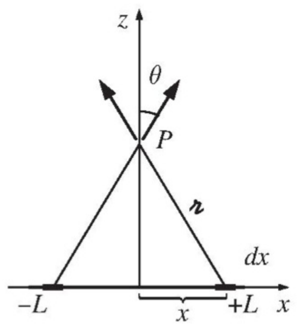
PHYS 507
HANDOUT 2 - *Questions on Static Electric Fields*

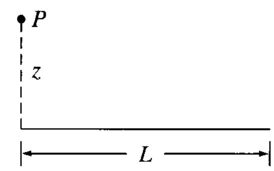
2.1 Twelve equal charges q are placed at the corners of a regular 12-sided polygon. A) What is the net force on a test charge Q placed at the center of the polygon? B) Suppose one of the charges is removed. What is the net force on the test charge?

2.2 Find the electric field (magnitude and direction) a distance z above the midpoint between two equal charges q. Check your result is consistent with what you would expect when $z >> d$.

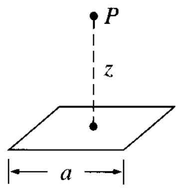
2.3 Find the electric field (magnitude and direction) a distance z above the midpoint of a straight line segment of length $2L$, which carries a uniform line charge λ shown in figure below.



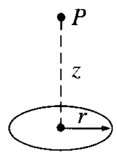
2.4 Find the electric field (magnitude and direction) a distance z above the midpoint of a straight line segment of length L, which carries a uniform line charge λ shown in figure below. Check your result is consistent with what you would expect when $z >> L$.



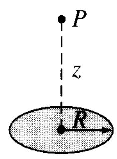
2.5 Find the electric field (magnitude and direction) a distance z above the center of a square loop as shown in the figure, which carries a uniform line charge λ. (Hint: Use problem 2.3 above).



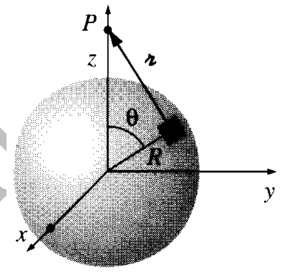
2.6 Find the electric field (magnitude and direction) a distance z above the center of a circular loop as shown in the figure, which carries a uniform line charge λ.



2.7 A) Find the electric field (magnitude and direction) a distance z above the center of a circular disk of radius R which carries a uniform charge of surface density σ as shown in the figure. B) What does the formula give as $R \to \infty$? C) Check also the case $z >> R$.



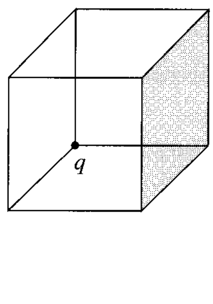
2.8 Find the electric field (magnitude and direction) a distance z above the center of a spherical surface of radius R which carries a uniform charge of surface density σ as shown in the figure. Treat the case of $z > R$ (outside) and $z < R$ (inside). Express your answer in terms of the total charge q of the sphere. [Hint: Use the law of cosines to write r in terms of R and θ. Be sure to take positive root: $\sqrt{R^2 + z^2 - 2Rz} = (R - z)$ if $R > z$ but it is $(R - z)$ if $R < z$.



THE GAUSS' LAW

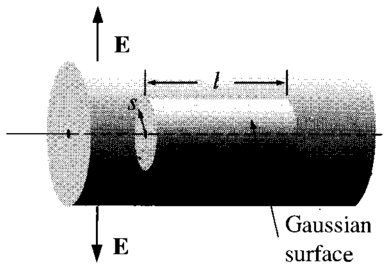
2.9 Suppose the electric field in some region is found to be $\mathbf{E} = kr^3\hat{\mathbf{r}}$, in spherical coordinates (k is some constant). (a) Find the charge density ρ. (b) Find the total charge contained in a sphere of radius R, centered at the origin.

2.10 A charge q sits at the back corner of a cube, as shown in figure. What is the flux of **E** through the shaded side?



2.11 Find the field outside a uniformly charged solid sphere of radius R and total charge q.

2.12 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.



2.13 An infinite plane carries a uniform surface charge σ. Find its electric field.

2.14 Two infinite parallel planes carry equal but opposite uniform charge densities $\pm\sigma$. Find the field in each of three regions: (i) to the left of both, (ii) between them, (iii) to the right of both.

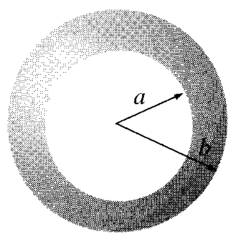
2.15 Use Gauss' law to find the electric field inside and outside a spherical shell of radius R, which carries a uniform surface density σ.

2.16 Use Gauss' law to find the electric field inside and outside a uniformly charged sphere of radius R, which has a charge density ρ.

2.17 Find the electric field a distance s from an infinitely long straight wire, which carries a uniform line charge λ.

2.18 Find the electric field inside a sphere which carries a charge density proportional to the distance from the origin, $\rho = kr$, for some constant k. [*Hint*: This charge density is *not* uniform, and you must *integrate* to get the enclosed charge.]

2.19 A hollow spherical shell carries charge density $\rho = k / r^2$ in the region $a \le r \le b$. Find the electric field in the three regions (i) $r < a$, (ii) $a < r < b$, and (iii) $r \ge b$. Plot $|\mathbf{E}|$ as a function of r.



2.20 A long coaxial cable carries a uniform volume charge density ρ on the inner cylinder (radius a) and a uniform surface charge density on the outer cylindrical shell (radius b). This surface charge density is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions; (i) inside the cylinder $s < a$, (ii) between the cylinders $a < s < b$ and (iii) and outside the cable ($s < b$). Plot $|\mathbf{E}|$ as a function of s.