**Chapter 28. Direct-Current Circuits**

St. ID: , Name:

1. Calculate the power delivered to each resistor in the circuit shown in Figure P27.13.

Ans: P1= 4.00W, P2=14.2W, P3=1.33W, P4=28.4W

To find the current in each resistor, we find the resistance seen by the battery. The given circuit reduces as shown in ANS. FIG. P27.13 (a), since

  

In ANS. FIG. P27.13 (b),

*I* = 18.0 V/6.75 Ω = 2.67 A

This is also the current in ANS. FIG. P27.13 (a), so the 2.00-Ω and 4.00-Ω resistors convert powers

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And **

The voltage across the 0.750-Ω resistor in ANS. FIG. P27.13 (a), and across both the 3.00-Ω and the 1.00-Ω resistors in Figure P27.13, is

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Then for the 3.00-Ω resistor,



 and the power is



 For the 1.00-Ω resistor,



1. Four resistors are connected to a battery as shown in Figure P27.15. (a) Determine the potential difference across each resistor in terms of ε. (b) Determine the current in each resistor in terms of *I.* (c) **What If?** If *R*3 is increased, explain what happens to the current in each of the resistors. (d) In the limit that *R*3→∞, what are the new values of the current in each resistor in terms of *I*, the original current in the battery?

Ans: (a) ∆V1= ***ε***/3, ∆V2= 2***ε***/9, ∆V3= 4***ε***/9, ∆V4= 2***ε***/3

(b) I1=I, I2=I/3, I3=I/3, I4=2I/3

(c) I1 increases andI1, I2,and I3 decrease

(d) I1=3I/4, I2=0, I3=0, I4=3I/4

(a) The resistors 2, 3, and 4 can be combined to a single 2*R* resistor. This is in series with resistor 1, with resistance *R*, so the equivalent resistance of the whole circuit is 3*R*. In series, potential difference is shared in proportion to the resistance, so resistor 1 gets 1/3 of the battery voltage and the 2-3-4 parallel combination gets 2/3 of the battery voltage. This is the potential difference across resistor 4, but resistors 2 and 3 must share this voltage. 1/3 goes to 2 and 2/3 to 3. The ranking by potential difference is



Based on the reasoning above the potential differences are

 

 (b) All the current goes through resistor 1, so it gets the most. The current then splits at the parallel combination. Resistor 4 gets more than half, because the resistance in that branch is less than in the other branch. Resistors 2 and 3 have equal currents because they are in series. The ranking by current is

 

Resistor 1 has a current of *I*. Because the resistance of 2 and 3 in series is twice that of resistor 4, twice as much current goes through 4 as through 2 and 3. The current through the resistors are

 

(c) Increasing resistor 3 increases the equivalent resistance of the entire circuit. The current in the circuit, which is the current through resistor 1, decreases. This decreases the potential difference across resistor 1, increasing the potential difference across the parallel combination. With a larger potential difference the current through resistor 4 is increased. With more current through 4, and less in the circuit to start with, the current through resistors 2 and 3 must decrease. To summarize,

 

(d) If resistor 3 has an infinite resistance it blocks any current from passing through that branch, and the circuit effectively is just resistor 1 and resistor 4 in series with the battery. The circuit now has an equivalent resistance of 4*R*. The current in the circuit drops to 3/4 of the original current because the resistance has increased by 3/4. All this current passes through resistors 1 and 4, and none passes through 2 or 3. Therefore,

 

1. The resistance between terminals *a* and *b* in Figure P27.36 is 75.0 V. If the resistors labeled *R* have the same value, determine *R.*

Ans: R=55.0Ω

The equivalent resistance is Req = *R* + Rp, where Rp is the total resistance of the three parallel branches;

 

Thus,

 

which reduces to



or 

Only the positive solution is physically acceptable, so .

1. A power supply has an open-circuit voltage of 40.0 V and an internal resistance of 2.00 V. It is used to charge two storage batteries connected in series, each having an emf of 6.00 V and internal resistance of 0.300 V. If the charging current is to be 4.00 A, (a) what additional resistance should be added in series? At what rate does the internal energy increase in (b) the supply, (c) in the batteries, and (d) in the added series resistance? (e) At what rate does the chemical energy increase in the batteries?

Ans: (a) R=4.40Ω (b) P=32.0W (c) P=9.60W (d) P=9.60W (e) P=48.0W

(a) Around the circuit,



Substituting numerical values,

 

 so 

 (b) Inside the supply,

 

 (c) Inside both batteries together,



 (d) For the limiting resistor,

 

 (e) 