

# Package ‘IAPWS95’

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**Title** Thermophysical Properties of Water and Steam

**Version** 1.1.0

**Description** Functions for Water and Steam Properties based on the 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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---

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

---

### Description

The function BT(T) returns the second virial coefficient, B [ m<sup>3</sup> kg<sup>-1</sup> ], for a given T [K].

### Usage

BT(T)

### Arguments

T                    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, <http://www.iapws.org/rellguide/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 [ m<sup>3</sup> kg<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

### Examples

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

---

CndTD *Thermal Conductivity, Function of Temperature and Density*

---

### Description

The function CndTD(T,D) calculates the Thermal Conductivity,  $k$  [ W m<sup>-1</sup> K<sup>-1</sup> ] for given T [K] and D [kg/m<sup>3</sup>], returning the computed thermal conductivity and an error message if an error occur.

### Usage

CndTD(T, D)

### Arguments

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

### 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. <http://www.iapws.org/relguide/ThCond.html>

### Value

The Thermal Conductivity:  $k$  [ W m<sup>-1</sup> K<sup>-1</sup> ] and an Error message if necessary

### Examples

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

---

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

---

### Description

The function CpfT(T) returns the Isobaric Heat Capacity of Fluid Phase [kJ kg<sup>-1</sup> K<sup>-1</sup>], Cpf, for given T [K].

### Usage

CpfT(T)

**Arguments**

T                      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, <http://www.iapws.org/rellguide/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<sup>-1</sup> K<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

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

---

**Description**

The function CpgT(T) returns the Isobaric Heat Capacity of Gas Phase [kJ kg<sup>-1</sup> K<sup>-1</sup>], Cpg, for given T [K].

**Usage**

```
CpgT(T)
```

**Arguments**

T                      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, <http://www.iapws.org/rellguide/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: Cp [kJ kg<sup>-1</sup> K<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 450.  
Cpg <- CpGT(T)  
Cpg
```

---

CpTD

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

---

**Description**

The function CpTD(T,D) returns the Specific Isobaric Heat Capacity, Cp [kJ kg<sup>-1</sup> K<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
CpTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.iapws.org/rellguide/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<sup>-1</sup> K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

CpTp	<i>Specific Isobaric Heat Capacity, Function of Temperature and Pressure</i>
------	--

---

### Description

The function `CpTp(T, p)` returns the Specific Isobaric Heat Capacity,  $C_p$  [ kJ kg<sup>-1</sup> K<sup>-1</sup> ], for given  $T$  [K] and  $p$  [MPa].

### Usage

```
CpTp(T, p)
```

### Arguments

$T$	Temperature [ 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, <http://www.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:  $C_p$  [ kJ kg<sup>-1</sup> K<sup>-1</sup> ] and an (if an error occur: [errorCodes](#))

### Examples

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



---

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

---

### Description

The function CT(T) returns the third virial coefficient, C [ m<sup>3</sup> kg<sup>-1</sup> ]\*\*2, for a given T [K].

### Usage

CT(T)

### Arguments

T                      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, <http://www.iapws.org/reldata/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 [ m<sup>3</sup> kg<sup>-1</sup> ]\*\*2 and an Error Message (if an error occur: [errorCodes](#))

### Examples

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

---

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

---

### Description

The function CvfT(T) returns the Isochoric Heat Capacity of Fluid Phase [kJ kg<sup>-1</sup> K<sup>-1</sup>], Cvf, for given T [K].

### Usage

CvfT(T)

**Arguments**

T                    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, <http://www.iapws.org/rellguide/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: Cv<sub>f</sub> [kJ kg<sup>-1</sup> K<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

CvgT	<i>Specific Isochoric Heat Capacity of Gas Phase, Function of Temperature</i>
------	---

---

**Description**

The function CvgT(T) returns the Isochoric Heat Capacity of Gas Phase [kJ kg<sup>-1</sup> K<sup>-1</sup>], Cvg, for given T [K].

**Usage**

```
CvgT(T)
```

**Arguments**

T                    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, <http://www.iapws.org/rellguide/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<sup>-1</sup> K<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 450.
Cvg <- CvGT(T)
Cvg
```

---

CvTD	<i>Specific Isochoric Heat Capacity, Function of Temperature and Density</i>
------	--

---

**Description**

The function CvTD(T,D) returns the Specific Isochoric Heat Capacity, Cv [kJ kg<sup>-1</sup> K<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
CvTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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<sup>-1</sup> K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

CvTp	<i>Specific Isochoric Heat Capacity, Function of Temperature and Pressure</i>
------	---

---

### Description

The function CvTp(T, p) returns the Specific Isochoric Heat Capacity, Cv [ kJ kg-1 K-1 ], for given T [K] and p [MPa].

### Usage

```
CvTp(T, p)
```

### Arguments

T	Temperature [ 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, <http://www.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

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

---

DCrit	<i>Water Critical Density</i>
-------	-------------------------------

---

**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	<i>Density Derivative with respect to Temperature, Function of Temperature and Density</i>
--------	--

---

**Description**

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

**Usage**

```
dDdTTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.iapws.org/rellguide/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:  $dD/dT$  [ kg m<sup>-3</sup> K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.
D <- 838.025
dDdT <- dDdTTD(T,D)
dDdT
```

---

dDdTTp

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

---

**Description**

The function `dDdTTp(T, p)` returns the Density derivative with respect to Temperature,  $dDdT$ , for given T [K] and p [MPa].

**Usage**

```
dDdTTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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:  $dD/dT$  [ kg m<sup>-3</sup> K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.  
p <- 10.0003858  
dDdT <- dDdTp(T,p)  
dDdT
```

---

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

---

**Description**

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

**Usage**

```
Dfp(p)
```

**Arguments**

`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, <http://www.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) returns the saturated liquid density [kg m<sup>-3</sup>], Df, for given s [kJ kg<sup>-1</sup> K<sup>-1</sup>].

**Usage**

Dfs(s)

**Arguments**

s                      Entropy [kJ kg<sup>-1</sup> K<sup>-1</sup>]

**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, <http://www.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<sup>-3</sup>] 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(T) returns the saturated liquid density [kg m<sup>-3</sup>], Df, for given T [K].

**Usage**

DfT(T)



**Arguments**

T                    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, <http://www.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<sup>-3</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 450.  
Df <- DfT(T)  
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<sup>-3</sup> ]

**Examples**

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

---

Dgp

*Saturated Gas Density, Funtion of Pressure*

---

### Description

The function `Dgp(p)` returns the saturated gas density [kg m<sup>-3</sup>], `Dg`, for given `p` [ MPa ].

### Usage

`Dgp(p)`

### Arguments

`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, <http://www.iapws.org/rellguide/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<sup>-3</sup>] 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)` returns the saturated gas density [kg m<sup>-3</sup>], `Dg`, for given `s` [kJ kg<sup>-1</sup> K<sup>-1</sup>].

### Usage

`Dgs(s)`

**Arguments**

s                      Entropy [kJ kg-1 K-1]

**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, <http://www.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(T) returns the saturated gas density [kg m-3], Dg, for given T [K].

**Usage**

```
DgT(T)
```

**Arguments**

T                      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, <http://www.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**

```
T <- 450.
Dg <- DgT(T)
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<sup>-3</sup> ]

**Examples**

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

---

Dhs *Density, Function of Enthalpy and Entropy*

---

**Description**

The function Dhs(h, s) returns the water density, D [ kg m<sup>-3</sup> ], for given h [kJ k<sup>-1</sup>] and s [ kJ k<sup>-1</sup> K<sup>-1</sup> ].

**Usage**

```
Dhs(h, s)
```

**Arguments**

h	Enthalpy [ kJ kg <sup>-1</sup> ]
s	Entropy [ kJ kg <sup>-1</sup> K <sup>-1</sup> ]

**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, <http://www.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(T,D)` returns the pressure derivative with respect to Density, `dpdD`, for given T [K] and D [kg m-3].

**Usage**

```
dpdDTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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**

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

---

dpdDTp

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

---

**Description**

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

**Usage**

```
dpdDTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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**

```
T <- 500.
p <- 10.0003858
dpdD <- dpdTp(T,p)
dpdD
```

---

dpdTTD	<i>Pressure Derivative with Respect to Temperature, Function of Temperature and Density</i>
--------	---

---

**Description**

The function `dpdTTD(T,D)` returns the pressure derivative with respect to Temperature, `dpdT`, for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
dpdTTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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 T: `dp/dT` [ MPa K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.
D <- 838.025
dpdT <- dpdT(T,D)
dpdT
```

---

dpdTTp	<i>Pressure Derivative with respect to Temperature, Function of Temperature and Pressure</i>
--------	--

---

### Description

The function `dpdTTp(T, p)` returns the pressure derivative with respect to Temperature, `dpdT`, for given `T` [K] and `p` [MPa].

### Usage

```
dpdTTp(T, p)
```

### Arguments

<code>T</code>	Temperature [ K ]
<code>p</code>	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, <http://www.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 `T`: `dp/dT` [ MPa K-1 ] and an Error Message (if an error occur: [errorCodes](#))

### Examples

```
T <- 500.  
p <- 10.0003858  
dpdT <- dpdTTp(T, p)  
dpdT
```



---

Dph *Density, Function of Pressure and Enthalpy*

---

**Description**

The function Dph(p, h) returns the water density, D [ kg m<sup>-3</sup> ], for given p [MPa] and h [ kJ k<sup>-1</sup> ].

**Usage**

Dph(p, h)

**Arguments**

p	Pressure [ MPa ]
h	Enthalpy [ kJ kg <sup>-1</sup> ]

**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, <http://www.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<sup>-3</sup> ] 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) returns the water density, D [ kg m<sup>-3</sup> ], for given p [MPa] and s [ kJ k<sup>-1</sup> K<sup>-1</sup> ].

**Usage**

Dps(p, s)

**Arguments**

p	Pressure [ MPa ]
s	Entropy [ kJ kg-1 K-1 ]

**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, <http://www.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, T) returns a table of Densities [kg m-3] for a fixed T [K] within a range of p [MPa]: p1:p2 [MPa]

**Usage**

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

**Arguments**

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

**Details**

This function provides a table of the densities [kg m<sup>-3</sup>] for a given T [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, <http://www.iapws.org/reldata/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.
T <- 500.
TabD <- DpTcteTab(p1, p2, dp, T)
TabD
```

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

---

DTh

*Density, Function of Temperature and Enthalpy*


---

**Description**

The function DTh(T,h) returns the water density, D [ kg m<sup>-3</sup> ], for given T [K] and h [ kJ kg<sup>-1</sup> ] (it may have two solutions for Density).

**Usage**

```
DTh(T, h)
```

**Arguments**

T	Temperature in Kelvin
h	Enthalpy in [ kJ kg <sup>-1</sup> ]

**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, <http://www.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<sup>-3</sup> ]

The Density 2: Density\_2 [ kg m<sup>-3</sup> ]

Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

DTp

*Density, Function of Temperature and Pressure*


---

**Description**

The function DTp(T, p) returns the water density, D [ kg m<sup>-3</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
DTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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**

```
T <- 500.
p <- 10.0003858
D <- DTp(T,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 T [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, <http://www.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(T, s)` returns the water density,  $D$  [ kg m<sup>-3</sup> ], for given  $T$  [K] and  $s$  [ kJ k<sup>-1</sup> K<sup>-1</sup> ].

### Usage

```
DTs(T, s)
```

### Arguments

<code>T</code>	Temperature [ K ]
<code>s</code>	Entropy [ kJ kg <sup>-1</sup> K <sup>-1</sup> ]

### 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, <http://www.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<sup>-3</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.  
s <- 2.56690919  
D_Ts <- DTs(T,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) returns the Helmholtz Free Energy, f [ kJ kg<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

fTD(T, D)

**Arguments**

T                    Temperature [ K ]  
D                    Density [ kg m<sup>-3</sup> ]

**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, <http://www.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**

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

---

fTp

*Helmholtz Free Energy, Function of Temperature and Pressure*


---

**Description**

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

**Usage**

```
fTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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**

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

---

FugaTp

*Fugacity, Function of Temperature and Pressure*

---

**Description**

The function FugaTp(T,p) returns the Fugacity, [ MPa ], for given T [K] and D [kg/m3].

**Usage**

```
FugaTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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**

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

---

 GibbsTp

*Specific Gibbs Energy, Function of Temperature and Pressure*


---

**Description**

The function GibbsTp(T,p) returns the Specific Gibbs Energy, [ MPa ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
GibbsTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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**

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

---

 hCrit

*Water Critical Enthalpy*


---

**Description**

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

**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(T) returns the saturated liquid enthalpy [kJ kg-1], hf, for given T [K].

**Usage**

```
hfT(T)
```

**Arguments**

T                      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, <http://www.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**

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

---

hgT *Saturated Gas Enthalpy, Function of Temperature*

---

**Description**

The function hgT(T) returns the saturated gas enthalpy [kJ kg<sup>-1</sup>], hg, for given T [K].

**Usage**

hgT(T)

**Arguments**

T                      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, <http://www.iapws.org/rellguide/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<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

hps *Enthalpy, Function of Pressure and Entropy*

---

**Description**

The function hps(p, s) returns the water enthalpy, h [ kJ kg<sup>-1</sup> ], for given p [MPa] and s [ kJ k<sup>-1</sup> K<sup>-1</sup> ].

**Usage**

hps(p, s)

**Arguments**

p	Pressure [ MPa ]
s	Entropy [ kJ kg-1 K-1 ]

**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, <http://www.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, T) returns a table of Enthalpies [kJ kg-1] for a fixed T [K] within a range of p [MPa]: p1:p2 [MPa]

**Usage**

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

**Arguments**

p1	first pressure value [ MPa ]
p2	final pressure [ MPa ]
dp	Pressure increment [ MPa ]
T	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, <http://www.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.
T <- 500.
Tabh <- hpTcteTab(p1, p2, dp, T)
Tabh

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

---

hTD

*Specific Enthalpy, Function of Temperature and Density*

---

**Description**

The function hTD(T,D) returns the Specific Enthalpy, h [ kJ kg<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
hTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

hTp

*Specific Enthalpy, Function of Temperature and Pressure*


---

**Description**

The function  $hTp(T, p)$  returns the Specific Enthalpy,  $h$  [ kJ kg<sup>-1</sup> ], for given  $T$  [K] and  $D$  [kg/m<sup>3</sup>].

**Usage**

```
hTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.
p <- 10.0003858
h <- hTp(T,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<sup>-1</sup>] for a fixed p [MPa] within a range of T [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, <http://www.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(T, D) returns the Joule-Thomson coefficient for given T [K] and D [kg/m<sup>3</sup>].

### Usage

```
JTcTD(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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

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

---

KapaTD

*Isothermal Compressibility, Function of Temperature and Density*

---

### Description

The function KapaTD(T,D) returns the Isothermal Compressibility, Kapa, for given T [K] and D [kg m-3].

### Usage

KapaTD(T, D)

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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: [error-Codes](#))

### Examples

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

---

KViscTD

*Kinematic Viscosity, Function of Temperature and Density*

---

### Description

The function `KViscTD(T,D)` computes the Kinematic Viscosity [ m<sup>2</sup> s<sup>-1</sup> ] for given T [K] and D [kg/m<sup>3</sup>], returning the calculated viscosity and an error message, if an error occur. [errorCodes](#)

### Usage

```
KViscTD(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

### Details

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

### Value

The Kinematic viscosity: [ m<sup>2</sup> s<sup>-1</sup> ] and an Error Message (if an error occur)

### Examples

```
T <- 500.  
D <- 838.025  
KVis <- KViscTD(T,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	<i>Ideal-Gas part of the Dimensionless Helmholtz Energy Equation, Function of Temperature and Density</i>
------	---

---

**Description**

The function phi0(T,D) returns the Ideal-gas part of the dimensionless Helmholtz Energy Equation, phi0, for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
phi0(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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**

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

---

phi0D	<i>First Derivative of the Ideal-Gas part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Density</i>
-------	---

---

### Description

The function phi0D(D) returns the First Derivative of the Ideal-gas part of the dimensionless Helmholtz Energy Equation for a given D [kg/m<sup>3</sup>].

### Usage

```
phi0D(D)
```

### Arguments

D	Density [ kg m-3 ] #' @param Opt: Option to not print the computed value (Opt = 0)
---	--

### 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, <http://www.iapws.org/rellguide/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	<i>Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Density</i>
--------	--

---

### Description

The function phi0DD(D) returns the Second Derivative of the Ideal-gas part of the dimensionless Helmholtz Energy Equation for a given D [kg/m<sup>3</sup>].

### Usage

```
phi0DD(D)
```

### Arguments

D	Density [ kg m <sup>-3</sup> ]
---	--------------------------------

### 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, <http://www.iapws.org/rellguide/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	<i>Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density and Temperature</i>
--------	---

---

### Description

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

### Usage

```
phi0DT()
```

### 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, <http://www.iapws.org/rellguide/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	<i>First Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density</i>
-------	---

---

### Description

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

### Usage

```
phi0T(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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 T Derivative of Ideal-gas part of the Helmholtz Energy: phi0T and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

phi0TT	<i>Second Derivative of the Ideal-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density</i>
--------	--

---

**Description**

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

**Usage**

```
phi0TT(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]



**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, <http://www.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 T Derivative of Ideal-gas part of the Helmholtz Energy: phi0TT and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

phir	<i>Residual-Gas Part of the Dimensionless Helmholtz Energy Equation, Function of Temperature and Density</i>
------	--

---

**Description**

The function `phir(T,D)` returns the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
phir(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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**

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

---

phirD	<i>First Derivative of the Residual-Gas part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Temperature and Density</i>
-------	--

---

**Description**

The function `phirD(T,D)` returns the First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
phirD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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**

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

---

phirDD	<i>Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density, Function of Temperature and Density</i>
--------	---

---

**Description**

The function `phirDD(T,D)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
phirDD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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**

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

---

phirDT	<i>Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Density and Temperature, Function of Temperature and Density</i>
--------	---

---

### Description

The function `phirDT(T,D)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to D and T, for given T [K] and D [kg/m<sup>3</sup>].

### Usage

```
phirDT(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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 T: `phirTT`, and an Error Message (if an error occur: `errorCodes`)

### Examples

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

---

phirT	<i>First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to Temperature, Function of Temperature and Density</i>
-------	--

---

### Description

The function `phirT(T,D)` returns the First Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to T, for given T [K] and D [kg/m<sup>3</sup>].

### Usage

```
phirT(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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 T: `phirT`, and an Error Message (if an error occur: [errorCodes](#))

### Examples

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

---

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

---

### Description

The function `phirTT(T,D)` returns the Second Derivative of the Residual-Gas Part of the Dimensionless Helmholtz Energy Equation with respect to T, for given T [K] and D [kg/m<sup>3</sup>].

### Usage

```
phirTT(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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

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

---

pMeltT	<i>Melting Pressure, Function of Temperature</i>
--------	--

---

### Description

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

### Usage

```
pMeltT(T)
```

### Arguments

T	Temperature [K]
---	-----------------

### 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, <http://www.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

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

---

PrandtTD	<i>Prandt Number, Function of Temperature and Density</i>
----------	---

---

### Description

The function PrandtTD(T,D) 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/m<sup>3</sup>].

### Usage

```
PrandtTD(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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

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

---

pSatD	<i>Saturation Pressure, Function of Density</i>
-------	---

---

### Description

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



**Usage**

```
pSatD(D)
```

**Arguments**

D                      Density [ kg m-3]

**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, <http://www.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) returns the saturation pressure [MPa], pSat, for given s [kJ kg-1 K-1].

**Usage**

```
pSats(s)
```

**Arguments**

s                      Entropy [ kJ kg-1 K-1 ]

**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, <http://www.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) returns the saturation pressure [MPa], pSat, for given T [K].

**Usage**

```
pSatT(T)
```

**Arguments**

T                      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, <http://www.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**

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

---

pTD

*Pressure, Function of Temperature and Density*

---

**Description**

The function pTD(T,D) returns the water pressure, p [ MPa ], for given T [K] and D [kg/m<sup>3</sup>], returning also an error message, if any error occur.

**Usage**

```
pTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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**

```
T <- 500.  
D <- 838.025  
p <- pTD(T,D)  
p  
  
T <- 647.096  
D <- 322.  
p <- pTD(T,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	<i>Table of Saturation Liquid Phase Enthalpies, Function of Temperature</i>
----------	---

---

### Description

The function `satTabhT(T1, T2, dT)` returns a table of saturation liquid enthalpies [kJ kg<sup>-1</sup> K<sup>-1</sup>] 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, <http://www.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	<i>Table of Saturation Densities, Enthalpies and Entropies, Function of Pressure</i>
---------	--

---

### Description

The function `satTabp(p1, p2, dp)` returns a table of three saturation properties for two phases: Density [kg/m<sup>3</sup>], Enthalpy [kJ kg<sup>-1</sup>] and Entropy [kJ kg<sup>-1</sup> K<sup>-1</sup>] 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, <http://www.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, <http://www.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	<i>Table of Saturation Densities, Enthalpies and Entropies, Function of Temperature</i>
---------	---

---

### Description

The function `satTabT(T1, T2, dT)` returns a table of three saturation properties for two phases: Density [kg/m<sup>3</sup>], Enthalpy [kJ kg<sup>-1</sup>] and Entropy [kJ kg<sup>-1</sup> K<sup>-1</sup>] 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, <http://www.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**

<code>p1</code>	First Pressure value [MPa]
<code>p2</code>	Final Pressure [MPa]
<code>dp</code>	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, <http://www.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	<i>Table of Saturation Volumes, Enthalpies and Entropies, Function of Pressure</i>
----------	--

---

### Description

The function `satTabvp(p1, p2, dp)` returns a table of three saturation properties for two phases: Specific Volume [ m<sup>3</sup> kg<sup>-1</sup> ], Enthalpy [kJ kg<sup>-1</sup>] and Entropy [kJ kg K<sup>-1</sup>] 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, <http://www.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	<i>Table of Saturation Volumes, Enthalpies and Entropies, Function of of Temperature</i>
----------	--

---

### Description

The function `satTabvT(T1, T2, dT)` returns a table of three saturation properties for two phases: Specific Volume [ m<sup>3</sup> kg<sup>-1</sup> ], Enthalpy [kJ kg<sup>-1</sup>] and Entropy [kJ kg K<sup>-1</sup>] 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, <http://www.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(T) returns the saturated liquid entropy [kJ kg-1 K-1], sf, for given T [K].

**Usage**

```
sfT(T)
```

**Arguments**

T                      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, <http://www.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**

```
T <- 450.  
sf <- sfT(T)  
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<sup>-1</sup> K<sup>-1</sup>]

**Examples**

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

---

sgT

*Saturated Gas Entropy, Function of Temperature*

---

**Description**

The function sgT(T) returns the saturated gas entropy [kJ kg<sup>-1</sup> K<sup>-1</sup>], sg, for given T [K].

**Usage**

```
sgT(T)
```

**Arguments**

T                      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, <http://www.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<sup>-1</sup> K<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 450.  
sg <- sgT(T)  
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<sup>-1</sup> K<sup>-1</sup>]

**Examples**

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

---

SigmaT

*Surface Tension, Function of Temperature*

---

### Description

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

### Usage

```
SigmaT(T)
```

### Arguments

T                    Temperature [ K ]

### 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]. <http://www.iapws.org/relguide/Surf-H2O.html>

### Value

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

### Examples

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

---

sph

*Entropy, Function of Pressure and Enthalpy*

---

### Description

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

### Usage

```
sph(p, h)
```

**Arguments**

p	Pressure [ MPa ]
h	Enthalpy [ kJ kg-1 ]

**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, <http://www.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, T) returns a table of Entropies [kJ kg-1 K-1] for a fixed T [K] within a range of p [MPa]: p1:p2 [MPa]

**Usage**

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

**Arguments**

p1	"initial"first pressure value [ MPa ]
p2	final pressure [ MPa ]
dp	Pressure increment [ MPa ]
T	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, <http://www.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 T and a p Interval: p1:p2.

**Examples**

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

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

---

sTD

*Specific Entropy, Function of Temperature and Density*

---

**Description**

The function sTD(T,D) returns the Specific Entropy, h [ kJ kg<sup>-1</sup> k<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
sTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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<sup>-1</sup> K<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

sTp

*Specific Entropy, Function of Temperature and Pressure***Description**

The function `sTp(T,p)` returns the Specific Entropy,  $h$  [ kJ kg<sup>-1</sup> K<sup>-1</sup> ], for given  $T$  [K] and  $D$  [kg/m<sup>3</sup>].

**Usage**

```
sTp(T, p)
```

**Arguments**

$T$	Temperature [ 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, <http://www.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<sup>-1</sup> K<sup>-1</sup> ] and an Error message (if an error occur: [errorCodes](#))

**Examples**

```
T <- 500.
p <- 10.0003858
s <- sTp(T,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<sup>-1</sup> K<sup>-1</sup>] 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, <http://www.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	<i>Water Critical Temperature</i>
-------	-----------------------------------

---

### 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	<i>Temperature, Function of Density and Enthalpy</i>
-----	--

---

### Description

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

### Usage

```
TDh(D, h)
```

### Arguments

D	Density [ kg m3 ]
h	Enthalpy in [ kJ kg-1 ]

**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, <http://www.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: T [ 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) returns the water temperature, T [ K ], for given D [kg/m<sup>3</sup>] and p [ MPa ].

**Usage**

```
TDp(D, p)
```

**Arguments**

D	Density [ kg m <sup>3</sup> ]
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, <http://www.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: T [ 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) returns the water temperature, T [ K ], for given D [kg/m<sup>3</sup>] and s [ kJ kg<sup>-1</sup> K<sup>-1</sup> ].

**Usage**

```
TDs(D, s)
```

**Arguments**

D	Density [ kg m <sup>3</sup> ]
s	Entropy in [ kJ kg <sup>-1</sup> K <sup>-1</sup> ]

**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, <http://www.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: T [ 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	<i>Isothermal Throttling Coefficient, Function of Tenoerature and Density</i>
--------	---

---

### Description

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

### Usage

```
ThrcTD(T, D)
```

### Arguments

T	Temperature [ K ]
D	Density [ kg m-3 ]

### 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, <http://www.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

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

---

Ths *Temperature, Function of Enthalpy and Entropy*

---

### Description

The function Ths(h, s) returns the water Temperature, T [ K ], for given h [kJ k-1] and s [ kJ k-1 K-1 ].

### Usage

Ths(h, s)

### Arguments

h	Enthalpy [ kJ kg-1 ]
s	Entropy [ kJ kg-1 K-1 ]

### 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, <http://www.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: T [ 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) returns the water temperature, T [ K ], for given p [MPa] and h [ kJ k-1 ].

### Usage

Tph(p, h)



**Arguments**

p	Pressure [ MPa ]
h	Enthalpy [ kJ kg-1 ]

**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, <http://www.iapws.org/reldata/IAPWS-95.html>. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

**Value**

The Temperature: T [ 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	<i>Temperature, Function of Pressure and Entropy</i>
-----	--

---

**Description**

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

**Usage**

```
Tps(p, s)
```

**Arguments**

p	Pressure [ MPa ]
s	Entropy [ kJ kg-1 K-1 ]

**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, <http://www.iapws.org/reldata/IAPWS-95.html>. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

**Value**

The Temperature: T [ 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)` returns the temperature [K], `TSat`, for given `D` [ kg m-3 ]: it may have two different values!

**Usage**

```
TSatD(D)
```

**Arguments**

`D`                      Density [ kg m-3 ]

**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, <http://www.iapws.org/rellguide/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) returns the temperature [K], TSat, for given p [ MPa ].

**Usage**

```
TSatp(p)
```

**Arguments**

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, <http://www.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	<i>Saturation Temperature, Function of Entropy</i>
-------	--

---

**Description**

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

**Usage**

```
TSats(s)
```

**Arguments**

s	Entropy [kJ kg-1 K-1]
---	-----------------------

**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, <http://www.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	<i>Water Temperature at Triple Point</i>
-----	--

---

**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(T) . returns the saturated liquid internal energy [kJ kg-1], uf, for given T [K].

**Usage**

```
ufT(T)
```

**Arguments**

T                      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, <http://www.iapws.org/rellguide/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: [error-Codes](#))

**Examples**

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

---

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

---

### Description

The function ugT(T) returns the saturated gas internal energy [kJ kg<sup>-1</sup>], ug, for given T [K].

### Usage

ugT(T)

### Arguments

T                      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, <http://www.iapws.org/rellguide/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<sup>-1</sup>] and an Error Message (if an error occur: [errorCodes](#))

### Examples

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

---

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

---

### Description

The function uTD(T,D) returns the Specific Internal Energy, h [ kJ kg<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

### Usage

uTD(T, D)

**Arguments**

T	Temperature [ K ]
D	Density [ kg m-3 ]

**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, <http://www.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**

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

---

uTp

*Specific Internal Energy, Function of Temperature and Pressure*


---

**Description**

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

**Usage**

```
uTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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<sup>-1</sup> ] and an Error message (if an error occur: [errorCodes](#))

**Examples**

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

---

ViscTD

*Dynamic Viscosity, Function of Temperature and Density*

---

**Description**

The function ViscTD(T,D) computes the Dynamic Viscosity [ Pa s ] for given T [K] and D [kg/m<sup>3</sup>], returning the computed viscosity and an error message, if an error occur. [errorCodes](#)

**Usage**

```
ViscTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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. <http://www.iapws.org/relguide/viscosity.html>

**Value**

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

**Examples**

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



---

Vp *Vapor pressure, Function of Temperature*

---

### Description

The function  $Vp(T)$  returns the vapor pressure,  $Vp$  [ kPa ], for a given  $T$  [K].

### Usage

$Vp(T)$

### Arguments

$T$                       Temperature [K]

### 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  $vTp(T, \rho)$  returns the Specific Volume, [  $m^3 kg^{-1}$  ], for given  $T$  [K] and  $D$  [kg/m<sup>3</sup>].

### Usage

$vTp(T, \rho)$

### Arguments

$T$                       Temperature [ K ]  
 $\rho$                       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, <http://www.iapws.org/rellguide/IAPWS-95.html>. It is valid from the triple point to the pressure of 1000 MPa and temperature of 1273.

**Value**

The Specific Volume:  $v$  [ m<sup>3</sup> kg<sup>-1</sup> ] and an (if an error occur: [errorCodes](#))

**Examples**

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

---

 wfT

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


---

**Description**

The function wfT(T) returns the Speed of Sound of Fluid Phase [m s<sup>-1</sup>], wf, for given T [K].

**Usage**

```
wfT(T)
```

**Arguments**

T                      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, <http://www.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<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

**Examples**

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

---

wgT

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

---

### Description

The function `wgT(T)` returns the Speed of Sound of Gas Phase [m s<sup>-1</sup>], `wg`, for given T [K].

### Usage

```
wgT(T)
```

### Arguments

T                      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, <http://www.iapws.org/rellguide/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<sup>-1</sup> ] and an Error Message (if an error occur: [errorCodes](#))

### Examples

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

---

wTD

*Speed of Sound, Function of Temperature and Density*

---

### Description

The function `wTD(T,D)` returns the Speed of Sound in water, `w` [ m s<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

### Usage

```
wTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.iapws.org/rellguide/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<sup>-1</sup> ]

Error message (if an error occur)

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

**Examples**

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

---

wTp

*Speed of Sound, Function of Temperature and Pressure*


---

**Description**

The function wTp(T, p) returns the Speed of Sound, [ m s<sup>-1</sup> ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
wTp(T, p)
```

**Arguments**

T	Temperature [ 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, <http://www.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<sup>-1</sup> ] and an (if an error occur: [errorCodes](#))

**Examples**

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

---

ZTD

---

*Compressibility Factor, Function of Temperature and Density*


---

**Description**

The function ZTD(T,D) returns the Compressibility Factor,  $Z$  [ - ], for given T [K] and D [kg/m<sup>3</sup>].

**Usage**

```
ZTD(T, D)
```

**Arguments**

T	Temperature [ K ]
D	Density [ kg m <sup>-3</sup> ]

**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, <http://www.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**

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

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