HOMEWORK WEEK 4

17. **SSM** **WWW** ***REASONING*** The resistance of a metal wire of length L, cross-sectional area A and resistivity ρ is given by Equation 20.3: $R = \rho L / A$. The volume V_2 of the new wire will be the same as the original volume V_1 of the wire, where volume is the product of length and cross-sectional area. Thus, $V_1 = V_2$ or $A_1L_1 = A_2L_2$. Since the new wire is three times longer than the first wire, we can write

$$A_1L_1 = A_2L_2 = A_2(3L_1) \quad \text{or} \quad A_2 = A_1/3$$

We can form the ratio of the resistances, use this expression for the area A_2, and find the new resistance.

SOLUTION The resistance of the new wire is determined as follows:

$$\frac{R_2}{R_1} = \frac{\rho L_2 / A_2}{\rho L_1 / A_1} = \frac{L_2 A_1}{L_1 A_2} = \frac{(3L_1)A_1}{L_1(A_1/3)} = 9$$

Solving for R_2, we find that

$$R_2 = 9R_1 = 9(21.0\ \Omega) = \boxed{189\ \Omega}$$

21. ***REASONING AND SOLUTION*** According to Equation 20.6c, the power dissipated by the iron is

$$P = \frac{V^2}{R} = \frac{(120\ \text{V})^2}{24\ \Omega} = \boxed{6.0 \times 10^2\ \text{W}}$$

23. **SSM** ***REASONING*** According to Equation 6.10b, the energy used is Energy = Pt, where P is the power and t is the time. According to Equation 20.6a, the power is $P = IV$, where I is the current and V is the voltage. Thus, Energy = IVt, and we apply this result first to the dryer and then to the computer.

SOLUTION The energy used by the dryer is

$$\text{Energy} = Pt = IVt = (16\ \text{A})(240\ \text{V})(45\ \text{min})\underbrace{\left(\frac{60\ \text{s}}{1.00\ \text{min}}\right)}_{\text{Converts minutes to seconds}} = 1.04 \times 10^7\ \text{J}$$

For the computer, we have

$$\text{Energy} = 1.04 \times 10^7\ \text{J} = IVt = (2.7\ \text{A})(120\ \text{V})t$$

Solving for t we find

$$t=\frac{1.04\times10^7\text{ J}}{(2.7\text{ A})(120\text{ V})}=3.21\times10^4\text{ s}=\left(3.21\times10^4\text{ s}\right)\left(\frac{1.00\text{ h}}{3600\text{ s}}\right)=\boxed{8.9\text{ h}}$$

---

39. SSM ***REASONING*** Using Ohm's law (Equation 20.2) we can write an expression for the voltage across the original circuit as $V = I_0R_0$. When the additional resistor R is inserted in series, assuming that the battery remains the same, the voltage across the new combination is given by $V = I(R + R_0)$. Since V is the same in both cases, we can write $I_0R_0 = I(R + R_0)$. This expression can be solved for R_0.

SOLUTION Solving for R_0, we have

$$I_0R_0 - IR_0 = IR \quad \text{or} \quad R_0(I_0 - I) = IR$$

Therefore, we find that

$$R_0=\frac{IR}{I_0-I}=\frac{(12.0\text{ A})(8.00\ \Omega)}{15.0\text{ A}-12.0\text{ A}}=\boxed{32\ \Omega}$$

41. ***REASONING AND SOLUTION*** The equivalent resistance of the circuit is

$$R_s = R_1 + R_2 = 36.0\ \Omega + 18.0\ \Omega = 54.0\ \Omega$$

Ohm's law for the circuit gives $I = V/R_s$ = (15.0 V)/(54.0 Ω) = 0.278 A

a. Ohm's law for R_1 gives V_1 = (0.278 A)(36.0 Ω) = $\boxed{10.0\text{ V}}$

b. Ohm's law for R_2 gives V_2 = (0.278 A)(18.0 Ω) = $\boxed{5.00\text{ V}}$

43. SSM ***REASONING*** The equivalent series resistance R_S is the sum of the resistances of
the three resistors. The potential difference V can be determined from Ohm's law as $V = IR_S$.

SOLUTION

a. The equivalent resistance is

$$R_s = 25\ \Omega + 45\ \Omega + 75\ \Omega = \boxed{145\ \Omega}$$

b. The potential difference across the three resistors is

$$V = IR_S = (0.51\text{ A})(145\ \Omega) = \boxed{74\text{ V}}$$