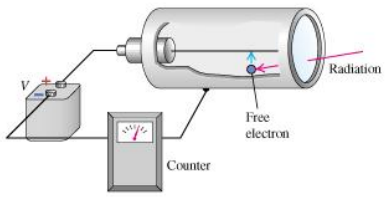
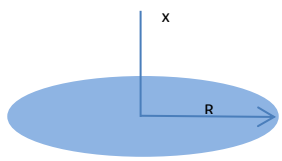
Fields 23.1

A Geiger counter detects radiation such as alpha particles by using the fact that the radiation ionizes the air along its path. A thin wire lies on the axis of a hollow metal cylinder and is insulated from it (see figure below) . A large potential difference is established between the wire and the outer cylinder, with the wire at higher potential; this sets up a strong electric field directed radially outward. When ionizing radiation enters the device, it ionizes a few air molecules. The free electrons produced are accelerated by the electric field toward the wire and, on the way there, ionize many more air molecules. Thus a current pulse is produced that can be detected by appropriate electronic circuitry and converted to an audible "click." Suppose the radius of the central wire is 145μm and the radius of the hollow cylinder is 1.80 cm. What potential difference between the wire and the cylinder produces an electric field of 2 x 10^4 V/m at a distance of 1.20 cm from the axis of the wire? (Assume that the wire and cylinder are both very long in comparison to their radii.)



Fields 23.2

A disk with radius R has uniform surface charge density σ. By regarding the disk as a series of thin concentric rings, calculate the electric potential V at a point on the disk's axis a distance x from the center of the disk. Assume that the potential is zero at infinity. Calculate $-\partial V / \partial x$.



Fields 23.3

Two plastic spheres, each carrying charge uniformly distributed throughout its interior, are initially placed in contact and then released. One sphere has a diameter of 59.0 cm, a mass of m_1 = 53.0 g, and contains -10.0 μC of charge. The other sphere has a diameter of 45.0 cm, a mass of m_2 = 160.0 g and contains -34.0 μC of charge. Assume that no other forces are acting on them. Find the maximum acceleration and speed achieved by each sphere.