Physics 1302: Formula Sheet Ch 19-22

$$|\vec{F}| = \frac{k|q_1||q_2|}{r^2}$$
$$\vec{F} = q_0\vec{E}$$
$$\Delta U = q_0 \Delta V$$
$$E = -\frac{\Delta V}{\Delta s}$$
$$|\vec{E}| = \frac{k|q|}{r^2}$$
$$V = \frac{kq}{r}$$
$$U = \frac{kq_1q_2}{r}$$

$$\phi = EAcos(\theta)$$
$$\phi = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

$$I = \frac{\Delta Q}{\Delta t}$$
$$V = IR$$
$$P = IV$$
$$R = \frac{\rho L}{A}$$

Series

$$R_{eq} = R_1 + R_2 + R_3...$$
$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3...$$

Parallel

$$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3...$$
$$C_{eq} = C_1 + C_2 + C_3...$$

$$\sum I_{in} = \sum I_{out}$$
$$\sum_{\textbf{Loop}} \Delta V = 0$$

$$C = \frac{Q}{V}$$
$$C = \frac{\kappa\epsilon_0 A}{d} = \kappa C_0; \kappa = \text{dielectric constant}$$
$$E = \frac{E_0}{\kappa};\ V = \frac{V_0}{\kappa}$$

$$U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$$
$$u_E = \frac{1}{2}\epsilon_0 E^2$$

Charging a capacitor

$$q(t) = C\mathcal{E}(1 - e^{-t/\tau});\ Q = C\mathcal{E}$$
$$I(t) = \frac{\mathcal{E}}{R}(e^{-t/\tau})$$
$$\tau = RC$$

Discharging a capacitor

$$q(t) = Qe^{-t/\tau}$$

$$F = qvB\sin(\theta)$$
$$F = LIB\sin(\theta)$$
$$r = \frac{mv}{qB}$$
$$\tau = NIAB\sin(\theta)$$

Wire: $B = \frac{\mu_0 I}{2\pi r}$

Solenoid: $B = \mu_0 nI = \mu_0 \frac{N}{L} I$

N loops: $B = \frac{N\mu_0 I}{2R}$

$$K = \frac{1}{2}mv^2$$
$$p = mv$$

$\mu = 10^{-6};$ n $= 10^{-9};$ m $= 10^{-3};$ k $= 10^{3};$ M $= 10^{6}$
$e = 1.6 \times 10^{-19}$ C
$m_e = 9.11 \times 10^{-31}$ kg
$k = 8.99 \times 10^{9}$ Nm^2/C^2 (electric constant)
$\epsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2
$\mu_0 = 4\pi \times 10^{-7}$ Tm/A

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$$\Phi_B = BA\cos\theta$$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$$

$$\mathcal{E} = NBA\omega\sin\omega t$$

$$|\mathcal{E}| = B_\perp v\ell$$

$$|\mathcal{E}| = L\left|\frac{\Delta I}{\Delta t}\right|$$

$$L = \mu_0 n^2 A\ell; n = N/\ell \text{ (solenoid)}$$

$$U_B = (1/2)LI^2$$

$$u_B = \frac{B^2}{2\mu_0}$$

$$I(t) = \frac{\mathcal{E}}{R}(1 - e^{-t/\tau});\ \tau = L/R$$

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

$$f' = f\left(1 \pm \frac{u}{c}\right)$$

$$c = f\lambda$$

$$u_{\text{EM}} = \frac{B^2}{\mu_0} = \epsilon_0 E^2$$

$$I = \frac{P}{A}$$

$$A_{\text{circle}} = \pi R^2$$

$$A_{\text{sphere}} = 4\pi R^2$$

$$I = uc$$

$$E = cB$$

$$x_{rms} = x_{max}/\sqrt{2}$$

$$I = I_0\cos^2\theta;\quad I = \frac{1}{2}I_0$$

$$f = \pm\frac{1}{2}R$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$v_n = c/n;\ \lambda_n = \lambda/n$$

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

$$c = 3.00 \times 10^8 \text{ m/s}$$

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$\Delta\ell = m\lambda; m = 0, 1, 2, ...$ (constructive)

$\Delta\ell = (m - 1/2)\lambda, m = 1, 2, 3, ...$ (destructive)

$y = L\tan\theta$

Two-slit

Constructive $d\sin\theta = m\lambda; m = 0, 1, 2, ...$

Destructive $d\sin\theta = (m - 1/2)\lambda; m = 1, 2, 3, ...$

Single slit

Dark Fringes $W\sin\theta = m\lambda; m = 1, 2, 3, ...$

Diffraction Grating

Principal Maxima $d\sin\theta = m\lambda; m = 0, 1, 2, ...$

$d = 1/N$

$f_{\text{peak}} = (5.88 \times 10^{10}\ \text{s}^{-1}\text{K}^{-1})T$

$E = hf = \dfrac{hc}{\lambda};\ p = \dfrac{h}{\lambda};\ c = f\lambda$ (photons)

$f_0 = \dfrac{W_0}{h}$

$K_{\max} = hf - W_0$

$\lambda = \dfrac{h}{p}$ (de Broglie)

$\Delta\lambda = \lambda' - \lambda = \dfrac{h}{m_e c}(1 - \cos\theta)$

$\Delta p\Delta y \geq \dfrac{h}{2\pi}$

$\Delta E\Delta t \geq \dfrac{h}{2\pi}$

$\dfrac{1}{\lambda} = R_R\left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right)$ (Hydrogen)

$n_f = 1, 2, 3, ...;\ n_i = n_f + 1, n_f + 2, n_f + 3, ...$

$E_n = (-13.6\text{ eV})\dfrac{Z^2}{n^2};\ n = 1, 2, 3...$

$E_n = -\dfrac{2\pi^2 m_e k^2 e^4 Z^2}{n^2 h^2}$

$v_n = \dfrac{nh}{2\pi m_e r_n}$

$r_n = \dfrac{n^2 h^2}{4\pi^2 m_e k Z e^2}$

$L = rp = rm_e v = \dfrac{nh}{2\pi}$

$N_e^{\max} = 2(2\ell + 1)$

$E = |\Delta m|c^2$

$N = N_0 e^{-\lambda t}$

$T_{1/2} = \dfrac{\ln 2}{\lambda}$

$R = \lambda N_0 e^{-\lambda t} = R_0 e^{-\lambda t}$ (activity)

$1\text{ eV} = 1.60 \times 10^{-19}$ J

1 W = 1 J/s

$1\text{ u} = 1.660540 \times 10^{-27}$ kg

$1\text{ u} = 931.5\text{ MeV}/c^2$

1 rad = 0.01 J/kg

dose in rem = dose in rad × RBE

$r_1 = 5.29 \times 10^{-11}$m

$h = 6.626 \times 10^{-34}$ Js $= 4.136 \times 10^{-15}$ eVs

$c = 3.00 \times 10^8$ m/s

$R_R = 1.097 \times 10^7\ \text{m}^{-1}$ (Rydberg constant)

$m_e = 9.11 \times 10^{-31}$ kg $= 0.0005485799$ u

$m_p = 1.673 \times 10^{-27}$ kg $= 1.007276$ u

$m_n = 1.675 \times 10^{-27}$ kg $= 1.008665$ u

$m_H = 1.007825$ u (atomic mass of ${}^1_1\text{H}$)

n $= 10^{-9}$; $\mu = 10^{-6}$; m $= 10^{-3}$; k $= 10^3$; M $= 10^6$

$K(n = 1);\ L(n = 2);\ M(n = 3);\ N(n = 4)$

$s(\ell = 0);\ p(\ell = 1); d(\ell = 2);\ f(\ell = 3)$

Chapter 16 Equations

$T_F = \dfrac{9}{5}T_C + 32$

$T_C = \dfrac{5}{9}(T_F - 32)$

$T = T_C + 273.15$

$\Delta L = \alpha L_0 \Delta T$

$\Delta V = \beta V \Delta T \approx 3\alpha V \Delta T$

$Q = mc\Delta T$

$Q = kA\left(\dfrac{\Delta T}{L}\right)t$

$P = e\sigma A T^4$

$P_{\text{net}} = e\sigma A(T^4 - T_s^4)$

1 cal = 4.186 J

$\sigma = 5.67 \times 10^{-8}\ \text{W}/(\text{m}^2\text{K}^4)$