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Psychrometry Formulas

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List of 45 Psychrometry Formulas

Psychrometry

1) Wet Bulb Depression

$$fx \quad WBD = t_{db} - T_w$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 96 = 110 - 14$$

By-Pass Factor of Heating and Cooling coil

2) By-Pass Factor of Cooling Coil

$$fx \quad BPF = \exp\left(-\frac{U \cdot A_c}{m_{air} \cdot c}\right)$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$ex \quad 0.88032 = \exp\left(-\frac{50W/m^2 \cdot K \cdot 64m^2}{6kg \cdot 4.184kJ/kg \cdot K}\right)$$

3) By-Pass Factor of Heating Coil

$$fx \quad BPF = \exp\left(-\frac{U \cdot A_c}{m_{air} \cdot c}\right)$$

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d_img.jpg\)](#)

$$ex \quad 0.88032 = \exp\left(-\frac{50W/m^2 \cdot K \cdot 64m^2}{6kg \cdot 4.184kJ/kg \cdot K}\right)$$



4) LMTD of Coil given By-Pass Factor

$$\text{fx } \Delta T_m = \frac{T_f - T_i}{\ln\left(\frac{1}{\text{BPF}}\right)}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 246.1252 = \frac{345\text{K} - 305\text{K}}{\ln\left(\frac{1}{0.85}\right)}$$

5) Mass of Air Passing over Coil given By-Pass Factor

$$\text{fx } m_{\text{air}} = -\left(\frac{U \cdot A_c}{c \cdot \ln(\text{BPF})}\right)$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 4.706026\text{kg} = -\left(\frac{50\text{W}/\text{m}^2 \cdot \text{K} \cdot 64\text{m}^2}{4.184\text{kJ}/\text{kg} \cdot \text{K} \cdot \ln(0.85)}\right)$$

6) Overall Heat Transfer Coefficient given By-Pass Factor

$$\text{fx } U = -\frac{\ln(\text{BPF}) \cdot m_{\text{air}} \cdot c}{A_c}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 63.74805\text{W}/\text{m}^2 \cdot \text{K} = -\frac{\ln(0.85) \cdot 6\text{kg} \cdot 4.184\text{kJ}/\text{kg} \cdot \text{K}}{64\text{m}^2}$$



7) Sensible Heat given Out by Coil using By-Pass Factor

$$\text{fx } Q_{\text{sensible}} = \frac{U \cdot A_c \cdot (T_f - T_i)}{\ln\left(\frac{1}{\text{BPF}}\right)}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 787600.6\text{J} = \frac{50\text{W}/\text{m}^2\cdot\text{K} \cdot 64\text{m}^2 \cdot (345\text{K} - 305\text{K})}{\ln\left(\frac{1}{0.85}\right)}$$

8) Surface Area of Coil given By-Pass Factor

$$\text{fx } A_c = -\frac{\ln(\text{BPF}) \cdot m_{\text{air}} \cdot c}{U}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 81.5975\text{m}^2 = -\frac{\ln(0.85) \cdot 6\text{kg} \cdot 4.184\text{kJ}/\text{kg}\cdot\text{K}}{50\text{W}/\text{m}^2\cdot\text{K}}$$

Degree of Saturation

9) Degree of Saturation given Partial Pressure of Water Vapour

$$\text{fx } S = \frac{p_v}{p_s} \cdot \frac{1 - \frac{p_s}{p_t}}{1 - \frac{p_v}{p_t}}$$

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a_img.jpg\)](#)

$$\text{ex } 0.148352 = \frac{60\text{Bar}}{91\text{Bar}} \cdot \frac{1 - \frac{91\text{Bar}}{100\text{Bar}}}{1 - \frac{60\text{Bar}}{100\text{Bar}}}$$



10) Degree of Saturation given Relative Humidity

[Open Calculator !\[\]\(bd1a142de767a21e5362c595f844a4ff_img.jpg\)](#)

$$fx \quad S = \Phi \cdot \frac{1 - \frac{p_s}{p_t}}{1 - \frac{\Phi \cdot p_s}{p_t}}$$

$$ex \quad 0.126405 = 0.616523 \cdot \frac{1 - \frac{91\text{Bar}}{100\text{Bar}}}{1 - \frac{0.616523 \cdot 91\text{Bar}}{100\text{Bar}}}$$

11) Degree of Saturation given Specific Humidity

[Open Calculator !\[\]\(830769b31eeeaca920791081939ff8ba_img.jpg\)](#)

$$fx \quad S = \frac{\omega}{\omega_s}$$

$$ex \quad 0.263158 = \frac{0.25}{0.95}$$

12) Partial Pressure of Water Vapor in Saturated Air given Degree of Saturation

[Open Calculator !\[\]\(47734e4656765d20df4fdbd5b7aff048_img.jpg\)](#)

$$fx \quad p_s = \left(\frac{1}{p_t} + \frac{S}{p_v} \cdot \left(1 - \frac{p_v}{p_t} \right) \right)^{-1}$$

$$ex \quad 88.23529\text{Bar} = \left(\frac{1}{100\text{Bar}} + \frac{0.2}{60\text{Bar}} \cdot \left(1 - \frac{60\text{Bar}}{100\text{Bar}} \right) \right)^{-1}$$



13) Total Pressure of Moist Air given Degree of Saturation

$$fx \quad p_t = \frac{(S - 1) \cdot p_s \cdot p_v}{S \cdot p_s - p_v}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 104.4976\text{Bar} = \frac{(0.2 - 1) \cdot 91\text{Bar} \cdot 60\text{Bar}}{0.2 \cdot 91\text{Bar} - 60\text{Bar}}$$

Efficiency of Heating and Cooling coil

14) Efficiency of Cooling Coil

$$fx \quad \eta = \frac{T_i - T_f}{T_i - T_c}$$

[Open Calculator !\[\]\(73002692dd5e7a64e60946be3158e719_img.jpg\)](#)

$$ex \quad -0.216216 = \frac{305\text{K} - 345\text{K}}{305\text{K} - 120\text{K}}$$

15) Efficiency of Cooling Coil given By-pass Factor

$$fx \quad \eta = 1 - \text{BPF}$$

[Open Calculator !\[\]\(104fbf564e2e5a8fbd84f31656d114c7_img.jpg\)](#)

$$ex \quad 0.15 = 1 - 0.85$$

16) Efficiency of Heating Coil

$$fx \quad \eta = \frac{T_f - T_i}{T_c - T_i}$$

[Open Calculator !\[\]\(21226b58c700e5231ab98d27101bac58_img.jpg\)](#)

$$ex \quad -0.216216 = \frac{345\text{K} - 305\text{K}}{120\text{K} - 305\text{K}}$$



17) Efficiency of Heating Coil given By-pass Factor

$$\text{fx } \eta = 1 - \text{BPF}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$\text{ex } 0.15 = 1 - 0.85$$

Enthalpy of Moist air

18) Dry Bulb Temperature given Enthalpy of Moist Air

$$\text{fx } t_{\text{db}} = \frac{h - 2500 \cdot \omega}{1.005 + 1.9 \cdot \omega}$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$\text{ex } 1469.595 = \frac{2800\text{kJ/kg} - 2500 \cdot 0.25}{1.005 + 1.9 \cdot 0.25}$$

19) Enthalpy of Dry Air

$$\text{fx } h_{\text{dry}} = 1.005 \cdot t_{\text{db}}$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$\text{ex } 110.55\text{kJ/kg} = 1.005 \cdot 110$$

20) Enthalpy of Moist Air

$$\text{fx } h = 1.005 \cdot t_{\text{db}} + \omega \cdot (2500 + 1.9 \cdot t_{\text{db}})$$

[Open Calculator !\[\]\(683dba75afe26e28cd4de5730b776760_img.jpg\)](#)

$$\text{ex } 787.8\text{kJ/kg} = 1.005 \cdot 110 + 0.25 \cdot (2500 + 1.9 \cdot 110)$$



21) Specific Enthalpy of Water Vapor

$$\text{fx } h_{\text{dry}} = 2500 + 1.9 \cdot t_{\text{db}}$$

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)

$$\text{ex } 2709\text{kJ/kg} = 2500 + 1.9 \cdot 110$$

22) Specific Humidity given Enthalpy of Moist Air

$$\text{fx } \omega = \frac{h - 1.005 \cdot t_{\text{db}}}{2500 + 1.9 \cdot t_{\text{db}}}$$

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$\text{ex } 0.992783 = \frac{2800\text{kJ/kg} - 1.005 \cdot 110}{2500 + 1.9 \cdot 110}$$

Pressure of Water Vapor

23) Dry Bulb Temperature using Carrier's Equation

$$\text{fx } t_{\text{db}} = \left((p_w - p_v) \cdot \frac{1544 - 1.44 \cdot T_w}{p_t - p_w} \right) + T_w$$

[Open Calculator !\[\]\(e9474ce1d70442456f8fe9c393ea149c_img.jpg\)](#)

$$\text{ex } 231.6914 = \left((65\text{Bar} - 60\text{Bar}) \cdot \frac{1544 - 1.44 \cdot 14}{100\text{Bar} - 65\text{Bar}} \right) + 14$$

24) Partial Pressure of Water Vapor

$$\text{fx } p_v = p_w - \frac{(p_t - p_w) \cdot (t_{\text{db}} - T_w)}{1544 - 1.44 \cdot T_w}$$

[Open Calculator !\[\]\(9db214d549b9aeebe72aa11d3a5c4b1a_img.jpg\)](#)

$$\text{ex } 62.79504\text{Bar} = 65\text{Bar} - \frac{(100\text{Bar} - 65\text{Bar}) \cdot (110 - 14)}{1544 - 1.44 \cdot 14}$$



25) Saturation Pressure Corresponding to Wet Bulb Temperature

fx

$$p_w = \frac{p_v + p_t \cdot \left(\frac{t_{db} - T_w}{1544 - 1.44 \cdot T_w} \right)}{1 + \left(\frac{t_{db} - T_w}{1544 - 1.44 \cdot T_w} \right)}$$

[Open Calculator !\[\]\(d66ff64371a51729ac8c1cdaa685ba6f_img.jpg\)](#)

ex

$$62.3706\text{Bar} = \frac{60\text{Bar} + 100\text{Bar} \cdot \left(\frac{110 - 14}{1544 - 1.44 \cdot 14} \right)}{1 + \left(\frac{110 - 14}{1544 - 1.44 \cdot 14} \right)}$$

26) Total Pressure of Moist Air using Carrier's Equation

fx

$$p_t = \frac{(p_w - p_v) \cdot (1544 - 1.44 \cdot T_w)}{t_{db} - T_w} + p_w$$

[Open Calculator !\[\]\(d3102649f02e825ddb76dc3de0190154_img.jpg\)](#)

ex

$$144.3667\text{Bar} = \frac{(65\text{Bar} - 60\text{Bar}) \cdot (1544 - 1.44 \cdot 14)}{110 - 14} + 65\text{Bar}$$

27) Wet Bulb Temperature using Carrier's Equation

fx

$$T_w = \frac{1544 \cdot (p_w - p_v) - t_{db} \cdot (p_t - p_w)}{1.44 \cdot (p_w - p_v) - (p_t - p_w)}$$

[Open Calculator !\[\]\(56549452e01ca28bdf2500ced9653143_img.jpg\)](#)

ex

$$-139.208633 = \frac{1544 \cdot (65\text{Bar} - 60\text{Bar}) - 110 \cdot (100\text{Bar} - 65\text{Bar})}{1.44 \cdot (65\text{Bar} - 60\text{Bar}) - (100\text{Bar} - 65\text{Bar})}$$



Relative Humidity

28) Partial Pressure of Vapor given Relative Humidity

$$fx \quad p_v = \Phi \cdot p_s$$

[Open Calculator !\[\]\(339a16584d5da0f0a3ca4e9ec17bf6a1_img.jpg\)](#)

$$ex \quad 56.10359\text{Bar} = 0.616523 \cdot 91\text{Bar}$$

29) Relative Humidity given Degree of Saturation

$$fx \quad \Phi = \frac{S}{1 - \frac{p_s}{p_t} \cdot (1 - S)}$$

[Open Calculator !\[\]\(6059a5aa8b4ca7bb793408023d6c6e42_img.jpg\)](#)

$$ex \quad 0.735294 = \frac{0.2}{1 - \frac{91\text{Bar}}{100\text{Bar}} \cdot (1 - 0.2)}$$

30) Relative Humidity given Mass of Water Vapor

$$fx \quad \Phi = \frac{m_v}{m_s}$$

[Open Calculator !\[\]\(e3275251d0893157c3584e20c81dc3ba_img.jpg\)](#)

$$ex \quad 0.6 = \frac{3\text{kg}}{5\text{kg}}$$

31) Relative Humidity given Partial Pressure of Water Vapor

$$fx \quad \Phi = \frac{p_v}{p_s}$$

[Open Calculator !\[\]\(eabd9f9ababee93effadc3b380fe65fd_img.jpg\)](#)

$$ex \quad 0.659341 = \frac{60\text{Bar}}{91\text{Bar}}$$



32) Saturation Pressure of Water Vapor given Relative Humidity

$$fx \quad p_s = \frac{p_v}{\Phi}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 97.31997\text{Bar} = \frac{60\text{Bar}}{0.616523}$$

Specific Humidity

33) Maximum Specific Humidity

$$fx \quad \omega_{\max} = \frac{0.622 \cdot p_s}{p_t - p_s}$$

[Open Calculator !\[\]\(5361750c22c4e047a52f4eac1ec2d4cc_img.jpg\)](#)

$$ex \quad 6.289111 = \frac{0.622 \cdot 91\text{Bar}}{100\text{Bar} - 91\text{Bar}}$$

34) Partial Pressure of Dry Air given Specific Humidity

$$fx \quad p_a = \frac{0.622 \cdot p_v}{\omega}$$

[Open Calculator !\[\]\(b792654f2cef9719eabeb6c5be00811e_img.jpg\)](#)

$$ex \quad 149.28\text{Bar} = \frac{0.622 \cdot 60\text{Bar}}{0.25}$$



35) Partial Pressure of Water Vapor given Specific Humidity

$$fx \quad p_v = \frac{p_t}{1 + \frac{0.622}{\omega}}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$ex \quad 28.66972\text{Bar} = \frac{100\text{Bar}}{1 + \frac{0.622}{0.25}}$$

36) Specific Humidity given Mass of Water Vapor and Dry Air

$$fx \quad \omega = \frac{m_v}{m_a}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 0.3 = \frac{3\text{kg}}{10\text{kg}}$$

37) Specific Humidity given Partial Pressure of Water Vapor

$$fx \quad \omega = \frac{0.622 \cdot p_v}{p_t - p_v}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 0.933 = \frac{0.622 \cdot 60\text{Bar}}{100\text{Bar} - 60\text{Bar}}$$

38) Specific Humidity given Specific Volumes

$$fx \quad \omega = \frac{v_a}{v_v}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 0.4 = \frac{0.02\text{m}^3/\text{kg}}{0.05\text{m}^3/\text{kg}}$$



39) Total Pressure of Moist Air given Specific Humidity

$$\text{fx } p_t = p_v + \frac{0.622 \cdot p_v}{\omega}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 209.28\text{Bar} = 60\text{Bar} + \frac{0.622 \cdot 60\text{Bar}}{0.25}$$

Vapour Density

40) Dry Bulb Temperature given Vapor Density

$$\text{fx } t_d = \frac{\omega \cdot (p_t - p_v)}{287 \cdot \rho_v}$$

[Open Calculator !\[\]\(8bba887393ca45b761e5cb49e755e762_img.jpg\)](#)

$$\text{ex } 108.885\text{K} = \frac{0.25 \cdot (100\text{Bar} - 60\text{Bar})}{287 \cdot 32\text{kg}/\text{m}^3}$$

41) Partial Pressure of Dry Air given Vapor Density

$$\text{fx } p_a = \frac{\rho_v \cdot 287 \cdot t_d}{\omega}$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3_img.jpg\)](#)

$$\text{ex } 128.576\text{Bar} = \frac{32\text{kg}/\text{m}^3 \cdot 287 \cdot 350\text{K}}{0.25}$$




42) Partial Pressure of Vapor given Vapor Density 

$$fx \quad p_v = p_t - \left(\frac{\rho_v \cdot 287 \cdot t_d}{\omega} \right)$$

Open Calculator 

$$ex \quad -28.576\text{Bar} = 100\text{Bar} - \left(\frac{32\text{kg/m}^3 \cdot 287 \cdot 350\text{K}}{0.25} \right)$$

43) Specific Humidity given Vapor Density 

$$fx \quad \omega = \frac{\rho_v \cdot t_d \cdot 287}{p_t - p_v}$$

Open Calculator 

$$ex \quad 0.8036 = \frac{32\text{kg/m}^3 \cdot 350\text{K} \cdot 287}{100\text{Bar} - 60\text{Bar}}$$

44) Total Pressure of Moist Air given Vapour Density 

$$fx \quad p_t = \frac{287 \cdot \rho_v \cdot t_d}{\omega} + p_v$$

Open Calculator 

$$ex \quad 188.576\text{Bar} = \frac{287 \cdot 32\text{kg/m}^3 \cdot 350\text{K}}{0.25} + 60\text{Bar}$$

45) Vapour Density 

$$fx \quad \rho_v = \frac{\omega \cdot (p_t - p_v)}{287 \cdot t_d}$$

Open Calculator 

$$ex \quad 9.955202\text{kg/m}^3 = \frac{0.25 \cdot (100\text{Bar} - 60\text{Bar})}{287 \cdot 350\text{K}}$$



Variables Used









- **A_c** Surface Area of Coil (Square Meter)
- **BPF** By Pass Factor
- **c** Specific Heat Capacity (Kilojoule per Kilogram per K)
- **h** Enthalpy of Moist Air (Kilojoule per Kilogram)
- **h_{dry}** Enthalpy of Dry Air (Kilojoule per Kilogram)
- **m_a** Mass of Dry Air (Kilogram)
- **m_{air}** Mass of Air (Kilogram)
- **m_s** Mass of Water Vapor in Saturated Air (Kilogram)
- **m_v** Mass of Water Vapor in Moist Air (Kilogram)
- **p_a** Partial Pressure of Dry Air (Bar)
- **p_s** Partial Pressure of Water Vapour in Saturated Air (Bar)
- **p_t** Total Pressure of Moist Air (Bar)
- **p_v** Pressure of Water Vapor (Bar)
- **p_w** Saturation Pressure Corresponding to WBT (Bar)
- **$Q_{sensible}$** Sensible Heat (Joule)
- **S** Degree of Saturation
- **T_c** Temperature of Coil (Kelvin)
- **t_d** Dry Bulb Temperature (Kelvin)
- **t_{db}** Dry Bulb Temperature in °C
- **T_f** Final Temperature (Kelvin)
- **T_i** Initial Temperature (Kelvin)





- T_w Wet Bulb Temperature
- U Overall Heat Transfer Coefficient (*Watt per Square Meter per Kelvin*)
- **WBD** Wet Bulb Depression
- ΔT_m Logarithmic Mean Temperature Difference
- η Efficiency
- v_a Specific Volume of Dry Air (*Cubic Meter per Kilogram*)
- v_v Specific Volume of Water Vapor (*Cubic Meter per Kilogram*)
- ρ_v Vapor Density (*Kilogram per Cubic Meter*)
- Φ Relative Humidity
- ω Specific Humidity
- ω_{max} Maximum Specific Humidity
- ω_s Specific Humidity of Saturated Air



Constants, Functions, Measurements used








- **Constant:** **e**, 2.71828182845904523536028747135266249
Napier's constant
- **Function:** **exp**, exp(Number)
Exponential function
- **Function:** **ln**, ln(Number)
Natural logarithm function (base e)
- **Measurement:** **Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement:** **Area** in Square Meter (m²)
Area Unit Conversion 
- **Measurement:** **Pressure** in Bar (Bar)
Pressure Unit Conversion 
- **Measurement:** **Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement:** **Heat of Combustion (per Mass)** in Kilojoule per Kilogram (kJ/kg)
Heat of Combustion (per Mass) Unit Conversion 
- **Measurement:** **Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg*K)
Specific Heat Capacity Unit Conversion 
- **Measurement:** **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
Heat Transfer Coefficient Unit Conversion 



- **Measurement: Density** in Kilogram per Cubic Meter (kg/m^3)
Density Unit Conversion 
- **Measurement: Specific Volume** in Cubic Meter per Kilogram (m^3/kg)
Specific Volume Unit Conversion 



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