26-3-18

DOON UNIVERSITY, DEHRADUN
Mid Semester Examination, Fourth Semester, 2017-18
Department of Physics, School of Physical Sciences
Integrated M.Sc. Physics 5 Year Programme
Course: PHC-252: Modern Physics

Time Allowed: 2 Hours **Maximum Marks: 30**

Instructions:

1) All questions are compulsory. Read the questions carefully and attempt each part.
2) Number the questions and their sub parts properly.
3) Explain the symbols used wherever applicable.

SECTION: A

Marks: 6 x 1 = 6

1) Write momentum (p) operator, and derive kinetic energy operator from p operator.
2) Which of the following is more suitable for observing Compton wavelength shift for an electron: visible light or X-ray? Explain why.
3) Write down one phenomenon each showing the wave nature and particle nature which highlight the wave particle duality?
4) Why was Rutherford's planetary model of an atom unstable?
5) Which of the following is more suitable for observing Compton wavelength shift for an electron: visible light or X-ray? Explain why.
6) What is an expectation value?

SECTION: B

Marks: 4 x 3 = 12

7) Ultravoilet light of wavelength 350 nm and intensity 1.00 W/m^2 is directed at a potassium surface. (a) Find the maximum KE of the photoelectrons. (b) If 0.50 percent of the incident photons produce photoelectrons, how many are emitted per second if the potassium surface has an area of 1.00 cm^2. (1.5 + 1.5)

Or

An electron has a de Broglie wavelength of 2.00 pm. Find its kinetic energy, given the rest mass energy of electron is 511 keV.

8) Prove that Pair Production cannot occur in vacuum.
9) Explain linearity and superposition (of wavefunctions), explain with the arrangement of double-slit experiment with electrons.
10) Show that $\Psi(x) = e^{icx}$, where c is finite constant, is acceptable eigenfunction. Also normalize it over the region $-a \leq x \leq a$. (1.5 + 1.5)

SECTION: C

Marks: 2 x 6 = 12

11) What are matter waves and write the formula for its wavelength. Explain Davisson-Germer experiment in detail and discuss its significance. (1.5 + 4.5)
12) (a) What is a wave function ψ, explain the physical significance of $|\psi|^2$. (b) Deduce the time dependent Schrodinger equation. (c) What is Hamiltonian operator? (d) Write the Schrodinger equation in terms of Hamiltonian operator. (1 + 3 + 1 + 1)