BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: IMSc **SEMESTER : II**
BRANCH: MATHS & COMPUTING **SESSION : SP/2023**

SUBJECT: PH109 PHYSICS-I

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

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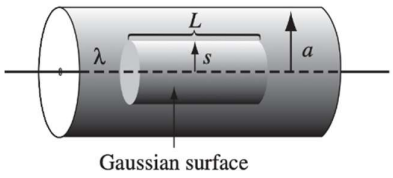
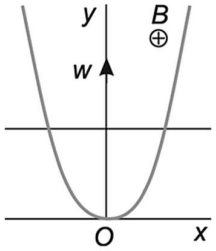
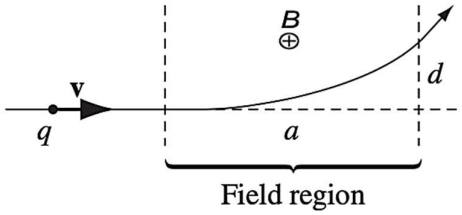
Q.1(a)	Define Brewster's angle. What is its value for a glass slab (n_1 = 1.5) immersed in water (n_2 = 1.33) in degrees? Show that at this angle the reflected and refracted rays are perpendicular to each other.	[5]	4,2,4
Q.1(b)	What do you understand by interference? What are the main methods of observing interference in lab? A narrow slit (in air) on an opaque screen is illuminated by laser of wavelength 1152.2 nm. It is found that the center of the 10^{th} dark fringe in the Fraunhofer pattern lies at an angle of 6.2 degrees off the central axis. What is the slit width? At what angle will the 10^{th} dark fringe appear if the entire setup is immersed in water (n = 1.33) instead of air (n = 1.0002)?	[5]	4,1,4
Q.2(a)	What is an "inertial observer"? Derive the Lorentz transformations connecting 2 inertial observers?	[5]	5,5,5
Q.2(b)	Define "proper length" and "proper time" in the context of special relativity. A cosmic ray particle (proper mean life time, τ = 1 micro-sec) is created in the upper atmosphere and travels at 0.9c, calculate the distance it travels before decay for 2 cases: (a) as measured by an observer on Earth, (b) as measured in the rest frame of the particle.	[5]	5,1,5
Q.3(a)	Define Binding energy of a nucleus? A nucleus with mass number A = 235 splits into two nuclei whose mass numbers are in the ratio 1:2. What is the ratio of their radii?	[5]	3,1,3
Q.3(b)	Define Isotopes, Isobars and Isotones? Using the Semi-empirical Mass formula below, determine the most stable Isobar for a nucleus having odd mass number (A). Take the coefficient values as: a_1 = 14.1 MeV, a_2 = 13.0 MeV, a_3 = 0.595 MeV, a_4 = 19.0 MeV. $BE(A, Z) = a_1 A - a_2 A^{2/3} - a_3 Z^2 A^{-1/3} - a_4 (A - 2Z)^2 A^{-1}$	[5]	3,5,3
Q.4(a)	Define Gauss law of electro-statics? Apply Gauss law to calculate the electric field at a distance **z** from an infinitely long straight wire carrying a uniform linear charge density λ.	[5]	1,3,1
Q.4(b)	Define the electric displacement vector ($\vec{D}$) for a linear, homogeneous, isotropic dielectric. A long straight wire carrying a uniform linear charge density λ, is surrounded by dielectric insulation out to radius a. Find the electric displacement vector.	[5]	1,1,1



Q.5(a) Define Faraday's law of electro-magnetism. A wire bent as a parbola $y = bx^2$ (where b is a constant) is located in a uniform magnetic field $\vec{B}$, which is perpendicular to the XY plane and pointing into this page. At the moment t = 0, a metal rod starts sliding translationally from the parabola apex with a constant acceleration $\vec{w}$. Find the induced emf in the loop thus formed as a function of y. [5] 2,1,2



Q.5(b) Define Lorentz force on a charged particle due to an electro-magnetic field. A particle of charge ***q*** enters a region of uniform magnetic field $\vec{B}$ (pointing into the page). The field deflects the particle a distance **d** above the original line of flight, as shown in the figure below. Is the charge positive or negative? In terms of a, d, B and q, find the momentum of the particle. [5] 2,1,2



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