



### Science Objectives

- Students will describe an electric field and electric field lines.
- Students will describe what happens when two like charges interact and when two unlike charges interact.
- Students will simulate the motion of a charged particle through an electric field using the properties of like and unlike charges.

### Vocabulary

- electric field
- electric field lines
- electric force
- negative charge
- positive charge

### About the Lesson



- This lesson is a simulation of an electric field where positive and negative charges interact. The fictitious context is of a hockey-style game where a positive charge (the “ball”) is pushed through the “goal.”
- As a result, students will:
  - Describe an electric field and electric field lines.
  - Describe the interaction of like and unlike charges.
  - Predict the motion of charged particles.

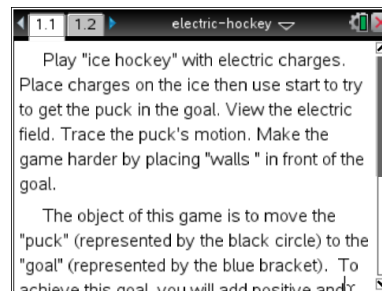


### TI-Nspire™ Navigator™

- Send out the *Electric\_Hockey.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to allow students to show how they manipulate variables that effect results.

### Activity Materials

- Compatible TI Technologies:  TI- Nspire™ CX Handhelds,  TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



### Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

#### Student Activity

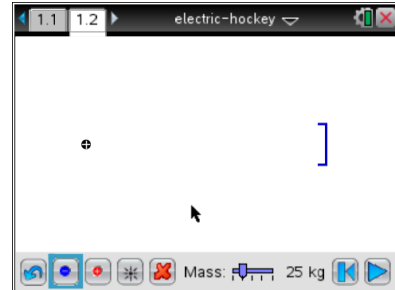
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




## Discussion Points and Possible Answers

### Part 1: Exploring Electric Fields


In this part of the lesson students explore electric fields and electric field lines. As you review the electric field around positive and negative charges, point out that the simulation only shows the direction of the electric field lines for the main positive charge.



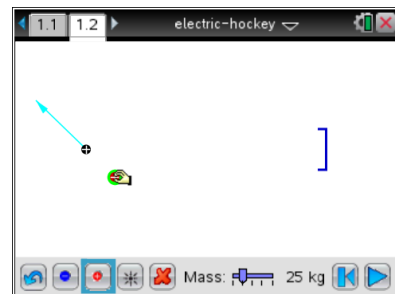
**Tech Tip:** Students can select Menu  or  to see various settings, including showing the magnetic field, that can be adjusted for the simulation.

1. Start the simulation.
2. Place a positive charge near the main positive charge. Select the Play  button.
3. Make sure students note that two positive charges repel each other and that the main charge moves in the direction indicated by the field line.



**Tech Tip:** After students select , they should place their finger over the charge and drag it to the desired location. Students can lift their finger to drop the charge.

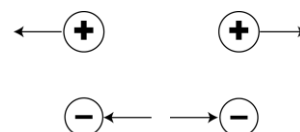
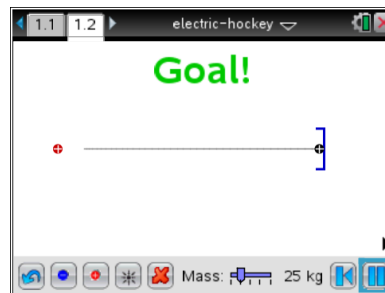
4. Have students move the positive charge to different positions to see the effect on the main charge. Selecting the Rewind button will retrieve the main charge once it leaves the screen.




**Part 2: Moving Charges**

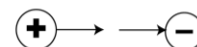
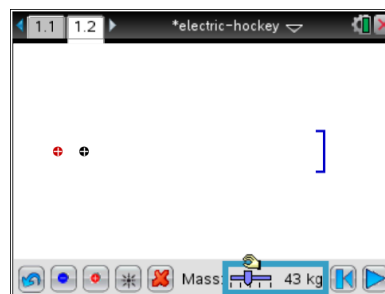
Having seen how placing a positive charge near the main charge results in moving the main charge, students can now think of directing this motion.

- Have students place positive charges (starting at first with just one) in line with the main charge and the goal, in such a way that the main charge will move toward the goal. The use of the field lines is important. Students can then try adding more positive charges to see the effect on the motion.
- Next, vary the mass of the main charge to see the effect on its motion. The change in motion and the change in mass allows for the introduction of an electric force. An electric force is exerted on the ball, and a force is exerted on the charge.



**Like charges repel each other.**

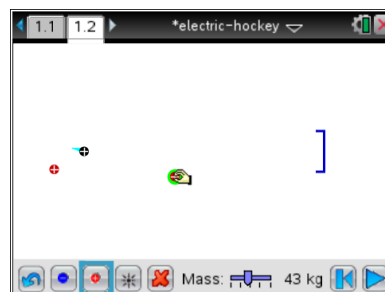
- Finally, students can explore ways of moving the main charge using negative charges and relying on the fact that unlike charges attract each other.



**Unlike charges attract each other.**

**Part 3: Changing the Direction of Motion**

Try to relate the notion of an electric field to the simulated hockey “field of play.” The main charge can be pushed toward the goal by positive charges or pulled toward the goal by negative charges. Now have students use both types of charges to move the main charge toward the goal, but then repelled by another set of charges to block the goal. Encourage students to be creative in their arrangement of charges. Also, make a note that, depending on the arrangement of charges, the main charge may move back and forth as it is attracted to the goal and then repelled. In such a case the main charge has a cyclical motion, like a recurring comet.






Q1. Describe what happens.

**Answer:** An arrow appears next to the main positive charge.

Q2. Describe what happens.


**Answer:** The main charge moves away from the positive charge placed onscreen.

Q3. Select the Rewind button: . Repeat Step 1 for different locations of the positive charge around the main charge. Write a general statement that describes what happens when you place two positive charges near each other.

**Answer:** Two positive charges will move away from each other.

Q4. Describe what happens to the electric field lines of the main positive charge.

**Answer:** The field lines from the main charge point toward the negative charge.

Q5. Select the Rewind button . Repeat Step 3 for different locations of the negative charge around the main charge. Write a general statement that describes what happens when you place two different charges near each other.

**Answer:** They move toward each other.

Q6. Describe the method you used to score a goal.

**Answer:** Students should move the charge to the left of the main charge in line with the goal.

Q7. Now place several more positive charges onscreen and try the same method. Describe what happens.

**Answer:** The main charge moves faster toward the goal.

Q8. What happens as you add more positive charges?

**Answer:** The main charge moves even faster.

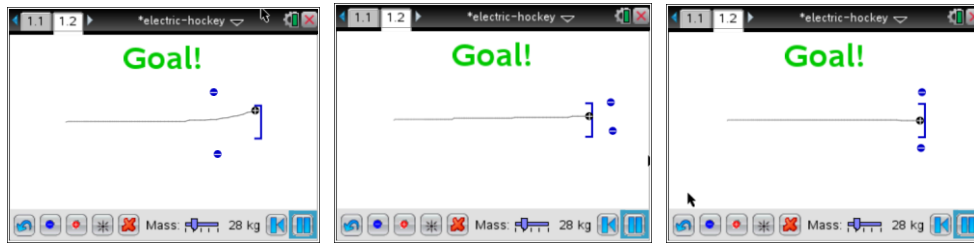
Q9. Describe what happens to the motion of the main positive charge.



**Answer:** As the mass increases, it moves more slowly toward the goal.

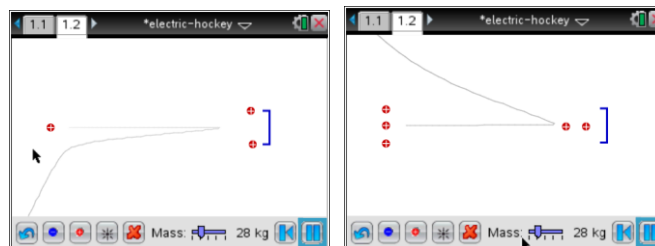
Q10. Describe your method for getting the positive charge into the goal.

**Answer:** Methods will vary. Some examples shown here.



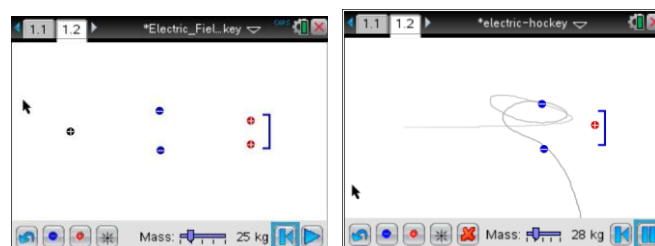
Q11. Describe your method for preventing the charge from hitting the goal.

**Answer:** Methods will vary. Some examples shown here.



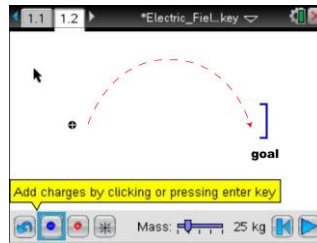
Q12. Describe your method for preventing the charge from hitting the goal.

**Answer:** Methods will vary. Some examples shown here.

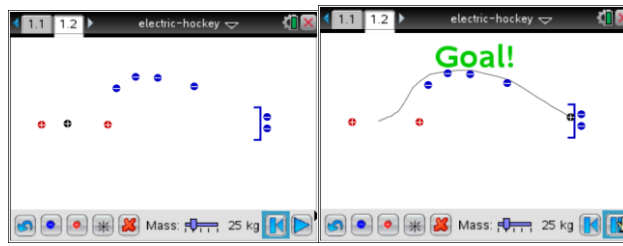




Q13. Create an arrangement of charges that has the puck follow this path toward the goal.



**Answer:** Methods will vary. Sample answer shown here.



### TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the mass and add new charges onscreen. Use Quick Poll to check for understanding during the course of the activity.

## Wrap Up

When students are finished with the activity, collect students' worksheets.

## Assessment

- Formative assessment will consist of questions embedded in the student worksheet. Analyze questions in the student worksheet with the students. Teacher can also collect scores that students earned in the game.
- Summative assessment will consist of questions/problems on the chapter test.