PHE-07

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

ELECTRIC AND MAGNETIC PHENOMENA

Valid from January 1, 2024 to December 31, 2024

It is compulsory to submit the Assignment before filling up the Term-End Examination Form.

Please Note

- **You can take electives (56 or 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.**
- **You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.**
- **At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits out of those 64 credits should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the responsibility will be yours.**

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

2024

Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the Section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation which would consist of **one tutor-marked assignment (TMA)** for this course.

Instructions for Formatting Your Assignments

Before attempting the assignment, please read the following instructions carefully:

1) On top of the first page of your TMA answer sheet, please write the details exactly in the following format:

ENROLMENT NO. : ……

NAME : ……

ADDRESS : ……

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COURSE CODE : ……..

COURSE TITLE : ……..…….

ASSIGNMENT NO. : ……..…

STUDY CENTRE : ……..……. DATE : ….……...……

Please follow the above format strictly to facilitate evaluation and to avoid delay.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate the question number along with the part being solved. Be precise. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.

6) **This assignment will remain valid from January 1, 2024 to December 31, 2024**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response. If you have any problems or queries related to the course, you can write to us on the e-mail **srjha@ignou.ac.in.**

We wish you good luck.

Tutor Marked Assignment
ELECTRIC AND MAGNETIC PHENOMENA

Course Code: PHE-07
Assignment Code: PHE-07/TMA/2024
Max. Marks: 100

Note: Attempt all questions. The marks for each question are indicated against it. Symbols have their usual meanings.

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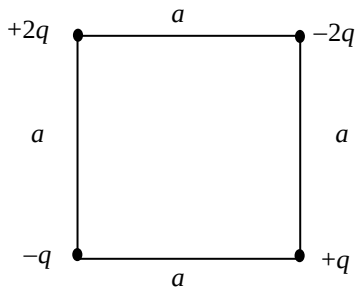
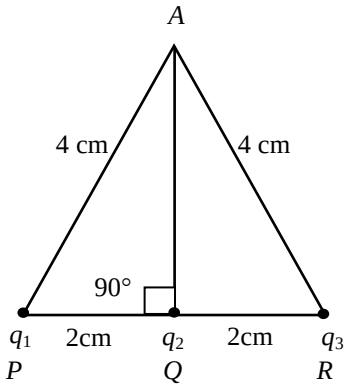
1. a) What do you understand by electrostatic potential energy? Calculate the electrostatic potential energy for the system of charges shown below. Take $q = 5\ \mu C$ and $a = 2$ cm. (4+6)



b) A 100 m long thread carries charges uniformly distributed along its length. An electron, 10 cm away from the centre of the thread along a line perpendicular to the thread experiences an attractive force of 2.7×10^{-12}N. Calculate the total charge on the thread. (5)

c) Consider the figure given below. Charges q_1, q_2 and q_3 are placed at *P*, *Q* and *R*, respectively, and $q_1 = q_2 = -q_3 = 2\mu C$. Determine the magnitude and the direction of the electric field at point *A*. (10)



2. a) The capacitance of a parallel plate capacitor is increased by a factor of 6 when a dielectric material fills the space between its plates. What is the relative permitivity of the dielectric material? If this material is placed in between the plates of a cylindrical capacitor of outer and inner radii 12 cm and 10 cm respectively, calculate the capacitance per unit length of the cylindrical capacitor. (5+5)

b) A glass of relative permittivity 5 is kept in an external electric field of magnitude 10^2 Vm^{-1}. Calculate the polarisation vector, molecular/atomic polarisability and the refractive index of the glass. (3+3+4)

3. a) A copper wire of diameter 2 mm and length 30 m is connected across a battery of 2V. Calculate the current density in the wire and drift velocity of the electrons. The resistivity of copper is 1.72×10^{-8} Ωm and $n = 8.0 \times 10^{28}$ electrons m^{-3}. (5)

b) A 10 eV electron is circulating in a plane at right angles to a uniform magnetic field of 1.0×10^{-4} T. Calculate the orbital radius of the electron, cyclotron frequency, period of revolution, and the direction of circular motion of the electron as viewed by an observer looking along the magnetic field. (3+3+2+2)

c) How do we differentiate between diamagnetic and paramagnetic materials? Show that for diamagnetic atoms placed in an external magnetic field **B**, the change in dipole moment is opposite to the direction of **B**. (5+5)

d) Establish the relation $\mathbf{B} = \mu_0 (\mathbf{H} + \mathbf{M})$ for a ferromagnetic material. (5)

4. a) An electric generator comprises a square wire loop of side 80 cm. The loop has 50 turns and is placed in a magnetic field of 0.5 T. By what frequency should this loop be rotated in the magnetic field to produce an AC voltage of peak value 250 V? (5)

b) Explain the physical significance of the Maxwell's equation $\nabla \times \mathbf{B} = \mu_0 \left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} \right)$.

Derive the wave equation for the *z*-component of the electric field of an electromagnetic wave. (5+5)

c) A sinusoidal plane electromagnetic wave propagates from water (n_w =1.33) to glass (n_g = 1.5). Calculate the reflection and transmission coefficients for this wave at the interface of the two media. Show that when an electromagnetic wave enters from one dielectric medium to the other, its frequency remains unchanged. (3+3+4)

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