Question. Compare the electrostatic and gravity force between a proton of charge $+e$ and of mass M at a distance r from an electron of charge $-e$ of mass m, take the proton to be 1840 times heavier than the electron. Evaluate their relative magnitude i.e the ratio of the electrostatic force of attraction to the gravitational force of attraction.

Solution.

The electrostatic force between a proton and an electron

$$F_e = \frac{1}{4\pi\varepsilon_0} \frac{|+e| \cdot |-e|}{r^2} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r^2}.$$

The gravity force between a proton and an electron

$$F_g = G \frac{m \cdot M}{r^2} = G \frac{m \cdot 1840 \cdot m}{r^2} = G \frac{1840 \cdot m^2}{r^2}.$$

So

$$\frac{F_e}{F_g} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r^2} : G \frac{1840 \cdot m^2}{r^2} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r^2} \cdot \frac{r^2}{G \cdot 1840 \cdot m^2} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{G \cdot 1840 \cdot m^2} =$$

$$= 9 \cdot 10^9 \cdot \frac{(1.6 \cdot 10^{-19})^2}{6.67 \cdot 10^{-11} \cdot 1840 \cdot (9.1 \cdot 10^{-31})^2} = 2.3 \cdot 10^{39}.$$

Answer. $\frac{F_e}{F_g} = 2.3 \cdot 10^{39}$.