Potential at a Distance

Model how one charge creates electric potential.

HS-PSII-4.4 "For a single isolated charge, develop graphical and mathematical representations that describe the relationship between the amount of charge..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the formula and the meanings of its variables, then circle one pair of table values that shows a distance change and another pair that shows a charge change.

A Probe Near a Point Charge

1. Imagine a lone point charge in empty space. A probe checks electric potential around it. Potential is energy per unit positive test charge, measured in volts (V). Set zero potential infinitely far away. For a point charge, $V = kQ/r$. Here Q is charge in coulombs, r is distance in meters, and k is about 9.0×10^9 V·m/C.

2. The table shows readings for two possible charges, each alone in empty space. One nanocoulomb (nC) equals 1×10^{-9} coulomb. Compare readings within a column to test how distance matters. Compare readings across a row to test how charge matters. A positive charge produces positive potential; a negative charge produces negative potential at the same distances.

POTENTIAL AROUND ONE POSITIVE POINT CHARGE

Distance r (m)	V for Q = +1 nC (V)	V for Q = +2 nC (V)
0.1	90	180
0.2	45	90
0.4	22.5	45
0.8	11.25	22.5

3. At fixed charge, doubling distance halves potential instead of subtracting a fixed number of volts. Graph distance horizontally and potential vertically. Positive-charge readings trace a curve toward zero as distance grows. Multiplying the charge multiplies each potential by the same factor. A negative charge gives a curve below the horizontal axis that also approaches zero farther away.

2 ANSWER WITH EVIDENCE

Use the passage

1. What potential would a single +3 nC charge create at 0.2 m? Show how you use the formula or table.

2. For a single +2 nC charge, calculate the potential at 0.3 m and 0.6 m. How does the change in distance affect the potential?

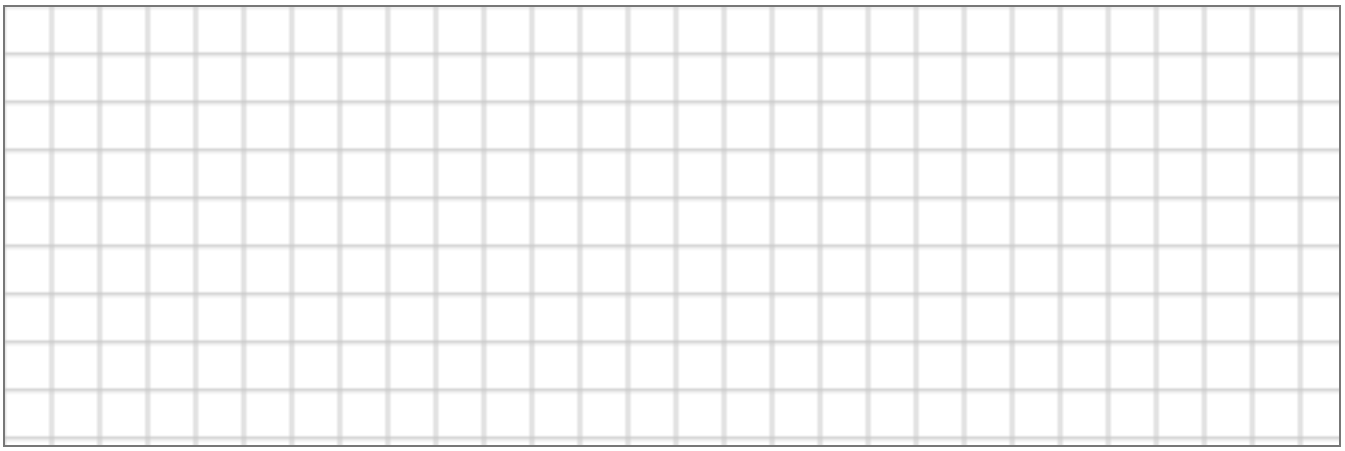
3. What potential would a single -3 nC charge create at 0.6 m? Explain its sign.

4. A single charge changes from +4 nC to +2 nC while the probe moves from 0.5 m to 0.25 m. Calculate the potential before and after. Does it change?

3 YOUR TURN

Your own words

On the grid, plot potential against distance for a single +6 nC charge at 0.3 m, 0.6 m, and 0.9 m. Label both axes, sketch the curve toward zero, and write one sentence explaining how doubling distance changes the potential.



ANSWER KEY

Potential at a Distance

PART 1 · READ AND MARK

Underline the formula and the meanings of its variables, then circle one pair of table values that shows a distance change and another pair that shows a charge change. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What potential would a single +3 nC charge create at 0.2 m? Show how you use the formula or table.	**135 V. At 0.2 m, +1 nC gives 45 V, so tripling the charge triples the potential.**
2	For a single +2 nC charge, calculate the potential at 0.3 m and 0.6 m. How does the change in distance affect the potential?	**60 V at 0.3 m and 30 V at 0.6 m. Doubling the distance halves the potential.**
3	What potential would a single -3 nC charge create at 0.6 m? Explain its sign.	**-45 V. V = kQ/r is negative because Q is negative.**
4	A single charge changes from +4 nC to +2 nC while the probe moves from 0.5 m to 0.25 m. Calculate the potential before and after. Does it change?	**Before: 72 V. After: 72 V. Halving the charge and halving the distance leave Q/r unchanged.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Horizontal axis: distance r (m). Vertical axis: potential V (V). Plot (0.3, 180), (0.6, 90), and (0.9, 60), then draw a decreasing curve through them that approaches zero. Doubling distance from 0.3 m to 0.6 m halves potential from 180 V to 90 V.

Accept calculations using V = kQ/r or proportional reasoning from the table. For the graph, accept a smooth decreasing curve through correctly plotted points that approaches zero without crossing the horizontal axis.