Where Energy Goes

Trace energy changes through a battery-powered circuit.

HS-PSII-5.1 "Relate the idea of electric potential energy to electric potential (i.e., voltage) in the context of electric circuits."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each voltage value in the passage. Underline the words that tell where charge gains electric potential energy and where it transfers that energy to a device.

A Fan at the Campsite

1. At a campsite, a battery powers a small motor that spins a fan and an indicator lamp that glows when the fan is on. Think of electric potential energy as energy associated with the position of charges in an electric field. A battery uses stored chemical energy to push charge through a circuit, raising its electric potential energy. Electric potential, measured in volts, describes electric potential energy per unit of charge. A potential difference of one volt means a change of one joule of electric potential energy for each coulomb of charge. Voltage describes a change per coulomb, not the total energy carried by all the charges.

2. In this fan circuit, the battery provides a potential rise of 12 V. The indicator lamp and motor are connected in series, so the same amount of charge passes through each device. Charge travels from the battery through the lamp and then the motor before returning to the battery. Across the lamp, the potential falls by 2 V as electric potential energy is transferred into light and thermal energy. Across the motor, electric potential energy is transferred mainly into motion and thermal energy. Assume the wires and the battery have no energy losses for this model.

3. Follow a packet of 0.5 C of charge around the circuit. Its electric potential energy increases as it passes through the battery, then decreases in the lamp and motor. To find an energy change in joules, multiply the charge in coulombs by the potential difference in volts. For example, this rule could tell you how much energy a device receives from a passing packet of charge. In one complete trip, the energy gained in the battery equals the energy transferred in both devices combined. Because the devices are in series, their potential drops also add up to the battery's potential rise.

2 ANSWER WITH EVIDENCE

Use the passage

1. How much electric potential energy does the battery add to each coulomb of charge? Explain how you know from its voltage.

2. How much electric potential energy does the 0.5 C packet transfer at the lamp? Use the lamp's voltage drop.

3. What is the motor's voltage drop? Explain how the battery and lamp voltages determine it.

4. How much more energy does the motor receive than the lamp from the 0.5 C packet? Connect your answer to their voltage drops.

3 YOUR TURN

Your own words

Imagine a 15 V battery powering a heater and a fan in series. Choose a different, nonzero voltage drop for each device, then explain how much energy 2 C of charge transfers at each device and gains at the battery.

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PART 1 · READ AND MARK

Circle each voltage value in the passage. Underline the words that tell where charge gains electric potential energy and where it transfers that energy to a device. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How much electric potential energy does the battery add to each coulomb of charge? Explain how you know from its voltage.	**The battery adds 12 J per coulomb because its potential rise is 12 V, or 12 J per coulomb.**
2	How much electric potential energy does the 0.5 C packet transfer at the lamp? Use the lamp's voltage drop.	**The packet transfers 1 J at the lamp: 0.5 C × 2 V = 1 J.**
3	What is the motor's voltage drop? Explain how the battery and lamp voltages determine it.	**The motor's drop is 10 V because the two device drops must total the battery's 12 V rise, and the lamp's drop is 2 V.**
4	How much more energy does the motor receive than the lamp from the 0.5 C packet? Connect your answer to their voltage drops.	**The motor receives 4 J more. Its 10 V drop gives 5 J for 0.5 C, while the lamp's 2 V drop gives 1 J.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I choose a 6 V drop across the heater and a 9 V drop across the fan, which add to 15 V. At the heater, 2 C transfers 12 J; at the fan, it transfers 18 J. The battery adds 30 J of electric potential energy to 2 C, matching the total transferred at the devices.

Accept any two unequal, nonzero device drops that sum to 15 V. Each energy transfer must equal 2 C times that device's drop, and the battery must add 30 J.