U.G. 5th Semester Examination - 2020

PHYSICS

[HONOURS]

Course Code : PHY(H)-P-CC-11/PR

[PRACTICAL]

(Quantum Mechanics & Applications)

Full Marks : 20 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Distribution of Marks:

a) Lab. Note Book: 05 Marks; b) Viva- voce : 05 Marks; c) Experiment: 10 marks

Answer any **one.**

1. Study the Electron spin resonance and determine magnetic field as a function of the resonance frequency.
2. Study Zeeman effect of Hg or Na line with external magnetic field and calculate Hyperfine splitting.
3. Show the tunneling effect in tunnel diode using I-V characteristics.
4. Find out Quantum efficiency of CCD s.

5. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = \frac{2m}{h^2}\left(E - V(r)\right)y$$

Where $V(r) = -e^2r$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is « -13.6 eV. Take $e = 3.795(eVA)^{\frac{1}{2}}$ he = 1973 (eVA) and $m = 0.511 \times 10^6 eV/c^2$.

6. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y(r)}{dr^2} = \frac{2m}{h^2}\left(E - V(r)\right)y(r) = 0,$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

Where $V(r) = -\left(e^2/r\right)\exp(-r/a)$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take $e=3.795(eVA)^{1/2}$, m = 0.51 |x|O^6 eV/c^2 and a = 3 A, 5 A, 7 A. In these units hc = 1973(eVA). The ground state energy is expected to be above -12 eV in all three cases.

7. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y(r)}{dr^2} = \frac{2m}{h^2}(E - V(r))y(r) = 0,$$

For the anharmonic oscillator potential

$$V(r)\left(\frac{1}{2}\right)kr^2 + \left(\frac{1}{3}\right)br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/ c , k = 100MeV fm"^{2}, b = 0, 10, 30 MeV fm"^{3} is these units, ch = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

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