PHE-07

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

ELECTRIC AND MAGNETIC PHENOMENA

Valid from January 1, 2025 to December 31, 2025

It is compulsory to submit the Assignment before filling in 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

2025

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, 2025 to December 31, 2025**. 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/2025
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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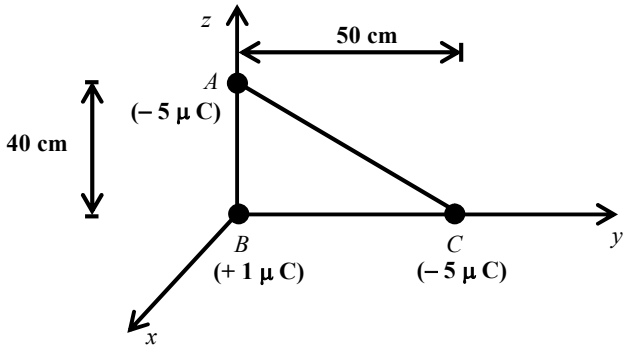
1. a) Determine the electrostatic force and electrostatic field on a charged particle located at *A* in the Figure given below due to the charged particles situated at *B* and *C*. The value of the charge on each of these particles is indicated in the Figure.



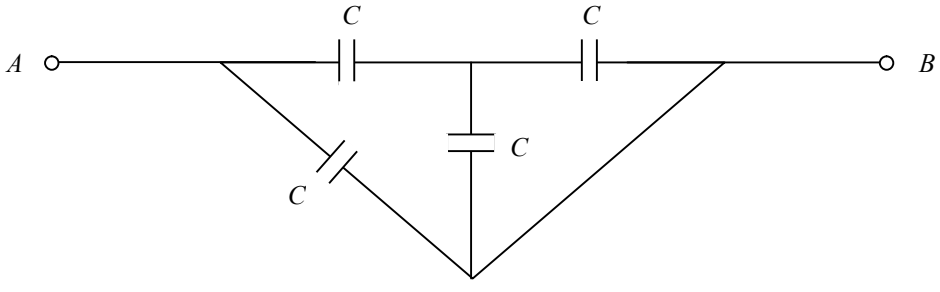
Express your result both in the unit vector notation and as magnitude. (10)

b) Explain with the help of diagrams what spherically and cylindrically symmetric charge distributions are. What is the electric field at a point inside a hollow metallic sphere of radius *R* having volume charge density ρ? (8+2)

c) Two particles carrying 4C and – 2C charges are placed on a 1 m long straight wire. Determine the point on the line joining these particles where the electric potential is zero with reference to the positively charged particle. (5)

2. a) Explain the phenomenon of polarisation of a dielectric. Show that, when a dielectric material is filled between the plates of a capacitor, the value of capacitance increases by factor of *K*, the dielectric constant of the material. (5+10)

b) Determine the value of equivalent capacitance between points *A* and *B* for the combination of capacitors shown in the Figure below:



(5)

c) The energy of a capacitor is 4.0 μJ after it has been charged by a 1.5 V battery. Calculate its energy when it is charged by a 6.0 V battery. (5)

3. a) Obtain an expression to show that the change in the quantity of charge enclosed in an arbitrary volume is accompanied by a net flow of charge inwards or outward across the surface of the enclosed volume. (10)

   b) A horizontal, straight wire carrying 12.0 A current from west to east is in the earth's magnetic field **B**. At this place, **B** is parallel to the surface of the earth, points to the north and its magnitude is 0.04 mT. Determine the magnetic force on 1 m length of the wire. If mass of this length of wire is 50 g, calculate the value of current in the wire so that its weight is balanced by the magnetic force. (5+5)

   c) A current is flowing in an infinitely long straight wire. Using Biot-Savart law, show that the resultant magnetic field at a point along a line perpendicular to the wire is inversely proportional to the distance of the point from the wire. (5)

4. a) Using Maxwell's equations in free space, derive the wave equation for the *x*-component of the electric field vector. (10)

   b) A uniform plane wave of 100 kHz travelling in free space strikes a large block of a material having $\varepsilon = 9\ \varepsilon_0$, $\mu = 4\ \mu_0$ and $\sigma = 0$ normal to the surface. If the incident electric field vector is given by

   $$\mathbf{E} = 100 \sin(\omega t - \beta y)\ \hat{\mathbf{x}}\ \text{V}$$

   write the complete expressions for the incident, reflected, and transmitted field vectors. (15)