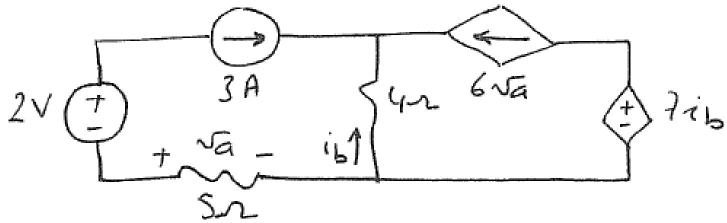
**PR.2** Given the circuit, determine whether the dependent voltage source is supplying or absorbing power; then find that power.

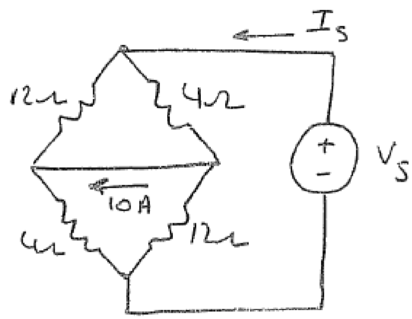



(a) $P_{absorbed}$=58.6W (b) $P_{absorbed}$=40W
(c) $P_{delivered}$=58.6W (d) $P_{delivered}$=450W
→ (e) none of the above 54.81 kW

**PR.3** A resistor draws a current I=8Sinwt at a voltage V=200Sinwt. Calculate the average power dissipated in the resistor.

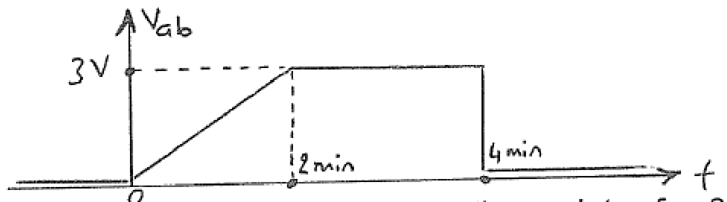
(a) 400W → (b) 800W (c) 1600W
(d) 0W (e) none of the above

**PR.4** Find $V_S$ and $I_S$ in the following circuit:




(a) $I_S$=10A
(b) $I_S$=30A
(c) $V_S$=60V
(d) $I_S$=20V
→ (e) none of the above 120 V, 20 A

**PR.5** Given a 2Ω resistor connected between terminals a an b and given that the voltage is shown in the graph below:




Find the power delivered by the resistor for 0<t<2min.

→ (a)$9t^2/8$ (b)$-9t^2/8$ (c)$-3t^2/960$
(d)$3t^2/960$ (e)none of the above

**PR.6** For the same given of problem 5, find the energy in joules converted into heat by the resistor for 2<t<4min.

→ (a)540 (b)180 (c)1080
(d)90 (e)none of the above

**PR.7** A 110 light bulb takes 0.9A and operates 12h/day. At the rate of 7cents/Kwh, find the cost to operate the bulb for 30 days.

(a)5$ → (b)2.5$ approx (c)2$
(d)252¢ (e)none of the above

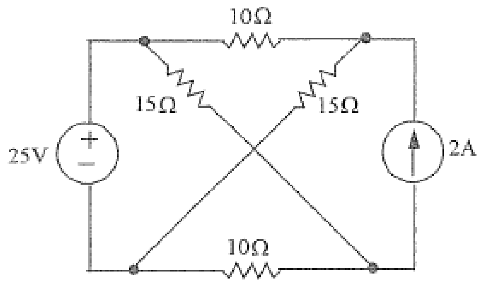



**Figure 1**

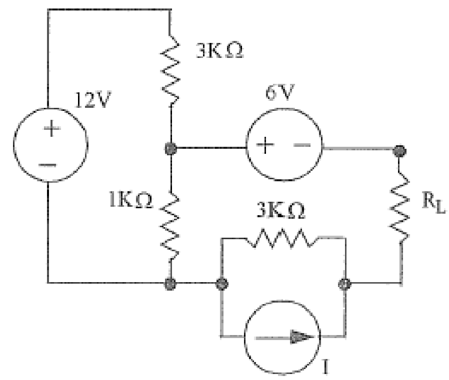



**Figure 2**

**1.** In the circuit shown in figure 1, calculate the total power delivered by the two sources.

a) 88 W
b) 72 W
**c) 98 W**
d) 110 W
e) None of the above

Hint: redraw as a bridge circuit

**2.** A 1Ω resistor is connected in parallel with a d'Arsonval movement having a full scale deflection of 1 mA. If a 40 mA current produces a deflection that is 80% of full scale, determine the resistance of the d'Arsonval movement.

a) 58Ω
**b) 49Ω**
c) 37Ω
d) 76Ω
e) None of the above

**3.** A 1 cm cube of material has a resistance of 2.5KΩ measured between opposite faces. Calculate the resistance of a rectangular block of this material that is 50 cm long and of 10 $cm^2$ cross-sectional area.

a) 10.8KΩ
**b) 12.5KΩ**
c) 22.0KΩ
d) 760Ω
e) None of the above

**4.** In the circuit shown in figure 2, determine I so that no current flows in $R_L$.

a) 3mA
b) 0mA
c) 2mA
**d) -1mA**
e) None of the above

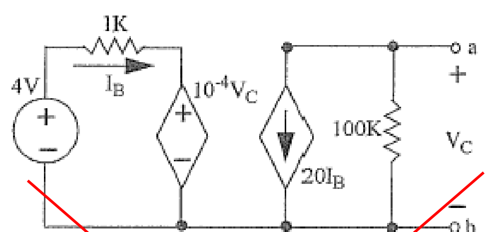



**Figure 3**

**5** In the circuit shown in figure 3, determine the resistance $R_L$ that should be connected between terminals ab for maximum transfer.

a) 100KΩ
**b) 125KΩ**
c) 1KΩ
d) 360Ω
e) None of the above

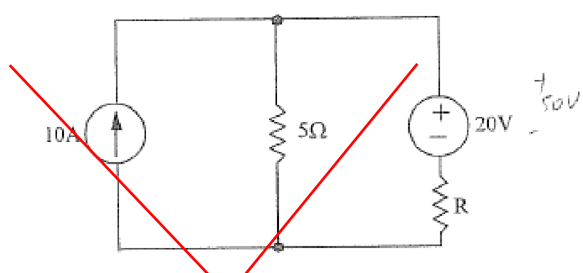



Figure 4

6. In the circuit shown in figure 4, determine the maximum power dissipation in the 5Ω resistor.

a) 300 W

b) 150 W

c) 45 W

**d) 500 W**

e) None of the above

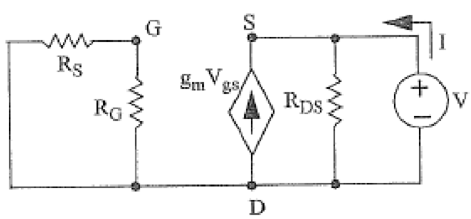



Figure 5

7. In the circuit shown in figure 5, determine determine $R_o = V/I$, if $V_{gd} = 0$.

a) $R_o = R_{DS} \| R_G$

b) $R_o = R_{DS}$

→ **c) $R_o = R_{DS} \| (1/g_m)$**

d) $R_o = R_S \| R_G \| R_{DS}$

e) None of the above

8. In the circuit shown in Figure 6, find $v_1$ and the voltage v across both sources if $i_s$ is given as 12 A.

a) $v_1 = 30V$ and $v = 22.5V$

b) $v_1 = 0.6V$ and $v = 2.25V$

→ **c) $v_1 = 30V$ and $v = 225V$**

d) $v_1 = 6V$ and $v = 225V$

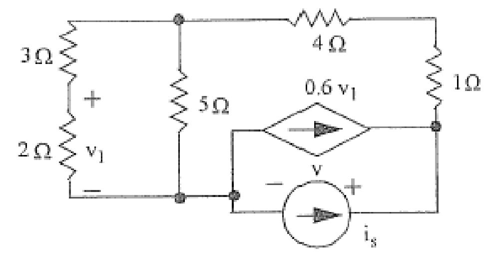



Figure 6

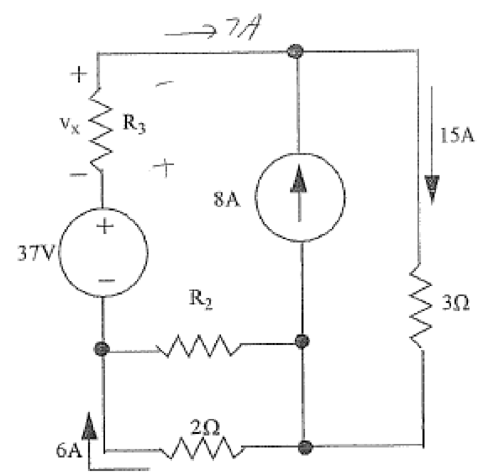



Figure 7

9. Determine $v_x$ in the circuit of figure 7.

→ **a) $v_x = 20V$**

b) $v_x = -30V$

c) $v_x = -20V$

d) $v_x = 15V$

e) None of the above

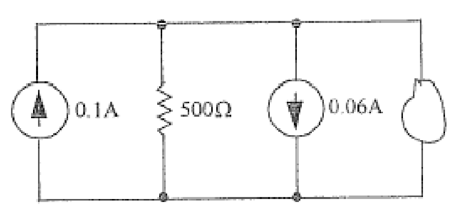



Figure 8

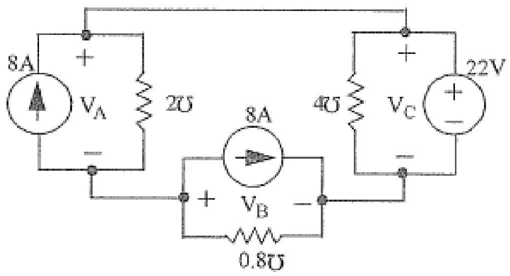



**Figure 9**

Hint: transform current sources to voltage sources

**11.** In the circuit of figure 9 find $V_A$, $V_B$ and $V_C$. Note that the resistors are labeled with their respective conductances.

$V_A$ = 12 V, $V_B$ = 10 V, $V_C$ = 22 V

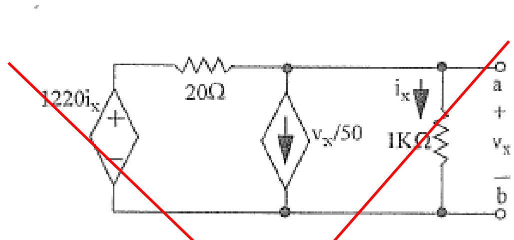



**Figure 10**

**12.** Find the Thevenin equivalent of the circuit shown in figure 10.

a) $V_{th}$ = 10V and $R_{th}$ = 1K

**b) $V_{th}$ = 0V and $R_{th}$ = 0.1K**

c) $V_{th}$ = 10V and $R_{th}$ = 2K

d) $V_{th}$ = 1V and $R_{th}$ = 1K

e) None of the above

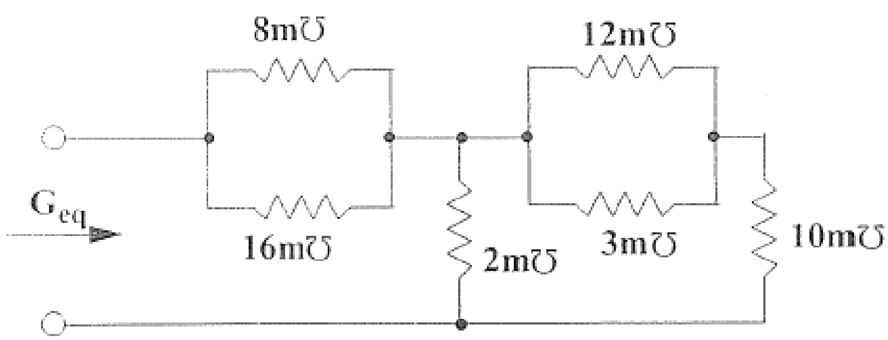



**Figure 1**

**2.** Find Geq for the network of figure 1. (round off your answer to 2 decimals).

a) 5 mhos

b) 7 mhos

c) 6 mhos

d) 4 mhos

e) None of the above

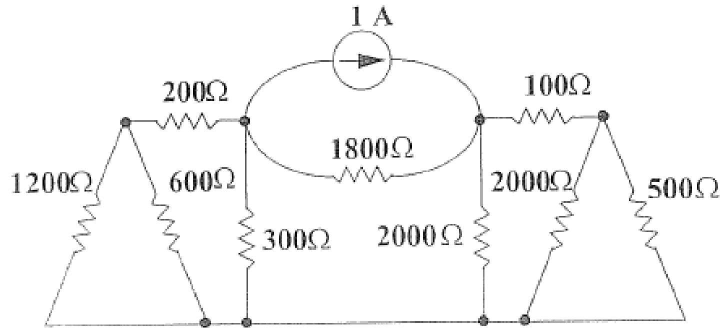
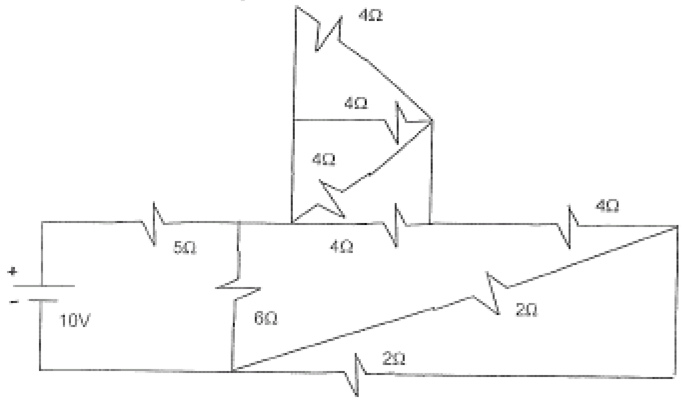



Figure 3

4. Given the circuit of figure 3. Find the power ($p_{source}$) supplied by the source and also the power ($p_{1800}$) absorbed by the 1800Ω resistor.

a) $p_{source}$ = 450 W ; $p_{1800}$ = 112.5 W
b) $p_{source}$ = 4.5 W ; $p_{1800}$ = 1.125 W
c) $p_{source}$ = 112.5 W ; $p_{1800}$ = 28.125 W
d) $p_{source}$ = 18 W ; $p_{1800}$ = 4.5 W
e) None of the above

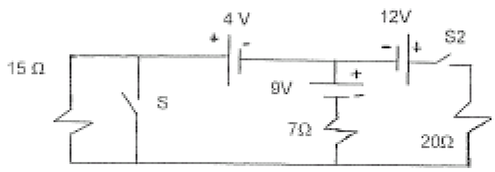
7. Consider the following circuit:




The equivalent resistance of the above circuit is:

A. 11Ω
B. 8 Ω
C. 6.2 Ω
D. 4 Ω
E. None of the above

8. Consider the following circuit:



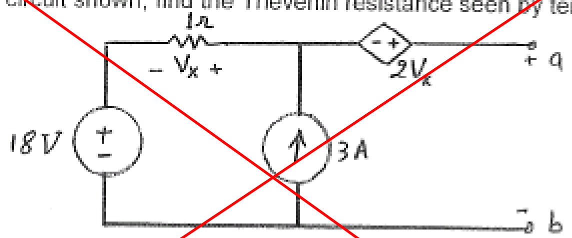

Assume switches S1 and S2 are both open, the current in the 15 Ω resistor is:

A. 0.34A
B. 1.86A
C. 0.59A
D. 0 A
E. None of the above

9. In problem 8, assume switches S1 and S2 are both closed, the power generated by the 12V battery is:

A. 4.8W
B. –8.76W
C. 17.52W
D. 8.76W
E. None of the above.

10. For the circuit shown, find the Thevenin resistance seen by terminals ab

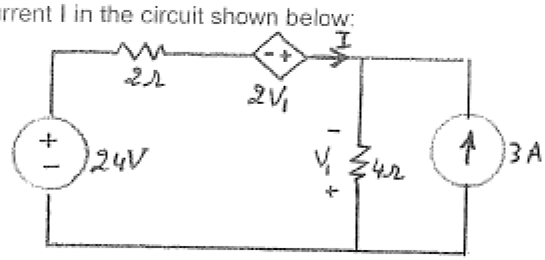


A. 4Ω
B. 5Ω
C. 3Ω
D. 6Ω
E. None of the above.

Test ID 1000- 4/5

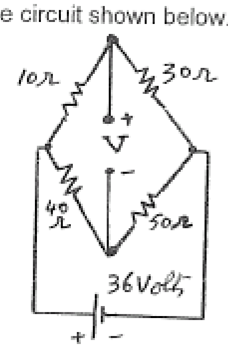


11. Find the current I in the circuit shown below:



A. 24/14 A
B. −0.857 A
C. −3A
D. 4A
E. None of the above.

13. Find the Voltage V in the circuit shown below.



A. 25 V
B. 7 V
C. 16 V
D. 9 V
E. None of the above

2. In the circuit of Figure 1, the Thevenin resistance as seen from terminals ab is:

a. 100/3Ω
b. 100/9Ω
c. 50/9Ω
d. 10Ω
e. None of the above



3. In the circuit of Figure 2, the equivalent resistance seen across the terminals ab is:

a. 7Ω
b. 7.5Ω
c. 6Ω
d. 6.5Ω
e. None of the above

Refer to figures below

4. The current $I_1$ across the 6V source in Figure 3 is:

a. 1.5A
b. 4.5A
c. 3A
d. 3.5A
e. None of the above

5. Find k in the circuit shown in Figure 4 such that the power dissipated in the 2-Ω resistor is 50W.

a. 5
b. 2
c. 10
d. 4
e. None of the above

9. Find the resistance R in the circuit of Figure 7 such that the power supplied by the 100-V source to the network is the same as the power supplied by the 5-A source.

a. 20Ω
b. 30Ω
c. 10Ω
d. 40Ω
e. None of the above

10. In the circuit of Figure 8, the Thevenin equivalent resistance, across terminals a-b, is:

a. 20Ω
b. 5Ω
c. -20Ω
d. 10Ω
e. None of the above

11. The current entering a circuit is shown in Figure 9. Determine the amount of charge that enters the circuit as a result of the current pulse.

a. 20mC
b. 40mC
c. 80mC
d. 60mC
e. None of the above

12. Four 60-W, 110-V light bulbs are to be operated from a 230-V source (see Figure 10). Determine the value of the resistance, R, connected in series with the line so that the voltage across the bulbs does not exceed 110-V.

a. 2Ω
b. 55Ω
c. 120Ω
d. 60Ω
e. None of the above



13. The power absorbed by the 4-Ω resistance of Figure 11 is:

a. 100W
b. 50W
c. 75W
d. 90W
e. None of the above.

14. In the circuit of Figure 12, the power delivered by the 10-V source is:

a. 20W
b. -40W
c. 40W
d. 60W
e. None of the above.

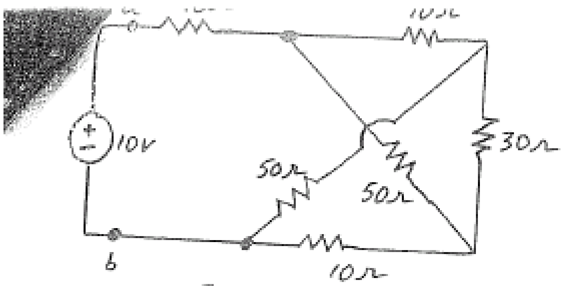



Fig. 1

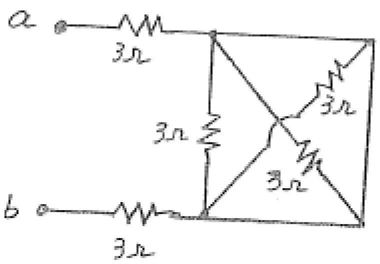



Fig. 2



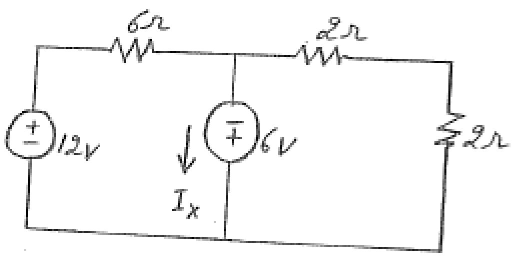



Fig. 3

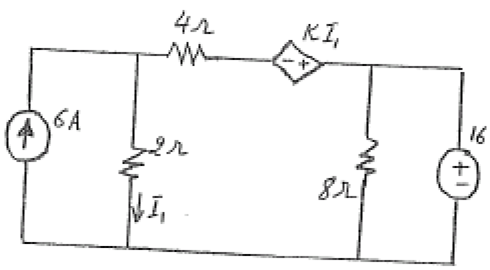



Fig. 4

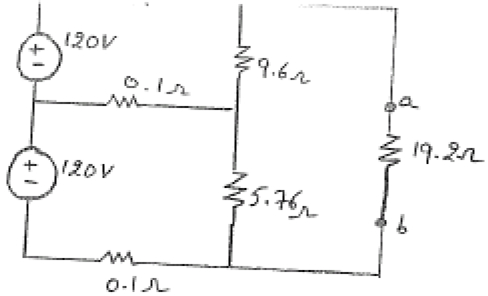



Fig. 5

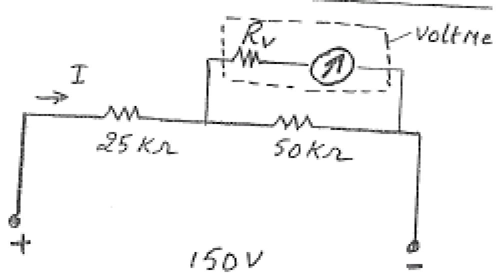



Fig. 6

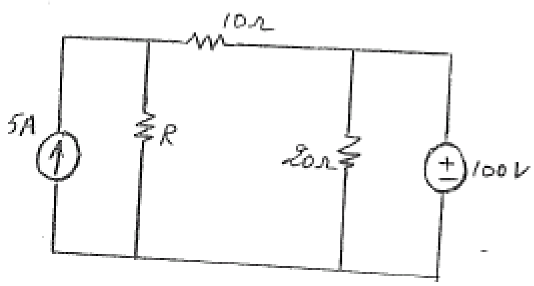



Fig. 7

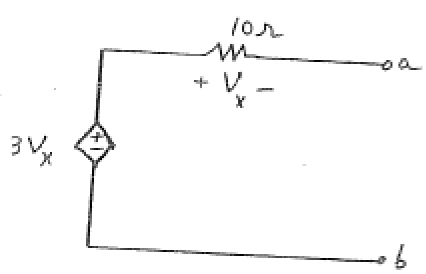



Fig. 8

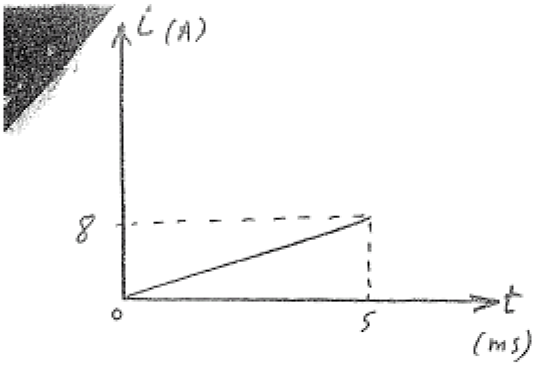



Fig. 9

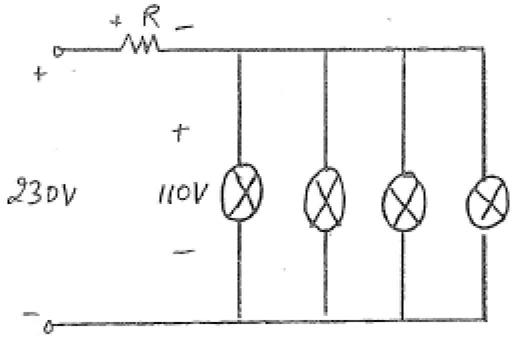



Fig. 10

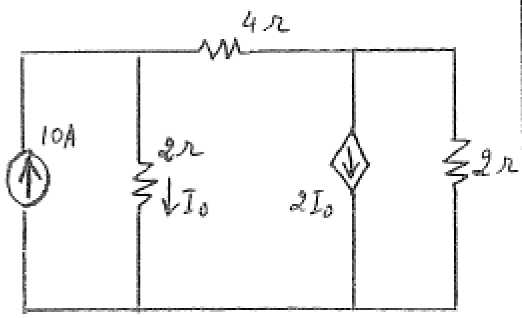



Fig. 11

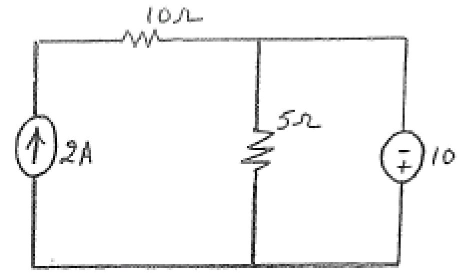



Fig. 12

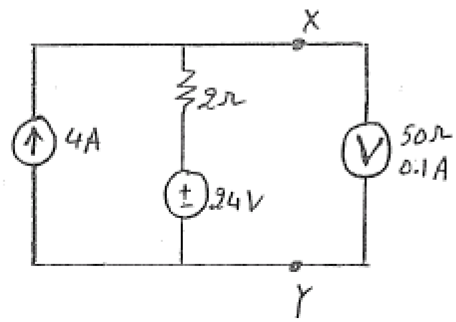
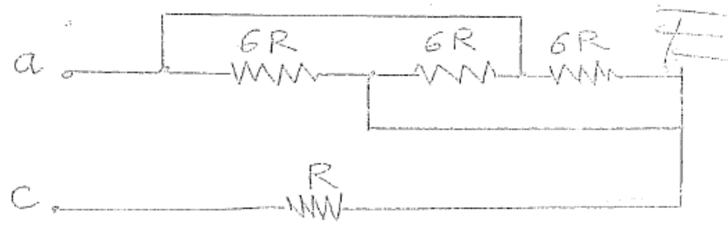





Fig. 13

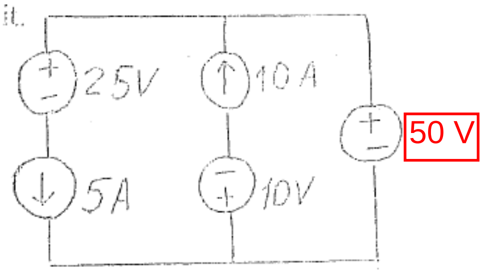
2 - In the circuit shown below, determine the equivalent resistance Rac.

a) 10 R
b) 18 R
c) 2 R
d) 3 R
e) none of the above

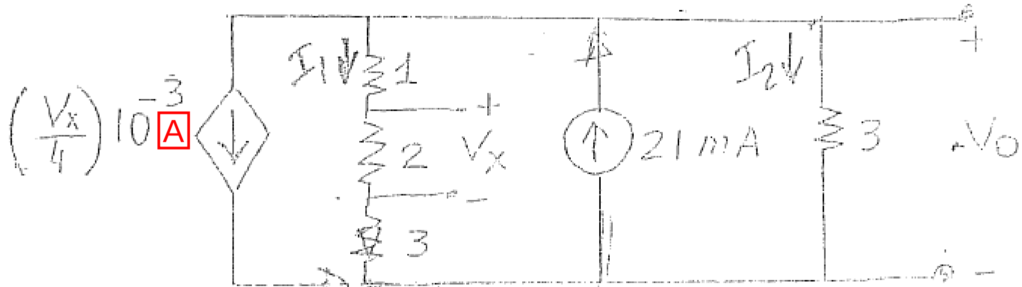



3 - If the interconnection of different sources in the following circuit is valid, find the total absorbed and delivered power in this circuit.

a) The interconnection is not valid
b) P(absorbed) is 2400 W, P(delivered) is 2400 W
c) P(absorbed) is 450 W, P(delivered) is 450 W
d) P(absorbed) is 600 W, P(delivered) is 600 W
e) none of the above



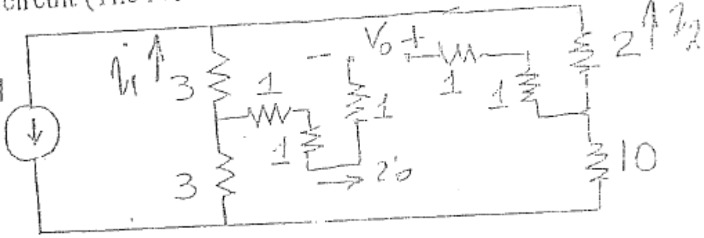

5 - Given the network below, find Vo. (The resistance are given in KΩ)



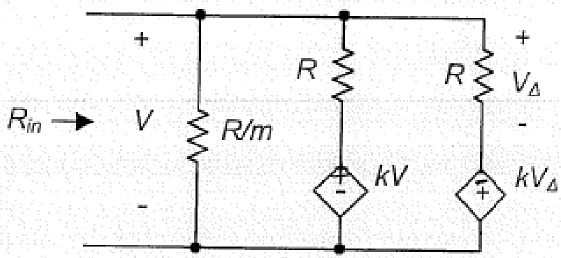

a) $36*10^{-3}$ V, b) 41 V, c) 36 V, d) 63 V
e) none of the above

7- Find Vo in the following circuit (The resistance are given in Ohm)

a) Vo = 5 V
b) Vo = – 200 V
c) Vo = – 20 V
d) Vo = – 25 V
e) none of the above

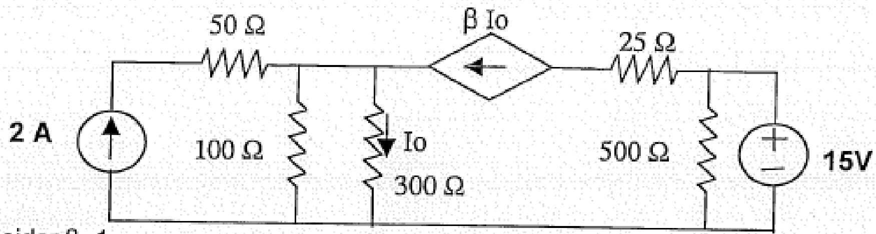


1. Determine $R_{in}$ in the figure, given that $R$ = 1 kΩ, $m$ = 2, and $k$ = 2.




→A. Infinite
B. Zero Ω
C. 1 kΩ
D. 2 kΩ
E. None of the above

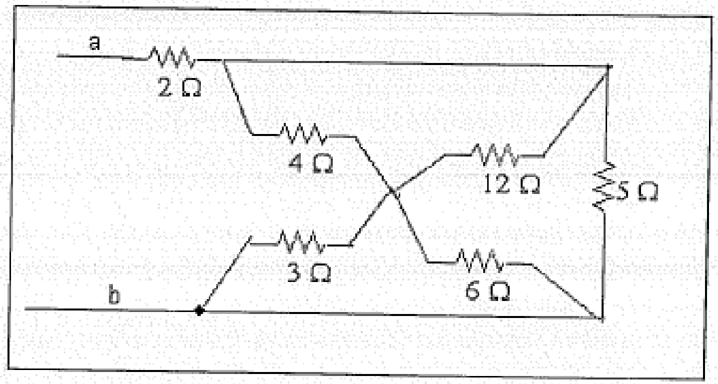
2. Considering the circuit below, find the current Io flowing through the resistor 300Ω.




Consider β=1

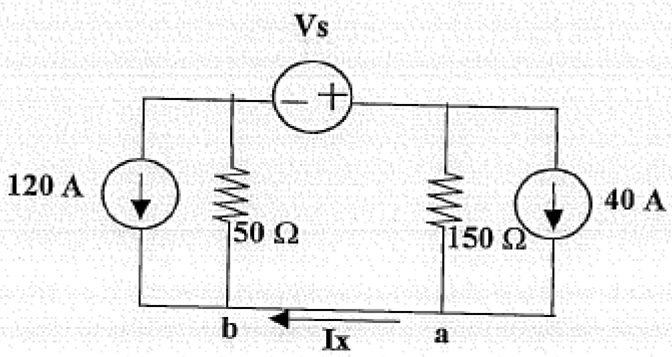
→a) 0.667 A
b) 1.000 A
c) 1.333 A
d) 2.000 A
e) None of the above

11. Find the equivalent resistance between the terminals (a,b).



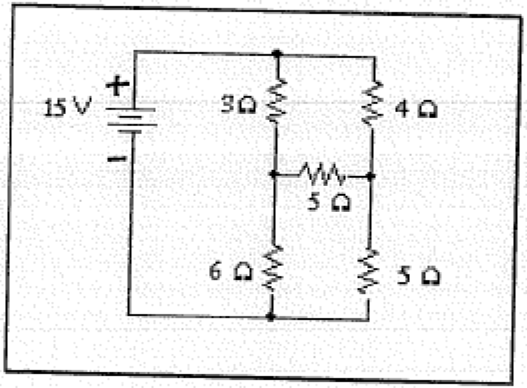

a) 4.50 Ω
b) 2.25 Ω
c) 12.5 Ω
d) 8.0 Ω
e) none of the above

2. In the circuit below, find the value of the current **Ix** flowing between node a and node b. (Vs =10V)




a) +50mA
b) +100mA
c) –30 A
d) +30A
e) None of the above

10. For the circuit shown below determine the power supplied by the source.

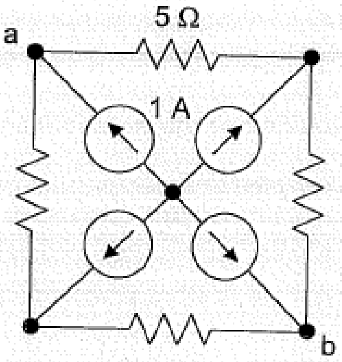



a. 63.1 W
b. 36.3 W
c. 21.6 W
d. 50.3 W
e. None of the above

7%

3. Determine $V_{ab}$, given that all current sources are 1 A and all resistances are 5 Ω.

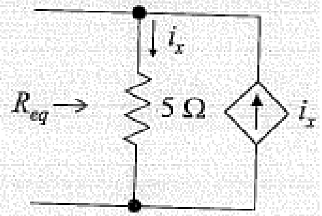
A. 5 V
B. 10 V
C. 15 V
D. 20 V
→ E. Not a valid connection



8%

1. Determine $R_{eq}$.

   A. 5 Ω
   B. 10 Ω
   C. 0
   D. Infinite
   E. None of the above

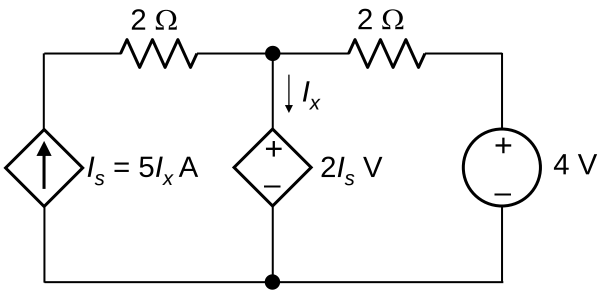



***Solution***: If a source $v_T$ is applied, the source current is $i_T = i_x - i_x = 0$. The resistance seen by the source $R_{eq}$ is therefore infinite.

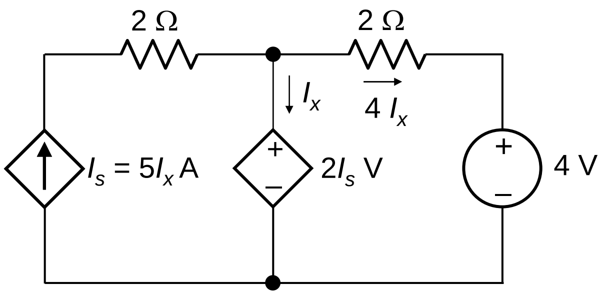
8%

2. Determine $I_x$ in the circuit shown.

   A. 2 A
   B. 4 A
   C. -2 A
   D. -4 A
   E. None of the above

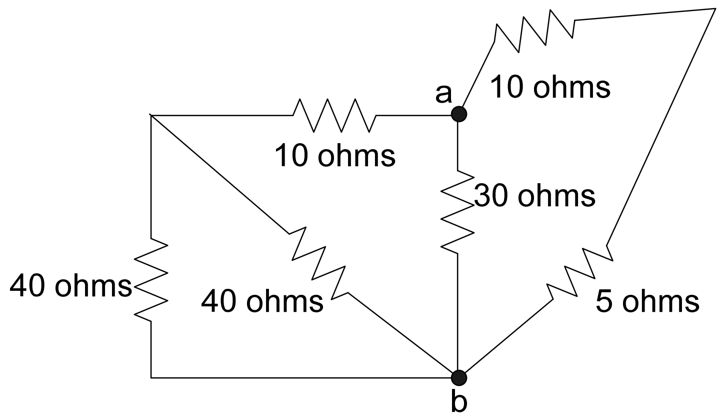



**Solution:** KCL at the upper node gives a current of $4I_x$ in the 2 Ω resistor; $2I_s = 10I_x$; from KVL around the right mesh: $10I_x = 8I_x + 4$, so that $I_x = 2$ A.



**Problem 1**
Find $R_{ab}$.

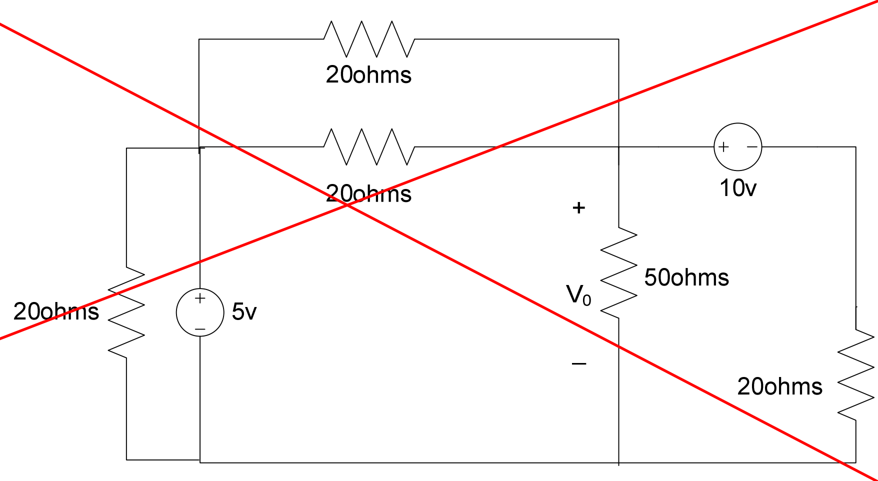
A) 12 ohms
B) 7.5 ohms
C) 10 ohms
D) 15 ohms
E) None of the above




**Problem 2**

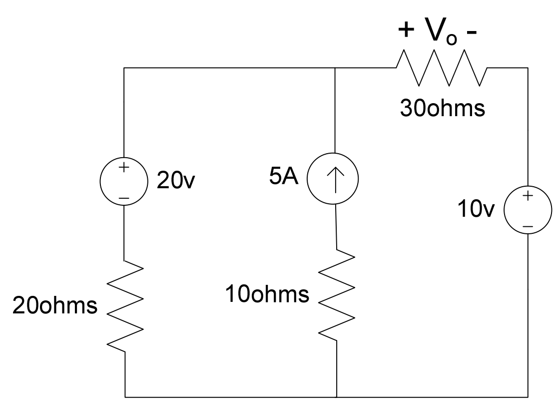
Find the power consumed by the 50 ohm resistor in the circuit shown below

A) P= 0.246 W
B) P= 0.692 W
C) P= 2.358 W
D) P= 5.100 W
E) None of the above

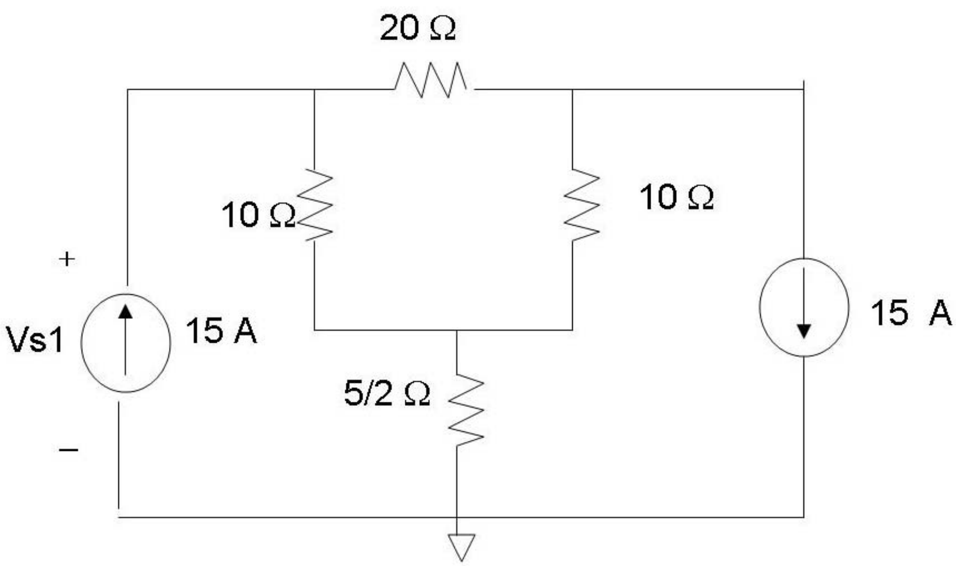



**Problem 3**
Find $V_0$ in the 30 Ohm resistor in the circuit shown below

A) $V_0 = 6$ V
B) $V_0 = 66$ V
C) $V_0 = 72$ V
D) $V_0 = 78$ V
E) None of the above



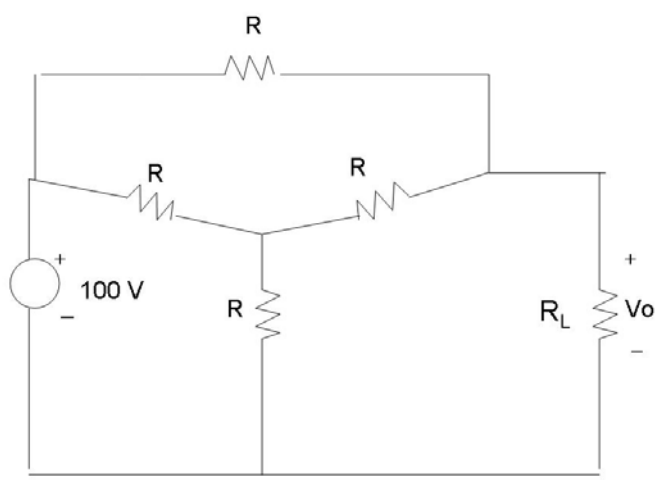
**Problem 4**




In the circuit shown, find the voltage denoted by Vs1

A) 300 V
B) 150 V
C) -150 V
D) 75 V
E) None of the above

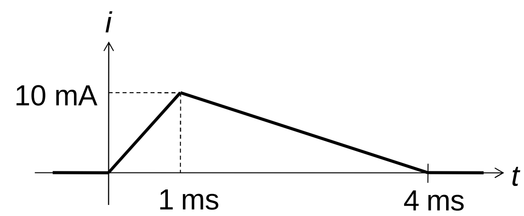
**Problem 5**




In the circuit shown above, find the value of the load resistance $R_L$ in terms of R such that Vo is 50 V.

A) R/3
B) 3R
C) R
D) 2R
E) None of the above

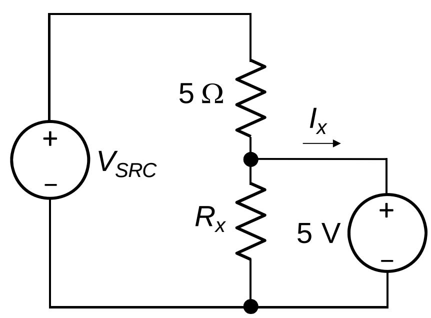
1. The current in a 1 μF capacitor is shown in the figure as a function of time. The total energy stored in μJ is:




   A. 40
   B. 100
   C. 200
   D. 50
   E. 25

**Solution:** $q$ at 4 ms is $\frac{10\times 4}{2}=20$ μC. The energy in μJ is $W=\frac{(20)^2}{2C}=\frac{200}{C}$, where $C$ is in μF.

2. If $V_{SRC}$ = 10 V, determine $R_x$ so that $I_x$ = 0.

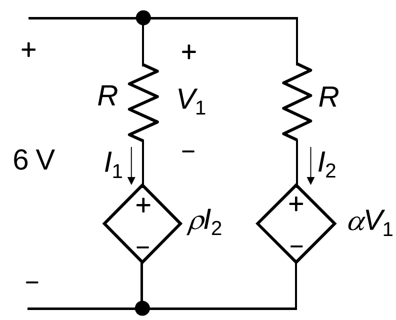



   A. 5 Ω
   B. 1.25 Ω
   C. 2.5 Ω
   D. 1 Ω
   E. 1.67 Ω

**Solution:** When $I_x$ = 0, $\frac{R_x}{R_x+5}V_{SRC}=5$, or

$$R_x=\frac{25}{V_{SRC}-5}\ \Omega.$$

3. If $R$ = 10 Ω, determine the ratio $\rho/\alpha$ so that $I_1 = I_2$.

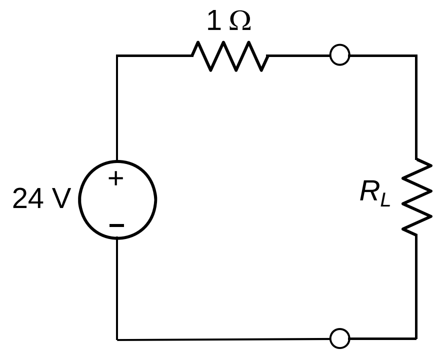



   A. 4 Ω
   B. 10 Ω
   C. 6 Ω
   D. 5 Ω
   E. 8 Ω

**Solution:** $I_1=\frac{6-\rho I_2}{R}$, $I_2=\frac{6-\alpha R I_1}{R}$, or

$\frac{6-\rho I_1}{R}=\frac{6-\alpha R I_1}{R}$, which gives $\rho/\alpha = R$.

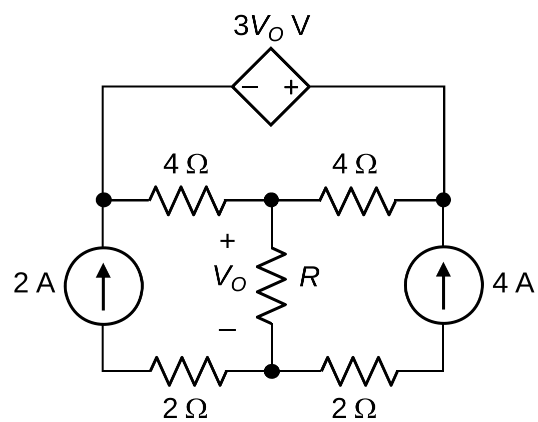
4. In the figure shown, the 24 V source having a source resistance of 1 Ω is replaced by the equivalent current source, the load resistance $R_L$ being the same. If $R_L$ = 5 Ω, the ratio of the power delivered by the **ideal** current source to the power delivered by the **ideal** 24 V source is:




   A. 5
   B. 11
   C. 7
   D. 14
   E. 9

**Solution:** The power delivered by the ideal voltage source is $24 \times \frac{24}{R_L + 1}$. The equivalent current source is an ideal current source of 24 A in parallel with 1 Ω. The power delivered by the current source is $24 \times 24 \frac{R_L \times 1}{R_L + 1}$. The ratio of the powers is numerically equal to $R_L$.

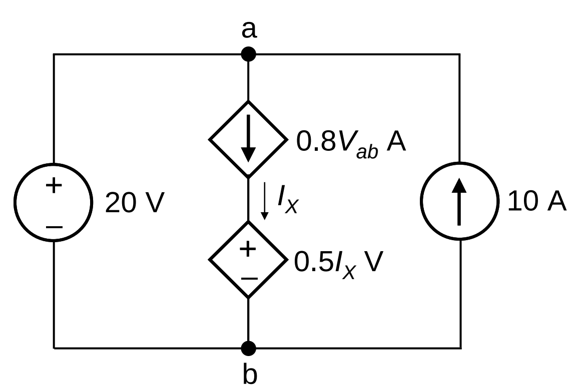
5. Determine $V_O$ in the circuit shown if $R$ = 1 Ω




   A. 18 V
   B. 12 V
   C. 30 V
   D. 6 V
   E. 24 V

**Solution:** The current through $R$ is 6 A, so that $V_O = 6R$.

6. Given the source connections shown. Determine the actual power delivered or absorbed by each source.




**Solution:** $I_X = 0.8 \times 20 = 16$ A. Current in 20 V source is 6 A in the direction of a voltage rise. Voltage across dependent voltage source is $0.5 \times 16 = 8$ V. Voltage across dependent current source is 20 – 8 = 12 V. It follows that:

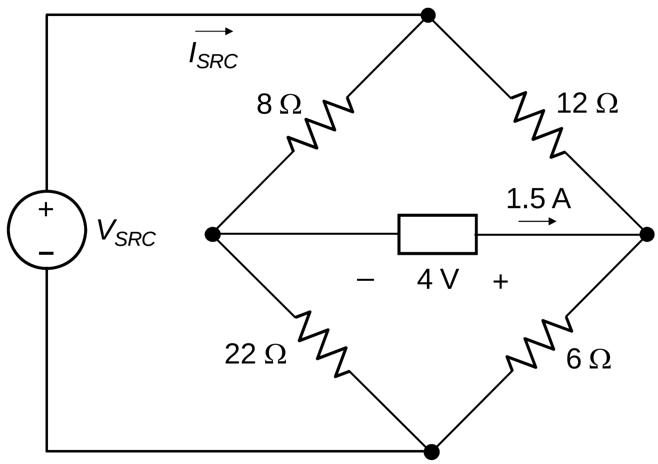
Power delivered by 20 V source is 20×6 = 120 W

Power delivered by 10 A source is 20×10 = 200 W

Power absorbed by dependent current source is 12×16 = 192 W

Power absorbed by dependent voltage source is 8×16 = 128 W

7. Determine $V_{SRC}$, $I_{SRC}$, and the voltages across the four resistors in the circuit shown. (Four grade points for each answer plus 1 bonus grade).

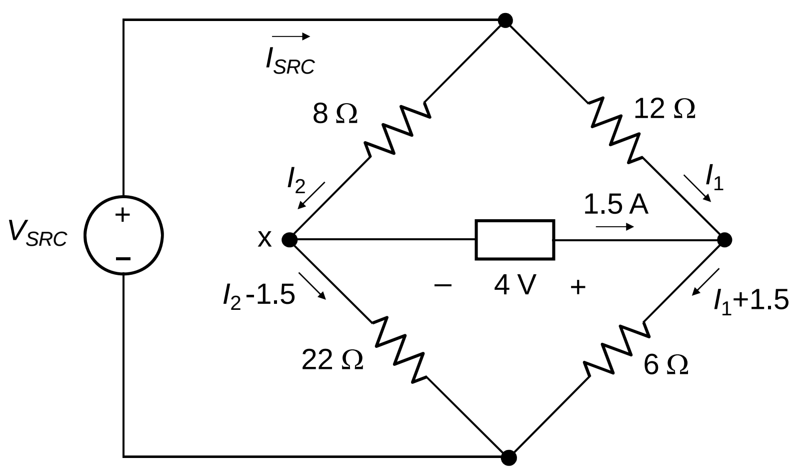



**Solution:** Going CCW around the upper mesh:

$4 + 12I_1 – 8I_2 = 0$

Going CW around the lower mesh:

$4 – 6(I_1 + 1.5) + 22(I_2 – 1.5) = 0$




The two equations reduce to:

$3I_1 – 2I_2 = -1$

$-3I_1 + 11I_2 = 19$

This gives: $I_1$ = 1 A; $I_2$ = 2 A. Hence,

Voltage across 12 Ω resistor: 12 V

Voltage across 6 Ω resistor: 15 V

Voltage across 8 Ω resistor: 16 V

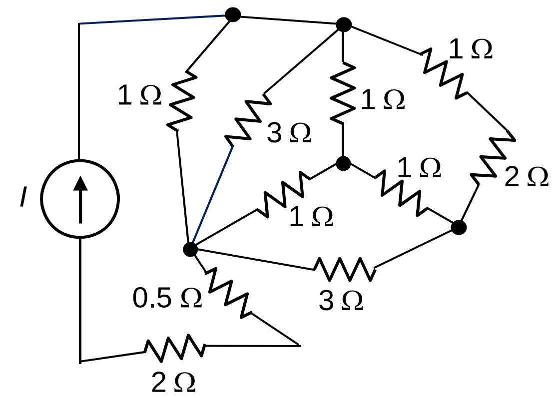
Voltage across 22 Ω resistor: 11 V

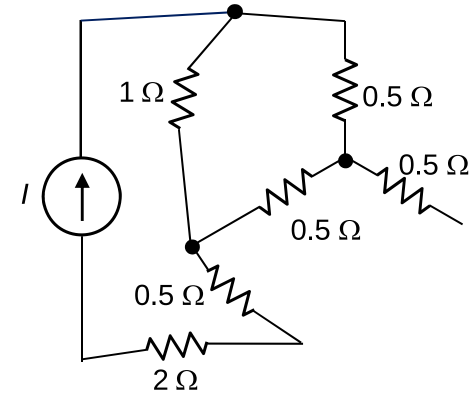
$V_{SRC}$ = 27 V

$I_{SRC}$ = 3 A.

1. Determine the power dissipated in the circuit, assuming $I$ = 1 A.

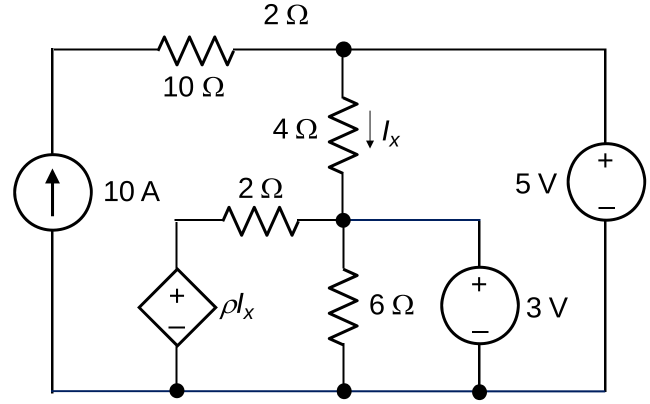
**Solution:** The 1 Ω Y is paralleled with a 3 Ω Δ, so that it effectively becomes a 0.5 Ω Y, and the circuit reduces to that shown. The resistance seen by the current source is 1||1 + 2.5 = 3 Ω, so that the power dissipated in the circuit is $P = 3I^2$ W.



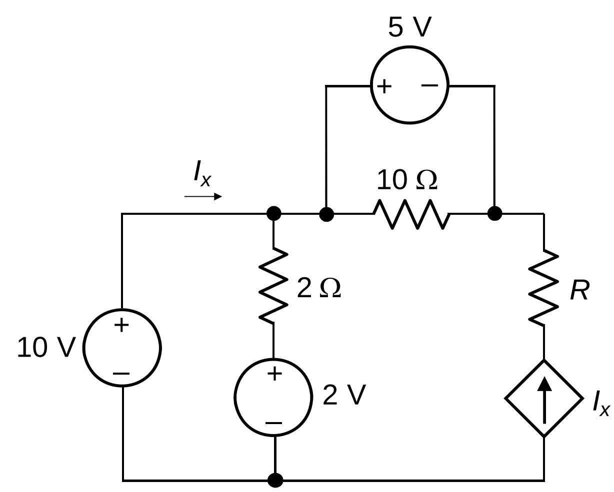

2. Determine the power delivered by the 3 V source, assuming $\rho$ = 2 V/A.

**Solution:** The upper node is at 5 V with respect to the lowest node, the middle node is at 3 V. hence, $I_x$ = 0.5 A and the current in the 6 Ω resistor is also 0.5 A. The current supplied by the 3 V source is $(3 - 0.5\rho)/2$ and the power delivered by the source is $P = 1.5(3 - 0.5\rho) = 4.5 - 0.75\rho$ W.




6. Determine the power absorbed or delivered by the dependent source assuming $R$ = 1 Ω.

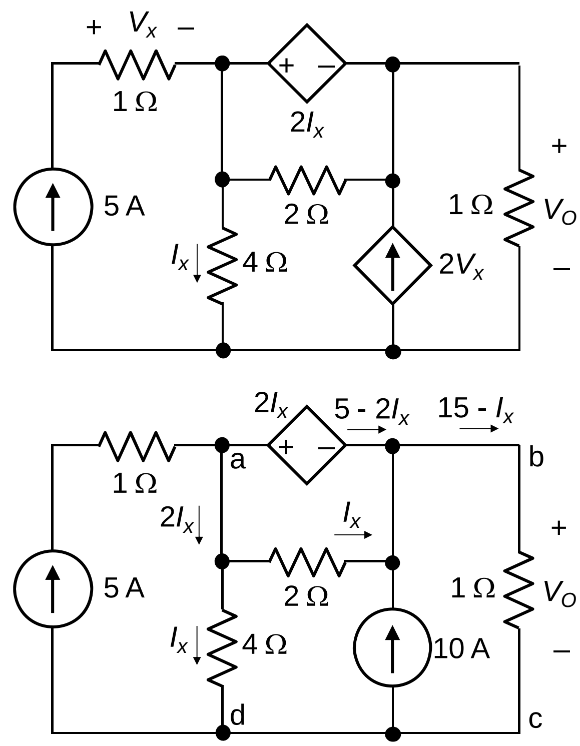
**Solution:** The current in the 2 Ω resistor is $2I_x$ flowing downwards. From KVL in the mesh on the left, $10 = 4I_x + 2$, or $I_x$ = 2 A. The voltage rise $V_x$ across the dependent source is given by: $V_x - RI_x = 5$, or $V_x = 2R$



+ 5; The power $P$ delivered by the source is $P = 2(2\times R + 5)$.

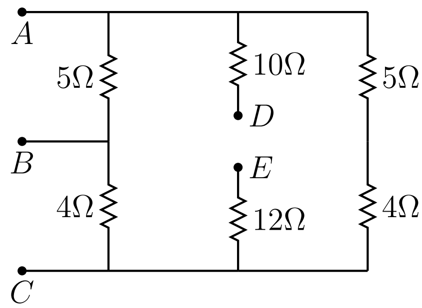
16. Determine $V_O$.

**Solution:** The $2V_x$ source is replaced by a 10 A source. The current in the 2 Ω resistor is $I_x$. The current in the dependent source is $5 - 2I_x$, so that the current in the 1 Ω resistor is $15 - I_x$. From KVL around the mesh abcd, $2I_x + 15 - I_x = 4I_x$, which gives $I_x = 5$ A. It follows that $V_O = 15 - I_x = 10$ V.



# Problem 1

Find the equivalent resistance between B and E.




A) 15.11Ω

B) 16Ω

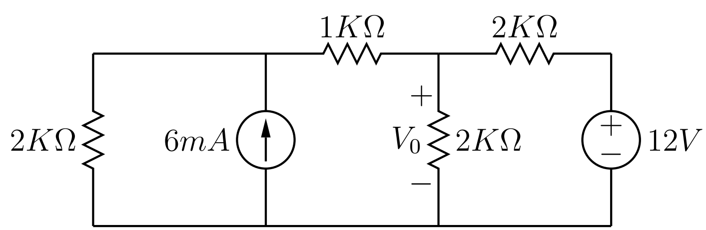
C) 8.33Ω

D) 13.61Ω

E) None of the above

# Problem 2

Find $V_0$.




A) 12V

B) 7.5V

C) -12V

D) -7.5V

E) None of the above

**1.** An electric field $\xi$ is applied in a region containing both positive and negative charges. A current $I_N$ flows due to the negative charges, and a current $I_P$ flows due to the positive charges. Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 1 is considered incorrect).

A. $I_N$ and $I_P$ are in the same direction as $\xi$.

B. $I_N$ and $I_P$ are in the opposite direction to $\xi$.

C. $I_P$ is in the direction of $\xi$ and $I_N$ is in the opposite direction.

D. $I_N$ is in the direction of $\xi$ and $I_P$ is in the opposite direction.

E. The total current is zero.

**Solution:** The positive charges will flow in the direction of $\xi$ and the negative charges will flow in the opposite direction. The currents of both types of charge will be in the direction of $\xi$.

**2.** Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 2 is considered incorrect).

A. An ideal capacitor **always** absorbs power.

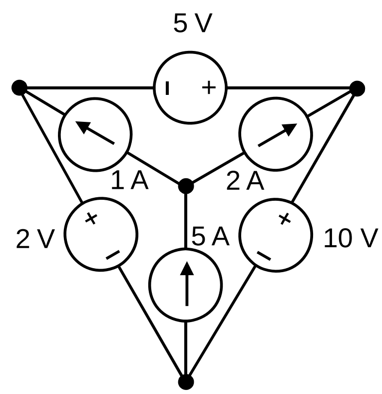
B. An ideal inductor **always** delivers power.

C. An ideal passive resistor **always** absorbs power.

D. An ideal, dependent voltage source **always** delivers power.

E. An ideal, dependent current source **always** absorbs power.

**Solution:** Ideal capacitors, inductors and sources can absorb or deliver power. An ideal passive resistor always absorbs and dissipates power.




**3.** Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 3 is considered incorrect).

A. The connection of current sources is valid, but the connection of voltage sources is invalid.

B. The connection of current sources is invalid, but the connection of voltage sources is valid.

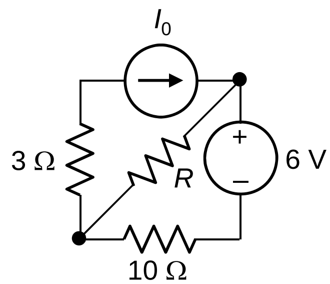
C. The connections of current sources and of voltage sources are valid.

D. The connections of current sources and of voltage sources are invalid.

E. the circuit cannot be made valid by changing the values of the sources.

**Solution:** The connection of current sources is invalid because it violates conservation of charge at the node in the middle. The connection of voltage of sources is invalid because it violates conservation of energy around the outer loop.

**4.** In the circuit shown, $I_0$ = 1 A and the 6 V source does not absorb or deliver any power. Determine the power absorbed or delivered by the source $I_0$. Note that the value of $R$ need not be known.




A. 9 W absorbed

B. 9 W delivered

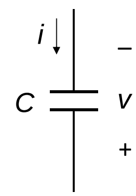
C. 24 W absorbed

D. 24 W delivered

E. No power absorbed or delivered.

**Solution:** Since the 6 V source does not absorb or deliver any power, it follows that the current through the 6 V source and the 10 Ω resistor is zero, which means that the voltage across $R$ is 6 V, and the current through $R$ and the 3 Ω resistor is $I_0$. It follows that the power dissipated in the resistors is $6I_0 + 3I_0^2 = 9$ W, which is also the power delivered by the source.

**5.** For the assigned positive directions shown, the voltage-current relationship for an ideal capacitor is:




A. $i = Cdv/dt$

B. $i = -Cdv/dt$

C. $v = Cdi/dt$

D. $v = -Cdi/dt$

E. $v = -(1/C)di/dt$.

**Solution:** The assigned positive direction of current is that of a voltage rise across the capacitor. According to the passive sign convention, the $i$-$v$ relation is written with a negative sign.

**6.** An ideal, parallel-plate capacitor of 10 μF is charged to $V_C$ = 1 V. if the distance between the parallel plates is doubled, what will be the voltage across the capacitor?

A. 3 V

B. 6 V

C. 2 V

D. 4 V

E. 5 V.

**Solution:** The charge on the capacitor is $10 \times V_C = 10V_C$ C. If the distance between the plates is doubled, the charge remains the same, but the capacitance is halved to 5 μF. The new voltage is $10V_C/5 = 2V_C$ V.

**7.** If all voltages and currents are dc, determine $V_X$ assuming $V_{SRC}$ = 2 V.

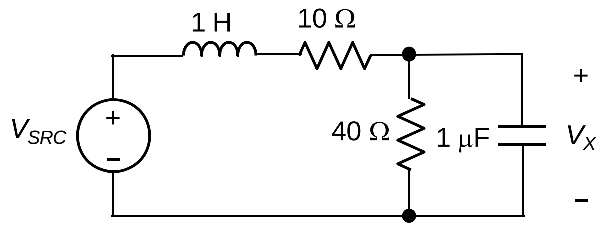
A. 1.6 V

B. 2.4 V

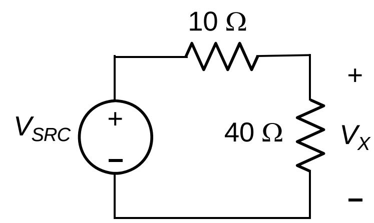
C. 3.2 V

D. -1.6 V

E. -2.4 V.




**Solution:** Under dc conditions, the inductor behaves as a short circuit and the capacitor as an open circuit. The circuit reduces to that shown. From voltage division, $V_X = \frac{40}{10+40}V_{SRC} = 0.8V_{SRC} = 1.6$ V.




**8.** The current through a 2 μF capacitor is shown as a function of time. Determine the charge on the capacitor at $t$ = 3.4 s.

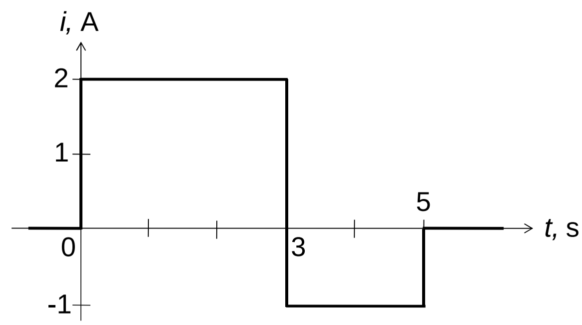
A. 5.6 C

B. 5.2 C

C. 4.8 C

D. 4.4 C

E. 4 C.




**Solution:** The charge at $t > 3$ s is the net area under the curve, which gives $q = 2\times3 - 1\times(t - 3) = (9 - t) = 5.6$ C.

**9.** If the current in Problem 8 is applied to a resistor $R$ = 5 Ω, determine the average power dissipated in the resistor over the interval from $t$ = 0 to $t$ = 5 s.

A. 50 W

B. 14 W

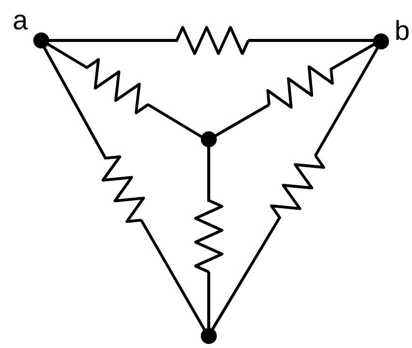
C. 70 W

D. 24 W

E. 12.5 W.

**Solution:** The power dissipated from $t$ = 0 to $t$ = 3 s is $(2)^2\times R = 4R$; the power dissipated from $t$ = 3 s to $t$ = 5 s is $(-1)^2\times R = R$; the average power dissipated is $P = (4R\times3 + R\times2)/5 = 2.8R = 14$ W

**10**. Determine the resistance between nodes a and b if each of the resistances connected in Y is $R$ and each of the resistances connected in the outer Δ is $3R$, with $R = 1\ \Omega$.




A. 15 Ω

B. 20 Ω

C. 15 Ω

D. 1 Ω

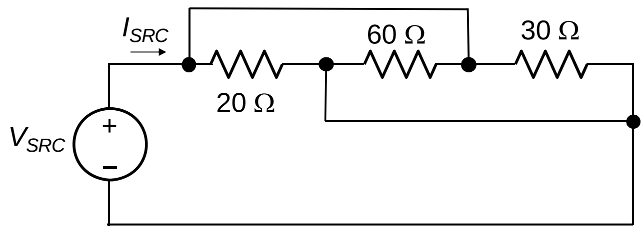
E. 10 Ω.

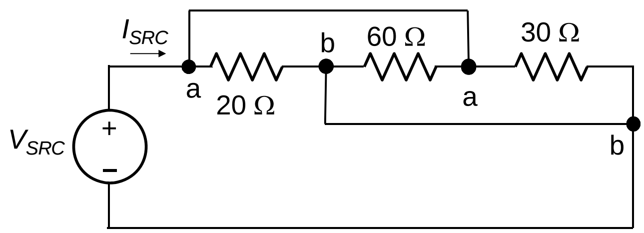
**Solution:** If the Δ is transformed to Y, each of the resistances in Y is $R$ Ω, and the two Y connections are in parallel. For each Y, the resistance between nodes a and b is $2R$ Ω, and these in parallel give $R = 1\ \Omega$.

Alternatively, if the Y is transformed to Δ, the resistances connected in Δ are $3R$ Ω. The two Δ connections in parallel will give a Δ connection of $1.5R$ Ω resistors. The resistance between nodes a and b will be $1.5R$ Ω in parallel with $3R$ Ω, which again gives $R = 1\ \Omega$.

**11.** Determine $I_{SRC}$ if $V_{SRC} = 10$ V.

**Solution:** If the nodes are labeled, it is seen that the three resistances are effectively connected between two nodes, which means that they are in parallel; 30 Ω in parallel with 60 Ω is (30)(60)/90 = 20 Ω, and 20 Ω in parallel with 20 Ω is 10 Ω. Hence, $I_{SRC} = V_{SRC}/10 = 0.1V_{SRC} = 1$ V.

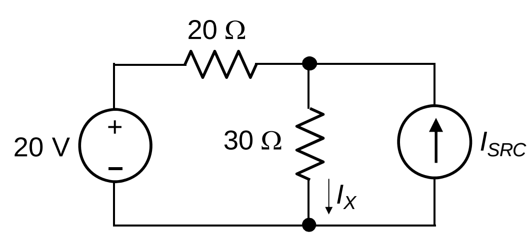


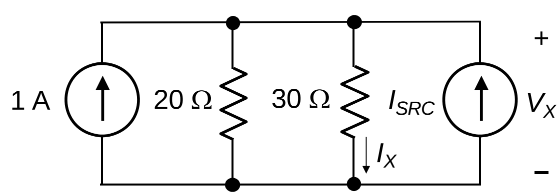




**12.** Determine $I_X$ **<u>using source transformation</u>**, and assuming $I_{SRC} = 1$ A.

**Solution:** The 20 V source in series with 20 Ω is transformed to a current source of (20 V)/(20 Ω) = 1A in parallel with 20 Ω. Applying KCL:

$I_{SRC} + 1 = \frac{V_X}{20} + \frac{V_X}{30} = \frac{V_X}{12}$. It follows that $V_X$ = $12(I_{SRC} + 1)$, and $I_X = \frac{V_X}{30} = 0.4(I_{SRC} + 1) =$ 0.8 A.



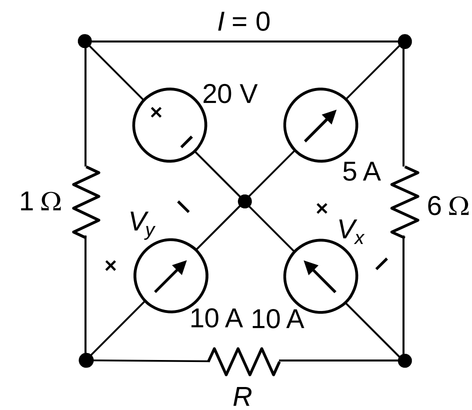
Alternatively, the two current sources can be combined into a single current source ($I_{SRC}$ + 1) A. From current division, $I_X = \frac{20}{20+30}(I_{SRC}+1) = 0.4(I_{SRC}+1) = 0.8$ A.

**13.** In the circuit shown, the current in the top connection is zero. Determine:

10% (a) $R$

10% (b) $V_x$

10% (c) $V_y$.




**Solution:**

(a) From KCL at node b, $I_{be}$ = 5 A.

From KCL at node e, $I_{de}$ = 5 A.

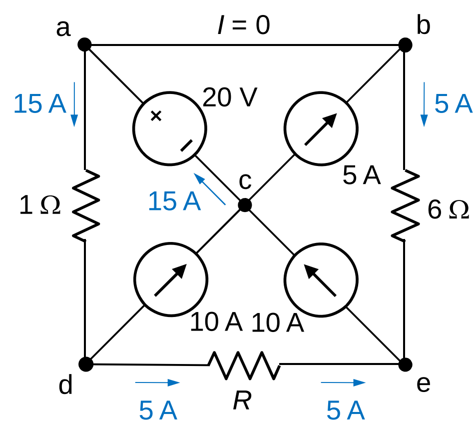
From KCL at node c, $I_{ca}$ = 15 A.

From KCL at node a, $I_{ad}$ = 15 A.

As a check, KCL at node d is satisfied.

From ohm's law, $V_{be}$ = 30 V, $V_{ad}$ = 15 V, and the voltage across $R$ is 5$R$.

Applying KVL to the outer loop starting from node e and going CW: 5$R$ + 15 – 30 = 0, which gives 5$R$ = 15, and $R$ = 15/5 = 3 Ω.




(b) From KVL around the mesh abc, starting from node a and going CW:

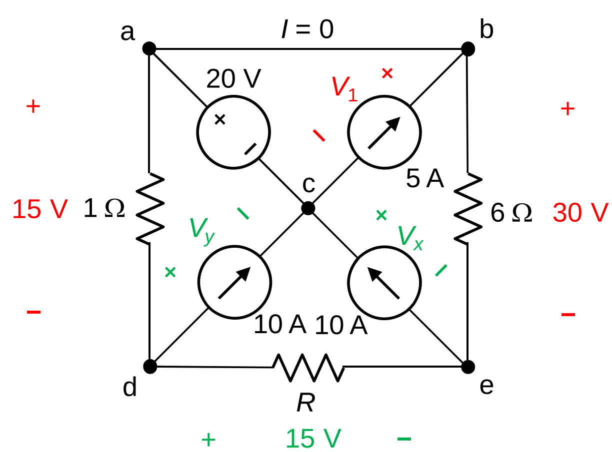
-$V_1$ + 20 = 0, or $V_1$ = 20 V.

From KVL around mesh cbe, starting from node c and going CW: $V_1$ – 30 + $V_x$ = 0, or $V_x$ = 10 V.

(c) From KVL around the mesh acd, starting from node a and going CW:

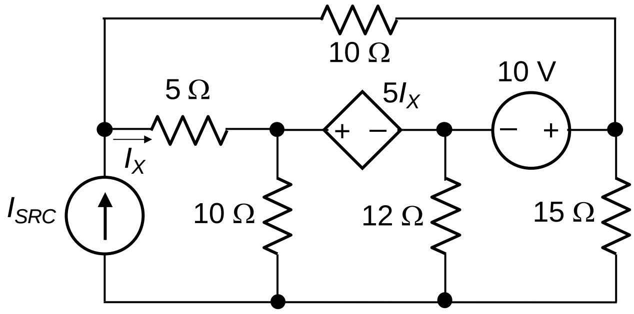
-20 + $V_y$ + 15 = 0, or $V_y$ = 5 V.

As a check, KVL around the mesh ced, starting from node c and doing CW: -$V_x$ + 15 – $V_y$ = 0, or -10 + 15 -5 = 0.



**1.** Determine $I_X$, assuming $I_{SRC}$ = 1 A (Hint: write one KVL equation and one KCL equation).

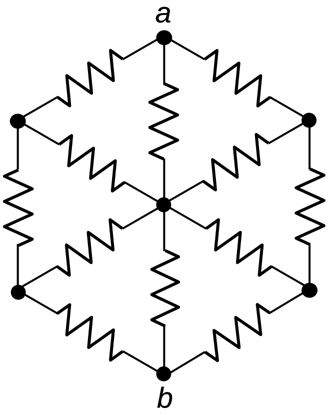
A. 4 A
B. 2 A
C. 3 A
D. 1 A
E. 5 A



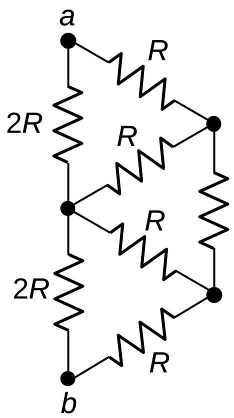

**Solution:** Let the current through the 10 Ω resistor be $I_Y$. From KVL around the mesh abcda: $5I_X + 5I_X - 10 - 10I_Y = 0$, which gives, $I_Y = I_X - 1$. From KCL at node a, $I_{SRC} = I_Y + I_X$, or $I_{SRC} = 2I_X - 1$. It follows that $I_X = (I_{SRC} + 1)/2 = 1$ A.

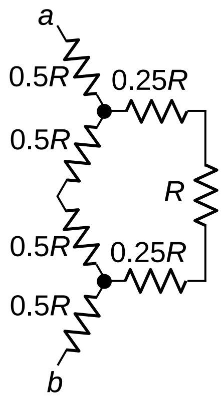
**4.** Determine the resistance between nodes a and b assuming that all resistances are 1 Ω.

A. 4 Ω
B. 2.4 Ω
C. 3.2 Ω
D. 1.6 Ω
E. 0.8 Ω



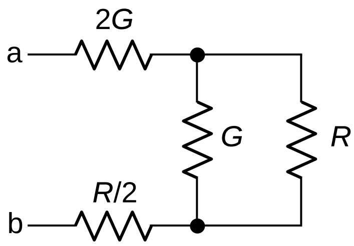

**Solution:** The resistances can be split into two halves in parallel, where the resistances in the middle become 2$R$. Applying Δ-Y transformation, the resistances become as shown. It follows that $2R_{ab} = 0.5R + R||1.5R + 0.5R = R + 0.6R = 1.6R$, so that $R_{ab} = 0.8R = 0.8$ Ω.



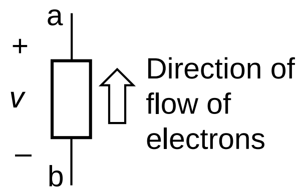

**3.** In the circuit shown, the values of two resistors are expressed in terms of the resistance $R$, and the values of two resistors are expressed in terms of the conductance $G$. Determine the resistance between terminals a and b, assuming $R = \frac{1}{G} = 1$ Ω.

A. 4.5 Ω
B. 3 Ω
C. 3/2 Ω
D. 7.5 Ω
E. 6 Ω




**Solution:** The resistance of a resistor whose conductance is 2$G$ is $\frac{1}{2G} = \frac{R}{2}$, and the resistance of a resistor whose conductance is $G$ is $\frac{1}{G} = R$. It follows that the resistance of the two paralleled resistors is $R$/2, and the total resistance between terminals ab is $R_{eqs} = 3R/2$.

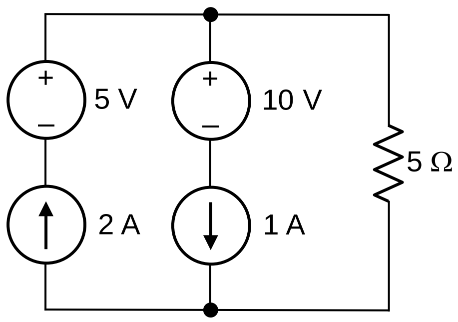
1. The figure shows the assigned voltage drop across a given circuit element, the current being carried by electrons flowing through the circuit element in the direction shown. Which of the following statements is, or are, true? (Note: if a false statement is marked true, the answer to this Question 1 is considered incorrect).



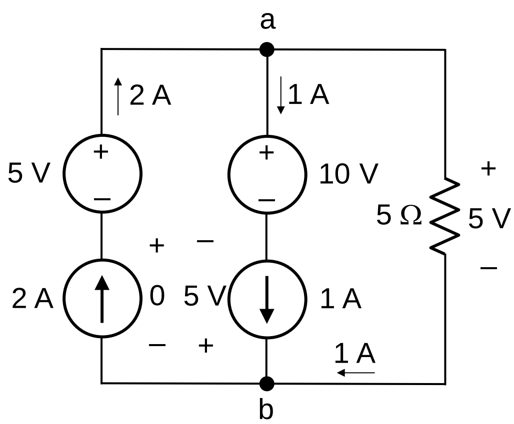

   A. The circuit element delivers power.
   B. The electric potential energy of electrons is higher at terminal a than at terminal b.
   C. If the flow of electrons is $3.2\times10^{19}$/s, and the charge per electron is $-1.6\times10^{-19}$ C, the magnitude of the current is $2\times10^{38}$ A.
   D. The difference between the electric potential energies of electrons at terminals a and b is independent of which of these terminals is grounded.
   E. If the element is a resistor and power is absorbed by the element, then if the rate of flow of electrons in particles per second is doubled, the power absorbed by the element will be doubled.

**Answers:** A. The direction of conventional current flow is opposite that of electron flow, because electrons are negatively charged. The current is in the direction of a voltage drop and power is absorbed by the element.
B. Because of their negative charge, electrons will have a higher electric potential energy at the more negatively charged terminal, b.
C. The magnitude of the current is $3.2\times10^{19}\times1.6\times10^{-19} = 5.12$ A.
D. The difference in electric potential energy is independent of where the arbitrary zero of this potential energy is taken.
E. When the rate of flow is doubled, the current is doubled, the voltage drop is doubled, and the power absorbed is quadrupled.
Only statement D is true.

**2.** Which of the following statements is, or are, true of the circuit shown? (Note: if a false statement is marked true, the answer to this Question 2 is considered incorrect).

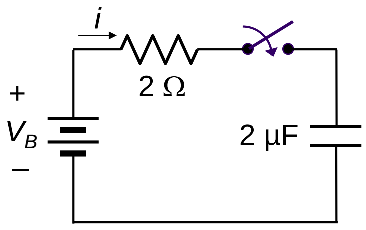



   A. It is impossible to tell whether or not the source connections are valid.
   B. The connections of voltage sources and current sources are valid.
   C. The connection of voltage sources is not valid.
   D. The connection of current sources is not valid.
   E. The source connections become valid if the 5 Ω resistor is removed.




**Solution:** From KCL, the currents in the voltage sources are the same as those of the current sources, and the current at node b is 1 A in the direction shown. The voltage across the 5 Ω resistor is 5 V in the polarity shown. From KVL, the voltage across the 2 A source is zero, and the voltage across the 1 A source is 5 V in the polarity shown. KVL and KCL are satisfied throughout the circuit, so the circuit is valid,

**4.** When the switch is closed, a current $i$ flows that begins charging the capacitor. After a sufficiently long time, the capacitor is fully charged. Determine the energy stored in the capacitor when it is fully charged, assuming $V_B$ = 2 V.




A. 4 µJ
B. 16 µJ
C. 36 µJ
D. 25 µJ
E. 9 µJ

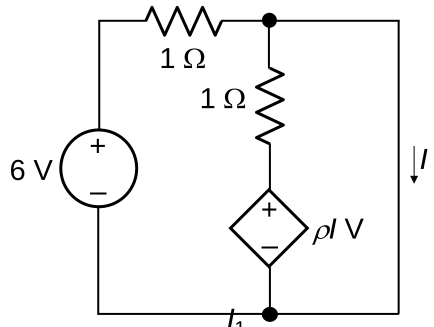
**Solution:** When the capacitor is fully charged, $i$ = 0, and the voltage across the capacitor is $V_B$, and the energy stored in the capacitor is $W = \frac{1}{2}CV_B^2$.

**5.** Determine the total energy delivered by the battery in the preceding problem when the capacitor is fully charged.

A. 32 µJ
B. 72 µJ
C. 18 µJ
D. 50 µJ
E. 8 µJ

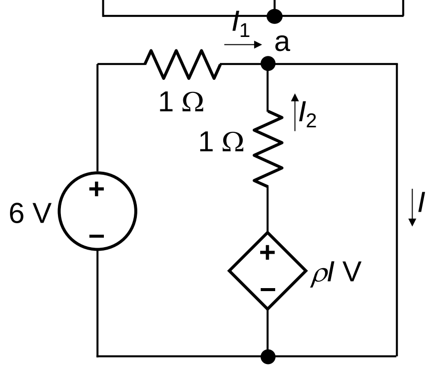
**Solution:** The instantaneous power delivered by the battery is $p = V_B i$. The total energy delivered by the battery is $W = \int_0^\infty V_B i dt = V_B \int_0^\infty i dt$, assuming that charging begins at $t$ = 0. But $\int_0^\infty i dt$ is the total charge delivered to the capacitor, which is $CV_B$. It follows that $W = CV_B^2$.

**6.** Determine $I$ assuming $\rho$ = 0.9 Ω.

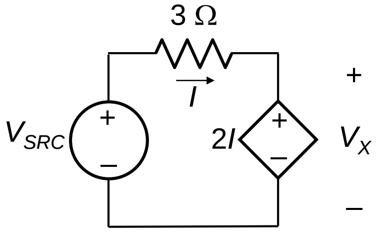



A. 30 A
B. 12 A
C. 60 A
D. 15 A
E. 20 A

**Solution:** From KCL at node a: $I = I_1 + I_2$; from KVL in the outer loop, $6 = 1\times I_1$; from KVL in the RHS mesh, $\rho I = 1\times I_2$; hence, $I = 6 + \rho I$, or $I = \frac{6}{1-\rho}$ A.




**9.** Determine $V_X$, assuming $V_{SRC}$ = 2.5 V.

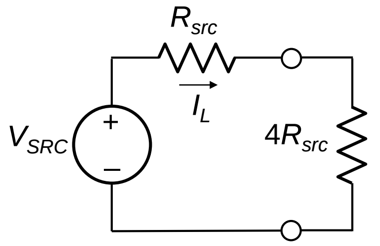



A. 1 V
B. 5 V
C. 3 V
D. 2 V
E. 4 V

**Solution:** From KVL, $V_{SRC} = 3I + V_x = 5I$; $I = V_{SRC}/5$, and $V_X = 2V_{SRC}/5 = 0.4V_{SRC}$.

**7.** A nonideal voltage source has an open-circuit voltage $V_{SRC}$. When connected to a load resistor that draws a current of $I_L$ = 1 A, the power dissipated in the load is four times the power dissipated in the source resistance. Determine the short-circuit current of the equivalent nonideal current source.

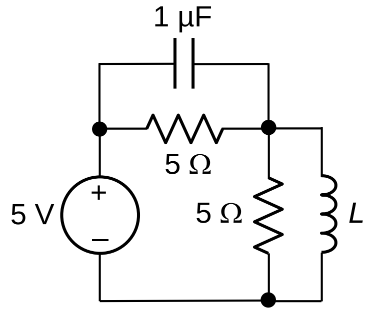
A. 12.5 A
B. 5 A
C. 7.5 A
D. 15 A
E. 10 A




**Solution:** Since the power dissipated in the load is four times the power dissipated in the source resistance, the load resistance is $4R_{src}$. The short-circuit current of the nonideal current source is $I_{SRC} = \frac{V_{SRC}}{R_{src}}$. From KVL, $V_{SRC} = 5R_{src}I_L$. It follows that $I_{SRC} = \frac{V_{SRC}}{R_{src}} = 5I_L$.

**8.** Determine the energy stored in the inductor if $L$ = 1 H assuming dc conditions, after all voltages and currents have assumed constant values.

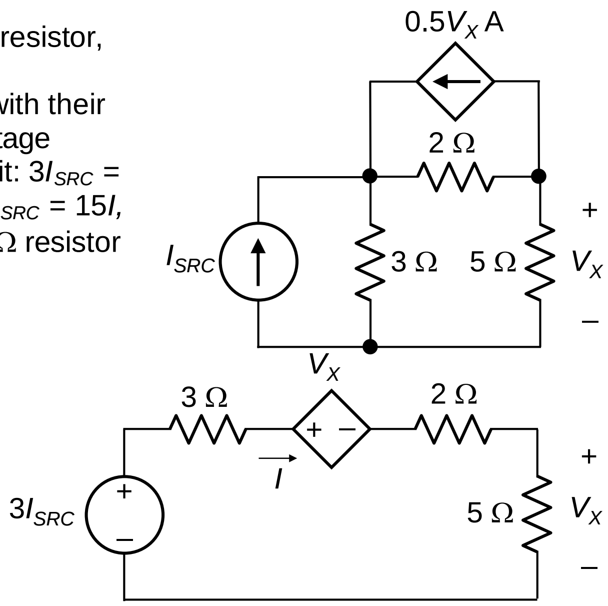
A. 0.75 J
B. 1 J
C. 1.5 J
D. 2 J
E. 0.5 J



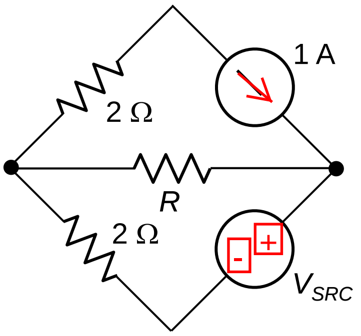

**Solution:** Under dc conditions, the current through the capacitors is zero, and the voltage across the inductor is zero. From KVL, a current equal to $\frac{5\text{ V}}{5\,\Omega} = 1\text{A}$ passes through the upper 5 Ω resistor and through $L$. The energy stored in the inductor is $W = \frac{1}{2}L1^2 = L/2$ J.

**13.** Determine the power dissipated in the 5 Ω resistor, assuming $I_{SRC}$ = 1 A.

**Solution:** The two current sources in parallel with their associated resistors can be transformed to voltage sources as shown. From KVL around the circuit: $3I_{SRC} = 2V_X + 5I$, where $V_X = 5I$. Substituting for $V_X$, $3I_{SRC} = 15I$, and $I = 0.2I_{SRC}$. The power dissipated in the 5 Ω resistor is $P = 5 \times 0.04I_{SRC}^2 = 0.2I_{SRC}^2$ W

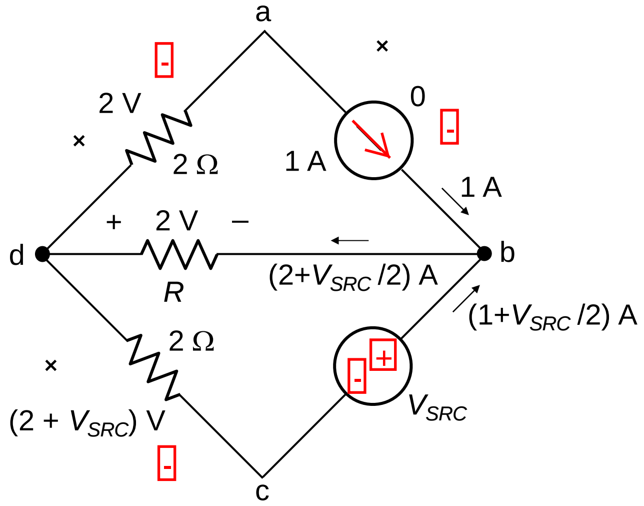


**11**. Determine $R$, so that no power is delivered or absorbed by the 1 A current source, assuming $V_{SRC}$ = -6 V.




**Solution:** The solution proceeds in the following steps:

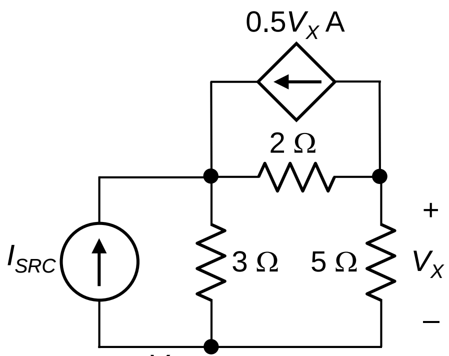
1. Since 1 A passes in branch ad, the voltage drop across the 2 Ω resistor is 2 V in the polarity shown.
2. Since no power is delivered or absorbed by the 1 A source, the voltage across this source is zero. From KVL around mesh abd, the voltage across $R$ is also 2 V.
3. From KVL around mesh bcd, the voltage across branch cd is (2 + $V_{SRC}$) V, since by going clockwise around this mesh, (2 + $V_{SRC}$) – 2 – $V_{SRC}$ = 0.
4. From Ohm's law, the current in the branch bc is (1 + $V_{SRC}$/2) A directed towards node b.
5. From KCL at node b, the current flowing away from node b is: (2 + $V_{SRC}$/2) A.
6. From Ohm's law applied to $R$, $R$(2 + $V_{SRC}$/2) = -2.

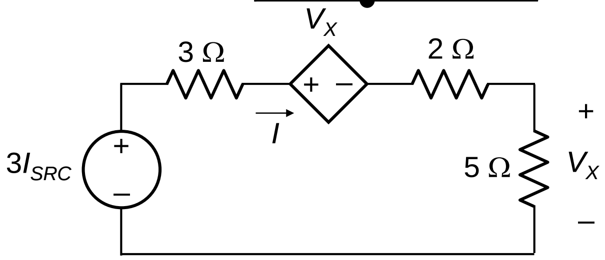



It follows that $R = \dfrac{2}{-V_{SRC}/2-2} = \dfrac{1}{-V_{SRC}/4-1}$.

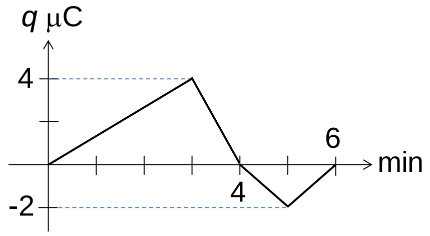
**13.** Determine the power dissipated in the 5 Ω resistor, assuming $I_{SRC}$ = 1 A.

**Solution:** The two current sources in parallel with their associated resistors can be transformed to voltage sources as shown. From KVL around the circuit: $3I_{SRC} = 2V_X + 5I$, where $V_X = 5I$. Substituting for $V_X$, $3I_{SRC} = 15I$, and $I = 0.2I_{SRC}$. The power dissipated in the 5 Ω resistor is $P = 5 \times 0.04 I_{SRC}^2 = 0.2 I_{SRC}^2$ W



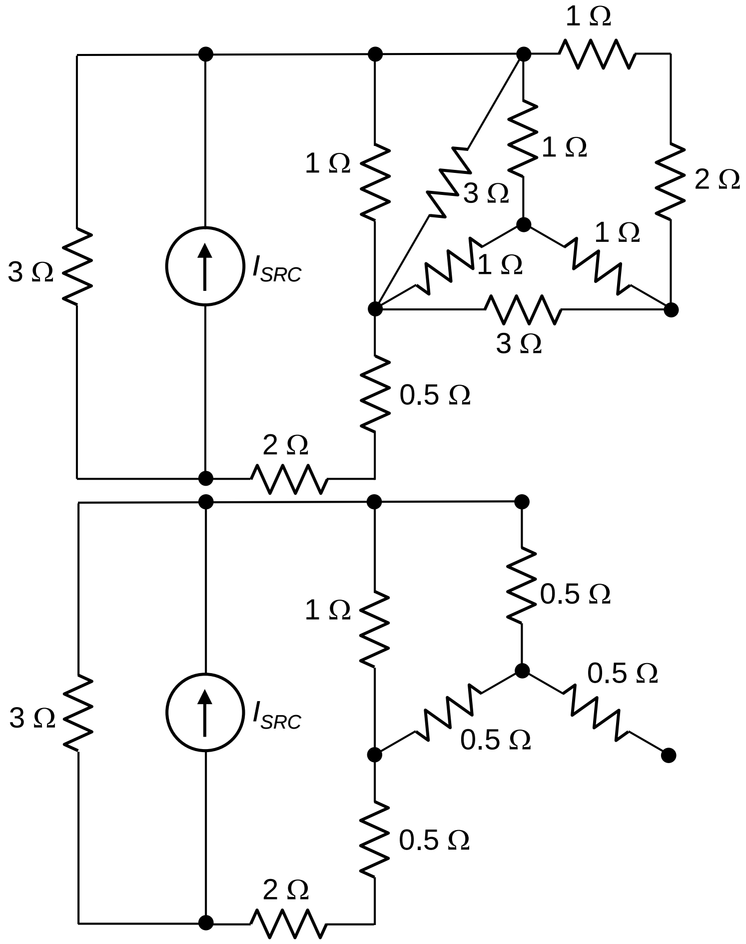
**10.** The figure shows the variation with time of the charge across a capacitor of 0.1 μF. Determine the average voltage across the capacitor.




A. V
B. 2.5 V
C. 2 V
D. 10 V
E. 5 V

**Solution:** The net area is $\frac{1}{2}(4\times4-2\times2)=6$ μC-min. The average charge is 6/6 = 1μC and the average voltage is $V$ = (1μC)/($C$ μF) = 1/$C$ V.

**12**. Determine the power delivered by $I_{SRC}$ = 1 A.




**Solution:** The 1 Ω and the 2 Ω resistors on the extreme RHS can be combined into a 3 Ω resistor. This gives a set of 3 Ω resistors connected in Δ, these being connected in parallel with three 1 Ω resistors connected in Y. The three Δ-connected resistors can be transformed to three 1 Ω resistors connected in Y. When these are paralleled with the existing 1 Ω resistors connected in Y, the result is three 0.5 Ω resistors connected in Y, as shown. The two 0.5 Ω resistors in series, paralleled with the give a 0.5 Ω resistor. When this is added to the 0.5 Ω and 2.5 Ω resistors, the resistors on the RHS of the source reduce to a 3 Ω resistor. Alternatively, the three 1 Ω resistors connected in Y can be transformed to three 3 Ω resistors connected in Δ. These are paralleled with the three 3 Ω Δ-connected resistors to give three 1.5 Ω resistors connected in Δ. These resistors can then be combined with the 1 Ω resistor to give a 0.5 Ω as before. The two 3 Ω resistors in parallel with $I_{SRC}$ give a 1.5 Ω resistor. The power delivered by the source is $P=1.5I_{SRC}^2$.