Fysiikka III – Physics III

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$$\rho_{\mathrm{n}} = N/V$$

$$N = nN_{\mathrm{A}} \qquad M = Nm = nM_{\mathrm{mol}} \qquad N_{\mathrm{A}} = 6,02{\cdot}10^{23}\,\mathrm{mol}^{-1}$$

$$T = \frac{p}{p_3^{\mathrm{vesi}}}{\cdot}273,16\,\mathrm{K}$$

$$pV = nRT \qquad pV = Nk_{\mathrm{B}}T$$

$$R \approx 8,31\,\mathrm{J/Kmol} \qquad k_{\mathrm{B}} \approx 1,38 \times 10^{-23}\,\mathrm{J/K}$$

$$E_{\mathrm{sys}} = E_{\mathrm{mech}} + E_{\mathrm{int}} = K + U + E_{\mathrm{th}} + E_{\mathrm{chem}} + E_{\mathrm{nuc}} + ...$$

$$\Delta E_{\mathrm{sys}} = \Delta E_{\mathrm{mech}} + \Delta E_{\mathrm{th}}$$

$$\Delta E_{\mathrm{sys}} = Q + W$$

$$dW = -p\,dV$$

$$W = -\int_{V_{\mathrm{i}}}^{V_{\mathrm{f}}} p\,dV$$

$$dV = 0 \Rightarrow W = 0$$

$$W = -p\int_{V_{\mathrm{i}}}^{V_{\mathrm{f}}} dV = -p\Delta V$$

$$W = -nRT\ln\frac{V_{\mathrm{f}}}{V_{\mathrm{i}}} = -nRT\ln\frac{P_{\mathrm{i}}}{P_{\mathrm{f}}}$$

$$Q = Mc\Delta T$$

$$\Delta E_{\mathrm{th}} = Mc\Delta T$$

$$Q = nC\Delta T$$

$$Q = \pm ML_{\mathrm{f}} \qquad Q = \pm ML_{\mathrm{v}}$$

$$Q_{\mathrm{net}} = Q_1 + Q_2 + \ldots + Q_K = 0$$

$$Q = nC_{\mathrm{V}}\Delta T \qquad Q = nC_{\mathrm{P}}\Delta T$$

$$C_{\mathrm{P}} = C_{\mathrm{V}} + R$$

$$\Delta E_{\mathrm{th}} = nC_{\mathrm{V}}\Delta T$$

$$W = nC_{\mathrm{V}}\Delta T$$

$$pV^{\gamma} = \text{VAKIO} \qquad \gamma = C_{\mathrm{P}}/C_{\mathrm{V}}$$

$$TV^{\gamma-1} = \text{VAKIO}$$

$$H = kA\,\frac{T_{\mathrm{H}} - T_{\mathrm{C}}}{L}$$

$$H = e\sigma AT^4 \quad \sigma \approx 5,67 \times 10^{-8}\,\mathrm{Wm^{-2}K^{-4}}$$

$$H_{\mathrm{net}} = H_{\mathrm{ulos}} - H_{\mathrm{sisn}} = e\sigma A(T^4 - T_0^4)$$

$$\lambda = \bar{v}\tau = \frac{V/N}{4\sqrt{2}\,\pi\,r^2}$$

$$p = \frac{1}{3}\frac{N}{V}mv_{\mathrm{rms}}^2 \qquad v_{\mathrm{rms}} = \sqrt{(v^2)_{\mathrm{avg}}}$$

$$\varepsilon = \tfrac{1}{2}mv^2 \qquad \varepsilon_{\mathrm{avg}} = \tfrac{1}{2}mv_{\mathrm{rms}}^2$$

$$\varepsilon_{\mathrm{avg}} = \tfrac{3}{2}k_{\mathrm{B}}T \qquad v_{\mathrm{rms}} = \sqrt{3k_{\mathrm{B}}T/m}$$

$$E_{\mathrm{th}} = \tfrac{3}{2}Nk_{\mathrm{B}}T = \tfrac{3}{2}nRT$$

$$dE_{\mathrm{th}} = nC_{\mathrm{V}}\,dT \;\Rightarrow\; C_{\mathrm{V}} = n^{-1}dE_{\mathrm{th}}/dT = \tfrac{3}{2}R$$

$$C_{\mathrm{V}} = \frac{5}{2}R \qquad C_{\mathrm{V}} = \frac{7}{2}R$$

$$W_{\mathrm{s}} = -W$$

$$W_{\mathrm{out}} = Q_{\mathrm{net}} = Q_{\mathrm{H}} - Q_{\mathrm{C}}$$

$$\eta = \frac{W_{\mathrm{out}}}{Q_{\mathrm{H}}} = 1 - \frac{Q_{\mathrm{C}}}{Q_{\mathrm{H}}}$$

$$K = \frac{Q_{\mathrm{C}}}{W_{\mathrm{in}}} = \frac{1}{Q_{\mathrm{H}}/Q_{\mathrm{C}} - 1}$$

$$\eta_{\mathrm{Carnot}} = 1 - \frac{T_{\mathrm{C}}}{T_{\mathrm{H}}}$$

$$T = 1/f \qquad v = \lambda f$$

$$\omega = 2\pi/T \qquad k = 2\pi/\lambda \qquad \Rightarrow \qquad v = \lambda/T = \omega/k$$

$$D(x,t) = A\sin(kx - \omega t + \phi_0)$$

$$D(x,t) = A\sin(2\pi x/\lambda - 2\pi t/T + \phi_0)$$

$$D(x, t+T) = D(x,t)$$

$$D(x+\lambda, t) = D(x,t)$$

$$D(x,t) = D(x - vt, 0)$$

$$D = D(x - vt)$$

$$\phi = kx - \omega t + \phi_0$$

$$\Delta\phi = \phi_2 - \phi_1 = k(x_2 - x_1) = 2\pi\frac{\Delta x}{\lambda}$$

$$v_{\mathrm{light}} = c = 299792458\,\mathrm{m/s} \approx 3 \cdot 10^8\,\mathrm{m/s}$$

$$v = c/n \qquad \lambda = \lambda_{\mathrm{vacuum}}/n \qquad k = k_{\mathrm{vacuum}}n$$

$$I = P/a = P_{\mathrm{source}}/4\pi r^2$$

$$I = \textsc{vakio} \times A^2$$

$$\beta = 10\,\log_{10}(I/I_0)\ \mathrm{dB} \qquad I_0 = 10^{-12}\,\mathrm{W/m^2}$$

$$\vec{D}_{\mathrm{net}}(\vec{r},t) = \vec{D}_1(\vec{r},t) + \vec{D}_2(\vec{r},t) + \ldots$$

$$D_{\mathrm{net}}(\vec{r},t) = D_1(\vec{r},t) + D_2(\vec{r},t) + \ldots$$

$$2\pi\Delta x/\lambda + \Delta\phi_0 = 2\pi\,m, \quad m \in Z$$

$$2\pi\Delta x/\lambda + \Delta\phi_0 = 2\pi\,(m + \tfrac{1}{2}), \quad m \in Z$$

$$D = A\sin[kx_{\mathrm{avg}} - \omega t + (\phi_0)_{\mathrm{avg}}]$$

$$A = 2a|\cos\tfrac{1}{2}\Delta\phi|$$

$$D_i = a\sin(kr_i - \omega t + \phi_0)$$

$$\Delta\phi = 2\pi\Delta r/\lambda + \Delta\phi_0$$

$$2\pi\Delta r/\lambda + \Delta\phi_0 = 2\pi\, m$$

$$2\pi\Delta r/\lambda + \Delta\phi_0 = 2\pi\,(m + \tfrac{1}{2})$$

$$\Delta r = m\lambda \qquad \Delta r = (m + \tfrac{1}{2})\lambda$$

$$D_1 = a\sin(k_1 x - \omega_1 t + \phi_{10}) \qquad D_2 = a\sin(k_2 x - \omega_2 t + \phi_{20})$$

$$D(0,t) = a\sin\omega_1 t + a\sin\omega_2 t = 2a\cos(\omega_{\mathrm{mod}} t)\,\sin(\omega_{\mathrm{avg}} t)$$

$$\omega_{\mathrm{mod}} = \tfrac{1}{2}|\omega_1 - \omega_2| \qquad \omega_{\mathrm{avg}} = \tfrac{1}{2}(\omega_1 + \omega_2).$$

$$\theta_m \approx \sin\theta_m = m\,\lambda/d$$

$$\theta'_m \approx \sin\theta'_m = (m + 1/2)\,\lambda/d$$

$$y_m \approx Lm\,\lambda/d$$

$$y'_m \approx L(m + 1/2)\,\lambda/d$$

$$I_{\mathrm{double}} = 4I_1\cos^2\Big(\pi\frac{d}{\lambda}\sin\theta\Big) \approx 4I_1\cos^2\Big(\frac{\pi d}{\lambda L}y\Big)$$

$$\sin\theta_m = m\,\lambda/d$$

$$\sin\theta = \pm\frac{\lambda}{a}$$

$$\theta_p \approx \sin\theta_p = p\frac{\lambda}{a}$$

$$\sin\theta_1 \approx 1,22\,\frac{\lambda}{D}$$

$$\theta_{\mathrm{r}} = \theta_{\mathrm{i}}$$

$$n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\theta_{\mathrm{c}} = \arcsin\,\frac{n_2}{n_1}$$

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$$

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$f = R/2$$

$$m = -s'/s$$

$$2d\,\cos\theta_m = m\lambda$$

$$E_{\mathrm{photon}} = hf = \hbar\omega$$

$$\lambda = h/p$$

Vesi
Ominaislämpö: 4190 J/kgK (neste), 2100 J/kgK (jää).
Höyrystymislämpö 2256 kJ/kg, sulamislämpö 334 kJ/kg.
Taitekerroin 1,33 (neste), 1.31 (jää).

Muuta
Lasin taitekerroin $\approx 3/2$ ja veden $\approx 4/3$.