Mapping the Electric Field-
Visualizing a static E-field with an ac circuit

Objectives: 1. Develop a visual picture of the electric field lines around two charged objects and an uncharged conductor.
    2. Compute an electric field magnitude.
    3. Learn that electric field lines are perpendicular to the lines of equal potential.
    4. Observe that metal conductors and their insides are at a single potential.

Procedures:

A. Set-up
1. Build the circuit shown below on the next page. Apply "charge" by connecting the ac voltage source (the yellow terminals) to the electrodes. Use the brass rectangle and cylinder for the electrodes, and the aluminum ring for an uncharged conductor. Connect the digital multimeter (DMM) in the ac volts mode. One wire (COM) is connected to the rectangular electrode and the other (V) is used as a probe to measure the electrical potential or voltage.
Set the ac voltage source to 16.0 volts. This is the fixed voltage measured between the rectangular and cylindrical electrodes. (An ac voltage is necessary because using a dc voltage drives an electrolysis process that alters the conductivity of the fluid with time.)

2. Avoid a symmetrical arrangement of the electrodes and ring. Also keep these three pieces several inches away from the sides of the box. Fill the box with about a quarter to a half-inch of water. Tap water usually has enough ions and impurities to function as a conductive fluid.

B. Gather data
1. Before you begin measuring potentials, be sure to record the positions of the electrodes and ring. You need these positions to transfer to the drawing and if you would accidentally bump one out of place you could replace it instead of starting the experiment over again from the beginning.

2. Record enough points (6-10) to enable you to sketch each line of equal potential across the entire region. Do this for the potentials of 2 volts, 4 volts, 6 volts, 8 volts, 10 volts, 12 volts, and 14 volts.

3. Record the potential inside the ring. Move the probe around and note the constant potential inside.

C. Make a drawing
1. Locate the conductors on the graph. Although really ac, consider the cylinder to be positively charged.

2. Plot the points for each potential and connect them with a line.

3. Keeping in mind that Electric field lines are perpendicular to the lines of equal potential, sketch in several (6-8) field lines running from one electrode to the other. Show also the direction with arrow heads.

D. Compute the magnitude of the electric field
Use adjacent equal potential lines, find the distance between them, and compute the field. Show on the graph the two points you used.

$$E_{x_{ave}} = -\frac{\Delta V}{\Delta x}$$

DMM (ac Volts)

probe

ac (yellow jacks)
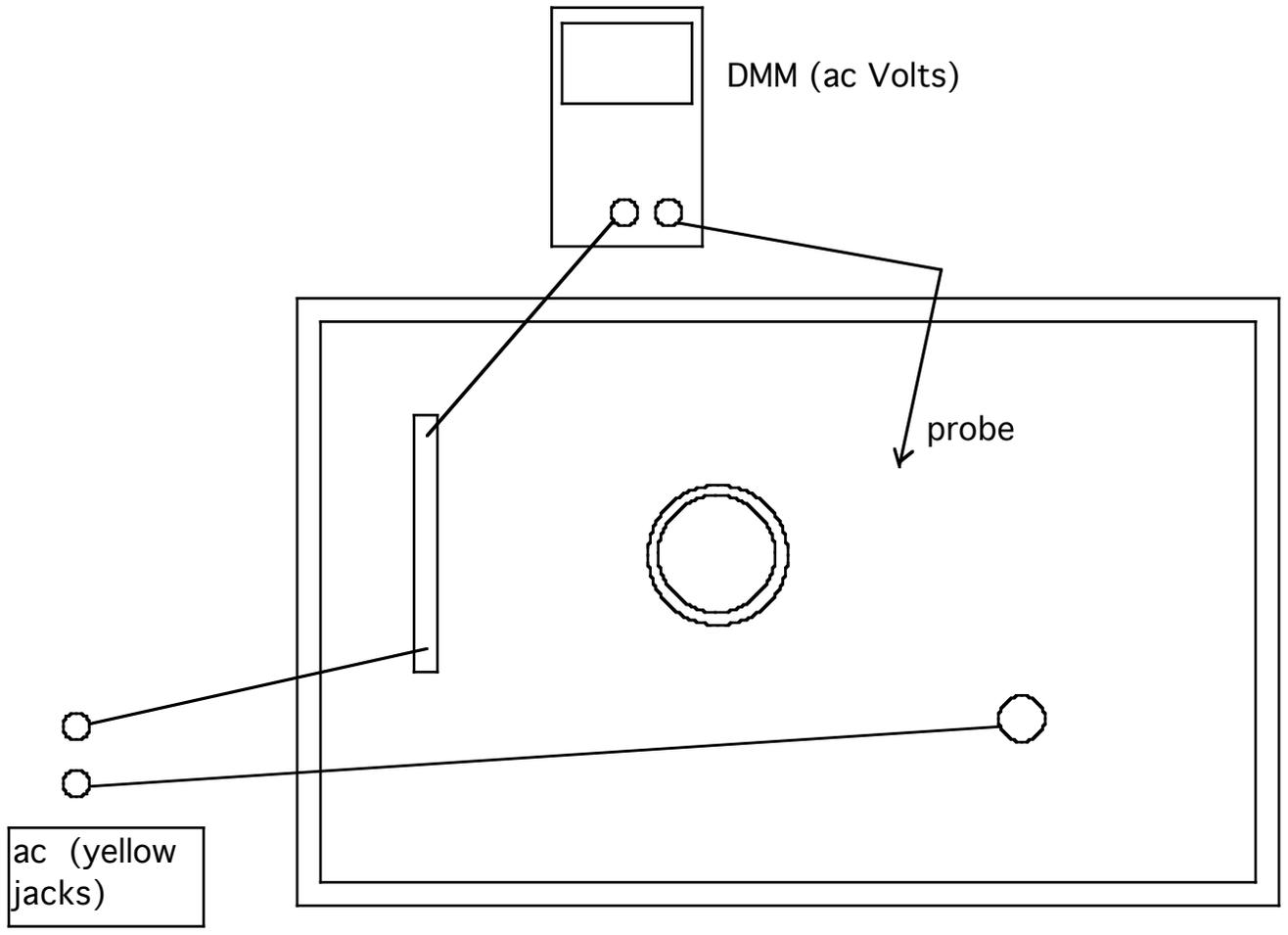
Circuit for electric field plotting