a place of mind

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Physics
Circuits

Science and Mathematics
Education Research Group

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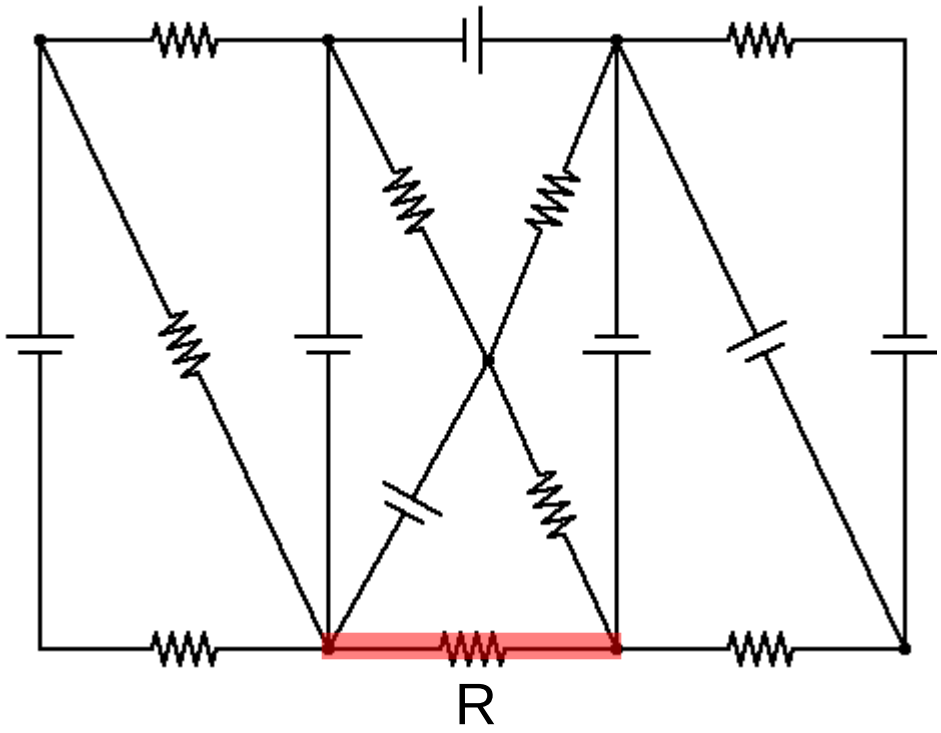
Multiple Battery Circuit



Single Battery Circuit I

A. 0.5 A

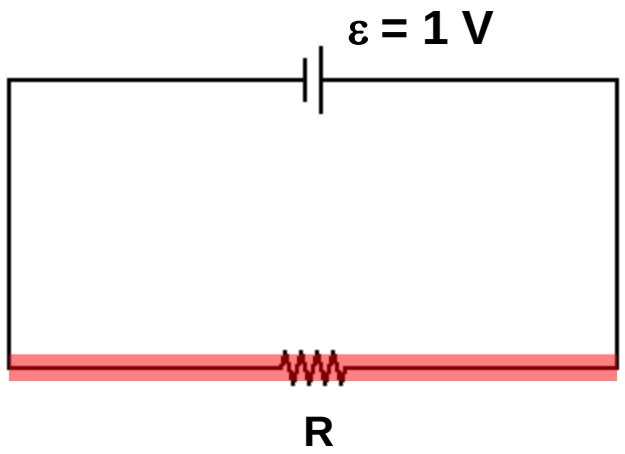
B. 1 A

C. 2 A

D. 4 A

E. None of the above

What is the current through the resistor labelled R? Each resistor has a resistance of 1 Ω and each battery is a 1 V battery.



Circuit built on falstad.com/circuit

Solution

Answer: B

Justification: This is a simple one battery, one resistor (one loop) circuit.

According to Ohm's Law: $I = \frac{V}{R}$, the current across the resistor is simply the voltage provided by the battery divided by the resistance:

$$I = \frac{V}{R} = \frac{1\,\text{V}}{1\,\Omega} = 1\,\text{A}$$

All other answers are incorrect application of the Ohm's Law.

Additional Resources: To see a simulation of this circuit, go to goo.gl/W4D3c. Make sure you have java installed or the applet will not run or you can alternatively use PhET circuit simulations.

Multiple Battery Circuit II

What is the current through the resistor labelled R_1? Each resistor is 1 Ω and each battery is 1 V

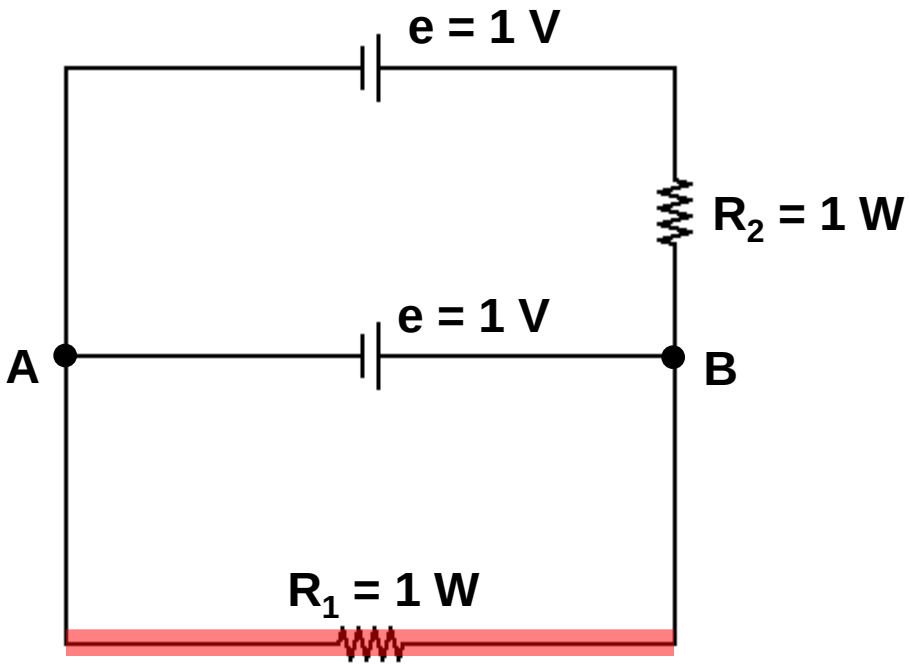
A. 0.5 A

B. 1 A

C. 2 A

D. 4 A

E. None of the above



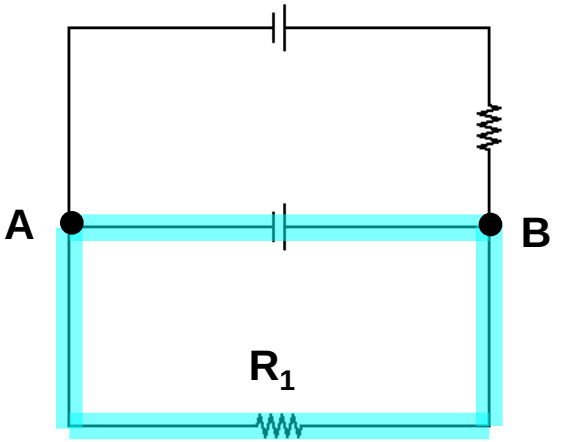
Circuit built on falstad.com/circuit

Solution

Answer: B

Justification: Since V_B-V_A is equal to the battery voltage, or 1 V, the voltage across resistor R_1 is 1 V. Therefore, applying the same considerations as in the earlier question (Ohm's law), 1 A of current must flow across resistor R_1. The rest of the circuit is superfluous as we only need to consider the potential difference across R_1.

Additional Resources: To see a simulation of this circuit, go to goo.gl/IZemE.



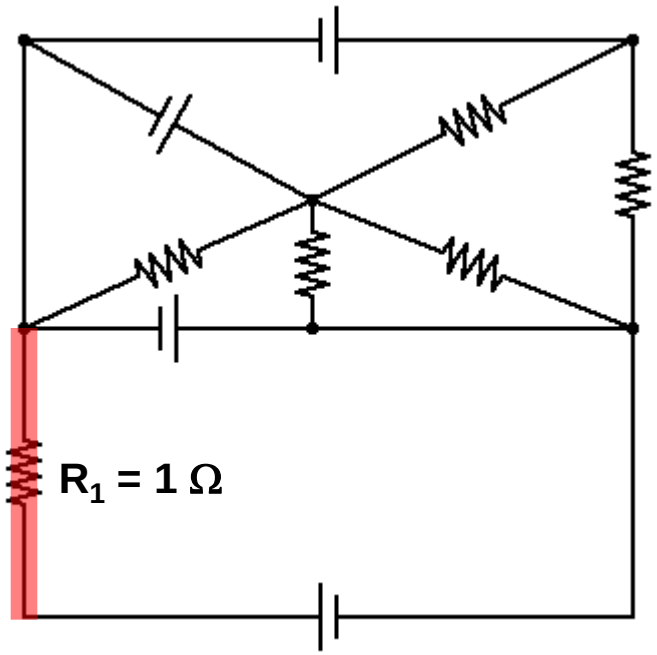
All other answers apply Ohm's law incorrectly.

Key concept: If you know the voltage across a resistor and its resistance, you can use Ohm's Law to find the current flowing through it.

Multiple Battery Circuit III

What is the current through the resistor labelled R_1? Each resistor is 1 Ω and each battery is 1 V

A. 4 A
B. 3.45 A
C. 2 A
D. 1 A
E. None of the above



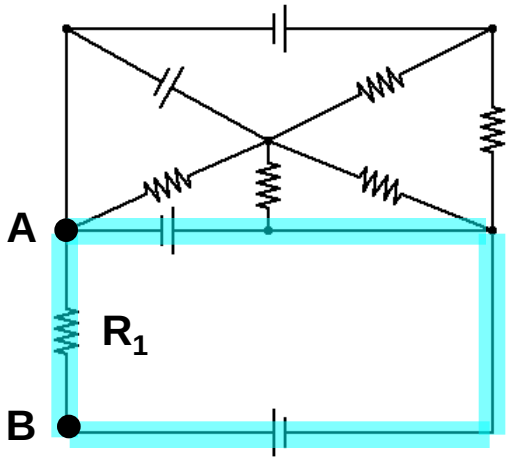
Circuit built on falstad.com/circuit

Solution

Answer: C

Justification: Similar to the last question, the top part of this circuit is completely irrelevant. As the voltage at the terminals of a battery must differ by the value of the battery, the voltage between the ends of the resistor must be equal to 2 V as the resistor is connected to two batteries in a loop. This gives us our answer of 2 A for the current.

Key concept: If you know the voltage across a resistor and its resistance, you can use Ohm's Law to find the current flowing through it. In a simple case, in order to find this voltage try to identify a closed loop that includes this element, batteries and no other resistors. Remember to notice how the batteries are connected (directionality) – "+ and –" .



Multiple Battery Circuit IV

A. 3 A

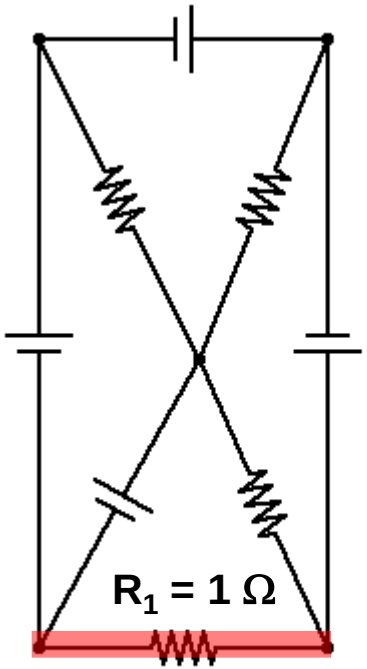
B. 7 A

C. 3.9 A

D. 1 A

E. None of the above

What is the current through the resistor labelled R_1? Each resistor is 1 Ω and each battery is 1 V



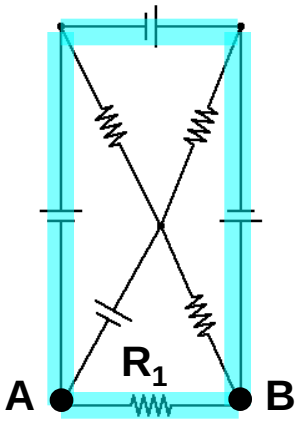
Circuit built on falstad.com/circuit

Solution

Answer: A

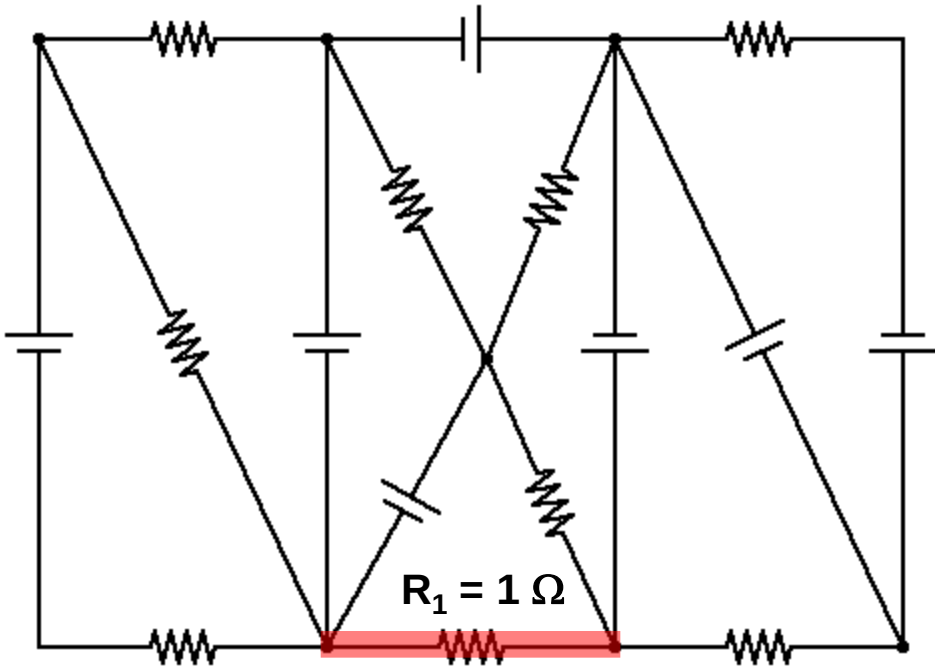
Justification: Look at the outside loop of the circuit, which is three batteries and a resistor. Each battery brings the voltage up by 1 V. Since there are three batteries, there is 3 V across the resistor, which means that 3 A flows through the resistor.

Key concept: If you know the voltage across a resistor and its resistance, you can use Ohm's Law to find the current flowing through it. In a simple case, in order to find this voltage try to identify a closed loop that includes this element, batteries and no other resistors. Remember to notice how the batteries are connected (directionality) – "+ and –" .



Multiple Battery Circuit V

What is the current through the resistor labelled R_1? Each resistor is 1 Ω and each battery is 1 V



A. 3 A
B. 7 A
C. 3.9 A
D. 1 A
E. None of the above

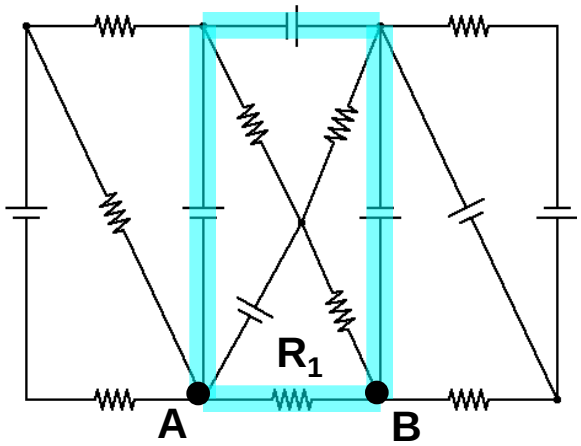
Circuit built on falstad.com/circuit

Solution

Answer: A

Justification: There is a loop consisting only of three batteries and the resistor R_1. Since the potential difference across ends of the resistor must be equal to the potential difference across the three batteries in the loop, 3 A of current flows through the resistor due to the 3 V of potential difference.

Key concept: While the question looks more complicated than the questions we encountered earlier, the concept behind it is the same and it is NOT more difficult than the previous ones!



Multiple Battery Circuit VI

A. 3 A

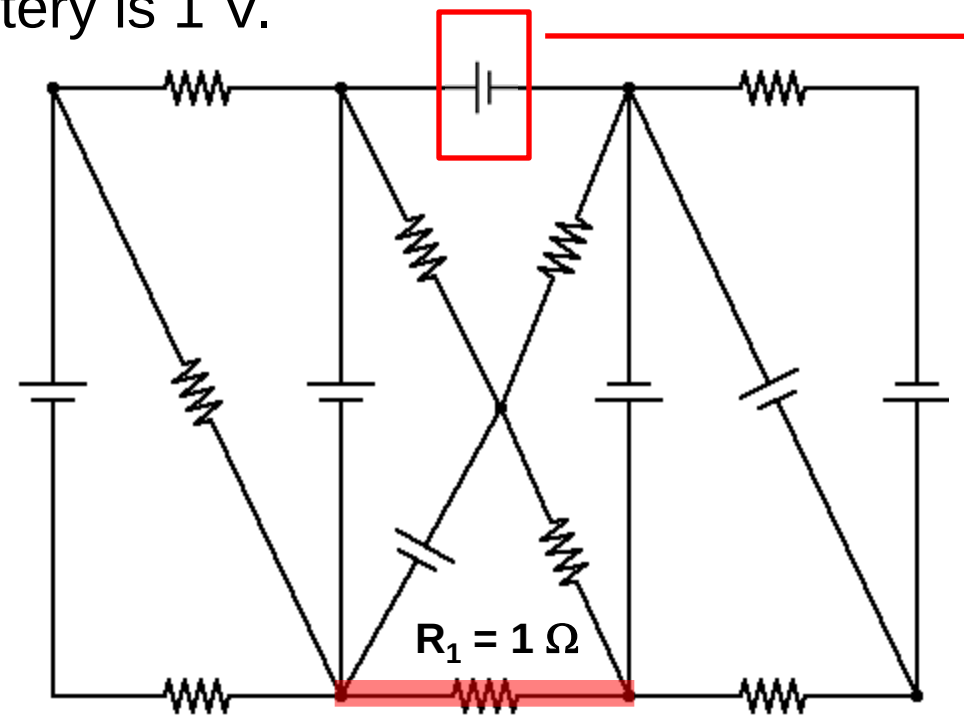
B. 7 A

C. 3.9 A

D. 1 A

E. None of the above

What is the current through the resistor labelled R_1? Each resistor is 1 Ω and each battery is 1 V.



Notice the direction of the battery is reversed compared to the previous question

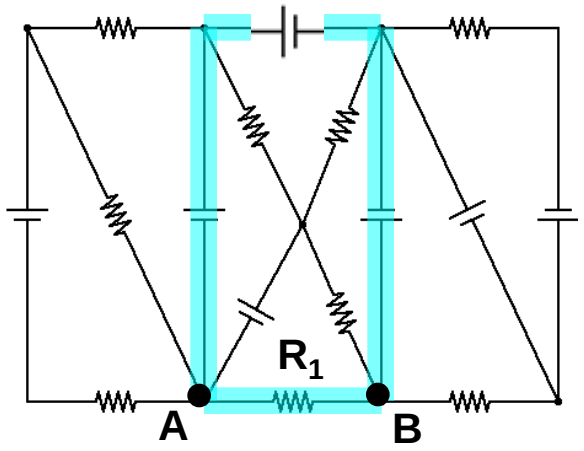
Circuit built on falstad.com/circuit

Solution

Answer: A

Justification: There is a loop consisting only of three batteries and the resistor R_1. Once again, the potential difference across ends of the resistor must be equal to the potential difference across the three batteries, which is 1 V in this case: 1 V – 1 V +1 V = 1 V (notice the directionality of the middle battery). Therefore, the current of 1 A flows through the resistor .

Key concept: Notice, while adding up the voltages across the batteries, you have to pay attention at the directions of the batteries relatively to each other: two identical batteries connected in series can either enhance each other: 1 V + 1 V = 2 V, or cancel each other 1 V – 1 V = 0 V (as in this example).



Multiple Battery Circuit VII

What is the current through the resistor labelled R? Each resistor is 1 Ω and each battery is 1 V

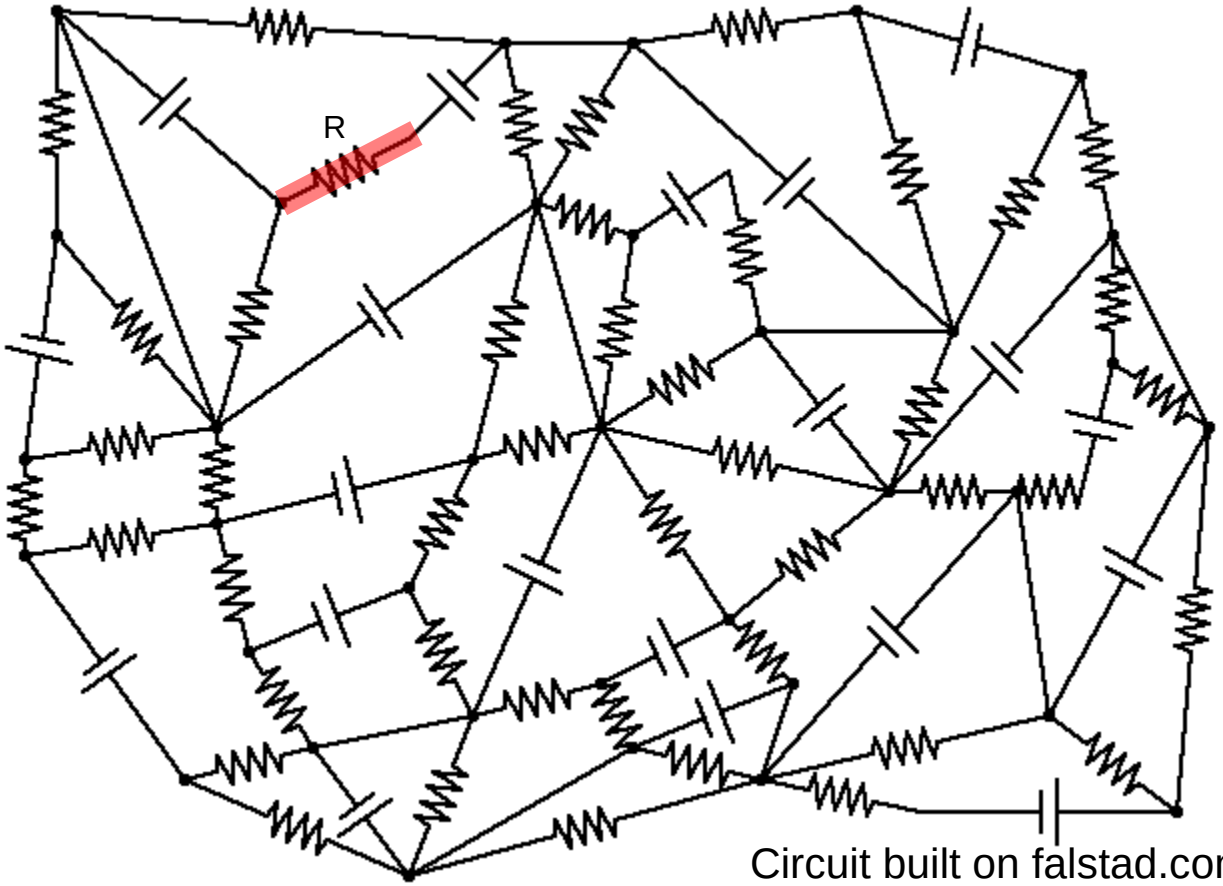
A. 15.42 A

B. 11 A

C. 0 A

D. 3.97 A

E. None of the above



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Solution

Answer: B

Justification: Consider the highlighted route below, which consists of 11 batteries and resistor R. As you can see, since each battery is connected to another by a wire, the highlighted network has a total potential difference of 11 V at the ends of resistor R. 11 V/1 Ω is 11 A, which is our answer.