

# Hallgatói segédlet fizika BSc záróvizsga felkészüléshez

$$a = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos(\alpha_2 - \alpha_1)}, \quad \tan \alpha = \frac{a_1 \sin \alpha_1 + a_2 \sin \alpha_2}{a_1 \cos \alpha_1 + a_2 \cos \alpha_2} \quad (1)$$

$$A = \frac{a_0}{\sqrt{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2}}, \quad \tan \delta = \frac{2\beta\omega}{\omega_0^2 - \omega^2} \quad (2)$$

$$x' = \frac{x - vt}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (3)$$

$$t' = \frac{t - \frac{xv}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (4)$$

$$T = 2\pi\sqrt{\frac{\Theta}{mgs}} = 2\pi\sqrt{\frac{l_r}{g}} \quad (5)$$

$$s = \frac{4}{E} \frac{l^3}{ab^3} F \quad (6)$$

$$\gamma = \frac{1}{G} \frac{F}{q} \quad (7)$$

$$\varphi = \frac{2}{\pi G} \frac{l}{R^4} M \quad (8)$$

$$\chi = 3 \frac{1 - 2\mu}{E}, \quad G = \frac{E}{2(1 + \mu)} \quad (9)$$

$$p_g = \alpha \left( \frac{1}{R_1} + \frac{1}{R_2} \right) \quad (10)$$

$$h = \frac{2\alpha \cos \vartheta}{\rho gr} \quad (11)$$

$$I = \frac{\pi}{8} \frac{1}{\eta} \frac{p_1 - p_2}{l} r^4 \quad (12)$$

$$R = \frac{\rho r v}{\eta} \quad (13)$$

$$\left( p + a \left( \frac{N}{V} \right)^2 \right) (V - Nb) = NkT \quad (14)$$

$$R = c_p - c_v, \quad \kappa = \frac{c_p}{c_v} \quad (15)$$

$$c_v = \frac{1}{m} \left( \frac{dU}{dT} \right)_V \quad (16)$$

$$c_p = \frac{1}{m} \left( \frac{dH}{dT} \right)_p \quad (17)$$

$$\Delta T = \frac{\Delta p}{c_p} \left( \frac{2a'}{RT} - b' \right), \quad (a = a' N_A^2, b = b' N_A) \quad (18)$$

$$\eta = \frac{T_1 - T_2}{T_1} \quad (19)$$

$$dS = \frac{dQ_{rev}}{dT} = \frac{dU + pdV}{T} \quad (20)$$

$$S = k \ln W \quad (21)$$

$$\frac{dT}{dp} = \frac{T(v_2 - v_1)}{L} \quad (22)$$

$$T_c = \frac{8a}{27bk}, \quad p_c = \frac{a}{27b^2}, \quad V_c = 3Nb \quad (23)$$

$$\bar{\xi}^2 = \frac{kT}{3\pi\eta r} \tau \quad (24)$$

$$\sqrt{v^2} = \sqrt{\frac{3kT}{\mu}} \quad (25)$$

$$\bar{l} = \frac{1}{4\sqrt{2}\pi r^2 N} \quad (26)$$

$$P(t) = U_{\text{eff}} I_{\text{eff}} (\cos \varphi - \cos(2\omega t - \varphi)) \quad (27)$$

$$U_{\text{ki,D}}(t) = U_0 \exp\left[-\frac{t}{\tau}\right] \quad (28)$$

$$U_{\text{ki,I}}(t) = U_0 \left(1 - \exp\left[-\frac{t}{\tau}\right]\right) \quad (29)$$

$$I_L = \frac{1}{L} \int U_0 \sin(\omega t) dt = I_0 \sin\left(\omega t - \frac{\pi}{2}\right) \quad (30)$$

$$I_C = \frac{dQ}{dt} = I_0 \sin\left(\omega t + \frac{\pi}{2}\right) \quad (31)$$

$$IR + \frac{Q}{C} + L \frac{dI}{dt} = 0 \quad (32)$$

$$F = \frac{\mu_0}{4\pi} \frac{2I_1 I_2}{b} \quad (33)$$

$$B = \frac{\mu_0}{4\pi} \frac{q(\vec{v} \times \vec{r})}{r^3} \quad (34)$$

$$R = \frac{1}{q/m} \frac{v_{\perp}}{B} \quad (35)$$

$$m^* \frac{d\vec{v}_d}{dt} = -e\vec{E} - r\vec{v}_d \quad (36)$$

$$m = \frac{1}{F} \frac{M}{z} Q \quad (37)$$

$$dq = \tau I \frac{dT}{dl} l \quad (38)$$

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t} \quad (39)$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad (40)$$

$$\nabla \cdot \vec{D} = \rho \quad (41)$$

$$\nabla \cdot \vec{B} = 0 \quad (42)$$

$$\nabla \left( \frac{1}{\mu_0} \vec{E} \times \vec{B} \right) = -\frac{\partial}{\partial t} \left( \frac{1}{2} \frac{1}{\mu_0} B^2 + \frac{1}{2} \varepsilon_0 E^2 \right) - \vec{E} \vec{J} \quad (43)$$

$$N_2(t) = N_1(0) \frac{\lambda_1}{\lambda_2 - \lambda_1} (e^{-\lambda_1 t} - e^{-\lambda_2 t}) \quad (44)$$

$$R = r_0 A^{1/3} \quad (45)$$

$$E(Z, A) = -e_b A + e_F A^{2/3} + e_C \frac{Z^2}{A^{1/3}} + e_A \frac{(A - 2Z)^2}{A} + e_P \delta \frac{1}{A^{3/4}} \quad (46)$$

$$Z_{\min} = \frac{A}{2} \left( \frac{1}{1 + A^{2/3} \frac{e_C}{4e_A}} \right) \quad (47)$$

$$\frac{\partial^2 \Psi}{\partial t^2} = c^2 \left( \frac{\partial^2 \Psi}{\partial x^2} + \frac{\partial^2 \Psi}{\partial y^2} + \frac{\partial^2 \Psi}{\partial z^2} \right) \quad (48)$$

$$\Psi(x, t) = A \cdot \sin \left[ \omega \left( t - \frac{x}{c} \right) + \alpha \right] \quad (49)$$

$$w = \frac{1}{2} \rho A^2 \omega^2 + \frac{1}{2} \rho A^2 \omega^2 \cos \left[ 2\omega \left( t - \frac{x}{c} \right) + 2\alpha \right] \quad (50)$$

$$I = c\bar{w} = \frac{1}{2} \rho c A^2 \omega^2 \quad (51)$$

$$\Delta E = \frac{E(Q)}{s} \cdot \sin \left[ \omega \left( t - \frac{s}{c} \right) + \frac{\pi}{2} \right] \cdot K(\chi) \cdot \Delta S \quad (52)$$

$$\Psi(x, t) = 2A \cdot \cos \left( \frac{2\pi}{\lambda} x + \frac{\alpha_2 - \alpha_1}{2} \right) \cdot \sin \left( \frac{2\pi}{T} t + \frac{\alpha_2 + \alpha_1}{2} \right) \quad (53)$$

$$f' = \left( 1 \pm \frac{v}{c} \right) f, \quad f' = \frac{f}{1 \mp \frac{v}{c}} \quad (54)$$

$$\sin \theta = \frac{v}{c} \quad (55)$$

$$J_\theta \approx \frac{\pi^2 (1 + \cos^2 \theta) (n^2 - 1) V^2}{2r^2 \lambda^4} J_0 \quad (56)$$

$$\Delta = \int_{G_{AB}} n(\vec{r}) ds \quad (57)$$

$$n = \frac{\sin \left( \frac{\delta_{\min} + \varphi}{2} \right)}{\sin \left( \frac{\varphi}{2} \right)} \quad (58)$$

$$N = s \left( \frac{1}{f} - \frac{1}{k} \right) \quad (59)$$

$$N = \frac{\Delta \cdot s}{f_1 \cdot f_2} \quad (60)$$

$$N = \frac{f_1}{f_2} \quad (61)$$

$$J = J_1 + J_2 + 2\sqrt{J_1 J_2} \cdot \cos \delta, \quad \delta = 2\pi \frac{n \cdot s_1 - n \cdot s_2}{\lambda} + \alpha_2 - \alpha_1 \quad (62)$$

$$l = c \cdot \Delta t \approx \frac{\lambda_0^2}{\Delta \lambda} \quad (63)$$

$$\Delta_{21} = 2dn \cos \beta = 2d\sqrt{n^2 - n_0^2 \sin^2 \alpha} \quad (64)$$

$$I_t = \frac{I_0}{1 + F \sin^2 \frac{\delta}{2}}, \quad F = \frac{4R}{(1 - R)^2} \quad (65)$$

$$x_m^{(v)} = \left( m + \frac{1}{2} \right) \frac{\lambda}{2n\theta}, \quad x_m^{(s)} = m \frac{\lambda}{2n\theta} \quad (66)$$

$$r_m \approx \sqrt{m\lambda \frac{ab}{a+b}}, \quad f_m = \pi\lambda \frac{ab}{a+b} \quad (67)$$

$$d \sin \alpha_1 = 1, 22\lambda \quad (68)$$

$$r_{\perp} = \frac{\cos \alpha - n \cdot \cos \beta}{\cos \alpha + n \cdot \cos \beta} \quad (69)$$

$$t_{\perp} = \frac{2 \cos \alpha}{\cos \alpha + n \cdot \cos \beta} \quad (70)$$

$$r_{\parallel} = \frac{n \cdot \cos \alpha - \cos \beta}{n \cdot \cos \alpha + \cos \beta} \quad (71)$$

$$t_{\parallel} = \frac{2 \cos \alpha}{n \cdot \cos \alpha + \cos \beta} \quad (72)$$

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{2xy}{ab} \cos \delta = \sin^2 \delta \quad (73)$$

$$u(\nu, T) = \frac{8\pi h \nu^3}{c^3} \frac{1}{e^{\frac{h\nu}{kT}} - 1} \quad (74)$$

$$\Delta\lambda = \lambda_C(1 - \cos \vartheta), \quad \lambda_C = \frac{h}{mc} \quad (75)$$

$$E_n = -\frac{m_e e^4}{8h^2 \varepsilon_0^2} \frac{1}{n^2} \quad (76)$$

$$a_0 = \frac{\hbar^2 4\pi \varepsilon_0}{e^2 m} \quad (77)$$

$$\alpha = \frac{e^2}{2\varepsilon_0 h c} \quad (78)$$

$$N_i^F = \frac{g_i}{A e^{\frac{E_i}{kT}} + 1} \quad (79)$$

$$N_i^B = \frac{g_i}{A e^{\frac{E_i}{kT}} - 1} \quad (80)$$

$$C_{e^-}(T) = \frac{\pi^2 N^{1/3} k^2 m}{(3\pi^2)^{2/3} \hbar^2} T = \frac{\pi^2 N k^2}{2E_F(0)} T \quad (81)$$

$$\vec{b}_i = 2\pi \frac{\vec{a}_j \times \vec{a}_k}{\vec{a}_i \cdot (\vec{a}_j \times \vec{a}_k)} \quad (82)$$

$$V' = \frac{8\pi^3}{V} \quad (83)$$

$$\omega^2 = \beta \left( \frac{1}{m} + \frac{1}{M} \right) \pm \beta \sqrt{\left( \frac{1}{m} + \frac{1}{M} \right)^2 - \frac{4 \sin^2 ka}{Mm}} \quad (84)$$

$$C_{\text{Einstein}} = Nk \left( \frac{\Theta_E}{T} \right)^2 \frac{e^{\frac{\Theta_E}{T}}}{\left( e^{\frac{\Theta_E}{T}} - 1 \right)^2}, \quad \Theta_E = \frac{\hbar\omega}{k} \quad (85)$$

$$C_{\text{Debye}} = \frac{12\pi^4 Nk}{5} \left( \frac{T}{\Theta} \right)^3, \quad \Theta = \frac{\hbar\omega_{\max}}{kT} \quad (86)$$

$$m^* = \left( \frac{1}{\hbar^2} \frac{d^2 E(k)}{dk^2} \right)^{-1} \quad (87)$$

$$E_F(0) = \frac{\hbar^2}{2m} (3\pi^2 n)^{2/3} \quad (88)$$

$$E_F(T) = E_F(0) \left[ 1 - \frac{\pi^2}{12} \left( \frac{kT}{E_F(0)} \right)^2 \right] \quad (89)$$

$$\chi_m = \frac{\mu_0 N \mu}{B} = -\frac{\mu_0 N Z e^2}{6m} \langle r^2 \rangle \quad (90)$$

$$\chi_m = \frac{\mu_0 n \mu^2}{3kT} \quad (91)$$

$$\mu_B = \frac{e\hbar}{2m} \quad (92)$$

$$\vec{\mu} = -g\mu_B \vec{J} \quad (93)$$

$$H_i = -g\mu_B \vec{B}_0 \vec{S}_i - J \sum_{j'} \vec{S}_i \vec{S}_j = -g\mu_B \vec{S}_i \left( \vec{B}_0 + \frac{J}{g\mu_B} \sum_{j'} \vec{S}_j \right) \quad (94)$$

$$m_\infty = \frac{N g \mu_B}{V 2} \quad (95)$$

$$\varepsilon(\omega) = \varepsilon'(\omega) + i\varepsilon''(\omega) \quad (96)$$

$$\mu\varepsilon' = n^2 - k^2 \quad (97)$$

$$\mu\varepsilon'' = 2nk \quad (98)$$

$$\varepsilon'(\omega) = 1 + \frac{2}{\pi} P_f \int_0^\infty \frac{s\varepsilon''(s)ds}{s^2 - \omega^2} \quad (99)$$

$$\varepsilon''(\omega) = -\frac{2\omega}{\pi} P_f \int_0^\infty \frac{(\varepsilon'(s) - 1)ds}{s^2 - \omega^2} \quad (100)$$

$$A_{jk} = \frac{|p_{jk}^0|^2 \omega_{jk}^3}{3\pi\varepsilon_0 \hbar c^3} \quad (101)$$

$$B_{jk} = \frac{2\pi^2}{3\varepsilon_0 \hbar^2} |p_{jk}^0|^2 \quad (102)$$

$$dI = \frac{h\nu_{jk}}{c} (N_j B_{jk} - N_k B_{kj}) I dx \quad (103)$$

$$z_R = \frac{\pi w_0^2}{\lambda}; \quad w(z) = w_0 \sqrt{1 + \left(\frac{z}{z_R}\right)^2}, \quad R(z) = z \left(1 + \left[\frac{z_R}{z}\right]^2\right) \quad (104)$$

$$f(t) = a_0 + \sum_{k=1} (a_k \cos k\omega_0 t + b_k \sin k\omega_0 t) \quad (105)$$

$$a_0 = \frac{1}{T} \int_0^T f(t) dt \quad (106)$$

$$a_k = \frac{1}{T} \int_0^T f(t) \cos k\omega_0 t dt \quad (107)$$

$$b_k = \frac{1}{T} \int_0^T f(t) \sin k\omega_0 t dt \quad (108)$$

$$a_I(\omega) = \frac{1}{1 + jCR\omega} = \frac{1}{1 + j\frac{\omega}{\omega_p}} \quad (109)$$

$$a_D(\omega) = \frac{j\frac{\omega}{\omega_p}}{1 + j\frac{\omega}{\omega_p}} \quad (110)$$

$$\tan \varphi_I = -\frac{\omega}{\omega_p} \quad (111)$$

$$\varphi_D = \frac{\pi}{2} - \arctan \frac{\omega}{\omega_p} \quad (112)$$

$$\phi = \arctan \frac{\omega}{\omega_z} - \arctan \frac{\omega}{\omega_p} \quad (113)$$

$$I_D = I_S \left( e^{\frac{U}{U_T}} - 1 \right), \quad U_T = \frac{kT}{e} \quad (114)$$