Engineering Physics
06PHY12
Assignment 2

Answer the following questions

1. Explain Heisenberg's uncertainty principle. Give its physical significance. [5]
2. Show that electrons cannot exist in the nucleus of an atom. [5]
3. What is the wave function? Give its physical significance. [5]
4. What is normalization of a wave function and give its significance. [5]
5. What are the properties of wave functions? [5]
6. Derive one-dimensional time-independent Schrödinger wave equation for an electron. [10]
7. Solve the time-independent Schrödinger wave equation for a free particle in one-dimension. [5]
8. Solve the Schrödinger equation for the allowed energy values in the case of particle in a box. [5]
9. Assuming the time independent Schrödinger wave equation, discuss the solution for a particle in one dimensional potential well of infinite height. Hence obtain the normalized wave function. [10]
10. Discuss the eigen function eigen values and probability density for a particle in a potential well of infinite depth. [10]
11. Obtain an expression for the energy of a particle inside a potential well of infinite height and calculate the gap between the ground state and the first two excited states. [5]
12. What are eigen values and eigen functions of a de Broglie wave? [5]
13. Find eigen values and eigen functions for a particle in one-dimensional potential well of infinite height. [5]
14. A wave function is given by $\psi = A\,\sin(n\pi x/L)$ for a motion of the particle in a zero potential well of breadth L. Calculate the value of A, where x is the position of the particle along L. [5]
15. Assuming that a particle of mass m is confined in a field free region between impenetrable walls at $x = 0$ and $x = a$, show that the stationary energy levels of the particle are given by $E_n = n^2h^2/8ma^2$. [5]

Solve the following problems

1. An electron has a speed of $4.8 \times 10^5 ms^{-1}$ accurate to 0.012%. With what accuracy can be located the position of electron. [4]
2. The speed of electron is measured to within an uncertainty of $2.2 \times 10^4\, ms^{-1}$ in one dimension. What is the minimum width required by the electron to be confined in an atom. [4]
3. A spectral line of wavelength $4000\mathring{A}$ has a width of $8 \times 10^{-5}\mathring{A}$. Evaluate the minimum time spent by the electrons in the upper energy state between the excitation and de-excitation processes. [5]

4. The inherent uncertainty in the measurement of time spent by Iridium-191 nuclei in the excited state is found to be $1.4 \times 10^{-10} s$. Estimate the uncertainty that results in its energy in the excited state. [4]

5. The position and momentum of $1\, keV$ electron are simultaneously determined and if its position is located within $1\mathring{A}$, what is the percentage of uncertainty in its momentum? [5]

6. Assuming that the radius of a nucleus of the order of $10^{-14}\, m$ calculate the energy associated with a free particle of mass $9.1 \times 10^{-31}\, kg$ within this nucleus. Comment on the result obtained. [5]

7. An electron is bound in one dimensional potential well of infinite height of width $0.12\, nm$. Find the energy values in the ground state and also the first two excited states in eV. [5]

8. A particle is moving in one-dimensional deep potential well of width $20\mathring{A}$. Calculate the probability of finding the particle at a/2 and a/3, where 'a' is the width of deep potential well and the interval being $4\mathring{A}$. [6]

9. An electron is trapped in a one dimensional potential well of infinite depth and a width of $1 \times 10^{-10}\, m$. What is the probability of finding the electron in the region from $x = 0.09 \times 10^{-10}\, m$ to $x = 0.11 \times 10^{-10}\, m$ in the ground state. [5]

10. An electron is trapped in a one dimensional potential well of infinite depth and a width of $1 \times 10^{-10}\, m$ and infinite height. Find the amount of energy required to excite the electron to its first excited state. What is the probability of finding the electron in its first excited state between $x = 0.4 \times 10^{-10}\, m$ to $x = 0.6 \times 10^{-10}\, m$? [8]

***