An Apparatus for the Study of 
Electrostatic Forces Between 
Charged Parallel Plates

A. Tomasch and A. Chang
University of Michigan Department of Physics

Abstract:
We describe a simple apparatus to quantitatively demonstrate 
the forces produced by the electrostatic attraction of charged 
parallel plates. The apparatus is based on an inexpensive digital 
scale with a least count of 0.01 gram, sufficiently sensitive to 
measure the force produced on one of two circular parallel 
plates with a 5 cm radius, and an inexpensive digital caliper, 
which measures the plate separation with a least-count 
resolution of 10 μm. The apparatus demonstrates the 
dependence of the electrostatic force on the potential between 
the plates ($\propto V^2$) and the distance of separation between the 
plates ($\propto d^{-2}$). Students can derive the force acting on the plate 
as a function of the potential difference between the plates and 
the plate separation by using Gauss’ Law to relate the plate 
surface charge density to the electric field between the plates 
and then applying the definitions of the electric field and 
electrostatic potential. By measuring the electrostatic force for 
a known potential difference and plate separation, $\varepsilon_0$ can be 
determined to within $\leq 5\%$ of the accepted value.

Description
This is a simple apparatus to construct. A small table is 
constructed from sheet plastic and cylindrical plastic support 
legs. Two banana binding posts are mounted to the side of this 
small support table. One plate rests on the pan of the digital 
scale supported by a lightweight foam pedestal. The second 
plate is supported by the movable jaw of the digital caliper 
which is mounted to the support table on a plastic support 
pylon. A mechanical stop attached to the caliper support
permits the top plate to rest with zero-gap and zero-load on the bottom plate. The inter-plate gap can then be set to a resolution of 10 μm by sliding the caliper jaw vertically. A fine copper wire lead, attached with conductive copper tape, connects the bottom plate to the positive binding post. The upper plate is connected to the negative binding post with wire and a ring lug. A special low-current high-voltage power supply maintains a fixed potential (0-6 kV) between the plates. A photo of the apparatus appears below: