Formelsamling - PHYS 102 Grunnkurs i elektrisitetslære, optikk og moderne fysikk.

Nyttige konstanter:

Elementærladningen	$e = 1{,}602\cdot 10^{-19}$ C
Permittiviteten til vakuum	$\varepsilon_0 = 8{,}85\cdot 10^{-12}\ \mathrm{C^2/(N\cdot m^2)}$
Permeabiliteten til vakuum	$\mu_0 = 4\pi\cdot 10^{-7}$ T·m/A
Elektronmassen	$m_e = 9{,}109\ 534\cdot 10^{-31}$ kg = $5{,}485\ 803\cdot 10^{-4}$ u
Protonmassen	$m_p = 1{,}672\ 648\cdot 10^{-27}$ kg = 1,007 276 u
Nøytronmassen	$m_n = 1{,}674\ 954\cdot 10^{-27}$ kg = 1,008 665 u
Elektronvolt	1 eV = $1{,}602\cdot 10^{-19}$ J
Lyshastigheten i vakuum	$c = 2{,}998\cdot 10^{8}$ m/s
Plancks konstant	$h = 6{,}626\cdot 10^{-34}$ J·s
Atommasseenheten	$u = 1{,}665\ 40\cdot 10^{-27}$ kg = 931,494 32 MeV/c^2

$$k = \frac{1}{4\pi\varepsilon_0}$$

$$F = k\frac{\|q_1 q_2\|}{r^2} = \frac{\|q_1 q_2\|}{4\pi\varepsilon_0 r^2} \qquad (18.1)$$

$$\mathbf{E} = \frac{\mathbf{F}}{q_0} \qquad (18.2)$$

$$E = \frac{k|q|}{r^2} \qquad (18.3)$$

$$E = \frac{q}{\varepsilon_0 A} = \frac{\sigma}{\varepsilon_0} \qquad (18.4)$$

$$\Phi_E = EA = \frac{q}{\varepsilon_0} \qquad (18.5)$$

$$\Phi_E = \Sigma(E\cos\phi)\Delta A \qquad (18.6)$$

$$\Sigma(E\cos\phi)\Delta A = \frac{Q}{\varepsilon_0} \qquad (18.7)$$

$$W_{AB} = \mathrm{EPE_A} - \mathrm{EPE_B} \qquad (19.1)$$

$$\frac{W_{AB}}{q_0} = \frac{\mathrm{EPE_A}}{q_0} - \frac{\mathrm{EPE_B}}{q_0} \qquad (19.2)$$

$$V = \frac{\mathrm{EPE}}{q_0} \qquad (19.3)$$

$$\Delta \mathrm{V} = \frac{\Delta(\mathrm{EPE})}{q_0} = \frac{-W_{AB}}{q_0} \qquad (19.4)$$

$$V_B - V_A = \frac{-W_{AB}}{q_0} = \frac{kq}{r_B} - \frac{kq}{r_A} \qquad (19.5)$$

$$V = \frac{kq}{r} \qquad (19.6)$$

$$E = -\frac{\Delta V}{\Delta s} \qquad (19.7)$$

$$q = CV \qquad (19.8)$$

$$\kappa = \frac{E_0}{E} \qquad (19.9)$$

$$C = \frac{\kappa\varepsilon_0 A}{d} \qquad (19.10)$$

$$\text{Energy} = \tfrac{1}{2}(CV)V = \tfrac{1}{2}CV^2 \qquad (19.11)$$

$$\text{Energy density} = \tfrac{1}{2}\kappa\varepsilon_0 E^2 \qquad (19.12)$$

$$I = \frac{\Delta q}{\Delta t} \qquad (20.1)$$

$$\frac{V}{I} = R = \text{constant} \qquad (20.1)$$

$$R = \rho\frac{L}{A} \qquad (20.3)$$

$$\rho = \rho_0[1 + \alpha(T - T_0)] \qquad (20.4)$$

$$R = R_0[1 + \alpha(T - T_0)] \qquad (20.5)$$

$$P = IV = I^2 R = \frac{V^2}{R} \qquad (20.6)$$

$$V = V_0 \sin 2\pi f t \qquad (20.7)$$

$$I = \frac{V_0}{R}\sin 2\pi f t = I_0 \sin 2\pi f t \qquad (20.8)$$

$$P = I_0 V_0 \sin^2 2\pi f t \qquad (20.9)$$

$\overline{P} = \frac{1}{2} I_0 V_0$ (20.10)

$\overline{P} = \left(\frac{I_0}{\sqrt{2}}\right)\left(\frac{V_0}{\sqrt{2}}\right) = I_{rms} V_{rms}$ (20.11)

$I_{rms} = \frac{I_0}{\sqrt{2}}$ (20.12)

$V_{rms} = \frac{V_0}{\sqrt{2}}$ (20.13)

$V_{rms} = I_{rms} R$ (20.14)

$\overline{P} = I_{rms} V_{rms} = I_{rms}^2 R = \frac{V_{rms}^2}{R}$ (20.15)

$R_S = R_1 + R_2 + R_3 + ...$ (20.16)

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$ (20.17)

$C_P = C_1 + C_2 + C_3 + ...$ (20.18)

$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ...$ (20.19)

$q = q_0 \left[1 - e^{-t/(RC)}\right]$ (20.20)

$\tau = RC$ (20.21)

$q = q_0 e^{-t/(RC)}$ (20.22)

$B = \frac{F}{q_0 (v \sin\theta)}$ (21.1)

$r = \frac{mv}{qB}$ (21.2)

$F = ILB \sin\theta$ (21.3)

$\tau = NIAB \sin\phi$ (21.4)

$B = \frac{\mu_0 I}{2\pi r}$ (21.5)

$B = N \frac{\mu_0 I}{2R}$ (21.6)

$B = \mu_0 n I$ (21.7)

$\mathcal{E} = vBL$ (22.1)

$\Phi = BA \cos\phi$ (22.2)

$\mathcal{E} = -N\left(\frac{\Phi - \Phi_0}{t - t_0}\right) = -N \frac{\Delta\Phi}{\Delta t}$ (22.3)

$\mathcal{E} = NAB\omega \sin(\omega t) = \mathcal{E}_0 \sin(\omega t)$ (22.4)

$I = \frac{V - \mathcal{E}}{R}$ (22.5)

$N_S \Phi_S = M I_p$ (22.6)

$\mathcal{E}_S = -M \frac{\Delta I_p}{\Delta t}$ (22.7)

$N\Phi = LI$ (22.8)

$\mathcal{E} = -L \frac{\Delta I}{\Delta t}$ (22.9)

$\text{Energy} = \frac{1}{2} L I^2$ (22.10)

$\text{Energy density} = \frac{1}{2\mu_0} B^2$ (22.11)

$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ (22.12)

$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_p}{N_s}$ (22.13)

$c = f\lambda$

$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ (24.1)

$u = \frac{\text{total energy}}{\text{volume}} = \frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0}$

$u = \varepsilon_0 E^2 = \frac{B^2}{\mu_0}$ (24.2)

$E = cB$ (24.3)

$S = \frac{\text{total energy}}{tA} = \frac{uctA}{tA} = uc$ (24.4)

$S = cu = \frac{1}{2} c\varepsilon_0 E^2 + \frac{cB^2}{2\mu_0}$

$S = c\varepsilon_0 E^2 = \frac{cB^2}{\mu_0}$ (24.5)

$f_o = f_s\left(1 \pm \frac{v_{rel}}{c}\right)$ når $v_{rel} << c$ (24.6)

$\overline{S} = S_0 \cos^2\theta$ (24.7)

$$f = \tfrac{1}{2}R \quad (25.1)$$
$$f = -\tfrac{1}{2}R \quad (25.2)$$
$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad (25.3)$$
$$m = -\frac{d_i}{d_o} \quad (25.4)$$

$$n = \frac{c}{v} \quad (26.1)$$
$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad (26.2)$$
$$d' = d\left(\frac{n_2}{n_1}\right) \quad (26.3)$$
$$\sin\theta_{\mathrm{c}} = \frac{n_2}{n_1} \quad (n_1 > n_2) \quad (26.4)$$
$$\tan\theta_{\mathrm{B}} = \frac{n_2}{n_1} \quad (26.5)$$
$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad (26.6)$$
$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \quad (26.7)$$

Refractive power (i diopters) =
$$\frac{1}{f\ \text{(i meter)}} \quad (26.8)$$
$$M = \frac{\theta'}{\theta} \quad (26.9)$$
$$M \approx \left(\frac{1}{f} - \frac{1}{d_i}\right)N \quad (26.10)$$
$$M \approx -\frac{(L - f_e)N}{f_o f_i} \quad (L > f_o + f_i) \quad (26.11)$$
$$M \approx -\frac{f_o}{f_i} \quad (26.12)$$

$$\sin\theta = \frac{m\lambda}{d} \quad m = 0,1,2,3... \quad (27.1)$$
$$\sin\theta = \frac{(m + \frac{1}{2})\lambda}{d} \quad m = 0,1,2,3... \quad (27.2)$$
$$\lambda_{film} = \frac{\lambda_{vakuum}}{n} \quad (27.3)$$
$$\sin\theta = m\frac{\lambda}{W} \quad m = 1,2,3,.... \quad (27.4)$$
$$\theta_{\min} \approx 1{,}22\frac{\lambda}{d} \quad (\theta_{\min}\ \text{i radianer}) \quad (27.6)$$
$$\sin\theta = m\frac{\lambda}{d} \quad m = 1,2,3,.... \quad (27.7)$$

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (28.1)$$
$$L = L_0\sqrt{1 - \frac{v^2}{c^2}} \quad (28.2)$$
$$p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (28.3)$$
$$E = \frac{mc^2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (28.4)$$
$$E_0 = mc^2 \quad (28.5)$$
$$KE = E - E_0 = mc^2\left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1\right) \quad (28.6)$$
$$E^2 = p^2c^2 + m^2c^4 \quad (28.7)$$
$$v_{AB} = \frac{v_{AC} + v_{CB}}{1 + \frac{v_{AC}v_{CB}}{c^2}} \quad (28.8)$$

$$E = nhf \quad n = 0,1,2,3,.... \quad (29.1)$$
$$E = hf \quad (29.2)$$
$$hf = KE_{\max} + W_0 \quad (29.3)$$
$$hf = hf' + KE \quad (29.4)$$
$$p = \frac{hf}{c} = \frac{h}{\lambda} \quad (29.6)$$

$$\lambda' - \lambda = \frac{h}{mc}(1-\cos\theta) \quad (29.7)$$

$$\lambda = \frac{h}{p} \quad (29.8)$$

$$\Delta p_y \approx \frac{h}{W} \quad (29.9)$$

$$(\Delta p_y)(\Delta y) \geq \frac{h}{4\pi} \quad (29.10)$$

$$(\Delta E)(\Delta t) \geq \frac{h}{4\pi} \quad (29.11)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right) \qquad n = 2,3,4,.... \quad (30.1)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right) \qquad n = 3,4,5,.... \quad (30.2)$$

$$\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{n^2}\right) \qquad n = 4,5,6,.... \quad (30.3)$$

$$E_i - E_f = hf \quad (30.4)$$

$$E = KE + EPE = \tfrac{1}{2}mv^2 - \frac{kZe^2}{r} \quad (30.5)$$

$$mv^2 = \frac{kZe^2}{r} \quad (30.6)$$

$$E = \frac{1}{2}\left(\frac{kZe^2}{r}\right) - \frac{kZe^2}{r} = -\frac{kZe^2}{2r} \quad (30.7)$$

$$L_n = mv_n r_n = n\frac{h}{2\pi} \qquad n = 1,2,3,.... \quad (30.8)$$

$$r_n = \left(\frac{h^2}{4\pi^2 mke^2}\right)\frac{n^2}{Z}$$

$$= (5{,}29 \cdot 10^{-11}\ \mathrm{m}) \qquad n = 1,2,3,... \quad (30.9\text{-}10)$$

$$E_n = -\left(\frac{2\pi^2 mk^2 e^4}{h^2}\right)\frac{Z^2}{n^2} = -(2{,}18 \cdot 10^{-18}\ \mathrm{J})\frac{Z^2}{n^2}$$

$$= -(13{,}6\ \mathrm{eV})\frac{Z^2}{n^2} \qquad n = 1,2,3,.. \quad (30.11\text{-}13)$$

$$\frac{1}{\lambda} = \frac{2\pi^2 mk^2 e^4}{h^3 c}\left(Z^2\right)\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right),$$

$$n_i, n_f = 1,2,3,... \quad \text{og } n_i > n_f \quad (30.14)$$

$$L = \sqrt{l(l+1)}\frac{h}{2\pi} \quad (30.15)$$

$$L_z = m_l \frac{h}{2\pi} \quad (30.16)$$

$$\lambda_0 = \frac{hc}{eV} \quad (30.17)$$

$$A = Z + N \quad (31.1)$$

$$r \approx \left(1{,}2 \cdot 10^{-15}\ m\right)A^{1/3} \quad (31.2)$$

$$\text{Bindingsenergi} = (\Delta m)c^2 \quad (31.3)$$

$$\frac{\Delta N}{\Delta t} = -\lambda N \quad (31.4)$$

$$N = N_0 e^{-\lambda t} \quad (31.5)$$

$$\lambda = \frac{0{,}693}{T_{1/2}} \quad (31.6)$$

$$\text{Eksponering (i röntgen)} = \left(\frac{1}{2{,}58 \cdot 10^{-4}}\right)\frac{q}{m} \quad (32.1)$$

$$\text{Absorbert dose} = \frac{\text{Absorbert energi}}{\text{Absorberende masse}} \quad (32.2)$$

Relativ biologisk virkningsgrad (RBE)

$$= \frac{\text{Dose av 200 keV röntgenstråling som forårsaker en effekt}}{\text{strålingsdose som gir samme effekt}} \quad (32.3)$$

Ekvivalent dose (i rem)

$$= \text{Absorbert dose (i rad)} \times \text{RBE} \quad (32.4)$$
