Consider two identical conducting spheres, one carrying charge $+q$ and the other carrying charge $+3q$, that are initially held a distance d apart. The spheres are allowed to touch briefly and then returned to separation distance d. Is the magnitude of the force they exert on each other after touching greater than, less than, or the same as the magnitude of the force they exerted on each other before touching?

Since the spheres are made of a conducting material, electric charges can move throughout them freely. When the spheres are brought into contact with each other, the charges will move to try to reduce the amount of net charge on each sphere. Basically, everything wants to be neutral or as close to neutral as it can be. When the spheres are touching, they will have the same amount of charge due to the charges spreading out evenly. But since the total amount of charge remains constant (it's not like charged particles are jumping off the spheres -- air is an insulator so there needs to be much more excess charge for this to happen), each sphere will have $+2q$. The total net charge of the system is:

$$q_{net} = (+q) + (+3q) = +4q$$

which distributes evenly over each sphere.

Now we can compare the forces. Initially, the force between the charged spheres was:

$$F_i = \frac{k(q)(3q)}{d^2}$$

and after they touch and are separated back to the original separation distance (d) the force is:

$$F_f = \frac{k(2q)(2q)}{d^2}$$

When you look at these two expressions for the force before (F_i) and after (F_f) touching the spheres, the only difference is in the numerator, so that is all we need to look at when we compare the forces.

Before: $q \times 3q = 3q^2$

After: $2q \times 2q = 4q^2$ $\longrightarrow$ force after touching > force before touching

You might recall from PHYS 1111 Newton's law of gravitation:

$$F_g = G\frac{m_1 m_2}{r^2}$$

which looks a lot like Coulomb's law, except that the interaction is between objects with mass rather than electric charge. If you consider the hydrogen atom, it is made of a proton (the nucleus) and an electron, that are bound together with the electric force. But the proton and electron both have mass, too. So there should be a gravitational attraction between them. I want you to compare these two forces: electrical and gravitational. You will need to look up some data, like the masses of the particles and the constants. Which force is bigger and by what factor?

Compare the magnitudes of the gravitational and electric forces exerted by the nucleus of a hydrogen atom on an electron when the two particles are 0.50 x 10^{-10} m apart.

The gravitation force is $F_g = \frac{G m_1 m_2}{r^2}$ and the electric force is $F_e = \frac{k q_1 q_2}{r^2}$.

We can write a ratio of the two forces to compare them:

$$\frac{F_e}{F_g} = \frac{\frac{k q_1 q_2}{r^2}}{\frac{G m_1 m_2}{r^2}}$$

We can cancel the distance (r) between the charges because this is a constant value in each force calculation. This gives us a force ratio of:

$$\frac{F_e}{F_g} = \frac{k q_1 q_2}{G m_1 m_2} = \frac{(9\times10^{9}\frac{N\cdot m^2}{C^2})(1.6\times10^{-19}C)(1.6\times10^{-19}C)}{(6.67\times10^{-11}\frac{N\cdot m^2}{kg^2})(9.11\times10^{-31}kg)(1.67\times10^{-27}kg)} = 2.27\times10^{39}$$

This means that the electric force between the electron and proton in hydrogen is 10^{39} times stronger than the gravitational force between the particles.