AP Physics C: Electricity and Magnetism Cheat Sheet

Practice AP Physics

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:**
  - $(F_e = k\frac{|q_1 q_2|}{r^2})$
  - $(E = \frac{F_e}{q})$
- **Electric Field:**
  - $(E = \frac{F_e}{q})$
  - $(E = k\frac{q}{r^2})$
- **Gauss's Law:**
  - $(\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enc}}}{\epsilon_0})$
- **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:**
  - $(\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots)$
- **Capacitors in Parallel:**
  - $(C_{\text{eq}} = C_1 + C_2 + \cdots)$
- **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**:
  - $(I = \frac{dQ}{dt})$ (Ohm's Law)
  - $(I = \frac{V}{R})$
- **Resistance:**
  - $(R = \frac{\rho L}{A})$
  - (ρ)rhop = resistivity, L = length, A = area
- **Ohm's Law:**
  - $(I = \frac{V}{R})$
- **Power:**
  - $(P = IV = I^2R = \frac{V^2}{R})$
- **Kirchhoff's Laws:**
  - Junction Rule: $(\sum I_{\text{in}} = \sum I_{\text{out}})$
  - Loop Rule: $(\sum \Delta V = 0)$
- **Resistors in Series:**
  - $(R_{\text{eq}} = R_1 + R_2 + \cdots)$
- **Resistors in Parallel:**
  - $(\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots)$
- **RC Circuits:**
  - $(q(t) = Q_{\max} e^{-t/RC})$
  - $(q(t) = Q_{\max}\left(1 - e^{-t/RC}\right))$

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Unit 4: Magnetic Fields

- **Magnetic Force on a Moving Charge:**
  - $(F_B = qvB\sin\theta)$
  - Right-hand rule: Thumb (v), Fingers (B), Palm (Force).
- **Magnetic Force on a Current-Carrying Wire:**
  - $(F_B = ILB\sin\theta)$
- **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:**
  - $(\tau = NIAB\sin\theta)$

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