

SI Physics - Full Discipline Demo

Electric Fields and Electric Potential

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

⚡ Battery	Force per unit charge	1
⚡ Electric field	Potential difference	2
⚡ Voltage	Transforms chemical energy into electric potential energy	3
⚡ Voltmeter	Device used to measure potential difference	4

Correct answers:

1 Electric field 2 Voltage 3 Battery 4 Voltmeter

Categorize each statement as true or false.

⚡ Electric field lines radiate away from positive charges and towards negative charges.	
⚡ Electric field is always perpendicular to equipotential lines.	
⚡ The electric field points in the direction of increasing electric potential.	
⚡ The electric field inside a parallel plate capacitor decreases as it approaches the negative plate.	
⚡ The units of electric field are either newtons per coulomb or volts per meter.	
True	False
1	2

Correct answers:

1

Electric field lines radiate away from positive charges and towards negative charges.

Electric field is always perpendicular to equipotential lines.

The units of electric field are either newtons per coulomb or volts per meter.

2

The electric field points in the direction of increasing electric potential.

The electric field inside a parallel plate capacitor decreases as it approaches the negative plate.

Exploration

Charge is measured in units of ____.

- ☐ newtons
- ☒ coulombs
- ☐ volts
- ☐ All of the above



The electric field is a ____ field.

- ☒ vector
- ☐ scalar
- ☐ planar
- ☐ All of the above

✓

The electric field represents the electric force that would act on a small ____ test charge.

- ☒ positive
- ☐ negative
- ☐ neutral
- ☐ All of the above

✓

The difference between the electric potential at two points is the ____.

- ☐ electric field
- ☐ electric potential energy
- ☒ voltage
- ☐ All of the above

✓

The electric potential is represented by ____.

- ☐ electric field lines
- ☐ electric field vectors
- ☒ equipotential lines
- ☐ None of the above

✓

The electric field must always be perpendicular to equipotential lines because no work is required to move a charge along an equipotential line.

- ☒ True
- ☐ False

✓

The electric field points in the direction of ____ potential.

- ☐ increasing
- ☒ decreasing
- ☐ constant
- ☐ All of the above



Exercise 1

Describe the relationship between the density of electric field lines and the strength of the electric field.

The denser the electric field lines, the stronger the electric field in that region.

Where was the electric field the strongest when using two round conductors? Explain your answer referencing Photo 1.

The electric field is the strongest next to the conductors. This is the location where the electric field lines are the densest.

What conclusion can you make about the electric field strength between two parallel plates? Explain your answer referencing Photo 2.

The electric field between two parallel plates is roughly constant. This is due to the density of the electric field lines not changing between the two conductors.

Do your electric field and equipotential lines appear as expected? Explain any deviations from the expected fields and possible sources of error.

Student answers will vary. Sources of error can include: the conductors not making full contact with the conducting paper, insufficient battery connections or low output voltage, inconsistent readings from the DMM, and too many holes in the conductive paper or fingerprints (skewing the ability for electrons to flow).

Photo 1: Two Round Conductors
(SAMPLE ANSWER BELOW)

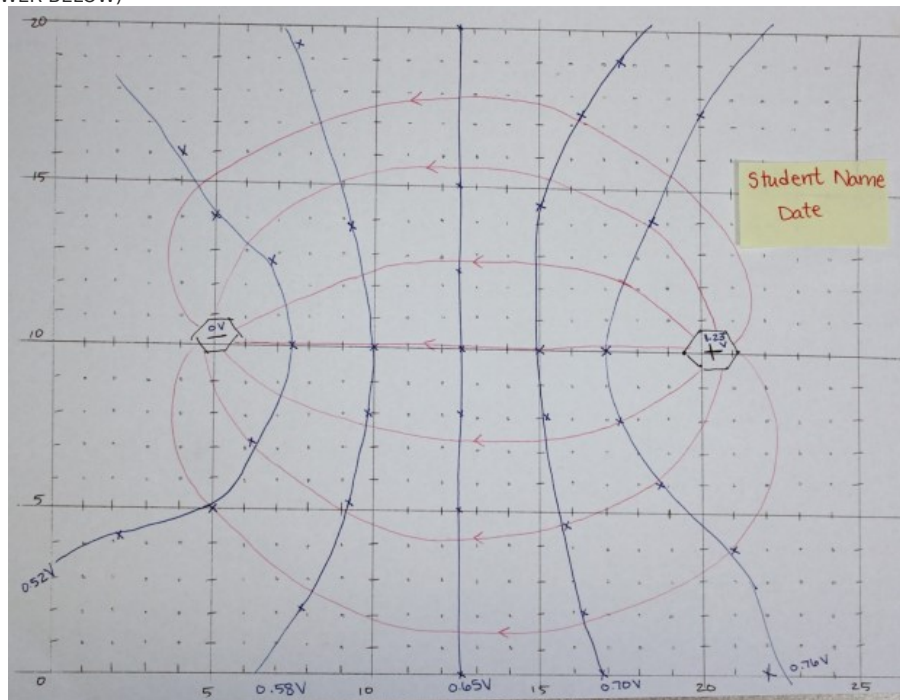
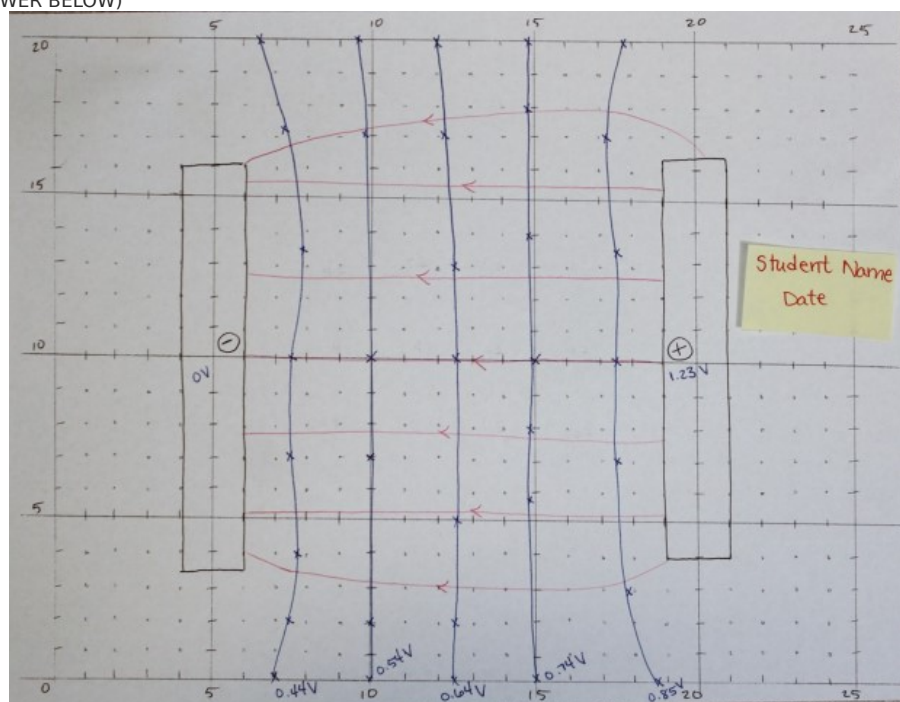


Photo 2: Two Parallel Conductors
(SAMPLE ANSWER BELOW)



Exercise 2

What is the relationship between voltage and the distance from charges? Reference Photos 3 and 4 in your answer.

The voltage reading gets larger and more positive as it moves closer to the positive charge and larger and more negative as it approaches the negative charge, as can be seen from the equipotential lines in **Photos 3** and **4**.

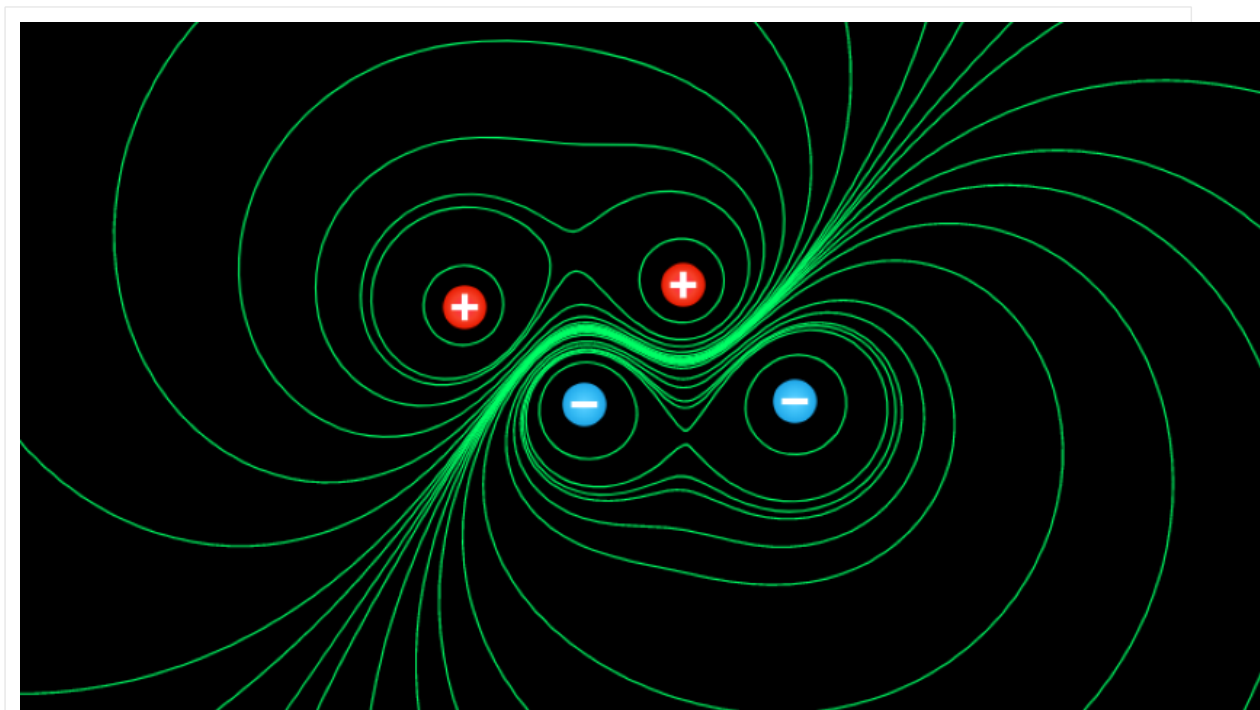
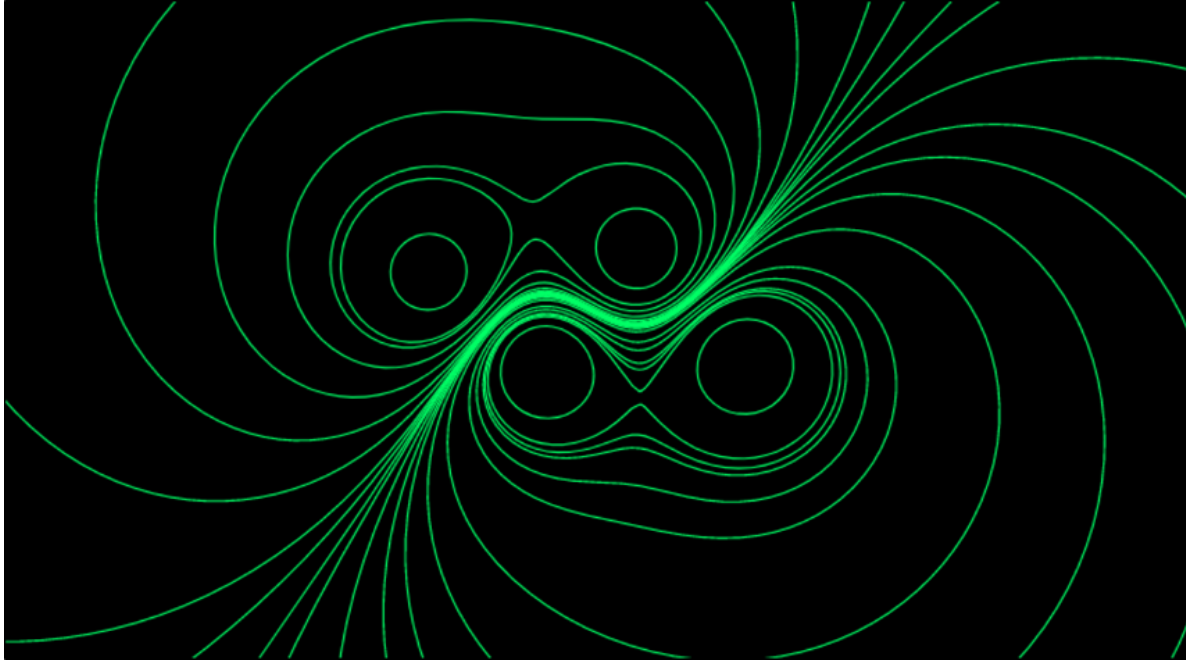
Describe how the electric field changes as it nears a charged object. Refer to Panels 1 and 2 in your answer.

The electric field gets larger as you move closer to the charged object and smaller as you move further away, as was described in **Panels 1** and **2**.

How do the results from Exercise 1 compare to the results of this exercise? Discuss why they are similar/different.

The results are similar for each part. Part 1 for Exercise 1 shows two round charged objects and Part 1 of Exercise 2 shows two point charges – the equipotential lines and resulting electric field look similar. The line of charges in Part 2 of Exercise 2 closely resembles the two long, parallel conductors from Exercise 1 – the equipotential lines and electric field look similar. Part of why they appear different comes from only measuring between the conductors in Exercise 1 – we were not able to see how the equipotential lines wrapped around the conductors as was seen in Exercise 2. Discrepancies come from experimental error, which could come from the conductors not making full contact with the conductive paper, insufficient connections to the battery, or shaky reading on the DMM.

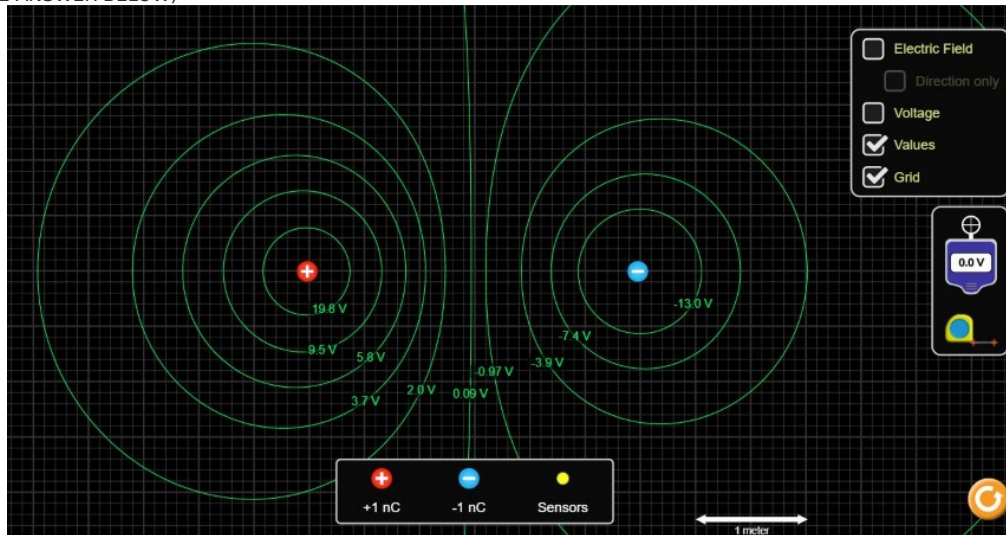
Draw or use the simulation to recreate the charge distribution that creates the following equipotential lines. Upload the image to Photo 5.



Describe sources of error in your calculations for the magnitude of the electric field reported in Data Table 1. What could be done to reduce the error? (Hint: Repeat the calculation in Part 3 with two charges closer together and then with two charges farther apart.)

The electric field equation used in this section is only an approximation - the electric field is actually found by taking the derivative of the potential with respect to distance. That is, the limit of the equation used in Part 3 as $\Delta x \rightarrow 0$. The error could be reduced by finding the potential difference between two points that are closer together.

Photo 3: Two Point Charges Simulation
(SAMPLE ANSWER BELOW)



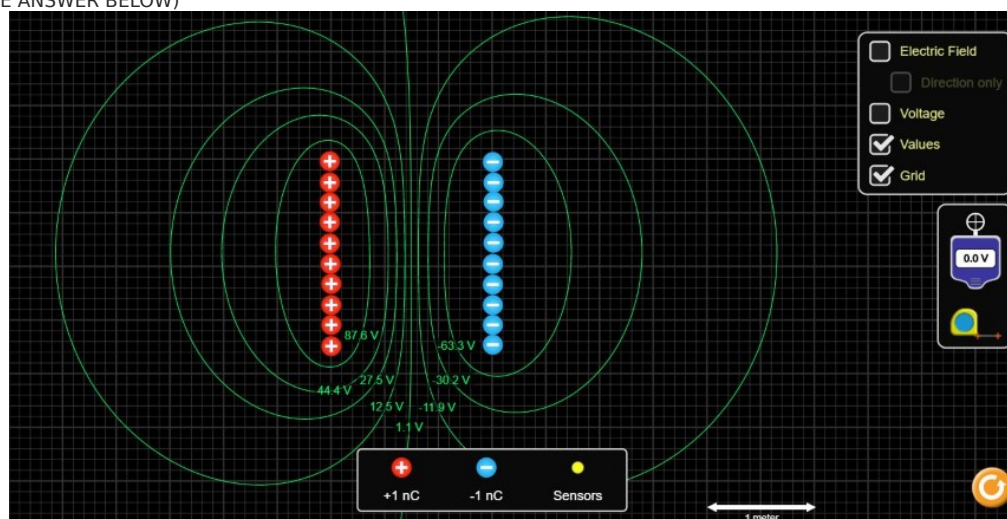
Panel 1: Electric Field Two Point Observations

(SAMPLE ANSWER BELOW)

The strength of the electric field gets larger the closer it is to either charge and reaches a minimum along the line connecting the charges at the midpoint between them. The field always points away from the positive charge and toward the negative charge, regardless of the sensor's location.

Photo 4: Two Lines of Charges Simulation

(SAMPLE ANSWER BELOW)



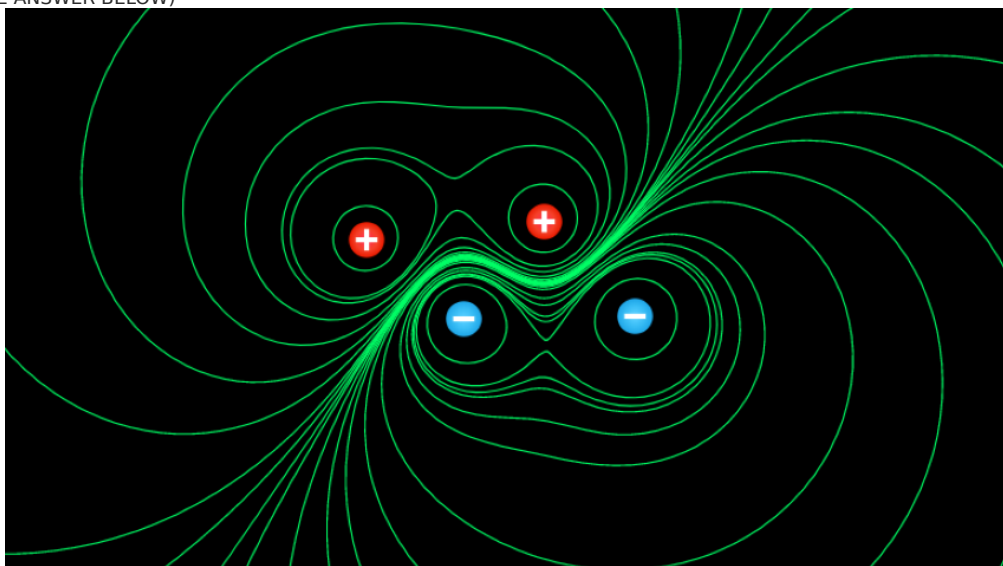
Panel 2: Electric Field Two Lines Observations
(SAMPLE ANSWER BELOW)

The electric field strength is strongest next to the lines of charge and is significantly higher than that seen for one charge. The field reaches a minimum between the two lines of charge, but the field is still quite large. The field between the lines of charge is larger than that directly outside the lines of charge configuration.

Data Table 1: Calculating Electric Field Strength of a Point Charge
(SAMPLE ANSWER BELOW)

V ₁ (V)	V ₂ (V)	ΔV (V)	Δx (m)	Calculated Electric Field Magnitude From $E= \Delta V/\Delta x $ (V/m)	Electric Field Reading of Sensor (V/m)	Percent Error (%)
16.2	12.1	-4.2	0.20	20.5	21.0	1.2

Photo 5: Charge Distribution for Question 4
(SAMPLE ANSWER BELOW)



Competency Review

Two positive electric charges will attract one-another.

- ☐ True
- ☒ False

✓

The electric field is the ____ per unit charge.

- ☒ force
- ☐ energy
- ☐ source
- ☐ None of the above

✓

The electric field points ____ a positive charge.

- ☐ around
- ☒ away from
- ☐ towards
- ☐ All of the above

✓

Electric field lines are ____ to electric force vectors.

- ☐ perpendicular
- ☐ parallel
- ☒ tangent
- ☐ None of the above

✓

A capacitor is used to store electric ____.

- ☐ charge
- ☒ energy
- ☐ source
- ☐ None of the above

✓

The electric potential is the electric ____ per unit charge.

- ☐ force
- ☒ energy
- ☐ source
- ☐ None of the above

✓

The electric potential ____ along parallel lines inside a parallel plate capacitor.

- ☐ increases
- ☐ decreases
- ☒ is constant
- ☐ None of the above

✓

The electric field is equal to the negative of the potential difference ____ the distance.

- ☐ multiplied by
- ☒ divided by
- ☐ plus
- ☐ None of the above

✓

The electric field is always ____ to the equipotential lines.

- ☒ perpendicular
- ☐ parallel
- ☐ tangent
- ☐ None of the above

✓

The voltage of the conductive paper between two conductors is greater than zero and less than the voltage of the battery.

- ☒ True
- ☐ False

✓

The lines traced out between two conductors on conductive paper connecting points of equal voltage are ____ lines.

- ☐ electric field
- ☒ equipotential
- ☐ potential difference
- ☐ None of the above

✓

The electric field between two parallel lines of opposite charge ____.

- ☐ is perpendicular to the lines of charge
- ☐ is uniform in magnitude and direction
- ☐ points from the positive charges to the negative charges
- ☒ All of the above

✓

The potential difference between two points separated by 2 meters is 7 volts, and the electric field between those two points is ____ volts per meter.

- ☒ 3.5
- ☐ 14
- ☐ 9
- ☐ None of the above



Extension Questions

A positively-charged particle is released near the positive plate of a parallel plate capacitor. a. Describe its path after it is released and explain how you know. b. If work is done on the particle after its release, is the work positive or negative? Explain your answer. If no work is done, explain why not. (SAMPLE ANSWER BELOW)

a. The positively charged particle will move in a straight line toward the negative plate, following the direction of the electric field between the plates. b. Positive work is done on the particle, because work is force multiplied by distance, and the particle moves in the same direction that the force points, which is the same direction as the electric field for a positive charge.