129-1135

Examples

```
SpeedOfSoundSeaWaterChenAndMillero(30, 0, 1.019716)
```

SpeedOfSoundSeaWaterCoppens
speed of sound (m/s) in sea water from Coppens 1981

Description

Returns the speed of sound (m/s) Range of validity: temperature 0 to 35 C salinity 0 to 45 parts per thousand and depth 0 to 4000 m

Usage

```
SpeedOfSoundSeaWaterCoppens(D, S, temperatureC)
```

Arguments

D,	depth in meters
S,	salinity in parts per thousand
temperatureC,	temperature in degrees Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

A.B. Coppens, 1981 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

A.B. Coppens, 1981 Simple equations for the speed of sound in Neptunian waters J. Acoust. Soc. Am. 69(3), pp 862-863

Examples

```
SpeedOfSoundSeaWaterCoppens(0, 35, 25)
```

`SpeedOfSoundSeaWaterDelGrosso` *speed of sound (m/s) in sea water from Del Grosso 1974*

Description

Returns the speed of sound (m/s) Range of validity: temperature 0 to 30 C, salinity 30 to 40 parts per thousand pressure 0 to 1000 kg/cm^2 , where 100 kPa=1.019716 kg/cm^2

Usage

```
SpeedOfSoundSeaWaterDelGrosso(S, temperatureC, P)
```

Arguments

`S,`	salinity in parts per thousand
`temperatureC,`	temperature in degrees Celsius
`P,`	pressure in kg/cm^2

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

V.A. Del Grosso, 1974 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://resource.npl.co.uk/acoustics/techguides/soundseawater/

References

V.A. Del Grosso, 1974 New equation for the speed of sound in natural waters (with comparisons to other equations). J. Acoust. Soc. Am 56(4) pp 1084-1091.

Examples

```
SpeedOfSoundSeaWaterDelGrosso(30, 0, 1.019716)
```

SpeedOfSoundSeaWaterFryeAndPugh
Calculation of speed of sound in sea water from Frye and Pugh 1971

Description

Returns the speed of sound in sea water from Frye and Pugh 1971

Usage

```
SpeedOfSoundSeaWaterFryeAndPugh(temperatureC, S, P)
```

Arguments

`temperatureC,`	temperature from -3C to 30C
`S,`	salinity from 33.1 to -36.6 per 1000
`P,`	hydrostatic pressure from 1.033 to 984.3 kg/cm^2

Value

the speed of sound

Author(s)

Jose Gama

Source

Frye, H.W. and Pugh, J.D. 1971 A new equation for the speed of sound in seawater J. Acoust. Soc. Am., 50, 384-6.

References

Frye, H.W. and Pugh, J.D. 1971 A new equation for the speed of sound in seawater J. Acoust. Soc. Am., 50, 384-6.

Examples

```
SpeedOfSoundSeaWaterFryeAndPugh(0, 30, 1.033)
```

`SpeedOfSoundSeaWaterLeroy68`
speed of sound (m/s) in sea water from Leroy 1968

Description

Returns the speed of sound (m/s)

Usage

```
SpeedOfSoundSeaWaterLeroy68(D, latitude)
```

Arguments

`D,`	depth in meters
`latitude,`	latitude in degrees

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Lurton, X, 2002 An Introduction to Underwater Acoustics, 1st ed. London, Praxis Publishing LTD, p37.

References

Lurton, X, 2002 An Introduction to Underwater Acoustics, 1st ed. London, Praxis Publishing LTD, p37.

Examples

```
SpeedOfSoundSeaWaterLeroy68(25, 0)
```

SpeedOfSoundSeaWaterLeroy69
speed of sound (m/s) in sea water from Leroy 1969

Description

Returns the speed of sound (m/s) Range of validity: -2:23 C, Error +-0.1

Usage

```
SpeedOfSoundSeaWaterLeroy69(D, S, temperatureC)
```

Arguments

`D,`	depth in meters
`S,`	salinity in parts per thousand
`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Leroy C.C. 1969 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://support.echoview.com/WebHelp/Reference/Algorithms/Sonar_calculator_algorithms.htm

References

Leroy C.C. 1969 Development of simple equations for accurate and more realistic calculation of the speed of sound in sea water. J. acoust. Soc. Am., 46, 216-26.

Examples

```
SpeedOfSoundSeaWaterLeroy69(0, 35, 25)
```

SpeedOfSoundSeaWaterLeroyEtAl2008 *Calculation of speed of sound in sea water from Leroy et Al 2008*

Description

Returns the speed of sound in sea water from Leroy et Al 2008

Usage

```
SpeedOfSoundSeaWaterLeroyEtAl2008(temperatureC, S, D, L)
```

Arguments

`temperatureC,`	temperature in degrees C 1990 universal temperature scale
`S,`	salinity in %
`D,`	depth in meters
`L,`	latitude in degrees

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Leroy, C.C., Robinson, S.P., and Goldsmith, M.J. 2008 A new equation for the accurate calculation of sound speed in all oceans J. Acoust. Soc. Am., 124, 2774-82.

Examples

```
SpeedOfSoundSeaWaterLeroyEtAl2008(0, 30, 0, 0)
```

`SpeedOfSoundSeaWaterLovett1`
Calculation of speed of sound in sea water from Lovett 1978

Description

Returns the speed of sound in sea water from Lovett 1978 Check value: at T=2C, S=34.7; P=6000 dbar; C = 1559.462 m/s.

Usage

```
SpeedOfSoundSeaWaterLovett1(temperatureC, S, P)
```

Arguments

`temperatureC,`	temperature in degrees C T48
`S,`	salinity in %
`P,`	pressure in decibars (0 at surface)

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Lovett, J.R. 1978 Merged seawater sound-speed equations J. Acoust. Soc. Am., 63, 1713-18.

Examples

```
SpeedOfSoundSeaWaterLovett1(2, 34.7, 6000)
```

`SpeedOfSoundSeaWaterLovett2`
Calculation of speed of sound in sea water from Lovett 1978b

Description

Returns the speed of sound in sea water from Lovett 1978b Check value: at T=2C, S=34.7; P=6000 dbar; C = 1559.393 m/s.

Usage

```
SpeedOfSoundSeaWaterLovett2(temperatureC, S, P)
```

Arguments

`temperatureC,`	temperature in degrees C T48
`S,`	salinity in %
`P,`	pressure in decibars (0 at surface)

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Lovett, J.R. 1978 Merged seawater sound-speed equations J. Acoust. Soc. Am., 63, 1713-18.

Examples

```
SpeedOfSoundSeaWaterLovett2(2, 34.7, 6000)
```

`SpeedOfSoundSeaWaterLovett3` *Calculation of speed of sound in sea water from Lovett 1978c*

Description

Returns the speed of sound in sea water from Lovett 1978c Check value: at T=2C, S=34.7; P=6000 dbar; C = 1559.499 m/s.

Usage

```
SpeedOfSoundSeaWaterLovett3(temperatureC, S, P)
```

Arguments

`temperatureC,`	temperature in degrees C T48
`S,`	salinity in %
`P,`	pressure in decibars (0 at surface)

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Lovett, J.R. 1978 Merged seawater sound-speed equations J. Acoust. Soc. Am., 63, 1713-18.

Examples

```
SpeedOfSoundSeaWaterLovett3(2, 34.7, 6000)
```

SpeedOfSoundSeaWaterMackenzie
speed of sound (m/s) in sea water from Mackenzie 1981

Description

Returns the speed of sound (m/s)

Usage

```
SpeedOfSoundSeaWaterMackenzie(D, S, temperatureC)
```

Arguments

`D,`	depth in meters
`S,`	salinity in parts per thousand
`temperatureC,`	temperatureC in Celsius

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

Mackenzie K.V., 1981 Underwater Acoustics Technical Guides - Speed of Sound in Sea Water http://support.echoview.com/WebHelp/Reference/Algorithms/Sonar_calculator_algorithms.htm

References

Mackenzie K.V., 1981 Nine-term equation for sound speed in the ocean. J. acoust. Soc. Am., 70, 807-12.

Examples

```
SpeedOfSoundSeaWaterMackenzie(0, 35, 25)
```

`SpeedOfSoundSeaWaterMedwin` *speed of sound (m/s) in sea water from Medwin 1975*

Description

Returns the speed of sound (m/s) (approximation) Range of validity: limited to 1000 meters in depth

Usage

```
SpeedOfSoundSeaWaterMedwin(temperatureC, D, S)
```

Arguments

`temperatureC,`	temperature in degrees Celsius
`D,`	depth in meters
`S,`	salinity in parts per thousand

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

X Lurton, 2002 An Introduction to Underwater Acoustics, 1st ed. London, Praxis Publishing LTD

References

Medwin H, 1975 Speed of sound in water: A simple equation for realistic parameters Journal of the Acoustical Society of America, 58, 1318-1319, 1975

Examples

```
SpeedOfSoundSeaWaterMedwin(0, 1, 30)
```

SpeedOfSoundSeaWaterSkone

speed of sound (m/s) in sea water from Skone et al 2002

Description

Returns the speed of sound (m/s) modelled using empirical formulae

Usage

```
SpeedOfSoundSeaWaterSkone(temperatureC, D, S)
```

Arguments

`temperatureC,`	temperature in degrees Celsius
`D,`	depth in meters
`S,`	salinity in parts per thousand

Value

the speed of sound (m/s)

Author(s)

Jose Gama

Source

de Jong, C.D., Lachapelle, G., Skone, S. and Elema, I. A., 2002 Hydrography. Delft University Press (The Netherlands). pp.194

References

de Jong, C.D., Lachapelle, G., Skone, S. and Elema, I. A., 2002 Hydrography. Delft University Press (The Netherlands). pp.194

Examples

```
SpeedOfSoundSeaWaterSkone(0, 1, 30)
```

`SpeedOfSoundSeaWaterWilson`
Calculation of speed of sound in sea water from Wilson 1960

Description

Returns the speed of sound in sea water from Wilson 1960

Usage

```
SpeedOfSoundSeaWaterWilson(temperatureC, S, P)
```

Arguments

`temperatureC,`	temperature from -4C to 30C
`S,`	salinity from 0 to 37 per 1000
`P,`	hydrostatic pressure from 0.1 MPa to 100 MPa

Value

the speed of sound

Author(s)

Jose Gama

Source

N. N. Andreyev Acoustics Institute, 2015 The speed of sound in sea water http://www.akin.ru/spravka_eng/s_i_svel_e.htm

References

Wilson W D, 1960 Equation for the speed of sound in sea water J. Acoust. Soc. Amer., vol.32, N 10, p. 1357

Examples

```
SpeedOfSoundSeaWaterWilson(0, 30, 0.1)
```

TargetStrength *Target Strength (TS)*

Description

Returns the Target Strength (TS), the echo returned by an underwater target

Usage

```
TargetStrength(Ir, Ii)
```

Arguments

`Ir`	reflected intensity referred to 1 m from the acoustic centre of the target
`Ii`	incident intensity

Value

Target Strength (TS)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 67.

Examples

```
TargetStrength( 900, 1000 )
```

TargetStrengthCircularPlateNormal *target strength Circular Plate normal*

Description

Returns the target strength Circular Plate normal

Usage

```
TargetStrengthCircularPlateNormal(r, lambda)
```

Arguments

`r`	radius (meters)
`lambda`	wavelength

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthCircularPlateNormal( 10, 500 )
```

`TargetStrengthConvexSurface` *target strength Convex surface*

Description

Returns the target strength Convex surface

Usage

```
TargetStrengthConvexSurface(r1, r2)
```

Arguments

`r1`	principal radii (meters)
`r2`	principal radii (meters)

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthConvexSurface( 100, 50 )
```

TargetStrengthCylinderNormal *target strength Cylinder normal*

Description

Returns the target strength Cylinder normal

Usage

```
TargetStrengthCylinderNormal(r, L, lambda)
```

Arguments

`r`	radius (meters)
`L`	length (meters)
`lambda`	wavelength

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthCylinderNormal( 10, 5, 500 )
```

`TargetStrengthCylinderThetaToNormal`
target strength Cylinder, theta to normal

Description

Returns the target strength Cylinder, theta to normal

Usage

```
TargetStrengthCylinderThetaToNormal(r, L, lambda, theta)
```

Arguments

`r`	radius (meters)
`L`	length (meters)
`lambda`	wavelength
`theta`	angle to normal

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthCylinderThetaToNormal( 10, 5, 500, 45 )
```

TargetStrengthPlateAnyShape

target strength Plate of any shape

Description

Returns the target strength Plate of any shape

Usage

```
TargetStrengthPlateAnyShape(A, lambda)
```

Arguments

`A`	area (meters)
`lambda`	wavelength

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthPlateAnyShape( 10, 500 )
```

TargetStrengthRectangularPlateNormal

target strength Rectangular Plate normal

Description

Returns the target strength Rectangular Plate normal

Usage

```
TargetStrengthRectangularPlateNormal(A, B, lambda)
```

Arguments

`A`	side, A>=B (meters)
`B`	side (meters)
`lambda`	wavelength

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthRectangularPlateNormal( 10, 500, 500 )
```

`TargetStrengthRectangularPlateThetaToNormal` *target strength Rectangular Plate, theta to normal*

Description

Returns the target strength Rectangular Plate, theta to normal

Usage

```
TargetStrengthRectangularPlateThetaToNormal(A, B, lambda, theta)
```

Arguments

`A`	side, A>=B (meters)
`B`	side (meters)
`lambda`	wavelength
`theta`	angle to normal

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 70.

Examples

```
TargetStrengthRectangularPlateThetaToNormal( 10, 500, 500, 45 )
```

TargetStrengthSphere *target strength sphere*

Description

Returns the target strength sphere

Usage

```
TargetStrengthSphere(r)
```

Arguments

r	radius (meters)

Value

Target Strength (TS) (dB)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 69.

Examples

```
PeakTS( 900, 1000 )
```

`TransmitDirectivityIndex` *transmit directivity index*

Description

Returns the transmit directivity index (DIt)

Usage

```
TransmitDirectivityIndex(Idir, Iomni)
```

Arguments

`Idir,`	intensity along the axis of the beam pattern
`Iomni,`	intensity of the equivalent non-directional projector

Value

transmit directivity index (DIt)

Author(s)

Jose Gama

References

Waite A. D., 2002 Sonar for Practising Engineers, 3rd Edition Chichester: Wiley. pp. 4.

Examples

```
TransmitDirectivityIndex( 700, 1000 )
```

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