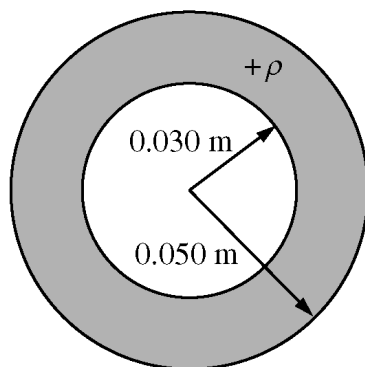




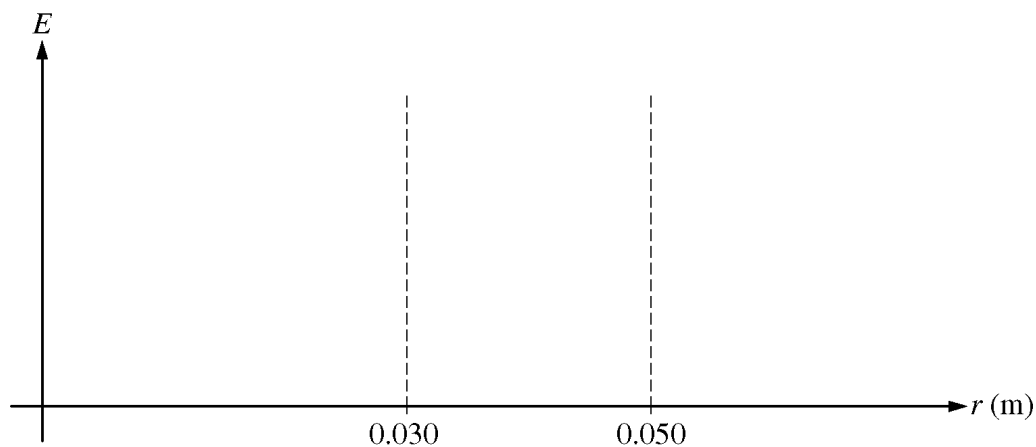
2. A nonconducting hollow sphere of inner radius 0.030 m and outer radius 0.050 m carries a positive volume charge density ρ , as shown in the figure above. The charge density ρ of the sphere is given as a function of the distance r from the center of the sphere, in meters, by the following.

$$r < 0.030 \text{ m: } \rho = 0$$

$$0.030 \text{ m} < r < 0.050 \text{ m: } \rho = b/r, \text{ where } b = 1.6 \times 10^{-6} \text{ C/m}^2$$

$$r > 0.050 \text{ m: } \rho = 0$$

- (a) Calculate the total charge of the sphere.
- (b) Using Gauss's law, calculate the magnitude of the electric field E at the outer surface of the sphere.
- (c) On the axes below, sketch the magnitude of the electric field E as a function of distance r from the center of the sphere.



- (d) Calculate the electric potential V at the outer surface of the sphere. Assume the electric potential to be zero at infinity.
- (e) A proton is released from rest at the outer surface of the sphere at time $t = 0$ s.
 - i. Calculate the magnitude of the initial acceleration of the proton.
 - ii. Calculate the speed of the proton after a long time.