Second Semester Honours

ELECTROSTATICS

Electric Flux and Gauss theorem

1) A charge Q is placed at the centre of the edge of a cube .What is the flux through the cube. A) $\frac{q}{4\varepsilon_0}$

2) A charge Q is placed at the centre of the face of a cube .What is the flux through the cube. A) $\frac{q}{2\varepsilon_0}$

3) If a charge Q is placed at the corner of a cube, then what is the flux through the cube .Also find the flux through the faces of the cube. A) $\frac{q}{8\varepsilon_0}$, $\frac{q}{24\varepsilon_0}$

4) A charge Q is placed at the centre of a cube. What is the flux through the cube. Also find the flux through any surface of the cube. A) $\frac{q}{\varepsilon_0}$, $\frac{q}{6\varepsilon_0}$

5) a charge q is distributed uniformly on a ring of radius r. A sphere of equal radius r is constructed with its centre at the periphery of ring .Calculate the flux of electric field through the surface of the sphere.

6) A charge q is placed at the centre of an imaginary hemispherical surface .Find the flux of electric field due to this charge through the surface of the hemisphere.

7) A charge q is placed at a distance a/2 above the centre of a horizontal square surface of edge a as shown in the figure . Find flux through the square surface. A) $\frac{q}{6\varepsilon_0}$

8) There is a straight rod of linear charge density λ, inside a cube of side a .What is the maximum possible value of electric flux through the cube. A) $\sqrt{3}a\lambda$

9) the electric flux from a cube of edge L is φ .What will be its value if edge of the cube is made 2L and charge enclosed is halved ……………….. φ/2

10) if the electric flux entering an enclosed surface is φ_1 and leaving the surface is φ_2 .find amount of charge enclosed in the closed surface .

11) Find the electric flux through each face of a cube bounded by the surfaces x=0,x=a, y=0,y=a ,z=0,z=a when the electric field E in the region is given by **E** $=E_0 \frac{x}{a}\hat{i}$. Also find the charge contained inside the cube. A) E_0a^2

12)) Find the electric flux through each face of a cube bounded by the surfaces x= a ,x= 2 a, y= 0,y= a ,z=0,z=a when the electric field E in the region is given by **E** $=E_0 \frac{x}{a}\hat{i}$ .Also find the charge contained inside the cube. A) E_0a^2

13) a solid sphere of radius R has a charge Q distributed in the volume with a charge density $\rho = k r^a$,where k and a are constants and r is the distance from the centre .If the electric field at $r = \frac{R}{2}$ is 1/8 times that at r=R ,find the value of a. a) a=2

14) A charged sphere of radius R carries a positive charge whose volume charge density depends only on the distance r from the centre of the sphere as $\rho = \rho_0\left(1 - \frac{r}{R}\right)$, where ρ_0 is constant. Find electric field inside and out side of the sphere as a function of distance r. Also Find maximum intensity and corresponding distance. $E_{\max} = \frac{\rho_0 R}{6\varepsilon_0}$

15) Consider an atom with atomic number Z as consisting of a positive point charge at the centre and surrounded by a distribution of negative electricity uniformly distributed within a sphere of radius R .Find the electric field at a point inside the atom at a distance r from the centre. Also find electric field outside the atom.

16) If an electric field is given by 10 $\hat{i}$ + 3 j + 4k , calculate the electric flux through a surface of area 10 units lying in yz plane.

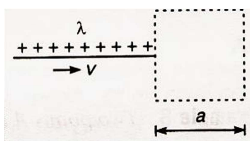
17) The electric field in a region is given by E =a i + b j . here a and b is constants. Find net flux passing through a square area of side L parallel to Y-Z plane.

18) Eight dipoles of charges of magnitude e are placed inside a cube .The total electric flux coming out of the cube will be

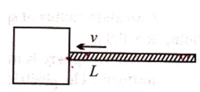
a) $8e/\varepsilon$ b) $16e/\varepsilon$ c) e/ε d) zero

19) A cube of side L is placed in a uniform field **E** =E $\hat{i}$ **.** Net flux through the cube is a) Zero b) L^2 E c) 4 L^2 E d) 6 L^2

20) Figure shows an imaginary cube of side 'a' .A uniformly charged rod of length a moves towards right at a constant speed v .At t=0 ,the right end of the rod just touches the left face of the cube .Plot a graph between electric flux passing through the cube versus time.



21) Figure shows an imaginary cube of sideL/2 .A uniformly charged rod of length L moves towards right at a constant speed v .At t=0 ,the left end of the rod just touches the right face of the cube .Plot a graph between electric flux passing through the cube versus time.



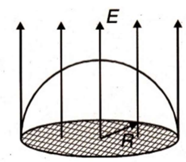
22) A point charge q is placed on the apex of a cone of semi vertical angle θ. The electric flux through the base of the cone is i) $q/2\epsilon_0(1 - \cos\theta)$

23) A charge q is placed at the centre of an uncharged hollow conducting sphere of radius r .Find surface charge density on the inner sphere and on the outer surface. $\frac{-q}{4\pi r^2}$, $\frac{q}{4\pi r^2}$

24) The electrostatic potential inside a charged spherical ball is given by φ = a r^2 + b , where r is the distance from the centre ; a, b are constants .Then the charge density inside the ball is a) -6a ε_0

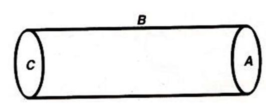
26) Total electric flux associated with unit positive charge in vacuum is : a) $\frac{1}{\varepsilon_0}$

27) A hemispherical surface of radius R is kept in a uniform electric field E as shown in figure .The electric flux through the curved surface is a) E π R^2



28) In the above question what is the flux perpendicular to the base of the body : a) E π R^2

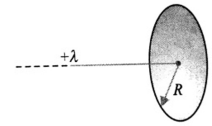
29) A hollow cylinder has a charge q within it .If φ is the electric flux associated with the curved surface B ,the flux linked with the plane surface A will be : a) $\frac{1}{2}(\frac{q}{\varepsilon_0} - \phi)$



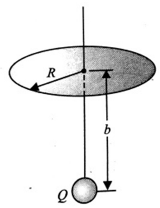
30) A point charge q is placed at the centre of a cylinder of radius R and length L .Find the flux crossing through the curved surface. $a) \frac{q}{\varepsilon_0}(\frac{L}{\sqrt{L^2+4R^2}})$

31) A cube of side L is placed in a electric field $\vec{E} = E\hat{i}$ .The net electric flux through the cube is : a) zero

32) Two charges q_1 and $-q_2$ are placed at A and B respectively. A line of force emanates from q_1 at angle α with the line AB. At what angle will it terminate at $-q_2$. $\beta = 2\sin^{-1}(\sqrt{\frac{q_1}{q_2}}\sin(\frac{\alpha}{2}))$



33) A point charge Q is located on the axis of a disk of radius R at a distance b from the plane of the disk. Show that if one fourth of the electric flux from the charge passes through the disk, then R=$\sqrt{3}\,b$



34) A Point charge q is fixed at the origin. Calculate the electric flux through the infinite plane y=a. a) $\frac{q}{2\varepsilon_0}$

35) Two conducting plates A and B are parallel .A is given a charge Q_1 and Q_2 .The charge on the inner side of B is

a) - $(\frac{Q_1 - Q_2}{2})$

36) Two point charges q and –q are 2L apart. Find the flux of the electric field strength vector across a circle of radius R placed at middle of the line. $\frac{q}{\varepsilon_0}(1-\frac{L}{\sqrt{L^2+R^2}})$

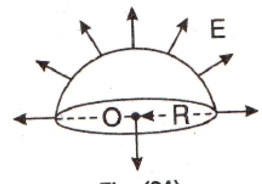
37) A cone of base radius R and height h is located in a uniform electric field parallel to its base. What is the electric flux entering the cone. a). E h R

38) A point charge Q is placed at the corner of a square of side a, then find the flux through the square. A) Zero

39) Electric potential inside a charged ball depends only on the distance from its centre as $\phi = a r^2 + b$ where a and b is constant. .Find charge density inside the ball. A) $-6a\varepsilon_0$

40) Show by the principal of superposition that if a cavity is removed from a uniformly charged sphere the field inside the cavity is $\frac{\rho \vec{a}}{3\varepsilon_0}$ where ρ the density of charge is and $\vec{a}$ is the vector from the centre of the sphere to the centre of cavity.

41) A wire of linear charge density λ passes through a cuboid of length L, Breadth b and height h in such a manner that flux through the cuboid is maximum. The position of wire is now changed, so that the flux through the cuboid is minimum. If L>b>h, then the ratio of maximum flux to minimum flux will be a) $\frac{\sqrt{L^2+b^2+h^2}}{h}$



42) A hemispherical body is placed in a radial electric field E normal to the curved surface as shown in the figure. The flux linked with the curved surface will be a) $2\pi R^2 E$

43) In the above question, if the electric field is produced by placing a point charge q at centre O, then flux linked with the curved surface will be a) $\frac{q}{2\varepsilon_0}$

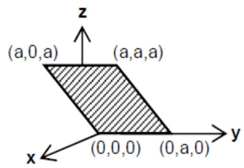
44) The total electric flux, leaving spherical surface of radius R and surrounding N electric dipole is a) Zero

44) A capacitor of capacitance C is charged to a potential V and is placed inside a closed surface. The electric flux through the closed surface is a) Zero

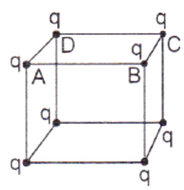
45) A charge q is distributed uniformly within the material of a hollow sphere of inner and outer radii a and b .The electric field at a point P at a distance x away from the centre for a<x<b is a) $\frac{q(x^3-a^3)}{4\pi\varepsilon_0 x^2 (b^3-a^3)}$

46) A very long uniformly charged thread oriented along the axis of a circle of radius R rests on its centre with one of the ends. The charge of the thread per unit length is λ . Find the flux of the vector E across thee circle area. A) $\frac{\lambda R}{2\varepsilon_0}$

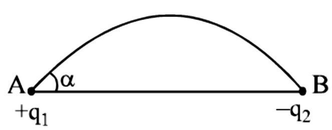
47) Consider an electric field $\vec{E} = E_0\,\hat{x}$ Where E_0 is a constant. The flux through the shaded area due to this field is a)$E_0 a^2$



48) Eight point charges having value q each are fixed at the vertices of a cube. The electric flux through square surface ABCD of the cube is a) $\dfrac{q}{6\varepsilon_0}$



49) Two charges $+q_1$ & $-q_2$ are placed at A and B respectively. A line of force emerges from q1 at angle a with line AB. At what angle will it terminate at $-q_2$?



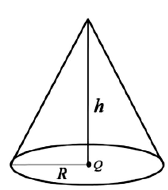
$a) 2\,sin^{-1}(sin\frac{\alpha}{2}\sqrt{\frac{q_1}{q_2}})$

50) The intensity of an electric field depends only on the coordinates x and y as $\vec{E} = \frac{\alpha(x\,\hat{\imath}+y\,\hat{\jmath})}{x^2+y^2}$ where α is a constant. Calculate the charge within a sphere of radius R having its centre at origin. A) $q = 4\,\pi\varepsilon_0\alpha\;R$

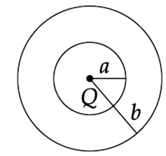
51) A point charge q is fixed at the origin. Calculate the electric flux through the infinite plane y=a.

$a)\ \dfrac{q}{2\varepsilon_0}$

52) Consider a charge Q at the origin of 3-dimensional coordinate system. The flux of the electric field through the curved surface of a cone that has a height h and a circular base of radius R (as shown in the figure) is $a)\ \dfrac{q}{2\varepsilon_0}$



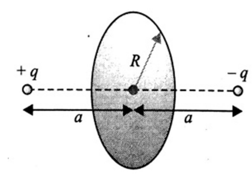
53) The region between two concentric spheres of radii 'a' and 'b', respectively (see figure), has volume charge density $\rho = \frac{A}{r}$ where A is a constant and r is the distance from the centre. At the centre of the spheres is a point charge Q. The value of A such that the electric field in the region between the spheres will be constant, is:



a) $\frac{C}{2\,\pi a^2}$

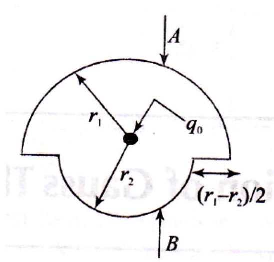
54) A solid sphere of radius R is uniformly charged and has charge per unit volume . Find the flux passing through a plane located at a distance r_0 (r_0 < R) from the centre. $a)\ \frac{\pi\,\rho\,r_0}{3\,\varepsilon_0}\,(R^2 - {r_0}^2)$

55) Two point charges +q and –q are placed 2R distance apart. Consider a circle of radius R placed perpendicular to the line joining charges, at its mid-point. Electric flux through the circle is



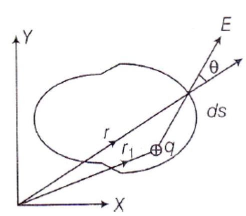
$a)\ \frac{q}{\varepsilon_0}\,(\frac{\sqrt{2}-1}{\sqrt{2}})$

56) A and B are semi-spherical surfaces of radius r_1 and r_2 (r_1>r_2) with E_1 and E_2 as the electric fields at their surfaces. Charge q_0 is placed as shown. What is the condition which may be satisfied? A) $\frac{\phi_1}{\phi_2} = 1, \frac{r_1}{\sqrt{E_2}} = \frac{r_2}{\sqrt{E_1}}$

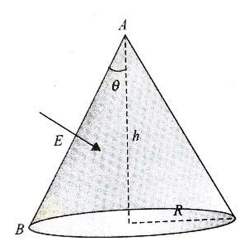


57) A charge q is placed at some distance along the axis of a uniformly charged disc of surface charge density σ. The flux due to the charge q through the disc is ϕ. The electric force on charge q exerted by the disc is a) $\sigma\,\phi$

58) Flux through an elementary area ds of the Gaussian surface is given by $a)\ \frac{q}{4\,\pi\varepsilon_0}\,\frac{(\vec{r}-\vec{r}_1)\,.\,\overrightarrow{ds}}{|\vec{r}-\vec{r}_1|^3}$



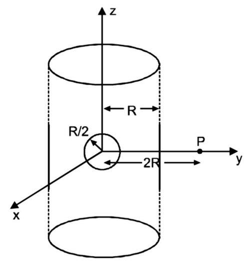
60) A conic su rface is placed in a uniform electric field E as shown in the figure such that the field is perpendicular to the surface on the side AB. The base of the cone is of radius R and



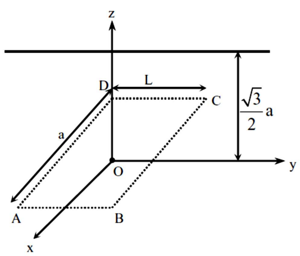
the height of the cone is h. The angle of the cone θ.Find the magnitude of the flux that enters the cone's curved surface from the left side.

$$a)\; E\,R\,[h\,cos\theta + \pi\,\frac{R}{2}sin\theta]$$

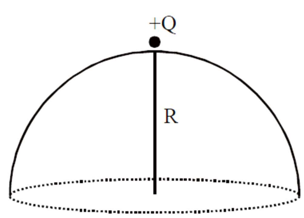
61) An infinite long solid cylinder of radius R has a uniform volume charge density ρ. It has a spherical cavity of radius R/2 with its centre on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P, which is at a distance 2R from the axis of the cylinder, is given by the expression $\frac{23\,\rho\,R}{16k\ _{0}}$. The value of k is a) 6



62) An infinite long uniform line charge distribution of charge per unit length λ lies parallel to the y-axis in the Y-Z plane at $Z = \frac{\sqrt{3}}{2}\,a$. If the magnitude of the flux of the electric field through the rectangular surface ABCD lying in the X-Y plane with its centre at the origin is $\frac{\lambda L}{n\varepsilon_0}$, then the value of n is a) 6



63) A point charge +Q is placed just outside an imaginary hemispherical surface of radius R as shown in the figure. Which of the following statements is/are correct?



(A) The electric flux passing through the curved surface of the hemisphere is $A) -\frac{Q}{2\,\varepsilon_0}(1-\frac{1}{\sqrt{2}})$

(B) The component of the electric field normal to the flat surface is constant over the surface

(C) Total flux through the curved and the flat surfaces is $\frac{Q}{\varepsilon_0}$

(D) The circumference of the flat surface is an equipotential

64) The electrostatics flux through a rectangular area of $\frac{7}{47}$ m^2 lying in a plane $2x + 3y + 6z = 10$ due to an electric field $(8\,\hat{\imath} + 6\,\hat{\jmath} + 10\,\hat{k})\,V/m$ will be in (V/m) a)2

65) A current I flows through a cylindrical rod of uniform cross-section area A and resistivity ρ. The electric flux through the shaded cross-section of rod as shown in figure is : $a)\;\varphi = \rho\, I$