Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, May 2021

Course: Elements of Modern Physics **Semester: IV**
Program: B.Sc. (H) Physics **Time: 3 Hrs**
Course Code: PHYS 2005 **Max. Marks: 100**

Section A
All questions are compulsory. Each question carries 5 marks.

S.No.	Question	CO
Q1	(i) The group speed of the matter wave associated with a non-relativistically freely moving particle is **(2)** (a) Half of the particle speed (b) Equal to the particle speed (c) More than the particle speed (d) Equal to the speed of light (ii) For the microscopic particles, the ……. nature is dominant over the ……. nature **(2)** (a) wave, particle (b) particle, wave (iii) Matter waves are……..in nature. **(1)** (a) electromagnetic (b) non-electromagnetic	**CO1**
Q2	(i) Select the correct statement. **(2)** (a) Population inversion is not a necessary condition to produce laser. (b) Absorption is always stimulated. (c) Spontaneous emission is always accompanied by stimulated emission. (d) Ruby laser is an example of electronic pumping. (ii) Which of these is a property of Laser. **(2)** (a) Monochromatic (b) Directional (c) Coherent (d) All of the above (iii) Isotone are those which have **(1)** (a) Same number of neutrons (b) Same mass number	**CO2**
Q3	The stability of Cl (A = 36, Z = 17) with respect to alpha, beta-plus, and beta-minus decay is to be determined. Do not consider the possibility of decay by electron capture. The following atomic masses are known:	**CO4**

	$^{4}_{2}He$ 4.002603 $^{32}_{15}P$ 31.973907 $^{36}_{16}S$ 35.967081 $^{36}_{17}Cl$ 35.968307 $^{36}_{18}Ar$ 35.967546 The Cl (A = 36, Z = 17) nuclide is: (a) subject to beta-plus decay only (b) subject to beta-minus decay only (c) subject to alpha decay only (d) not subject to alpha, beta-plus, or beta-minus decay (e) subject to beta-plus or beta-minus decay, but not to alpha decay	
Q4	What do you mean by the term pair production?	**CO1**
Q5	What are thermonuclear reactions.	**CO1**
Q6	Out of protons, electrons and neutrons which is the most suitable probe to study properties of nucleus and why?	**CO4**
	Section B **All questions are compulsory. Each question carries 10 marks.**	
Q7	Establish a relation between Einstein's A and B coefficients.	**CO3**
Q8	A system is defined by the wave function $\varphi(x) = Acos\left(\frac{2\pi x}{L}\right)$ for $-\frac{L}{4} \leq x \leq \frac{L}{4}$. Find the probability of finding the particle between $x = 0$ and $x = \frac{L}{16}$.	**CO3**
Q9	Write a brief note on the semi-empirical mass formula inclusive of all terms of binding energy.	**CO2**
Q10	A piece of an ancient wooden box shows an activity of ^{14}C of 3.9 disintegrations per minute per gm of Carbon. Estimate the age of the box if the half-life of ^{14}C is 5568 years if the activity of fresh ^{14}C is 15.6 disintegrations per minute per gm.	**CO3**
Q11	Starting from the momentum conservation equations (in Compton effect) derive a relation between the angle of scattering Ø and angle of recoil θ. $$tan\theta = \frac{cot\frac{\emptyset}{2}}{1 + \frac{h\nu}{m_o c^2}}$$ where *v* is the frequency of incident photon and m_0 is the rest mass of the electron.	**CO4**

Section C
Attempt any one question. Each question carries 20 marks.

Q12	Discuss the motion of an electron across a potential step of finite height. Calculate the reflection and transmission coefficients. OR A beam of particles with energy E is incident on a potential barrier with potential function $$\left.\begin{matrix} V(x) = 0 & for\ x < 0 \\ V(x) = V_o & for\ 0 < x < a \\ V(x) = 0 & for\ x > a \end{matrix}\right\}$$ where the symbols have their usual meaning. Show that there is a finite probability of transmission even if $E < V_o$.	**CO2**

Values of some physical constants:

Planck's constant, h = 6.6 x 10^{-34} J.s
Boltzmann's constant, k = 1.38 x 10^{-23} J/K
Mass of electron, m_e = 9.1 x 10^{-31} Kg
Mass of proton, m_p = 1.67 x 10^{-27} Kg
Velocity of light, c = 3 x 10^8 m/s
Rydberg Constant, R = 1.097 x 10^7 m^{-1}
Avogadro's number = 6.023 x 10^{23}
Permittivity of free space, ε_o = 8.85 x 10^{-12} F/m
Permeability of free space, $\mu_o = 4\pi$ x 10^{-7} H/m