PHY3004W Formula Sheet

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1 Electromagnetism

$$\nabla \cdot \mathbf{D} = \rho_f \quad (1.1)$$
$$\nabla \cdot \mathbf{B} = 0 \quad (1.2)$$
$$\nabla \times \mathbf{E} = \frac{\partial \mathbf{B}}{\partial t} \quad (1.3)$$
$$\nabla \times \mathbf{H} = \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t} \quad (1.4)$$

$$\mathbf{D} = \epsilon_0 \mathbf{E} + \mathbf{P} \quad (1.5)$$
$$\mathbf{B} = \mu_0(\mathbf{H} + \mathbf{M}) \quad (1.6)$$

$$\oint \mathbf{D} \cdot \mathrm{d}\mathbf{a} = Q_{f,enc} \quad (1.7)$$
$$\oint \mathbf{H} \cdot \mathrm{d}\mathbf{l} = I_{f,enc}(t) + \frac{\mathrm{d}\Phi_{\mathbf{D}}}{\mathrm{d}t} \quad (1.8)$$
$$\oint \mathbf{B} \cdot \mathrm{d}\mathbf{a} = 0 \quad (1.9)$$
$$\oint \mathbf{E} \cdot \mathrm{d}\mathbf{l} = -\frac{\mathrm{d}\Phi_{\mathbf{B}}}{\mathrm{d}t} \quad (1.10)$$

$$D_1^{\perp} - D_2^{\perp} = \sigma_f \quad (1.11)$$
$$B_1^{\perp} - B_2^{\perp} = 0 \quad (1.12)$$
$$\mathbf{E}_1^{\parallel} - D_2^{\parallel} = 0 \quad (1.13)$$
$$\mathbf{H}_1^{\parallel} - \mathbf{H}_2^{\parallel} = \mathbf{K}_f \times \hat{\mathbf{n}} \quad (1.14)$$

$$\mathbf{S} = \frac{1}{\mu} \mathbf{E} \times \mathbf{B} \quad (1.15)$$
$$I = \langle S \rangle = \frac{1}{2} v \epsilon E_0^2 \quad (1.16)$$

1.1 Special Relativity

$$\Lambda = \begin{pmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \quad (1.17)$$

$$u' = \frac{u - v}{1 - \frac{uv}{c^2}} \quad (1.18)$$

$$\Lambda^{\mu}_{\alpha} g_{\mu\nu} \Lambda^{\nu}_{\beta} = g_{\alpha\beta} \quad (1.19)$$

$$I = s^2 = x_\mu x^\mu = c^2 t^2 - d^2 \quad (1.20)$$

$$\mathrm{d}\tau = \frac{\mathrm{d}t}{\gamma} \quad \text{(proper time)} \quad (1.21)$$
$$\eta^\mu = \frac{\mathrm{d}x^\mu}{\mathrm{d}\tau} = \begin{pmatrix} \gamma c \\ \gamma \mathbf{u} \end{pmatrix} \quad \text{(proper velocity)} \quad (1.22)$$
$$\eta^\mu = m\eta^\mu = \begin{pmatrix} E/c \\ \mathbf{p} \end{pmatrix} \quad \text{(proper velocity)} \quad (1.23)$$

$$\eta_\mu \eta^\mu = c^2 \quad (1.24)$$
$$p_\mu p^\mu = E^2/c^2 - \mathbf{p}^2 = m^2 c^2 \quad (1.25)$$
$$(1.26)$$

$$F^{\mu\nu} = \begin{pmatrix} 0 & -E_x/c & -E_y/c & -E_z/c \\ E_x/c & 0 & -B_z & B_y \\ E_y/c & B_z & 0 & -B_x \\ E_z/c & -B_y & B_x & 0 \end{pmatrix} \quad (1.27)$$

$$K^\mu = q F^{\mu\nu} g_{\nu\alpha} \eta^\alpha \quad (1.28)$$

2 Nuclear Physics

$$\Delta M(Z, A) = M(Z, A) - [Z(M_p + m_e) + N M_n] \quad (2.1)$$

$$B(A, Z) = -\Delta M(Z, A) c^2 \quad \text{(Binding energy)} \quad (2.2)$$

$$Q = [(M_i + M_I) - (M_f + M_F)] c^2 \quad (2.3)$$
$$Q = B(f) + B(F) - B(i) + B(I) \quad (2.4)$$

$$T_{1/2} = \frac{\ln 2}{\lambda} \quad (2.5)$$

$$-\frac{\mathrm{d}N(t)}{\mathrm{d}t} = \lambda N(t) \quad (2.6)$$
$$N(t) = N(0) e^{-\lambda N(t)} \quad (2.7)$$

$$R(t) = -\frac{\mathrm{d}N(t)}{\mathrm{d}t} \quad (2.8)$$
$$R(t) = \lambda N(0) e^{-\lambda N(t)} \quad (2.9)$$

$$I(x) = I_0 e^{-\mu x} \quad \text{(Intensity loss of } \gamma) \tag{2.10}$$

$$I(x) = I_0 e^{-N\sigma x} \quad \text{(Neutron absorption)} \tag{2.11}$$

$$D_{\text{tissue}} = \frac{E_{\text{deposited}}}{m_{\text{tissue}}} \tag{2.12}$$

$$H_{\text{tissue}} = \sum_R W_R D_{\text{tissue},R} \quad \text{(Equivalent Dose)} \tag{2.13}$$

$$N = In\Delta x\sigma \tag{2.14}$$

$$I = I_0 e^{-n\sigma t} \quad \text{(For a thick target)} \tag{2.15}$$

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\Sigma} \tag{2.16}$$

maybe include SEMF?

$$(n\ell_j)^k \quad \text{(Labeling states } [k = 2j+1]) \tag{2.17}$$

$$S, P, D, F, G, \cdots \implies \ell = 0, 1, 2, 3, 4, \ldots \tag{2.18}$$

$$P = (-1)^\ell \quad \text{(for single particle state)} \tag{2.19}$$

3 Atomic Physics

4 Thermal Physics

5 Particle Physics

6 Solid State Physics