Task:
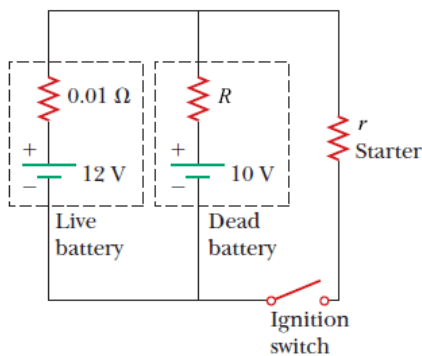
A dead battery is charged by connecting it to the live battery of another car with jumper cables (see figure). (Take R = 2.03 Ω and r = 0.09 Ω. For this problem, if your answers are used in any subsequent calculations, make sure to base your calculation on the rounded values

(a) Determine the current in the starter.

(b) Determine the current in the dead battery.

Solution:

I'll list all resistors in milliohms for ease of calculation.

Use superposition.
1. Replace 10 V battery with a short. Parallel combo of 2030 mΩ and 90 mΩ is 86.18 mΩ. That is in series with 10 mΩ for total of 96.18 mΩ. Total Current is 12 V / 96.18 mΩ = 124.77 A. That produces a voltage across the starter of 10.75 V, and a current through it of 119.47 A.

2. Replace 12 V battery with a short. Parallel combo of 10 mΩ and 90 mΩ is 9 mΩ. That is in series with 2030 mΩ for total of 2039 mΩ. Total Current is 10 V / 2039 mΩ = 4.904 A. That produces a voltage across the starter of 0.044 volts, and a current through it of 0.49 A.

Total current is the sum, 119.47 A +0.49 A = 119.96 A

this means the voltage across the starter of is 10.796 V.
The voltage across R is 10.796 V −10 V = 0.796 V
The current through R is 0.796 V / 2030 mΩ = 0.392 A, downwards

Answer:

(a) Total current is 119.96 A

(b) The current through R is 0.392 A, downwards