EPHY105L (I Semester 2021-2022)

Sample Questions

1. **Consider a sphere of radius R carrying a total charge Q distributed uniformly in the entire volume of the sphere. Find the value of $\int_V (\nabla.\vec{E}) d\tau$, where, the volume is that of a concentric sphere of radius $\frac{R}{3}$.**

2. **Calculate the work done in carrying a 4 C charge from point a(4,0,0) to point b(0,1,0) along the straight line connecting the two points in the electric field $\vec{E} = 2x\hat{x} + 3y\hat{y}$.**

3. **Eight charges of same sign and magnitude +Q are placed on a ring of radius 'R' at equal distances. The axis of the ring is taken to be along z-axis. A charge +q is placed at a height 'z' on the axis of the ring. What is the force on the charge q?**

4. **Find the electric potential at the center of a circle of radius 2m when there are three charges 2C, -3C and 1C on its circumference. Coulomb's constant = $9 \times 10^9 N.m^2/C^2$.**

5. **A negative charge of 1C is kept inside the cavity of a spherical shell of inner and outer radius of 0.5cm and 1 cm respectively. Calculate the charge density on the outer surface.**

6. **Two point charges ϵ_0 and $-2\epsilon_0$ are located at origin and (1,1,0) respectively. Calculate the electrostatic flux passing through a sphere of radius 1m and centered at the origin.**

7. **A point charge +Q is kept at a point (3,0,0). Calculate the potential difference between points (0,0,1) and (0,0,-1).**

8. **An electric dipole with dipole moment $\vec{p} = 6\hat{z}$ nC.m is located at the origin in free space. What would be the potential at a point with $r = 4,\ \theta = 20^\circ,\ \phi = 0^\circ$?**

9. **A charge q is located at the origin of a sphere of radius R. What is the total electric flux passing through the portion of the sphere bounded by $0 < \theta < \frac{\pi}{2}$ and $0 < \phi < \frac{\pi}{2}$?**

10. **A total charge Q is distributed inside a sphere of radius R with an isotropic charge density $\rho(r) = A(R^2 - r^2)$. What is A in terms of Q and R?**

11. **Calculate the electric field at a distance 'r' from the center of a uniformly charged solid sphere of radius 'R' when $r < R$. The charge density is given by ρ.**

12. **The electric field intensity at a point situated 4 metres from a point charge is 200 N/C. If the distance is reduced to 2 metres, find the change in the field intensity.**

13. **An electric dipole is placed at an angle of 30° with an electric field intensity 2×10^5 N/C. It experiences a torque equal to 4 N-m. If the dipole length is 2 cm, what is the charge on the dipole?**

Class Quiz Questions (Upto Electric Dipole)

1. **The following vector can represent an electric field: $\vec{E}_1 = xy\hat{x} + yz\hat{y} + xz\hat{z}$. Is this statement true or false?**

2. **We have one point charge +q each on three corners of a square of side 'a'. Calculate the work done in order to bring another charge +q on the fourth corner of the square.**
Ans: $\frac{q^2}{4\pi\epsilon_0 a}(2+\frac{1}{\sqrt{2}})$

3. **In a certain region of space the electrostatic potential is given by $V(x,y) = 2xy + 4y + 5y^2$. Find the point where the electric field will be zero.**
Ans: x = -2, y = 0

4. **Suppose the electric field in some region is found to be $\vec{E} = kr^3\hat{r}$. Find the charge density ρ.**
Ans: $5\epsilon_0 kr^2$

5. **We have a spherical shell with inner and outer radius of 'a' and 'b' respectively. It is carrying charge -Q. Inisde the spherical shell we have suspended a solid conducting sphere carrying charge +2Q. What are the magnitude of the electric fields ($|\vec{E}(\vec{r})|$) at $a < r < b$ and $r > b$ respectively?**
Ans: 0, $\frac{Q}{4\pi\epsilon_0 r^2}$

6. **A positive charge Q=8 mC is placed inside a spherical conducting shell with inner radius a and outer radius b which has an extra charge of 4 mC placed somewhere on it. When all motion of charges ends, find the charges on the inner and outer surfaces of the shell.**
Ans: Inner charge = −8 mC, Outer charge = 12 mC

7. **A charge 1 nC (1 nC=10^{-9} C) is placed at a point (2,0,0). Calculate the potential difference due to this charge between two points (0,-2,0) and (0,2,0).**
Ans: 0

8. **Suppose we have two positive charges q_1 and q_2 placed at (-a,0,0) and (b,0,0). The points are in Cartesian coordinates. Find the ratio $\frac{q_1}{q_2}$ for the electrostatic field to be zero at the origin.**
Ans: $\frac{a^2}{b^2}$

9. **Find the value of $\vec{A}.(\vec{B}\times\vec{C})$ when $\vec{A} = a\hat{x} + b\hat{y}$, $\vec{B} = a\hat{z}$, $\vec{C} = b\hat{x} + a\hat{z}$.**
Ans: ab^2

10. **Find the Azimuthal angle (ϕ) coordinate (in degree) corresponding to a point described in Cartesian coordinate as (a,b,0).**
Ans: $\frac{180}{\pi}\tan^{-1}\left(\frac{b}{a}\right)$

11. **Evaluate $\vec{\nabla}.(\vec{\nabla}\times\vec{v})$, where $\vec{v}$ is of the form $\vec{v} = ax^2y\hat{i} + bxyz\hat{k}$**
Ans: 0

12. **Find the Laplacian of $T(x,y,z) = x^2y + y^2x + xyz$ at point P(a,a,a).**
Ans: $4a$

13. **Find line integral for the function $\vec{v} = xy^2\hat{x} + yx^2\hat{y}$ from point A(0,0,0) to point B(a,b,0).**
Ans: $\frac{1}{2}a^2b^2$

14. **Find the angle (in degrees) between the vectors $\vec{A} = a\hat{y} + b\hat{z}$ and $\vec{B} = b\hat{x} + a\hat{z}$.**
Ans: $\frac{180}{\pi}\cos^{-1}\left(\frac{ab}{a^2+b^2}\right)$

15. The electric flux entering and leaving an enclosed surface are represented by ϕ_1 and ϕ_2 respectively. Find the electric charge inside the surface.
Ans: $\epsilon_0(\phi_2 - \phi_1)$

16. Calculate the ratio of electric field strengths at points (0,0,5) and (5,0,0) due to a dipole of dipole moment p_0 oriented along the z-axis.
Ans: 2