B.Sc. F.Y. (CBCS Pattern) Semester - II

USPHT03 - Physics Paper-I (Vector Analysis and Electrostatics)

P. Pages : 3 **GUG/S/23/11590**

Time : Three Hours Max. Marks : 50

* 1 7 2 1 *

Notes : 1. All questions are compulsory.
2. Draw well labelled diagram wherever necessary.

Given : 1) $\frac{1}{4\pi\varepsilon_o} = 9\times10^9\ \text{Nm}^2/\text{cm}^2$

2) $\varepsilon_o = 8.85\times10^{-12}\text{c}^2/\text{Nm}^2$

3) $\frac{\mu_0}{4\pi} = 10^{-7}$

4) $e = 1.6\times10^{-19}\text{C}$

Either

1. a) i) Distinguish between scalar and vector quantity. **2**

ii) Define scalar product of two vector and express it in terms of their rectangular components. **3**

iii) Define vector product of two vectors. **2**

iv) If $\bar{A} = 2\hat{i}+3\hat{j}+4\hat{k}$ & $\bar{B} = \hat{i}+3\hat{k}$ **3**
Find i) $\bar{A}\cdot\bar{B}$ ii) $\bar{A}\times\bar{B}$ iii) $2\bar{A}+4\bar{B}$

OR

b) i) Define gradient of scalar field in cartesian coordinate. Explain its physical significance. **2½**

ii) Explain significance of divergence. **2½**

iii) State Gauss-divergence and stokes theorem. **2½**

iv) Find the divergence of the vector $\bar{A}$ at point (1, 1, -1), where $\bar{A} = (xy\hat{i}+yz\hat{j}+zx\hat{k})$. **2½**

Either

2. a) i) Define electric dipole and electric dipole moment. **2**

ii) Derive an expression for electric field due to an electric dipole at a point **5**
a) On axial line
b) On equatorial line. Hence, Prove $E_{axial} = 2\times$ Equatorial.

iii) Calculate the intensity of the electric field due to an electric dipole of dipole moment 4.5×10^{-10} coulometer at a distance of 1 meter from **3**
a) It on its axis and
b) On the perpendicular axis bisector

OR

b) i) Derive an expression for torque acting on a dipole placed in an uniform electric field. **2½**

ii) Show that electric field is a negative gradient of potential. **2½**

iii) The radius of nucleus of silver (atomic number z = 47) is 3.4×10^{-14} m. Calculate the electric potential of the surface of nucleus. **2½**

iv) Show that potential energy of an electric dipole in an uniform electric field is $\bar{U} = -\bar{P}\cdot\bar{E}$. **2½**

Either

3. a) i) State the Gauss's theorem of electrostatics and express it in differential form. **2**

ii) Derive an expression for electric field due to a uniformly charged spherical shell using Gauss's law, at a point **5**
a) Outside the shell
b) On the surface of the shell
c) Inside the shell

iii) A charge 10^{-8}C is uniformly distributed on a spherical shell of radius 0.1m. Determine the electric field intensity. **3**
a) At a point on the surface of spherical shell
b) At a distance 5cm from the centre of the shell
c) At a distance 0.50m from the centre of the shell

OR

b) i) Derive an expression for electric field intensity due to point charge. **2½**

ii) Obtain an expression for electric potential due point charge. **2½**

iii) Obtain an expression for electric field at a point near the plane charge sheet. **2½**

iv) A point charge 14C is located at the centre of the cube of side 7cm. Find the electric flux through **2½**
a) Whole of the cube b) Each face of the cube

Either

4. a) i) Define capacity of a capacitor state its SI unit. **2**

ii) Obtain an expression for capacity of a parallel plate capacitor when it is completely filled with dielectrics. **5**

iii) The distance between the parallel plates of capacity c is d. If the slab of deectric constant k and thickness 3d/4 is inserted between the plates. Find the capacity of the system. **3**

OR

b) i) Obtain the relation between three electric vectors $\bar{D}, \bar{E}$ and $\bar{P}$. **2½**

ii) Derive an expression for energy per unit volume of a charged capacitor. **2½**

iii) Explain why the introduction of dielectric slab between the plates of capacitor increases its capacitance. **2½**

iv) Capacitance of parallel plate separated by 1mm in air is $1\mu F$. Find the area of each plate. **2½**

5. Attempt **any ten** of the following.

a) Define volume integral of vector field. **1**

b) Define curl of a vector. **1**

c) If $\bar{E} = (x+y)\hat{i} + (y-2x)\hat{j} - 2z\hat{k}$. Prove that $\bar{\nabla} \cdot \bar{E} = 0$. **1**

d) Check whether the electric field $E = xy\hat{i} + y^3\hat{j}$ is conservative or not? **1**

e) Define electric field and electric field intensity. **1**

f) Define electric potential and write its SI unit. **1**

g) What is Gaussian surface? **1**

h) Represent graphically the variation of electric field intensity with a distance from the center due to the solid sphere. **1**

i) A sphere of radius 5cm has a point charge $q = 17.7\ell c$ located at its center. Find electric flux through it. **1**

j) What is polarization of a dielectrics? **1**

k) 10 microcoulomb charge given to a conductor increases its potential by 2.5VoH. What is the capacitance of the conductor? **1**

l) What is spherical capacitor? **1**

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