Estimating charges and forces

This is an estimation problem. You probably won't use exactly the same technique or make exactly the same approximations that I made, so your numerical answer won't be exactly the same as mine. But it should be close!

What is the positive charge on 100 pounds of water?

100 pounds of water

$\Longrightarrow$	50 pounds of protons	[[about half the weight is protons, half neutrons]]
$\Longrightarrow$	25 kg of protons	[[for our purposes 2 lb/kg is close enough to 2.205 lb/kg]]
$\Longrightarrow$	1.5×10^{28} protons	[[mass of a proton is 1.67×10^{-27} kg]]
$\Longrightarrow$	charge on protons is 25×10^8 C	[[charge on a proton is 1.60×10^{-19} C]]

Hence

charge on protons in Veronica $\approx 25 \times 10^8$ C	0.01% excess $\approx 25 \times 10^4$ C
charge on protons in Ivan $\approx 50 \times 10^8$ C	0.01% excess $\approx 50 \times 10^4$ C

Force at 100 ft $\approx$ 30 m is

$$(9 \times 10^9 \text{ Nm}^2/\text{C}^2)\frac{(25 \times 10^4 \text{ C})(50 \times 10^4 \text{ C})}{(30 \text{ m})^2} \approx 1.2 \times 10^{18} \text{ N}.$$

Wow! This is, of course, a huge force. If Ivan and Veronica really were attracted to each other with a force like this, they would be pulled toward each other and both would die in the resulting crash. The moral of the story is that Ivan and Veronica do *not* suffer charge excesses of 0.01% ... real life charge excesses are much smaller than this.

In everyday life rarely know about our encounters with electrostatics: perhaps when we get a shock after walking across a carpet and then reaching for a door knob. This is not because the electrostatic force is so weak ... it's because the electrostatic force is so strong that positive and negative forces rarely separate.

Grading: There are many ways to execute this problem and any way, done correctly, earns full credit. Your solution must have some estimate for charge (5 points) and, from that estimate, some use of Coulomb's law (5 points).