

Physics of Waves

PH11003

Tutorial 11 Problems

Topic : Quantum Mechanics I

04 February 2023

[11.1] Green light has a wavelength of about 500 nm. Through what potential difference must an electron be accelerated to have this wavelength?

[11.2] The position and momentum of a 1.00 keV electron are simultaneously determined. Its position is located to within 0.100 nm, what is the percentage of uncertainty in its momentum?

[11.3] Compute the de Broglie wavelengths of (a) an electron, (b) a proton, and (c) an alpha particle of 4.5-keV kinetic energy.

[11.4] Using the relativistic expression $E^2 = p^2c^2 + m^2c^4$, (a) show that the phase velocity of an electron wave is greater than c . (b) Show that the group velocity of an electron wave equals the particle velocity of the electron.

[11.5] According to statistical mechanics, the average kinetic energy of a particle at temperature T is $3kT/2$, where k is the Boltzmann constant. What is the average de Broglie wavelength of nitrogen molecules at room temperature?

Answers :

1. $5.0 \mu\text{V}$

2. 3.1 %