

Solved Problems on Quantum Mechanics in One Dimension

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Given here are solutions to 15 problems on Quantum Mechanics in one dimension.

The solutions were used as a learning-tool for students in the introductory undergraduate course Physics 200 *Relativity and Quanta* given by Malcolm McMillan at UBC during the 1998 and 1999 Winter Sessions. The solutions were prepared in collaboration with Charles Asman and Adam Monahan who were graduate students in the Department of Physics at the time.

The problems are from Chapter 5 *Quantum Mechanics in One Dimension* of the course text *Modern Physics* by Raymond A. Serway, Clement J. Moses and Curt A. Meyer, Saunders College Publishing, 2nd ed., (1997).

Planck's Constant and the Speed of Light.

When solving numerical problems in Quantum Mechanics it is useful to note that the product of Planck's constant

$$h = 6.6261 \times 10^{-34} \text{ J s} \quad (1)$$

and the speed of light

$$c = 2.9979 \times 10^8 \text{ m s}^{-1} \quad (2)$$

is

$$hc = 1239.8 \text{ eV nm} = 1239.8 \text{ keV } \mu\text{m} = 1239.8 \text{ MeV fm} \quad (3)$$

where

$$1 \text{ eV} = 1.6022 \times 10^{-19} \text{ J} \quad (4)$$

Also,

$$hc = 197.32 \text{ eV nm} = 197.32 \text{ keV } \mu\text{m} = 197.32 \text{ MeV fm} \quad (5)$$

where $\hbar = h/2\pi$.

Wave Function for a Free Particle

Problem 5.3, page 224

A free electron has wave function

$$\Psi(x, t) = \sin(kx - \omega t) \quad (6)$$

- Determine the electron's de Broglie wavelength, momentum, kinetic energy and speed when $k = 50 \text{ nm}^{-1}$.
- Determine the electron's de Broglie wavelength, momentum, total energy, kinetic energy and speed when $k = 50 \text{ } \mu\text{m}^{-1}$.

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ML Morrison



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Table of Contents Solved Problems On Quantum Mechanics In One Dimension

1. Understanding the eBook Solved Problems On Quantum Mechanics In One Dimension
 - The Rise of Digital Reading Solved Problems On Quantum Mechanics In One Dimension
 - Advantages of eBooks Over Traditional Books
2. Identifying Solved Problems On Quantum Mechanics In One Dimension
 - 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 Solved Problems On Quantum Mechanics In One Dimension
 - User-Friendly Interface
4. Exploring eBook Recommendations from Solved Problems On Quantum Mechanics In One Dimension
 - Personalized Recommendations

- Solved Problems On Quantum Mechanics In One Dimension User Reviews and Ratings
- Solved Problems On Quantum Mechanics In One Dimension and Bestseller Lists
- 5. Accessing Solved Problems On Quantum Mechanics In One Dimension Free and Paid eBooks
 - Solved Problems On Quantum Mechanics In One Dimension Public Domain eBooks
 - Solved Problems On Quantum Mechanics In One Dimension eBook Subscription Services
 - Solved Problems On Quantum Mechanics In One Dimension Budget-Friendly Options
- 6. Navigating Solved Problems On Quantum Mechanics In One Dimension eBook Formats
 - ePub, PDF, MOBI, and More
 - Solved Problems On Quantum Mechanics In One Dimension Compatibility with Devices
 - Solved Problems On Quantum Mechanics In One Dimension Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Solved Problems On Quantum Mechanics In One Dimension
 - Highlighting and Note-Taking Solved Problems On Quantum Mechanics In One Dimension
 - Interactive Elements Solved Problems On Quantum Mechanics In One Dimension
- 8. Staying Engaged with Solved Problems On Quantum Mechanics In One Dimension
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Solved Problems On Quantum Mechanics In One Dimension
- 9. Balancing eBooks and Physical Books Solved Problems On Quantum Mechanics In One Dimension
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Solved Problems On Quantum Mechanics In One Dimension
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Solved Problems On Quantum Mechanics In One Dimension
 - Setting Reading Goals Solved Problems On Quantum Mechanics In One Dimension
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Solved Problems On Quantum Mechanics In One Dimension
 - Fact-Checking eBook Content of Solved Problems On Quantum Mechanics In One Dimension

- 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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