

U.G. 4th Semester Examination - 2022**PHYSICS****[HONOURS]****Course Code : BPHSCCHC402****Course Title : Elements of Modern Physics**

Full Marks : 30

Time : 2 Hours

*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any **ten** questions: $1 \times 10 = 10$
- What solutions of Schrodinger's time dependent equation are called stationary?
 - Define eigenvalue and eigenfunction of an operator.
 - What do you understand by wave-particle duality?
 - Why do we not observe de-Broglie wavelength with a fast moving cricket ball?
 - Write the expression for Balmer line.
 - What is the need for normalizing a wave function?

- How He-Ne Laser is superior to Ruby laser?
- What is the importance of Compton effect?
- Why do you need population inversion in a laser?
- Why stable nuclei have more neutron than protons?
- Write down the shell configuration of ${}_{13}^{27}\text{Al}$ nucleus and ${}_{29}^{63}\text{Cu}$ nucleus on the basis of shell model.
- What do you understand by a 'metastable state'?
- Write down the equation of mass parabola.
- What is magic number?
- What is the physical interpretation of the wave function ψ ?

2. Answer any **five** questions: $2 \times 5 = 10$
- Light of wavelengths 3000 \AA and 3400 \AA causes the emission of electrons having kinetic energy 2.145 eV and 1.343 eV respectively from sodium. Determine the value of Planck's constant from this data.
 - Show that the de-Broglie wave length of a particle in a one-dimensional box in the first excited state is equal to the length of the box.

- c) Calculate the probability current density corresponding to $\psi = \frac{1}{r} e^{ikr}$.
- d) An electron of energy $E=15\text{eV}$ is incident on a step potential of height $V_0=10\text{eV}$. Find the reflection coefficient R and transmission coefficient T .
- e) Find the probability that a particle can be found between $x=0.45$ and 0.55 when the particle is limited to the x - axis and has the wave function $\psi(x) = \sqrt{3}x$ for $0 \leq x \leq 1$. Also find the average value of x .
- f) Sketch the N - Z plot, where M is the neutron number and Z the atomic number. Briefly explain the nature of the plot.
- g) Explain nuclear fission and nuclear fusion.
- h) For odd A , there is a single mass parabola for each A and for even A , there are two mass parabola for same A , why?

3. Answer any **two** questions: $5 \times 2 = 10$

- a) What potential difference must be applied to stop fastest photo electrons emitted by a surface electromagnetic radiation of frequency 1.5×10^{15} Hz is allowed to fall on it? The work function of the surface is 5 eV .

- b) The average life time of an excited atomic state is 10^{-9}s . If the spectral line associated with the decay of this state is 5600 \AA , estimate the width of the line.
- c) Derive the relationship between various Einstein's coefficients. Discuss their significance in context of Laser operations.

3+2
