Part L Problems

1. Two 4-ohm resistors are connected in series. (a) What is the equivalent resistance of this combination? (b) What would be the equivalent resistance if they were connected in parallel?

2. Prove that the equivalent resistance of two resistors R connected in parallel is R/2, then show that the equivalent resistance of three resistors R connected in parallel is R/3.

3. A battery is connected to a single resistor. The power output of the battery is 30 watts. What would be the power output if the battery voltage were doubled?

4. An incandescent light bulb designed for use with a 110-volt power supply is marked as 75 W. What is the bulb's filament resistance?

5. What must be the voltage of a battery connected to a single 20-ohm resistor in order that the power consumed by the resistor be 40 watts?

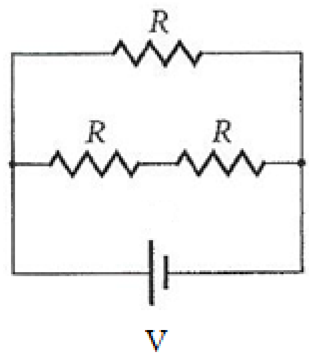
6. If the power consumed by a resistor is 200 W, what would be the power consumed if the current through the resistor were tripled?

7. Six amperes approach the branch point of a pair of equal resistors. The total power consumed by the pair is 54 W. What is the resistance of each resistor?

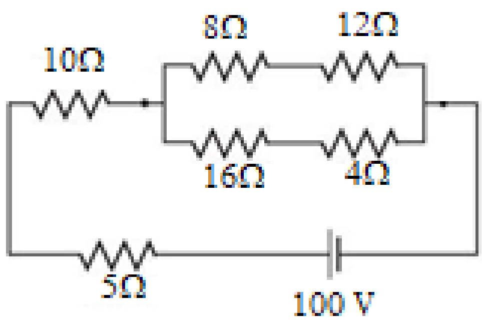
8. A 12-volt battery is in series with a 4-ohm resistor and a 2-ohm resistor. What is the power consumed by each resistor?

9. A 3-Ω resistor is connected in parallel with a 6-Ω resistor, and the combination is attached to the terminals of a 10-volt battery. What is the total power consumed by the two resistors, in watts?

10. Each of the three resistors in the circuit below has the same resistance, 6 ohms. The battery voltage is 24 volts. The power consumed in the upper resistor is 96 watts. What power is consumed in the lower branch of the parallel combination?

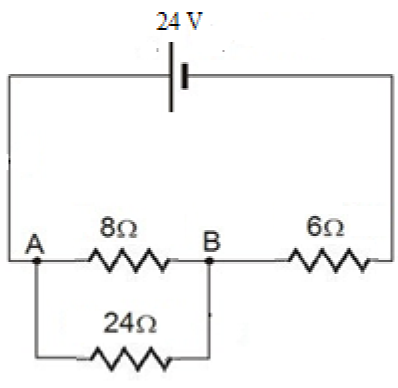


11. What is the power output of the battery in the circuit below?

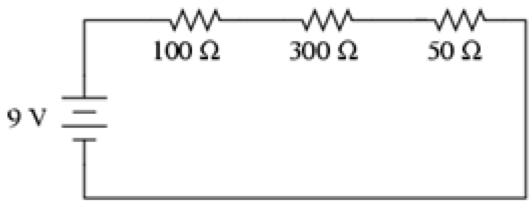


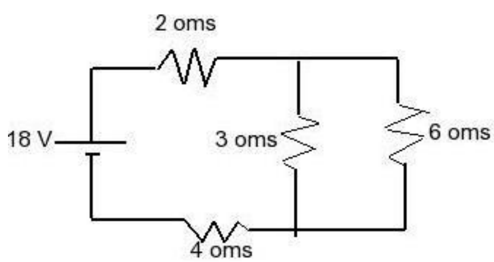
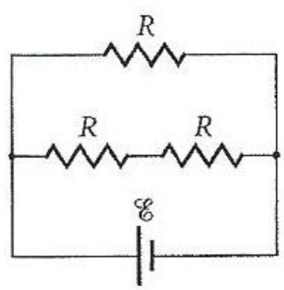
12. Two identical resistors are connected in parallel. Across the branch points of this parallel combination is connected a 40-volt battery. What would have to be the resistance of each resistor in order that the output power of the battery be 100 watts?

13. What is the power consumed by 8-ohm resistor in the circuit below?



14. What is the power output (in milli-watts) of the battery below?



15. What is the power consumed by the 6-ohm resistor in the circuit below? 	16. Each of the three resistors in the circuit below has a resistance of 10 ohms. The current through the top branch is 4.0 A, and the current through the bottom branch is 2.0 A. What is the power output (in watts) of the battery? 

Solutions

1.

(a) $R = 4 + 4$
$= 8\ \Omega$

(b) $R = (4)(4)/(4 + 4)$
$= 2\ \Omega$

2. Replace two of the three resistors in parallel with each other:

$R_{EQ} = (R)(R))/(R + R)$
$= R/2$

Then, we have R/2 in parallel with the third R:

$(R/2)R / (R/2 + R)$
$= (R^2/2) / (3R/2)$
$= (R^2/2)(2/3R)$
$= R/3$

General Rule: if N resistors of *equal* resistance R are in parallel, the equivalent resistance is R/N.

3.

$P = IV$

Doubling V doesn't mean the product IV is doubled because when battery voltage is changed, the current from the batter also changes.

The alternative battery power equation $P = V^2/R$ makes it easier to see what happens to P when V is doubled:

When V is doubled, V^2 is quadrupled, while R doesn't change. Consequently, V^2/R is likewise quadrupled. Therefore, when V is doubled, P is quadrupled from 30 W to 120 W.

4. $P = V^2/R$
$75 = 110^2/R$
$R = 161\ \Omega$

5. $40 = V^2/20$
$V = 28.3$ volts

6. $P_1 = I_1^2R$
$= 200$
$P_2 = (3I_1)^2 R$
$= 9 I_1^2R$
$= 9 (200)$
$= 1800$ W

7. Equal resistances in parallel, so each receives half of the 6 A that arrives at the branch point, and therefore they each consume the same power. Each consumes half of 54 W, or 27 W. $3^2R = 27$ $R = 3\ \Omega$	**8.** $R = 4 + 2$ $= 6\ \Omega$ $I = 12/6$ $= 2$ A 4 Ω power: $2^2\,4 = 16$ W 2 Ω power: $2^2\,2 = 8$ W	**9.** $(3)(6)/(3+6) = 2\ \Omega$ $I = 10/2$ $= 5$ A $P = 5(10)$ $= 50$ W = Power Produced The power consumed equals the power produced, so the two resistors together consume 50 W of power.

10. Equivalent resistance: (6)(12)/(6 + 12) = 4 ohms. Battery Output Power: $P = 24^2/4$ $= 144$ watts Top branch consumes 96 W, so the bottom branch uses 144-96 = 48 watts.	**11.** Top branch: 20 Ω Bottom branch: 20 Ω $R_{EQ} = 10\ \Omega$ 10 Ω in series with 10 Ω and 5 Ω gives a total equivalent resistance of 25 Ω. $P = 100^2/25$ $= 400$ W	**12.** $40^2/R = 100$ $R = 16\ \Omega$ Two 32-Ω resistors in parallel have an equivalent resistance of 16 Ω.

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13.

8 Ω and 24 Ω in parallel: 6 Ω

6 Ω in series with 6 Ω is equivalent to 12 Ω.

I = V/R
= 24/12
= 2 A

Current out of battery: 2 A

Current through 8 Ω:

I = (24/32)2
= 1.5 A

$P = (1.5)^2\,8$
= 18 W

14. R =100 + 300 + 50
= 450 Ω

$P = V^2/R$
$= 9^2/450$
= 0.180 W
= 180 mW

15.

3 Ω and 6 Ω in parallel is equivalent to 2 Ω. That resistor is in series with the other 2 Ω resistor and the 4 Ω resistor. Therefore, the total resistance seen by the battery is 2 + 2 + 4 = 8 Ω

2 Ω in series with 2 Ω and 4 Ω gives a total equivalent resistance = 8 Ω

Current from battery:
I = V/R
= 18/8
= 2.25 A
Other divided by sum rule:
6 Ω current = (3/9)(2.25)
= 0.75 A
$P = 0.75^2(6)$
= 3.38 W

16.

4 A through the 10 Ω resistor:

$P = 4^2(10)$
= 160 W

2 A through each of the two other resistors:

$P = 2^2\,(10) + 2^2\,(10)$
= 80 W
Total from battery:

160 + 80 = 240 W