Exercise 2.3 Find the equivalent resistance between the indicated terminals (all resistances in ohms) in Figure 2.3.

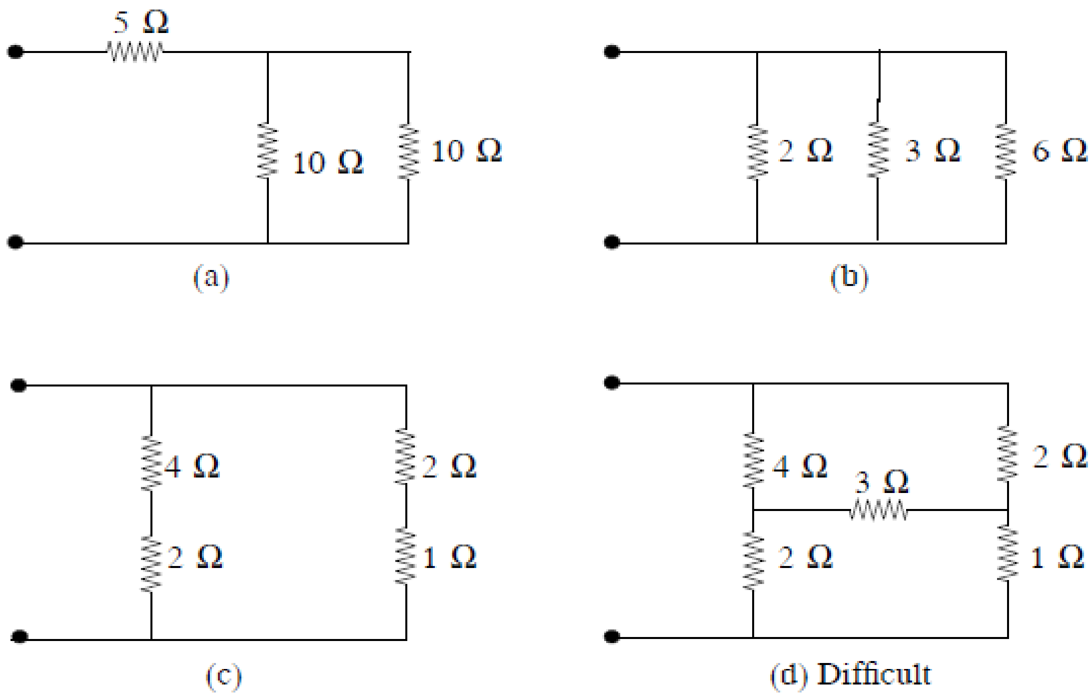


Figure 2.3:

Solution:

a) $R_{EQ} = 5 + 10||10 = 10\Omega$

b) $R_{EQ} = [2||3]||6 = 1\Omega$

c) $R_{EQ} = (4+2)||(2+1) = 2\Omega$

d) Apply test voltage: $R_{EQ} = \frac{v_{test}}{i_{test}}$

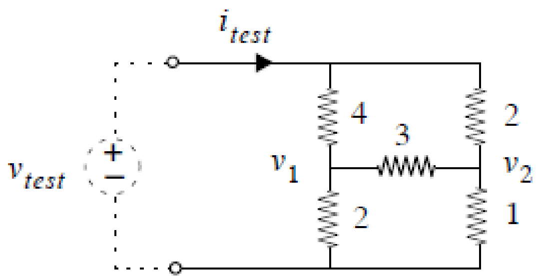


Figure 2.4:

$$\frac{(v_{test} - v_1)}{4} + \frac{(0 - v_1)}{2} + \frac{(v_2 - v_1)}{3} = 0$$

$$\frac{(v_{test} - v_2)}{2} + \frac{(v_1 - v_2)}{3} + \frac{(0 - v_2)}{1} = 0$$

$$v_1 = \frac{v_{test}}{3}, \qquad v_2 = \frac{v_{test}}{3}$$

Substitute these expressions into the equation below:

$$i_{test} + \frac{(v_1 - v_{test})}{4} + \frac{(v_2 - v_{test})}{2} = 0$$

$$\frac{v_{test}}{i_{test}} = R_{EQ} = 2\Omega$$

ANS:: (a) 10Ω (b) 1Ω (c) 2Ω (d) 2Ω

Exercise 2.8 Sketch the i-v characteristics for the networks in Figure 2.12. Label intercepts and slopes.

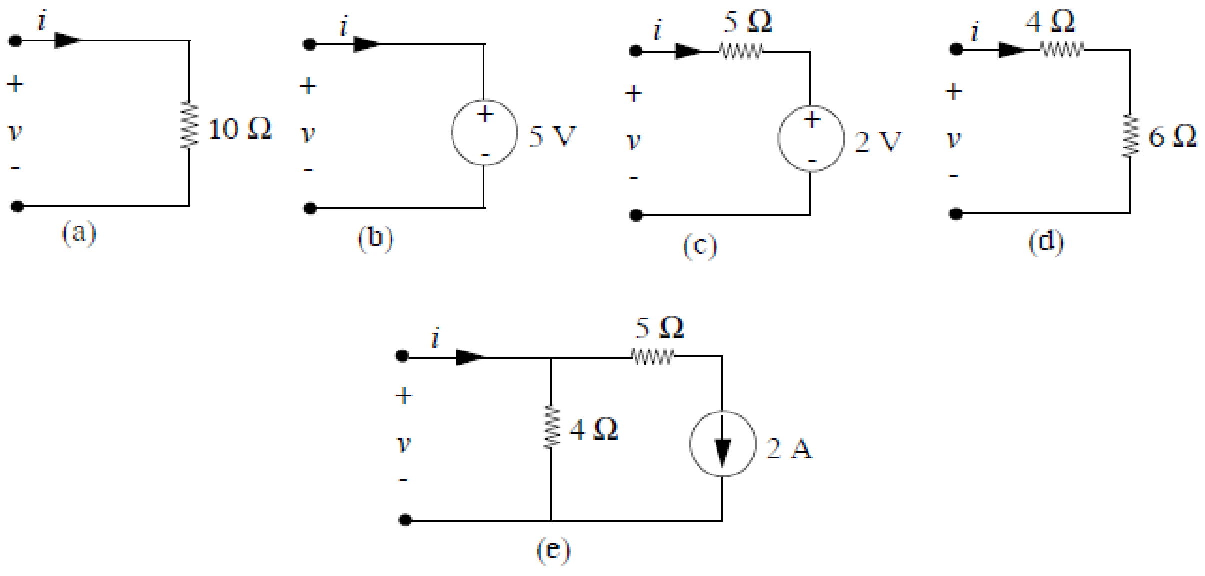


Figure 2.12:

Solution:

c) See Figure 2.15

$$v = 5i + 2$$

$$i = \frac{1}{5}v - \frac{2}{5}$$

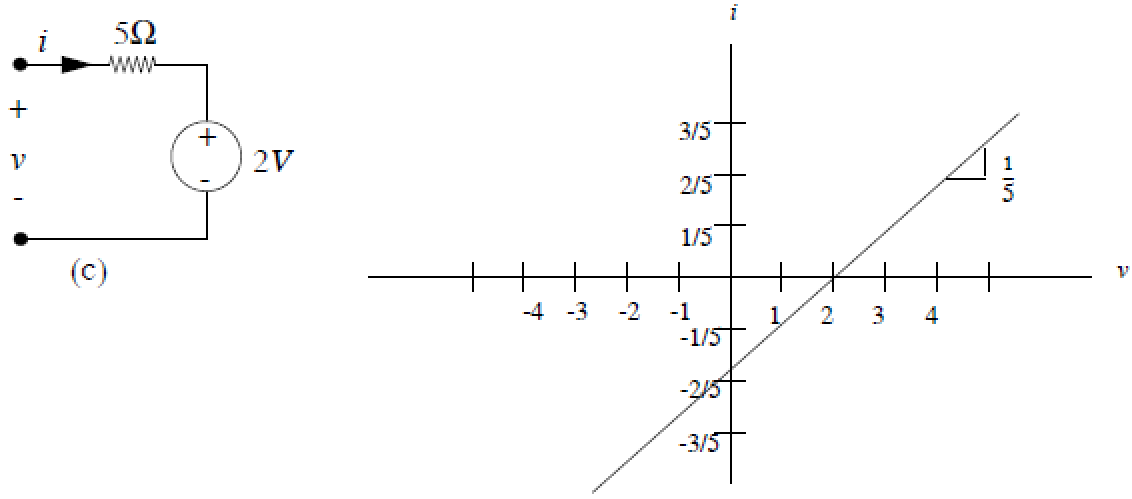
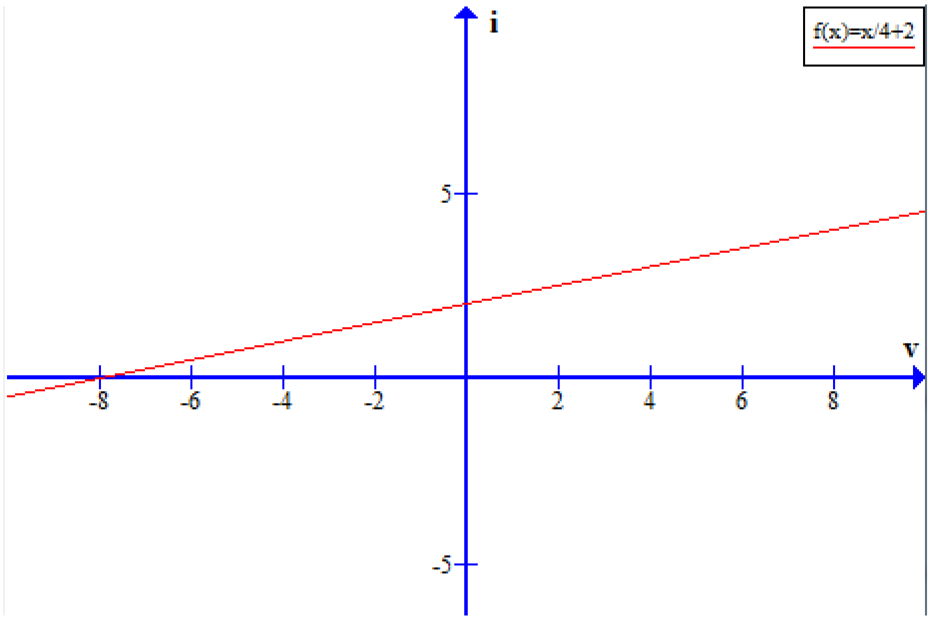


Figure 2.15:

e)

$$v = 4i - 8$$
$$i = v/4 + 2$$



Problem 2.6 In each network in Figure 2.28, find the *numerical* values of the indicated variables (Units are Amperes, Volts and Ohms).

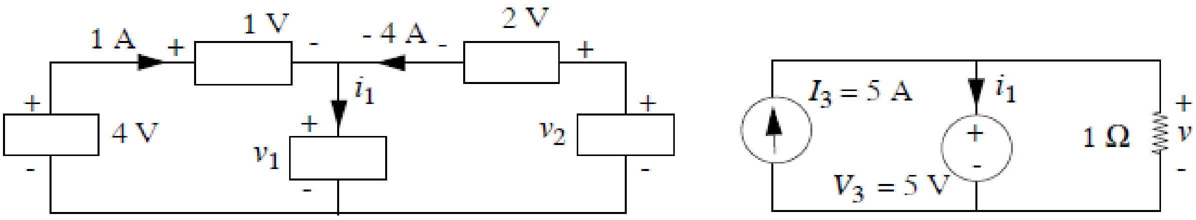


Figure 2.28:

Solution:

Top figure, $v_1 = 4V - 1V = 3V$, $v_2 = 3V + 2V = 5V$, $i_1 = -3A$

Bottom figure, since 5V is in parallel across the 1Ω resistor, all 5A of I_3 go through the resistor. $v = 5V, i_1 = 0A$

Top: $v_1 = 3V, v_2 = 5V, i_1 = -3A$, Bottom: $v = 5V, i_1 = 0A$.

ANS:: Top: $v_1 = 3V, v_2 = 5V, i_1 = -3A$, Bottom: $v = 5V, i_1 = 0A$.

Problem 2.9 Calculate the power dissipated in the resistor R in Figure 2.31.

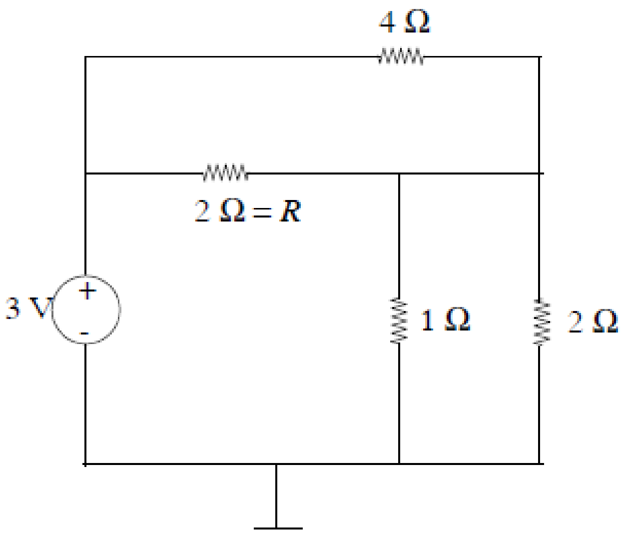


Figure 2.31:

Solution:

The equivalent resistance is 2Ω, so $\frac{3}{2}A$ of current is split between the 2Ω and 4Ω resistors. Therefore, $1A$ current goes through R.

Power $= 2W$

ANS:: Power $= 2W$

Problem 2.11 Consider the network in Figure 2.33 in which a non-ideal battery drives a load resistor R_L. The battery is modeled as a voltage source V_S in series with a resistor R_S. The following are some proofs about power transfer.

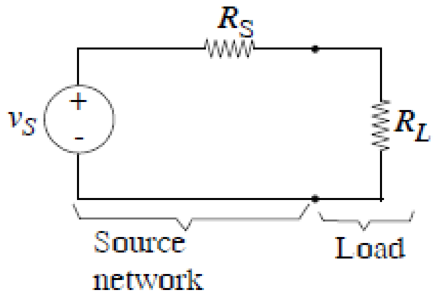


Figure 2.33:

a) Prove that for R_S variable and R_L fixed, the power dissipated in R_L in maximum when $R_S = 0$.

b) Prove that for R_S fixed and R_L variable, the power dissipated in R_L is maximum when $R_S = R_L$ ("matched resistances").

a) Power dissipated in resistor R_L:

$$P = I_{circuit}^2 R_L$$

$$P = \frac{V_S^2}{(R_S + R_L)^2} R_L$$

$$P|_{R_S=0} = \frac{V_S^2}{(0 + R_L)^2} R_L = \frac{V_S^2}{R_L}$$

$$lim_{R_S \to \infty} \frac{V_S^2}{(R_S + R_L)^2} R_L = 0$$

So, power dissipated in R_L maximum when $R_S = 0$. Otherwise power in R_L decreases as R_S increases.

b)

$$P = I_{circuit}^2 R_L$$

$$P = \frac{V_S^2}{(R_S + R_L)^2} R_L$$

Maximize with respect to R_L:

$$\frac{dP}{dR_L} = \frac{(R_S + R_L)^2 (V_S^2) - (V_S^2 R_L)(2(R_S + R_L))}{(R_S + R_L)^4} = 0$$

$$\frac{V_S^2}{(R_S + R_L)^2} = \frac{2V_S^2 R_L}{(R_S + R_L)^3}$$

$$(R_S + R_L)V^2 = 2V^2 R_L$$

$\rightarrow R_S = R_L$ (when this holds power maximized in R_L)