PHYS 2020: College Physics
Manic Monday #1

"One does not, by knowing all the physical laws as we know them today, immediately obtain an understanding of anything much."
∼Richard Feynman

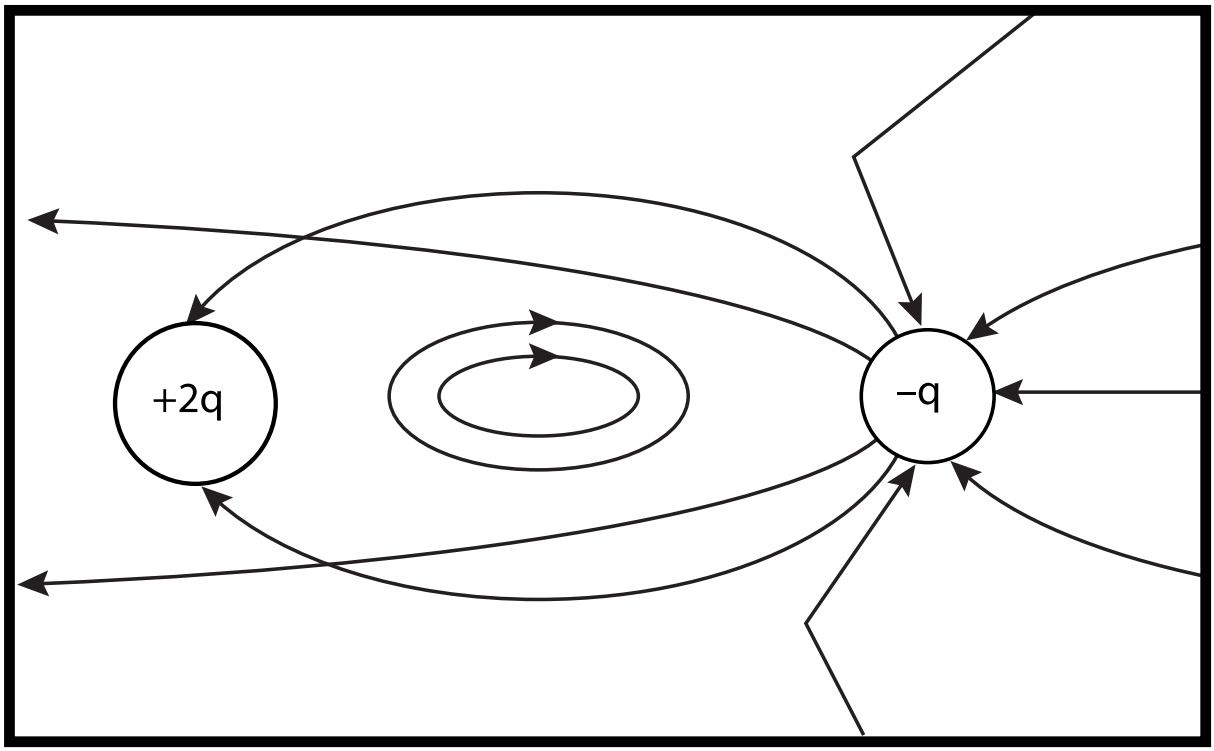
Electric Fields: Near and Far

The concept of the *electric field* was introduced by the English physicist Michael "The Brain" Faraday to simplify our approach to experiments in electrostatics. In addition to this, he was also a chemist, who discovered benzene and invented the bunsen burner. He had little training in the way of higher mathematics (*e.g. calculus*), but was never-the-less one of the most influential figures in scientific history, and is widely regarded as one of the finest experimentalist in the history of science — you want this dude to be your lab partner!

In this exercise, we will practice drawing electric fields; let us recall the rules for electric field line diagrams:

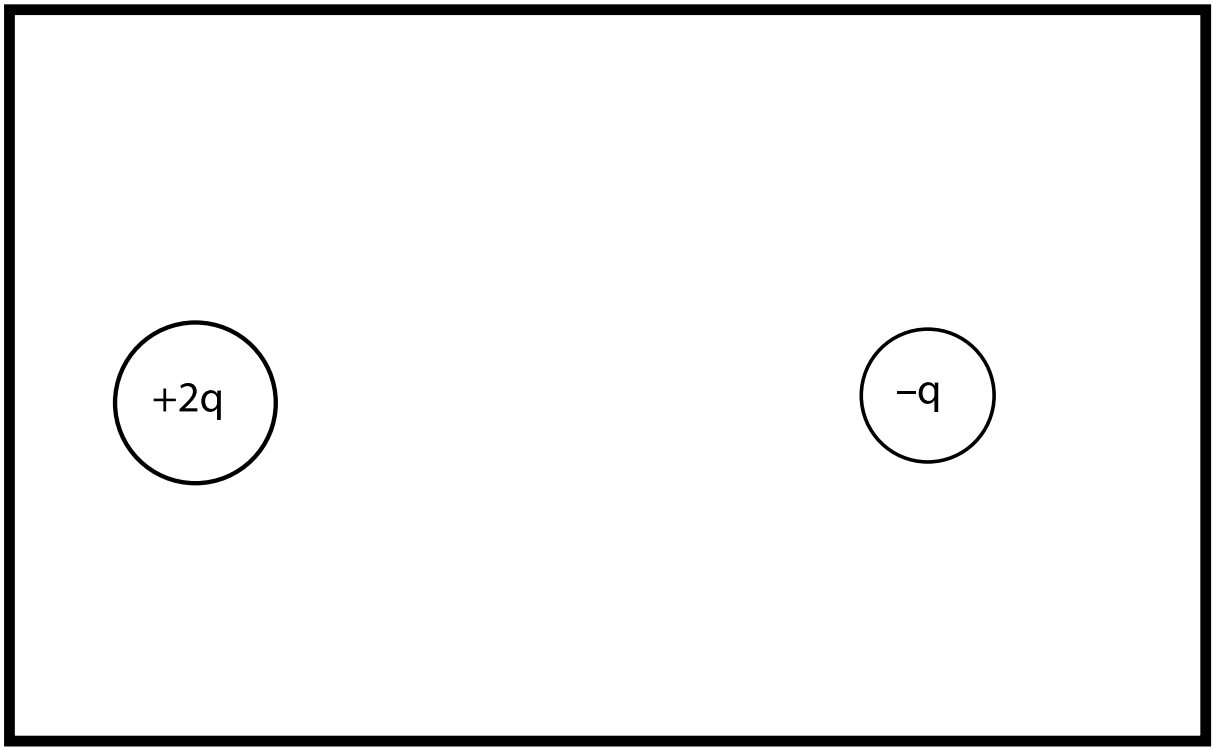
- ▷ At each point, the total electric field vector $\vec{E}$ is tangent to the field line
- ▷ E-field lines *point away* from positive (+) charges, and *point toward* negative (−) charges
- ▷ E-field lines start on positive charges or at infinity (off the edge of your paper)
- ▷ E-field lines end on negative charges or at infinity (off the edge of your paper)
- ▷ E-field lines are densest where the field is strongest; the number of lines leaving a charge is an indicator of the charge strength

A▷ Bad Drawing!
An E-field diagram has been drawn below, but there are several improper things about it. Circle each incorrect feature, label it $(a, b, c, \ldots)$, and explain why the feature is incorrect in the space provided.



List of Incorrectness with Drawing

B▷ Draw Your Own E-field
On the diagram below, draw your very own (*correct!*) representation of the electric field diagram!



B▷ Proximity to Electric Charges
Consider the situation below. You are interested in the electric field at the point A, where the charge on the left is only 1 cm away from A, and the charge on the right is 100 cm away.

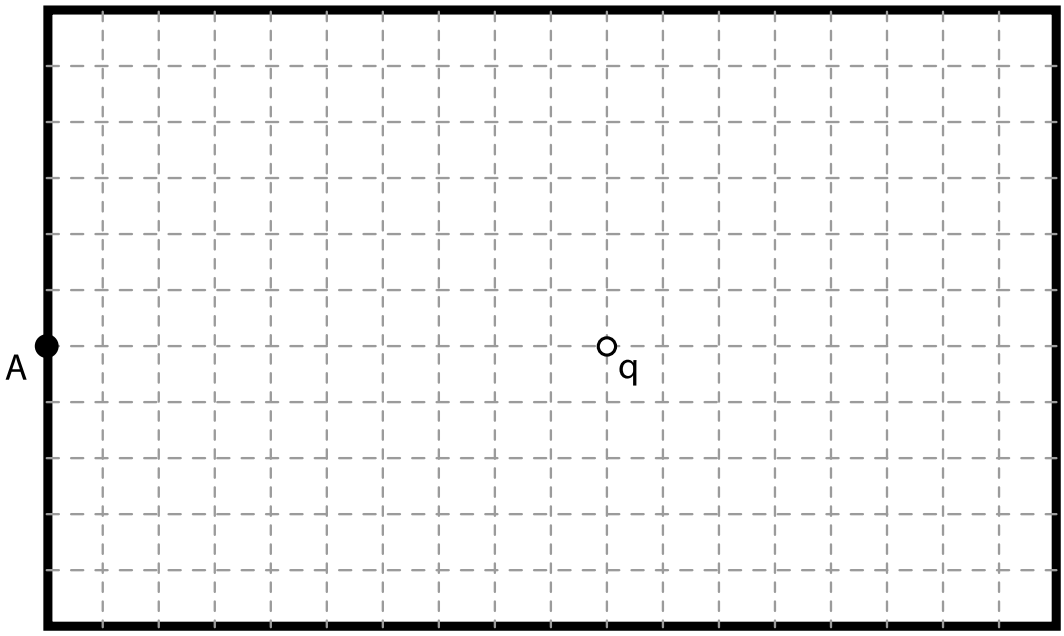
▷ Write down the magnitude of the E-field due to each charge at point A. Leave your answer in terms of q and k, but put in values for r in each case.

▷ What is the ratio of the electric field due to the left charge compared to the right charge?

▷ At the point A, which is much closer to the left charge than the right charge, can I ignore the right charge? Explain.

▷ Give your answer to the last question, make a sketch of the E-field very close to the left charge.

C▷ Far From Electric Charges
Consider the situation below. You are interested in the electric field at the point A. The two charges are 1 cm apart; only one charge has been drawn on the diagram. Each square is 100 m to a side.



▷ On the sketch, put a dot at the location of the second charge. *Make sure the distance between the charges is correct on the scale of the grid!*

▷ Give the location of the two charges, sketch the electric field lines due to each charge on the sketch. What is the *net electric field* at A?

▷ How would your electric field lines look different if one charge had magnitude $+q$ and the other was $-q$? What would the *net electric field* at point A be? Explain.

D▷ Practice sketches
On a separate piece of paper, sketch the electric field lines for each of the following charge configurations.