PH2023 Equation Sheet

$V_{\text{sphere}} = \frac{4}{3}\pi R^3$	$A_{\text{sphere}} = 4\pi R^2$	$\epsilon_0 = 8.85 \times 10^{-12} \text{C}^2/\text{N}\cdot\text{m}^2$	$k_e = 8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$
$\mu_0 = 4\pi \times 10^{-7} \text{T}\cdot\text{m/A}$	$e = 1.60 \times 10^{-19}$ C	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = 1.67 \times 10^{-27}$ kg
$P_{atm} = 1.013 \times 10^5$ Pa	1 eV $= 1.60 \times 10^{-19}$ J	$\rho_{\text{water}} = 1000\ \text{kg/m}^3$	

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\begin{aligned}
x &= x_0 + v_0 t + \frac{1}{2}at^2 \\
F_c &= \frac{mv^2}{r} \\
\boldsymbol{\tau} &= \mathbf{r} \times \mathbf{F} \\
P &= F/A \\
P &= P_0 + \rho g h \\
F_B &= \rho_{\text{fluid}} g V \\
Av &= \text{const} \\
P + \frac{1}{2}\rho v^2 + \rho g y &= \text{const} \\
\mathbf{F}_{12} &= \frac{k q_1 q_2}{r_{12}^2}\hat{r}_{12} \\
\mathbf{E} &= \frac{kQ}{r^2}\hat{r} \\
E &= \frac{\sigma}{2\epsilon_0}, \quad E = \frac{2k\lambda}{r} \\
\mathbf{F} &= q\mathbf{E} \\
\boldsymbol{\tau} &= \mathbf{p} \times \mathbf{E} \\
U &= -\mathbf{p} \cdot \mathbf{E} \\
V &= \frac{kQ}{r} \\
E_x &= -\frac{\partial V}{\partial x} \\
\Delta V &= -\int_A^B \mathbf{E} \cdot d\boldsymbol{\ell} \\
\Delta V &= -Ed \\
U &= k\frac{q_1 q_2}{r} \\
U &= qV \\
R &= \rho\frac{l}{A} \\
\rho &= \rho_{20}[1 + \alpha(T - 20^\circ)] \\
I &= nqv_d A \\
\mathcal{P} &= I^2 R \\
\oint \mathbf{E} \cdot d\mathbf{A} &= \frac{Q_{\text{in}}}{\epsilon_0} \\
Q &= CV \\
C_0 &= \epsilon_0 \frac{A}{d} \\
C &= \kappa C_0 \\
U &= \frac{1}{2}QV = \frac{Q^2}{2C} = \frac{1}{2}CV^2 \\
C_{\text{eq}} &= C_1 + C_2 + C_3 + \cdots \\
\frac{1}{C_{\text{eq}}} &= \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots
\end{aligned}
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$$
\begin{aligned}
V &= IR \\
R_{\text{eq}} &= R_1 + R_2 + R_3 + \cdots \\
\frac{1}{R_{\text{eq}}} &= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \\
\mathbf{F} &= q\mathbf{v} \times \mathbf{B} \\
\mathbf{F} &= I\boldsymbol{\ell} \times \mathbf{B} \\
r &= \frac{mv}{qB} \\
\mathcal{E} &= -N\frac{d\phi_B}{dt} \\
\mathcal{E} &= Blv \\
L &= \frac{N\phi_B}{I} \\
L &= \frac{\mu_0 N^2 A}{l} \\
\mathcal{E}_L &= -L\frac{dI}{dt} \\
U &= \frac{1}{2}LI^2 \\
\phi_B &= \int \mathbf{B} \cdot d\mathbf{A} \\
\boldsymbol{\mu} &= NI\mathbf{A} \\
\boldsymbol{\tau} &= \boldsymbol{\mu} \times \mathbf{B} \\
U &= -\boldsymbol{\mu} \cdot \mathbf{B} \\
\oint \mathbf{B} \cdot d\boldsymbol{\ell} &= \mu_0 I_{in} + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt} \\
\mathbf{B} &= \frac{\mu_0 I}{4\pi} \int \frac{d\boldsymbol{\ell} \times \hat{r}}{r^2} \\
B &= \mu_0 n I \\
B &= \frac{\mu_0 I}{2\pi R} \\
B &= \frac{\mu_0 I}{2R} \\
E &= cB \\
u_E &= \frac{1}{2}\epsilon_0 E^2 \\
u_B &= \frac{B^2}{2\mu_0} \\
\omega &= \frac{1}{\sqrt{LC}} \\
Q(t) &= C\mathcal{E}(1 - e^{-t/RC}) \\
Q(t) &= Q_0 e^{-t/RC} \\
I(t) &= I_0 e^{-t/RC} \\
I(t) &= I_0 e^{-Rt/L} \\
I(t) &= \frac{\mathcal{E}}{R}(1 - e^{-Rt/L})
\end{aligned}
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