PHE-07

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

ELECTRIC AND MAGNETIC PHENOMENA

Valid from January 1, 2022 to December 31, 2022

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

2022

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, 2022 to December 31, 2022**. 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** or **vijayashri@ignou.ac.in**

We wish you good luck.

Tutor Marked Assignment
ELECTRIC AND MAGNETIC PHENOMENA

Course Code: PHE-07
Assignment Code: PHE-07/TMA/2022
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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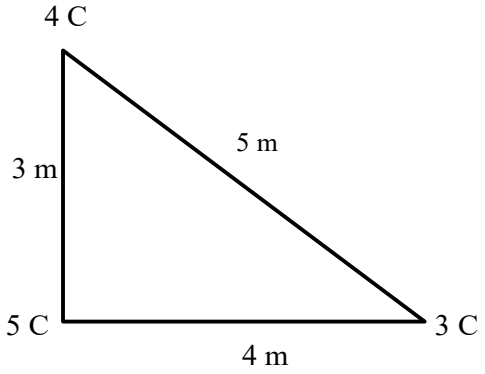
1. a) Let the charges q and $-q$ be placed alternatively along the x-axis at positions $x = 2$ m, $x = 3$ m, $x = 5$ m and $x = 8$ m. What is the electric field at $x = 0$ due to these charges? (5)

   b) Two electric charges 2 μC and –1 μC are placed at a distance of 20 cm from each other in vacuum. Locate the point on the line joining these two charges outside the region between them at which the electric potential is zero with reference to the positive charge. (5)

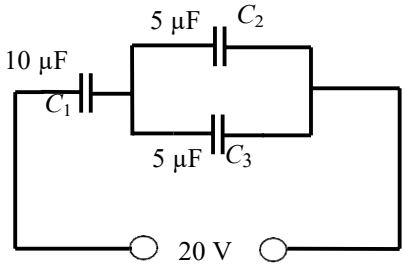
   c) Determine the electric potential energy of the system of charges shown in the figure below: (5)



   d) A sphere of radius R carries a charge of volume charge density $\rho = ar$, where a is a constant and r denotes the distance from the centre of the sphere. Calculate the total charge enclosed by the sphere and the electric field at points lying inside and outside the sphere. (10)

2. a) A dielectric object is placed in an electric field. The object becomes polarised and a large number of atomic/molecular dipoles in the object align in the direction of the applied electric field. Derive an expression for the electric field produced by this polarised dielectric at a point outside the dielectric. (10)

   b) Three capacitors are connected to a 20 V potential difference as shown in the figure below:



   Calculate the charge on each plate and the potential difference across each capacitor when fully charged. (5+5)

c) Establish Gauss's law in a dielectric medium. (5)

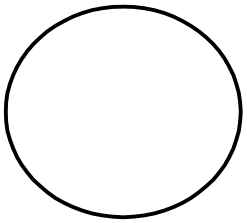
3. a) A fuse is made of material that melts when the current density reaches 400 A cm^2. What is the diameter of the fuse wire needed to limit the current to 0.40 A? (5)

b) Using Biot-Savart Law, obtain an expression for the magnetic field along the axis of a current loop. (5)

c) In the Bohr model of hydrogen atom, the electron follows a circular orbit centred on the nucleus containing a proton. The motion of the electron along the circular orbit constitutes a current. Calculate the magnetic field produced by the orbiting electron at the site of the proton. (5)

d) In a cyclotron, the diameter of the pole faces is 100 cm and the magnetic field between the pole faces is 0.50 T. The cyclotron is used for accelerating protons. Calculate the kinetic energy of proton in eV and speed of the proton as it emerges from the cyclotron. Also determine the cyclotron frequency. (4+3+3)

4. a) A time varying magnetic field $\mathbf{B}(t) = \mathbf{B}_0 \cos\omega t$ pointing out of the page fills the region enclosed by a circle of radius a shown in the figure below. Determine the induced electric field. (5)



b) Do the following fields satisfy all four Maxwell's equations?

$$\mathbf{E}(t) = \mathbf{E}_0 \sin x \sin t$$

$$\mathbf{B}(t) = \mathbf{B}_0 \cos x \cos t$$ (10)

c) Determine the magnitude of the Poynting vector and the energy per unit time delivered to a wire of length L and cross-section A when electric current I flows in it. (10)

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