

# Electric field and potential

Physics 225 – Week 7 activity

## LEARNING OBJECTIVES

This lab connects with all five learning objectives:

- Perform basic error analysis/propagation.
- Perform graphical analysis of data, including a variety of functional fits (e.g. linear, parabolic, power law).
- Assemble electrical circuits based on a diagram, using circuit elements, power supplies, and meters.
- Measure and map electric field and electric potential.
- Write a formal lab report.

## BEFORE, DURING, AFTER

1. Before the experiment, read this document and finish the prelab on Blackboard.
2. During the experiment, take notes in your lab notebook.
3. After the experiment, collaborate with your team on the post-lab report.

## RESEARCH QUESTIONS

Here are questions that you will answer using this lab's materials:

- ① How does the electric potential vary with position in a model for a parallel-plate capacitor?
- ② How does the electric potential vary with position inside a model for a coaxial cable?
- ③ How does the electric field vary with position for the model systems in ① and ②?

## RESOURCES

Lab documents:

The equipment for this lab provides two-dimensional models of common electrical systems: a parallel plate capacitor and a coaxial cable. Details about these objects are [here](#):

Parallel-plate capacitor

<https://drive.google.com/open?id=1rtPKxixYZ3mzkQiz1iXgbwsqXEnPTAST>

Coaxial cable

<https://drive.google.com/open?id=1SNwhhU5GkuyMnldzb9q2MQ5imgQodH6m>

Details about electric field and electric potential are in this document:

[https://drive.google.com/open?id=1nAA0llwcSi5J\\_dZIDhGlvT2pmYgih9xh](https://drive.google.com/open?id=1nAA0llwcSi5J_dZIDhGlvT2pmYgih9xh)

Equipment guide for this lab:

<https://drive.google.com/open?id=1aCnRwjwRGX1bi40gsHyYB4Qx8VKXakWI>

Recommended web resources:

Free online textbook - Determining field from potential:

<https://cnx.org/contents/eg-XcBxE@16.7:nBUQxEHv@5/7-4-Determining-Field-from-Potential>

Free online textbook - Equipotential surfaces and conductors:

<https://cnx.org/contents/eg-XcBxE@16.7:GYAoAVIF@7/7-5-Equipotential-Surfaces-and-Conductors>

Video: Equipotential lines from Bozeman science, captioned, 6:10 (Parallel plates discussed around 2:30) <https://www.youtube.com/watch?v=1XI4D4SgHTw>

## EXPLORE QUALITATIVELY

Place the black paper on the metal base (pattern up), then the matching white paper on top (pattern up), and secure with the clamp-down bars. Apply a voltage (use a banana-to-post lead to go from the power supply to the silver paint).

**Use only one sheet of painted black paper at a time.** There should be two on your apparatus, so remove one before testing.

Here is how to measure voltages for this setup:

- Set the multimeter as a voltmeter, and connect its COM to the negative terminal of the power supply.
- Attach the alligator/push-pin to one end of a banana-to-banana lead; put the other lead in the V terminal of the multimeter.
- To measure V at some point, press the pin through the white paper until it makes electrical contact with the black paper.

- If the connection is good, the reading should be stable.

①, ② Map out voltages for each configuration (black paper). Especially look for equipotential lines.

Labeled and captioned images of your equipotentials should be included in your report, and discussed, particularly ③ the qualitative relationship between the electric potential and the electric field.

## EXPLORE QUANTITATIVELY

①, ② Gather data for the electric potential as a function of position for both plate configurations. You don't need to gather a full two-dimensional set of data: focus on symmetry directions where the potential shows significant variation. These data should be tabulated in your notebook. Properly formatted tables and graphs of these data should be included in your report, and discussed.

③ Use your electric potential data to calculate the position dependence of the electric field, for both the parallel-plate capacitor and coaxial cable. Graph these data, and compare with the predicted behavior.

Have your instructor check your lab notebook. Make sure you've collected all appropriate data, and have generated appropriate graphs.

## DELIVERABLES

**As a group**, use the Lab Work Submission form to finish the post-lab activity. Save your work as a PDF file, and then submit it on Blackboard.