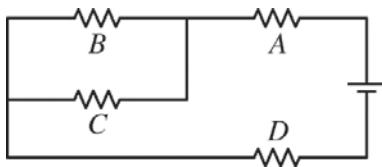


2016 AP® PHYSICS 1 FREE-RESPONSE QUESTIONS



4. (7 points, suggested time 13 minutes)

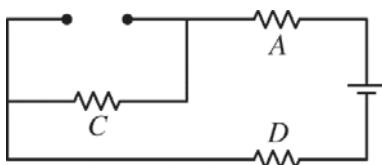
A circuit contains a battery and four identical resistors arranged as shown in the diagram above.

- (a) Rank the magnitude of the potential difference across each resistor from greatest to least. If any resistors have potential differences with the same magnitude, state that explicitly. Briefly explain your reasoning.

Ranking:

Brief explanation:

Resistor *B* is now removed from the circuit, and there is no connection between the wires that were attached to it. The new circuit diagram is shown below.



- (b) When resistor *B* is removed, does the current through resistor *A* increase, decrease, or remain the same?

Increase Decrease Remain the same

Briefly explain your reasoning.

- (c) When resistor *B* is removed, does the current through resistor *C* increase, decrease, or remain the same?

Increase Decrease Remain the same

Briefly explain your reasoning.

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Question 4

7 points total

**Distribution
of points**

(a) 3 points

Correct ranking is $(A = D) > (B = C)$.

For indicating that the potential difference is the same across A and D because the current is the same through each (A and D are in series.) 1 point

For indicating that the potential difference is the same across B and C because B and C are in parallel 1 point

For indicating that the potential difference is less across B (and/or C) than across A (and/or D) because the current splits or the current is less through B and C 1 point

Example: The full battery current passes through both A and D , so they have the same current. Because they have the same resistance, $\Delta V_A = \Delta V_D$. B and C are in parallel, so $\Delta V_B = \Delta V_C$. Less than the full current passes through B , and A and B have the same resistance, so ΔV_B is less than ΔV_A .

(b) 2 points

Correct answer: Decrease

No points are earned if the correct answer is selected, but the explanation is completely incorrect, or there is no explanation.

If the wrong answer is selected, up to one point can still be earned.

For indicating that the effective resistance of the circuit increases 1 point

For a correct explanation of why the current through A decreases based on changes in current or potential difference throughout the circuit 1 point

Examples:

Because B is replaced with an infinite resistance, the effective resistance of the circuit increases and the battery current decreases. Because the battery current decreases and that current equals the current through A , the current through A decreases.

When B is removed, the effective resistance of that piece of the circuit increases because there is no longer a parallel combination there. Because the resistance is greater, the potential difference across that piece is a greater percent of the total. So the potential difference across A decreases and thus the current through it decreases.

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Question 4 (continued)

**Distribution
of points**

(c) 2 points

Correct answer: Increase

No points are earned if the correct answer is selected, but the explanation is completely incorrect, or there is no explanation.

If the wrong answer is selected, up to one point can still be earned.

For indicating that all the current from the battery passes through C ; the current no longer splits 1 point

For making either a current argument or potential difference argument for the increase (i.e., an argument for why an increase in current through C more than compensates for the decrease in the full current or explaining that, by the loop rule, the potential difference across C must increase in order for the potential difference around the circuit loop to remain zero) 1 point