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Daffodil International University

Faculty of Science & Information Technology

Department of Computer Science and Engineering

Final Examination, Summer-2026

Course Code: PHY102, Course Title: Physics II

Level: 1 Term: 3 Batch: 70

Time: 2 Hour **Marks: 40**

Answer ALL Questions

[The figures in the right margin indicate the full marks and corresponding course outcomes. All portions of each question must be answered sequentially.]

1.	a)	List down the observations of Rutherford's Gold Foil Experiment.	2	CO1
	b)	Using a suitable diagram, describe how a chain reaction occurs in a radioactive material.	2	
	c)	Write down difference between inertial and non-inertial frame of reference.	2	
	d)	Review the fundamental concept of the Compton Effect with a suitable diagram.	2	
	e)	Describe why an electron cannot stay inside the nucleus	2	
2.	a)	A satellite's hydrogen sensor detects an electron in the third Bohr orbit of a hydrogen atom. As the calibration engineer, derive the expression for the radius of the orbit and determine its numerical value.	3+1	CO2
	b)	As a medical imaging technician, you need to estimate the usable lifetime of a radioactive tracer before performing a diagnostic scan. Starting from the radioactive decay law, interpret the expression for the half-life of the radioactive tracer.	4	
	c)	A particle accelerator researcher observes that particles lose mass during high-energy collisions while releasing energy. Demonstrate Einstein's mass–energy equivalence equation.	4	
	d)	A company is testing a photoelectric sensor for an automatic door system. Explain the photoelectric effect, explain its significance and experimental observations and sketch the graph of stopping potential versus frequency.	3	
3.	a)	Apply: (i) the mass defect, (ii) the binding energy, and (iii) the binding energy per nucleon of a calcium (Ca) nucleus. Express the mass defect in amu and the binding energy in MeV, eV, and joules. Mass of a proton = 1.00728 amu, mass of a neutron = 1.00876 amu, and 1 amu = 931 MeV	3	CO3
	b)	The decay constants of four radioactive elements A, B, C, and D, are 0.125 d^{-1}, 0.200 d^{-1}, 0.300 d^{-1}, and 0.400 d^{-1}, respectively. (i) Calculate the mean life of element D. (ii) Utilize will the time required for 77% decay be the same for all four elements? Justify your answer with appropriate mathematical analysis. (iii) Arrange the four elements in ascending order of their mean lives.	3	

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	c)	A spacecraft has a proper length of 2.5 km and a rest mass of 8.0×10^4 kg. It moves with a velocity of 1.8×10^8 m s^{-1} relative to an observer on Earth. (i) Estimate the Lorentz factor (γ) of the spacecraft. (ii) Determine the contracted length of the spacecraft as measured by the Earth observer. (iii) Calculate the relativistic mass of the spacecraft. (iv) If the velocity of the spacecraft is increased to 2.4×10^8 m s^{-1}, determine its new relativistic mass.	3	
	d)	Due to collision of X-ray photon of initial frequency 5.0×10^{19} Hz collides with a stationary electron in a target material. After the collision, the photon is scattered through an angle of 60°. Measure the frequency of the scattered photon.	3	
	e)	The radius of a hydrogen atom is found to be 8.48×10^{-8} m. Using Bohr's model, demonstrate:(i) the principal quantum number, (ii) the energy of the electron in that orbit. Here, $a_0 = 0.53$Å and $E_1 = -13.6$ eV.	3	