Electric Charge

1. A lightning bolt has a charge of 20 C. Howmany electrons make up the bolt?

$20 = n(1.602\times10^{-19})$ $\quad n = 1.2\times10^{20}$

2. An electroscope has a charge of 1.2 μC. How many electrons pass through your fingers as you ground this electroscope?

$1.2\times10^{-6} = n(1.602\times10^{-19})$ $\quad n = 7.5\times10^{12}$

3. A charged rod has an excess of 6.4×10^{8} electrons which it shares equally with a pith ball when they touch. What is the charge on the pith ball?

$Q = 3.2\times10^{8}(1.602\times10^{-19}) = 51\times10^{-11}\ C$

4. Calculate the electrostatic force between a proton and an electron which are 1×10^{-10} m apart.

$$F = \frac{(9\times10^{9})(1.602\times10^{-19})(-1.602\times10^{-19})}{(1\times10^{-10})^{2}} = 2.3\times10^{-8}\ N$$

5. A pith ball with a charge of +6.0 μC is placed 12 cm from another ball with a charge of -4.3 μC.

a) Which ball has an excess of electrons? $-4.3\mu C$

i) How many electrons in excess does it have?

$4.3\times10^{-6} = n(1.602\times10^{-19})$ $\quad n = 2.7\times10^{13}$

b) Which ball has a deficit of electrons? $6.0\mu C$

ii) How many electrons in deficit does it have?

$6.0\times10^{-6} = n(1.602\times10^{-19})$ $\quad n = 3.7\times10^{13}$

c) What is the force acting between the two balls?

$$F = \frac{(9\times10^{9})(4.3\times10^{-6})(6.0\times10^{-6})}{(.12)^{2}} = 16\ N$$

d) Is the force attractive or repulsive?

6. A charge of 17.0 μC is placed 15.0 cm from a second charge. The force of attraction between the two is 21.4 N. Caclculate the second charge.

$$21.4 = \frac{(9\times10^{9})(17\times10^{-6})Q_2}{(.15)^{2}} \qquad Q_2 = 3.15\times10^{-6}\ C$$

7. a) Calculate the electric force holding an electron in orbit ($r = 0.53 \times 10^{-10}$ m) around a proton.

$$F = \frac{(9.0\times10^{9})(1.602\times10^{-19})(1.602\times10^{-19})}{(.53\times10^{-10})^{2}} = 8.2\times10^{-8}\ N$$

b) Calculate the gravitational force between the same proton and electron.
(mass of electron = 9.11×10^{-31} kg and mass of proton = 1.67×10^{-27} kg)

$$F_G = \frac{(6.67\times10^{-11})(9.11\times10^{-31})(1.67\times10^{-27})}{(.53\times10^{-10})^{2}} = 3.6\times10^{-47}\ N$$

c) Which force is more significant within the atom, electrostatic or gravitational?

8. How many electrons make up a charge of 30.0 μC?

$30 \times 10^{-6} = n\,(1.602 \times 10^{-19})$ $n = 1.9 \times 10^{14}$

9. Two charged smoke particles exert a force of 0.042 N on each other. What will the force if they are moved so they are only half as far apart?

4x greater

.168 N

10. What is the magnitude of the electric force of attraction between an iron nucleus (26 protons) and its innermost electron if the distance between them is 1.5×10^{-12} m?

$$F = \frac{(9 \times 10^{9})(26)(1.602 \times 10^{-19})^{2}}{(1.5 \times 10^{-12})^{2}} = .0027N$$

11. A person scuffing her feet on a wool rug on a dry day accumulates a net charge of -60 μC. How many excess electrons does this person get, and by how much does her mass increase?

$60 \times 10^{-6} = n\,(1.602 \times 10^{-19})$

$$3.75 \times 10^{14}\,e \times \frac{9.11 \times 10^{-31}\,kg}{1\,e} = 3.4 \times 10^{-16}\,kg$$