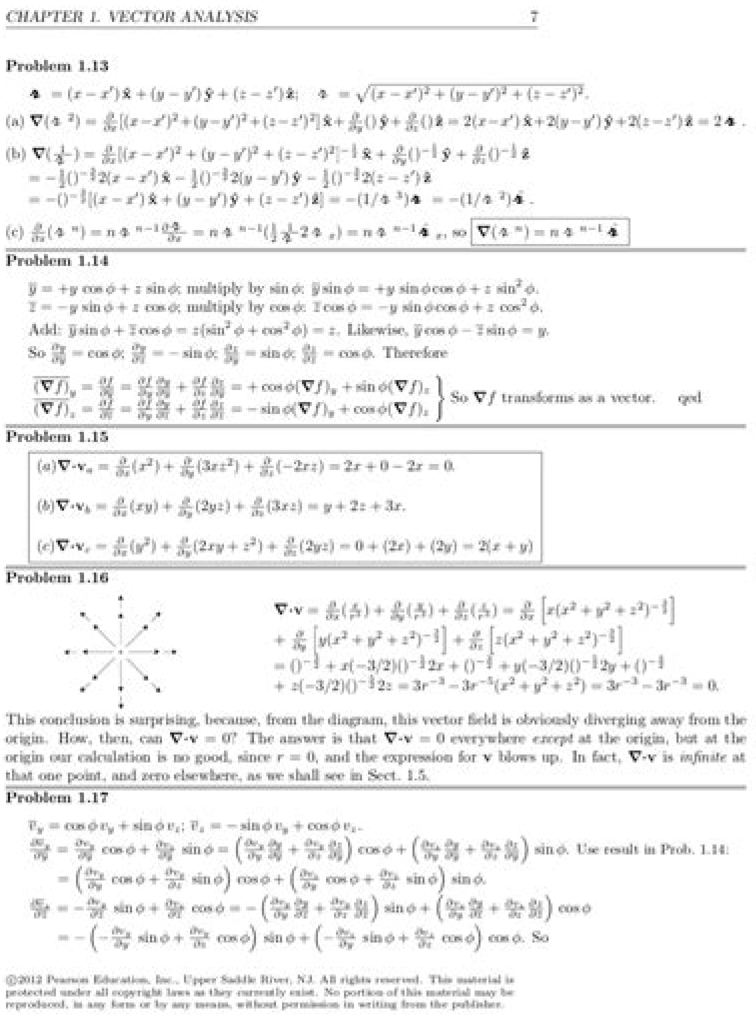
Introduction To Electrodynamics Griffiths Solutions



Problem 1.13

$\boldsymbol{\mathscr{r}} = (x-x')\,\hat{\mathbf{x}} + (y-y')\,\hat{\mathbf{y}} + (z-z')\,\hat{\mathbf{z}}; \quad \mathscr{r} = \sqrt{(x-x')^2+(y-y')^2+(z-z')^2}.$

(a) $\boldsymbol{\nabla}(\mathscr{r}^2) = \frac{\partial}{\partial x}[(x-x')^2+(y-y')^2+(z-z')^2]\,\hat{\mathbf{x}} + \frac{\partial}{\partial y}()\,\hat{\mathbf{y}} + \frac{\partial}{\partial z}()\,\hat{\mathbf{z}} = 2(x-x')\,\hat{\mathbf{x}} + 2(y-y')\,\hat{\mathbf{y}} + 2(z-z')\,\hat{\mathbf{z}} = 2\boldsymbol{\mathscr{r}}.$

(b) $\boldsymbol{\nabla}(\frac{1}{\mathscr{r}}) = \frac{\partial}{\partial x}[(x-x')^2+(y-y')^2+(z-z')^2]^{-\frac{1}{2}}\,\hat{\mathbf{x}} + \frac{\partial}{\partial y}()^{-\frac{1}{2}}\,\hat{\mathbf{y}} + \frac{\partial}{\partial z}()^{-\frac{1}{2}}\,\hat{\mathbf{z}}$

$= -\frac{1}{2}()^{-\frac{3}{2}}2(x-x')\,\hat{\mathbf{x}} - \frac{1}{2}()^{-\frac{3}{2}}2(y-y')\,\hat{\mathbf{y}} - \frac{1}{2}()^{-\frac{3}{2}}2(z-z')\,\hat{\mathbf{z}}$

$= -()^{-\frac{3}{2}}[(x-x')\,\hat{\mathbf{x}} + (y-y')\,\hat{\mathbf{y}} + (z-z')\,\hat{\mathbf{z}}] = -(1/\mathscr{r}^3)\boldsymbol{\mathscr{r}} = -(1/\mathscr{r}^2)\hat{\boldsymbol{\mathscr{r}}}.$

(c) $\frac{\partial}{\partial x}(\mathscr{r}^n) = n\mathscr{r}^{n-1}\frac{\partial \mathscr{r}}{\partial x} = n\mathscr{r}^{n-1}(\frac{1}{2}\frac{1}{\mathscr{r}}2\mathscr{r}_x) = n\mathscr{r}^{n-1}\hat{\boldsymbol{\mathscr{r}}}_x$, so $\boxed{\boldsymbol{\nabla}(\mathscr{r}^n) = n\mathscr{r}^{n-1}\hat{\boldsymbol{\mathscr{r}}}}$

Problem 1.14

$\bar{y} = +y\cos\phi + z\sin\phi$; multiply by $\sin\phi$: $\bar{y}\sin\phi = +y\sin\phi\cos\phi + z\sin^2\phi$.
$\bar{z} = -y\sin\phi + z\cos\phi$; multiply by $\cos\phi$: $\bar{z}\cos\phi = -y\sin\phi\cos\phi + z\cos^2\phi$.

Add: $\bar{y}\sin\phi + \bar{z}\cos\phi = z(\sin^2\phi + \cos^2\phi) = z$. Likewise, $\bar{y}\cos\phi - \bar{z}\sin\phi = y$.

So $\frac{\partial y}{\partial \bar{y}} = \cos\phi$; $\frac{\partial y}{\partial \bar{z}} = -\sin\phi$; $\frac{\partial z}{\partial \bar{y}} = \sin\phi$; $\frac{\partial z}{\partial \bar{z}} = \cos\phi$. Therefore

$$\left.\begin{array}{l} \overline{(\boldsymbol{\nabla} f)}_y = \frac{\partial f}{\partial \bar{y}} = \frac{\partial f}{\partial y}\frac{\partial y}{\partial \bar{y}} + \frac{\partial f}{\partial z}\frac{\partial z}{\partial \bar{y}} = +\cos\phi(\boldsymbol{\nabla} f)_y + \sin\phi(\boldsymbol{\nabla} f)_z \\ \overline{(\boldsymbol{\nabla} f)}_z = \frac{\partial f}{\partial \bar{z}} = \frac{\partial f}{\partial y}\frac{\partial y}{\partial \bar{z}} + \frac{\partial f}{\partial z}\frac{\partial z}{\partial \bar{z}} = -\sin\phi(\boldsymbol{\nabla} f)_y + \cos\phi(\boldsymbol{\nabla} f)_z \end{array}\right\}$$ So $\boldsymbol{\nabla} f$ transforms as a vector. qed

Problem 1.15

(a) $\boldsymbol{\nabla}\cdot\mathbf{v}_a = \frac{\partial}{\partial x}(x^2) + \frac{\partial}{\partial y}(3xz^2) + \frac{\partial}{\partial z}(-2xz) = 2x + 0 - 2x = 0.$

(b) $\boldsymbol{\nabla}\cdot\mathbf{v}_b = \frac{\partial}{\partial x}(xy) + \frac{\partial}{\partial y}(2yz) + \frac{\partial}{\partial z}(3xz) = y + 2z + 3x.$

(c) $\boldsymbol{\nabla}\cdot\mathbf{v}_c = \frac{\partial}{\partial x}(y^2) + \frac{\partial}{\partial y}(2xy + z^2) + \frac{\partial}{\partial z}(2yz) = 0 + (2x) + (2y) = 2(x+y)$

Problem 1.16

$\boldsymbol{\nabla}\cdot\mathbf{v} = \frac{\partial}{\partial x}(\frac{x}{r^3}) + \frac{\partial}{\partial y}(\frac{y}{r^3}) + \frac{\partial}{\partial z}(\frac{z}{r^3}) = \frac{\partial}{\partial x}\left[x(x^2+y^2+z^2)^{-\frac{3}{2}}\right]$
$+ \frac{\partial}{\partial y}\left[y(x^2+y^2+z^2)^{-\frac{3}{2}}\right] + \frac{\partial}{\partial z}\left[z(x^2+y^2+z^2)^{-\frac{3}{2}}\right]$
$= ()^{-\frac{3}{2}} + x(-3/2)()^{-\frac{5}{2}}2x + ()^{-\frac{3}{2}} + y(-3/2)()^{-\frac{5}{2}}2y + ()^{-\frac{3}{2}}$
$+ z(-3/2)()^{-\frac{5}{2}}2z = 3r^{-3} - 3r^{-5}(x^2+y^2+z^2) = 3r^{-3} - 3r^{-3} = 0.$

This conclusion is surprising, because, from the diagram, this vector field is obviously diverging away from the origin. How, then, can $\boldsymbol{\nabla}\cdot\mathbf{v} = 0$? The answer is that $\boldsymbol{\nabla}\cdot\mathbf{v} = 0$ everywhere *except* at the origin, but at the origin our calculation is no good, since $r = 0$, and the expression for $\mathbf{v}$ blows up. In fact, $\boldsymbol{\nabla}\cdot\mathbf{v}$ is *infinite* at that one point, and zero elsewhere, as we shall see in Sect. 1.5.

Problem 1.17

$\bar{v}_y = \cos\phi\, v_y + \sin\phi\, v_z$; $\bar{v}_z = -\sin\phi\, v_y + \cos\phi\, v_z$.

$\frac{\partial \bar{v}_y}{\partial \bar{y}} = \frac{\partial v_y}{\partial \bar{y}}\cos\phi + \frac{\partial v_z}{\partial \bar{y}}\sin\phi = \left(\frac{\partial v_y}{\partial y}\frac{\partial y}{\partial \bar{y}} + \frac{\partial v_y}{\partial z}\frac{\partial z}{\partial \bar{y}}\right)\cos\phi + \left(\frac{\partial v_z}{\partial y}\frac{\partial y}{\partial \bar{y}} + \frac{\partial v_z}{\partial z}\frac{\partial z}{\partial \bar{y}}\right)\sin\phi$. Use result in Prob. 1.14:

$= \left(\frac{\partial v_y}{\partial y}\cos\phi + \frac{\partial v_y}{\partial z}\sin\phi\right)\cos\phi + \left(\frac{\partial v_z}{\partial y}\cos\phi + \frac{\partial v_z}{\partial z}\sin\phi\right)\sin\phi.$

$\frac{\partial \bar{v}_z}{\partial \bar{z}} = -\frac{\partial v_y}{\partial \bar{z}}\sin\phi + \frac{\partial v_z}{\partial \bar{z}}\cos\phi = -\left(\frac{\partial v_y}{\partial y}\frac{\partial y}{\partial \bar{z}} + \frac{\partial v_y}{\partial z}\frac{\partial z}{\partial \bar{z}}\right)\sin\phi + \left(\frac{\partial v_z}{\partial y}\frac{\partial y}{\partial \bar{z}} + \frac{\partial v_z}{\partial z}\frac{\partial z}{\partial \bar{z}}\right)\cos\phi$

$= -\left(-\frac{\partial v_y}{\partial y}\sin\phi + \frac{\partial v_y}{\partial z}\cos\phi\right)\sin\phi + \left(-\frac{\partial v_z}{\partial y}\sin\phi + \frac{\partial v_z}{\partial z}\cos\phi\right)\cos\phi$. So

Introduction to Electrodynamics Griffiths Solutions is a fundamental topic for students and enthusiasts of physics. David J. Griffiths' textbook, "Introduction to Electrodynamics," is widely regarded as one of the best resources for understanding the principles of electricity and magnetism. This article aims to provide an overview of the key concepts covered in Griffiths' work, the significance of solutions, and how these solutions can aid in mastering electrodynamics.

Understanding Electrodynamics

Electrodynamics is the branch of physics that deals with the study of electric charges in motion and the forces and fields associated with them. It is essential for understanding various phenomena in both classical and modern physics. The core concepts of electrodynamics can be broken down into the following categories:

- Electric Charges and Fields
- Magnetic Fields and Forces
- Electromagnetic Waves
- Electromagnetic Induction

These concepts form the foundation of classical electromagnetism and are crucial for various applications in engineering, technology, and natural sciences.

The Role of Griffiths' Textbook

David Griffiths' "Introduction to Electrodynamics" is designed primarily for undergraduate students. It provides a clear and concise approach to electrodynamics, making complex topics accessible. The book is structured to gradually build understanding, starting from basic principles and moving towards more advanced topics. Some notable features of Griffiths' textbook include:

1. **Clear Explanations:** Each concept is thoroughly explained, often with intuitive reasoning or analogies that help students grasp difficult ideas.
2. **Well-Structured Problems:** The end-of-chapter problems range in difficulty and often require a deeper understanding of the material.
3. **Illustrative Examples:** Griffiths includes numerous examples that demonstrate the application of theoretical concepts to practical problems.
4. **Mathematical Rigor:** The book balances physical intuition with mathematical precision, making it suitable for students with varying levels of mathematical background.

Importance of Solutions in Learning Electrodynamics

Solutions to the problems presented in Griffiths' textbook play a crucial role in the learning process. They serve multiple purposes:

1. Reinforcement of Concepts

By working through solutions, students can reinforce their understanding of the material. The problems are designed to challenge students, and solutions provide insight into how to approach similar questions in the future.

2. Development of Problem-Solving Skills

Electrodynamics often involves complex calculations and critical thinking. Solutions can help students develop systematic problem-solving skills, which are essential for tackling real-world physics problems.

3. Clarification of Difficult Topics

Some concepts in electrodynamics can be particularly challenging. Solutions often clarify these topics, providing step-by-step breakdowns that help demystify the material.

4. Preparation for Exams

Working through solutions is an effective way to prepare for exams. It helps students identify areas where they may need additional practice and strengthens their overall understanding.

Key Topics in Griffiths' Electrodynamics

The textbook covers a wide array of topics in electrodynamics. Here are some of the key areas:

1. Electrostatics

Electrostatics is the study of electric charges at rest. Key concepts include:

- Electric Field (E)
- Electric Potential (V)
- Coulomb's Law
- Gauss's Law

Griffiths introduces the concept of electric fields generated by point charges and extends it to continuous charge distributions, emphasizing the importance of symmetry in solving electrostatic problems.

2. Magnetostatics

Magnetostatics deals with magnetic fields produced by steady currents. Important topics include:

- Biot-Savart Law
- Ampère's Law
- Magnetic Field due to Currents
- Magnetic Materials

Griffiths explains how to visualize magnetic fields and introduces the concept of magnetic force acting on moving charges.

3. Electromagnetic Induction

One of the most significant discoveries in physics, electromagnetic induction, is the process by which a changing magnetic field can induce an electric current. Key concepts include:

- Faraday's Law
- Lenz's Law
- Self-Induction and Mutual Induction

Griffiths provides practical examples, such as transformers and electric generators, to illustrate these principles.

4. Electromagnetic Waves

The relationship between electricity and magnetism culminates in the study of electromagnetic waves. Griffiths discusses:

- Wave Equations
- Propagation of Electromagnetic Waves
- Polarization
- Reflection and Refraction

This section highlights the implications of Maxwell's equations and how they unite electric and magnetic fields.

Utilizing Griffiths Solutions Effectively

To make the most of Griffiths' solutions, students should consider the following strategies:

1. Active Problem Solving

Instead of passively reading solutions, students should attempt to solve problems independently before consulting the solutions. This active engagement promotes deeper learning.

2. Study Groups

Working in study groups can enhance understanding. Discussing problems and solutions with peers can provide different perspectives, leading to a more robust grasp of the material.

3. Office Hours and Tutoring

Taking advantage of office hours or seeking tutoring can provide personalized assistance. Instructors can offer valuable insights into difficult topics and guide students through complex problems.

4. Online Resources

Many online platforms offer additional resources, including video tutorials and forums where students can ask questions and discuss problems. These can be beneficial supplements to Griffiths' textbook.

Conclusion

In conclusion, **Introduction to Electrodynamics Griffiths Solutions** provides a comprehensive framework for understanding the principles of electrodynamics. Griffiths' textbook is an invaluable resource for students, and the solutions to its problems play a vital role in reinforcing concepts, developing problem-solving skills, and preparing for exams. By actively engaging with the material, utilizing study groups, and seeking additional resources, students can enhance their understanding of this fascinating and essential field of physics. Whether pursuing a career in physics, engineering, or a related discipline, mastering the concepts of electrodynamics is crucial for future success.

Frequently Asked Questions

What is 'Introduction to Electrodynamics' by David J. Griffiths about?

It is a textbook that covers the fundamental principles of electromagnetism, including electric fields, magnetic fields, and the behavior of charged particles, aimed at undergraduate students in physics.

Where can I find solutions to the problems in Griffiths' 'Introduction to Electrodynamics'?

Solutions to the problems can typically be found in companion solution manuals, online forums, or educational websites dedicated to physics and mathematics resources.

Are the solutions provided in Griffiths' book official?

No, the solutions available online or in unofficial solution manuals are not officially endorsed by the author and may vary in accuracy.

What topics are covered in the problem sets of Griffiths' 'Introduction to Electrodynamics'?

The problem sets cover a range of topics including Coulomb's law, Gauss's law, electromagnetic waves, and Maxwell's equations.

Why is Griffiths' 'Introduction to Electrodynamics' popular among physics students?

It is well-regarded for its clear explanations, intuitive approach to complex concepts, and extensive problem sets that reinforce learning.

How can I effectively use Griffiths' solutions to study electrodynamics?

Use the solutions to check your work after attempting problems, ensuring you understand each step, and refer back to the textbook for theoretical concepts.

What is a common challenge students face when studying from Griffiths' book?

Many students struggle with the mathematical rigor and abstract concepts, particularly in vector calculus and differential equations required in electrodynamics.

Can I study electrodynamics without Griffiths' book?

Yes, there are other textbooks and resources available, but Griffiths is often recommended for its clarity and depth, making it a solid choice for foundational understanding.

Introduction To Electrodynamics Griffiths Solutions

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