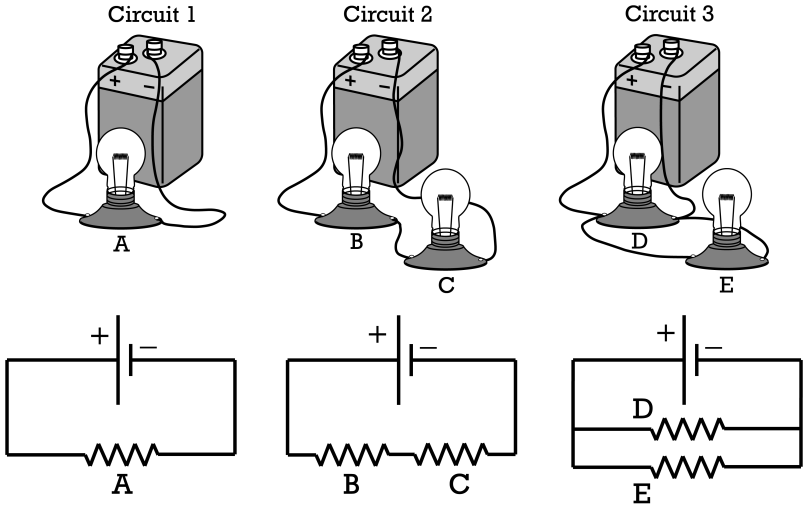
Flipping Physics Lecture Notes:

2017 #1 Free Response Question - AP Physics 1 - Exam Solution
http://www.flippingphysics.com/ap1-2017-frq1.html

This Paragraph Argument Short Answer question also works as a part of the AP Physics C: Electricity & Magnetism curriculum.



In the three circuits shown above, the batteries are all identical, and the lightbulbs are all identical. In circuit 1 a single lightbulb is connected to the battery. In circuits 2 and 3, two lightbulbs are connected to the battery in different ways, as shown. The lightbulbs are labeled A–E.

(a) Rank the magnitudes of the potential differences across lightbulbs A, B, C, D, and E from largest to smallest. If any lightbulbs have the same potential difference across them, state that explicitly.

Ranking: $A = D = E > B = C$

Briefly explain how you determined your ranking: *A, D, and E are each connected across the battery, and therefore, each has the same electric potential difference as the battery. B and C are in series with the battery and therefore have an electric potential difference which is less than the electric potential difference across the battery. B and C are identical and therefore have the same electric potential difference.*

(b) The batteries all start with an identical amount of usable energy and are all connected to the lightbulbs in the circuits at the same time.

In which circuit will the battery run out of usable energy first?
____ Circuit 1 ____ Circuit 2 _X_ Circuit 3

In which circuit will the battery run out of usable energy last?
____ Circuit 1 _X_ Circuit 2 ____ Circuit 3

In a clear, coherent paragraph-length response that may also contain equations and drawings, explain your reasoning.

The rate at which the battery uses its electric potential energy is electric power. Electric power equals current times electric potential difference. The electric potential differences of all three batteries are the same, so the electric power of each battery is directly proportional to the current delivered by each battery. Considering electric potential difference equals current times resistance, current is inversely

proportional to resistance. Therefore, the circuit with the smallest equivalent resistance will have the largest current delivered by the battery and will run out of usable energy first, and the circuit with the largest equivalent resistance will have the smallest current delivered by the battery and will run out of usable energy last.

Circuit 3 has two resistors in parallel and adding a resistor in parallel decreases the equivalent resistance. That means circuit 3 has the smallest equivalent resistance and will run out of usable energy first.

Circuit 2 has two resistors in series and adding a resistor in series increases the equivalent resistance. That means circuit 2 has the largest equivalent resistance and will run out of usable energy last.

From the Scoring Guidelines, you gain 1 point out of 7 for this question for part (b):
"For a logical, relevant, and internally consistent argument that addresses the required argument or question asked, and follows the guidelines described in the published requirements for the paragraph-length response."

Please make sure you have watched my video describing Qualitative/Quantitative Translation and Paragraph Argument Short Answer! https://www.flippingphysics.com/qqt-pasa.html And realize, you can gain a point for "a logical, relevant, and internally consistent argument" even if your conclusions end up being incorrect.