Chapters 17—18 (Exam 1)

electron: $m_e = 9.11\times10^{-31}$ kg, $q_e = -e$ proton: $m_p = 1.67\times10^{-27}$ kg, $q_p = +e$

neutron: $m_n = 1.67\times10^{-27}$ kg, $q_n = 0$ $e = 1.60\times10^{-19}$ C

$F = k\frac{|q_1 q_2|}{r^2}$ $k = \frac{1}{4\pi\varepsilon_0}$ $k = 8.99\times10^9$ N·m^2/C^2 $\varepsilon_0 = 8.854\times10^{-12}$ C^2/(N·m^2)

$\vec{E} = \frac{\vec{F}}{q}$ point charge: $E = k\frac{|q|}{r^2}$ $\sum E_\perp \Delta A = 4\pi k Q_{\text{encl}}$

circumference of a circle $= 2\pi r$ area of a circle $= \pi r^2$

surface area of a cylinder $= 2\pi rl + 2\pi r^2$ volume of a cylinder $= \pi r^2 l$

surface area of a sphere $= 4\pi r^2$ volume of a sphere $= \frac{4}{3}\pi r^3$

$W_{a\to b} = U_a - U_b$ $K_a + U_a = K_b + U_b$ point charges: $U = k\frac{qq'}{r}$

$V = \frac{U}{q'}$ point charge: $V = k\frac{q}{r}$ $E = -\frac{\Delta V}{\Delta s}$

$C = \frac{Q}{V_{ab}}$ $E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{\varepsilon_0 A}$ parallel-plate capacitor: $C_0 = \varepsilon_0\frac{A}{d}$

series: $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$ parallel: $C_{\text{eq}} = C_1 + C_2 + C_3 + \ldots$

$U = \frac{1}{2}QV = \frac{Q^2}{2C} = \frac{1}{2}CV^2$ energy density $u = \frac{1}{2}\varepsilon_0 E^2$ $K = \frac{C}{C_0}$

Chapters 19, 20, 21 (Exam 2)

$I = \frac{\Delta Q}{\Delta t}$ $V = IR$ $R = \frac{\rho L}{A}$ $R = R_0[1 + \alpha(T - T_0)]$

$P = V_{ab} I$ $P = V_{ab} I = I^2 R = \frac{V^2}{R}$

series: $R_{\text{eq}} = R_1 + R_2 + R_3 + \ldots$ parallel: $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots.$

junction rule: $\sum I = 0$ loop rule: $\sum_{\text{around loop}} V = 0$

$i = I_0 e^{-t/RC}$ $q = Q_{\text{final}}(1 - e^{-t/RC})$ $\tau = RC$ $i = I_0 e^{-t/RC}$ $q = Q_0 e^{-t/RC}$

$F = |q| vB\sin\phi$ $a_{\text{rad}} = v^2/R$ $F = IlB\sin\phi$ $\tau = IAB\sin\phi$ $\mu = IA$

$B = \frac{\mu_0 I}{2\pi r}$ $\mu_0 = 4\pi\times10^{-7}$ T·m/A $\frac{F}{l} = \frac{\mu_0 II'}{2\pi r}$

$B = \frac{\mu_0 NI}{2R}$ $B = \mu_0 nI$ $B = \frac{\mu_0 NI}{2\pi r}$

$\Delta B = \frac{\mu_0}{4\pi}\frac{I\Delta l\sin\theta}{r^2}$ $\sum B_\parallel \Delta s = \mu_0 I_{\text{encl}}$

$\Phi_B = B_\perp A = BA\cos\phi$ $\quad \mathcal{E} = \left|\frac{\Delta\Phi_B}{\Delta t}\right|$ $\quad \mathcal{E} = vBL$

$N_2\left|\Phi_{B2}\right| = M_{21}\left|i_1\right|$ $\quad M = M_{21} = M_{12} = \left|\frac{N_2\Phi_{B2}}{i_1}\right| = \left|\frac{N_1\Phi_{B1}}{i_2}\right|$ $\quad \mathcal{E}_2 = M\left|\frac{\Delta i_1}{\Delta t}\right|$

$\mathcal{E}_1 = M\left|\frac{\Delta i_2}{\Delta t}\right|$

$N\left|\Phi_B\right| = L\left|i\right|$ $\quad \mathcal{E} = L\left|\frac{\Delta i}{\Delta t}\right|$ $\quad U = \frac{1}{2}LI^2$ $\quad u = \frac{B^2}{2\mu_0}$ $\quad \frac{V_2}{V_1} = \frac{N_2}{N_1}$

$i = \frac{\mathcal{E}}{R}\left(1 - e^{-(R/L)t}\right)$ $\quad \tau = L/R$ $\quad i = I_0 e^{-(R/L)t}$ $\quad \omega = \frac{1}{\sqrt{LC}}$

Chapters 22--25 (Exam 3)

$\varepsilon_0 = 8.854\times10^{-12}\ \mathrm{C^2/N\cdot m^2}$ $\quad \mu_0 = 4\pi\times10^{-7}\ \mathrm{T\cdot m/A}$ $\quad I_{\mathrm{rms}} = I/\sqrt{2}$ $\quad V_{\mathrm{rms}} = V/\sqrt{2}$

$V_R = IR$ $\quad X_L = \omega L$ $\quad V_L = IX_L$ $\quad X_C = \frac{1}{\omega C}$ $\quad V_C = IX_C$ $\quad \omega = 2\pi f$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$ $\quad V = IZ$ $\quad \tan\phi = \frac{X_L - X_C}{R}$

$P = \frac{1}{2}VI\cos\phi = V_{\mathrm{rms}}I_{\mathrm{rms}}\cos\phi$ $\quad \omega_0 = \frac{1}{\sqrt{LC}}$

$E = cB$ $\quad c = \frac{1}{\sqrt{\varepsilon_0\mu_0}} = 3.00\times10^8\ \mathrm{m/s}$ $\quad c = f\lambda$ $\quad k = \frac{2\pi}{\lambda}$ $\quad \omega = 2\pi f$

$E = E_{\max}\sin(\omega t - kx)$ $\quad B = B_{\max}\sin(\omega t - kx)$

$E = -E_{\max}\sin(\omega t + kx)$ $\quad B = B_{\max}\sin(\omega t + kx)$

$u = \frac{1}{2}\varepsilon_0 E^2 + \frac{B^2}{2\mu_0} = \varepsilon_0 E^2$ $\quad S = cu = \varepsilon_0 cE^2 = \frac{1}{\mu_0}EB$

$I = S_{\mathrm{av}} = \frac{1}{2}\varepsilon_0 cE_{\max}^2 = \frac{E_{\max}B_{\max}}{2\mu_0} = cu_{\mathrm{av}}$ $\quad p = \frac{I}{c}$ (absorbing surface) $\quad p = \frac{2I}{c}$ (reflecting surface)

$n = \frac{c}{v}$ $\quad \lambda = \frac{\lambda_0}{n}$ $\quad \theta_r = \theta_a$ $\quad n_a\sin\theta_a = n_b\sin\theta_b$ $\quad I = I_{\max}\cos^2\phi$ $\quad \tan\theta_{\mathrm{p}} = \frac{n_b}{n_a}$

spherical mirrors: $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\quad f = R/2$ $\quad m = -\frac{s'}{s}$

$\frac{n_a}{s} + \frac{n_b}{s'} = \frac{n_b - n_a}{R}$ $\quad m = -\frac{n_a s'}{n_b s}$

thin lens: $\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\quad m = -\frac{s'}{s}$ $\quad \frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\quad f\text{-number} = \frac{f}{D}$

$M = \frac{\theta'}{\theta} = \frac{25\ \mathrm{cm}}{f}$ (magnifier) $\quad M = \frac{(25\ \mathrm{cm})s_1'}{f_1 f_2}$ (microscope) $\quad M = -\frac{f_1}{f_2}$ (telescope)

Chapters 26, 28, 29 (Exam 4)

$r_2 - r_1 = m\lambda,\ m = 0, \pm 1, \pm 2, \ldots$ $\quad r_2 - r_1 = (m + \frac{1}{2})\lambda,\ m = 0, \pm 1, \pm 2, \ldots$

$d \sin\theta = m\lambda,\ m = 0, \pm 1, \pm 2, \ldots$ $\quad d \sin\theta = (m + \frac{1}{2})\lambda,\ m = 0, \pm 1, \pm 2, \ldots$

$y_m = R\dfrac{m\lambda}{d},\ m = 0, \pm 1, \pm 2, \ldots$ $\quad y_m = R\dfrac{(m + \frac{1}{2})\lambda}{d},\ m = 0, \pm 1, \pm 2, \ldots$

$2t = m\lambda,\ m = 0, 1, 2$ $\quad 2t = (m + \frac{1}{2})\lambda,\ m = 0, 1, 2$

$\sin\theta = \dfrac{m\lambda}{a},\ m = \pm 1, \pm 2, \pm 3, \ldots$ $\quad y_m = R\dfrac{m\lambda}{a},\ m = \pm 1, \pm 2, \pm 3, \ldots$

$2d \sin\theta = m\lambda,\ m = \pm 1, \pm 2, \pm 3, \ldots$ $\quad \sin\theta_1 = 1.22\dfrac{\lambda}{D}$ $\quad \theta_{\text{res}} = 1.22\dfrac{\lambda}{D}$

$\frac{1}{2}mv_{\max}^2 = hf - \phi = eV_0$

$E = hf = \dfrac{hc}{\lambda}$ $\quad p = \dfrac{E}{c} = \dfrac{h}{\lambda}$ $\quad h = 6.626 \times 10^{-34}\ \text{J} \cdot \text{s} = 4.136 \times 10^{-15}\ \text{eV} \cdot \text{s}$

$hf = E_i - E_f$ $\quad hf = E_f - E_i$ $\quad \dfrac{1}{\lambda} = R\left(\dfrac{1}{2^2} - \dfrac{1}{n^2}\right)$ $\quad R = 1.097 \times 10^7\ \text{m}^{-1} = \dfrac{me^4}{8\varepsilon_0^2 h^3 c}$

$E_n = -\dfrac{hcR}{n^2} = -\dfrac{13.6\ \text{eV}}{n^2},\ n = 1, 2, 3, \ldots$ $\quad L = mvr = n\dfrac{h}{2\pi},\ n = 1, 2, 3, \ldots$

$r_n = \varepsilon_0 \dfrac{n^2 h^2}{\pi m e^2}$ $\quad r_1 = 0.5293 \times 10^{-10}\ \text{m}$ $\quad v_n = \dfrac{1}{\varepsilon_0}\dfrac{e^2}{2nh}$ $\quad v_1 = 2.19 \times 10^6\ \text{m/s}$

$\varepsilon_0 = 8.854 \times 10^{-12}\ \text{C}^2/(\text{N} \cdot \text{m}^2)$ $\quad m = 9.109 \times 10^{-31}\ \text{kg}$ $\quad e = 1.602 \times 10^{-19}\ \text{C}$

$\Delta\lambda = \lambda' - \lambda = \dfrac{h}{mc}(1 - \cos\phi)$ $\quad \dfrac{h}{mc} = 2.426 \times 10^{-12}\ \text{m}$

$\lambda = \dfrac{h}{p} = \dfrac{h}{mv}$ $\quad \Delta x \Delta p_x \geq \dfrac{h}{2\pi}$ $\quad \Delta E \Delta t \geq \dfrac{h}{2\pi}$ $\quad \hbar = \dfrac{h}{2\pi} = 1.054 \times 10^{-34}\ \text{J} \cdot \text{s}$

$L = \sqrt{l(l+1)}\hbar,\ l = 0, 1, 2, \ldots, n-1$ $\quad L_z = m_l\hbar,\ m_l = 0, \pm 1, \pm 2, \ldots, \pm l$

$S = \dfrac{\sqrt{3}}{2}\hbar$ $\quad S_z = s\hbar,\ s = \pm\frac{1}{2}$

Chapter 30

$A = Z + N$ $\quad R = R_0 A^{1/3},\ R_0 = 1.2 \times 10^{-15}\ \text{m}$

$1\ \text{u} = 1.6605 \times 10^{-27}\ \text{kg}$ $\quad m_p = 1.007276\ \text{u}$ $\quad m_n = 1.008665\ \text{u}$ $\quad m_e = 0.000549\ \text{u}$

$m_H = m_p + m_e = 1.007825\ \text{u}$ $\quad \Delta M = Zm_p + Nm_n - M$ $\quad E_B = (\Delta M)c^2$

1 u is equivalent to 931.5 MeV

$\dfrac{\Delta N}{\Delta t} = -\lambda N$ $\quad N = N_0 e^{-\lambda t}$ $\quad T_{1/2} = \dfrac{0.693}{\lambda}$ $\quad T = \dfrac{1}{\lambda} = \dfrac{T_{1/2}}{0.693}$ $\quad 1\ \text{Ci} = 3.70 \times 10^{10}\ \text{Bq}$

$Q = (M_A + M_B - M_C - M_D)c^2$