

Solved Problems on Quantum Mechanics in One Dimension

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Fall 1999; revised 2011 by Malcolm McMillan

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. Moyer, 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

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

where

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

Also,

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

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 $k = 50 \text{ pm}^{-1}$.

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