Experiment 14: Electric Fields and Potentials

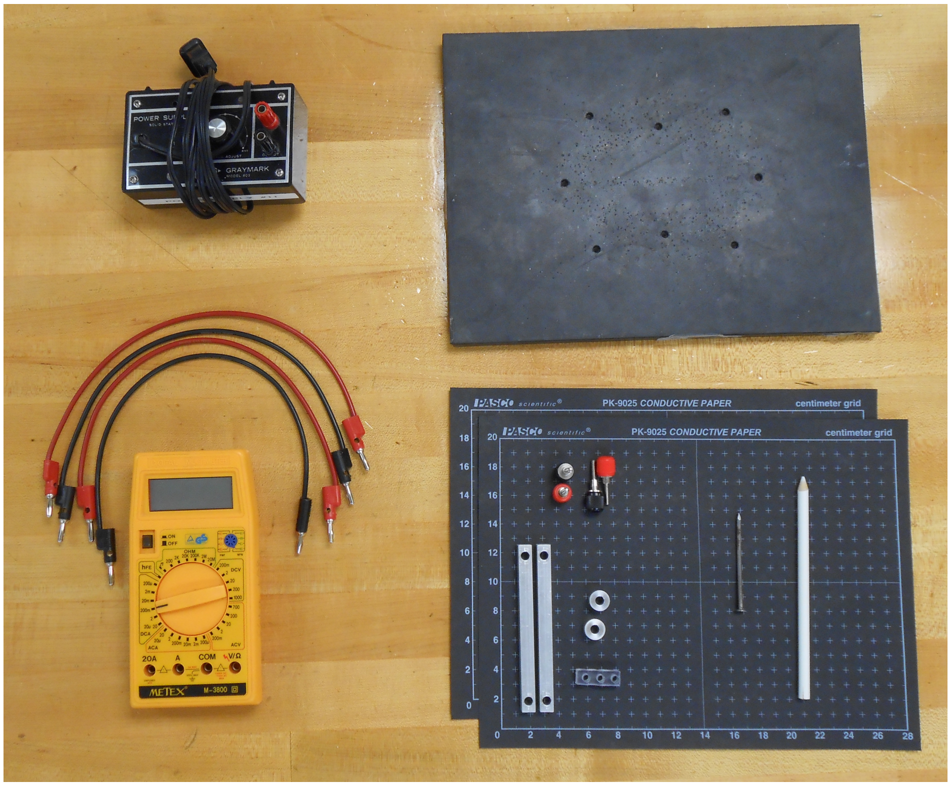

Figure 14.1: Electric Fields and Potentials

Power Supply: Always connect the red lead to the red post and the black lead to the black post. Turn the power supply off and get a TA to check the circuit prior to plugging in the power supply.

Digital Multi-Meter (DMM) as a Voltmeter: Connect the red lead to the V/Ω jack and the black lead to the COM jack. Turn the dial to 20V DCV and turn on. You will need to adjust the voltmeter scale (turn the dial) as you perform experiment. Adjust the scale so that you obtain the most significant figures possible without incurring an overflow symbol ("1.").

EQUIPMENT

Conductive/Resistive Paper (2)
Electric Fields Circuit Board
(2) Point Charge Connectors
(2) Parallel Plate Connectors
(4) Posts (2 Red, 2 Black)
Tip Holder
Digital Multi-Meter (DMM)
Power Supply
Grease Pencil (*or* white colored pencil)
(4) Wire Leads

Advance Reading

Text: Electric field, electric potential energy, equipotential, voltage.

Objective

To map equipotential lines and electric field lines of two charge arrangements; to measure the electric field strength of each arrangement.

Theory

Electric potential at a point is defined as the amount of *potential energy per coulomb* of charge placed at that point. Voltage is only defined as a difference in potential between two points. This change in potential, ΔV, is equal to the negative of the work per charge done by the electric force to move a charge from one point to another:

$$\Delta V = V_b - V_a = -W/q \qquad (14.1)$$

An **equipotential surface** is defined as a surface where all points on the surface have the same electric potential. To move a charge around on such a surface requires no work. In two dimensions, the equipotential surfaces are equipotential lines. How close the lines are to each other is an indication of the strength of the corresponding electric field.

An **electric field**, E, at a point is defined as the *force per coulomb* exerted on a charge at the point:

$$\vec{\mathbf{E}} = \vec{\mathbf{F}}/q \qquad (14.2)$$

Electric fields push positive charges toward a lower state of potential energy, or towards a lower equipotential. Thus, electric field lines are always perpendicular to equipotential lines.

Electric field can also be measured by how quickly voltage is changing at that point, in volts/meter. A stronger electric field indicates electric potential is varying more rapidly over a particular distance.

The two conductive patterns we investigate for this experiment, point charges and parallel plates, are on conductive/resistive paper.

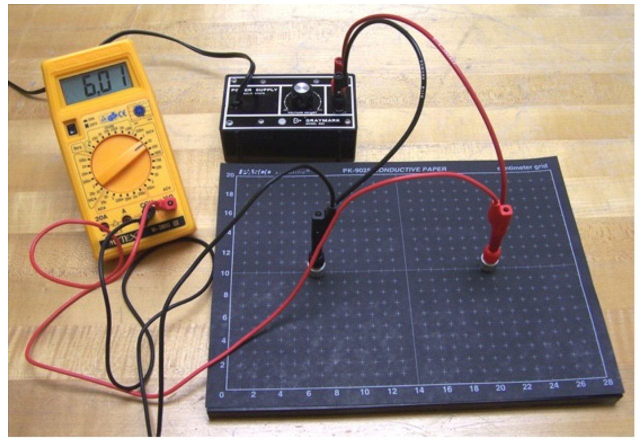

Figure 14.2: Point Charge Arrangement

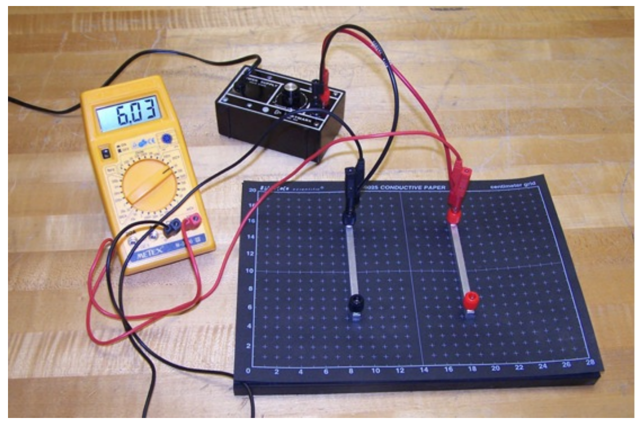

Figure 14.3: Parallel Plate Arrangement

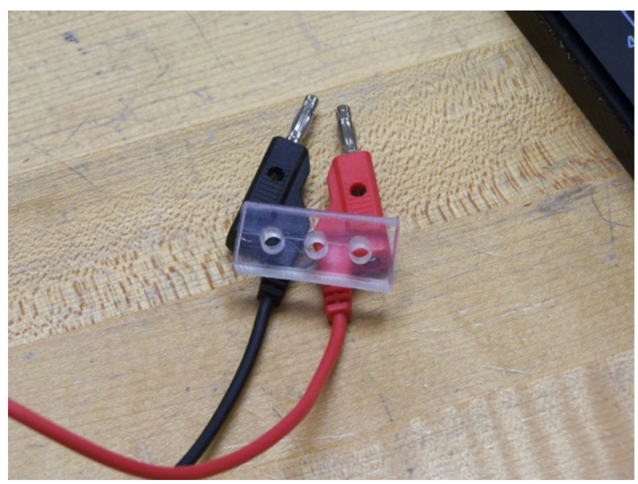

Figure 14.4: Tip Holder

Note the 3 holes for positioning tips of wire leads.