Energy on the Move

Track a charged bead through a uniform electric field.

HS-PSII-4.7 "Apply conservation of energy to determine changes in the electric potential energy, translational kinetic energy, and speed of a single charged object (i.e., a point particle) placed in a uniform electric field."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the bead's starting condition and the rule that keeps its total energy constant. Then circle the two potential-energy values you need to find its speed at C.

A Bead in an Electric Field

1. Inside an evacuated tube, a tiny positively charged bead moves along a frictionless straight track. Its mass is 2 mg, its charge is 2 nC, and a uniform electric field of 1,000 N/C points to the right. Treat the bead as a point particle and ignore other forces. It begins at station A at rest.

2. The table gives the bead's position and electric potential energy at four stations. Station D is the zero of potential energy. For this positive bead, moving right with the field lowers its electric potential energy by 2 μJ for every meter traveled. The electric force transfers that lost energy into translational kinetic energy.

BEAD POSITIONS AND ELECTRIC POTENTIAL ENERGY

Station	Position (m)	Electric potential energy (μJ)
A	0	16
B	2	12
C	4.5	7
D	8	0

3. With no other work done, electric potential energy plus translational kinetic energy stays constant. Kinetic energy is $K = \frac{1}{2}mv^2$. For this 2 mg bead, K in μJ equals its speed in m/s squared. Motion to the left raises potential energy and reduces kinetic energy. The bead cannot reach a station whose potential energy exceeds its total energy.

2 ANSWER WITH EVIDENCE

Use the passage

1. From A to B, how much does the bead's electric potential energy change, how much does its kinetic energy change, and what speed does it reach at B?

2. At C, what are the bead's kinetic energy and speed if it began at rest at A? Show how energy conservation gives the kinetic energy.

3. As the bead moves from B to D, how do its electric potential energy and kinetic energy change, and what is its speed at D?

4. In a separate trial, the same bead starts at D moving left at 3 m/s. Can it reach B? Use energy to justify your answer.

3 YOUR TURN

Your own words

Choose a new starting position between B and C, but not at either station, and release the same bead from rest there. State your position, then use conservation of energy to find its potential energy there, its changes in potential and kinetic energy on reaching D, and its speed at D; show your steps.

Energy on the Move

PART 1 · READ AND MARK

Underline the bead's starting condition and the rule that keeps its total energy constant. Then circle the two potential-energy values you need to find its speed at C. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	From A to B, how much does the bead's electric potential energy change, how much does its kinetic energy change, and what speed does it reach at B?	**Electric potential energy decreases by 4 μJ, kinetic energy increases by 4 μJ, and speed at B is 2 m/s.**
2	At C, what are the bead's kinetic energy and speed if it began at rest at A? Show how energy conservation gives the kinetic energy.	**Kinetic energy is 16 μJ − 7 μJ = 9 μJ. Speed is 3 m/s.**
3	As the bead moves from B to D, how do its electric potential energy and kinetic energy change, and what is its speed at D?	**Electric potential energy decreases by 12 μJ, kinetic energy increases by 12 μJ, and speed at D is 4 m/s.**
4	In a separate trial, the same bead starts at D moving left at 3 m/s. Can it reach B? Use energy to justify your answer.	**No. Its kinetic energy at D is 9 μJ, so its total energy is 9 μJ. Potential energy at B is 12 μJ, which exceeds that total.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I choose a starting position of 3 m. Its potential energy is 16 μJ − (2 μJ/m)(3 m) = 10 μJ. By D, potential energy decreases by 10 μJ, so kinetic energy increases by 10 μJ. Since K in μJ equals speed squared in m/s, its speed at D is √10 m/s, about 3.16 m/s.

Accept any position strictly between 2 m and 4.5 m with consistent calculations. The bead starts with zero kinetic energy, and its potential energy decreases by 2 μJ per meter traveled to the right.