Name: Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2022

Course: Elements of Modern Physics | **Semester : III**
Program: B.Sc (H) Physics & Intg B.Sc+M.Sc 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
(5Q x 4M = 20 Marks)

- All questions are compulsory, Each Question carries **4 Marks**
- Write very Short Answers/ Solve

Q. No.	Statement of question	Marks	CO
1	What are the fundamental laws of photoelectric emission?	4	CO1
2	Find the de-Broglie wavelength of an electron accelerated through a potential difference of 182 volts.	4	CO1
3	Uncertainty in the time of an excited atom is about 10^{-8} sec. What are the uncertainties in energy and frequency of radiation?	4	CO1
4	Explain the nuclear fission and fusion processes.	4	CO2
5	Distinguish between an ordinary light source and a laser light source.	4	CO2

SECTION B
(4Q x 10M = 40 Marks)

- All questions are compulsory, **Q.No. 9** has an internal choice, Each Question carries **10 Marks**
- Write Short/ Brief notes/ Derive/ Solve

Q. No.	Statement of question	Marks	CO
6	A metallic surface, when illuminated with light of wavelength λ_1, emits electrons with energies upto a maximum value E_1, and when illuminated with light of wavelength λ_2, where $\lambda_2 < \lambda_1$, it emits electrons with energies upto a maximum value E_2. Prove that Planck's constant h and the work function φ of the metal are given by; $h = \frac{(E_2 - E_1)\lambda_1\lambda_2}{C(\lambda_1 - \lambda_2)}$ and $\varphi = \frac{E_2\lambda_2 - E_1\lambda_1}{(\lambda_1 - \lambda_2)}$ **(10)**	10	CO1
7	**(a)** Prove the relation $v_g \times v_p = c^2$ for a relativistically moving particle and its associated waves if the particle velocity equals the group velocity. **(5)** **(b)** Calculate the lowest energy of an electron confined in a 3-D cubical box of each side 1 Å **(5)**	10	CO2

8	**(a)** Derive an expression to explain the law of radioactive decay. **(5)** **(b)** Find the half-life period of a radioactive material if its activity drops to $(1/16)$th of its initial value in 30 years. **(5)**	**10**	**CO3**
9	**(a)** Explain the construction and working of a pulsed laser with the help of a neat energy level diagram. **(10)** **(OR)** **(b)** What are Einstein's Coefficients? Show that the ratio of Eisntein's coefficient of spontaneous emission to stimulated emission is proportional to the cube of the frequency of the incident photon. **(10)**	**10**	**CO2**

SECTION-C

(2Q x 20M = 40 Marks)

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

Q. No	Statement of question	Marks	CO
10	**(a)** Derive a relation for the semi-empirical mass formula for the nucleus giving arguments for each of the terms involved. **(10)** **(b)** 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**	**CO3**
11	**(a)** Show that the wave function of a particle trapped into a one-dimension box of length L is $\Psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi x}{L}\right)$ **(10)** **(b)** A particle is confined to one dimensional infinite potential well of width 0.2×10^{-19}m. It is found that when the energy of the particle is 230 eV its eigen function has five antinodes. Find the mass of the particle and show that it can never have an energy equal to 1 keV. **(10)** **(OR)** Obtain an expression for the transmission coefficient in a rectangular potential barrier. **(20)**	**20**	**CO4**

Constant	Standard Values
Planck's Constant (h)	6.63×10^{-34} Joule − sec
Permittivity of free space (ε_0)	8.85×10^{-12} Farad/meter
Velocity of light (c)	3×10^{8} m/sec
Boltzmann constant (k_B)	1.38×10^{-23} JK^{-1}
Rest mass of an Electron (m_o)	9.11×10^{-31} kg
Mass of the proton (m_p)	1.67×10^{-27}kg
Charge of an electron (e)	1.6×10^{-19} C