Problems for Computer Sciences major students

1. Electric field

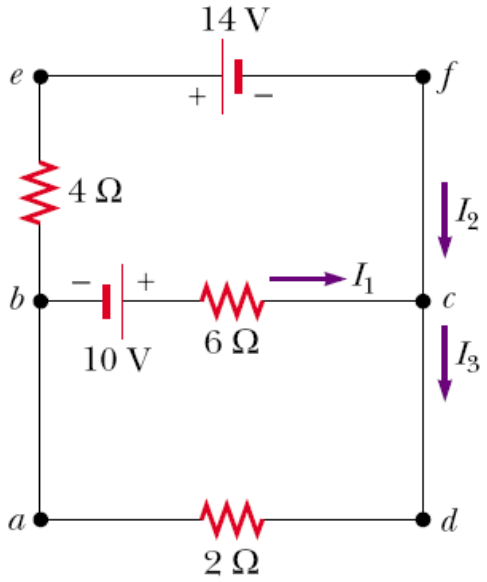
1.1 A charge q_1=7.0·10^{-6} C is located at the origin, and a second charge q_2=-5.0×10^{-6} C is located on the x axis, 0.30 m from the origin. Find the electric field at the point P, which has coordinates (0, 0.40) m.

1.2 Two identical small charged spheres, each having a mass of 3.0 × 10-2 kg, hang in equilibrium on two strings of equal lengths, suspended at the same point. The length of each string is 0.15 m, and the angle is 5.0°. Find the magnitude of the charge on each sphere.

1.3 Two capacitors C_1 =5.0×10^{-6} F and C_2 =12.0×10^{-6} F are connected in parallel, and the resulting combination is connected to a 9.00-V battery. (a) What is the value of the equivalent capacitance of the combination? What are (b) the potential difference across each capacitor, (c) the charge stored on each capacitor and (d) the energy stored in each capacitor? Consider the case when the capacitors are connected in series and to a 9.00-V battery.

2. Direct current laws

2.1 One lightbulb is marked “25 W 120 V,” and another “100 W 120 V”; this means that each bulb converts its respective power when plugged into a constant 120-V potential difference. (a) Find the

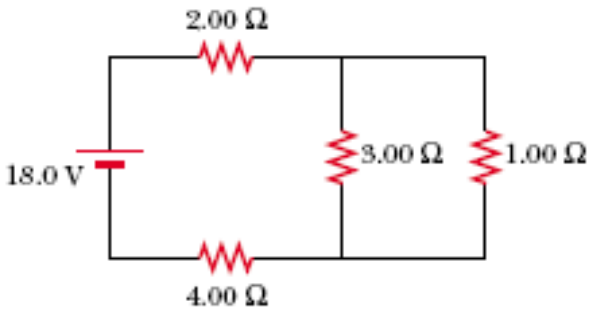


resistance of each bulb. (b) How long does it take for 1.00 C to pass through the dim bulb? (c) How long does it take for 1.00 J to pass through the dim bulb?

2.2 Find the currents I_1 , I_2 , and I_3 in the circuit shown in Figure.

2.3 A 500-W heating coil designed to operate from 110 V is made of Nichrome wire 0.500 mm in diameter. (a) Assuming that the resistivity of the Nichrome remains constant at its 20.0°C value, find the length of wire used. (b) Now consider the variation of resistivity with temperature. What power does the coil of part (a) actually deliver when it is heated to 1 200°C? Resistivity of Nichrome equals 1.5×10^{-6} Ω·m, temperature coefficient is 0.4×10^{-3} K^{-1}.

2.4 Calculate the power delivered to each resistor in the circuit shown in Figure



3. Magnetic field.

3.1 A proton is moving in a circular orbit of radius 14 cm in a uniform 0.35-T magnetic field perpendicular to the velocity of the proton. Find the linear speed of the proton.

3.2 A wire 2.80 m in length carries a current of 5.00 A in a region where a uniform magnetic field has a magnitude of 0.390 T. Calculate the magnitude of the magnetic

force on the wire if the angle between the magnetic field and the current is (a) 60.0°, (b) 90.0°, (c) 120°.

3.3 A conductor consists of a circular loop of radius R = 0.1 m and two straight, long sections, as shown in Figure. The wire lies in the plane of the paper and carries a current of I = 7.00 A. Determine the magnitude and direction of the magnetic field at the center of the loop.