Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, December 2020

Course: Elements of Modern Physics **Semester: III**
Program: B.Sc. (H) Chemistry & B.Sc. (H) Maths **Time: 3 Hrs**
Course Code: PHYS 2009 **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	**CO2**
	(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	
Q2	(i)	The spectral lines obtained when electronic transition takes place to the fourth energy level from other higher levels is called **(2)** (a) Lyman series (b) Balmer series (c) Paschem series (d) Brackett series (e) Pfund series	**CO2**
	(ii)	Who postulated that the electrons orbit the nucleus like planets orbit the Sun? **(2)** (a) Rutherford (b) Bohr (c) Einstein (d) de-Broglie	
	(iii)	While moving in the Bohr's orbits the electrons emit electromagnetic radiation. **(1)** (a) Yes (b) No	

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: $^{4}_{2}He$ 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	**CO5**
Q4	List out the properties of a wave function.	**CO3**
Q5	What is the role of moderator in a nuclear reactor?	**CO5**
Q6	Out of protons, electrons and neutrons which is the most suitable probe to study properties of nucleus and why?	**CO5**
Section B **All questions are compulsory. Each question carries 10 marks.**		
Q7	Discuss the Davisson-Germer experiment.	**CO1**
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 $x = \frac{L}{8}$.	**CO3**
Q9	Write a brief note on the semi-empirical mass formula inclusive of all terms of binding energy.	**CO5**
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.	**CO5**
Q11	What do you mean by pair production? Show that pair production can't happen in empty space.	**CO5**

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 $\begin{Bmatrix} V(x) = 0 & for\ x < 0 \\ V(x) = V_o & for\ 0 < x < a \\ V(x) = 0 & for\ x > a \end{Bmatrix}$ where the symbols have their usual meaning. Show that there is a finite probability of transmission even if $E < V_o$.	**CO4**

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