

Equations in Atmospheric Chemistry/Physics – May be Used at the Exam

Constants, values and parameters:

Adiabatic lapse rate (dry):	$\Gamma = -dT/dz = g/C_p = 9,8 \text{ K/km}$
Adiabatic lapse rate (wet):	$\Gamma_w = -dT/dz = 2 - 7 \text{ K/km}$
Aerosol particle/drop diameter:	D
Altitude:	z
Angular velocity:	ω
Atmospheric absorption of radiation:	f
Atmospheric mean composition (dry):	N ₂ : 0,78; O ₂ : 0,21; Ar: 0,01 [mole/mole]
Atmospheric mean pressure at sea level:	1013 hPa
Atmospheric mean surface pressure:	984 hPa
Atmospheric mean temperature at sea level:	288 K
Atmospheric mean temperature (vertically):	260 K
Avogadro's number:	$N_{av} = 6,023 \cdot 10^{26} \text{ kmole}^{-1}$
Backscattered fraction:	β
Cloud droplets, number concentration:	N
Cunningham correction factor:	C_c
Density:	ρ
Earth albedo:	A = 0,28
Earth radius:	$R_j = 6,37 \cdot 10^6 \text{ m}$
Earth-to-sun distance:	$d = 1,496 \cdot 10^{11} \text{ m}$
Gas constant:	$R = 8314,3 \text{ J/(kmole K)}$
Gravitation:	$g = 9,81 \text{ m/s}^2$
Latitude:	λ
Molar mass:	M
Molar mass, mean for the atmosphere:	M_a
No. ions per salt "molecule":	v
Optical depth:	δ
Pressure:	P
Solar constant:	$F_S = 1370 \text{ W/m}^2$
Solar radius:	$R_S = 6,96 \cdot 10^8 \text{ m}$
Solar surface temperature:	$T_S = 5780 \text{ K}$
Stefan-Boltzmann constant:	$\sigma = 5,67 \cdot 10^{-8} \text{ W/(m}^2\text{K}^4)$
Surface tension:	σ_D
Target distance:	ΔX
Temperature:	T
Vapour pressure:	P
Vapour pressure, saturated:	P_{sat}
Velocity relative the earth surface:	v
Velocity relative surrounding air:	V
Viscosity:	μ

Physics:

Albedo, aerosol layer: $A_a = \beta\delta$

Albedo, sum of two layers:

$$A_T = A_1 + A_0(1 - A_1)^2 + A_0^2 A_1(1 - A_1)^2 + \sum_{n=2}^{\infty} A_0^{n+1} A_1^n (1 - A_1)^2$$

Albedo, change for clouds:

$$\Delta A = \frac{A(1 - A)}{3} \frac{\Delta N}{N}$$

Barometric law:

$$P = P_0 \exp(-z/H), \text{ scale height } H = RT/M_a g$$

Boyant acceleration:

$$\gamma_b = (\rho' - \rho)g/\rho$$

Climate sensitivity parameter:

$$\lambda = 1/[4(1 - f)\sigma T^3]$$

Coriolis acceleration:

$$\gamma_c = 2\omega v \sin(\lambda)$$

Coriolis, resultind deviation:

$$\Delta Y = \omega(\Delta X)^2 \sin(\lambda)/v$$

Drag force (Stokes' law):

$$F_m = 3\pi v \eta D/C_c$$

Kelvin effekt:

$$P^*/P_{\text{sat}} = \exp(4\sigma_D M/\rho R T D)$$

Köhler equation:

$$P/P_{\text{sat}} = \exp(4\sigma_D M/\rho R T D)/[1 + 6v m_s M_w/(M_s \rho_w \pi D^3)]$$

Mass balance equation:

$$dm/dt = F_{\text{in}} - F_{\text{ut}} + E - D + P - L$$

Radiative forcing:

$$\Delta F = F_{\text{ut, jämvikt}} - F_{\text{ut, störd}}$$

Radiation from a black body:

$$F_T = \sigma T^4$$

Raoults law:

$$P/P_{\text{sat}} = 1/[1 + 6v m_s M_w/(M_s \rho_w \pi D^3)]$$

Relative humidity:

$$RH = 100 P_{\text{H}_2\text{O}}/P_{\text{sat}} (\%)$$

Residence time:

$$\tau = m/(F_{\text{ut}} + D + L)$$

Sedimentation velocity aerosol:

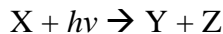
$$V_{\text{TS}} = \rho_p D^2 g C_c / (18\eta)$$

Chemistry:

Irreversible reaction (A+B → C+D):

$$\frac{d[C]}{dt} = \frac{d[D]}{dt} = \frac{-d[A]}{dt} = \frac{-d[B]}{dt} = k[A][B]$$

Photolysis:



$$-d[X]/dt = k[X], \quad k = q\sigma I \text{ (photolysis rate constant)}$$

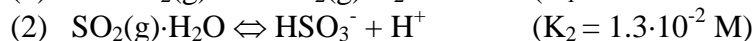
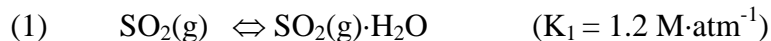
Stationary state:

$$d[X]/dt = P - L = 0$$

Oxygen atoms:

O denotes O(³P) which is a biradical.

Gases SO₂ and CO₂ dissolves in several steps in water according to the formulae below (K_i equilibrium constants):



respective

