Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2021

Course: Elements of Modern Physics **Semester: III**
Course Code: PHYS 2009G
Programme: B.Sc (H) Chemistry, Mathematics & Geology **Max. Marks: 100**
Total pages: 2 **Time: 03 hrs.**

Instructions:

- All questions are compulsory (**Q9** and **Q11** have an internal choice)
- Use blank paper as rough work to solve the questions in section-A and write only the correct options (type answers, no upload)
- Scientific calculators can be used for calculations.

SECTION-A

S. No.		**Marks**	**CO**
Q1.	The de-Broglie wavelength of virus particle of mass 1.5×10^{-15} kg moving at a speed of 2×10^{-3} m/s is ………. (answer upto the third decimal) (use $h = 6.63 \times 10^{-34}$ J − s)	**4**	**CO2**
Q2.	Explain the two drawbacks of Rutherford's atomic model.	**4**	**CO1**
Q3.	Select all options that satisfy the properties of wave function ψ (a) the wave function must be single-valued (b) the wave function must be discontinuous (c) the wave function must be continuous (d) the wave function must be differentiable (e) the wave function must be infinite (f) the wave function must be finite valued (g) the wave function must be normalizable	**4**	**CO1**
Q4.	Calculate the work function in electron volts of a metal, given that the photoelectric threshold wavelength (a) 6200 Å and (b) 5000 Å (answer upto the second decimal) (use $h = 6.62 \times 10^{-34}$ J − s)	**4**	**CO3**
Q5.	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 $\log_{10} 20 = 1.3010$)	**4**	**CO4**

SECTION-B (Question No: 9 has an internal choice)

Q6.	Describe the Davisson and Germer experiment to demonstrate the wave character of electrons.	**10**	**CO1**
Q7.	Calculate the following for Hydrogen atom by making use of the given physical constants, (a) the velocity of an electron in the ground state (b) the radius of Bohr's orbit in the ground state (c) time taken by the electron to traverse the first Bohr's orbit and (d) the Rydberg constant $h = 6.6 \times 10^{-34}$ J − s, $m_e = 9.1 \text{ x } 10^{-31}$kg, $e = 1.6 \times 10^{-19}$ Coulomb, $c = 3 \times 10^8$ m/s, $\varepsilon_0 = 8.86 \times 10^{-12}$ coulomb^2/Newton − metre^2	**10**	**CO2**
Q8.	Describe the liquid drop model of the nucleus.	**10**	**CO4**
Q9.	Explain the de-Broglie concept of wave velocity and group velocity. Derive a relation between the wave velocity and group velocity. **OR** What is the uncertainty principle? By applying the uncertainty principle, explain the non-existence of an electron in the atomic nucleus.	**10**	**CO3**
SECTION-C (Question No: 11 has an internal choice)			
Q10.	(a) 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 (b) Define the range of the α-particle. Explain Gamow's theory of alpha decay with the necessary diagram.	**10** **10**	**CO4** **CO4**
Q11.	Obtain an expression for the transmission coefficient in a rectangular potential barrier. **OR** (a) 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. (b) Show that the wave function of a particle trapped into a one-dimension box of length L is $\Psi_n(x) = \sqrt{\frac{2}{L}}\sin(\frac{n\pi x}{L})$, where n=1, 2, 3,…..	**20** **10** **10**	**CO3** **CO3** **CO3**