Problem 23.4

This is a bit of a funky problem in the sense that to have 1% more electrons than protons on one's body, you need to know how many protons you started out with. This is the same as the number of atoms. If we assume the body is mostly water and an individual body weight of 70.0 kg, we can write:

$$N(\text{protons}) = \left(\frac{\#\ \text{protons}}{\text{molecule}}\right)\left(\frac{\#\ \text{molecules}}{\text{mole}}\right)\left(\frac{\text{mass}}{H_2O\text{'s mass/mole}}\right)$$

$$= \left(\frac{10\ \text{protons}}{\text{molecule}}\right)\left(\frac{6.02\text{x}10^{23}\ \text{molecules}}{\text{mole}}\right)\left(\frac{70{,}000\ \text{grams}}{18\ \text{grams/mole}}\right)$$

$$= 2.34\text{x}10^{28}\ \text{protons}$$

1% of this is $2.34\text{x}10^{26}$ electrons. With $1.6\text{x}10^{-19}$ coulombs of charge on each electron and q_p being the charge on each person, the force between the two people will be:

Electrical force between the people:

$$F = k\frac{q_p q_p}{r^2} = k\frac{[q_p]^2}{r^2}$$

$$= \left(9\text{x}10^9\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{\left[\left(2.34\text{x}10^{26}\ e^-\right)\left(1.6\text{x}10^{-19}\ \text{C}/e^-\right)\right]^2}{(0.60\ \text{m})^2}$$

$$= 3.50\text{x}10^{25}\ \text{N}$$

Weight of the earth:

$$F_{earth} = mg$$

$$= \left(6\text{x}10^{24}\ \text{kg}\right)\left(9.8\ \text{m/s}^2\right)$$

$$= 5.88\text{x}10^{25}\ \text{N}$$

Conclusion: The electrical force is almost big enough to lift the earth.