Constants:

$$
\begin{aligned}
N_A &= 6.022 \times 10^{23}\,\text{things/mol} \\
k_e &\equiv 1/4\pi\epsilon_o = 8.98755 \times 10^{9}\,\text{N}\cdot\text{m}^2\cdot\text{C}^{-2} \\
\epsilon_o &= 8.85 \times 10^{-12}\,\text{C}^2/\text{N}\cdot\text{m}^2 \\
e &= 1.60218 \times 10^{-19}\,\text{C} \\
m_e &= 9.10938 \times 10^{-31}\,\text{kg}
\end{aligned}
$$

Quadratic formula:

$$0 = ax^2 + bx^2 + c \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Basic Equations:

$$
\begin{aligned}
\vec{F}_{net} &= \frac{d\vec{p}}{dt} = m\vec{a} \quad \text{Newton's Second Law} \\
\vec{F}_{centr} &= -\frac{mv^2}{r}\hat{r} \quad \text{Centripetal}
\end{aligned}
$$

Vectors:

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2} \quad \text{magnitude} \qquad \theta = \tan^{-1}\left[\frac{F_y}{F_x}\right] \quad \text{direction}$$

Current:

$$
\begin{aligned}
I &= \frac{\Delta Q}{\Delta t} = nqAv_d \\
J &= \frac{I}{A} = nqv_d \\
v_d &= \frac{e\tau}{m}E \quad \tau = \text{scattering time} \\
\rho &= \frac{m}{ne^2\tau} \\
\Delta V &= \frac{\rho l}{A} I = RI \\
R &= \frac{\Delta V}{I} = \frac{\rho l}{A} \\
\mathscr{P} &= E\cdot\Delta t = I\Delta V = I^2R = \frac{[\Delta V]^2}{R} \quad \text{power}
\end{aligned}
$$

Ohm:

$$
\begin{aligned}
\Delta V &= IR \\
\mathscr{P} &= E\cdot\Delta t = I\Delta V = I^2R = \frac{[\Delta V]^2}{R} \quad \text{power}
\end{aligned}
$$

Electric Potential:

$$
\begin{aligned}
\Delta V &= V_B - V_A = \frac{\Delta PE}{q} \\
\Delta PE &= q\Delta V = -q|\vec{E}||\Delta\vec{x}|\cos\theta = -qE_x\Delta x \\
&\quad \uparrow \text{ constant E field} \\
V_{\text{point charge}} &= k_e\frac{q}{r} \\
PE_{\text{pair of point charges}} &= k_e\frac{q_1q_2}{r_{12}} \\
PE_{\text{system}} &= \text{sum unique pairs} = \sum_{\text{pairs } ij}\frac{k_e q_i q_j}{r_{ij}} \\
-W &= \Delta PE = q(V_B - V_A)
\end{aligned}
$$

Electric Force & Field

$$
\begin{aligned}
\vec{F}_{e,12} &= q\vec{E}_{12} = \frac{k_e q_1 q_2}{r_{12}^2}\hat{r}_{12} \\
\vec{E} &= k_e\frac{|q|}{r^2} \\
\Phi_E &= |\vec{E}|A\cos\theta_{EA} = \frac{Q_{\text{inside}}}{\epsilon_0} \quad \text{Gauss} \\
\Delta PE &= -W = -q|\vec{E}||\Delta\vec{x}|\cos\theta = -qE_x\Delta x \\
&\quad \uparrow \text{ constant E field}
\end{aligned}
$$

Capacitors:

$$
\begin{aligned}
Q_{\text{capacitor}} &= C\Delta V \\
C_{\text{parallel plate}} &= \frac{\epsilon_0 A}{d} \\
E_{\text{capacitor}} &= \frac{1}{2}Q\Delta V = \frac{Q^2}{2C} \\
C_{\text{eq, par}} &= C_1 + C_2 \\
C_{\text{eq, series}} &= \frac{C_1C_2}{C_1 + C_2} \\
C_{\text{with dielectric}} &= \kappa C_{\text{without}}
\end{aligned}
$$

Unit	Symbol	equivalent to
newton	N	$kg\cdot m/s^2$
joule	J	$kg\cdot m^2/s^2 = N\cdot m$
watt	W	$J/s = m^2\cdot kg/s^3$
coulomb	C	$A\cdot s$
amp	A	C/s
volt	V	$W/A = m^2\cdot kg/\cdot s^3\cdot A$
farad	F	$C/V = A^2\cdot s^4/m^2\cdot kg$
ohm	Ω	$V/A = m^2\cdot kg/s^3\cdot A^2$
-	1 N/C	1 V/m

Power	Prefix	Abbreviation
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T