Name: Enrolment No:	UPES UNIVERSITY OF TOMORROW

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

Course: Elements of Modern Physics — **Semester : IV**
Program: B.Sc (H) Physics — **Time : 03 hrs.**
Course Code: PHYS 2005 — **Max. Marks: 100**

Instructions:

- All questions are compulsory (**Q.No. 9** and **Q.No. 11** have 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 is the photoelectric effect? What are the factors that influence the photoelectric effect?	**4**	**CO1**
2	Calculate the de-Broglie wavelength associated with a proton moving with a velocity equal to $(1/20)^{th}$, of the velocity of light.	**4**	**CO4**
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 pair production by gamma-ray photons in the vicinity of the nucleus.	**4**	**CO4**
5	Distinguish between spontaneous and stimulated emissions.	**4**	**CO1**

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	What is Compton Effect? Explain the Compton effect with a neat diagram. Derive an equation for a shift in the Compton wavelength.	**10**	**CO2**
7	(a) Prove that the relation between the phase velocity(v_p) and group velocity (v_g) in a dispersive medium is **(5)** $$v_g = v_p - \lambda\left(\frac{dv_p}{d\lambda}\right)$$ (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) Mention any five properties of α-radiations. **(5)**	**10**	**CO2**

	(b) 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 $\log_{10} 20 = 1.3010$) **(5)**		
9	(a) Explain the construction and working of a pulsed laser with the help of a neat energy level diagram. **(OR)** (b) What are Einstein's Coefficients? Derive the relation between Einstein's coefficients.	**10**	**CO3**

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 answers/ Derive/ Solve

Q. No	Statement of question	Marks	CO
10	(a) Show that the wave function of a particle trapped into a one-dimension box of length L is **(10)** $\Psi_n(x) = \sqrt{\frac{2}{L}}\sin(\frac{n\pi x}{L})$, where n=1, 2, 3,….. (b) Electrons with energies of 1 eV and 2 eV are incident on a barrier 5 eV high and 5 Å wide. Find their respective transmission probabilities. **(10)**	**20**	**CO3**
11	(a) Define the range of the α-particle. Explain Gamow's theory of alpha decay with the necessary diagram. **(10)** (b) Explain the binding energy of the nucleus. Find the binding energy of an α-particle from the below-given data. Mass of Helium nucleus $= 4.001265$ a.m.u Mass of proton $= 1.007277$ a.m.u Mass of neutron $= 1.008666$ a.m.u 1 a.m.u $= 931.4812$ MeV **(10)** **(OR)** (a) What are various nuclear models? State and explain the liquid drop model of the nucleus, with the analogies between a small drop of a liquid and a nucleus. **(10)** (b) Derive a relation for the semi-empirical mass formula for the nucleus giving arguments for each of the terms involved. **(10)**	**20**	**CO3**

Values of Constants

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	9.11×10^{-31} kg
Mass of the proton	1.67×10^{-27} kg
Charge of an electron	1.6×10^{-19} C