UN – 171

V Semester B.Sc. Examination, November/December 2015

(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. Describe how classical theory fails in explaining

   a) Photo-electric effect

   b) Black body radiation. (3+3)

2. a) Obtain an expression for the de-Broglie wavelength of matter waves.

   b) Show that for an electron accelerated through a potential difference of V volt, the associated de-Broglie wavelength is equal to $\frac{12.27\,\text{Å}}{\sqrt{V}}$. (3+3)

3. a) Define phase velocity and group velocity for a matter wave.

   b) Show that the group velocity of a wave packet is equal to the particle velocity. (2+4

4. Arrive at Schrödinger's time-dependent wave equation for a free particle in one dimension. 6

5. Derive an expression for energy eigen values of a particle trapped in one dimensional box of infinite height. 6

6. a) Define ionisation and excitation potential.

   b) Describe Franck-Hertz experiment. (2+4)

7. a) What is Zeeman effect ?

   b) Describe an experimental set up for the study of normal Zeeman effect. (1+5)

8. a) Distinguish between Rayleigh scattering and Raman scattering.

   b) Mention any three applications of Raman effect. (3+3)

PART – B

Solve **any four** of the following. **Each** problem carries **five** marks. (4×5=20)

Make use of the data given below wherever necessary.

Mass of electron (Me) = 9.1×10^{-31} kg

Charge on electron (e) = 1.6×10^{-19} C

Velocity of light (c) = 3.0×10^{8} ms^{-1}

Planck's constant (h) = 6.63×10^{-34} Js

9. A proton is confined to a nucleus of radius 5×10^{-15} m. Calculate the uncertainty in its momentum. (mass of proton = 1.67×10^{-27} kg).

10. Calculate the zero point energy and spacing of the energy levels in respect of a linear harmonic oscillate of frequency 2 KHz.

11. What is the energy of neutron whose de-Broglie wavelength is 1 Å (mass of neutron = 1.6747×10^{-27}kg).

12. Calculate the value of Bohr magneton using the data given above.

13. In Davisson and Germer experiment, the electrons accelerated through a potential difference of 100 V are incident on a metal crystal of lattice spacing 2.15 Å. Calculate the glancing angle for which the first order diffraction becomes maximum.

14. In an experiment in the study of Raman effect, using mercury green radiation of 546.1 nm, a Raman line of wavelength 554.3 nm was observed. Find the Raman frequency and wavelength of corresponding antistokes line.

PART – C

15. Answer **any five** of the following. **Each** question carries **two** marks. **(5×2=10)**

a) An electron and a proton have the same de-Broglie wavelength. Which one will move faster ? Explain.

b) A revolving electron takes a spiral path of decreasing radius according to classical theory. Explain.

c) The zero point energy of a harmonic oscillator is not zero. Justify.

d) What is the significance of negative sign in the expression for energy of the electron in an atom ?

e) Sodium exhibits a doublet fine structure eventhough it has only one spectral electron. Explain.

f) The colour of rising and setting sun is reddish orange. Explain.
