Worked examples – Coulomb's law HW

Data required:

$k = 1/(4\pi\varepsilon_0) = 9.0 \times 10^9$ N m^2 C^{-2}

mass of an electron = 9.11×10^{-31} kg

mass of a proton = 1.67×10^{-27} kg

G = 6.67×10^{-11} N m^2 kg^{-2}

1. What is the force of repulsion between two electrons held one metre apart in a vacuum? What is the gravitational force of attraction between them? By what factor is the electric repulsion greater than the gravitational attraction?

2. By what factor is the electric force between two protons greater than the gravitational force between them?

3. Given the difference in magnitudes of gravitational and electrical forces you've just discovered, why do you feel gravitational attraction from the earth, but no electrical forces?

4. Human beings are electrically neutral objects to a high degree of accuracy. In this question you will estimate the force that would exist between 2 students standing one metre apart if they had just 1% of the electrons in their body somehow removed, leaving them both positively charged. Take the mass of each student to be 60 kg, and as a rough estimate, assume that humans are 100% water. The molar mass of H_2O (the mass of 6.02×10^{23} molecules) is 18 g.

   How many water molecules do the students contain?

   How many electrons are there in a water molecule?

   How many electrons are there in total in each student?

   Taking 1% of these away will leave each student with a net positive charge equal to the charge of 1% of their electrons. What is this value?

   Now calculate the force between the two students, if they are standing 1 metre apart, and comment.