Formulas:

(1.1)
$$q = 1.60\cdot 10^{-19}C;\ 1\text{eV}=1.60\cdot 10^{-19}J$$
$$m_e = 9.1\cdot 10^{-31}kg = 0.511MeV/c^2$$

$$k_B = 1.38\cdot 10^{-23}; R = 8.314J/mole\cdot{}^\circ K = 0.08206Latm/mole\cdot{}^\circ K; \hbar = \frac{h}{2\pi} = 1.05\cdot 10^{-34}Js;$$

$$\sigma = 5.67\cdot 10^{-8}(Stefan); \dot{Q} = eA\sigma T^4; \Delta U = nC_V\Delta T; C_P - C_V = R; \frac{1}{2}m\overline{\mathrm{v}^2} = \frac{3}{2}k_BT; \dot{Q} = \frac{A\Delta T}{\sum \frac{L_i}{k_i}}$$

$$TV^{\gamma-1} = \text{const;PV=}Nk_BT = nRT; PV^\gamma = \text{const;}\Delta U = Q+W; \Delta S = \int_i^f \frac{dQ_r}{T}; \lambda = 1/\sqrt{2}\pi d^2 n_V$$

$$ndE = n_0 e^{-\frac{E}{k_BT}}dE; W = -\int_{V_i}^{V_f} PdV; 1cal = 4.186J; L_{water} = 80cal/g$$

$$k_e = \frac{1}{4\pi\varepsilon_0} = 8.89\cdot 10^9;\quad \varepsilon_0 = 8.85\cdot 10^{-12}S.I.\ \text{;parallel plate capacitor: } E = \frac{\sigma}{\varepsilon_0}; C = \kappa\frac{\varepsilon_0 A}{d}$$

$$E = \frac{Q}{4\pi\varepsilon_0}\frac{1}{r^2}; \vec{E} = -\overrightarrow{grad}\cdot V; \Delta V_{ab} = -\int_a^b \vec{E}\cdot d\vec{s}; C = \frac{Q}{\Delta V}; \vec{F} = q\vec{E}; U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}C\left(\Delta V\right)^2;$$

$$dW = qdV; U_{dipole} = -\vec{p}\bullet\vec{E}; \vec{\tau} = \vec{p}\times\vec{E}; q = C\varepsilon\left(1-e^{\frac{-t}{RC}}\right); m_p = 1.67E-27kg = 938MeV/c^2$$

$$coaxial: C = L/2k_e\ln\frac{b}{a}; I = \dot{Q} = \iint_{surface}\vec{j}d\vec{A}; \vec{j} = nq\vec{\mathrm{v}}_{\mathrm{d}}; \vec{j} = \sigma\vec{E}; \rho_\Omega = \frac{1}{\sigma}; \frac{\Delta\rho}{\rho} = \alpha\Delta T$$

$$copper: \rho_\Omega = 1.7\cdot 10^{-8}\Omega m\ at\ 20^\circ C; \alpha = 3.9\cdot 10^{-5}/C^\circ; \Delta V = RI; P = I\Delta V = RI^2; \Delta V = \varepsilon - rI$$

(1.2)
$$div\vec{E} = \frac{\rho}{\varepsilon_0}\text{;(1.3) }\vec{F}_B = q\vec{\mathrm{v}}\times\vec{B}$$

(1.4) $d\vec{F}_B = I\left(d\vec{s}\times\vec{B}\right) \Rightarrow \vec{F}_B = I\vec{L}\times\vec{B}$

(1.5) $\vec{\mu} = I\vec{A} =$ magnetic dipole moment

(1.6) $U_B = -\vec{\mu}\cdot\vec{B}; \vec{\tau}_B = \vec{\mu}\times\vec{B}$

(1.7) $curl\vec{B} = \mu_0\vec{j}$

(1.8) $d\vec{B} = \frac{\mu_0 I}{4\pi}\frac{d\vec{s}\times\vec{r}}{r^3} = \frac{\mu_0 I}{4\pi}\frac{d\vec{s}\times\vec{u}_r}{r^2}$; Biot-Savart **;** $\frac{\mu_0}{4\pi} = 10^{-7}; \mu_0 = 1.2566\cdot 10^{-6}$

(1.9) $curl\vec{B} = \mu_0\left(\vec{j} + \underbrace{\varepsilon_0\frac{\partial\vec{E}}{\partial t}}_{\vec{j}_d}\right)$ displacement current

(1.10) Faraday's law $\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$ $\varepsilon = -N\frac{d\Phi_B}{dt}$

(1.11) $\varepsilon = -\frac{d}{dt}\left(\vec{B}\cdot\vec{A}\right) = -\frac{d}{dt}\left(BA\cos\theta\right) = -\frac{d}{dt}\left(BA\cos\omega t\right) = BA\omega\sin\omega t$

(1.12) $\varepsilon_L = -N\frac{d\Phi_B}{dt} = -L\frac{dI}{dt}$

(1.13) $L = \frac{N\Phi_B}{I}$

(1.14) $U_B = \frac{1}{2}LI^2$ electromagnetic energy in an inductor

Energy (instantaneous) density in a capacitor and coil:

(1.15) $u_E = \frac{1}{2}\varepsilon_0 E^2 ; u_B = \frac{B^2}{2\mu_0}$

ac currents

$\hat{I}(t) = \frac{\hat{V}(t)}{\hat{z}_{eq}}; I_{rms} = \frac{I_{\max}}{\sqrt{2}}; V_{rms} = \frac{V_{\max}}{\sqrt{2}}$

(1.16) $\hat{Z}_L = i\omega L \Rightarrow \hat{I}(t) = \frac{\hat{V}(t)}{i\omega L}; I_{\max} = \frac{V_{\max}}{\omega L}$

$\hat{Z}_C = \frac{1}{i\omega C} \Rightarrow \hat{I}(t) = i\omega C\hat{V}(t); I_{\max} = \omega C V_{\max}$

(1.17) $P = \hat{V}_{rms}\hat{I}_{rms}\cos\Phi$

(1.18) In electromagnetic fields: $E = cB ; u_E\left(t\right) = \frac{1}{2}\varepsilon_0 E^2 ; u_B\left(t\right) = \frac{1}{2\mu_0}B^2$

Instantaneous energy density in an em wave with equal contributions from the electric field and the magnetic field:

(1.19) $u\left(t\right)_{total} = \frac{B^2}{\mu_0} = \varepsilon_0 E^2$

$\bar{u}_{avg} = \frac{1}{2}\frac{B_{\max}^2}{\mu_0} = \frac{\varepsilon_0}{2}E_{\max}^2$

Poynting vector, averaged over a period

(1.20) $\bar{S}_{avg} = \frac{1}{2}\frac{E_{\max}^2}{\mu_0 c} = \frac{1}{2}\frac{cB_{\max}^2}{\mu_0}; \mu_0\varepsilon_0 c^2 = 1$ $; \varepsilon_0\mu_0 = \frac{1}{c^2}$

(1.21) $\frac{S}{c} = u = \frac{U}{V} = \frac{Fdx}{Adx} = pressure\ P$ in an em-wave

(1.22) $p = \frac{2U}{c}$ Perfect reflector

(1.23) $p = \frac{U}{c}$ Perfect absorber

(1.24) $\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}\left(\vec{A} \bullet \vec{C}\right) - \vec{C}\left(\vec{A} \bullet \vec{B}\right)$ for any three vectors $\vec{A}, \vec{B}, \vec{C}$

(1.25)
$$\vec{E}(x,y,z,t) = \vec{E} = \vec{E}_0 e^{i\left(\vec{k} \bullet \vec{r} - \omega t\right)}$$
$$\vec{B}(x,y,z,t) = \vec{B} = \vec{B}_0 e^{i\left(\vec{k} \bullet \vec{r} - \omega t\right)}$$

$$\frac{\partial}{\partial t}(-i\omega t) = -i\omega$$
$$\vec{\nabla} \Rightarrow i\vec{k}$$

(1.26)
$$\vec{\nabla} \times \vec{B} = curl\vec{B} = i\vec{k} \times \vec{B}; \vec{\nabla}\vec{B} = div\vec{B} = i\vec{k} \cdot \vec{B}$$
$$\vec{\nabla} U = \overrightarrow{grad} U = i\vec{k} U$$
$$\vec{\nabla} \bullet \vec{\nabla} = \Delta = Laplace = \left(i\vec{k}\right)^2 = -k^2$$