SN – 238

V Semester B.Sc. Examination, November/December 2014
(OS) (Prior to 2013-14)
PHYSICS – VI
Quantum Mechanics, Atomic and Molecular Physics

Time : 3 Hours

Max. Marks : 60

Instruction: *Answer* ***any five*** *questions in Part –* ***A***, ***four*** *questions in Part –* ***B*** *and* ***five*** *questions in Part –* ***C***.

PART – A

Answer **any five** of the following. **Each** question carries **six** marks. (5×6=30)

1. Explain how Quantum theory helps in explaining (a) Photoelectric effect and (b) Compton effect. (3+3)

2. Explain phase velocity and group velocity for a matter wave. Establish a relation between the particle velocity and group velocity of a non-relativistic particle. 6

3. Obtain Schrodinger time dependent equation for a free particle in one dimension. 6

4. What is zero point energy of a harmonic oscillator ? Explain the significance of zero point energy with respect to uncertainty principle. How is the spacing between two states related to the zero point energy ? 6

5. Describe Franck-Hertz experiment. What are its limitations ? 6

6. What is Pauli Exclusion Principle ? What is the maximum number of electron in a shell ? 6

7. Explain Stern-Gerlach experiment. Give its significance. 6

8. Explain Raman Effect using Quantum theory. Comment on the intensity of the Raman lines. 6

PART – B

$m_e = 9.1 \times 10^{-31}\ kg,\ e = 1.9 \times 10^{-19}\ C,\ h = 6.63 \times 10^{-34}\ Js,$
$\varepsilon_0 = 8.854 \times 10^{-12}\ SI\ units,\ c = 3 \times 10^{8}\ ms^{-1},\ 1eV = 1.6 \times 10^{-19}\ J$

Solve **any four** of the following. **Each** problem carries **five** marks. (4x5=2

9. The radius of the ground state of Hydrogen atom is called the Bohr's radius. Radius is given by $a_n = \frac{\varepsilon_0 h^2 n^2}{\pi m_e e^2}$ where the symbols having their usual meaning. Find the value of Bohr's radius using the data given above.

10. Calculate the wavelength of an electron moving with a velocity of $2.3 \times 10^6\ ms^{-1}$.

11. Find the energy of an electron in the first excited state, when it is confined to a box of 1.3 Å.

12. Calculate the minimum energy in electron volt required to excite the line of wavelength 656.3 nm in Hydrogen.

13. What magnetic flux density B is required to observe the normal Zeeman effect, if a spectrometer can resolve spectral line separated by 0.06 nm at 500 nm ?

14. For a HCl molecule the separation between the pure rotational line is $20.82 \times 10^2\ m^{-1}$. Find the moment of inertia of rotation.

PART – C

15. Answer **any five** of the following. **Each** question carries **two** marks. (5x2=

a) Even when a monochromatic X-ray is used, the Compton spectrum contains more than one line. Why ?

b) Can we observe the de Broglie wavelength with a speeding tennis ball of mass 0.1 kg and speed $130\ ms^{-1}$?

c) Is there a difference between a free particle and a particle in a box ? Explain.

d) There is a difference between the ground state energy and the ionization potential energy of Hydrogen. Explain.

e) Doublets are observed in the alkali spectra. Explain.

f) Do all molecules show rotational spectra ? Explain.