

I. Az „élő” anyag legfontosabb szerkezeti tulajdonságai és szerepük a biológiai funkciókban

$$hf = E_j - E_i \quad (I.1) \quad n_i = n_0 e^{-\frac{\varepsilon_i - \varepsilon_0}{kT}} \quad R = N_A k \quad (I.25)$$

$$\lambda = \frac{h}{p} = \frac{h}{m\nu} \quad (I.3) \quad \bar{\varepsilon}_{\text{mozgási}} = \frac{1}{2} m \overline{\nu^2} = \frac{3}{2} kT \quad (I.34)$$

$$\Delta M = [Z \cdot m_p + (A - Z) \cdot m_n] - M(A, Z) \quad pV = NkT \quad (I.35)$$

$$E = mc^2 \quad (I.19)$$

II. Sugárzások és kölcsönhatásuk az „élő” anyaggal

$$M = \frac{\Delta P}{\Delta A} \quad (II.2) \quad \frac{M_{\lambda_i}}{\alpha_{\lambda_i}} = \frac{M_{\lambda_j}}{\alpha_{\lambda_j}} \quad (II.39)$$

$$E_{\text{be}} = \frac{\Delta P}{\Delta A} \quad \sim \frac{1}{r^2}, \quad \sim \frac{1}{r} \quad (II.3) \quad M_{\text{fekete}}(T) = \sigma T^4 \quad (II.41)$$

$$J_E = \frac{\Delta E}{\Delta t \Delta A} \quad \text{a továbbiakban } J \quad (II.5) \quad \Delta M = \sigma(T_{\text{test}}^4 - T_{\text{környezet}}^4)$$

$$\Delta J = -\mu \Delta x J \quad (II.10) \quad \lambda_{\text{max}} T = \text{állandó} \quad (II.42)$$

$$J = J_0 e^{-\mu x} \quad \mu = \frac{1}{\delta} \quad (II.11) \quad \mu = K(N_1 - N_2) \quad (II.56)$$

$$J = J_0 2^{-\frac{x}{D}} \quad (II.12) \quad P_{\text{szórt}} \sim \frac{p_0^2}{c^3} \omega^4 \sim \frac{1}{\lambda^4} \quad (II.60)$$

$$\mu = \frac{\ln 2}{D} \quad (II.13) \quad \kappa = \frac{-\frac{\Delta V}{V}}{\Delta p} \quad (II.63)$$

$$\frac{\sin \alpha}{\sin \beta} = \frac{c_1}{c_2} = n_{21} \quad (II.14) \quad Z = c\rho \quad (II.67)$$

$$D = \frac{n_2 - n_1}{r} \quad (II.17) \quad R = \frac{J_R}{J_0} \quad (II.76)$$

$$D = D_1 + D_2 \quad (II.21) \quad R = \left(\frac{Z_1 - Z_2}{Z_1 + Z_2} \right)^2 \quad (II.77)$$

$$c = \frac{\lambda}{T}, \quad \text{illetve } c = \lambda f \quad (II.26) \quad eU_{\text{anód}} = \varepsilon_{\text{max}} = hf_{\text{max}} \quad (II.79)$$

$$J \sim A^2 \quad (II.27) \quad \lambda_{\text{min}} = \frac{hc}{eU_{\text{anód}}} \quad (II.80)$$

$$J_1 + J_2 \neq J_{\text{eredő}} \quad (II.28) \quad P_{\text{Rt}} = c_{\text{Rt}} U_{\text{anód}}^2 Z I_{\text{anód}} = \eta U_{\text{anód}} I_{\text{anód}} \quad (II.82)$$

$$E_{\text{mozgási}} = hf - W_{\text{ki}} \quad (II.37)$$

$$\mu = \mu_m \rho \quad x_m = \rho x \quad (\text{II.85})$$

$$\varepsilon = hf = E_{\text{kötési}} + E_{\text{mozgási}} \quad (\text{II.86})$$

$$\tau_m = \frac{\tau}{\rho} = C_{\text{foto}} \lambda^3 Z^3 \quad (\text{II.87})$$

$$hf = E_{\text{kötési}} + hf' + E_{\text{mozgási}} \quad (\text{II.89})$$

$$\frac{\Delta N}{\Delta t} = -\lambda N \quad (\text{II.95})$$

$$N = N_0 e^{-\lambda t} \quad \lambda = \frac{1}{\tau} \quad (\text{II.96})$$

$$\lambda T = \ln 2 \quad \frac{1}{T_{\text{eff}}} = \frac{1}{T_{\text{fiz}}} + \frac{1}{T_{\text{biol}}} \quad (\text{II.98})$$

$$A = -\frac{\Delta N}{\Delta t} \quad (\text{II.99})$$

$$A = A_0 e^{-\lambda t} \quad (\text{II.101})$$

$$\mu = \tau + \sigma + \kappa \quad s = \frac{\Delta E}{\Delta x} \quad s = s_m \rho \quad (\text{II.102})$$

$$hf = 2m_e c^2 + 2E_{\text{mozgási}} \quad (\text{II.103})$$

$$D = \frac{\Delta E}{\Delta m} \quad D_{\text{levegő}} = K_\gamma \frac{At}{r^2} \quad (\text{II.105})$$

$$X = \frac{\Delta Q}{\Delta m} \quad (\text{II.106})$$

$$D_{\text{levegő}} = f_0 X \quad (\text{II.107})$$

$$D \sim \mu_m J, \text{ illetve } D \sim s_m$$

$$H_T = \sum_R w_R D_{TR} \quad (\text{II.108})$$

$$E = \sum_T w_T H_T \quad (\text{II.110})$$

$$S = \sum_i N_i E_i \quad (\text{II.111})$$

III. Transzportjelenségek élő rendszerekben

$$I_V = \frac{\Delta V}{\Delta t} = \frac{\Delta v}{c \Delta t} \quad (\text{III.1})$$

$$u = \frac{v}{F} \quad (\text{III.19})$$

$$I_V = A \bar{v} = \text{állandó} \quad (\text{III.4})$$

$$l = \bar{v} \tau \quad (\text{III.25})$$

$$p + \frac{1}{2} \rho v^2 + \rho gh = \text{állandó} \quad (\text{III.5})$$

$$v_{\text{drift}} = \frac{F}{m} \tau \quad (\text{III.26})$$

$$F = \eta A \frac{\Delta v}{\Delta h} \quad (\text{III.6})$$

$$I_N = \frac{\Delta N}{\Delta t} \quad (\text{III.28})$$

$$I_V = -\frac{\pi}{8\eta} R^4 \frac{\Delta p}{\Delta l} \quad (\text{III.12})$$

$$I_v = \frac{\Delta v}{\Delta t} \quad (\text{III.29})$$

$$R_{\text{cső}} = 8\pi\eta \frac{\Delta l}{(r^2 \pi)^2} \quad (\text{III.14})$$

$$J_v = \frac{\Delta I_v}{\Delta A} \quad (\text{III.30})$$

$$v_{\text{krit}} = \text{Re} \frac{\eta}{\rho r} \quad (\text{III.17})$$

$$J_v = -D \frac{\Delta c}{\Delta x} \quad (\text{III.31})$$

$$F = 6\pi\eta r v \quad (\text{III.18})$$

$$D = \frac{1}{3} vl = ukT \quad (\text{III.33})$$

$$-\frac{\Delta J_v}{\Delta x} = \frac{\Delta c}{\Delta t} \quad (\text{III.38})$$

$$D \frac{\Delta \left(\frac{\Delta c}{\Delta x} \right)}{\Delta x} = \frac{\Delta c}{\Delta t} \quad (\text{III.39})$$

$$\sigma_x \sim \overline{R(t)} \sim \sqrt{Dt} \quad (\text{III.40})$$

$$p_{\text{ozmózis}} = cRT \quad (\text{III.50})$$

$$J_v = -L_T \frac{\Delta T}{\Delta x} \quad (\text{III.51})$$

$$J_E = -\lambda \frac{\Delta T}{\Delta x} \quad (\text{III.53})$$

$$J = LX \quad J = \frac{\Delta x_{\text{ext}}}{A \Delta t} \quad X = -\frac{\Delta y_{\text{int}}}{\Delta x} \quad (\text{III.54})$$

$$\Delta E = Q_E + W \quad Q_E = cm \Delta T \quad (\text{III.56})$$

$$W_V = -p \Delta V \quad W_Q = \varphi \Delta Q \quad W_v = \mu \Delta v \quad (\text{III.58})$$

$$W^{(i)} = y_{\text{int}}^{(i)} \Delta x_{\text{ext}}^{(i)} \quad (\text{III.59})$$

$$W_{vQ} = W_v + W_Q = (\mu + zF\varphi) \Delta v = \mu_e \Delta v \quad (\text{III.61})$$

$$Q_E = T \Delta S \quad (\text{III.63})$$

$$\Delta E = \sum_{(i)} y_{\text{int}}^{(i)} \Delta x_{\text{ext}}^{(i)} \quad (\text{III.64})$$

$$\Delta S = \frac{\Delta E_1}{T_1} + \frac{\Delta E_2}{T_2} = \Delta E \left(\frac{1}{T_1} - \frac{1}{T_2} \right) \quad (\text{III.67})$$

$$S = k \ln \Omega \quad (\text{III.72})$$

$$E = TS - pV + \mu v \quad (\text{III.83})$$

$$H = E + pV \quad (\text{III.84})$$

$$\Delta H_p = Q_E + W_v \quad (\text{III.87})$$

$$\Delta H_{p,v} = Q_E \quad (\text{III.88})$$

$$F = E - TS \quad (\text{III.89})$$

$$\Delta F_T = W_V + W_v \quad (\text{III.91})$$

$$\Delta F_{T,v} = W_V \quad (\text{III.92})$$

$$\Delta F_{T,V} = W_v \quad (\text{III.93})$$

$$G = H - TS \quad (\text{III.94})$$

$$\Delta G_{T,p} = W_v \quad (\text{III.96})$$

$$\Delta G_{T,p} \leq 0 \quad (\text{III.99})$$

$$\Delta F_{T,V} \leq 0 \quad (\text{III.100})$$

$$\Delta H_{S,p} \leq 0 \quad (\text{III.101})$$

$$G = \mu_A v_A + \mu_B v_B \quad (\text{III.105})$$

$$\mu_A = \mu_A^0 + RT \ln(c_A) \quad (\text{III.109})$$

$$J_m = -p(c_{v_2} - c_{v_1}) \quad (\text{III.113})$$

$$J_k = -L_k \frac{\Delta \mu_e}{\Delta x} \quad (\text{III.116})$$

$$L_k = c_k \frac{D_k}{RT} = \frac{c_k u_k}{N_A} \quad (\text{III.118})$$

$$J_k = -D_k \left(\frac{\Delta c_k}{\Delta x} + c_k \frac{z_k F}{RT} \frac{\Delta \varphi}{\Delta x} \right) \quad (\text{III.119})$$

$$U = \frac{RT}{F} \ln \frac{\sum_{k=1}^m p_k^+ c_{k,\text{II}}^+ + \sum_{k=1}^n p_k^- c_{k,\text{I}}^-}{\sum_{k=1}^m p_k^+ c_{k,\text{I}}^+ + \sum_{k=1}^n p_k^- c_{k,\text{II}}^-} \quad (\text{III.121})$$

$$U = \varphi^{\text{II}} - \varphi^{\text{I}} = \frac{RT}{z_1 F} \ln \frac{c_i^{\text{I}}}{c_i^{\text{II}}} \quad (\text{III.123})$$

$$U_m(t) = U_t \left(1 - e^{-\frac{t}{R_m C_m}} \right) \quad (\text{III.130})$$

$$U_m(t) = U_t e^{-\frac{t}{R_m C_m}} \quad (\text{III.132})$$

$$U_m(x) - U_m(0) = U_t e^{-\frac{x}{\lambda}} \quad (\text{III.133})$$

IV. Az érzékszervek biofizikája

$$\Delta\Psi \sim \frac{\Delta\Phi}{\Phi} \quad (IV.5) \quad n = 10 \lg \left(\frac{J_1}{J_2} \right) \quad (IV.25)$$

$$\Psi \sim \log \frac{\Phi}{\Phi_0} \quad (IV.6) \quad n = 10 \lg \left(\frac{P_{ki}}{P_{be}} \right) = 10 \lg \left(\frac{J_{ki}}{J_{be}} \right) \quad (IV.26)$$

$$\frac{\Delta\Psi}{\Psi} \sim \frac{\Delta\Phi}{\Phi} \quad (IV.7) \quad n = n_{er\acute{o}s\acute{i}t\acute{e}s} + n_{csillap\acute{i}t\acute{a}s} \quad (IV.27)$$

$$\Psi \sim \left(\frac{\Phi}{\Phi_0} \right)^n \quad (IV.8) \quad H_{phon} = 10 \lg \left(\frac{J}{J_0} \right) \quad (IV.29)$$

$$n_{okt\acute{a}v} = \log_2 \frac{f_2}{f_1} \quad (IV.22) \quad H_{son} = \frac{1}{16} \left(\frac{J}{J_0} \right)^{0,3} \quad (IV.31)$$

VI. A molekul\aris \e>s sejtdiagnosztika fizikai m\odszerei

$$N_{sz\acute{o}g} = \frac{\operatorname{tg} \beta}{\operatorname{tg} \alpha} = a \left(\frac{1}{f} - \frac{1}{k} \right) \quad (VI.18) \quad N = N_0 e^{-(k_f + k_{nr})t} \quad (VI.39)$$

$$N_{sz\acute{o}g} = -\frac{da}{f_1 f_2} \quad (VI.23) \quad \tau = \frac{1}{k_f + k_{nr}} \quad (VI.40)$$

$$\Delta s = d \sin \alpha_k = k \lambda \quad (VI.24) \quad Q_f = k_f \tau \quad (VI.41)$$

$$\delta = 0,61 \frac{\lambda}{n \sin \omega} \quad f = \frac{1}{\delta} \quad (VI.28) \quad p = \frac{J_{VV} - J_{VH}}{J_{VV} + J_{VH}} \quad (VI.43)$$

$$A = \lg \left(\frac{J_0}{J} \right) = \varepsilon(\lambda) c x \quad (VI.34)$$

VII. Elektromos jelek \e>s m\odszerek az orvosi gyakorlatban

$$U_R = U_T e^{-\frac{t}{RC}} \quad U_C = U_T \left(1 - e^{-\frac{t}{RC}} \right) \quad (VII.2) \quad K_U = \frac{U_{ki}}{U_{be}} \quad K_P = \frac{P_{ki}}{P_{be}} \quad (VII.6)$$

$$X_C = \frac{1}{2\pi f C} \quad (VII.4) \quad K_P = K_U^2 \quad \text{ha } R_{ki} = R_{be} \quad (VII.8)$$

$$U_{ki} = U_{be} \frac{R}{\sqrt{R^2 + X_C^2}} \quad f_h = \frac{1}{2\pi RC} \quad (VII.5) \quad U_{ki} = (U_{be_1} - U_{be_2}) K_U \quad (VII.11)$$

$$f_0 = \frac{1}{2\pi \sqrt{LC}} \quad K_{U_v} = \frac{K_U}{1 - K_{v_U} K_U} \quad K_{v_U} = \frac{U_{vissza}}{U_{ki}} \quad (VII.14)$$

VIII. Képzőmódszerek

$$\lg \frac{J_0}{J} = (\mu_1 x_1 + \mu_2 x_2 + \dots) \lg e \quad (\text{VIII.2})$$

$$hf_0 = g_N \mu_N H_0 \quad (\text{VIII.3})$$

$$f' = f \left(1 \pm \frac{v}{c} \right) \quad (\text{VIII.4})$$

$$f_D = f' - f = \frac{\pm v}{c} f \quad f_D = \frac{\pm 2v}{c} f \quad (\text{VIII.5})$$

$$HU = \frac{\mu - \mu_{\text{vöz}}}{\mu_{\text{vöz}}} 1000 \quad (\text{VIII.10})$$

IX. Terápiás módszerek fizikai alapjai

$$a_{\text{küszöb}} = \frac{q}{\tau} + r$$

$$2r = \frac{q}{C} + r$$

Statisztika

$$g(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (1)$$

$$r = \frac{Q_{xy}}{\sqrt{Q_x Q_y}} \quad (19)$$

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} \quad (2)$$

$$t_{[n-1]} = \frac{\bar{x} - \mu_0}{s_{\bar{x}}} \quad (20)$$

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{Q_x}{n-1}} \quad (4)$$

$$t_{[n_1+n_2-2]} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{Q_1+Q_2}{n_1+n_2-2}}} \sqrt{\frac{n_1 n_2}{n_1+n_2}} \quad (21)$$

$$Q_x \equiv Q_{xx} = \sum_{i=1}^n x_i^2 - \frac{\left(\sum_{i=1}^n x_i \right)^2}{n} \quad (6)$$

$$t_{[n-2]} = r \sqrt{\frac{n-2}{1-r^2}} \quad (22)$$

$$Q_{xy} = \sum_{i=1}^n x_i y_i - \frac{\left(\sum_{i=1}^n x_i \right) \left(\sum_{i=1}^n y_i \right)}{n}$$

$$\chi_{[1]}^2 = \frac{n(ad-bc)^2}{(a+b)(c+d)(a+c)(b+d)} \quad (23)$$

$$s_{\bar{x}} = \frac{s}{\sqrt{n}} \quad (8)$$

$$\chi^2 = \sum \left[\frac{(O-E)^2}{E} \right] \quad (24)$$

$$Q_h(a,b) = \sum_{i=1}^n [y_i - (ax_i + b)]^2 \quad (16)$$

$$z = \frac{T_1 - n_1(n_1+n_2+1)/2}{\sqrt{n_1 n_2 (n_1+n_2+1)/12}}$$

$$a^* = \frac{Q_{xy}}{Q_{xx}} \quad (17)$$

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2-1)} \quad (25)$$

$$b^* = \bar{y} - a^* \bar{x} \quad (18)$$

$$RR = \frac{a/(a+b)}{c/(c+d)} = \frac{a(c+d)}{c(a+b)} \quad (26)$$

$$SE(\ln RR) = \sqrt{\frac{1-a/(a+b)}{a} + \frac{1-c/(c+d)}{c}} \quad (27)$$

$$OR = \frac{a/b}{c/d} = \frac{ad}{bc} \quad (28)$$

Gyakorlatok

MIKROSZKÓP

$$D = \frac{1}{f} = (n_{21} - 1) \left(\frac{1}{R_1} + \frac{1}{R_2} \right) \quad (2)(\text{II.23})$$

$$N_{\text{szög}} = -\frac{da}{f_1 f_2} \quad (\text{VI.23})$$

SPECIÁLIS MIKROSZKÓPOK

$$\Delta s = d \sin \alpha_k = k\lambda \quad (1)(\text{VI.24})$$

$$\delta = 0,61 \frac{\lambda}{n \sin \omega} \quad (3)(\text{VI.28})$$

REFRAKTOMÉTER

$$\frac{1}{\sin \beta_h} = \frac{n_2}{n_1} = n_{21} \quad (5)$$

$$n = n_0 + Kc \quad (7)$$

FÉNYEMISSZIÓ

$$\lambda_{\text{max}} T = \text{állandó} \quad (\text{II.42})$$

$$hf = E_j - E_i \quad (\text{I.1})$$

FÉNYABSZORPCIÓ

$$T = \frac{J}{J_0} (100\%) \quad (2)$$

$$A = \lg \left(\frac{J_0}{J} \right) = \varepsilon(\lambda) cx \quad (7)(\text{VI.34})$$

A SZEM OPTIKÁJA

$$D = \frac{n}{t} + \frac{n'}{k} \quad (1)(\text{II.18})$$

$$SE(\ln OR) = \sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}} \quad (29)$$

$$\Delta D = D_p - D_r = \frac{1}{t_p} - \frac{1}{t_r} \quad (4)$$

$$\text{látásélesség (visus)} = \frac{1(\prime)}{\alpha(\prime)} 100\% \quad (6)$$

$$\alpha(\prime) \approx \frac{a}{x} (\text{rad}) \frac{360(\circ)}{2\pi(\text{rad})} 60 \left(\frac{\prime}{\circ} \right) \quad (7)$$

$$a' = \frac{17a}{x} (\text{mm}) \quad (8)$$

$$\text{receptorsűrűség} \approx \frac{1}{(a')^2} \left(\frac{1}{\text{mm}^2} \right) \quad (9)$$

$$d'_1 = 17 \frac{d}{x_1} (\text{mm}) \quad d'_2 = 17 \frac{d}{x_2} (\text{mm}) \quad (11)$$

NUKLEÁRIS MÉRÉSTECHNIKA

$$N_j = N_{j+z} - N_z \quad (2)$$

GAMMA ABSZORPCIÓ

$$\frac{J}{J_0} = \frac{1}{2} = e^{-\mu D} \quad (2)$$

$$x_{1/10} = 3,33D \quad (5)$$

$$\mu = \frac{\ln 2}{D} \quad (\text{II.13})(3)$$

$$\mu = \mu_m \rho \quad D_m = \rho D \quad (\text{II.85})$$

$$\mu_m = \tau_m + \sigma_m + \kappa_m \quad (10)$$

GAMMA ENERGIA

$$\frac{\varepsilon_1}{\varepsilon_2} = \frac{U_1}{U_2} \quad (1)$$

IZOTÓPDIAGNOSZTIKA

$$\frac{1}{T_{\text{eff}}} = \frac{1}{T_{\text{fiz}}} + \frac{1}{T_{\text{biol}}} \quad (1)$$

RÖNTGEN – CT

$$D_i = \lg \frac{J_{i_0}}{J_i} = \lg e \cdot \sum_{j=1}^n \mu_{ij} \Delta x \quad (6)$$

DOZIMETRIA

$$D = \frac{\Delta E}{\Delta m} \quad (1 \text{ rad} = 0,01 \text{ J/kg}) \quad (1)$$

$$X = \frac{\Delta q}{\Delta m} \quad (1 \text{ R} = 2,6 \cdot 10^{-4} \text{ C/kg}) \quad (2)$$

$$D_{\text{levegő}} = f_0 X \quad (3)(\text{II.107})$$

$$D_{\text{levegő}} = K_\gamma \frac{At}{r^2} \quad (8)$$

$$U = \frac{Q}{C} \sim X \quad (10)$$

$$U = IR = \frac{Q}{t} R \sim \frac{X}{t} \quad (11)$$

$$P_{\text{Rtg}} = c_{\text{Rtg}} U_{\text{anód}}^2 Z I_{\text{anód}} \quad (\text{II.82})$$

UV-DOZIMETRIA

$$E_{\text{be}} = \frac{\Delta P}{\Delta A} \quad (1)(\text{II.3})$$

$$H = SEt \quad (2)$$

$$A(t) = A_\infty + (A_0 - A_\infty)e^{-H_U} \quad (5)$$

$$H_U = \ln \frac{A_0 - A_\infty}{A(t) - A_\infty} \quad (6)$$

OSZCILLOSZKÓP

$$U_{\text{pp}} = 2U_{\text{max}} = 2\sqrt{2}U_{\text{eff}} \quad (5)$$

ERŐSÍTŐ

$$K_U = \frac{U_{\text{ki}}}{U_{\text{be}}} \quad K_P = \frac{P_{\text{ki}}}{P_{\text{be}}} \quad (3)(\text{VII.6})$$

$$n = 20 \lg K_U + 10 \lg \frac{R_{\text{be}}}{R_{\text{ki}}} \quad (\text{dB}) \quad (6)$$

SZINUSZOSZCILLÁTOR

$$K_{U_v} = \frac{K_U}{1 - K_v K_U} \quad f_0 = \frac{1}{2\pi\sqrt{LC}} \quad (3)(\text{VII.14})$$

$$Q = \sigma E^2 V t \quad (4)$$

$$R = \left(\frac{Z_1 - Z_2}{Z_1 + Z_2} \right)^2 \quad Z = c\rho \quad (5)(\text{II.77})$$

IMPULZUSGENERÁTOR

$$T = \tau_1 + \tau_2 \quad (2)$$

$$\text{kitöltési tényező} = \frac{\tau_1}{\tau_1 + \tau_2} 100\% \quad (3)$$

COULTER SZÁMLÁLÓ

$$h = \frac{c_{\text{megadott}}}{c_{\text{mért}}} \quad (1)$$

BŐRIMPEDANCIA

$$Z = \frac{U_{\text{eff}}}{I_{\text{eff}}} \quad (13)$$

$$\rho^* = RA \quad (14)$$

$$C = \frac{1}{2\pi f Z} \quad (15)$$

$$\gamma^* = \frac{C}{A} \quad (16)$$

AUDIOMETRIA

$$J = \eta \frac{U_{\text{eff}}^2}{R} \quad (1)$$

$$J_{\text{saját}} = AU^2 \quad (2)$$

$$n = 10 \lg \left(\frac{J}{J_0} \right) \quad (5)$$

SZENZOR

$$\Psi \sim \left(\frac{\Phi}{\Phi_0} \right)^n \quad (\text{IV.8})$$

EKG

$$U_{\text{ki}} = (U_{\text{be}_1} - U_{\text{be}_2}) K_U \quad (\text{VII.11})$$

$$U_{\text{I}} = \varphi_{\text{L}} - \varphi_{\text{R}}$$

$$U_{\text{II}} = \varphi_{\text{F}} - \varphi_{\text{R}}$$

$$U_{\text{III}} = \varphi_{\text{F}} - \varphi_{\text{L}}$$

ÁRAMLÁS

$$\frac{\Delta V}{\Delta t} = I_V = -\frac{\pi}{8\eta} R^4 \frac{\Delta p}{\Delta l} \quad (3)(\text{III.12})$$

$$\eta = \frac{\pi}{8} \frac{R^4}{\Delta V} \frac{\overline{\Delta h} \rho g}{l} \Delta t \quad (11)$$

$$\Delta p = R_{\text{cső}} I_V \quad (U = RI)$$

$$R_{\text{cső}} = 8\pi\eta \frac{l}{A^2} \quad (6)$$

$$R_{\text{párhuzamos eredő}} = \frac{R}{n} \quad (7)$$

DIFFÚZIÓ

$$D \Delta t \frac{\Delta \left(\frac{\Delta c}{\Delta x} \right)}{\Delta x} + c(t) = c(t + \Delta t) \quad (4)$$

$$\nu = K \nu_0 e^{-\frac{t}{\tau}} \quad (T = \ln 2 \cdot \tau) \quad (5)$$

$$D = 0,12 \frac{r^2}{T} \quad (8)$$

$$\sigma_{\text{elektrolit}} = \frac{1}{R} \hat{C} \quad (12)$$

A korábbi tanulmányokból ismertnek vélt összefüggések

$$E_{\text{magassági}} = mgh$$

$$R = \frac{U}{I}$$

$$E_{\text{mozgási}} = \frac{1}{2} m v^2$$

$$R = \rho \frac{l}{A}$$

$$E_{\text{kondenzátor}} = \frac{1}{2} C U^2$$

$$Z = \frac{U_{\text{eff}}}{I_{\text{eff}}}$$

$$\varepsilon = hf$$

$$X_L = 2\pi f L$$

$$n = \frac{c_{\text{vákuum}}}{c_{\text{közeg}}}$$

$$X_C = \frac{1}{2\pi f C}$$

$$\frac{1}{f} = \frac{1}{t} + \frac{1}{k}$$

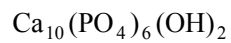
$$C = \varepsilon_0 \varepsilon \frac{A}{d}$$

$$N = \frac{K}{T} = \frac{k}{t}$$

$$P_{\text{elektromos}} = UI$$

$$Q = cm \Delta t$$

Kiegészítés FOK hallgatók számára



$$\varepsilon = \frac{\Delta l}{l} = \frac{1}{E} \frac{F}{A}$$

$$\varepsilon = \frac{1}{E} \sigma$$

$$s_{ab} = \frac{4}{E} \frac{l^3}{ab^3} F$$

$$s_R = \frac{4}{3\pi E} \frac{l^3}{R^4} F$$

$$s_{\text{cső}} = \frac{4}{3\pi E} \frac{l^3}{R_2^4 - R_1^4} F$$

$$W_{\text{rugó}} = \frac{1}{2} D(\Delta l)^2 \sim E \frac{A}{l} (\Delta l)^2$$

$$W_{ab} \sim E \frac{ab^3}{l^3} s^2$$

$$W_R \sim E \frac{R^4}{l^3} s^2$$

Kiegészítés GYTK hallgatók számára

$$\frac{\Delta N}{N} = A v^2 e^{-\frac{mv^2}{2kT}}$$

$$\frac{\Delta N}{N} = B \sqrt{\varepsilon} e^{-\frac{\varepsilon}{kT}}$$

$$E = E_{\text{mozgási}} + E_{\text{elektron}} + E_{\text{rezgési}} + E_{\text{forgási}}$$

$$\Delta U = T\Delta S - p\Delta V + \sum_{i=1}^n \mu_i \Delta v_i + \varphi \Delta q + A \Delta \xi$$

Statisztikai táblázatok

t-eloszlás

szabadságfok	p (valószínűség, kétoldali próba)							
	0,5	0,2	0,1	0,05	0,02	0,01	0,002	0,001
1	1,00	3,08	6,31	12,7	31,8	63,7	318,3	636,6
2	0,82	1,89	2,92	4,30	6,96	9,92	22,3	31,6
3	0,76	1,64	2,35	3,18	4,54	5,84	10,2	12,9
4	0,74	1,53	2,13	2,78	3,75	4,60	7,17	8,61
5	0,73	1,48	2,02	2,57	3,37	4,03	5,89	6,87
6	0,72	1,44	1,94	2,45	3,14	3,71	5,21	5,96
7	0,71	1,41	1,89	2,36	3,00	3,50	4,79	5,41
8	0,71	1,40	1,86	2,31	2,90	3,36	4,50	5,04
9	0,70	1,38	1,83	2,26	2,82	3,25	4,30	4,78
10	0,70	1,37	1,81	2,23	2,76	3,17	4,14	4,59
11	0,70	1,36	1,80	2,20	2,72	3,11	4,02	4,44
12	0,70	1,36	1,78	2,18	2,68	3,05	3,93	4,32
13	0,69	1,35	1,77	2,16	2,65	3,01	3,85	4,22
14	0,69	1,35	1,76	2,14	2,62	2,98	3,79	4,14
15	0,69	1,34	1,75	2,13	2,60	2,95	3,73	4,07
16	0,69	1,34	1,75	2,12	2,58	2,92	3,69	4,01
17	0,69	1,33	1,74	2,11	2,57	2,90	3,65	3,97
18	0,69	1,33	1,73	2,10	2,55	2,88	3,61	3,92
19	0,69	1,33	1,73	2,09	2,54	2,86	3,58	3,88
20	0,69	1,33	1,72	2,09	2,53	2,85	3,55	3,85
21	0,69	1,32	1,72	2,08	2,52	2,83	3,53	3,82
22	0,69	1,32	1,72	2,07	2,51	2,82	3,51	3,79
23	0,69	1,32	1,71	2,07	2,50	2,81	3,49	3,77
24	0,68	1,32	1,71	2,06	2,49	2,80	3,47	3,75
25	0,68	1,32	1,71	2,06	2,49	2,79	3,45	3,73
26	0,68	1,31	1,71	2,06	2,48	2,78	3,44	3,71
27	0,68	1,31	1,70	2,05	2,47	2,77	3,42	3,69
28	0,68	1,31	1,70	2,05	2,47	2,76	3,41	3,67
29	0,68	1,31	1,70	2,05	2,46	2,76	3,40	3,66
30	0,68	1,31	1,70	2,04	2,46	2,75	3,39	3,65
40	0,68	1,30	1,68	2,02	2,42	2,70	3,31	3,55
60	0,68	1,30	1,67	2,00	2,39	2,66	3,23	3,46
120	0,68	1,30	1,66	1,98	2,36	2,62	3,16	3,37
∞	0,68	1,29	1,64	1,96	2,33	2,58	3,09	3,29

χ^2 (khi-négyzet)-eloszlás

szabadságfok	<i>p</i> (valószínűség)						
	0,99	0,975	0,95	0,05	0,025	0,01	0,001
1	0,0000157	0,0000982	0,000393	3,84	5,02	6,63	10,83
2	0,0201	0,0506	0,103	5,99	7,88	9,21	13,82
3	0,115	0,216	0,352	7,81	9,35	11,34	16,27
4	0,297	0,484	0,711	9,49	11,14	13,28	18,47
5	0,554	0,831	1,15	11,07	12,83	15,09	20,51
6	0,872	1,24	1,64	12,59	14,45	16,81	22,46
7	1,24	1,69	2,17	14,07	16,01	18,47	24,32
8	1,65	2,18	2,73	15,51	17,53	20,09	26,13
9	2,09	2,70	3,33	16,92	19,02	21,67	27,88
10	2,56	3,25	3,94	18,31	20,48	23,21	29,59
11	3,05	3,61	4,57	19,68	21,92	24,72	31,26
12	3,57	4,40	5,23	21,03	23,34	26,22	32,91
13	4,11	5,01	5,89	22,36	24,74	27,69	34,53
14	4,66	5,63	6,57	23,68	26,12	29,14	36,12
15	5,23	6,26	7,26	25,00	27,49	30,58	37,70
16	5,81	6,91	7,96	26,33	28,85	32,00	39,25
17	6,41	7,56	8,67	27,59	30,19	33,41	40,79
18	7,01	8,23	9,39	28,87	31,53	34,81	42,31
19	7,63	8,91	10,12	30,14	32,85	36,19	43,82
20	8,26	9,59	10,85	31,41	34,17	37,57	45,31
21	8,90	10,28	11,59	32,67	35,48	38,93	46,80
22	9,54	10,98	12,34	33,92	36,78	40,29	48,27
23	10,20	11,69	13,09	35,17	38,08	41,64	49,73
24	10,86	12,40	13,85	36,42	39,36	42,98	51,18
25	11,52	13,12	14,61	37,65	40,65	44,31	52,62
26	12,20	13,84	15,38	38,89	41,92	45,64	54,05
27	12,88	14,57	16,15	40,11	43,19	46,96	55,48
28	13,56	15,31	16,93	41,34	44,46	48,28	56,89
29	14,26	16,05	17,71	42,56	45,72	49,59	58,30
30	14,95	16,79	18,49	43,77	46,98	50,89	59,70
40	22,16	24,43	26,51	55,76	59,34	63,69	73,40
50	29,71	32,36	34,76	67,51	71,42	76,15	86,66
60	37,48	40,48	43,19	79,08	83,30	88,38	99,61
100	70,06	74,22	77,93	124,3	129,5	135,8	149,4

Állandók és adatok

egyetemes gázállandó	$R = 8,31 \text{ J}/(\text{mol}\cdot\text{K})$
Avogadro-szám	$N_A = 6\cdot 10^{23} /\text{mol}$
Boltzmann-állandó	$k = 1,38\cdot 10^{-23} \text{ J}/\text{K}$
Faraday-állandó	$F = 96500 \text{ C}/\text{mol}$
Planck-állandó	$h = 6,6\cdot 10^{-34} \text{ J}\cdot\text{s}$
fénysebesség (vákuumban)	$c = 3\cdot 10^8 \text{ m}/\text{s}$
elektron töltése (elemi töltés)	$e = 1,6\cdot 10^{-19} \text{ C}$
elektron nyugalmi tömege	$m_e = 9,1\cdot 10^{-31} \text{ kg}$
proton nyugalmi tömege	$m_p = 1,673\cdot 10^{-27} \text{ kg}$
neutron nyugalmi tömege	$m_n = 1,675\cdot 10^{-27} \text{ kg}$
Stefan–Boltzmann-állandó	$\sigma = 5,7\cdot 10^{-8} \text{ J}/(\text{m}^2\cdot\text{K}^4\cdot\text{s})$
Reynolds-szám (sima falú csövekre)	$Re = 1160$
c_{Rtg}	$1,1\cdot 10^{-9} \text{ V}^{-1}$
C_{foto}	$6 \text{ cm}^2/(\text{g}\cdot\text{nm}^3)$
f_0	$34 \text{ J}/\text{C}$

relatív atomtömeg	
nitrogén:	14
oxigén:	16
sűrűség [kg/m ³]	
alumínium (Al):	$2,7\cdot 10^3$
vas (Fe)	$7,9\cdot 10^3$
ólom (Pb):	$11,3\cdot 10^3$
testszövet (lágú):	$1,04\cdot 10^3$
vér (átlagos):	$1,05\cdot 10^3$
levegő (0°C, 101 kPa):	1,29
csont:	$1,7\cdot 10^3$
zsírszövet:	$0,92\cdot 10^3$
viszkózitás [mPa·s]	
víz (27°C-on):	0,85
vér (37°C-on):	4,5
fajhő [kJ/(kg·K)]	
víz:	4,18
izom:	3,76
vér:	3,9
tömör csont:	1,3
zsírszövet:	3
testszövet (átlagos)	3,5

fajhő [kJ/(kg·K)]	
oxigén: c_v	0,65
oxigén: c_p	0,92
olvadáshő [kJ/kg]	
jég:	334,4
párolgáshő [kJ/kg]	
víz (100°C, 101 kPa):	2257
standard kémiai potenciál [kJ/mol]	
glükóz:	-902,5
törésmutató	
levegő:	1
víz:	1,333
cédrusolaj:	1,505
tömeggyengítési együttható [cm ² /g]	
μ_m (²⁴ Na, ólom absz.):	$5\cdot 10^{-2}$
hallásküszöb [W/m ²]	
emberi fül (1 kHz-en):	10^{-12}
hangsebesség [m/s]	
testszövet (lágú):	1600
csont:	3600
fajlagos vezetőképesség [S/m]	
izomszövet:	0,8

A fontosabb radioaktív izotópok jellemző adatai:

kémiai elem és rendszáma		izotóp	felezési idő	bomlás módja	maximális részecske energiák (MeV)	γ -energia (MeV)	$K\gamma$ dózis-konstans ($\frac{\mu\text{Gy}_{\text{lev}} \cdot \text{m}^2}{\text{GBq} \cdot \text{h}}$)
hidrogén	1	^3H	12,33 év	β^-	0,0186	–	
szén	6	^{11}C	20,4 perc	β^+	0,96	–	
		^{14}C	5760 év	β^-	0,155	–	
nitrogén	7	^{13}N	10 perc	β^+	1,19	–	
oxigén	8	^{15}O	2 perc	β^+	1,73	–	
fluor	9	^{18}F	109,8 perc	β^+	0,633	–	
nátrium	11	^{24}Na	15,02 óra	β^-, γ	1,392	2,754 1,369	444
foszfor	15	^{32}P	14,28 nap	β^-	1,710	–	
kén	16	^{35}S	87,2 nap	β^-	0,167	–	
kálium	19	^{40}K	$1,28 \cdot 10^9$ év	$\beta^-, \text{K} (10\%)$	1,31	1,46 K után	
		^{42}K	12,36 óra	β^-, γ	3,52 (75%) 1,99 (25%)	1,525	
kalcium	20	^{45}Ca	163 nap	β^-	0,257	–	
króm	24	^{51}Cr	27,7 nap	K, e^-, γ	0,315 (e^-)	0,320	
vas	26	^{52}Fe	8,2 óra	β^+, γ	0,8	0,5	160
		^{59}Fe	44,6 nap	β^-, γ	1,566	1,30 1,10	
kobalt	27	^{60}Co	5,272 év	β^-, γ	0,318	1,33 1,17	305
réz	29	^{64}Cu	12,74 óra	$\beta^- (39\%)$ $\beta^+ (19\%)$ $\text{K} (42\%)$ $\gamma (1\%)$	0,575 0,656	1,34	
kripton	36	^{85}Kr	10,73 év	β^-, γ	0,687	0,514	
rubídium	37	^{81}Rb	4,7 óra	β^+, γ	0,99	1,93 0,95	
		^{86}Rb	18,65 nap	β^-, γ	1,78	1,078	
stroncium	38	^{90}Sr	29 év	β^-	0,546	–	
ittrium	39	^{90}Y	64 óra	$\beta^-, \gamma (0,4\%)$	2,29	1,761	
technécium	43	$^{99\text{m}}\text{Tc}$	6,02 óra	γ	–	0,140	
indium	49	$^{113\text{m}}\text{In}$	1,658 óra	γ	–	0,391	
jód	53	^{123}I	13,3 óra	K, γ	–	0,16	54
		^{125}I	59,7 nap	K, γ	–	0,0355	
		^{131}I	8,04 nap	β^-, γ	0,606 0,25 0,81	0,364 0,080 0,723	
xenon	54	^{133}Xe	5,29 nap	β^-, γ	0,346	0,081	
cézium	55	^{137}Cs	30,1 év	β^-, γ	0,512 (92,6%) 1,173 (7,4%)	0,661	80
arany	79	^{198}Au	2,695 nap	β^-, γ	0,961	0,411	
higany	80	^{203}Hg	46,6 nap	β^-, γ	0,212	0,279	
radon	86	^{222}Rn	3,824 nap	α	5,489	–	
rádium	88	^{226}Ra	1600 év	$\alpha, \gamma (6\%)$	4,784	0,186 0,260	
					4,598	0,609	
urán	92	^{238}U	$4,47 \cdot 10^9$ év	α, γ	4,2	0,048	