27. (III) In the Bohr model of the hydrogen atom, an electron orbits a proton (the nucleus) in a circular orbit of radius 0.53×10^{-10} m. (*a*) What is the electric potential at the electron's orbit due to the proton? (*b*) What is the kinetic energy of the electron? (*c*) What is the total energy of the electron in its orbit? (*d*) What is the *ionization energy*—that is, the energy required to remove the electron from the atom and take it to $r = \infty$, at rest? Express the results of parts b, c and d in joules and eV.

* 17–6 Electric Dipoles

* 28. (I) An electron and a proton are 0.53×10^{-10} m apart. What is their dipole moment if they are at rest?

* 29. (II) Calculate the electric potential due to a dipole whose dipole moment is 4.8×10^{-30} C·m at a point 1.1×10^{-9} m away if this point is (*a*) along the axis of the dipole nearer the positive charge; (*b*) 45° above the axis but nearer the positive charge; (*c*) 45° above the axis but nearer the negative charge.

* 30. (III) The dipole moment, considered as a vector, points from the negative to the positive charge. The water molecule, Fig. 17–28, has a dipole moment $\vec{\mathbf{p}}$ which can be considered as the vector sum of the two dipole moments, $\vec{\mathbf{p}}_1$ and $\vec{\mathbf{p}}_2$, as shown. The distance between each H and the O is about 0.96×10^{-10} m. The lines joining the center of the O atom with each H atom make an angle of 104°, as shown, and the net dipole moment has been measured to be $p = 6.1 \times 10^{-30}$ C·m. Determine the charge q on each H atom.

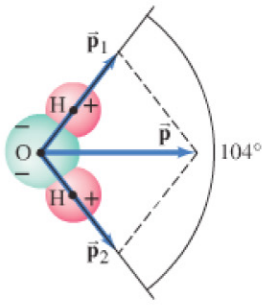

FIGURE 17–28
Problem 30.

17–7 Capacitance

31. (I) The two plates of a capacitor hold $+2500\,\mu$C and $-2500\,\mu$C of charge, respectively, when the potential difference is 850 V. What is the capacitance?

32. (I) A 9500-pF capacitor holds plus and minus charges of 16.5×10^{-8} C. What is the voltage across the capacitor?

33. (I) The potential difference between two short sections of parallel wire in air is 120 V. They carry equal and opposite charge of magnitude 95 pC. What is the capacitance of the two wires?

34. (I) How much charge flows from each terminal of a 12.0-V battery when it is connected to a 7.00-μF capacitor?

35. (I) A 0.20-F capacitor is desired. What area must the plates have if they are to be separated by a 2.2-mm air gap?

36. (II) The charge on a capacitor increases by $18\,\mu$C when the voltage across it increases from 97 V to 121 V. What is the capacitance of the capacitor?

37. (II) An electric field of 8.50×10^5 V/m is desired between two parallel plates, each of area 35.0 cm^2 and separated by 2.45 mm of air. What charge must be on each plate?

38. (II) If a capacitor has opposite $5.2\,\mu$C charges on the plates, and an electric field of 2.0 kV/mm is desired between the plates, what must each plate's area be?

39. (II) How strong is the electric field between the plates of a 0.80-μF air-gap capacitor if they are 2.0 mm apart and each has a charge of $72\,\mu$C?

40. (III) A 7.7-μF capacitor is charged by a 125-V battery (Fig. 17–29a) and then is disconnected from the battery. When this capacitor (C_1) is then connected (Fig. 17–29b) to a second (initially uncharged) capacitor, C_2, the final voltage on each capacitor is 15 V. What is the value of C_2? [*Hint*: charge is conserved.]

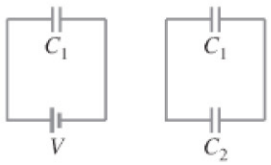

FIGURE 17–29
Problems 40 and 52.

41. (III) A 2.50-μF capacitor is charged to 857 V and a 6.80-μF capacitor is charged to 652 V. These capacitors are then disconnected from their batteries. Next the positive plates are connected to each other and the negative plates are connected to each other. What will be the potential difference across each and the charge on each? [*Hint*: charge is conserved.]

17–8 Dielectrics

42. (I) What is the capacitance of two square parallel plates 5.5 cm on a side that are separated by 1.8 mm of paraffin?

43. (I) What is the capacitance of a pair of circular plates with a radius of 5.0 cm separated by 3.2 mm of mica?

44. (II) A 3500-pF air-gap capacitor is connected to a 22-V battery. If a piece of mica is placed between the plates, how much charge will flow from the battery?

* 45. (II) The electric field between the plates of a paper-separated $(K = 3.75)$ capacitor is 8.24×10^4 V/m. The plates are 1.95 mm apart, and the charge on each plate is $0.775\,\mu$C. Determine the capacitance of this capacitor and the area of each plate.

17–9 Electric Energy Storage

46. (I) 650 V is applied to a 2200-pF capacitor. How much energy is stored?

47. (I) A cardiac defibrillator is used to shock a heart that is beating erratically. A capacitor in this device is charged to 5.0 kV and stores 1200 J of energy. What is its capacitance?

48. (II) How much energy is stored by the electric field between two square plates, 8.0 cm on a side, separated by a 1.5-mm air gap? The charges on the plates are equal and opposite and of magnitude $420\,\mu$C.

49. (II) A homemade capacitor is assembled by placing two 9-in. pie pans 5 cm apart and connecting them to the opposite terminals of a 9-V battery. Estimate (*a*) the capacitance, (*b*) the charge on each plate, (*c*) the electric field halfway between the plates, and (*d*) the work done by the battery to charge the plates. (*e*) Which of the above values change if a dielectric is inserted?

50. (II) A parallel-plate capacitor has fixed charges $+Q$ and $-Q$. The separation of the plates is then doubled. (*a*) By what factor does the energy stored in the electric field change? (*b*) How much work must be done in doubling the plate separation from d to $2d$? The area of each plate is A.