Paths Through Potential

Map a field and predict how charges move

HS-PSII-4.5 "Map electric fields and equipotential lines, showing the electric field lines are perpendicular to the equipotential lines, and draw conclusions about the motion of a charged particle either between or along equipotential lines due the..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the descriptions of the equipotential lines and electric-field arrows. Circle the sentences that explain how a charge's sign affects its motion.

Inside the Plate Chamber

1. Imagine a clear chamber with two broad metal plates facing each other. The left plate is held at 90 volts, and the right plate at 0 volts. Between their central regions, the voltage falls evenly across the gap. A narrow region one third of the way from the left has a potential of 60 volts; another, two thirds of the way across, has a potential of 30 volts. Picture thin vertical lines through these regions on a paper map of the chamber. Each line joins places with the same electric potential, so each is an equipotential line.

2. To map the electric field, draw arrows from higher potential toward lower potential. In the central gap, these arrows run horizontally from left to right. They cross the vertical equipotential lines at right angles, not at a slant. This perpendicular pattern matters because a move along one equipotential line changes position without changing electric potential. The electric field has no component along that line and does no work on a charge moving only along it. A move across the lines changes potential. In this chamber's central region, equal drops of 30 volts occur over equal horizontal distances.

3. A positive test charge feels an electric force in the arrows' direction; a negative charge feels a force opposite the arrows. Released from rest, either kind accelerates in the direction of its force, provided other forces are negligible. A particle already moving along an equipotential line need not stop: its motion parallel to that line continues while the electric force changes its motion across the lines. Its path can curve, even though the field does no work during motion exactly along the line. As a particle crosses equipotential lines, the electric field can change its kinetic energy.

2 ANSWER WITH EVIDENCE

Use the passage

1. On a map of the chamber, where would you draw the 30-volt equipotential line relative to the 60-volt line? How would an electric-field line cross both?

2. A positive test charge is released from rest at the 60-volt line. Will the field push it toward 90 volts or 30 volts? Explain.

3. A negative charge is released from rest at the 30-volt line. Will the field push it toward 60 volts or 0 volts? Explain.

4. A positive charge is already moving upward along the 60-volt line. Does the electric field push it upward along that line? Describe how its path changes.

3 YOUR TURN

Your own words

Draw a new map with horizontal equipotential lines labeled 40 volts at the top, 20 volts in the middle, and 0 volts at the bottom. Add perpendicular electric-field arrows and sketch the path of a negative charge that starts moving right along the 20-volt line. Write one sentence explaining the curve.

ANSWER KEY

Paths Through Potential

HIGH SCHOOL · HS-PSII-4.5

PART 1 · READ AND MARK

Underline the descriptions of the equipotential lines and electric-field arrows. Circle the sentences that explain how a charge's sign affects its motion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	On a map of the chamber, where would you draw the 30-volt equipotential line relative to the 60-volt line? How would an electric-field line cross both?	**Draw the 30-volt line to the right of the 60-volt line. Draw a horizontal field line with a right-pointing arrow, crossing both at right angles.**
2	A positive test charge is released from rest at the 60-volt line. Will the field push it toward 90 volts or 30 volts? Explain.	**Toward 30 volts. A positive charge feels a force in the field's direction, toward lower potential.**
3	A negative charge is released from rest at the 30-volt line. Will the field push it toward 60 volts or 0 volts? Explain.	**Toward 60 volts. A negative charge feels a force opposite the field arrows.**
4	A positive charge is already moving upward along the 60-volt line. Does the electric field push it upward along that line? Describe how its path changes.	**No. The field has no upward component; it pushes the positive charge rightward, so its upward path curves right.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Sketch: three horizontal lines labeled 40 volts at the top, 20 volts in the middle, and 0 volts at the bottom; vertical field arrows point downward; a path begins on the 20-volt line moving right and curves upward. Sentence: The negative charge curves upward because its electric force points opposite the downward electric field.

Accept any path that begins rightward at the 20-volt line and bends upward. Field arrows must point from higher to lower potential and cross the equipotential lines at right angles.