Calculate Temperature, Dewpoint, or Relative Humidity

1) Choose a temperature scale.
2) Enter values in 2 of the 3 boxes.
3) Press "Calculate" to find the missing value.

Fahrenheit   Celsius

Temperature **T** (°)   Clear

Dewpoint **T_d** (°)   Clear

Relative Humidity **RH** (%)   Clear

Calculate   Clear All

* Values are calculated using the August-Roche-Magnus approximation.

* Equations for each unknown written in terms of the two knowns.

* Spreadsheet-ready equations for each unknown in terms of the two knowns:

```
    RH: =100*(EXP((17.625*TD)/(243.04+TD))/EXP((17.625*T)/(243.04+T)))
    TD: =243.04*(LN(RH/100)+((17.625*T)/(243.04+T)))/(17.625-LN(RH/100)-((17.625*T)/(243.04+T)))
     T: =243.04*(((17.625*TD)/(243.04+TD))-LN(RH/100))/(17.625+LN(RH/100)-
((17.625*TD)/(243.04+TD)))
```

(• replace "T", "TD", and "RH" with your actual cell references)
(• T and TD inputs/outputs to the equations are in *Celsius*)

References:
Alduchov, O. A., and R. E. Eskridge, 1996: Improved Magnus' form approximation of saturation vapor pressure. *J. Appl. Meteor.*, **35**, 601–609.
August, E. F., 1828: Ueber die Berechnung der Expansivkraft des Wasserdunstes. *Ann. Phys. Chem.*, **13**, 122–137.
Magnus, G., 1844: Versuche über die Spannkräfte des Wasserdampfs. *Ann. Phys. Chem.*, **61**, 225–247.

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How do I calculate dew point when I know the temperature and the relative humidity?

Relative humidity gives the ratio of how much moisture the air is holding to how much moisture it could hold at a given temperature.

This can be expressed in terms of vapor pressure and saturation vapor pressure:

RH = 100% x (E/Es)

where, according to an approximation of the Clausius-Clapeyron equation:

E = E0 x exp[(L/Rv) x {(1/T0) - (1/Td)}] and

Es = E0 x exp[(L/Rv) x {(1/T0) - (1/T)}]

where E0 = 0.611 kPa, (L/Rv) = 5423 K (in Kelvin, over a flat surface of water), T0 = 273 K (Kelvin)

and T is temperature (in Kelvin), and Td is dew point temperature (also in Kelvin).

So, if you know the temperature, you can solve for Es, and substitute the equation for E into the expression for relative humidity and solve for Td (dew point).

If you are interested in a simpler calculation that gives an approximation of dew point temperature if you know the observed temperature and relative humidity, the following formula was proposed in a 2005 article by Mark G. Lawrence in the Bulletin of the American Meteorological Society:

Td = T - ((100 - RH)/5.)

where Td is dew point temperature (in degrees Celsius), T is observed temperature (in degrees Celsius), and RH is relative humidity (in percent). Apparently this relationship is fairly accurate for relative humidity values above 50%.

More details can be found in the article:

Lawrence, Mark G., 2005: The relationship between relative humidity and the dewpoint temperature in moist air: A simple conversion and applications. *Bull. Amer. Meteor. Soc.*, **86**, 225-233. doi: http;//dx.doi.org/10.1175/BAMS-86-2-225

-- Michael Bell

How do I convert between units of dew point and relative humidity? (FAQ - Thermal)

Dew point (or **dew-point temperature**) is the temperature at which dew, or condensation, forms, on cooling a gas. Where the condensate is ice, this is known as frost point.

Relative humidity is the ratio of the amount of water vapour, e, in the air to the amount of water vapour, e_s, that would be in the air if saturated at the same temperature and pressure, and can be expressed

$$\text{relative humidity (in \%)} = 100 \times e/e_s \qquad (1)$$

Unfortunately, there is no simple, direct formula for converting in either direction between dew point and relative humidity. Conversions between these two parameters must be carried out via the intermediate step of evaluating both the actual vapour pressure of water and the saturation vapour pressure at the prevailing temperature, i.e.

To convert from dew point or frost point to relative humidity:

- **Convert dew-point temperature and ambient temperature into water vapour pressures using equation (2) or (3) below (or equation (4) or (5) for greater accuracy)**
- **Use these values of vapour pressure in equation (1) to find relative humidity**

To convert from relative humidity and ambient temperature to dew point or frost point:

- **Use equation (2) or (3) below (or equation (4) or (5) for greater accuracy) to find saturation vapour pressure from ambient temperature**
- **Use equation (1) to calculate water vapour pressure from saturation vapour pressure and known relative humidity**
- **Use equation (2) or (3) below (or (4) or (5)) to calculate dew or frost point temperature from vapour pressure (requires iteration if using (4) or (5)).**

Vapour pressure can be calculated using the **Magnus formulae**:

At a temperature t (in °C), the saturation vapour pressure $e_w(t)$, in pascals, over liquid water, is

$$\ln e_w(t) = \ln 611.2 + (17.62\, t)/(243.12+t) \qquad (2)$$

($e_w(t)$, is in pascals (Pa): 100 Pa = 1 millibar (mbar))

For the range -45 °C to +60 °C, values given by this equation have an uncertainty of less than ±0.6 percent of value, at the 95% confidence level.

Over ice, $e_i(t)$ is

$$\ln e_i(t) = \ln 611.2 + (22.46\, t)/(272.62+t) \qquad (3)$$

For the range -65 °C to +0.01 °C, values given by this equation have an uncertainty of less than ±1.0 percent of value, at the 95% confidence level.

A more accurate but complex alternative formula for vapour pressure (in pascals) from dew point (in kelvin) is as follows for water

$$\ln e_w(T) = -6096.9385\, T^{-1} + 21.2409642 - 2.711193\times10^{-2}\, T + 1.673952\times10^{-5}\, T^2 + 2.433502 \ln T \qquad (4)$$

and for ice

$$\ln e_i(T) = -6024.5282\, T^{-1} + 29.32707 + 1.0613868\times10^{-2}\, T - 1.3198825\times10^{-5}\, T^2 - 0.49382577 \ln T \qquad (5)$$

(Formulae due to Sonntag, 1990, updated from formulae given by Wexler, 1976 and 1977.)

The uncertainties associated with these equations are:

- less than 0.01 percent of value, for water from 0 °C to +100 °C
- ess than 0.6 percent, for supercooled water below 0 °C down to -50 °C

- less than 1.0 percent for ice down to -100 °C

at the 95% confidence level.

The accuracy of these calculations depends slightly on the pressure and temperature of the gas concerned. For air near room temperature and atmospheric pressure, the **water vapour enhancement factor**, affects the result by approximately 0.5 percent of value.

Further information and tables are given in the publication "A Guide to the measurement of Humidity".

Last Updated: 25 Mar 2010
Created: 8 Oct 2007

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