B.Sc. 4th Semester (Honours) Examination, 2020-21

PHYSICS

Course ID: 42412 **Course Code: SH/PHS/402/C-9/T-9**

Course Title: Elements of Modern Physics

Time: 1 Hour 15 Minutes **Full Marks: 25**

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

Section-I

1. Answer any ***five*** of the followings: 1×5=5

(a) What is a linear operator?

(b) What is mass defect?

(c) What are magic numbers?

(d) What do you mean by population inversion?

(e) What is the significance of eigen values of a quantum mechanical operator?

(f) What are slow neutrons?

(g) Why gamma ray is used in Heisenberg thought experiment?

(h) Show that for a non-dispersive medium the group velocity and phase velocity of wave are equal.

Section-II

2. Answer any ***two*** of the followings: 5×2=10

(a) A particle in one dimensional potential box of length 'a' is in the ground state. Calculate the probability of finding the particle in the interval $\Delta x = 0.01a$ at the point $x = a/2$.

(b) Find the probability current density for the plane wave $\exp\{i(kx-\omega t)\}$.

(c) What is Compton wavelength? Calculate the kinetic energy of the recoil electron in a Compton scattering event. [2+3]

(d) Draw the energy level diagram of He-Ne laser and briefly explain it's working principle. [2+3]

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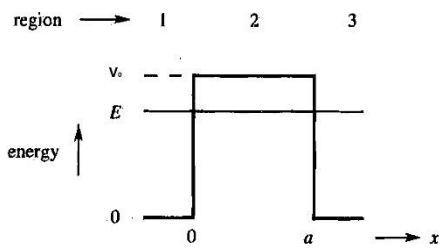
Section-III

3. Answer any ***one*** of the followings: 10×1=10

(a) What are the basis of liquid drop model? Write down and explain the origin of each term of semi empirical mass formula for binding energy of nucleus. [3+7]

(b) A stream of particles of mass m and energy E is incident on a potential barrier (as shown in figure) given by –



V(x) = 0 for x < 0 and x > a,

= V_0 for 0 < x < a, Where V_0 > E

Show that the fraction transmitted to region 3 is –

$T = \{1 + \frac{{V_0}^2}{4E(V_0 - E)} sinh^2 \gamma a\}^{-1}$ where $\gamma = \frac{2m(V_0 - E)}{\hbar^2}$
