Lab 4
Electrostatic Fields

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Electric Fields

- Two charged bodies exert a force on each other:
  - $F = \frac{kQ_1Q_2}{r^2}$
- This can be described as an electric field from one particle acting on the charge of the other particle:
  - $F_2 = Q_2E_1 \rightarrow E = \underset{Q\rightarrow 0}{Limit}\frac{F}{Q}$
- Work is force times displacement, so the work done by an electric field on a charge is:
  - $W = Q\boldsymbol{E}\cdot\boldsymbol{s}$
- Work is the change in potential energy; Electric potential is potential energy per unit charge:
  - $V \equiv \frac{W}{Q}$

Electric Fields

- An **electric field does no work** to a charge moving **perpendicular** to the field direction
- **Equipotentials** are lines (or curves) that have the same potential
- When a charge moves along an equipotential, **no work is done**
- This means that the **electric field intersects the equipotential perpendicularly**
- Electric field curves should be marked with arrows pointing from high to low potential
- We will measure the electric potential (V) and map out equipotential curves
- We will then map the electric field by drawing smooth curves that intersect the equipotentials perpendicularly

Electric Fields

- The average magnitude of the electric field between potentials is:
  - $E = -\frac{(V_f - V_i)}{d}$
- As the field fans out from a point charge, the magnitude of the electric field decreases. We will verify this

Equipment

- Power supply
- Multi-meter
- Voltage probe
- Conducting sheets with electrode patterns (5 in total)
- Plain white paper with pen for marking equipotentials

Procedure

- Tack a plain piece of paper onto the pen side
- Tack the electrodes with metallic push-pins
- Connect the push-pins to the power supply with alligator clips
- Set the multimeter to DC – 20 volts
- Connect the ground terminal of the supply to the low input of the multi-meter
- Connect the probe to the high (+) input of the multi-meter
- Touch the probe to the push-pin connected to the high (+) output of the power supply and adjust until the meter reads 10.00 V
- Touch the probe to different points on the conducting sheet and note the variation in potential

Procedure

- Check that the electrodes are themselves equipotentials
- Mark the extreme points on the electrodes on the plain paper and sketch the electrode
- Map out several equipotentials and record the potential for each one
- Draw in the field lines including arrows pointing from high->low potential