

Formulário de Meteorologia

$$PV = nRT \quad PV = mR_d T \quad PV = mR_d T_v \quad du = c_v dT \quad h = c_p T$$

$$\frac{dp}{dz} = -\rho g \quad p = p_0 e^{-\frac{g}{R_d T}(z-z_0)} \quad z - z_0 = \frac{R_d \bar{T}_v}{g} \ln\left(\frac{p_0}{p}\right) \quad TP^{-\kappa} = const \quad \kappa = \frac{R}{c_p}$$

$$dS = \frac{\delta Q}{T} s = c_p \ln \theta + const \quad \theta = T \left(\frac{p}{p_{00}}\right)^{-\kappa} \quad p_{00} = 10^5 Pa \quad \left(\frac{dT}{dz}\right)_{ad} = -\frac{g}{c_p}$$

$$N^2 = \frac{g}{\theta} \frac{d\theta}{dz} \quad r = \frac{m_v}{m_d} \quad eV = m_v R_v T \quad r \approx \frac{\epsilon \epsilon}{p} \quad T_v \approx T(1 + 0.61 r)$$

$$RH = \frac{r}{r^{sat}} = \frac{e}{e^{sat}} \frac{1}{e^{sat}} \frac{de^{sat}}{dT} = \frac{l_v}{R_v T^2} \quad \delta Q = mc_p dT + l_v dm_v \quad \frac{\delta Q}{m} = c_p dT + l_v dr$$

$$c_p(T - T_w) = -l_v(r - r_w) \quad \frac{dw}{dt} = \frac{T - T_{amb}}{T_{amb}} g \quad CAPE, CIN = \int \frac{g(T - T_{amb})}{T_{amb}} dz \quad N = \sqrt{\frac{g}{T} \left[-\left(\frac{dT}{dz}\right)_{ad} + \left(\frac{dT}{dz}\right)_{amb} \right]}$$

$$F_{Stokes} = 3\pi\eta Dv \quad v_{terminal} = \frac{D^2 \rho g}{18\eta}$$

$$v = \frac{1}{\rho f} \frac{\Delta p}{\Delta n}, \quad fv - \frac{1}{\rho} \frac{\Delta p}{\Delta n} - \frac{v^2}{R} = 0, \quad \frac{Q}{m} = c_p \Delta T + l_v \Delta r, \quad -fv + \frac{1}{\rho} \frac{\Delta p}{\Delta n} - \frac{v^2}{R} = 0, \quad v = \sqrt{\frac{R \Delta p}{\rho \Delta n}}, \quad \begin{cases} \frac{1}{\rho} \frac{\Delta p}{\Delta n} - fv \cos \alpha - F_a \sin \alpha = 0 \\ fv \sin \alpha - F_a \cos \alpha = 0 \end{cases},$$

$$\begin{cases} \frac{dv}{dt} = -\frac{1}{\rho} \frac{\partial p}{\partial s} - F_a & u_2 - u_1 = -\frac{R_d}{f} \frac{dT}{dy} \ln\left(\frac{p_1}{p_2}\right) \\ \frac{v^2}{R} = -\frac{1}{\rho} \frac{\partial p}{\partial n} - fv & v_2 - v_1 = \frac{R_d}{f} \frac{dT}{dx} \ln\left(\frac{p_1}{p_2}\right) \end{cases}, \quad u = -\frac{1}{\rho f} \left(\frac{\partial p}{\partial y}\right)_{x,z}; \quad v = \frac{1}{\rho f} \left(\frac{\partial p}{\partial x}\right)_{y,z}, \quad \phi = gz, \quad u = -\frac{1}{f} \left(\frac{\partial \phi}{\partial y}\right)_{x,p}; \quad v = \frac{1}{f} \left(\frac{\partial \phi}{\partial x}\right)_{y,p},$$

$$\frac{dT}{dt} = \frac{\partial T}{\partial t} + u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} + w \frac{\partial T}{\partial z},$$

$$\begin{cases} \frac{\partial u}{\partial t} = -u \frac{\partial u}{\partial x} - v \frac{\partial u}{\partial y} - w \frac{\partial u}{\partial z} - \frac{1}{\rho} \frac{\partial p}{\partial x} + fv + F_x \\ \frac{\partial v}{\partial t} = -u \frac{\partial v}{\partial x} - v \frac{\partial v}{\partial y} - w \frac{\partial v}{\partial z} - \frac{1}{\rho} \frac{\partial p}{\partial y} - fu + F_y, \quad \tan(\alpha) = \frac{\Delta z}{\Delta x} = \frac{f(\rho_1 v_1 - \rho_2 v_2)}{g(\rho_1 - \rho_2)}, \quad u = \frac{u_*}{k} \ln\left(\frac{z}{z_0}\right) \\ \frac{\partial w}{\partial t} = -u \frac{\partial w}{\partial x} - v \frac{\partial w}{\partial y} - w \frac{\partial w}{\partial z} - \frac{1}{\rho} \frac{\partial p}{\partial z} - g + F_z \end{cases}$$

$$\vec{\zeta} = \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right) \vec{k} = \zeta \vec{k}, \quad \frac{\partial v}{\partial x} \approx \frac{v\left(x + \frac{\Delta x}{2}, y\right) - v\left(x - \frac{\Delta x}{2}, y\right)}{\Delta x}, \quad \delta = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}$$

$$\frac{\partial u}{\partial y} \approx \frac{u\left(x, y + \frac{\Delta y}{2}\right) - u\left(x, y - \frac{\Delta y}{2}\right)}{\Delta y}$$

$$\frac{\partial \zeta_g}{\partial p} = -\frac{R_d}{fp} \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right), \quad w \approx -\frac{\omega}{\rho g}, \quad \zeta_g = \left(\frac{\partial v_g}{\partial x}\right) - \left(\frac{\partial u_g}{\partial y}\right) = \frac{1}{f} \left(\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2}\right)$$

$$\frac{dC}{dt} = \oint_L \vec{v} \cdot d\vec{l} = -\oint_L \frac{dp}{\rho}, \quad (\overline{w'u'}) = -K_m \frac{\partial \bar{u}}{\partial z} \quad \begin{cases} u = u_g(1 - e^{-\gamma z} \cos \gamma z) \\ v = u_g e^{-\gamma z} \sin \gamma z \end{cases}, \quad \bar{u} = \frac{u_*}{k} \ln\left(\frac{z}{z_0}\right)$$

CONSTANTES

Constante	Símbolo	Valor
<i>Constantes universais</i>		
Constante de gravitação	G	$6.673 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Constante de Planck	h	$6.6262 \times 10^{-34} \text{ J s}$
Constante de Stefan-Boltzmann	σ	$5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Constante de Wien	c_w	$2897 \text{ K } \mu\text{m}$
Velocidade da luz no vácuo	c	$2.998 \times 10^8 \text{ m s}^{-1}$
Número de Avogadro	N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Constante de Boltzmann	k	$1.381 \times 10^{-23} \text{ J K}^{-1}$
Constante dos gases ideais	R^*	$8.3143 \text{ J K}^{-1} \text{ mol}^{-1}$
Volume de 1 mol de gas ideal a 0°C, 1 atm (ptn)		22.415 l
<i>Propriedades do ar</i>		
Peso molecular médio do ar seco	M_{as}	28.964 u.m.a.
“Constante” dos gases ideais para o ar seco	R_{as}	$287.05 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor específico a pressão constante do ar seco	c_p	$1005 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor específico a volume constante do ar seco	c_v	$718 \text{ J kg}^{-1} \text{ K}^{-1}$
Condutividade térmica do ar seco (ptn)	λ	$2.40 \times 10^{-2} \text{ W m}^{-1} \text{ K}^{-1}$
Viscosidade cinemática do ar seco (ptn)	ν	$1.34 \times 10^{-5} \text{ m}^2 \text{ s}^{-1}$
<i>Propriedades da água</i>		
Massa molecular	M_{H_2O}	18.016
“Constante” dos gases ideais para o vapor de água	R_{H_2O}	$461 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor latente de vaporização da água (a 0°C)	l_v	$2.5 \times 10^6 \text{ J kg}^{-1}$
Calor latente de vaporização da água (a 100°C)	l_v	$2.25 \times 10^6 \text{ J kg}^{-1}$
Calor latente de fusão da água (a 0°C)	l_f	$3.34 \times 10^5 \text{ J kg}^{-1}$
Calor específico da água líquida (a 0°C)	c_w	$4218 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor específico do vapor de água, a pressão constante (a 0°C)	c_{pv}	18
		$1.85 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor específico do vapor de água, a volume constante (a 0°C)	c_{pv}	$1.39 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$
Calor específico do gelo a 0°C	c_i	$2106 \text{ J kg}^{-1} \text{ K}^{-1}$
Densidade do vapor de água em relação ao ar seco	ϵ	0.622
Massa volúmica da água (a 0°C)		1000 kg m^{-3}
Massa volúmica do gelo (a 0°C)		917 kg m^{-3}
Tensão de vapor de saturação (a 0°C)	ρ^{sat}	610.7Pa
<i>Planeta Terra</i>		
Constante solar	S	$1.37 \times 10^3 \text{ W m}^{-2}$
Velocidade angular da Terra	Ω	$7.292 \times 10^{-5} \text{ s}^{-1}$
Raio médio da Terra	R_T	6371 km
Distância média Terra-Sol (1 unidade astronómica)	R_{TS}	$1.5 \times 10^{11} \text{ m}$
Aceleração da gravidade (valor de referência)	g	9.80665 m s^{-2}
Pressão de referência à superfície	p_0	1013.25 hPa
<i>Outras</i>		
Constante de von Karman	k	0.4