PHE-07

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

ELECTRIC AND MAGNETIC PHENOMENA

Valid from January 1, 2026 to December 31, 2026

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

Please Note

- **You can take electives (56 to 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 should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for that course. Otherwise, your result will not be declared and the onus will be squarely on you.**

School of Sciences
Indira Gandhi National Open University
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2026

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, 2026 to December 31, 2026**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool. Answer sheets received after the due date shall not be accepted.

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
PHE-07: Electric and Magnetic Phenomena

Course Code: PHE-07
Assignment Code: PHE-07/TMA/2026
Max. Marks: 100

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

1. a) Two positively charged particles having charges 10 μC and – 5 μC, respectively, are kept at a distance of 1 m from each other. Determine the force on each charge and the electric field due to each charge. Show the force and electric field vectors on appropriate diagrams. What is the resultant force at a point midway from the two charges along the straight line joining them? (2+2+4+2)

   b) State Gauss's Law. What does spherically symmetric charge distribution mean? Use Gauss's Law to determine the electric field of a solid metallic sphere of radius *R* having volume charge density ρ at a point outside the sphere. (2+2+6)

   c) A uniform electric field of $3\times10^3\ \mathrm{NC}^{-1}$ is in the positive *x*-direction. A positive point charge 2 μC is released from rest at the origin.

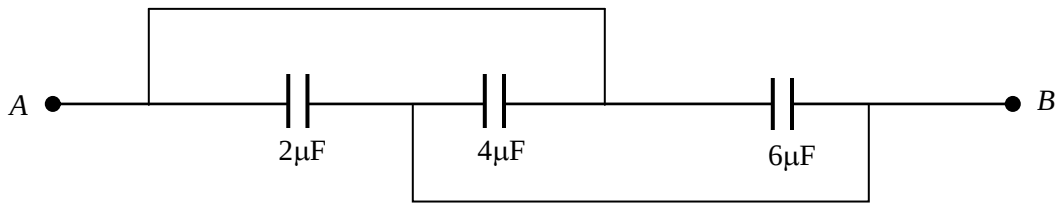
      i) Calculate the potential difference $V(5\ \mathrm{m}) - V(0)$.

      ii) What is the change in electrostatic potential energy of the charge when it is moved from $x = 0$ to $x = 5\,\mathrm{m}$?

      iii) Calculate the kinetic energy of the charge when it is at $x = 5\,\mathrm{m}$.

      iv) Calculate the value of the potential $V(x)$ if electric potential is chosen to be zero at $x = 0$ and $x = 1\mathrm{m}$. (2+2+3+3)

2. a) Three capacitors are connected to each other as shown below:



   Calculate the equivalent capacitance between points *A* and *B*. (5)

   b) Show that the line integral of the electric field over a closed path is equal to zero. (5)

   c) Suppose that a Gaussian surface encloses zero net charge. i) Does Gauss's law require that the electric field be zero for all points on the surface? ii) If the electric field is zero everywhere on the Gaussian surface, does Gauss's law require that the net charge inside the surface be zero? (3+3)

d) A particle carrying a charge of 2.7×10^{-9} C is enclosed in a cubical Gaussian surface of side 0.5 m. Calculate the electric flux through the surface of the cube and any one of its faces. (4)

3. a) What do you understand by linear conductors? Discuss the conditions under which metals do not behave as linear conductors. (5)

b) The number density of electrons in aluminium metal is 9.64×10^{28} m^{-3}. Calculate the drift velocity of electrons in an aluminium wire of cross-sectional area 2.0 mm^2 in which a current of 4A is flowing. (5)

c) Using Biot-Savart's law, obtain an expression for the magnetic field due to electric current flowing in a long straight wire at a distance *R* from the wire along a line perpendicular to the wire. (10)

d) Show that in the presence of external magnetic field, the magnetisation of a paramagnetic material depends on the strength of the magnetic field and the temperature of the material. (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 MHz travelling in free space strikes normal to the surface of a large block of material having $\varepsilon = 9\varepsilon_0$, $\mu = 4\mu_0$ and $\sigma = 0$. If the incident electric field vector is given by

$\vec{\mathbf{E}} = 1000\cos(\omega t - \beta y)\ \hat{\mathbf{z}}\ \text{Vm}^{-1}$,

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

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