

FREE AP PHYSICS C: E&M

FORMULA SHEET

All the Essential Formulas You Need for Test Day

Unit 1: Electrostatics

- Coulomb's Law: $\mathbf{F} = k (q_1 q_2) / r^2$
- Electric Field (point charge): $\mathbf{E} = k q / r^2$
- Electric Force: $\mathbf{F} = q \mathbf{E}$
- Electric Potential (point charge): $V = k q / r$
- Potential Energy (two charges): $U = k (q_1 q_2) / r$
- Relationship between field and potential: $E = -\Delta V / \Delta x$
- Gauss's Law: $\oint \mathbf{E} \cdot d\mathbf{A} = Q_{\text{enclosed}} / \epsilon_0$

Unit 2: Conductors, Capacitors, Dielectrics

- Capacitance: $C = Q / V$
- Parallel-Plate Capacitor: $C = \epsilon_0 A / d$
- Energy in a Capacitor: $U = \frac{1}{2} C V^2$
- Equivalent Capacitance (series): $1/C_{\text{eq}} = 1/C_1 + 1/C_2 + \dots$
- Equivalent Capacitance (parallel): $C_{\text{eq}} = C_1 + C_2 + \dots$

Unit 3: Work, Energy, and Power

- Ohm's Law: $V = I R$
- Electric Power: $P = IV = I^2 R = V^2 / R$
- Resistors in Series: $R_{\text{eq}} = R_1 + R_2 + \dots$
- Resistors in Parallel: $1/R_{\text{eq}} = 1/R_1 + 1/R_2 + \dots$
- Current: $I = \Delta Q / \Delta t$
- Kirchhoff's Rules:
 - Junction Rule: $\sum I_{\text{in}} = \sum I_{\text{out}}$
 - Loop Rule: $\sum \Delta V = 0$

Constants

- $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / (\text{N} \cdot \text{m}^2)$
- $\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m} / \text{A}$
- $k = 1 / (4\pi\epsilon_0) \approx 9.0 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$
- $e = 1.60 \times 10^{-19} \text{ C}$
- $c = 3.0 \times 10^8 \text{ m/s}$
- $h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$

Need help mastering these formulas?

Our Ivy League Physics Tutors are here to help you reach your target score.

Book a free consultation on our site

Unit 4: Magnetic Fields

- Magnetic Force on a Charge: $\mathbf{F} = q \mathbf{v} \times \mathbf{B} \sin\theta$
- Magnetic Force on a Wire: $\mathbf{F} = I L \mathbf{B} \sin\theta$
- Torque on a Current Loop: $\tau = I A \mathbf{B} \sin\theta$
- Magnetic Field of a Long Straight Wire: $\mathbf{B} = \mu_0 I / (2\pi r)$
- Biot-Savart Law: $\mathbf{B} = (\mu_0 / 4\pi) \int (I d\mathbf{l} \times \hat{r}) / r^2$
- Ampère's Law: $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{\text{enclosed}}$

Unit 5: Electromagnetism & Induction

- Magnetic Flux: $\Phi_B = B A \cos\theta$
- Faraday's Law: $\epsilon = -\frac{d\Phi_B}{dt}$
- Lenz's Law: **Direction of induced current opposes flux change**
- Inductance: $\epsilon = -L (dI/dt)$
- Energy in an Inductor: $U = \frac{1}{2} L I^2$

Unit 6: Maxwell's Equations (Integral Form)

- Rotational kinetic energy: $KE_{\text{rot}} = \frac{1}{2} I \omega^2$
- Total kinetic energy (rolling): $KE_{\text{total}} = \frac{1}{2} M v^2 + \frac{1}{2} I \omega^2$
- Angular momentum:
 - $\mathbf{L} = \mathbf{r} \times \mathbf{p}$ (particle), $\mathbf{L} = I \omega$ (rigid body)
- Conservation of angular momentum: $\mathbf{L}_{\text{initial}} = \mathbf{L}_{\text{final}}$

Tip: AP Physics C: E&M questions test how formulas connect, not just memorization. Practice linking electric and magnetic concepts