

# Cheat Sheet — Midterm 2

PHYS 142 (Summer 2014)

Constants:

$$\epsilon_0 = 8.9 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2 \quad \mu_0 = 4\pi \times 10^{-7} \text{ Wb}/\text{A} \cdot \text{m} \quad g = 9.8 \text{ m/s}^2$$

$$e = 1.6 \times 10^{-19} \text{ C} \quad m_e = 9.1 \times 10^{-31} \text{ kg} \quad m_p = 1.7 \times 10^{-27} \text{ kg} \quad c = 3.0 \times 10^8 \text{ m/s}$$

## Charges, Currents, and the Electromagnetic Field

Forces on Charges and Currents:

$$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B}) \quad \vec{F} = \int I d\vec{s} \times \vec{B}$$

Flux:

$$\Phi_E = \iint_A \vec{E} \cdot \hat{n} dA \quad \Phi_B = \iint_A \vec{B} \cdot \hat{n} dA$$

Maxwell's Equations:

$$\iint_A \vec{E} \cdot \hat{n} dA = \frac{Q_{\text{enc}}}{\epsilon_0} \quad \iint_A \vec{B} \cdot \hat{n} dA = 0 \quad \oint_C \vec{E} \cdot d\vec{s} = -\frac{d\Phi_E}{dt} \quad \oint_C \vec{B} \cdot d\vec{s} = \mu_0 I_{\text{enc}} + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$

Sources of Electric and Magnetic Fields:

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r} \quad \vec{E} = \frac{1}{4\pi\epsilon_0} \int \frac{\rho(\vec{r}')}{r^2} \hat{r} \quad \vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2} \quad \vec{B} = \frac{\mu_0}{4\pi} \int \frac{I d\vec{s} \times \hat{r}}{r^2}$$

Electrostatic Potential:

$$V = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{r} \quad V_a - V_b = \int_a^b \vec{E} \cdot d\vec{s} \quad \vec{E} = -\nabla V = -\frac{\partial V}{\partial x} \hat{i} - \frac{\partial V}{\partial y} \hat{j} - \frac{\partial V}{\partial z} \hat{k}$$

Electric Dipole:

$$\vec{p} = q\vec{d} \quad \vec{E} = \vec{p} \times \vec{R} \quad U = -\vec{p} \cdot \vec{E}$$

Magnetic Dipole:

$$\vec{\mu} = I\vec{A} \hat{n} \quad \vec{E} = \vec{\mu} \times \vec{B} \quad U = -\vec{\mu} \cdot \vec{B}$$

Energy in Fields:

$$U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2\mu_0} B^2$$

Motion in B-Field:

$$R = \frac{mv}{qB}$$

B-Fields of Infinite Objects:

$$B = \frac{\mu_0 I}{2\pi r} \text{ (wire)} \quad B = \mu_0 n I \text{ (solenoid)}$$

## Electrical Circuits

Current:

$$I = \frac{dQ}{dt} = n(q)(v_d)A \quad \vec{J} = nq\vec{v}_d \quad \rho = \frac{E}{J}$$

Kirchoff's Rules:

$$\sum_{\text{loop}} V = 0 \quad \sum_{\text{junction}} I = 0$$

Faraday's Law:

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

Capacitors:

$$C = \frac{Q}{V} \quad \frac{1}{C_{\text{eq}}} = \sum_{i=1}^n \frac{1}{C_i} \text{ (Series)} \quad C_{\text{eq}} = \sum_{i=1}^n C_i \text{ (Parallel)} \quad U = \frac{1}{2} CV^2 = \frac{Q^2}{2C}$$

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**Wenbin Ji**



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## **Table of Contents Mastering Physics Solutions Chapter 21**

1. Understanding the eBook Mastering Physics Solutions Chapter 21
  - The Rise of Digital Reading Mastering Physics Solutions Chapter 21
  - Advantages of eBooks Over Traditional Books
2. Identifying Mastering Physics Solutions Chapter 21
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mastering Physics Solutions Chapter 21
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mastering Physics Solutions Chapter 21
  - Personalized Recommendations
  - Mastering Physics Solutions Chapter 21 User Reviews and Ratings
  - Mastering Physics Solutions Chapter 21 and Bestseller Lists
5. Accessing Mastering Physics Solutions Chapter 21 Free and Paid eBooks
  - Mastering Physics Solutions Chapter 21 Public Domain eBooks
  - Mastering Physics Solutions Chapter 21 eBook Subscription Services
  - Mastering Physics Solutions Chapter 21 Budget-Friendly Options
6. Navigating Mastering Physics Solutions Chapter 21 eBook Formats
  - ePub, PDF, MOBI, and More
  - Mastering Physics Solutions Chapter 21 Compatibility with Devices
  - Mastering Physics Solutions Chapter 21 Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mastering Physics Solutions Chapter 21
  - Highlighting and Note-Taking Mastering Physics Solutions Chapter 21
  - Interactive Elements Mastering Physics Solutions Chapter 21

8. Staying Engaged with Mastering Physics Solutions Chapter 21
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mastering Physics Solutions Chapter 21
9. Balancing eBooks and Physical Books Mastering Physics Solutions Chapter 21
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mastering Physics Solutions Chapter 21
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Mastering Physics Solutions Chapter 21
  - Setting Reading Goals Mastering Physics Solutions Chapter 21
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Mastering Physics Solutions Chapter 21
  - Fact-Checking eBook Content of Mastering Physics Solutions Chapter 21
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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