General Physics - E&M (PHY 1308) Lecture Notes

Homework000

SteveSekula, 18 January 2011 (created 17 January 2011)

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Expectations for the quality of your handed-in homework are available at http://www.physics.smu.edu/sekula/phy1308/homework.pdf. Failure to meet these guidelines will result in loss of points as detailed in that document. This assignment covers material from Wolfson Chapter 20. Each problem is worth 20 points, and the total assignment is worth 100 points.

This homework is due no later than 8:00pm on Monday, January 24.

Reading Assignment:

Appendix A, Chapter 20 (All)

Exercise *SS-1*: Electric Charge and the Behavior of Electric Charges

For this exercise, you will be using a computer simulation of electric charges called "Electric Field of Dreams." It is free and available online from:

http://phet.colorado.edu/en/simulation/efield

You will need to use a computer with Java installed:

- Install Java:
  - Windows and Linux: if it's not already installed,
    - Select the "JRE" (Java Runtime Environment) link from http://www.oracle.com/technetwork/java/javase/downloads/index.html or . . .

    - Go to this link: http://bit.ly/enbwQi
  - For Mac users: Java should already be installed if you are using Max OSX Leopard or Snow Leopard.

If you do not have access to a computer with Java and/or cannot install Java, please come to the office hours for help.

Information

You will be placing single electric charges, and pairs of electric charges, on a board. Arrows will appear around the charges, representing a "field of force" around a charge. These arrows can be interpreted as follows (you will explore this below): they indicate the direction of force exerted by the charge as if it were acting on a tiny, almost negligible positive electric charge placed on the board at the location of the arrow's tail. For instance, if you place a charge on the board and one of the arrows that results is pointing to the right, you can interpret this to mean that this is the direction your charge would push on a tiny, tiny second positive charge placed on that location. The length of the arrow indicates the strength of the force at that location; longer arrows mean a stronger force. The direction of the arrow indicates the direction of the force.

Procedures

Procedure:

1. Create, observe and draw the electric field around a single negative point charge. To do this:
   - Click on the "Properties" button and set the charge to -1.0 Coulomb. Click the "Done" button on the properties window to save your changes.
   - Click the "Add" button. This will add a -1.0 Coulomb (negative) charge to the simulation.
   - You may move the charge around the field by dragging it with your mouse pointer.
   - The arrows indicate the direction of the force field around the charge.
   - Note that the arrows all point towards the charge with the largest arrows nearest the charge.
   - In your **Results section** (see below) draw the charge and the field around it.
   - When you are done with this part of the exercise, clear the simulation’s field by clicking the "Reset All" button and choosing

yes.

2. Create, observe and draw the electric field around a single positive point charge. To do this:
    - Click on the "Properties" button and set the charge to +1.0 Coulomb. Click the "Done" button on the properties window to save your changes.
    - As above, click the "Add" button to create a single charge on the board.
    - Then click the "Properties" button and change the -1.0 Coulomb charge to a +1.0 Coulomb charge.
    - Note the difference in direction of the arrows around this charge.
    - In your **Results section,** draw the charge and the field around it.
    - When done hit the "Reset All" button and choose yes to clear the simulation’s field.

3. Create, observe, and draw the electric field around two positive charges. Do this by:
    - Clicking on the "Properties" button and setting the charge to +1.0 Coulomb. Click the "Done" button on the properties window to save your changes.
    - Clicking the "Add" button twice in succession.
    - Two charges should start to move around the screen with the field lines (arrows) indicating the direction and magnitude of the electric force at each point in space.
    - Hit the pause button to stop the charge movement and drag the charges to opposite sides of the board.
    - Draw a picture of the charges and the field between them in your **Results section**.
    - These are two of the same charge and thus their fields repel one another. You can therefore expect the field to be weakest between the charges and greatest outside the charges where both fields are pushing the same way.
    - Reset the simulation by hitting the "Reset All" button and saying yes to the reset all.

4. Create, observe, and draw the electric field around two opposite point charges. To do this:
    - Click the "Properties" button and set the charge to -1.0 Coulomb. Click the "Done" button in the properties window to save your changes.
    - Click the "Add" button once to give you a negative charge on the board.
    - Click the "Propeties" button again and change the charge to +1.0

Coulomb. Click the "Done" button in the properties window to save your changes.
- Click the "Add" button again, this time placing a positive electric charge on the board.
- Now click the "Properties" button -and change the charge back to -1 Coulomb.
- The two charges should move around the screen, somewhat attracted to one another.
- Hit the pause button and use your cursor to drag the positive charge to the right side of the screen and the negative charge to the left side of the screen.
- Draw the charges and the field between them. Record the drawing in your **Results section**
- The strongest field should be between the charges as they both are pulling in the same direction at this location.
- Reset the simulation by hitting the "Reset all " button and choosing yes for the question.

5. Create, observe, and comment on the behavior of a tiny electric charge in the present of a bigger electric charge. To do this:
   - Click the "Properties" button and set the charge to +10.0 Coulomb. Set the mass to 100.0. Click the "Done" button in the properties window to save your changes.
   - Click the "Add" button once to give you a negative charge on the board.
   - Click the "Propeties" button again and change the charge to +0.001 Coulomb. Set the mass to 0.001. Click the "Done" button in the properties window to save your changes.
   - Click the "Add" button again, placing your very tiny charge on the board.
   - Click the "Pause" button to freeze the simulation.
   - Put your big charge on the left side of the board, in the middle of the left wall.
   - Move your tiny charge to a location next to the big charge.
   - Click "Play" to unfreeze the simulation.
   - Record your observations about the behavior of the tiny charge in your **Results section.** For instance, how does the motion of the tiny charge change when it is near or far from the big charge (try starting it from different locations)? Does the little charge ever get closer to the big charge than the distance it started from the big charge? Does the behavior of the tiny charge confirm the statement made at the beginning of this exercise: placing a tiny, tiny charge next to the big charge has a negligible impact on the big charge, and lets you determine the direction that a tiny positive charge will

move in the field?

6. Answer the interpretive questions given at the end of your **Results section.** Use what you have learned from studying individual and pairs of charges to answer these questions.

Results Section:

Single Negative Charge	Single Positive Charge
Like Charges	Opposite Charges

Big charge, small charge

Conclusion Questions:

1. In what direction was the force and force field around a positive charge? (e.g. do the arrows of force point toward or away from the charge?)

2. Where was the force field the greatest around the positive charge? (e.g. where were the arrows the longest: near or far from the charge?)

3. Where was the force field the greatest for two like charges (between or outside of the charges)?

4. Where was the force field the greatest for two opposite charges (between or outside the charges)?

5. Single charges produced in steps 1 and 2 did not move around while the 2 opposite and like charges produced in steps 3 and 4 did. Using your observations, explain why this is.