

AP Physics C: Electricity and Magnetism Cheat Sheet

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Unit 1: Electrostatics

- **Law of Conservation of Charge:** Charge cannot be created or destroyed, only transferred.
- **Conductors:** Charge distributes evenly on the surface, does not hold inside.
- **Inside has zero net charge.**
- **Insulator:** Charge does not distribute evenly, holds charge in one spot.
- **Coulomb's Law:** $(F_e = k \frac{|q_1 q_2|}{r^2})$
- **Positive F_e : repel, Negative F_e : attract**
- **Electric Field:** $(E = \frac{F_e}{q})$
- $(E = k \frac{q}{r^2})$ for a point charge.
- **Gauss's Law:** $(\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0})$
- **Electric Potential Energy:** $(\frac{q_1 q_2}{r})$
- **Electric Potential:** $(V = \frac{U}{q} = k \frac{q}{r})$
- **Potential Difference (Voltage):** $(\Delta V = - \int \vec{E} \cdot d\vec{s})$
- **Equipotential Surfaces:** Surfaces where the potential is constant, (\vec{E})
- **is perpendicular to equipotential surfaces.**

Additional Notes:

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Unit 2: Conductors, Capacitors, & Dielectrics

- **Capacitance:** $(C = \frac{Q}{V})$
- **Units:** Farads (F)
- **Parallel Plate Capacitor:** $(C = \frac{\epsilon_0 A}{d})$
- **Capacitors in Series:** $(\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \dots)$
- **Capacitors in Parallel:** $(C_{eq} = C_1 + C_2 + \dots)$
- **Energy Stored in Capacitor:** $(U = \frac{1}{2} CV^2)$
- **Dielectrics:** Increases capacitance by a factor K: $C' = KC$
- **Electric Field in Dielectrics:** $(E = \frac{E_0}{K})$
- **Capacitance with Dielectric:** $(C = \frac{K\epsilon_0 A}{d})$
- $(U = \frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} CV^2)$

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Unit 3: Electric Circuits

- **Current:** $(I = \frac{dQ}{dt})$
- $(I = \frac{V}{R})(Ohm's\ Law)$
- **Resistance:** $(R = \frac{\rho L}{A})$
- $\rho = \text{resistivity, } L = \text{length, } A = \text{area}$
- **Ohm's Law:** $V = IR$
- **Power:** $(P = IV = I^2R = \frac{V^2}{R})$
- **Kirchhoff's Laws:** **Junction Rule:** $\Sigma I_{in} = \Sigma I_{out}$
- **Loop Rule:** $\Sigma \Delta = 0$
- **Resistors in Series:** $(R_{eq} = R_1 + R_2 + \dots)$
- **Resistors in Parallel:** $(\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots)$
- **RC Circuits:** **Charging:** $(q(t) = Q_{max} (1 - e^{-t/RC}))$
- **Discharging:** $(q(t) = Q_{max} e^{-t/RC})$

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Unit 4: Magnetic Fields

- **Magnetic Force on a Moving Charge:** $F_6 = qvB\sin\theta$
- **Right-hand rule:** Thumb (v), Fingers (B), Palm (Force).
- **Magnetic Force on a Current-Carrying Wire:** $F_6 = ILB\sin\theta$
- **Biot-Savart Law:** $(d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{l} \times \hat{r}}{r^2})$
- **Ampère's Law:** $(\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{enc}})$
- **Magnetic Flux:** $(\Phi_B = \vec{B} \cdot \vec{A} = BA \cos \theta)$
- **Torque on a Loop:** $T = NIAB\sin\theta$

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Unit 5: Electromagnetism

- **Faraday's Law of Induction:** $(\mathcal{E} = -\frac{d\Phi_B}{dt})$
- **Induced emf opposes the change in magnetic flux (Lenz's Law).**

- **Inductance:** $(V = L \frac{dI}{dt})$

- $(L = \frac{\mu_0 N^2 A}{l})$

- **Inductors in Circuits: RL Circuit (Charging):**

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

- **RL Circuit (Discharging):** $I(t) = I_0 e^{-t/\tau}$

- **Time constant:** $(\tau = \frac{L}{R})$
- **LC Oscillations:** $(\omega_0 = \frac{1}{\sqrt{LC}})$

- $(f_0 = \frac{1}{2\pi\sqrt{LC}})$

- **Transformers:** $(\frac{V_s}{V_p} = \frac{N_s}{N_p})$

- $(\frac{I_s}{I_p} = \frac{N_p}{N_s})$

Additional Notes: