#### ELECTRIC CHARGE, FORCE, AND FIELD

#### EXERCISES

#### Section 20.1 Electric Charge

 INTERPRET We'll estimate the charge your body would carry if the electron charge slightly differed from the proton charge.

DEVELOP—Since the human body is about 60% water, let's assume that the number of protons/electrons per kilogram in your body is the same as that of a water molecule. Water is 2 by drogen atoms (with one proton and one electron each) and one oxygen atom (with 8 protons and 8 electrons). If the charges on the electrons and protons are different by one part in a billion, then the net charge on a water molecule would be

$$|\Delta q| = 10|q_{\text{min}} - q_{\text{domin}}| = 10(10^{-9} c) = 10(1.60 \times 10^{-26} C) = 1.60 \times 10^{-27} C$$

The mass of a water molecule is the mass of two hydrogens and one oxygen:  $\frac{1u + 1u + 16u}{1u + 16u} = 18u$ , where  $1u = 1.66 \times 10^{-6}$  kg. Therefore, the net charge to mass ratio for a water molecule would be:

$$\left[\frac{|\Delta q|}{m}\right]_{n_{c0}} = \frac{1.60 \times 10^{-17} \text{ C}}{18(1.66 \times 10^{-27} \text{ kg})} = 0.05 \text{ C/kg}$$

EVALUATE We'll assume your mass is 65 kg. If we approximate this mass as pure water, then the total charge on your body would be approximately

$$|\Delta q| \sim m \left[ \frac{|\Delta q|}{m} \right]_{z_{c} = (65 \text{ kg})(0.05 \text{ C/kg}) \approx 3 \text{ C}$$

Assess This is a huge amount of charge. Imagine half of the charge was in your head/chest and the other half was in your legs, about a meter away. Then the magnitude of the force of repulsion between the upper and lower parts of your body would be

$$F_{c1} = \frac{kq_1q_2}{r^2} = \frac{(9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)(\frac{1}{7}3 \text{ C})^2}{(1 \text{ m})^2} = 2 \times 10^{50} \text{ N}$$

This would rip you apart!

 INTERPRET This problem deals with quantity of charge in a typical lightning flash. We want to express the quantity in terms of the elementary charge e.

DEVELOP. Since the magnitude of elementary charge e is  $e = 1.6 \times 10^{-6}$  C, the number N of electrons involved in the lightening flash is given by N = Q/e.

EVALUATE. Substituting the values given in the problem statement, we find

$$N = Q\%c = \frac{25 \text{ C}}{1.6 \times 10^{-19} \text{ C}} = 1.6 \times 10^{50}$$

ASSESS Since I coulomb is about 6.35 = 10<sup>10</sup> elementary charges, our result has the right order of magnitude.

Interpret This problem asks us to find the combination of w and d quarks needed to make a proton, which has a
positive unit change v, and a neutron, which has zero change.

# **Section 20 Electric Charge Study Guide Answers**

**David D. Reid** 

# **Section 20 Electric Charge Study Guide Answers:**

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