Design Problems

DP 2-1 Specify the resistance R in Figure DP 2-1 so that both of the following conditions are satisfied:

1. $i > 40$ mA.

2. The power absorbed by the resistor is less than 0.5 W.

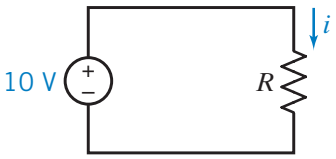

Figure DP 2-1

Solution:

$$1.)\ \frac{10}{R} > 0.04 \quad \Rightarrow \quad R < \frac{10}{0.04} = 250\,\Omega$$

$$2.)\ \frac{10^2}{R} < \frac{1}{2} \quad \Rightarrow \quad R > 200\,\Omega$$

Therefore 200 < R < 250 Ω. For example, R = 225 Ω.

DP 2-2 Specify the resistance R in Figure DP 2-2 so that both of the following conditions are satisfied:

1. $v > 40$ V.

2. The power absorbed by the resistor is less than 15 W.

Hint: There is no guarantee that specifications can always be satisfied.

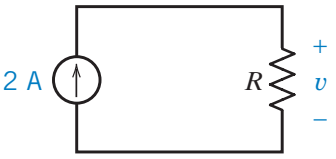

Figure DP 2-2

Solution:

$$1.)\ 2R > 40 \quad \Rightarrow \quad R > 20\,\Omega$$

$$2.)\ 2^2 R < 15 \quad \Rightarrow \quad R < \frac{15}{4} = 3.75\,\Omega$$

Therefore 20 < R < 3.75 Ω. These conditions cannot satisfied simultaneously.

DP 2-3 Resistors are given a power rating. For example, resistors are available with ratings of 1/8 W, 1/4 W, 1/2 W, and 1 W. A 1/2-W resistor is able to safely dissipate 1/2 W of power, indefinitely. Resistors with larger power ratings are more expensive and bulkier than resistors with lower power ratings. Good engineering practice requires that resistor power ratings be specified to be as large as, but not larger than, necessary.

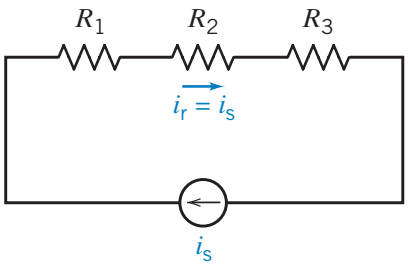

Figure DP 2-3

Consider the circuit shown in Figure DP 2-3. The values of the resistances are

$$R_1 = 1000\,\Omega, R_2 = 2000\,\Omega, \text{ and } R_3 = 4000\,\Omega$$

The value of the current source current is

$$i_s = 30\,\text{mA}$$

Specify the power rating for each resistor.

Solution::

$$P_1 = (30\text{ mA})^2 \cdot (1000\,\Omega) = (.03)^2\,(1000) = 0.9\text{ W} < 1\text{ W}$$

$$P_2 = (30\text{ mA})^2 \cdot (2000\,\Omega) = (.03)^2\,(2000) = 1.8\text{ W} < 2\text{ W}$$

$$P_3 = (30\text{ mA})^2 \cdot (4000\,\Omega) = (.03)^2\,(4000) = 3.6\text{ W} < 4\text{ W}$$