Coulomb Force

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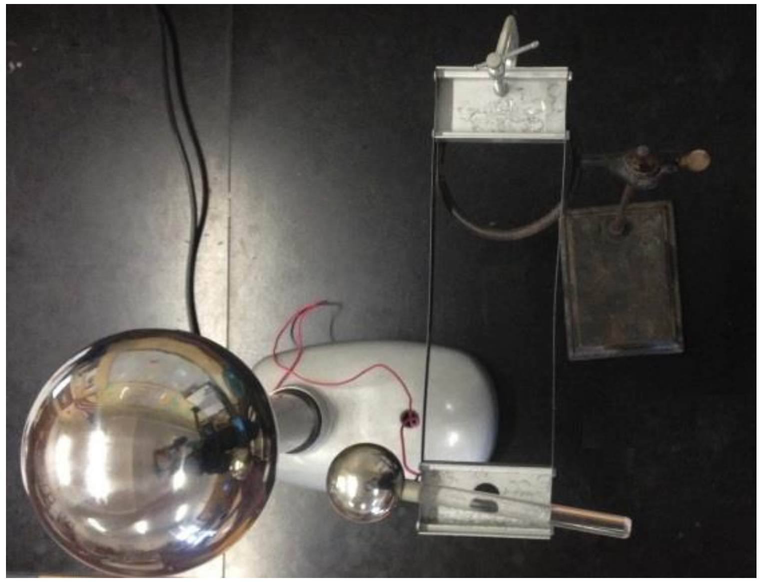
Apparatus



A Van de Graaff generator is set up with the negative electrode attached to the pan of an inertial balance. The inertial balance is secured to a ring stand and is positioned so that it can oscillate toward and away from the positive electrode of the Van de Graaff generator, as shown:

Qualitative Demonstration

As charge builds up on the Van de Graaff generator, the Coulomb force causes the negative electrode to be attracted to the positive electrode. The force causes a displacement in the spring of the inertial balance, and the negative electrode moves toward the positive electrode.

Each time the Van de Graaff generator discharges, the reduction in charge on the electrodes causes a decrease in the Coulomb force, and the spring of the inertial balance pulls the pan away from the positive electrode, causing the inertial balance to oscillate.

Quantitative Demonstration

Students first perform a separate experiment to determine the spring constant for the inertial balance.

A paper ruler is taped to the negative electrode, such that it can be used to measure the distance between the two electrodes. The equilibrium position is measured with the Van de Graaff generator powered off. The Van de Graaff generator is then powered on, and the smallest distance between the electrodes (immediately before discharge) is recorded. The force is determined using $F_s = k_s x$ and the charge is then determined using $F_s = F_e = \frac{k_e q_1 q_2}{r^2}$, assuming $q_1 = q_2$. (*Note*: students may be confused by the use of k to represent both the spring constant in the spring equation and the electrostatic constant in Coulomb's equation. The constants are represented here as k_s and k_e respectively.)