

chapter 18 1 electromagnetic waves workbook pearson answers

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Introduction

Welcome to your definitive guide on mastering **Chapter 18 – Electromagnetic Waves** from the Pearson workbook. Whether you're a high school physics student tackling the first edition of the textbook or a university freshman diving into the fundamentals of electromagnetism, this article will help you navigate the chapter's concepts, solve practice questions, and locate reliable answers. We'll break down the material into digestible sections, provide step by step problem solving strategies, and share a curated selection of fully worked out solutions. By the end, you'll feel confident tackling the workbook's exercises and reinforcing your understanding of electromagnetic waves.

Overview of Chapter 18 – Electromagnetic Waves

Chapter 18 introduces the core principles of electromagnetic wave propagation, covering everything from Maxwell's equations to wave properties such as frequency, wavelength, and speed. The chapter is divided into several logical blocks: the derivation of the wave equation from Maxwell's equations, the characteristics of plane waves, the polarization of light, and real world applications like radio transmission and optical fibers. Each section builds on the last, ensuring a solid conceptual framework before moving into quantitative analysis.

Key Topics Covered

- Maxwell's equations in differential form
- Derivation of the electromagnetic wave equation
- Speed of light in vacuum and media
- Wave parameters: wavelength, frequency, period
- Polarization states: linear, circular, elliptical
- Reflection, refraction, and the Fresnel equations
- Applications: radio, microwaves, infrared, visible light, and beyond

Why the Pearson Workbook Matters

The Pearson workbook is more than a collection of practice problems; it's a structured learning tool that reinforces textbook concepts through targeted exercises. Each problem is carefully aligned with the chapter's learning objectives, allowing you to test your understanding immediately after studying the theory. Additionally, the workbook often includes conceptual questions, numerical calculations, and real life scenarios, giving you a well-rounded experience. By working through the problems and reviewing the answers, you'll develop problem solving skills that are essential for exams, projects, and future coursework.

How to Approach the Workbook Questions

When you first open the workbook, you might feel overwhelmed by the sheer number of questions. A systematic approach can turn this challenge into an opportunity for mastery. Here's a proven strategy to tackle each section:

1. Read the question carefully. Identify the type of problem: conceptual, calculation, or application.

2. List known quantities. Write down the given variables and any constants (e.g., speed of light, permittivity of free space).
3. Identify the relevant formula. Match the problem to the appropriate equation (e.g., $c = \lambda f$ for wave speed).
4. Perform the calculation. Keep track of units and significant figures.
5. Check your answer. Verify that it makes physical sense and matches any expected ranges.
6. Reflect on the solution. Consider alternative approaches or underlying principles.

Step by Step Problem Solving Techniques

Let's illustrate these steps with a generic example from Chapter 18:

1. Question: "A radio wave has a frequency of 100 /MHz. What is its wavelength in free space?"
2. Known: $f = 100 \text{ MHz} = 1.0 \times 10^8 \text{ Hz}$; $c = 3.00 \times 10^8 \text{ m/s}$.
3. Formula: $\lambda = \frac{c}{f}$.
4. Calculation: $\lambda = \frac{3.00 \times 10^8}{1.0 \times 10^8} = 3.00 \text{ m}$.
5. Check: A 100 /MHz radio wave indeed has a wavelength of roughly 3 /m, which is consistent with typical broadcast wavelengths.
6. Reflection: Notice how the inverse relationship between frequency and wavelength governs antenna design.

Sample Answers for Chapter 18 – Electromagnetic Waves

Below you'll find a selection of fully worked out solutions to common workbook questions. These examples illustrate the application of theory, the use of relevant equations, and the importance of unit analysis. Use them as a reference to verify your own work or to guide you when you're stuck.

Question 1: Calculate the wavelength of a 500 /THz light wave in vacuum.

Answer: The speed of light in vacuum is $c = 3.00 \times 10^8 \text{ m/s}$. Using $\lambda = \frac{c}{f}$, we have $\lambda = \frac{3.00 \times 10^8}{5.00 \times 10^{14}} = 6.00 \times 10^{-7} \text{ m} = 600 \text{ nm}$. This falls within the visible spectrum, confirming the calculation.

Question 2: A plane electromagnetic wave travels through a medium with refractive index $(n = 1.5)$. What is its speed?

Answer: The speed in the medium is $v = \frac{c}{n} = \frac{3.00 \times 10^8}{1.5} = 2.00 \times 10^8 \text{ m/s}$. The wave slows down by a factor of 1.5 compared to vacuum.

Question 3: Determine the period of a wave with frequency 60 /Hz.

Answer: The period (T) is the reciprocal of the frequency: $T = \frac{1}{f} = \frac{1}{60} \approx 0.0167 \text{ s}$. This is the time taken for one complete cycle of an audio tone.

Question 4: A light wave is linearly polarized at (45°) to the horizontal axis. What are the components of its electric field vector?

Answer: The electric field can be decomposed into horizontal (E_x) and vertical (E_y) components. If the total amplitude is (E_0) , then $E_x = E_0 \cos 45^\circ = \frac{E_0}{\sqrt{2}}$ and $E_y = E_0 \sin 45^\circ = \frac{E_0}{\sqrt{2}}$. Both components have equal magnitude.

Question 5: A radio broadcast at 98 /MHz uses a quarter wave monopole antenna. What is the antenna's physical length?

Answer: For a quarter wave antenna, the length $(L = \frac{\lambda}{4})$. First, find the wavelength: $\lambda = \frac{c}{f} = \frac{3.00 \times 10^8}{9.8 \times 10^7} \approx 3.06 \text{ m}$. Then, $L = \frac{3.06}{4} \approx 0.765 \text{ m}$.

0.765 m). The antenna is roughly 76.5 cm long.

Question 6: A laser emits light at 650 nm. What is its photon energy in electronvolts (eV)?

Answer: Photon energy $(E = hf = \frac{hc}{\lambda})$. Using $(h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s})$, $(c = 3.00 \times 10^8 \text{ m/s})$, and $(\lambda = 650 \times 10^{-9} \text{ m})$, we get $(E = \frac{6.626 \times 10^{-34} \times 3.00 \times 10^8}{650 \times 10^{-9}} \approx 3.06 \times 10^{-19} \text{ J})$. Converting to eV $(1 \text{ eV} = 1.602 \times 10^{-19} \text{ J})$, $(E \approx \frac{3.06 \times 10^{-19}}{1.602 \times 10^{-19}} \approx 1.91 \text{ eV})$.

Common Mistakes and How to Avoid Them

Even seasoned physics students can fall into traps when working through electromagnetic wave problems. Below are the most frequent errors and practical tips to sidestep them:

- Unit confusion. Always convert frequencies to hertz and wavelengths to meters before plugging them into equations. Mixing up MHz with Hz or cm with m can lead to off by a factor errors.
- Ignoring the refractive index. When a problem involves a medium other than vacuum, remember to divide the speed of light by the refractive index. Forgetting this step will overestimate the wave speed.
- Misapplying polarization formulas. Polarization questions often involve trigonometric components. Double check the angle reference (e.g., 0° is horizontal, 90° is vertical) to avoid sign errors.
- Overlooking significant figures. Physical constants like (c) are given to a certain precision. Carry the appropriate number of significant figures through your calculation and round only at the final step.
- Skipping unit analysis. After solving an equation, verify that the result's units match the expected physical quantity (e.g., meters for wavelength, seconds for period).

Study Tips for Mastering Electromagnetic Waves

Tags: #chapter #electromagnetic #waves #workbook #pearson #answers

