

Purcell Morin Electricity And Magnetism Solutions Problems

forces is equal and opposite to the sum of the vertical components of the tensions. This gives

$$2 \left(\frac{qQ}{4\pi\epsilon_0 \ell^2} \right) \sin \theta + \frac{q^2}{4\pi\epsilon_0 (2\ell \sin \theta)^2} = 2T \sin \theta \implies \frac{q^2}{16\pi\epsilon_0 \sin^3 \theta} = 2T\ell^2 - \frac{qQ}{2\pi\epsilon_0}. \quad (14)$$

Similarly, each charge Q is in equilibrium if

$$2 \left(\frac{qQ}{4\pi\epsilon_0 \ell^2} \right) \cos \theta + \frac{Q^2}{4\pi\epsilon_0 (2\ell \cos \theta)^2} = 2T \cos \theta \implies \frac{Q^2}{16\pi\epsilon_0 \cos^3 \theta} = 2T\ell^2 - \frac{qQ}{2\pi\epsilon_0}. \quad (15)$$

The righthand sides of the two preceding equations are equal, so the same must be true of the lefthand sides. This yields $q^2/\sin^3 \theta = Q^2/\cos^3 \theta$, or $q^2/Q^2 = \tan^3 \theta$, as desired.

Some limits: If $Q \gg q$, then $\theta \rightarrow 0$. And if $q \gg Q$, then $\theta \rightarrow \pi/2$. Also, if $q = Q$, then $\theta = 45^\circ$. These all make intuitive sense.

ALTERNATIVELY: To solve the exercise by minimizing the electrostatic energy, note that the only variable terms in the sum-over-all-pairs expression for the energy are the ones involving the diagonals of the rhombus. The other four pairs involve the sides of the rhombus which are of fixed length. The variable terms are $q^2/4\pi\epsilon_0(2\ell \sin \theta)$ and $Q^2/4\pi\epsilon_0(2\ell \cos \theta)$. Minimizing this as a function of θ yields

$$0 = \frac{d}{d\theta} \left(\frac{q^2}{\sin \theta} + \frac{Q^2}{\cos \theta} \right) = -q^2 \frac{\cos \theta}{\sin^2 \theta} + Q^2 \frac{\sin \theta}{\cos^2 \theta} \implies \frac{q^2}{Q^2} = \tan^3 \theta. \quad (16)$$

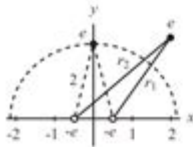


Figure 1

1.40. Zero potential energy

Let's first consider the general case where the three charges don't necessarily lie on the same line. Without loss of generality, we can put the two electrons on the x axis a unit distance apart (that is, at the values $x = \pm 1/2$), as shown in Fig. 1. And we may assume the proton lies in the xy plane. For an arbitrary location of the proton in this plane, let the distances from the electrons be r_1 and r_2 . Then setting the potential energy of the system equal to zero gives

$$U = \frac{1}{4\pi\epsilon_0} \left(\frac{e^2}{1} - \frac{e^2}{r_1} - \frac{e^2}{r_2} \right) \implies \frac{1}{r_1} + \frac{1}{r_2} = 1. \quad (17)$$

One obvious location satisfying this requirement has the proton on the y axis with $r_1 = r_2 = 2$, that is, with $y = \sqrt{5}/2 \approx 1.94$. In general, Eq. (17) defines a curve in the xy plane, and a surface of revolution around the x axis in space. This surface is the set of all points where the proton can be placed to give $U = 0$. The surface looks something like a prolate ellipsoid, but it isn't.

Let's now consider the case where all three charges lie on the x axis. Assume that the proton lies to the right of the right electron. We then have $r_1 = x - 1/2$ and $r_2 = x + 1/2$, so Eq. (17) becomes

$$\frac{1}{x - 1/2} + \frac{1}{x + 1/2} = 1 \implies x^2 - 2x - 1/4 = 0 \implies x = \frac{2 \pm \sqrt{5}}{2}. \quad (18)$$

The negative root must be thrown out because it violates our assumption that $x > 1/2$. (With $x < 1/2$, the distance r_1 isn't represented by $x - 1/2$). So we find $x = 2.118$. The distance from the right electron at $x = 1/2$ equals $(1 + \sqrt{5})/2$. The ratio of this

Purcell Morin electricity and magnetism solutions problems are essential for students and educators alike, as they navigate the complexities of physics. The textbook by Edwin M. Purcell and David J. Morin is a staple in many physics courses, offering rigorous explanations and challenging problems that help students grasp the foundational concepts of electricity and magnetism. This article delves into the various components of the Purcell Morin textbook, the types of problems presented, and effective strategies for solving them.

Understanding the Purcell Morin Textbook

The Purcell Morin textbook, officially titled "Electricity and Magnetism," is part of the Berkeley Physics Course series. It is designed for advanced undergraduate students and covers a wide range of topics in electricity and magnetism, focusing on both theoretical understanding and practical applications. The authors emphasize a conceptual approach, encouraging students to develop a deep understanding of the principles governing electric and magnetic fields.

Key Topics Covered

The textbook encompasses several key topics, including:

- Electrostatics
- Electric Fields and Potentials
- Magnetic Fields and Forces
- Electromagnetic Induction
- Maxwell's Equations
- Electromagnetic Waves

Each topic is presented with a combination of theoretical discussions, mathematical formulations, and practical examples, ensuring that students can connect theory to real-world applications.

Types of Problems in Purcell Morin

Problems in the Purcell Morin textbook are known for their variety and depth. They can be categorized into several types:

Conceptual Problems

These problems focus on the underlying principles of electricity and magnetism. They often require students to explain phenomena or apply concepts in new contexts. For example:

- Explain why a charged particle experiences a force when moving through a magnetic field.

- Discuss the implications of Gauss's Law in understanding electric fields.

Mathematical Problems

These problems require students to apply mathematical techniques to solve for unknowns. They typically involve calculations related to electric fields, magnetic fields, and potentials. Example problems include:

- Calculate the electric field due to a point charge at a given distance.
- Determine the magnetic field around a long, straight wire carrying a current.

Application-Based Problems

These problems challenge students to apply their knowledge to real-world scenarios. They may involve circuit analysis, electromagnetic waves, or energy transfer. For instance:

- Analyze a simple RC circuit and determine the time constant.
- Calculate the wavelength of an electromagnetic wave given its frequency.

Strategies for Solving Problems

To effectively tackle the problems presented in the Purcell Morin textbook, students can employ several strategies:

1. Master the Fundamentals

Before delving into problem-solving, it's crucial for students to have a solid grasp of the fundamental concepts. This includes understanding key terms, laws, and equations. A strong foundation will make it easier to approach complex problems.

2. Break Down the Problem

When faced with a challenging problem, students should break it down into manageable parts. Identify the knowns and unknowns, and determine which principles apply. This systematic approach can simplify the problem-solving process.

3. Utilize Diagrams

Visual aids can be invaluable in understanding and solving physics problems. Drawing

diagrams can help students visualize electric and magnetic fields, forces, and circuit configurations, making it easier to apply relevant equations.

4. Practice Regularly

Consistent practice is key to mastering the material. Students should work through a variety of problems, from easy to challenging, to develop their skills. Utilizing solution manuals or study groups can provide additional support and insight.

5. Review and Reflect

After solving a problem, students should review their work. Reflecting on the solution process can help identify areas for improvement and reinforce learning. Understanding why a solution works is just as important as arriving at the correct answer.

Utilizing Additional Resources

While the Purcell Morin textbook is a comprehensive resource, students can benefit from additional materials to enhance their understanding. Consider the following resources:

- **Online Tutorials:** Websites like Khan Academy and Coursera offer video lectures and interactive exercises on electricity and magnetism.
- **Physics Forums:** Engaging with online communities can provide insights and answers to specific questions.
- **Solution Manuals:** While they should be used responsibly, solution manuals can help students verify their answers and understand the solution process.
- **Study Groups:** Collaborating with peers can facilitate discussion and deepen understanding of complex topics.

Conclusion

In summary, **Purcell Morin electricity and magnetism solutions problems** serve as a vital educational tool for students studying physics. By understanding the structure and types of problems within the textbook, and by employing effective problem-solving strategies, students can enhance their grasp of electricity and magnetism. Leveraging additional resources will aid in navigating the complexities of these topics, ultimately leading to a more profound understanding and appreciation of the physical world. Whether

you're a student tackling challenging coursework or an educator guiding your students, the principles and strategies discussed in this article will prove invaluable in mastering electricity and magnetism.

Frequently Asked Questions

What is the basic premise of Purcell and Morin's approach to electricity and magnetism?

Purcell and Morin emphasize a conceptual understanding of electricity and magnetism, focusing on physical intuition and real-world applications while using a problem-solving approach.

How can I effectively solve problems from Purcell and Morin's 'Electricity and Magnetism'?

Start by thoroughly reading the relevant sections to grasp the concepts, then attempt the problems without looking at the solutions. Once you have a solution, compare it with the provided answers to identify any gaps in understanding.

Are there any online resources available for additional problems related to Purcell and Morin?

Yes, there are various online platforms, including educational websites and forums like Stack Exchange, where students discuss Purcell and Morin problems. Additionally, some universities provide supplementary problem sets and solutions.

What kind of problems can be found in Purcell and Morin's textbook?

The textbook includes a variety of problems ranging from conceptual questions and numerical exercises to real-world applications involving electric fields, magnetic fields, circuits, and electromagnetic waves.

How does the book approach the topic of electric fields?

Purcell and Morin introduce electric fields through the concept of force on charges, building up to Gauss's law and electric potential, providing a clear progression from basic concepts to more complex applications.

What is the significance of problem-solving in learning electricity and magnetism?

Problem-solving is crucial as it reinforces theoretical concepts, enhances critical thinking skills, and allows students to apply their knowledge to practical scenarios, deepening their understanding of the subject.

Can I find solutions to all problems in Purcell and Morin's 'Electricity and Magnetism'?

While complete solutions to every problem may not be available, many key problems are solved in accompanying solution manuals or online educational resources, providing guidance on tackling challenging problems.

What are some common mistakes students make when solving electricity and magnetism problems?

Common mistakes include misapplying formulas, neglecting to account for vector directions, overlooking assumptions in the problem statement, and failing to visualize the physical situation.

How can I study effectively for exams using Purcell and Morin's textbook?

Break down the material into manageable sections, actively solve problems, review conceptual summaries, and form study groups to discuss challenging concepts and share problem-solving strategies.

What role do diagrams play in solving problems in electricity and magnetism?

Diagrams are essential for visualizing problems, helping to clarify relationships between quantities, and organizing information, which can significantly aid in the problem-solving process.

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