Name:

Enrolment No:

UPES

End Semester Examination, December 2023

Course: Elements of Modern Physics **Semester: III**

Program: B.Sc.(H) Physics **Time : 03 hrs.**

Course Code: PHYS 2026 **Max. Marks: 100**

Instructions:

- All questions are compulsory (**Q.No. 9** and **Q.No. 11** has an internal choice)
- Scientific calculators can be used for calculations.

SECTION A (5Qx4M=20Marks)

• All questions are compulsory; Each Question carries **4 Marks.**

• Write very Short Answers/ Solve.

S. No.	Statement of question	Marks	CO
Q 1	The threshold frequency for photoelectric emission in copper is 1.1×10^{15} sec^{-1}. Find the maximum energy of photoelectrons when light of frequency 1.5×10^{15} sec^{-1} falls on a copper surface. [$h = 6.63 \times 10^{-34}$ Joule $-$ sec]	**4**	**CO1**
Q 2	Mention any four properties of matter waves.	**4**	**CO1**
Q 3	Explain the nuclear fission and fusion processes.	**4**	**CO1**
Q 4	A He-Ne laser of wavelength 6328 Å has an internal beam of radius 0.46 mm. What would be the beam divergence angle.	**4**	**CO2**
Q 5	Explain about the main components to produce laser.	**4**	**CO1**

SECTION B (4Qx10M= 40 Marks)

• All questions are compulsory, **Q.No. 9** has an internal choice, Each Question carries **10 Marks**.

• Write Short/ Brief notes/ Derive/ Solve

S. No.	Statement of question	Marks	CO
Q 6	Explain the properties of the nucleus with reference to size, charge, and mass. What are nuclear forces? Discuss the characteristics of nuclear forces.	**10**	**CO 2**
Q 7	The position and momentum of a 4 keV electron are simultaneously measured. If the position is located within 4 Å, what is the percentage of uncertainty in momentum. [$m_o = 9.11 \times 10^{-31}$ kg, $h = 6.63 \times 10^{-34}$ Joule $-$ sec]	**10**	**CO 3**
Q 8	Illustrate the construction of a gas laser with a neat diagram and explain its working with the help of an energy level diagram.	**10**	**CO 1**
Q 9	**(a)** What is Compton Effect? Show that the direction of the recoiled		

	electron in Compton's effect is $$\tan\phi = \frac{cot\frac{\theta}{2}}{1+\frac{hv}{m_0c^2}}$$ where θ is the scattering angle and ϕ is the angle of the recoiled electron. **(10)** **OR** **(b)** Show that the de Broglie wavelength of a material particle of rest mass m_o and charge e, accelerated from rest through a potential difference V volts relativistically is $$\lambda = \frac{h}{\sqrt{2m_oeV\left\{1+\left(\frac{\text{eV}}{2\text{m}_\text{o}c^2}\right)\right\}}}$$ **(10)**	**10**	**CO3**

SECTION-C (2Qx20M=40 Marks)

- All questions are compulsory, **Q.No. 11** has an internal choice, Each Question carries **20 Marks.**
- Write long answer/ Derive/ Solve

S. No.	Statement of question	Marks	CO
Q 10	**(a)** Explain about the single step potential barrier. Derive expressions for the reflection coefficient and transmission coefficient when the energy of the particle is less than the height of the barrier. **(15)** **(b)** Calculate the lowest energy of an electron confined in a 3-D cubical box of each side 2 Å **(5)**	**20**	**CO4** **CO3**
Q 11	**(a)** Explain the β-ray continuous spectrum. Explain the neutrino's theory of β-decay. **(10)** **(b)** Derive a relation between the half-life time and mean lifetime. The half-life of Radon is 3.8 days. After how many days will only one-twentieth of the radon sample be leftover. (answer upto the second decimal) (use $\log_{10} 20 = 1.3010$) (**10**) **OR** **(c)** Derive a relation for the semi-empirical mass formula for the nucleus giving arguments for each of the terms involved. **(10)** **(d)** Explain the terms mass defect, packing fraction and binding energy of the nucleus**.** Find the binding energy of Lithium nucleus and binding energy per nucleon from the below-given data. Mass of Lithium nucleus $= 7.006005$ a. m. u. Mass of proton $= 1.007277$ a. m. u Mass of neutron $= 1.008665$ a. m. u (Given 1 a. m. u $= 931.4812$ MeV) (**10**)	**20**	**CO 3** **CO 2** **CO 3** **CO 2**