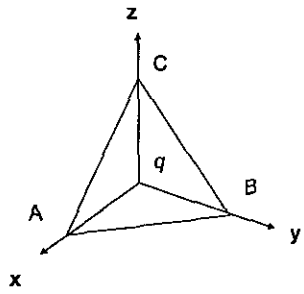
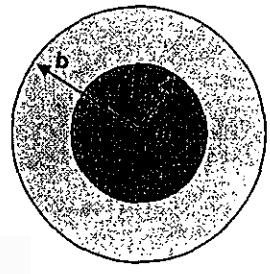
1. A point charge q is situated at the origin of the Cartesian coordinate system as shown in the figure. The coordinates of the relevant points are A(1,0,0), B(0,1,0) and C(0,0,1), respectively.

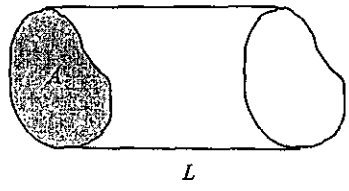


   (a) Calculate the flux of the electric field due to the charge q through the triangular surface ABC.
   (b) Calculate the line integral of the electric field due to the charge q along the line segment AB.

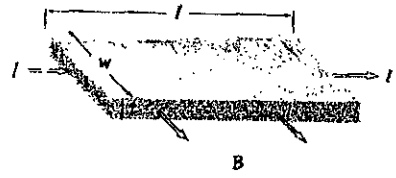
2. A metal sphere of radius a carrying a charge Q is surrounded, out to radius b, by a linear dielectric material with permittivity ε (see the figure). Find the electric potential at the center (relative to infinity).



3. Consider a cylindrical resistor of cross-sectional area A and length L which is made from material with conductivity σ, cf. the following figure. If the potential is kept constant over each end, and the difference between the ends is V. Please
   (a) Show that the electrical field within the body is uniform.
   (b) Determine the current in terms of the variables, A, L, σ, V.
   (c) Determine the resistance of the wire.



4. Describe the following phenomenon and explain the physical reason.
   (a) Faraday cage, a sensitive apparatus being placed inside a grounded solid conductor.
   (b) Eddy current effect, taking a chunk of aluminum and shaking it around in a nonuniform magnetic field.
   (c) Jumping ring demonstration, winding a solenoidal coil around an iron core and placing a metal ring on top, then plugging it in.
   (d) Hall effect, using the device shown below (a current I flowing to the right through a rectangular bar of conducting material in the presence of a uniform magnetic field B pointing out of the page) to determine the sign of the mobile charge carriers.



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