2024/06

SET A

B.SC. PHYSICS
SECOND SEMESTER
ELECTRICITY & MAGNETISM
BSP – 921 IDMJ

[USE OMR FOR OBJECTIVE PART]

Duration: 1:30 hrs. Full Marks: 35

Objective

Time: 15mins. Marks: 10

Choose the correct answer from the following: ***1×10=10***

1. The electric field for a point charge goes as (in spherical polar coordinates)
   a. $1/r$ b. $1/r^2$
   c. $1/r^3$ d. $1/r^4$

2. Physically, the electric field is
   a. force per unit charge b. force per unit length
   c. force per unit current d. force per unit area

3. Choose the correct statement.
   a. Field lines begin from positive charges. b. Field lines begin from negative charges.
   c. Field lines can terminate in midair. d. Field lines can cross each other.

4. If σ is the charge per unit surface, then over an area A, the total charge would be
   a. σ b. σA
   c. σ^2 d. σ/A

5. The flux of an electric field $\vec{E}$ through a surface S is
   a. $\int \vec{E} \cdot d\vec{a}$ b. $\int \vec{E} \times d\vec{a}$
   c. $\int E^2 da$ d. None of these

6. The curl of an electrostatic field is
   a. ρ/ϵ_0 b. ρ
   c. $\epsilon_0 \rho$ d. 0

7. Magnetic force in a charge Q, moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$, is the Lorentz force, and it is expressed as

a.	$\vec{F}_{mag} = Q(\vec{v} \times \vec{B})$	**b.**	$\vec{F}_{mag} = (\vec{v} \times \vec{B})$
c.	$\vec{F}_{mag} = Q\vec{v}$	**d.**	$\vec{F}_{mag} = Q\vec{B}$

8. $\nabla \cdot \vec{E} = ?$

a.	ρ/ϵ_0	b.	ϵ_0
c.	ρ	d.	$\rho\epsilon_0$

9. $\vec{E}$ and V are the electric field and potential respectively. The relation between them

a.	$\vec{E} = -\nabla V$	**b.**	$\nabla \cdot \vec{E} = V$
c.	$\nabla \cdot \nabla \times \vec{E} = V$	**d.**	None of these

10. Poisson's equation reads as

a.	$\nabla^2 V = 0$	**b.**	$\nabla^2 V = \rho/\epsilon_0$
c.	$\nabla^2 V = -\rho/\epsilon_0$	**d.**	None of these

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Descriptive

Time : 1 hr. 15 min. Marks : 25

[Answer question no.1 & any two (2) from the rest]

1. Draw the field lines for 1.25×4=5
   - **a.** a charge q
   - **b.** a charge 2q
   - **c.** two equal charges separated by some distance.
   - **d.** two equal and opposite charges separated by some distance.

2. **a.** Find the electric field (magnitude and direction) a distance z above the midpoint between two equal charges, q, a distance d apart. 5+5=10

   b. Find the electric field (magnitude and direction) a distance z above the midpoint between two equal but opposite charges, $q, -q$, a distance d apart.

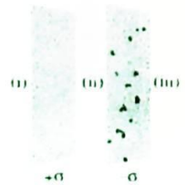
3. **a.** A long cylinder carries a charge density that is proportional to the distance from the axis: $\rho = ks$, for some constant k. Find the electric field inside this cylinder. 4+3+3=10

   b. Suppose the electric field in some region is found to be $\vec{E} = kr^3\hat{r}$, in spherical coordinates (k is some constant).
   (a) Find the charge density ρ.
   (b) Find the total charge contained in a sphere of radius R, centered at the origin.
   Hint: $\left|\nabla . \mathbf{V} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta\, v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial\phi}\right|$

4. **a.** Three charges are situated at the corners of a square (side a), as shown in the given figure. How much work does it take to bring in another charge, $+q$, from far away and place it in the fourth corner? 5+5=10

b. How much work does it take to assemble the whole configuration of four charges?

5. **a.** Two infinite parallel planes carry equal but opposite uniform charge densities $\pm\sigma$, as shown in the given figure. Find the electric field in each of the three regions: (i) to the left of both, (ii) between them, (iii) to the right of both. 6+4=10



b. Find the electric field outside a uniform charged solid sphere of radius R and total charge q.

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