Energy or Voltage?

Read how charge, energy, and voltage relate in a circuit.

HS-PSII-4.6 "Distinguish between electric potential energy and electric potential (i.e., voltage)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each statement about total electric potential energy or energy transferred, and circle each statement about electric potential or voltage. Number two places where the passage explains how charge connects the two ideas.

What a Battery's Voltage Means

(1) Inside a battery, chemical reactions separate electric charges. That separation stores electric potential energy, much as lifting a book stores gravitational potential energy. When charges move through a circuit, energy can be transferred to a lamp, which produces light and heat. Electric potential energy is measured in joules and describes energy associated with the arrangement of charges. The amount of energy involved in moving charge between two points depends on how much charge moves. So an energy value by itself does not tell you how much energy is available for each coulomb of charge.

(2) Electric potential measures electric potential energy per unit charge at a location, compared with a chosen reference location. The difference in electric potential between two locations is voltage. A volt is one joule per coulomb, written J/C. If a battery maintains a voltage between its terminals, that number describes the energy transferred per coulomb of charge passing through the circuit under ideal conditions. Voltage is not the total energy transferred by every charge combined. Think of it as energy per amount of charge, not as a store of energy measured in joules.

(3) For example, a 12 V source can transfer 12 joules for each coulomb that moves through an external circuit. If two coulombs move, the total energy transferred can be 24 joules, while the voltage stays 12 V. Now imagine two identical lamps connected to the same source, one used briefly and the other used longer, in separate tests. If more charge passes through the second lamp, more total energy is transferred, even though the source voltage is unchanged. To compare voltage, divide the energy transferred by the charge moved. To compare total energy transferred, consider both voltage and charge.

2 ANSWER WITH EVIDENCE

Use the passage

1. One battery maintains 3 V in two tests. In the first test, 1 C moves; in the second, 4 C moves. How much energy is transferred in each test, and what stays the same?

2. Two circuits each transfer 18 J of energy. In one, 3 C moves; in the other, 6 C moves. Find each voltage and explain why they differ.

3. Two circuits each move 2 C of charge. One transfers 8 J and the other transfers 14 J. Which has the greater voltage? Show how you know.

4. A student says that a voltage of 5 J/C means 5 J of total energy is transferred. Explain the mistake, then find the total energy transferred when 3 C moves.

3 YOUR TURN

Your own words

Invent two cases involving a battery with the same voltage but different amounts of charge moving. State the voltage and charge in each case, calculate the energy transferred in each, and explain why the voltage stays the same while the total energy differs.

ANSWER KEY

Energy or Voltage?

HIGH SCHOOL · HS-PSII-4.6

PART 1 · READ AND MARK

Underline each statement about total electric potential energy or energy transferred, and circle each statement about electric potential or voltage. Number two places where the passage explains how charge connects the two ideas. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	One battery maintains 3 V in two tests. In the first test, 1 C moves; in the second, 4 C moves. How much energy is transferred in each test, and what stays the same?	**The first test transfers 3 J and the second transfers 12 J. The voltage stays at 3 V.**
2	Two circuits each transfer 18 J of energy. In one, 3 C moves; in the other, 6 C moves. Find each voltage and explain why they differ.	**The voltages are 6 V and 3 V, respectively. The same energy is transferred across different amounts of charge, so the energy per coulomb differs.**
3	Two circuits each move 2 C of charge. One transfers 8 J and the other transfers 14 J. Which has the greater voltage? Show how you know.	**The circuit that transfers 14 J has the greater voltage: 14 J ÷ 2 C = 7 V, compared with 8 J ÷ 2 C = 4 V.**
4	A student says that a voltage of 5 J/C means 5 J of total energy is transferred. Explain the mistake, then find the total energy transferred when 3 C moves.	**5 J/C is energy transferred per coulomb, not total energy. When 3 C moves, the total energy transferred is 15 J.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

In case A, 2 C moves through a circuit at 4 V, transferring 8 J; in case B, 5 C moves through a circuit at 4 V, transferring 20 J. Both cases transfer 4 J per coulomb, so the voltage is the same, but more total energy is transferred in case B because more charge moves.

Accept any correct use of voltage as energy transferred per unit charge and total energy transferred as voltage multiplied by charge. In Part 3, the two cases must use the same voltage, different nonzero amounts of charge, and correctly calculated energy values.