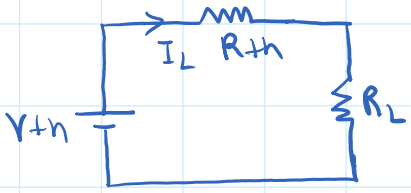
# Network Theorems

Tuesday, November 23, 2021 9:36 PM

Prove $R_{th} = R_L$




$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

$$P = I_L^2 R_L$$

$$= \frac{V_{th}^2 \times R_L}{(R_{th} + R_L)^2}$$

$$\frac{dP}{dR_L} = V_{th}^2 \left( \frac{(R_{th} + R_L)^2 - 2(R_{th} + R_L) R_L}{(R_{th} + R_L)^4} \right)$$

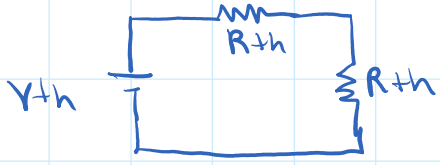
$$\frac{dP}{dR_L} = 0$$

$$(R_{th} + R_L)^2 - 2(R_{th} + R_L) R_L$$

$$R_{th}^2 + R_L^2 + 2R_{th}R_L - 2R_{th}R_L - 2R_L^2$$

$$R_{th}^2 = R_L$$

$$\boxed{R_L = R_{th}}^{*}$$




$$I = \frac{V_{th}}{2R_{th}}$$

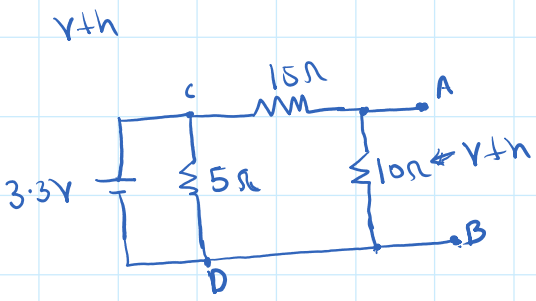
$$P_{max} = \frac{V_{th}^2}{4R_{th}^2} \times R_{th}$$

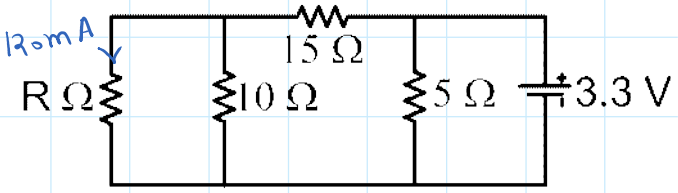
$$\boxed{P_{max} = \frac{V_{th}^2}{4R_{th}}}$$

# Illustration 1

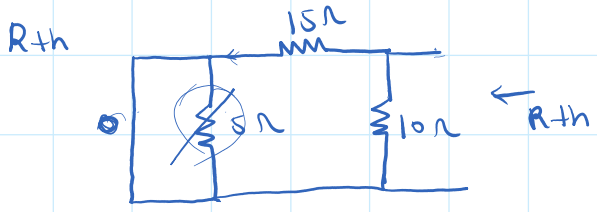
Tuesday, November 16, 2021 3:40 PM

Using Thevenin's theorem, find the value of R such that the current through it is 120 mA




$$V_{th} = \frac{3.3 \times 10}{10+15} = 1.32\,V \qquad R_{th} = \frac{0 \times 5}{0+5} = 0$$




$$R_{th} = \frac{10 \times 15}{10+15} = 6\,\Omega$$


$$I = \frac{V_{th}}{R_{th}+R}$$

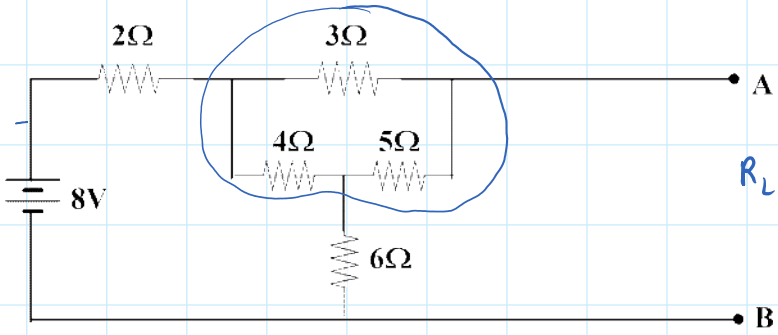
$$120 \times 10^{-3} = \frac{1.32}{6+R}$$

$$\boxed{R = 5\,\Omega}$$

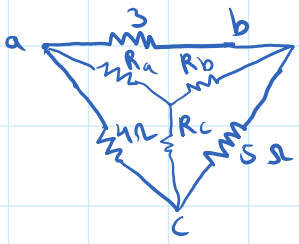
# Illustration 2

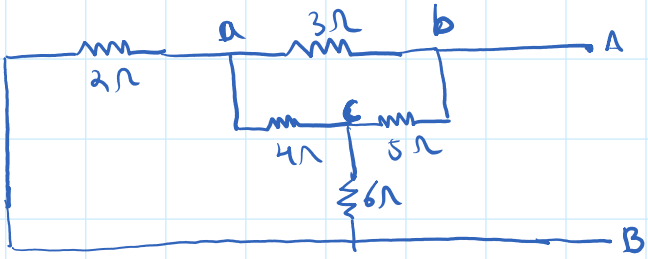
Tuesday, November 16, 2021 3:41 PM

Determine the value of resistor to be connected across the terminals A & B such that maximum power is transferred to the that resistor. Also, find the value of maximum power.




$R_L = R_{th}$

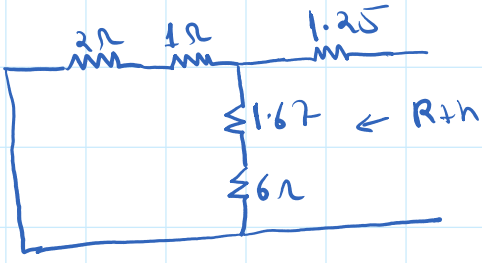


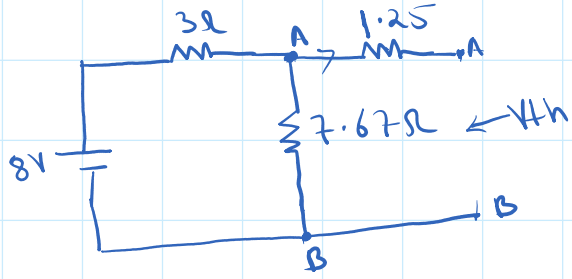




$R_a = \frac{3 \times 4}{3+4+5} = 1$

$R_b = \frac{3 \times 5}{3+5+4} = 1.25$

$R_c = \frac{4 \times 5}{3+5+4} = 1.67$

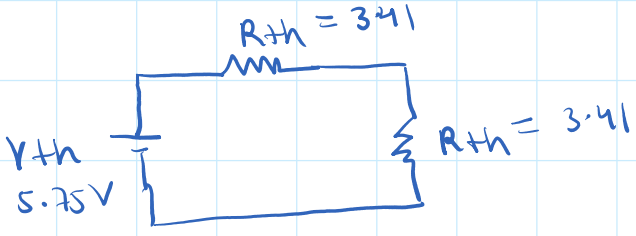



$R_{th} = \frac{3 \times 7.7}{10.7} + 1.25$

$= 3.41\Omega$

$V_{th} = \frac{8 \times 7.67}{10.67} = 5.75V$

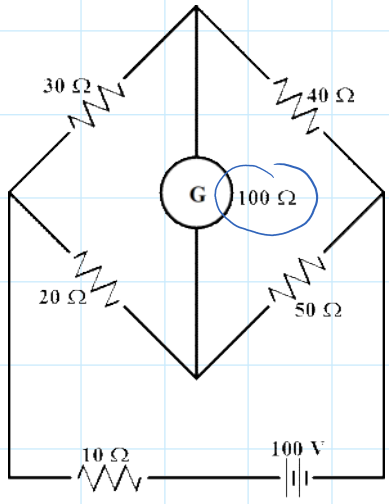


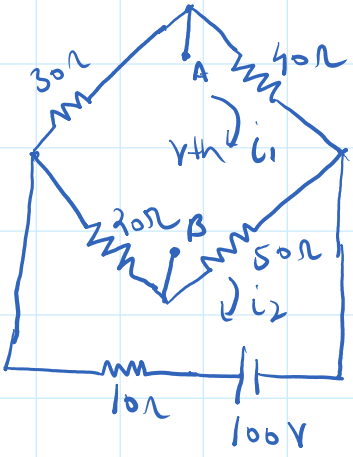
$$P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{(5.75)^2}{4 \times 3.41} = 2.43W$$

# Illustration 3

Tuesday, November 16, 2021 3:40 PM

Determine the current through the galvanometer using Thevenin's Theorem




$V_{th} = V_{AB}$

$V_A - 40i_1 - 50(i_1 - i_2) = V_B$

$V_A - V_B = V_{th} = 40i_1 + 50(i_1 - i_2)$

$V_{th} = -\frac{100}{9}\ V$

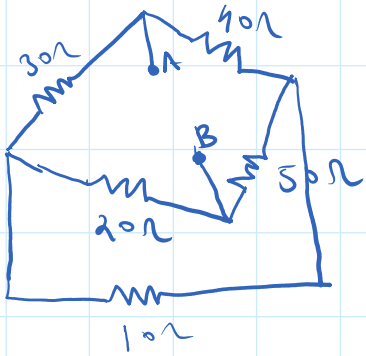
$100 - 10i_2 - 20(i_2 - i_1) - 50(i_2 - i_1) = 0$

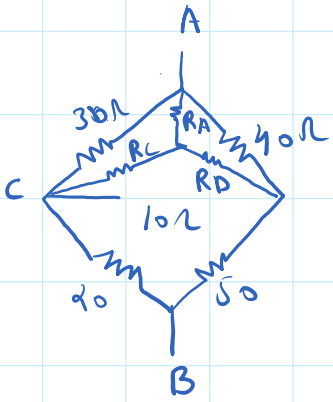
$-70i_1 + 80i_2 = 100 \quad -(1)$

$-30i_1 - 40i_1 - 50(i_1 - i_2) - 20(i_1 - i_2) = 0$

$140i_1 - 70i_2 = 0 \quad -(2)$

$i_1 = \frac{10}{9}$ $i_2 = \frac{20}{9}$

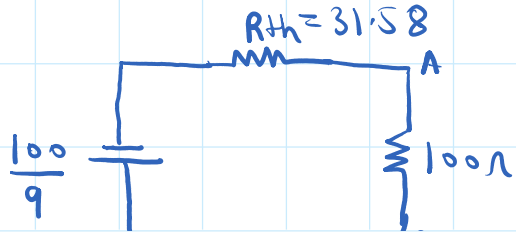


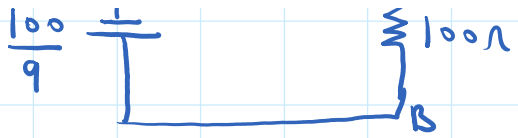

$R_A = 15$

$R_C = \frac{15}{4}$

$R_D = 5$




$R_{th} = 31.58$

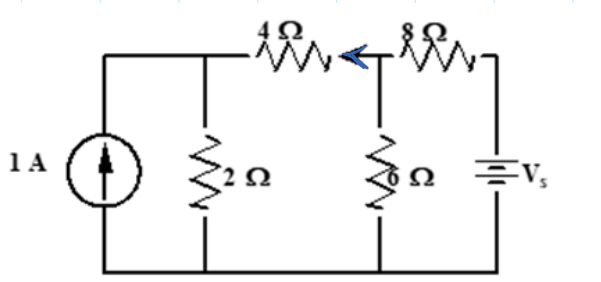


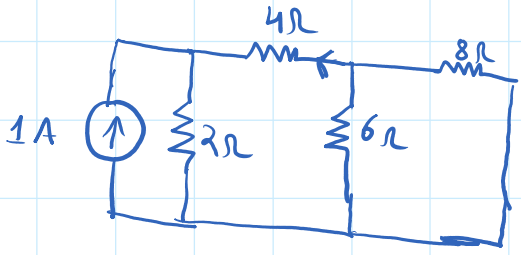

$$I = \frac{100/9}{31.58 + 100} = 84.44\ mA$$

# Question 1

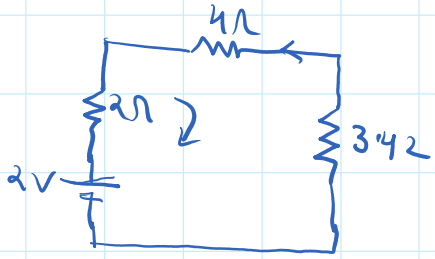
Tuesday, November 23, 2021 10:00 PM

- Using Superposition theorem, find the value of Vs if the current in 4 Ω is 0.515 A and the direction is as shown in the diagram below.



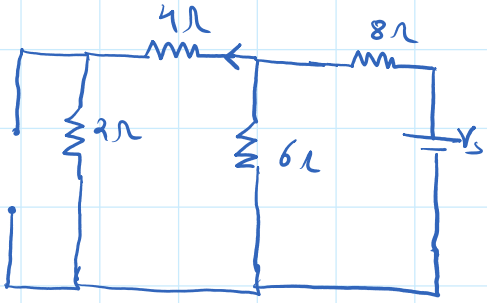



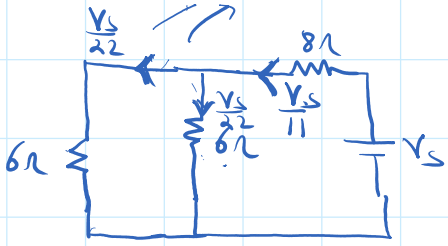

$$R = \frac{8 \times 6}{14}$$

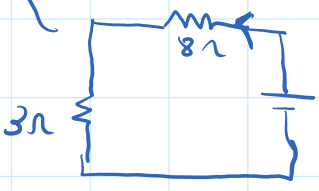



$$I = \frac{2}{9.42} \cong 0.212$$

$$I_{4\Omega} = -0.212$$




$$I = \frac{V_s}{8+3}$$

$$I = \frac{V_s}{11}$$

$$I_{4\Omega} = \frac{V_s}{22}$$

$$I = I_{4\Omega}^{I} + I_{4\Omega}^{V}$$

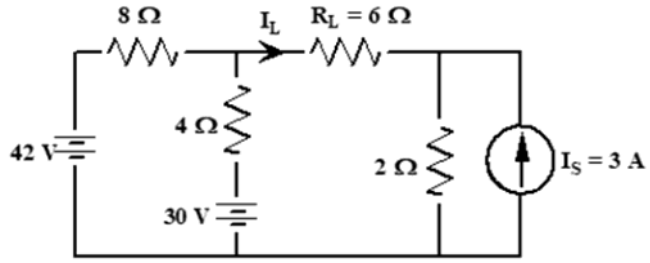
$$0.515 = -0.212 + \frac{V_s}{22}$$

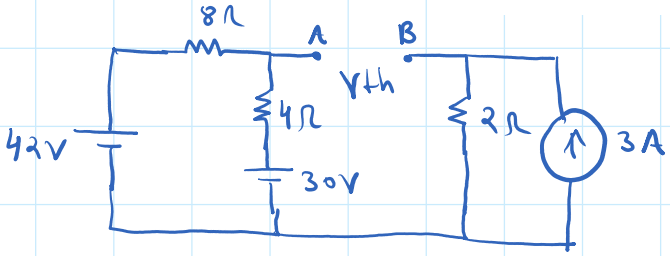
$$\boxed{V_s = 16\,V}$$

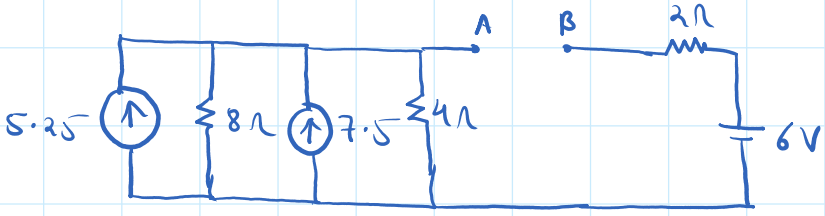
## Question 2

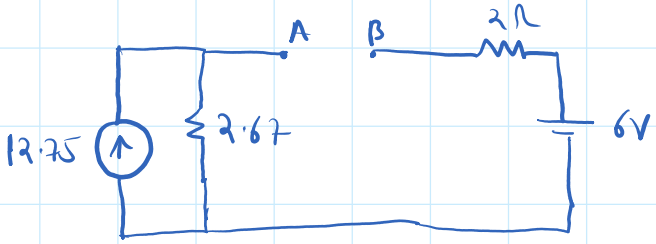
Tuesday, November 23, 2021 10:00 PM

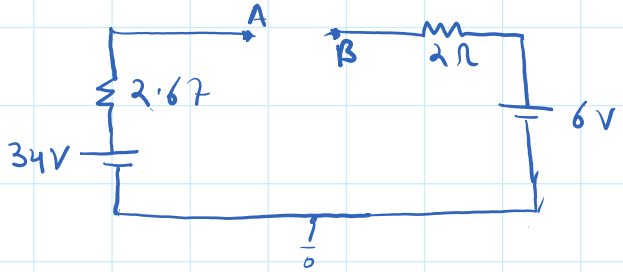
- For the circuit shown find the current $I_L$ through 6 Ω resistor using Thevenin's theorem

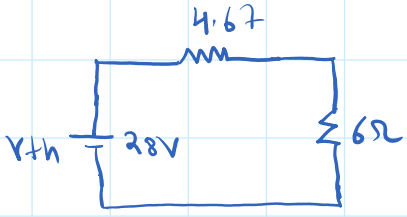



$V_{AB} = 34 - 6$

$V_{th} = 28V$

$R_{th} = 4.67$

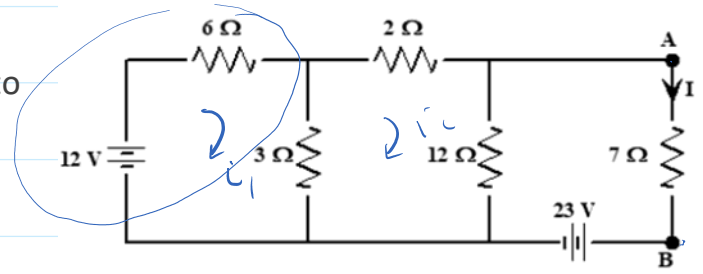
$$I = \frac{V_{th}}{R_{th} + R_L} = \frac{28}{10.67}$$

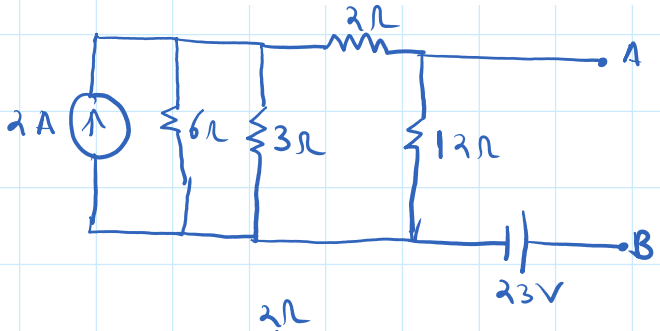
$= 2.624A$

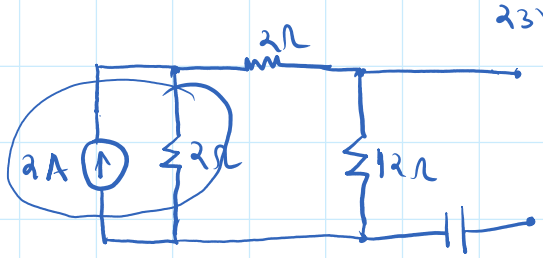
# Question 3

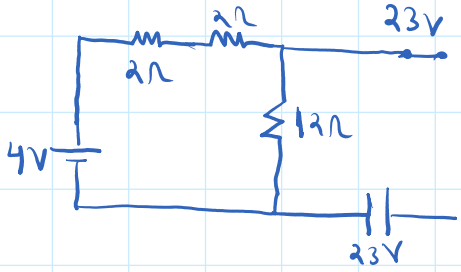
Tuesday, November 23, 2021 10:00 PM

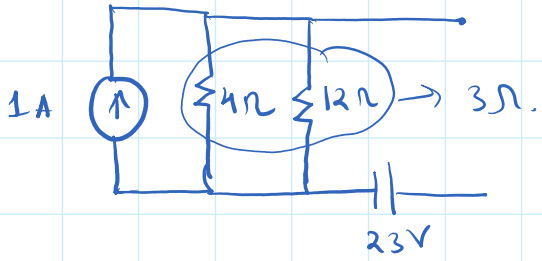
- In the figure shown below replace the network to the left of terminals A & B by its Thevenin's equivalent circuit. Hence, determine I

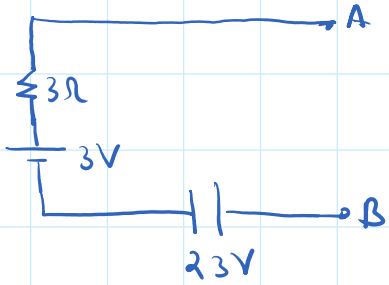


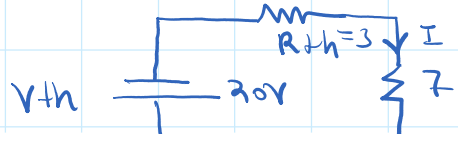




$V_{AB} = -20V$

$R_{th} = 3\Omega.$




$I = \frac{-20}{}$


$$I = \frac{-20}{10}$$

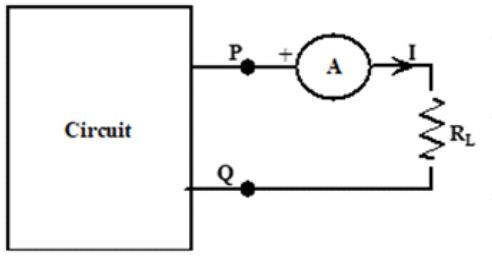
$$\boxed{I = -2A}$$

# Question 4

Tuesday, November 23, 2021 10:00 PM

- The box shown in the adjacent figure consists of independent dc sources and resistances. Measurements are taken by connecting an ammeter in series with the resistor $R_L$ and the results are shown in the table below. Find the value of $R_L$ for which the current is 0.6 A

| $R_L$ | I |
|---|---|
| 10 Ω | 2.0 A |
| 20 Ω | 1.5 A |
| ? | 0.6 A |



# Question 5

Tuesday, November 23, 2021 10:04 PM

Find the value of **R** such that maximum power is transferred to **8 Ω** resistor