

Name:

Criterion C - Processing & Evaluating

Criterion Benchmarks	Descriptors
0	The student does not reach a standard described by any of the descriptors below.
1 - 2	The student is able to: i. collect and present data in numerical and/or visual forms ii. accurately interpret data iii. state the validity of a hypothesis based on the outcome of a scientific investigation iv. state the validity of the method based on the outcome of a scientific investigation v. state improvements or extensions to the method.
3 - 4	The student is able to: i. correctly collect and present data in numerical and/or visual forms ii. accurately interpret data and explain results iii. outline the validity of a hypothesis based on the outcome of a scientific investigation iv. outline the validity of the method based on the outcome of a scientific investigation v. outline improvements or extensions to the method that would benefit the scientific investigation.
5 - 6	The student is able to: i. correctly collect, organize and present data in numerical and/or visual forms ii. accurately interpret data and explain results using scientific reasoning iii. discuss the validity of a hypothesis based on the outcome of a scientific investigation iv. discuss the validity of the method based on the outcome of a scientific investigation v. describe improvements or extensions to the method that would benefit the scientific investigation.
7 - 8	The student is able to: i. correctly collect, organize, transform and present data in numerical and/or visual forms ii. accurately interpret data and explain results using correct scientific reasoning iii. evaluate the validity of a hypothesis based on the outcome of a scientific investigation iv. evaluate the validity of the method based on the outcome of a scientific investigation v. explain improvements or extensions to the method that would benefit the scientific investigation.

SOI: Through identifying relationships of similarity and difference (identities and relationships), we understand how force and matter interact.



Investigation

Electric potential vs. distance

Go to the [PHET simulation](https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_en.html) at https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_en.html to collect electric field strength and distance values.

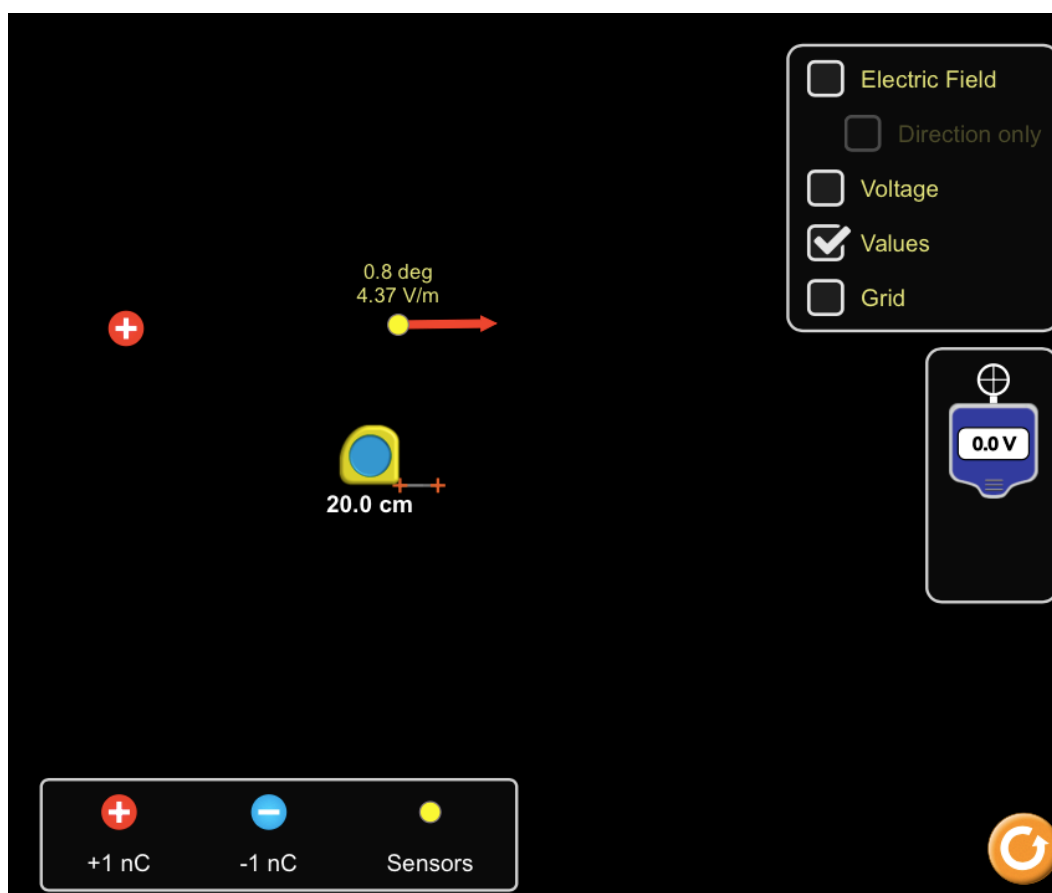


Figure 1

Procedure:

1. Insert one positive charge at the center of your screen.
2. Tick only values on the right top corner.
3. Drag a sensor and a ruler on your screen. See the figure 1.



4. Measure the distance between the charge and the sensor by placing one end of the ruler at the center of the charge and the other end at the center of the sensor. See figure 2.



Figure 2

5. Measure the electric field strength in V/m using the sensor.
6. Repeat step 4 and 5 for at least 5 different positions in the range between 20 cm and 400 cm.



Processing

This task addresses the key concept of **relationship** and focuses on Criteria C.

Question 1-3 focuses on strand i: present collected and transformed data.

1. Present your data in the form of a data table. In your data table include the values of;

- electric field strength (E)
- distance (d)
- 1/squared of distance ($1/d^2$)

2. Plot a graph of electric field strength E (vertical axis) vs distance d (horizontal axis) graph. Label the axis names. Use scatter plot in your graphing software to produce the graph. Include a best-fit line using the trendline option. Display the equation of the trendline. Copy and paste your graph below.

3. Plot a graph of E vs $1/d^2$ graph. Use scatter plot in your graphing software to produce the graph. Include a best-fit line using the trendline option. Display the equation of the trendline. Copy and paste your graph below.



Evaluating

Question 4- focuses on strand i: interpret data and explain results using scientific reasoning.

4. Based on your graphs which of the following statements are correct.

Place a tick next to correct statement.

Electric field strength E is proportional to distance d . $E \propto d$	
Electric field strength E is proportional to distance squared. $E \propto d^2$	
$E \propto 1/d$	
$E \propto 1/d^2$	

5. Explain your answer to question 4 briefly.

Question 6 focuses on strand iii: evaluate the validity of a hypothesis based on the outcome of a scientific investigation.



6. According to Coulomb's Law,

$$F_E = k \frac{Q_1 Q_2}{d^2}$$

where F_E is electric force; Q_1 is charge 1; Q_2 is charge 2; d^2 is squared of distance between point charges and k is Coulomb's constant which is equal to $8.99 * 10^9 Nm^2 C^{-2}$.

- Using one set of data from your data table, calculate the Coulomb's constant in your experiment. Show your work clearly.
- Does the results of your experiment support Coulomb's Law?
- Based on your answer to part a and the graphs you plotted in question 2 and 3, evaluate the validity of Coulomb's Law.

Hint: You should calculate G , Coulomb's constant using the slope of a graph you plotted to further support your statements.



Question 7 focuses on strand iv: evaluate the validity of the method.

7. a. Based on the outcome of your investigation, state whether the method is valid or not.

b. Evaluate the validity of the method in detail.

Hint: Consider strength and limitations of the method. Refer to your results to support your answers.



Question 8-10 focuses on strand v: explain improvements or extensions to the method.

8. State improvements to the method or extensions to the data collection briefly.
9. Describe how would you proceed your improvement/extension to the method.
10. Explain how your suggestion would benefit the scientific investigation.

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