51. (II) How does the energy stored in a capacitor change if (*a*) the potential difference is doubled, and (*b*) the charge on each plate is doubled, as the capacitor remains connected to a battery?

52. (III) A 2.70-μF capacitor is charged by a 12.0-V battery. It is disconnected from the battery and then connected to an uncharged 4.00-μF capacitor (Fig. 17–29). Determine the total stored energy (*a*) before the two capacitors are connected, and (*b*) after they are connected. (*c*) What is the change in energy?

* 17–10 Cathode Ray Tube

* 53. (III) In a given CRT, electrons are accelerated horizontally by 7.0 kV. They then pass through a uniform electric field E for a distance of 2.8 cm, which deflects them upward so they reach the screen top 22 cm away, 11 cm above the center. Estimate the value of E.

* 54. (III) Electrons are accelerated by 6.0 kV in a CRT. The screen is 30 cm wide and is 34 cm from the 2.6-cm-long deflection plates. Over what range must the horizontally deflecting electric field vary to sweep the beam fully across the screen?

General Problems

55. An electron starting from rest acquires 6.3 keV of KE in moving from point A to point B. (*a*) How much KE would a proton acquire, starting from rest at B and moving to point A? (*b*) Determine the ratio of their speeds at the end of their respective trajectories.

56. A lightning flash transfers 4.0 C of charge and 4.2 MJ of energy to the Earth. (*a*) Across what potential difference did it travel? (*b*) How much water could this boil and vaporize, starting from room temperature?

57. There is an electric field near the Earth's surface whose magnitude is about 150 V/m. How much energy is stored per cubic meter in this field?

58. In a television picture tube, electrons are accelerated by thousands of volts through a vacuum. If a television set were laid on its back, would electrons be able to move upward against the force of gravity? What potential difference, acting over a distance of 3.0 cm, would be needed to balance the downward force of gravity so that an electron would remain stationary? Assume that the electric field is uniform.

59. A huge 4.0-F capacitor has enough stored energy to heat 2.5 kg of water from 21° C to 95° C. What is the potential difference across the plates?

60. An uncharged capacitor is connected to a 24.0-V battery until it is fully charged, after which it is disconnected from the battery. A slab of paraffin is then inserted between the plates. What will now be the voltage between the plates?

61. Dry air will break down if the electric field exceeds 3.0×10^6 V/m. What amount of charge can be placed on a parallel-plate capacitor if the area of each plate is 56 cm^2?

62. Three charges are at the corners of an equilateral triangle (side L) as shown in Fig. 17–30. Determine the potential at the midpoint of each of the sides.

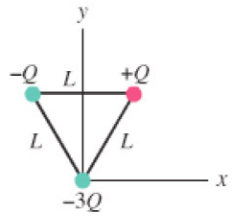

FIGURE 17–30 Problem 62.

63. A 3.4 μC and a −2.6 μC charge are placed 1.6 cm apart. At what points along the line joining them is (*a*) the electric field zero, and (*b*) the electric potential zero?

64. A 2600-pF air-gap capacitor is connected to a 9.0-V battery. If a piece of Pyrex glass is placed between the plates, how much charge will then flow from the battery?

65. An electron is accelerated horizontally from rest in a television picture tube by a potential difference of 5500 V. It then passes between two horizontal plates 6.5 cm long and 1.3 cm apart that have a potential difference of 250 V (Fig. 17–31). At what angle θ will the electron be traveling after it passes between the plates?

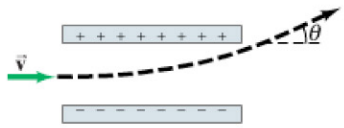

FIGURE 17–31 Problem 65.

66. A capacitor of capacitance C_1 carries a charge Q_0. It is then connected directly to a second, uncharged, capacitor of capacitance C_2, as shown in Fig. 17–32. What charge will each carry now? What will be the potential difference across each?

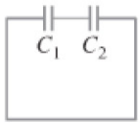

FIGURE 17–32 Problem 66.

67. To get an idea how big a farad is, suppose you want to make a 1-F air-filled parallel-plate capacitor for a circuit you are building. To make it a reasonable size, suppose you limit the plate area to 1.0 cm^2. What would the gap have to be between the plates? Is this practically achievable?

68. Near the surface of the Earth there is an electric field of about 150 V/m which points downward. Two identical balls with mass $m = 0.540$ kg are dropped from a height of 2.00 m, but one of the balls is positively charged with $q_1 = 650\ \mu$C, and the second is negatively charged with $q_2 = -650\ \mu$C. Use conservation of energy to determine the difference in the speed of the two balls when they hit the ground. (Neglect air resistance.)