Package 'IAPWS95'

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Title Thermophysical Properties of Water and Steam

Version 1.2.5

Description An implementation of the International Association for the Properties of Water (IAPWS) Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use and on the releases for viscosity, conductivity, surface tension and melting pressure.

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Contents

BT *Second Virial Coefficient (B), Function of Temperature*

Description

The function `BT(Temp,digits=9)` returns the second virial coefficient, B [m3 kg-1], for a given T [K].

Usage

```
BT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The second virial coefficient: B [m3 kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
B_T <- BT(Temp)
B_T
```

CndTD *Thermal Conductivity, Function of Temperature and Density*

Description

The function `CndTD(Temp,D,digits=9)` calculates the Thermal Conductivity, k [W m-1 K-1] for given Temp [K] and D [kg/m3], returning the computed thermal conductivity and an error message if an error occur.

Usage

```
CndTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the equations developed by the International Association for the Properties of Water and Steam, valid from the triple point to the pressure of 1000 MPa and temperature of 1173.15K. https://iapws.org/relguide/ThCond.html

Value

The Thermal Conductivity: k [W m-1 K-1] and an Error message if necessary

Examples

```
Temp <- 500.
D <- 838.025
Cond <- CndTD(Temp,D)
Cond
```

CpfT *Specific Isobaric Heat Capacity of Fluid Phase, Function of Temperature*

Description

The function `CpfT(Temp,digits=9)` returns the Isobaric Heat Capacity of Fluid Phase [kJ kg-1 K-1], Cpf, for given T [K].

Usage

```
CpfT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isobaric Heat Capacity of Fluid Phase: Cpf [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Cpf <- CpfT(Temp)
Cpf
```

CpgT *Specific Isobaric Heat Capacity of Gas Phase, Function of Temperature*

Description

The function `CpgT(Temp,digits=9)` returns the Isobaric Heat Capacity of Gas Phase [kJ kg-1 K-1], Cpg, for given Temp [K].

Usage

```
CpgT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isobaric Heat Capacity of Gas Phase: Cpg [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Cpg <- CpgT(Temp)
Cpg
```

CpTD *Specific Isobaric Heat Capacity, Function of Temperature and Density*

Description

The function `CpTD(Temp,D,digits=9)` returns the Specific Isobaric Heat Capacity, Cp [kJ kg-1 K-1], for given Temp [K] and D [kg/m3].

Usage

```
CpTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Isobaric Heat Capacity: Cp [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
Cp <- CpTD(Temp,D)
Cp
```

`CpTp` *Specific Isobaric Heat Capacity, Function of Temperature and Pressure*

Description

The function `CpTp(Temp,p,digits=9)` returns the Specific Isobaric Heat Capacity, Cp [kJ kg-1 K-1], for given Temp [K] and D [kg/m3].

Usage

```
CpTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Isobaric Heat Capacity: Cp [kJ kg-1 K-1] and an (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
Cp <- CpTp(Temp,p)
Cp
```

CT *Third Virial Coefficient (C), Function of Temperature*

Description

The function `CT(Temp,digits=9)` returns the third virial coefficient, C [m3 kg-1]**2, for a given Temp [K].

Usage

```
CT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The second virial coefficient: C [m3 kg-1]**2 and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
C_T <- CT(Temp)
C_T
```

CvfT *Specific Isochoric Heat Capacity of Fluid Phase, Function of Temperature*

Description

The function `CvfT(Temp,digits=9)` returns the Isochoric Heat Capacity of Fluid Phase [kJ kg-1 K-1], Cvf, for given Temp [K].

Usage

```
CvfT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isochoric Heat Capacity of Fluid Phase: Cvf [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Cvf <- CvfT(Temp)
Cvf
```

CvgT — *Specific Isochoric Heat Capacity of Gas Phase, Function of Temperature*

Description

The function `CvgT(Temp,digits=9)` returns the Isochoric Heat Capacity of Gas Phase [kJ kg-1 K-1], Cvg, for given Temp [K].

Usage

```
CvgT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isochoric Heat Capacity of GaS Phase: Cvg [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Cvg <- CvgT(Temp)
Cvg
```

`CvTD` *Specific Isochoric Heat Capacity, Function of Temperature and Density*

Description

The function `CvTD(Temp,D,digits=9)` returns the Specific Isochoric Heat Capacity, Cv [kJ kg-1 K-1], for given Temp [K] and D [kg/m3].

Usage

```
CvTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Isochoric Heat Capacity: Cv [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
Cv <- CvTD(Temp,D)
Cv
```

`CvTp` *Specific Isochoric Heat Capacity, Function of Temperature and Pressure*

Description

The function `CvTp(Temp,p,digits=9)` returns the Specific Isochoric Heat Capacity, Cv [kJ kg-1 K-1], for given Temp [K] and D [kg/m3].

Usage

```
CvTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Isochoric Heat Capacity: Cv [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
Cv <- CvTp(Temp,p)
Cv
```

DCrit *Water Critical Density*

Description

The function `DCrit()` returns the water density at the critical point [kg m-3].

Usage

```
DCrit()
```

Value

The Water Critical Density: Dc [kg m-3]

Examples

```
DC <- DCrit()
DC
```

---

dDdTTD *Density Derivative with respect to Temperature, Function of Temperature and Density*

Description

The function `dDdTTD(Temp,D,digits=9)` returns the pressure derivative with respect to Density, dpdD, for given Temp [K] and D [kg m-3].

Usage

```
dDdTTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density Derivative with respect to T: dD/dTemp [kg m-3 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
dDdTemp <- dDdTTD(Temp,D)
dDdTemp
```

`dDdTTp` *Density Derivative with respect to Temperature, Function of Temperature and Pressure*

Description

The function `dDdTTp(Temp,p,digits=9)` returns the Density derivative with respect to Temperature, dDdTemp, for given Temp [K] and p [MPa].

Usage

```
dDdTTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density derivative with respect to Temp: dD/dTemp [kg m-3 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
dDdTemp <- dDdTTp(Temp,p)
dDdTemp
```

`Dfp` *Saturated Liquid Density, Funtion of Pressure*

Description

The function `Dfp(p,digits=9)` returns the saturated liquid density [kg m-3], Df, for given p [MPa].

Usage

```
Dfp(p, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated liquid density: Df [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 0.932203564
Df <- Dfp(p)
Df
```

Dfs — *Saturated Liquid Density, Function of Entropy*

Description

The function `Dfs(s,digits=9)` returns the saturated liquid density [kg m-3], Df, for given s [kJ kg-1 K-1].

Usage

```
Dfs(s, digits = 9)
```

Arguments

`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated Liquid density: Df [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
s <- 2.10865845
Df <- Dfs(s)
Df
```

DfT — *Saturated Liquid Density, Function of Temperature*

Description

The function `DfT(Temp,digits=9)` returns the saturated liquid density [kg m-3], Df, for given Temp [K].

Usage

```
DfT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated liquid density: Df [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Df <- DfT(Temp)
Df
```

DfTr *Liquid Water Density at Triple Point*

Description

The function `DfTr()` returns the Water Liquid Density at Triple Point.

Usage

```
DfTr()
```

Value

Triple Point Liquid Density: DfTr [kg m-3]

Examples

```
DfTrip <- DfTr()
DfTrip
```

Dgp *Saturated Gas Density, Function of Pressure*

Description

The function `Dgp(p,digits=9)` returns the saturated gas density [kg m-3], Dg, for given p [MPa].

Usage

```
Dgp(p, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated gas density: Dg [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 0.932203564
Dg <- Dgp(p)
Dg
```

Dgs *Saturated Gas Density, Function of Entropy*

Description

The function `Dgs(s,digits=9)` returns the saturated gas density [kg m-3], Dg, for given s [kJ kg-1 K-1].

Usage

```
Dgs(s, digits = 9)
```

Arguments

s	Entropy [kJ kg-1 K-1]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated Gas density: Dg [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
s <- 5.4731
Dg <- Dgs(s)
Dg
```

DgT *Saturated Gas Density, Function of Temperature*

Description

The function `DgT(Temp,digits=9)` returns the saturated gas density [kg m-3], Dg, for given Temp [K].

Usage

```
DgT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated gas density: Dg [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
Dg <- DgT(Temp)
Dg
```

DgTr *Water Gas Density at Triple Point*

Description

The function `DgTr()` returns the Water Gas Density at Triple Point.

Usage

```
DgTr()
```

Value

Triple Gas Density: DgTr [kg m-3]

Examples

```
DgTrip <- DgTr()
DgTrip
```

Dhs *Density, Function of Enthalpy and Entropy*

Description

The function `Dhs(h,s,digits=9)` returns the water density, D [kg m-3], for given h [kJ k-1] and s [kJ k-1 K-1].

Usage

```
Dhs(h, s, digits = 9)
```

Arguments

h	Enthalpy [kJ kg-1]
s	Entropy [kJ kg-1 K-1]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density: D [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
h <- 977.181624
s <- 2.56690919
D_hs <- Dhs(h,s)
D_hs
```

---

dpdDTD *Pressure Derivative with respect to Density, Function of Temperature and Density*

Description

The function dpdDTD(Temp,D,digits=9) returns the pressure derivative with respect to Density, dpdD, for given T [K] and D [kg m-3].

Usage

```
dpdDTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The pressure derivative with respect to D: dp/dD [MPa kg-1 m3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
dpdD <- dpdDTD(Temp,D)
dpdD
```

---

dpdDTp *Pressure Derivative with respect to Density, Function of Temperature and Pressure*

Description

The function `dpdDTp(Temp,p)` returns the pressure derivative with respect to Density, dpdD, for given Temp [K] and p [MPa].

Usage

```
dpdDTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The pressure derivative with respect to d: dp/dD [MPa kg-1 m3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
dpdD <- dpdDTp(Temp,p)
dpdD
```

---

dpdTTD *Pressure Derivative with Respect to Temperature, Function of Temperature and Density*

Description

The function `dpdTTD(Temp,D,digits=9)` returns the pressure derivative with respect to Temperature, dpdT, for given Temp [K] and D [kg/m3].

Usage

```
dpdTTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The pressure derivative with respect to Temp: dp/dTemp [MPa K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
dpdTemp <- dpdTTD(Temp,D)
dpdTemp
```

---

dpdTTp *Pressure Derivative with respect to Temperature, Function of Temperature and Pressure*

Description

The function `dpdTTp(Temp,p,digits=9)` returns the pressure derivative with respect to Temperature, dpdTemp, for given Temp [K] and p [MPa].

Usage

```
dpdTTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The pressure derivative with respect to Temp: dp/dTemp [MPa K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
dpdTemp <- dpdTTp(Temp,p)
dpdTemp
```

Dph *Density, Function of Pressure and Enthalpy*

Description

The function `Dph(p,h,digits=9)` returns the water density, D [kg m-3], for given p [MPa] and h [kJ k-1].

Usage

```
Dph(p, h, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`h`	Enthalpy [kJ kg-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density: D [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
h <- 977.181624
D_ph <- Dph(p,h)
D_ph
```

Dps *Density, Function of Pressure and Entropy*

Description

The function `Dps(p,s,digits=9)` returns the water density, D [kg m-3], for given p [MPa] and s [kJ k-1 K-1].

Usage

```
Dps(p, s, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density: D [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
s <- 2.56690919
D_ps <- Dps(p,s)
D_ps
```

DpTcteTab *Table of Densities, Function of Pressure for a Fixed Temperature*

Description

The function `DpTcteTab(p1, p2, dp, Temp)` returns a table of Densities [kg m-3] for a fixed Temp [K] within a range of p [MPa]: p1:p2 [MPa]

Usage

```
DpTcteTab(p1, p2, dp, Temp)
```

Arguments

`p1`	first pressure value [MPa]
`p2`	final pressure [MPa]
`dp`	Pressure increment [MPa]
`Temp`	Temperature [K]

Details

This function provides a table of the densities [kg m-3] for a given Temp [K] within a range of p [MPa]

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Densities for fixed T and a p Interval: p1:p2.

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 1.
Temp <- 500.
TabD <- DpTcteTab(p1, p2, dp, Temp)
TabD

p1 <- 10.
p2 <- 100.
dp <- 10.
Temp <- 450.
TabD <- DpTcteTab(p1, p2, dp, Temp)
```

TabD

DTh *Density, Function of Temperature and Enthalpy*

Description

The function DTh(Temp,h,digits=9) returns the water density, D [kg m-3], for given Temp [K] and h [kJ kg-1] (it may have two solutions for Density).

Usage

```
DTh(Temp, h, digits = 9)
```

Arguments

Temp	Temperature in Kelvin
h	Enthalpy in [kJ kg-1]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density 1: Density_1 [kg m-3]

The Density 2: Density_2 [kg m-3]

Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
h <- 977.181624
D_Th <- DTh(Temp,h)
D_Th
```

DTp *Density, Function of Temperature and Pressure*

Description

The function `DTp(Temp,p,digits=9)` returns the water density, D [kg m-3], for given Temp [K] and D [kg/m3].

Usage

```
DTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density: D [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
D <- DTp(Temp,p)
D
```

DTpcteTab *Table of Densities, Function of Temperature for Fixed Pressure*

Description

The function DTpcteTab(T1, T2, dT, p) returns a table of densities [kg m-3] for a fixed p [MPa] within a range of Temp [K]: T1:T2 [K].

Usage

```
DTpcteTab(T1, T2, dT, p)
```

Arguments

T1	first Temperature value[K]
T2	final Temperature [K]
dT	Temperature increment [K]
p	Pressure [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Densities for fixed p and a T Interval: T1:T2.

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
p <- 5.
TabD <- DTpcteTab(T1, T2, dT, p)
TabD

T1 <- 300.
T2 <- 500.
dT <- 10.
p <- 10.
TabD <- DTpcteTab(T1, T2, dT, p)
TabD
```

DTs *Density, Function of Temperature and Entropy*

Description

The function `DTs(Temp,s,digits=9)` returns the water density, D [kg m-3], for given Temp [K] and s [kJ k-1 K-1].

Usage

```
DTs(Temp, s, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Density: D [kg m-3] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
s <- 2.56690919
D_Ts <- DTs(Temp,s)
D_Ts
```

errorCodes *Error Codes*

Description

Error codes due values out of validity range, incorrect inputs, and/or convergence issues

Usage

```
errorCodes
```

Format

An object of class `data.frame` with 21 rows and 2 columns.

Source

errorCodes.rda

fTD *Helmholtz Free Energy, Function of Temperature and Density*

Description

The function `fTD(T,D,digits=9)` returns the Helmholtz Free Energy, f [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
fTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Helmholtz Free Energy: f [kJ kg-1] and an Error Message if an error occur: errorCodes

Examples

```
Temp <- 500.
D <- 838.025
f <- fTD(Temp,D)
f
```

`fTp` *Helmholtz Free Energy, Function of Temperature and Pressure*

Description

The function `fTp(Temp,p,digits=9)` returns the Helmholtz Free Energy, f [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
fTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Helmholtz Free Energy: f [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
f <- fTp(Temp,p)
f
```

FugaTp *Fugacity, Function of Temperature and Pressure*

Description

The function `FugaTp(Temp,p,digits=9)` returns the Fugacity, [MPa], for given Temp [K] and D [kg/m3].

Usage

```
FugaTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Fugacity: Fuga [MPa] and an (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
Fuga <- FugaTp(Temp,p)
Fuga
```

GibbsTp *Specific Gibbs Energy, Function of Temperature and Pressure*

Description

The function `GibbsTp(Temp,p,digits=9)` returns the Specific Gibbs Energy, [MPa], for given Temp [K] and D [kg/m3].

Usage

```
GibbsTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Gibbs Energy: Gibbs [MPa] and an (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
Gibbs <- GibbsTp(Temp,p)
Gibbs
```

hCrit *Water Critical Enthalpy*

Description

@description The function `hCrit()` returns the water enthalpy at the critical point [kJ kg-1].

Usage

```
hCrit()
```

Value

The Water Critical Enthalpy: hc [kJ kg-1]

Examples

```
hC <- hCrit()
hC
```

hfT *Saturated Liquid Enthalpy, Function of Temperature*

Description

The function `hfT(Temp,digits=9)` returns the saturated liquid enthalpy [kJ kg-1], hf, for given Temp [K].

Usage

```
hfT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated liquid enthalpy: hf [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
hf <- hfT(Temp)
hf
```

---

hgT *Saturated Gas Enthalpy, Function of Temperature*

Description

The function `hgT(Temp,digits=9)` returns the saturated gas enthalpy [kJ kg-1], hg, for given Temp [K].

Usage

```
hgT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated gas enthalpy: hg [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
hg <- hgT(Temp)
hg
```

hps *Enthalpy, Function of Pressure and Entropy*

Description

The function `hps(p,s,digits=9)` returns the water enthalpy, h [kJ kg-1], for given p [MPa] and s [kJ k-1 K-1].

Usage

```
hps(p, s, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Enthalpy: h [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
s <- 2.56690919
h_ps <- hps(p,s)
h_ps
```

hpTcteTab *Table of Enthalpies, Function of Pressure for Fixed Temperature*

Description

The function hpTcteTab(p1, p2, dp, Temp) returns a table of Enthalpies [kJ kg-1] for a fixed Temp [K] within a range of p [MPa]: p1:p2 [MPa]

Usage

```
hpTcteTab(p1, p2, dp, Temp)
```

Arguments

p1	first pressure value [MPa]
p2	final pressure [MPa]
dp	Pressure increment [MPa]
Temp	Temperature [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Enthalpies for fixed T and a p Interval: p1:p2.

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 1.
Temp <- 500.
Tabh <- hpTcteTab(p1, p2, dp, Temp)
Tabh

p1 <- 10.
p2 <- 100.
dp <- 10.
Temp <- 450.
Tabh <- hpTcteTab(p1, p2, dp, Temp)
Tabh
```

hTD *Specific Enthalpy, Function of Temperature and Density*

Description

The function `hTD(Temp,D,digits=9)` returns the Specific Enthalpy, h [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
hTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Enthalpy: h [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
h <- hTD(Temp,D)
h
```

hTp *Specific Enthalpy, Function of Temperature and Pressure*

Description

The function `hTp(Temp,p,digits=9)` returns the Specific Enthalpy, h [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
hTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Enthalpy: h [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
h <- hTp(Temp,p)
h
```

hTpcteTab *Table of Enthalpies, Function of Temperature and Fixed Pressure*

Description

The function `hTpcteTab(T1, T2, dT, p)` returns a table of enthalpies [kJ kg-1] for a fixed p [MPa] within a range of Temp [K]: T1:T2 [K]

Usage

```
hTpcteTab(T1, T2, dT, p)
```

Arguments

T1	first Temperature value [K]
T2	final Temperature [K]
dT	Temperature increment [K]
p	Pressure [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Enthalpies for fixed p and a T Interval: T1:T2.

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
p <- 5.
Tabh <-  hTpcteTab(T1, T2, dT, p)
Tabh

T1 <- 300.
T2 <- 500.
dT <- 10.
p <- 10.
Tabh <- hTpcteTab(T1, T2, dT, p)
Tabh
```

JTcTD *Joule-Thomson Coefficient, Function of Temperature and Density*

Description

The function JTcTD(Temp,D,digits=9) returns the Joule-Thomson coefficient for given Temp [K] and D [kg/m3].

Usage

```
JTcTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273. The temperature change produced during a Joule-Thomson expansion is quantified by the Joule-Thomson coefficient, which may be positive (cooling) or negative (heating).

Value

The Joule-Thomson coefficient and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
JT <- JTcTD(Temp,D)
JT
```

KapaTD *Isothermal Compressibility, Function of Temperature and Density*

Description

The function `KapaTD(Temp,D,disgits=9)` returns the Isothermal Compressibility, Kapa, for given Temp [K] and D [kg m-3].

Usage

```
KapaTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isothermal Compressibility: Kapa [MPa-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
Kapa <- KapaTD(Temp,D)
Kapa
```

KViscTD *Kinematic Viscosity, Function of Temperature and Density*

Description

The function `KViscTD(Temp,D,digits=9)` computes the Kinematic Viscosity [m2 s-1] for given T [K] and D [kg/m3], returning the calculated viscosity and an error message, if an error occur. errorCodes

Usage

```
KViscTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calculates the Kinematic Viscosity that is the relation `ViscTD(D,Temp)/D`, valid from the triple point to the pressure of 1000 MPa and temperature of 1173.15K.

Value

The Kinematic viscosity: [m2 s-1] and an Error Message (if an error occur)

Examples

```
Temp <- 500.
D <- 838.025
KVis <- KViscTD(Temp,D)
KVis
```

pCrit *Water Critical Pressure*

Description

This function `pCrit()` returns the water critical pressure [MPa].

Usage

```
pCrit()
```

Value

The Water Critical Pressure: pc [MPa]

Examples

```
pc <- pCrit()
pc
```

`phi0` *Ideal-Gas part of the Dimensionless Helmholtz Energy Equation, Function of Temperature and Density*

Description

The function `phi0(Temp,D,digits=9)` returns the Ideal-gas part of the dimensionless Helmholtz Energy Equation, phi0, for given Temp [K] and D [kg/m3].

Usage

```
phi0(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Ideal-gas part of the Helmholtz Energy Equation: phi0 and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phi_0 <- phi0(Temp,D)
phi_0
```

phi0D *First Derivative of the Ideal-Gas part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Density*

Description

The function `phi0D(D,digits=9)` returns the First Derivative of the Ideal-gas part of the dimensionless Helmholtz Energy Equation for a given D [kg/m3].

Usage

```
phi0D(D, digits = 9)
```

Arguments

`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The First D Derivative of Ideal-gas part of the Helmholtz Energy: phi0D and an Error Message (if an error occur: errorCodes)

Examples

```
D <- 838.025
phi_0 <- phi0D(D)
phi_0
```

phi0DD — *Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Density*

Description

The function `phi0DD(D,digits=9)` returns the Second Derivative of the Ideal-gas part of the dimensionless Helmholtz Energy Equation for a given D [kg/m3].

Usage

```
phi0DD(D, digits = 9)
```

Arguments

`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second D Derivative of Ideal-gas part of the Helmholtz Energy: phi0DD and an Error Message (if an error occur: errorCodes)

Examples

```
D <- 838.025
phi_0 <- phi0DD(D)
phi_0
```

phi0DT *Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density and Temperature*

Description

The function `phi0DT(digits=9)` returns the Second Derivative of the Ideal-gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density and Temperature.

Usage

```
phi0DT(digits = 9)
```

Arguments

`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second DT Derivative of Ideal-gas Part of the Helmholtz Energy: phi0DT and an Error Message (if an error occur: errorCodes)

Examples

```
phi0_DT <- phi0DT()
phi0_DT
```

phi0T *First Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density*

Description

The function `phi0T(Temp,D,digits=9)` returns the First Derivative of the Ideal-gas Part of the dimensionless Helmholtz Energy Equation with respect to Temperature, for given Temp [K] and D [kg/m3].

Usage

```
phi0T(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The First Temp Derivative of Ideal-gas part of the Helmholtz Energy: phi0T and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phi0_T <- phi0T(Temp,D)
phi0_T
```

---

phi0TT — *Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density*

Description

The function `phi0TT(Temp,D,digits=9)` returns the Second Derivative of the Ideal-gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, for given Temp [K] and D [kg/m3].

Usage

```
phi0TT(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second Temp Derivative of Ideal-gas part of the Helmholtz Energy: phi0TT and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phi0_TT <- phi0TT(Temp,D)
phi0_TT
```

---

phir *Residual-Gas Part of the Dimensionless Helmholtz Energy Equation, Function of Temperature and Density*

Description

The function `phir(Temp,D,digits=9)` returns the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given Temp [K] and D [kg/m3].

Usage

```
phir(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Residual-Gas Part of the Dimensionless Helmholtz Energy Equation: phir and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_TD <- phir(Temp,D)
phir_TD
```

---

phirD — *First Derivative of the Residual-Gas part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Temperature and Density*

Description

The function `phirD(Temp,D,digits=9)` returns the First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given Temp [K] and D [kg/m3].

Usage

```
phirD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation: phirD, and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_D <- phirD(T,D)
phir_D
```

`phirDD` *Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Temperature and Density*

Description

The function `phirDD(Temp,D,digits=9)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given Temp [K] and D [kg/m3].

Usage

```
phirDD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation: phirDD, and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_DD <- phirDD(Temp,D)
phir_DD
```

`phirDT` *Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density and Temperature, Function of Temperature and Density*

Description

The function `phirDT(Temp,D,digits=9)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to D and Temp, for given Temp [K] and D [kg/m3].

Usage

```
phirDT(Temp, D, digits)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to D and Temp: phirTT, and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_DT <- phirDT(Temp,D)
phir_DT
```

phirT — *First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density*

Description

The function `phirT(Temp,D,digits=9)` returns the First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temp, for given Temp [K] and D [kg/m3].

Usage

```
phirT(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temp: phirT, and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_T <- phirT(Temp,D)
phir_T
```

phirTT *Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density*

Description

The function `phirTT(Temp,D,digits=9)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temp, for given Temp [K] and D [kg/m3].

Usage

```
phirTT(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to T: phirTT, and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
phir_TT <- phirTT(Temp,D)
phir_TT
```

pMeltT *Melting Pressure, Function of Temperature*

Description

The function pMeltT(Temp,digits=9) returns the water melting pressure, pMelt [MPa], for a given Temp [K].

Usage

```
pMeltT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the equations given at the Revised Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance (September 2011), developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/MeltSub.html. It is valid from the Temperature of 256.164 [K] to the Temperature of 715 [K].

Value

The melting pressure: pMelt [MPa] for regions III, V , VI and VII

The melting pressure: pMeltIh [MPa] for region Ih

The sublimation pressure: pSubl [MPa], below triple point Temperature

Error message (if an error occur)

Examples

```
Temp <- 275.
p_Melt <- pMeltT(Temp)
p_Melt
```

PrandtTD *Prandt Number, Function of Temperature and Density*

Description

The function `PrandtTD(Temp,D,digits=9)` computes the Prandt Number, i.e., the product of the dynamic viscosity by the specific isobaric heat capacity, divided by the thermal conductivity of water for given T [K] and D [kg/m3].

Usage

```
PrandtTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that computes the Prandt Number, valid from the triple point to the pressure of 1000 MPa and temperature of 1173.15K.

Value

The Prandt Number: Pr [-]

Error message (if an error occur)

Examples

```
Temp <- 500.
D <- 838.025
Pran <- PrandtTD(Temp,D)
Pran
```

pSatD *Saturation Pressure, Function of Density*

Description

The function `pSatD(D,digits=9)` returns the saturation pressure [MPa], pSat, for given D [kg m-3]: it may have two different values!

Usage

```
pSatD(D, digits = 9)
```

Arguments

`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The first saturation pressure: pSat_1 [MPa]

The second saturation pressure: pSat_2 [MPa]

An Error Message (if an error occur: errorCodes)

Examples

```
D <- 890.341250
p_Sat <- pSatD(D)
p_Sat

D <- 999.887406
p_Sat <- pSatD(D)
p_Sat
```

pSats *Saturation Pressure, Function of Entropy*

Description

The function `pSats(s,digits=9)` returns the saturation pressure [MPa], pSat, for given s [kJ kg-1 K-1].

Usage

```
pSats(s, digits = 9)
```

Arguments

`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturation pressure: pSat [MPa] and an Error Message (if an error occur: errorCodes)

Examples

```
s <- 2.10865845
p_Sat <- pSats(s)
p_Sat
```

pSatT *Saturation Pressure, Function of Temperature*

Description

The function `pSatT(T,digits=9)` returns the saturation pressure [MPa], pSat, for given Temp [K].

Usage

```
pSatT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturation pressure: pSat [MPa] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
p_Sat <- pSatT(Temp)
p_Sat
```

---

pTD *Pressure, Function of Temperature and Density*

Description

The function pTD(T,D,digits=9) returns the water pressure, p [MPa], for given Temp [K] and D [kg/m3], returning also an error message, if any error occur.

Usage

```
pTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Pressure: p [MPa] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
p <- pTD(Temp,D)
p

Temp <- 647.096
D <- 322.
p <- pTD(Temp,D)
p
```

---

pTr *Water Pressure at Triple Point*

Description

The function `pTr()` returns the Water Pressure at Triple Point [MPa].

Usage

```
pTr()
```

Value

The Triple Point Pressure: pTr [MPa]

Examples

```
pTrip <- pTr()
pTrip
```

Rwater *Water Specific Gas Constant*

Description

The function `Rwater()` returns the Water Specific Gas Constant.

Usage

```
Rwater()
```

Value

Water Specific Gas Constant: R [K-1]

Examples

```
Rw <- Rwater()
Rw
```

satTabhT *Table of Saturation Liquid Phase Enthalpies, Function of Temperature*

Description

The function `satTabhT(T1, T2, dT)` returns a table of saturation liquid enthalpies [kJ kg-1 K-1] for a Temperature interval, T1:T2 [K].

Usage

```
satTabhT(T1, T2, dT)
```

Arguments

`T1`	First Temperature value [K]
`T2`	Final Temperature [K]
`dT`	Temperature increment [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation fluid enthalpies, function of T

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
TabT <- satTabhT(T1, T2, dT)
TabT

T1 <- 300.
T2 <- 500.
dT <- 10.
TabT <- satTabhT(T1, T2, dT)
TabT
```

---

satTabp *Table of Saturation Densities, Enthalpies and Entropies, Function of Pressure*

Description

The function `satTabp(p1, p2, dp)` returns a table of threee saturation properties for two phases: Density [kg/m3], Enthalpy [kJ kg-1] and Entropy [kJ kg K-1] for a Pressure interval, p1:p2 [MPa].

Usage

```
satTabp(p1, p2, dp)
```

Arguments

p1	First Pressure value [MPa]
p2	Final Pressure [MPa]
dp	Pressure increment [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation D, h and s, function of p

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 0.5
Tabp <- satTabp(p1, p2, dp)
Tabp

p1 <- 0.1
p2 <- 10.
dp <- 0.5
Tabp <- satTabp(p1, p2, dp)
Tabp
```

`satTabpT` *Table of Saturation Pressures, Function of Temperature*

Description

The function `satTabpT(T1, T2, dT)` returns a table of saturation pressures [MPa] for a Temperature interval, T1:T2 [K].

Usage

```
satTabpT(T1, T2, dT)
```

Arguments

`T1`	First Temperature value [K]
`T2`	Final Temperature [K]
`dT`	Temperature increment [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation pressures, function of T

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
TabT <- satTabpT(T1, T2, dT)
TabT

T1 <- 300.
T2 <- 500.
dT <- 10.
TabT <- satTabpT(T1, T2, dT)
TabT
```

---

satTabT *Table of Saturation Densities, Enthalpies and Entropies, Function of Temperature*

Description

The function satTabT(T1, T2, dT) returns a table of threee saturation properties for two phases: Density [kg/m3], Enthalpy [kJ kg-1] and Entropy [kJ kg K-1] for a Temperature interval, T1:T2 [K].

Usage

```
satTabT(T1, T2, dT)
```

Arguments

T1	First Temperature value [K]
T2	Final Temperature [K]
dT	Temperature increment [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation D, h and s, function of T

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
TabT <- satTabT(T1, T2, dT)
TabT

T1 <- 300.
T2 <- 500.
dT <- 10.
TabT <- satTabT(T1, T2, dT)
TabT
```

`satTabTp` *Table of Saturation Temperatures, Function of Pressure*

Description

The function `satTabTp(p1, p2, dp)` returns a table of Saturation Temperatures [K] for a Pressure interval, p1:p2 [MPa].

Usage

```
satTabTp(p1, p2, dp)
```

Arguments

`p1`	First Pressure value [MPa]
`p2`	Final Pressure [MPa]
`dp`	Pressure increment [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A Table of Saturation Temperatures, function of p

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 0.5
Tabp <- satTabTp(p1, p2, dp)
Tabp

p1 <- 0.1
p2 <- 10.
dp <- 0.5
Tabp <- satTabTp(p1, p2, dp)
Tabp
```

`satTabvp` *Table of Saturation Volumes, Enthalpies and Entropies, Function of Pressure*

Description

The function `satTabvp(p1, p2, dp)` returns a table of threee saturation properties for two phases: Specific Volume [m3 kg-1], Enthalpy [kJ kg-1] and Entropy [kJ kg K-1] for a Pressure interval, p1:p2 [MPa].

Usage

```
satTabvp(p1, p2, dp)
```

Arguments

`p1`	First Pressure value [MPa]
`p2`	Final Pressure [MPa]
`dp`	Pressure increment [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation v, h and s, function of p

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 0.5
Tabp <- satTabvp(p1, p2, dp)
Tabp

p1 <- 0.1
p2 <- 10.
dp <- 0.5
Tabp <- satTabvp(p1, p2, dp)
Tabp
```

`satTabvT` *Table of Saturation Volumes, Enthalpies and Entropies, Function of of Temperature*

Description

The function `satTabvT(T1, T2, dT)` returns a table of threee saturation properties for two phases: Specific Volume [m3 kg-1], Enthalpy [kJ kg-1] and Entropy [kJ kg K-1] for a Temperature interval, T1:T2 [K].

Usage

```
satTabvT(T1, T2, dT)
```

Arguments

`T1`	First Temperature value [K]
`T2`	Final Temperature [K]
`dT`	Temperature increment [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of saturation v, h and s, function of T

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
TabT <- satTabvT(T1, T2, dT)
TabT

T1 <- 300.
T2 <- 500.
dT <- 10.
TabT <- satTabvT(T1, T2, dT)
TabT
```

---

sCrit *Water Critical Entropy*

Description

The function `sCrit()` returns the entropy at the critical point [kJ k-1 K-1].

Usage

```
sCrit()
```

Value

The Water Critical Entropy: sc [kJ kg-1 K-1]

Examples

```
sC <- sCrit()
sC
```

---

sfT *Saturated Liquid Entropy, Function of Temperature*

Description

The function `sfT(Temp,digits=9)` returns the saturated liquid entropy [kJ kg-1 K-1], sf, for given Temp [K].

Usage

```
sfT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated liquid entropy: sf [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
sf <- sfT(Temp)
sf
```

---

sfTr *Liquid Water Entropy at Triple Point*

Description

The function `sfTr()` returns the Water Liquid Entropy at Triple Point.

Usage

```
sfTr()
```

Value

Triple Point Liquid Entropy: sfTr [kJ kg-1 K-1]

Examples

```
sfTrip <- sfTr()
sfTrip
```

sgT *Saturated Gas Entropy, Function of Temperature*

Description

The function `sgT(Temp,digits=9)` returns the saturated gas entropy [kJ kg-1 K-1], sg, for given Temp [K].

Usage

```
sgT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated gas entropy: sg [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
sg <- sgT(Temp)
sg
```

sgTr *Water Gas Entropy at Triple Point*

Description

The function `sgTr()` returns the Water Gas Entropy at Triple Point.

Usage

```
sgTr()
```

Value

Triple Point Gas Entropy: sgTr [kJ kg-1 K-1]

Examples

```
sgTrip <- sgTr()
sgTrip
```

`SigmaT` *Surface Tension, Function of Temperature*

Description

The function `SigmaT(Temp,digits=9)` computes the Surface Tension [mN m-1] for a given Temp [K], returning the calculated Surface Tension and an error message, if an error occur. errorCodes

Usage

```
SigmaT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the equations developed by the International Association for the Properties of Water and Steam, valid from the triple point to the critical temperature [273.13K to 647.096K]. https://iapws.org/relguide/Surf-H2O.html

Value

The Surface Tension: Sigma [mN m-1] and an Error Message (if an error occur)

Examples

```
Temp <- 500.
Sig <- SigmaT(Temp)
Sig
```

sph *Entropy, Function of Pressure and Enthalpy*

Description

The function `sph(p,h,digits=9)` returns the water entropy, s [kJ kg-1 K-1], for given p [MPa] and h [kJ k-1].

Usage

```
sph(p, h, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`h`	Enthalpy [kJ kg-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Entropy: s [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
h <- 977.181624
s_ph <- sph(p,h)
s_ph
```

spTcteTab *Table of Entropies, Function of Pressure for Fixed Temperature*

Description

The function spTcteTab(p1, p2, dp, Temp) returns a table of Entropies [kJ kg-1 K-1] for a fixed Temp [K] within a range of p [MPa]: p1:p2 [MPa]

Usage

```
spTcteTab(p1, p2, dp, Temp)
```

Arguments

p1	"initial"first pressure value [MPa]
p2	final pressure [MPa]
dp	Pressure increment [MPa]
Temp	Temperature [K]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Entropies for fixed Temp and a p Interval: p1:p2.

Examples

```
p1 <- 1.0
p2 <- 10.
dp <- 1.
Temp <- 500.
Tabs <- spTcteTab(p1, p2, dp, Temp)
Tabs

p1 <- 10.
p2 <- 100.
dp <- 10.
Temp <- 450.
Tabs <- spTcteTab(p1, p2, dp, Temp)
Tabs
```

sTD *Specific Entropy, Function of Temperature and Density*

Description

The function sTD(Temp,D,digits=9) returns the Specific Entropy, h [kJ kg-1 k-1], for given Temp [K] and D [kg/m3].

Usage

```
sTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Entropy: s [kJ kg-1 K-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
s <- sTD(Temp,D)
s
```

sTp *Specific Entropy, Function of Temperature and Pressure*

Description

The function `sTp(Temp,p,digits=9)` returns the Specific Entropy, h [kJ kg-1 K-1], for given Temp [K] and D [kg/m3].

Usage

```
sTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Entropy: s [kJ kg-1 K-1] and an Error message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
s <- sTp(Temp,p)
s
```

sTpcteTab *Table of Entropies, Function of Temperature for a Fixed Pressure*

Description

The function `sTpcteTab(T1, T2, dT, p)` returns a table of entropies [kJ kg-1 K-1] for a fixed p [MPa] within a range of T [K]: T1:T2 [K]

Usage

```
sTpcteTab(T1, T2, dT, p)
```

Arguments

T1	first Temperature value [K]
T2	final Temperature [K]
dT	Temperature increment [K]
p	Pressure [MPa]

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

A table of Entropies for fixed p and a T Interval: T1:T2.

Examples

```
T1 <- 275.
T2 <- 450.
dT <- 5.
p <- 5.
Tabs <- sTpcteTab(T1, T2, dT, p)
Tabs

T1 <- 300.
T2 <- 500.
dT <- 10.
p <- 10.
Tabs <- sTpcteTab(T1, T2, dT, p)
Tabs
```

TCrit *Water Critical Temperature*

Description

@description The function `TCrit()` returns the water critical temperature [K].

Usage

```
TCrit()
```

Value

The Water Critical Temperature: Tc [K]

Examples

```
Tc <- TCrit()
Tc
```

TDh *Temperature, Function of Density and Enthalpy*

Description

The function `TDh(D,h,digits=9)` returns the water temperature, Temp [K], for given D [kg/m3] and h [kJ kg-1].

Usage

```
TDh(D, h, digits = 9)
```

Arguments

`D`	Density [kg m3]
`h`	Enthaly in [kJ kg-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
D <- 838.025
h <- 977.181624
T_Dh <- TDh(D,h)
T_Dh
```

TDp *Temperature, Function of Density and Pressure*

Description

The function `TDp(D,p,digits=9)` returns the water temperature, Temp [K], for given D [kg/m3] and p [MPa].

Usage

```
TDp(D, p, digits = 9)
```

Arguments

`D`	Density [kg m3]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
D <- 838.025
p <- 10.0003858
T_Dp <- TDp(D,p)
T_Dp
```

TDs *Temperature, Function of Density and Entropy*

Description

The function `TDs(D,s,digits=9)` returns the water temperature, Temp [K], for given D [kg/m3] and s [kJ kg-1 K-1].

Usage

```
TDs(D, s, digits = 9)
```

Arguments

`D`	Density [kg m3]
`s`	Entropy in [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
D <- 838.025
s <- 2.56690919
T_Ds <- TDs(D,s)
T_Ds
```

ThrcTD *Isothermal Throttling Coefficient, Function of Temperature and Density*

Description

The function ThrcTD(Temp,D,digits=9) returns the Isothermal Throttling Coefficient, Thrc, for given Temp [K] and D [kg m-3].

Usage

```
ThrcTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Isothermal Throttling Coefficient: Thrc [kJ kg-1 MPa-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
Thrc <- ThrcTD(Temp,D)
Thrc
```

Ths *Temperature, Function of Enthalpy and Entropy*

Description

The function `Ths(h,s,digits=9)` returns the water Temperature, Temp [K], for given h [kJ k-1] and s [kJ k-1 K-1].

Usage

```
Ths(h, s, digits = 9)
```

Arguments

`h`	Enthalpy [kJ kg-1]
`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
h <- 977.181624
s <- 2.56690919
T_hs <- Ths(h,s)
T_hs
```

Tph *Temperature, Function of Pressure and Enthalpy*

Description

The function `Tph(p,h,digits = 9)` returns the water temperature, Temp [K], for given p [MPa] and h [kJ k-1].

Usage

```
Tph(p, h, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`h`	Enthalpy [kJ kg-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
h <- 977.181624
T_ph <- Tph(p,h)
T_ph
```

`Tps` *Temperature, Function of Pressure and Entropy*

Description

The function `Tps(p,s,digits=9)` returns the water temperature, Temp [K], for given p [MPa] and s [kJ k-1 K-1].

Usage

```
Tps(p, s, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`s`	Entropy [kJ kg-1 K-1]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Temperature: Temp [K] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 10.0003858
s <- 2.56690919
T_ps <- Tps(p,s)
T_ps
```

TSatD *Saturation Temperature, Function of Density*

Description

The function `TsatD(D,digits=9)` returns the temperature [K], TSat, for given D [kg m-3]: it may have two different values!

Usage

```
TSatD(D, digits = 9)
```

Arguments

`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The first saturation Temperature: TSat_1 [K]

The second saturation pressure: TSat_2 [K]

An Error Message (if an error occur: errorCodes)

Examples

```
D <- 890.341250
T_Sat <- TSatD(D)
T_Sat

D <- 999.887406
T_Sat <- TSatD(D)
T_Sat
```

TSatp *Saturation Temperature, Function of pressure*

Description

The function `TSatp(p,digits=9)` returns the temperature [K], TSat, for given p [MPa].

Usage

```
TSatp(p, digits = 9)
```

Arguments

`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Saturation Temperature: Tsat [K] and an Error Message (if an error occur: errorCodes)

Examples

```
p <- 0.932203564
T_Sat <- TSatp(p)
T_Sat
```

TSats *Saturation Temperature, Function of Entropy*

Description

The function `TSats(s,digits=9)` returns the temperature [K], TSat, for given s [kJ kg-1 K-1].

Usage

```
TSats(s, digits = 9)
```

Arguments

s	Entropy [kJ kg-1 K-1]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Saturation Temperature: Tsat [K] and an Error Message (if an error occur: errorCodes)

Examples

```
s <- 2.10865845
T_Sat <- TSats(s)
T_Sat
```

TTr *Water Temperature at Triple Point*

Description

The function `TTr()` returns the Water Temperature at Triple Point [K]

Usage

```
TTr()
```

Value

The Triple Point Temperature: TTr [K]

Examples

```
Ttrip <- TTr()
Ttrip
```

ufT *Saturated Liquid Specific Internal Energy, Function of Temperature*

Description

The function `ufT(Temp,digits=0)`. returns the saturated liquid internal energy [kJ kg-1], uf, for given Temp [K].

Usage

```
ufT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated liquid internal energy: uf [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
uf <- ufT(Temp)
uf
```

ugT *Saturated Gas Specific Internal Energy, Function of Temperature*

Description

The function `ugT(Temp,digits=9)` returns the saturated gas internal energy [kJ kg-1], ug, for given Temp [K].

Usage

```
ugT(Temp, digits = 9)
```

Arguments

Temp	Temperature [K]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The saturated gas internal energy: ug [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
ug <- ugT(Temp)
ug
```

---

uTD *Specific Internal Energy, Function of Temperature and Density*

Description

The function uTD(Temp,D,digits=9) returns the Specific Internal Energy, h [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
uTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Internal Energy: u [kJ kg-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
u <- uTD(Temp,D)
u
```

---

uTp *Specific Internal Energy, Function of Temperature and Pressure*

Description

The function `uTp(Temp,p,digits=9)` returns the Specific Internal Energy, h [kJ kg-1], for given Temp [K] and D [kg/m3].

Usage

```
uTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specific Internal Energy: u [kJ kg-1] and an Error message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
u <- uTp(Temp,p)
u
```

`ViscTD` *Dynamic Viscosity, Function of Temperature and Density*

Description

The function `ViscTD(Temp,D,digits=9)` computes the Dynamic Viscosity [Pa s] for given Temp [K] and D [kg/m3], returning the computed viscosity and an error message, if an error occur. errorCodes

Usage

```
ViscTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the equations developed by the International Association for the Properties of Water and Steam, valid from the triple point to the pressure of 1000 MPa and temperature of 1173.15K. https://iapws.org/relguide/viscosity.html

Value

The Dynamic viscosity: [Pa s] and an Error Message (if an error occur)

Examples

```
Temp <- 500.
D <- 838.025
Vis <- ViscTD(Temp,D)
Vis
```

Vp *Vapor pressure, Function of Temperature*

Description

The function `Vp(Temp,digits=9)` returns the vapor pressure, Vp [kPa], for a given Temp [K].

Usage

```
Vp(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function solves the Wagner Equation (Wagner and Pruss (1993)) which gives one of the best fits to experimental data. It expresses reduced vapor pressure as a function of reduced temperature. This equation, for water, is valid from the temperature of 273.16 K to the critical temperature (624.096 K).

vTp *Specific Volume, Function of Temperature and Pressure*

Description

The function `vTp(Temp,p,digits=9)` returns the Specific Volume, [m3 kg-1], for given Temp [K] and D [kg/m3].

Usage

```
vTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Specifiv Volume: v [m3 kg-1] and an (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
v <- vTp(Temp,p)
v
```

---

wfT *Speed of Sound of Fluid Phase, Function of Temperature*

Description

The function `wfT(Temp,digits=9)` returns the Speed of Sound of Fluid Phase [m s-1], wf, for given Temp [K].

Usage

```
wfT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Speed of Sound of Fluid Phase: wf [m s-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
wf <- wfT(Temp)
wf
```

---

wgT *Speed of Sound of Gas Phase, Function of Temperature*

Description

The function `wgT(Temp,digits=9)` returns the Speed of Sound of Gas Phase [m s-1], wg, for given Temp [K].

Usage

```
wgT(Temp, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Speed of Sound of Gas Phase: wg [m s-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 450.
wg <- wgT(Temp)
wg
```

wTD *Speed of Sound, Function of Temperature and Density*

Description

The function wTD(Temp,D,digits=9) returns the Speed of Sound in water, w [m s-1], for given Temp [K] and D [kg/m3].

Usage

```
wTD(Temp, D, digits = 9)
```

Arguments

Temp	Temperature [K]
D	Density [kg m-3]
digits	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Speed of Sound: w [m s-1]

Error message (if an error occur)

The Speed of Sound: w [m s-1] and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 0.435
w <- wTD(Temp,D)
w
```

wTp *Speed of Sound, Function of Temperature and Pressure*

Description

The function `wTp(Temp,p,digits=9)` returns the Speed of Sound, [m s-1], for given Temp [K] and D [kg/m3].

Usage

```
wTp(Temp, p, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`p`	Pressure [MPa]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Speed of Sound: w [m s-1] and an (if an error occur: errorCodes)

Examples

```
Temp <- 500.
p <- 10.0003858
w <- wTp(Temp,p)
w
```

ZTD *Compressibility Factor, Function of Temperature and Density*

Description

The function `ZTD(Temp,D,digits=9)` returns the Compressibility Factor, Z [-], for given Temp [K] and D [kg/m3].

Usage

```
ZTD(Temp, D, digits = 9)
```

Arguments

`Temp`	Temperature [K]
`D`	Density [kg m-3]
`digits`	Digits of results (optional)

Details

This function calls a Fortran DLL that solves the Helmholtz Energy Equation. in accordance with the Revised Release on the IAPWS Formulation 1995 for the Thermodynamic Properties of Ordinary Water Substance for General and Scientific Use (June 2014) developed by the International Association for the Properties of Water and Steam, https://iapws.org/relguide/IAPWS-95.html. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

Value

The Compressibility Factor and an Error Message (if an error occur: errorCodes)

Examples

```
Temp <- 500.
D <- 838.025
z <- ZTD(Temp,D)
z
```

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