Indian School Al Wadi Al Kabir
Unit Test (2025-2026)

Class: XII | Subject: Physics (042) | Max. marks: 30
Date: 22/05/2025 | SET- II | Time: 1 hour

General Instructions

1. There are 15 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, B, C, D & E.
3. **Section A** contains eight questions, six MCQ's and two Assertion Reasoning based of 1 mark each.
4. **Section B** contains two questions of two marks each, **Section C** contains three questions of three marks each, **Section D** contains one case study-based question of 4 marks and **Section E** contains one long answer question of five marks.
5. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks, one question for case study and for long answer question. You have to attempt only one of the choices in such questions.
6. You may use log tables if necessary but use of calculator is not allowed.
7. You may use the following values of physical constants wherever necessary:

$c = 3 \times 10^8\ ms^{-1}$, $h = 6.626 \times 10^{-34} Js$, $e = 1.602 \times 10^{-19}\ C$,
$\epsilon o = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$, $k = 9 \times 10^9\ C^{-2}Nm^2$.
$m_e = 9.1 \times 10^{-31} kg$,
$m_n = 1.675 \times 10^{-27} kg$, $m_p = 1.673 \times 10^{-27}\ kg$,
Avogadro's number $N_A = 6.023 \times 10^{23}\ /mol^{-1}$,
Boltzmann Constant $= 1.38 \times 10^{-23}\ J/K$

SECTION A(1 MARK)

1. A thin plastic rod is bent into a circular ring of radius R. It is uniformly charged with charge density. The magnitude of the electric field at its centre is:

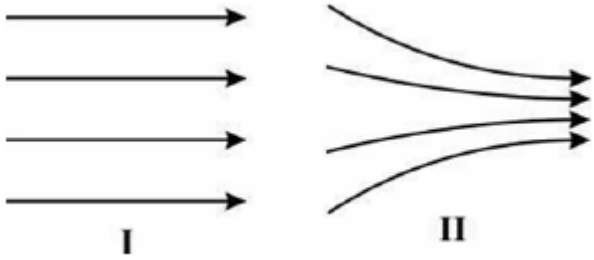
(A) $\frac{\lambda}{2\varepsilon_0 R}$ (B) Zero (C) $\frac{\lambda}{4\pi\varepsilon_0 R}$ (D) $\frac{\lambda}{4\varepsilon_0 R}$

2. A parallel plate capacitor is charged by a battery. The battery is then disconnected and the plates of the charged capacitor are then moved farther apart. In this process:
   (A) the charge on the capacitor increases.
   (B) the potential difference across the plates decreases
   (C) the capacitance of the capacitor increases.
   (D) the electrostatic energy stored in the capacitor increases.

3. Electric field at a point varies as r^0 for
   (A) An electric dipole
   (B) A point charge
   (C) A plane infinite sheet of charge
   (D) A line charge of infinite length

4. In a given region of an electric field, there is no charge present. A closed container is placed in this region of the electric field. What is the requirement for the total flux through the closed container to be zero?
   (A) The field must be uniform.
   (B) The container must be symmetric.
   (C) The container must be oriented in a particular direction.
   (D) There is no such requirement. The total flux through the container is zero no matter what.

5. The image below shows two examples of electric field lines. Which of the following statements is true?



(A) The electric fields in both I and II arise due to a single positive point charge located somewhere on the left.
(B) The electric fields in both I and II can be created by negative charges located somewhere on the left and positive charges somewhere on the right.
(C) The electric field in I is the same everywhere but the electric field in II becomes stronger as we move from left to right.
(D) As you move from left to right, the electric fields in both I and II become stronger.

(6) The capacitance of a capacitor is Co. It is connected to a battery of voltage V which charges the capacitor. With the capacitor still connected to the battery, a slab of dielectric material is introduced between the plates of the capacitor. Which of the following explains the effect of the dielectric slab in the above situation?
(A) The electric field between the plates of the capacitor rises.
(B) The potential difference between the plates falls.
(C) The total charge on the capacitor increases.
(D) The ability of the capacitor to store charge decreases.

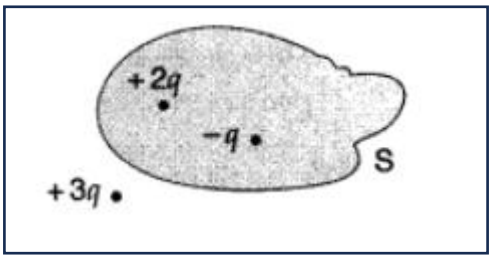
For Questions 7 & 8, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.
(A) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) If Assertion is true but Reason is false.
(D) If both Assertion and Reason are false.

7. **Assertion(A):** When we rub a glass rod with silk, the road gets positively charged and the silk gets negatively charged.
   Reason(R): On rubbing, the electrons from silk cloth move to the glass rod.

8. **Assertion(A):** In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.
   Reason(R): The dipoles of a polar dielectric are randomly oriented.

SECTION-B (2 MARKS)

9. Define electric flux. Figure shows three-point charges, +2q, -q and + 3q. Two charges +2q and -q are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'?



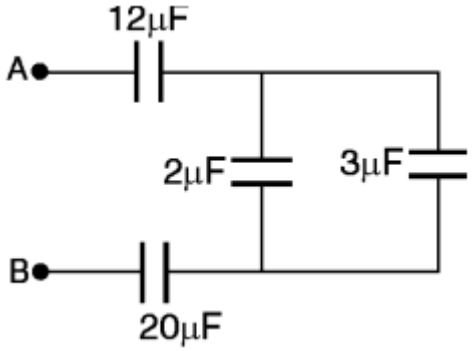
OR

Derive an expression for the torque experienced by an electric dipole in a uniform electric field.

10. Two charged particles are placed on the x axis of a coordinate system. The first ($q_1 = 2x10^{-6}$ C) is at the origin. The second ($q_2 = -5x10^{-6}$ C) is at x = 1.0 m. Determine a point in between these two charges where the electric potential is zero.

SECTION-C(3 MARKS)

11. Four capacitors are connected as shown in the fig. The potential difference between A and B is 1500 volt. What is the potential difference across the 2 μF capacitor?



OR

A parallel plate capacitor filled with mica having εr = 5 is connected to a 10 V battery. The area of the parallel plate is 6 m^2 and separation distance is 6 mm. Find the capacitance, stored charge and the stored energy.

12. State Gauss's law. Using Gauss's law obtain an expression for the electric field due to a uniformly charged spherical shell (a) inside the shell and (b) outside the shell.

13. What are equipotential surfaces? Draw the equipotential surfaces
(a) for a single negative charge (b) for a dipole.

SECTION D(4 MARKS)

14. Read the passage given below and answer the questions

Animals emit low frequency electric fields due to a process known as osmoregulation. This process allows the concentration of ions to flow between the inside of their bodies and outside. In order for their cells to stay intact, the flow of ions needs to be balanced. But balanced doesn't necessarily mean equal. The concentration of the ions within a shrimp's body is much lower than that of the seawater it swims in. Their voltage or potential difference generated between the two conservations across the surfaces can then be measured.

(i) The Gaussian surface for ions in the body of animals
(a) can pass through a continuous charge distribution.
(b) cannot pass through a continuous charge distribution.
(c) can pass through any system of discrete charges.
(d) can pass through a continuous charge distribution as well as any system of discrete charges.

(ii) Gauss's law is valid for
(a) any closed surface.
(b) only regular closed surfaces.
(c) any open surface.
(d) only irregular open surfaces.

(iii) The electric field inside a shrimp's body of uniform charge density is:
(a) zero
(b) constant different from zero
(c) proportional to the distance from the curve
(d) None of the above

(iv) If a small piece of linear isotropic dielectric is swallowed by a shrimp and inside the body it is influenced by an electric field *E*, then the polarization *P* is:
(a) independent of *E*
(b) inversely proportional to *E*
(c) directly proportional to $\sqrt{\boldsymbol{E}}$
(d) directly proportional to *E*

OR

(iv) Field due to multiple charges or ions inside shrimp's body at a point is found by using
(a) Principle of quantization
(b) Superposition principle
(c) Principle of conservation of charges
(d) Equality of charges

SECTION-E (5 MARKS)

15. (a) Derive an expression for the capacitance of a parallel plate capacitor with a dielectric slab filling the space.
(b) A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected parallel to another uncharged capacitor having the same capacitance. Find out the ratio of the energy stored in the combined system to that stored initially in the single capacitor.

OR

(a) Derive an expression for the electric potential at a point on the axial line of an electric dipole.
(b) What is the amount of work done in moving a point charge Q Around a circular arc of radius 'r' at the center of which another point charge q is located?