

Package ‘psychrolib’

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Type Package

Title Psychrometric Properties of Moist and Dry Air

Version 2.5.0

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Description Implementation of 'PsychroLib'
<<https://github.com/psychrometrics/psychrolib>> library which contains functions to enable the calculation properties of moist and dry air in both metric (SI) and imperial (IP) systems of units. References: Meyer, D. and Thevenard, D (2019) <doi.org/10.21105/joss.01137>.

Depends R (>= 3.0.0)

Imports Rcpp

Suggests testthat (>= 2.1.0), covr

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URL <https://github.com/psychrometrics/psychrolib>

BugReports <https://github.com/psychrometrics/psychrolib/issues>

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(<https://www.ashrae.org>) for equations and coefficients published
ASHRAE Handbook Fundamentals Chapter 1.)

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psychrolib-package *PsychroLib: Psychrometric Properties of Moist and Dry Air*

Description

Contains functions for calculating thermodynamic properties of gas-vapor mixtures and standard atmosphere suitable for most engineering, physical and meteorological applications.

Details

Most of the functions are an implementation of the formulae found in the 2017 ASHRAE Handbook - Fundamentals, in both International System (SI), and Imperial (IP) units. Please refer to the information included in each function for their respective reference.

psychroLib is a port of the [psychrolib](#) library for R.

Package options

- `psychrolib.units` The default unit system. Should be either be "SI" or "IP".

Note

We have made every effort to ensure that the code is adequate, however, we make no representation with respect to its accuracy. Use at your own risk. Should you notice an error, or if you have a suggestion, please notify us through GitHub at <https://github.com/psychrometrics/psychrolib/issues>.

Author(s)

- Hongyuan Jia and Jason Banfelder for R implementation.
- D. Thevenard and D. Meyer for the core library implementations.
- Equations and coefficients published ASHRAE Handbook — Fundamentals, Chapter 1 Copyright (c) 2017 ASHRAE Handbook — Fundamentals (<https://www.ashrae.org>)

See Also

Useful links:

- <https://github.com/psychrometrics/psychrolib>
- Report bugs at <https://github.com/psychrometrics/psychrolib/issues>

Examples

```

library(psychrolib)
# Set the unit system, for example to SI (can be either SI or IP)
SetUnitSystem("SI")

# Calculate the dew point temperature for a dry bulb temperature of 25 C
# and a relative humidity of 80%
GetTDewPointFromRelHum(25.0, 0.80)

```

CalcPsychrometricsFromRelHum

Calculate psychrometric values from relative humidity.

Description

Utility function to calculate humidity ratio, wet-bulb temperature, dew-point temperature, vapour pressure, moist air enthalpy, moist air volume, and degree of saturation of air given dry-bulb temperature, relative humidity and pressure.

Usage

```
CalcPsychrometricsFromRelHum(TDryBulb, RelHum, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
RelHum	A numeric vector of relative humidity in range [0, 1]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A list with named components for each psychrometric value computed:

HumRatio Humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

TWetBulb Wet-bulb temperature in degreeF [IP] or degreeC [SI]

TDewPoint Dew-point temperature in degreeF [IP] or degreeC [SI]

VapPres Partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

MoistAirEnthalpy Moist air enthalpy in Btu lb-1 [IP] or J kg-1 [SI]

MoistAirVolume Specific volume of moist air in ft3 lb-1 [IP] or in m3 kg-1 [SI]

DegreeOfSaturation Degree of saturation [unitless]

Examples

```
SetUnitSystem("IP")
CalcPsychrometricsFromRelHum(80:100, 0.13, 14.69)
```

```
SetUnitSystem("SI")
CalcPsychrometricsFromRelHum(25:40, 0.5, 101325.0)
```

CalcPsychrometricsFromTDewPoint

Calculate psychrometric values from dew-point temperature.

Description

Utility function to calculate humidity ratio, wet-bulb temperature, relative humidity, vapour pressure, moist air enthalpy, moist air volume, and degree of saturation of air given dry-bulb temperature, dew-point temperature, and pressure.

Usage

```
CalcPsychrometricsFromTDewPoint(TDryBulb, TDewPoint, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TDewPoint	A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A list with named components for each psychrometric value computed:

HumRatio Humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

TWetBulb Wet-bulb temperature in degreeF [IP] or degreeC [SI]

RelHum Relative humidity in range [0, 1]

VapPres Partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

MoistAirEnthalpy Moist air enthalpy in Btu lb-1 [IP] or J kg-1 [SI]

MoistAirVolume Specific volume of moist air in ft3 lb-1 [IP] or in m3 kg-1 [SI]

DegreeOfSaturation Degree of saturation [unitless]

Examples

```
SetUnitSystem("IP")
CalcPsychrometricsFromTDewPoint(80:100, 40.0, 14.696)
```

```
SetUnitSystem("SI")
CalcPsychrometricsFromTDewPoint(25:40, 20.0, 101325.0)
```

CalcPsychrometricsFromTWetBulb

Calculate psychrometric values from wet-bulb temperature.

Description

Utility function to calculate humidity ratio, dew-point temperature, relative humidity, vapour pressure, moist air enthalpy, moist air volume, and degree of saturation of air given dry-bulb temperature, wet-bulb temperature, and pressure.

Usage

CalcPsychrometricsFromTWetBulb(TDryBulb, TWetBulb, Pressure)

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TWetBulb	A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A list with named components for each psychrometric value computed:

HumRatio Humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

TDewPoint Dew-point temperature in degreeF [IP] or degreeC [SI]

RelHum Relative humidity in range [0, 1]

VapPres Partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

MoistAirEnthalpy Moist air enthalpy in Btu lb-1 [IP] or J kg-1 [SI]

MoistAirVolume Specific volume of moist air in ft3 lb-1 [IP] or in m3 kg-1 [SI]

DegreeOfSaturation Degree of saturation [unitless]

Examples

```
SetUnitSystem("IP")
CalcPsychrometricsFromTWetBulb(80:100, 65.0, 14.696)
```

```
SetUnitSystem("SI")
CalcPsychrometricsFromTWetBulb(25:40, 20, 101325.0)
```

GetDegreeOfSaturation *Return the degree of saturation (i.e humidity ratio of the air / humidity ratio of the air at saturation at the same temperature and pressure) given dry-bulb temperature, humidity ratio, and atmospheric pressure.*

Description

Return the degree of saturation (i.e humidity ratio of the air / humidity ratio of the air at saturation at the same temperature and pressure) given dry-bulb temperature, humidity ratio, and atmospheric pressure.

Usage

```
GetDegreeOfSaturation(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of degree of saturation in arbitrary unit

Note

This definition is absent from the 2017 Handbook. Using 2009 version instead.

References

ASHRAE Handbook - Fundamentals (2009) ch. 1 eqn 12

Examples

```
SetUnitSystem("IP")
GetDegreeOfSaturation(80:100, 0.01, 14.175)
```

```
SetUnitSystem("SI")
GetDegreeOfSaturation(20:30, 0.01, 95461.0)
```

GetDryAirDensity *Return dry-air density given dry-bulb temperature and pressure.*

Description

Return dry-air density given dry-bulb temperature and pressure.

Usage

```
GetDryAirDensity(TDryBulb, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of dry air density in lb ft-3 [IP] or kg m-3 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

- Eqn 14 for the perfect gas relationship for dry air.
- Eqn 1 for the universal gas constant.
- The factor 144 in IP is for the conversion of Psi = lb in-2 to lb ft-2.

Examples

```
SetUnitSystem("IP")  
GetDryAirDensity(77:87, 14.696)
```

```
SetUnitSystem("SI")  
GetDryAirDensity(25:30, 101325)
```

GetDryAirEnthalpy *Return dry-air enthalpy given dry-bulb temperature.*

Description

Return dry-air enthalpy given dry-bulb temperature.

Usage

```
GetDryAirEnthalpy(TDryBulb)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of dry air enthalpy in Btu lb-1 [IP] or J kg-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 28

Examples

```
SetUnitSystem("IP")
GetDryAirEnthalpy(77:87)
```

```
SetUnitSystem("SI")
GetDryAirEnthalpy(10:30)
```

GetDryAirVolume *Return dry-air volume given dry-bulb temperature and pressure.*

Description

Return dry-air volume given dry-bulb temperature and pressure.

Usage

```
GetDryAirVolume(TDryBulb, Pressure)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Pressure A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of dry air volume in ft³ lb⁻¹ [IP] or in m³ kg⁻¹ [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

- Eqn 14 for the perfect gas relationship for dry air.
- Eqn 1 for the universal gas constant.
- The factor 144 in IP is for the conversion of Psi = lb in⁻² to lb ft⁻².

Examples

```
SetUnitSystem("IP")
GetDryAirVolume(77:87, 14.696)
```

```
SetUnitSystem("SI")
GetDryAirVolume(25:30, 101325)
```

GetHumRatioFromEnthalpyAndTDryBulb

Return humidity ratio from enthalpy and dry-bulb temperature.

Description

Return humidity ratio from enthalpy and dry-bulb temperature.

Usage

```
GetHumRatioFromEnthalpyAndTDryBulb(MoistAirEnthalpy, TDryBulb)
```

Arguments

MoistAirEnthalpy

A numeric vector of moist air enthalpy in Btu lb⁻¹ [IP] or J kg⁻¹

TDryBulb

A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of humidity ratio in lb_{H2O} lb_{Air}⁻¹ [IP] or kg_{H2O} kg_{Air}⁻¹ [SI]

Note

Based on the [GetMoistAirEnthalpy](#) function, rearranged for humidity ratio.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 30.

Examples

```
SetUnitSystem("IP")
GetHumRatioFromEnthalpyAndTDryBulb(42.6168, 76:86)
```

```
SetUnitSystem("SI")
GetHumRatioFromEnthalpyAndTDryBulb(81316.0, 20:30)
```

GetHumRatioFromRelHum *Return humidity ratio given dry-bulb temperature, relative humidity, and pressure.*

Description

Return humidity ratio given dry-bulb temperature, relative humidity, and pressure.

Usage

```
GetHumRatioFromRelHum(TDryBulb, RelHum, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
RelHum	A numeric vector of relative humidity in range [0, 1]
Pressure	A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetHumRatioFromRelHum(80:100, 0.5, 14.175)
```

```
SetUnitSystem("SI")
GetHumRatioFromRelHum(20:30, 0.5, 95461.0)
```

GetHumRatioFromSpecificHum

Return the humidity ratio (aka mixing ratio) from specific humidity.

Description

Return the humidity ratio (aka mixing ratio) from specific humidity.

Usage

```
GetHumRatioFromSpecificHum(SpecificHum)
```

Arguments

SpecificHum A numeric vector of specific humidity in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

Value

A numeric vector of humidity ratio in lb_H2O lb_Dry_Air-1 [IP] or kg_H2O kg_Dry_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 9b (solved for humidity ratio)

Examples

```
SetUnitSystem("IP")
GetHumRatioFromSpecificHum(seq(0.006, 0.016, 0.001))
```

```
SetUnitSystem("SI")
GetHumRatioFromSpecificHum(seq(0.006, 0.016, 0.001))
```

GetHumRatioFromTDewPoint

Return humidity ratio given dew-point temperature and pressure.

Description

Return humidity ratio given dew-point temperature and pressure.

Usage

```
GetHumRatioFromTDewPoint(TDewPoint, Pressure)
```

Arguments

TDewPoint A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]
 Pressure A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 13

Examples

```
SetUnitSystem("IP")
GetHumRatioFromTDewPoint(50:80, 14.175)

SetUnitSystem("SI")
GetHumRatioFromTDewPoint(20:30, 95461.0)
```

GetHumRatioFromTWetBulb

Return humidity ratio given dry-bulb temperature, wet-bulb temperature, and pressure.

Description

Return humidity ratio given dry-bulb temperature, wet-bulb temperature, and pressure.

Usage

```
GetHumRatioFromTWetBulb(TDryBulb, TWetBulb, Pressure)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
 TWetBulb A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]
 Pressure A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 33 and 35

Examples

```
SetUnitSystem("IP")
GetHumRatioFromTWetBulb(80:100, 77.0, 14.175)
```

```
SetUnitSystem("SI")
GetHumRatioFromTWetBulb(20:30, 19.0, 95461.0)
```

GetHumRatioFromVapPres

Return humidity ratio given water vapor pressure and atmospheric pressure.

Description

Return humidity ratio given water vapor pressure and atmospheric pressure.

Usage

```
GetHumRatioFromVapPres(VapPres, Pressure)
```

Arguments

VapPres	A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 20

Examples

```
SetUnitSystem("IP")
GetHumRatioFromVapPres(seq(0.4, 0.6, 0.01), 14.175)
```

```
SetUnitSystem("SI")
GetHumRatioFromVapPres(seq(3000, 4000, 100), 95461)
```

GetMoistAirDensity *Return moist air density given humidity ratio, dry bulb temperature, and pressure.*

Description

Return moist air density given humidity ratio, dry bulb temperature, and pressure.

Usage

```
GetMoistAirDensity(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of moistAirDensity: Moist air density in lb ft-3 [IP] or kg m-3 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 11

Examples

```
SetUnitSystem("IP")  
GetMoistAirDensity(80:100, 0.02, 14.175)  
  
SetUnitSystem("SI")  
GetMoistAirDensity(20:30, 0.02, 95461)
```

GetMoistAirEnthalpy *Return moist air enthalpy given dry-bulb temperature and humidity ratio.*

Description

Return moist air enthalpy given dry-bulb temperature and humidity ratio.

Usage

```
GetMoistAirEnthalpy(TDryBulb, HumRatio)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

Value

A numeric vector of moist air enthalpy in Btu lb-1 [IP] or J kg-1

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 30

Examples

```
SetUnitSystem("IP")
GetMoistAirEnthalpy(80:100, 0.02)

SetUnitSystem("SI")
GetMoistAirEnthalpy(20:30, 0.02)
```

GetMoistAirVolume	<i>Return moist air specific volume given dry-bulb temperature, humidity ratio, and pressure.</i>
-------------------	---

Description

Return moist air specific volume given dry-bulb temperature, humidity ratio, and pressure.

Usage

```
GetMoistAirVolume(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of specific volume of moist air in ft3 lb-1 of dry air [IP] or in m3 kg-1 of dry air [SI]

Note

In IP units, $R_DA_IP / 144$ equals 0.370486 which is the coefficient appearing in eqn 26.
The factor 144 is for the conversion of $\text{Psi} = \text{lb in}^{-2}$ to lb ft^{-2} .

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 26

Examples

```
SetUnitSystem("IP")
GetMoistAirVolume(80:100, 0.02, 14.175)
```

```
SetUnitSystem("SI")
GetMoistAirVolume(20:30, 0.02, 95461)
```

GetRelHumFromHumRatio *Return relative humidity given dry-bulb temperature, humidity ratio, and pressure.*

Description

Return relative humidity given dry-bulb temperature, humidity ratio, and pressure.

Usage

```
GetRelHumFromHumRatio(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in $\text{lb_H2O lb_Air}^{-1}$ [IP] or $\text{kg_H2O kg_Air}^{-1}$ [SI]
Pressure	A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of relative humidity in range [0, 1]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetRelHumFromHumRatio(80:100, 0.01, 14.175)
```

```
SetUnitSystem("SI")
GetRelHumFromHumRatio(20:30, 0.01, 95461.0)
```

GetRelHumFromTDewPoint

Return relative humidity given dry-bulb temperature and dew-point temperature.

Description

Return relative humidity given dry-bulb temperature and dew-point temperature.

Usage

```
GetRelHumFromTDewPoint(TDryBulb, TDewPoint)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TDewPoint	A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of relative humidity in range [0, 1]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 22

Examples

```
SetUnitSystem("IP")
GetRelHumFromTDewPoint(80:100, 65)
```

```
SetUnitSystem("SI")
GetRelHumFromTDewPoint(20:30, 15)
```

GetRelHumFromTWetBulb *Return relative humidity given dry-bulb temperature, wet bulb temperature and pressure.*

Description

Return relative humidity given dry-bulb temperature, wet bulb temperature and pressure.

Usage

```
GetRelHumFromTWetBulb(TDryBulb, TWetBulb, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TWetBulb	A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of relative humidity in range [0, 1]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetRelHumFromTWetBulb(80:100, 79.9, 14.696)

SetUnitSystem("SI")
GetRelHumFromTWetBulb(25:40, 20, 101325.0)
```

GetRelHumFromVapPres *Return relative humidity given dry-bulb temperature and vapor pressure.*

Description

Return relative humidity given dry-bulb temperature and vapor pressure.

Usage

```
GetRelHumFromVapPres(TDryBulb, VapPres)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
VapPres	A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

Value

A numeric vector of relative humidity in range [0, 1]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 12, 22

Examples

```
SetUnitSystem("IP")
GetRelHumFromVapPres(70:80, 0.0149)

SetUnitSystem("SI")
GetRelHumFromVapPres(20:30, 12581)
```

GetSatAirEnthalpy	<i>Return saturated air enthalpy given dry-bulb temperature and pressure.</i>
-------------------	---

Description

Return saturated air enthalpy given dry-bulb temperature and pressure.

Usage

```
GetSatAirEnthalpy(TDryBulb, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of saturated air enthalpy in Btu lb-1 [IP] or J kg-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetSatAirEnthalpy(80:100, 14.696)
```

```
SetUnitSystem("SI")
GetSatAirEnthalpy(20:30, 101325)
```

GetSatHumRatio	<i>Return humidity ratio of saturated air given dry-bulb temperature and pressure.</i>
----------------	--

Description

Return humidity ratio of saturated air given dry-bulb temperature and pressure.

Usage

```
GetSatHumRatio(TDryBulb, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of humidity ratio of saturated air in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 36, solved for W

Examples

```
SetUnitSystem("IP")
GetSatHumRatio(80:100, 14.696)
```

```
SetUnitSystem("SI")
GetSatHumRatio(20:30, 101325)
```

GetSatVapPres	<i>Return saturation vapor pressure given dry-bulb temperature.</i>
---------------	---

Description

Return saturation vapor pressure given dry-bulb temperature.

Usage

```
GetSatVapPres(TDryBulb)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of vapor pressure of saturated air in Psi [IP] or Pa [SI]

Note

Important note: the ASHRAE formulae are defined above and below the freezing point but have a discontinuity at the freezing point. This is a small inaccuracy on ASHRAE's part: the formulae should be defined above and below the triple point of water (not the freezing point) in which case the discontinuity vanishes. It is essential to use the triple point of water otherwise function GetTDewPointFromVapPres, which inverts the present function, does not converge properly around the freezing point.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 5 & 6

Examples

```
SetUnitSystem("IP")  
GetSatVapPres(80:100)
```

```
SetUnitSystem("SI")  
GetSatVapPres(20:30)
```

GetSeaLevelPressure *Return sea level pressure given dry-bulb temperature, altitude above sea level and pressure.*

Description

Return sea level pressure given dry-bulb temperature, altitude above sea level and pressure.

Usage

```
GetSeaLevelPressure(StationPressure, Altitude, TDryBulb)
```

Arguments

StationPressure	A numeric vector of observed station pressure in Psi [IP] or Pa [SI]
Altitude	A numeric vector of altitude in ft [IP] or m [SI]
TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of sea level barometric pressure in Psi [IP] or Pa [SI]

Note

The standard procedure for the US is to use for TDryBulb the average of the current station temperature and the station temperature from 12 hours ago.

References

Hess SL, Introduction to theoretical meteorology, Holt Rinehart and Winston, NY 1959, ch. 6.5;
Stull RB, Meteorology for scientists and engineers, 2nd edition, Brooks/Cole 2000, ch. 1.

Examples

```
SetUnitSystem("IP")
GetSeaLevelPressure(14.68, 300:400, 62.94)

SetUnitSystem("SI")
GetSeaLevelPressure(101226.5, 105:205, 17.19)
```

GetSpecificHumFromHumRatio

Return the specific humidity from humidity ratio (aka mixing ratio).

Description

Return the specific humidity from humidity ratio (aka mixing ratio).

Usage

```
GetSpecificHumFromHumRatio(HumRatio)
```

Arguments

HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Dry_Air-1 [IP] or kg_H2O kg_Dry_Air-1 [SI]
----------	--

Value

A numeric vector of specific humidity in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 9b

Examples

```
SetUnitSystem("IP")
GetSpecificHumFromHumRatio(seq(0.006, 0.016, 0.001))
```

```
SetUnitSystem("SI")
GetSpecificHumFromHumRatio(seq(0.006, 0.016, 0.001))
```

GetStandardAtmPressure

Return standard atmosphere barometric pressure, given the elevation (altitude).

Description

Return standard atmosphere barometric pressure, given the elevation (altitude).

Usage

```
GetStandardAtmPressure(Altitude)
```


Arguments

Altitude A numeric vector of altitude in ft [IP] or m [SI]

Value

A numeric vector of standard atmosphere barometric pressure in Psi [IP] or Pa [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 3

Examples

```
SetUnitSystem("IP")
GetStandardAtmPressure(seq(-500, 1000, 100))
```

```
SetUnitSystem("SI")
GetStandardAtmPressure(seq(-500, 1000, 100))
```

GetStandardAtmTemperature

Return standard atmosphere temperature, given the elevation (altitude).

Description

Return standard atmosphere temperature, given the elevation (altitude).

Usage

```
GetStandardAtmTemperature(Altitude)
```

Arguments

Altitude A numeric vector of altitude in ft [IP] or m [SI]

Value

A numeric vector of standard atmosphere dry-bulb temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 4

Examples

```
SetUnitSystem("IP")
GetStandardAtmTemperature(seq(-500, 1000, 100))
```

```
SetUnitSystem("SI")
GetStandardAtmTemperature(seq(-500, 1000, 100))
```

GetStationPressure *Return station pressure from sea level pressure.*

Description

Return station pressure from sea level pressure.

Usage

```
GetStationPressure(SeaLevelPressure, Altitude, TDryBulb)
```

Arguments

SeaLevelPressure	A numeric vector of sea level barometric pressure in Psi [IP] or Pa [SI]
Altitude	A numeric vector of altitude in ft [IP] or m [SI]
TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of station pressure in Psi [IP] or Pa [SI]

Note

This function is just the inverse of [GetSeaLevelPressure](#).

References

See [GetSeaLevelPressure](#).

Examples

```
SetUnitSystem("IP")
GetStationPressure(14.68, 300:400, 62.94)
```

```
SetUnitSystem("SI")
GetStationPressure(101226.5, 105:205, 17.19)
```

GetTCelsiusFromTKelvin

Utility function to convert temperature to degree Celsius (degreeC) given temperature in Kelvin (K).

Description

Utility function to convert temperature to degree Celsius (degreeC) given temperature in Kelvin (K).

Usage

GetTCelsiusFromTKelvin(TKelvin)

Arguments

TKelvin A numeric vector of temperature in degree Kelvin (K)

Value

A numeric vector of temperature in Celsius (degreeC)

Notes

Exact conversion.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 section 3

Examples

GetTCelsiusFromTKelvin(300:400)

GetTDewPointFromHumRatio

Return dew-point temperature given dry-bulb temperature, humidity ratio, and pressure.

Description

Return dew-point temperature given dry-bulb temperature, humidity ratio, and pressure.

Usage

GetTDewPointFromHumRatio(TDryBulb, HumRatio, Pressure)

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetTDewPointFromHumRatio(80:100, 0.01, 14.175)

SetUnitSystem("SI")
GetTDewPointFromHumRatio(20:30, 0.01, 95461.0)
```

GetTDewPointFromRelHum

Return dew-point temperature given dry-bulb temperature and relative humidity.

Description

Return dew-point temperature given dry-bulb temperature and relative humidity.

Usage

```
GetTDewPointFromRelHum(TDryBulb, RelHum)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
RelHum	A numeric vector of relative humidity in range [0, 1]

Value

A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetTDewPointFromRelHum(80:100, 0.2)
```

```
SetUnitSystem("SI")
GetTDewPointFromRelHum(20:30, 0.4)
```

GetTDewPointFromTWetBulb

Return dew-point temperature given dry-bulb temperature, wet-bulb temperature, and pressure.

Description

Return dew-point temperature given dry-bulb temperature, wet-bulb temperature, and pressure.

Usage

```
GetTDewPointFromTWetBulb(TDryBulb, TWetBulb, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TWetBulb	A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetTDewPointFromTWetBulb(80:100, 65.0, 14.696)
```

```
SetUnitSystem("SI")
GetTDewPointFromTWetBulb(25:40, 20, 101325.0)
```

GetTDewPointFromVapPres

Return dew-point temperature given dry-bulb temperature and vapor pressure.

Description

Return dew-point temperature given dry-bulb temperature and vapor pressure.

Usage

```
GetTDewPointFromVapPres(TDryBulb, VapPres)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
VapPres	A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

Value

A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

Note

- The dew point temperature is solved by inverting the equation giving water vapor pressure at saturation from temperature rather than using the regressions provided by ASHRAE (eqn. 37 and 38), which are much less accurate and have a narrower range of validity.
- The Newton-Raphson (NR) method is used on the logarithm of water vapour pressure as a function of temperature, which is a very smooth function.
- Convergence is usually achieved in 3 to 5 iterations.
- TDryBulb is not really needed here, just used for convenience.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn. 5 and 6

Examples

```
SetUnitSystem("IP")
GetTDewPointFromVapPres(70:80, seq(0.0149, 0.0249, 0.001))
```

```
SetUnitSystem("SI")
GetTDewPointFromVapPres(70:80, 12581:12591)
```

`GetTDryBulbFromEnthalpyAndHumRatio`*Return dry bulb temperature from enthalpy and humidity ratio.*

Description

Return dry bulb temperature from enthalpy and humidity ratio.

Usage

```
GetTDryBulbFromEnthalpyAndHumRatio(MoistAirEnthalpy, HumRatio)
```

Arguments

MoistAirEnthalpy

A numeric vector of moist air enthalpy in Btu lb-1 [IP] or J kg-1

HumRatio

A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]

Value

A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]

Note

Based on the [GetMoistAirEnthalpy](#) function, rearranged for temperature.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 30

Examples

```
SetUnitSystem("IP")
GetTDryBulbFromEnthalpyAndHumRatio(42.6168, seq(0.01, 0.02, 0.001))
```

```
SetUnitSystem("SI")
GetTDryBulbFromEnthalpyAndHumRatio(81316.0, seq(0.01, 0.02, 0.001))
```

GetTDryBulbFromMoistAirVolumeAndHumRatio

Return dry-bulb temperature given moist air specific volume, humidity ratio, and pressure.

Description

Return dry-bulb temperature given moist air specific volume, humidity ratio, and pressure.

Usage

```
GetTDryBulbFromMoistAirVolumeAndHumRatio(MoistAirVolume, HumRatio, Pressure)
```

Arguments

MoistAirVolume	A numeric vector of specific volume of moist air in ft ³ lb ⁻¹ of dry air [IP] or in m ³ kg ⁻¹ of dry air [SI]
HumRatio	A numeric vector of humidity ratio in lb _{H2O} lb _{Air} ⁻¹ [IP] or kg _{H2O} kg _{Air} ⁻¹ [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of tDryBulb : Dry-bulb temperature in degreeF [IP] or degreeC [SI]

Note

- In IP units, $R_{DA_IP} / 144$ equals 0.370486 which is the coefficient appearing in eqn 26.
- The factor 144 is for the conversion of Psi = lb in⁻² to lb ft⁻².
- Based on the 'GetMoistAirVolume' function, rearranged for dry-bulb temperature.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 26

Examples

```
SetUnitSystem("IP")
GetTDryBulbFromMoistAirVolumeAndHumRatio(14.72, seq(0.02, 0.03, 0.001), 14.175)
```

```
SetUnitSystem("SI")
GetTDryBulbFromMoistAirVolumeAndHumRatio(0.94, seq(0.02, 0.03, 0.001), 95461)
```

GetTFahrenheitFromTRankine

Utility function to convert temperature to degree Fahrenheit (degreeF) given temperature in degree Rankine (degreeR).

Description

Utility function to convert temperature to degree Fahrenheit (degreeF) given temperature in degree Rankine (degreeR).

Usage

GetTFahrenheitFromTRankine(TRankine)

Arguments

TRankine A numeric vector of temperature in degree Rankine (degreeR)

Value

A numeric vector of temperature in degree Fahrenheit (degreeF)

Notes

Exact conversion.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 section 3

Examples

GetTFahrenheitFromTRankine(500:600)

GetTKelvinFromTCelsius

Utility function to convert temperature to Kelvin (K) given temperature in degree Celsius (degreeC).

Description

Utility function to convert temperature to Kelvin (K) given temperature in degree Celsius (degreeC).

Usage

GetTKelvinFromTCelsius(TCelsius)

Arguments

TCelsius A numeric vector of temperature in degree Celsius (degreeC)

Value

A numeric vector of temperature in Kelvin (K)

Notes

Exact conversion.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 section 3

Examples

```
GetTKelvinFromTCelsius(20:30)
```

GetTRankineFromTFahrenheit

*Utility function to convert temperature to degree Rankine (degreeR)
given temperature in degree Fahrenheit (degreeF).*

Description

Utility function to convert temperature to degree Rankine (degreeR) given temperature in degree Fahrenheit (degreeF).

Usage

```
GetTRankineFromTFahrenheit(TFahrenheit)
```

Arguments

TFahrenheit A numeric vector of temperature in degree Fahrenheit (degreeF)

Value

A numeric vector of temperature in degree Rankine (degreeR)

Notes

Exact conversion.

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 section 3

Examples

```
GetTRankineFromTFahrenheit(1:100)
```

```
GetTWetBulbFromHumRatio
```

Return wet-bulb temperature given dry-bulb temperature, humidity ratio, and pressure.

Description

Return wet-bulb temperature given dry-bulb temperature, humidity ratio, and pressure.

Usage

```
GetTWetBulbFromHumRatio(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric Pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 33 and 35 solved for Tstar

Examples

```
SetUnitSystem("IP")  
GetTWetBulbFromHumRatio(80:100, 0.01, 14.175)
```

```
SetUnitSystem("SI")  
GetTWetBulbFromHumRatio(20:30, 0.01, 95461)
```

GetTWetBulbFromRelHum *Return wet-bulb temperature given dry-bulb temperature, relative humidity, and pressure.*

Description

Return wet-bulb temperature given dry-bulb temperature, relative humidity, and pressure.

Usage

```
GetTWetBulbFromRelHum(TDryBulb, RelHum, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
RelHum	A numeric vector of relative humidity in range [0, 1]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetTWetBulbFromRelHum(80:100, 0.2, 14.696)

SetUnitSystem("SI")
GetTWetBulbFromRelHum(25:40, 0.2, 101325.0)
```

GetTWetBulbFromTDewPoint

Return wet-bulb temperature given dry-bulb temperature, dew-point temperature, and pressure.

Description

Return wet-bulb temperature given dry-bulb temperature, dew-point temperature, and pressure.

Usage

```
GetTWetBulbFromTDewPoint(TDryBulb, TDewPoint, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
TDewPoint	A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of wet-bulb temperature in degreeF [IP] or degreeC [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1

Examples

```
SetUnitSystem("IP")
GetTWetBulbFromTDewPoint(80:100, 40.0, 14.696)

SetUnitSystem("SI")
GetTWetBulbFromTDewPoint(25:40, 20.0, 101325.0)
```

GetUnitSystem	<i>Return system of units in use.</i>
---------------	---------------------------------------

Description

Return system of units in use.

Usage

```
GetUnitSystem()
```

Value

A string indicating system of units in use ("SI" or "IP")

GetVaporPressureDeficit

Return Vapor pressure deficit given dry-bulb temperature, humidity ratio, and pressure.

Description

Return Vapor pressure deficit given dry-bulb temperature, humidity ratio, and pressure.

Usage

```
GetVaporPressureDeficit(TDryBulb, HumRatio, Pressure)
```

Arguments

TDryBulb	A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of vapor pressure deficit in Psi [IP] or Pa [SI]

References

Oke (1987) eqn 2.13a

Examples

```
SetUnitSystem("IP")
GetVaporPressureDeficit(80:100, 0.01, 14.175)
```

```
SetUnitSystem("SI")
GetVaporPressureDeficit(20:30, 0.01, 95461.0)
```

 GetVapPresFromHumRatio

Return vapor pressure given humidity ratio and pressure.

Description

Return vapor pressure given humidity ratio and pressure.

Usage

```
GetVapPresFromHumRatio(HumRatio, Pressure)
```

Arguments

HumRatio	A numeric vector of humidity ratio in lb_H2O lb_Air-1 [IP] or kg_H2O kg_Air-1 [SI]
Pressure	A numeric vector of atmospheric pressure in Psi [IP] or Pa [SI]

Value

A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 20 solved for pw

Examples

```
SetUnitSystem("IP")
GetVapPresFromHumRatio(seq(0.02, 0.03, 0.001), 14.175)

SetUnitSystem("SI")
GetVapPresFromHumRatio(seq(0.02, 0.03, 0.001), 95461)
```

 GetVapPresFromRelHum *Return partial pressure of water vapor as a function of relative humidity and temperature.*

Description

Return partial pressure of water vapor as a function of relative humidity and temperature.

Usage

```
GetVapPresFromRelHum(TDryBulb, RelHum)
```

Arguments

TDryBulb A numeric vector of dry-bulb temperature in degreeF [IP] or degreeC [SI]
RelHum A numeric vector of relative humidity in range [0, 1]

Value

A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 12, 22

Examples

```
SetUnitSystem("IP")  
GetVapPresFromRelHum(77, seq(0.1, 0.8, 0.1))  
  
SetUnitSystem("SI")  
GetVapPresFromRelHum(20, seq(0.1, 0.8, 0.1))
```

GetVapPresFromTDewPoint

Return vapor pressure given dew point temperature.

Description

Return vapor pressure given dew point temperature.

Usage

```
GetVapPresFromTDewPoint(TDewPoint)
```

Arguments

TDewPoint A numeric vector of dew-point temperature in degreeF [IP] or degreeC [SI]

Value

A numeric vector of partial pressure of water vapor in moist air in Psi [IP] or Pa [SI]

References

ASHRAE Handbook - Fundamentals (2017) ch. 1 eqn 36

Examples

```
SetUnitSystem("IP")  
GetVapPresFromTDewPoint(12:20)
```

```
SetUnitSystem("SI")  
GetVapPresFromTDewPoint(12:20)
```

isIP	<i>Check whether the system in use is IP or SI.</i>
------	---

Description

Check whether the system in use is IP or SI.

Usage

```
isIP()
```

Value

TRUE if unit system is IP

SetUnitSystem	<i>Set the system of units to use (SI or IP).</i>
---------------	---

Description

Set the system of units to use (SI or IP).

Usage

```
SetUnitSystem(units)
```

Arguments

units A string indicating the system of units chosen. Should be either "SI" or "IP"

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