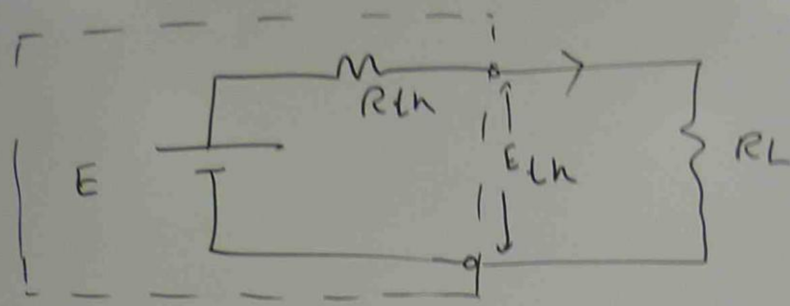
MAXIMUM POWER TRANSFER THEOREM



EQUIVALENT OF BATTERY

R_L = LOAD RESISTANCE

R_{th} = BATTERY INTERNAL RESISTANCE
(SOURCE RESISTANCE)

MAXIMUM POWER IS TRANSFERRED WHEN BATTERY INTERNAL RESISTANCE IS EQUAL TO LOAD RESISTANCE.

$$R_{th} = R_L \longrightarrow P_{MAX}$$

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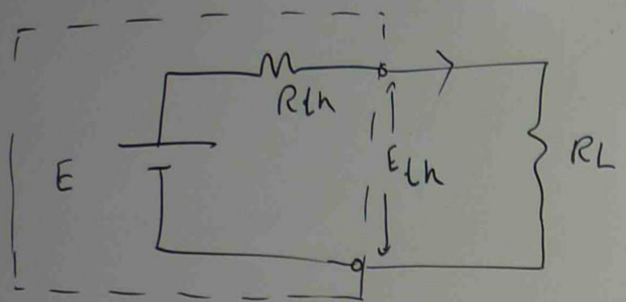

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MAXIMUM POWER IS TRANSFERRED WHEN BATTERY INTERNAL RESISTANCE IS EQUAL TO LOAD RESISTANCE.

$$R_{th} = R_L \longrightarrow P_{MAX}$$

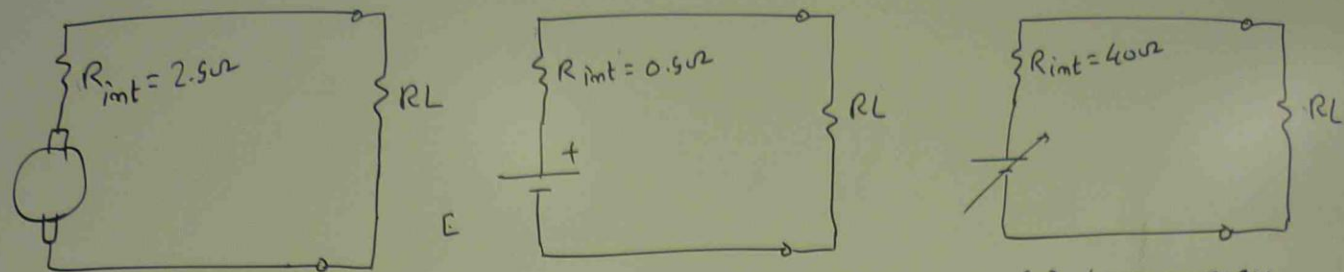
% EFFICIENCY $(\% \eta) = \dfrac{\text{LOAD POWER}}{\text{SOURCE POWER}} \times 100$

LOAD MAXIMUM POWER $= \dfrac{E_{th}^2}{4 R_{th}}$

LOAD RESISTANCE AT MAXIMUM POWER TRANSFER

$$R_L = \frac{\eta R_{th}}{1 - \eta}$$

EX A DC GENERATOR, BATTERY AND LABORATORY SUPPLY ARE CONNECTED TO A RESISTIVE LOAD R_L IN FIGURE (a) (b) AND (c) RESPECTIVELY.



(a) DC GENERATOR (b) BATTERY (c) LABORATORY

(a) FOR EACH, DETERMINE THE VALUE OF RL FOR MAXIMUM POWER TRANSFER TO RL

(b) DETERMINE RL FOR 75% EFFICIENCY

(a) DC GENERATOR

$$R_L = R_{th} = 2.5\Omega$$

(b) BATTERY

$$R_L = R_{th} = 0.5\Omega$$

(c) LABORATORY

$$R_L = R_{th} = 40\Omega$$

(b) $$R_L = \frac{n\,R_{th}}{1-n}$$

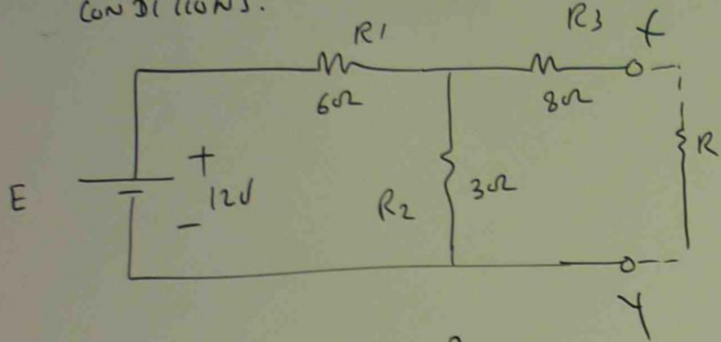
$75\% \longrightarrow n = 0.75$

(a)
$$R_L = \frac{0.75 \times 2.5}{1-0.75} = \frac{0.75 \times 2.5}{0.25} = 7.5\Omega$$

(b) $$R_L = \frac{0.75 \times 0.5}{1-0.75} = \frac{0.75 \times 0.5}{0.25} = 1.5\Omega$$

(c) $$R_L = \frac{0.75 \times 40}{1-0.75} = \frac{0.75 \times 40}{0.25} = 120\Omega$$

Ex: For the network of given figure, determine the value of R for maximum power to R, and calculate the power delivered under these conditions.



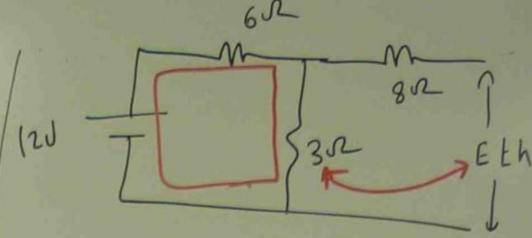
$E_{th} = ?$, $R_{th} = ?$

Thevenin's equivalent voltage

Thevenin's equivalent resistance.

E_{th}

- Remove load resistance
- Calculate the voltage across terminal



E_{th} = VOLTAGE ACROSS 3Ω

$$V_{3\Omega} = E \times \frac{3\Omega}{3\Omega + 6\Omega}$$

$$V_{R2} = E \times \frac{R_2}{R_1 + R_2}$$

$$V_{R1} = E \times \frac{R_1}{R_1 + R_2}$$

POTENTIAL DIVIDER THEOREM

$$V_{3\Omega} = 12 \times \frac{3}{3+6}$$

$$= \frac{36}{9} = 4V$$

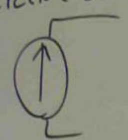
$$V_{3\Omega} = E_{th} = 4V$$

$R_{th} = ?$

- To find R_{th}, kill the source
- Find the equivalent resistance across terminal

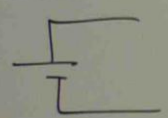
Kill the source

Current source

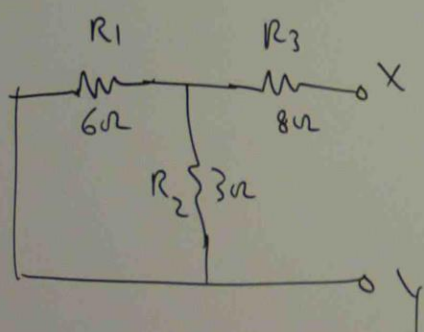


Remove

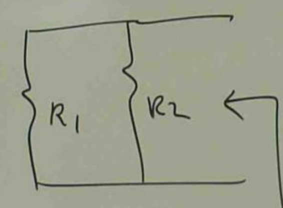
Voltage source



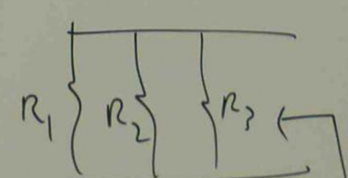
→ Short circuit



$$R_{XY} = R_{th} = R_3 + \frac{R_1 R_2}{R_1 + R_2}$$



$$R_{12} = \frac{R_1 R_2}{R_1 + R_2}$$

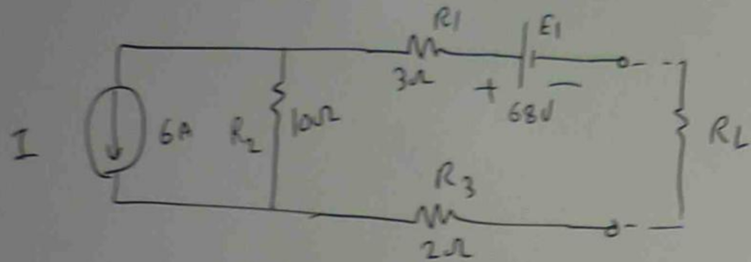


$$R_{123} = \frac{R_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1}$$

$$R_{th} = 8 + \frac{6 \times 3}{6+3} = 8 + \frac{18}{9} = 10\Omega$$

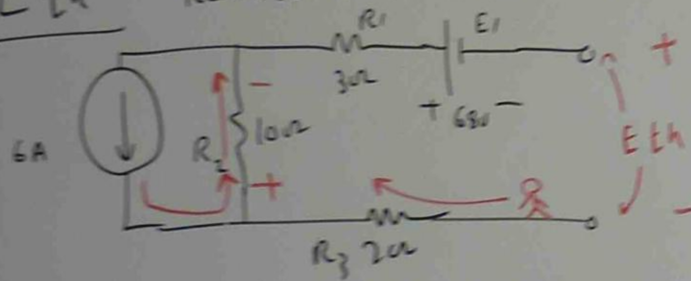
$$P_{max} = \frac{E_{th}^2}{4 R_{th}} = \frac{4^2}{4 \times 10} = \frac{16}{40} = 0.4 \text{ WATT}$$

Ex. FIND THE VALUE OF R_L IN FIGURE FOR MAXIMUM POWER TO R_L AND DETERMINE THE MAXIMUM POWER



Eth

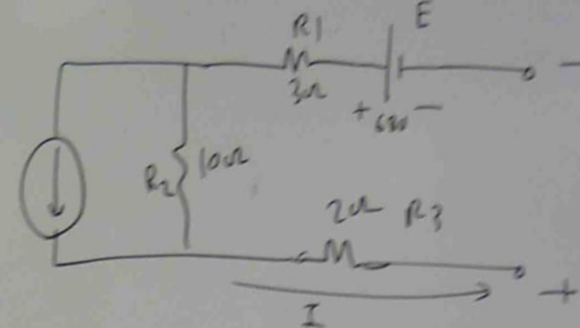
REMOVE LOAD RESISTANCE



$$(+6\times 10) + (+68) + E_{th} = 0$$

$$128 + E_1 = 0$$

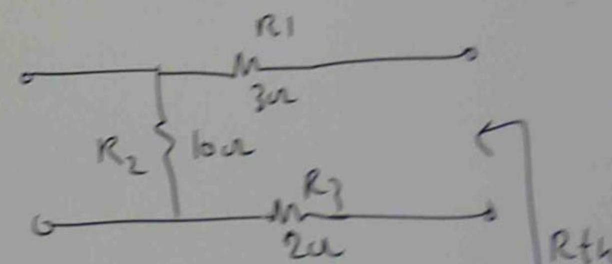
$$E_1 = -128$$



$128V = E_{th}$

Rth

KILL THE SOURCE



$$R_{th} = R_1 + R_2 + R_3$$

$$= 10 + 3 + 2 = 15\Omega$$

To flow maximum power $R_L = R_{th}$

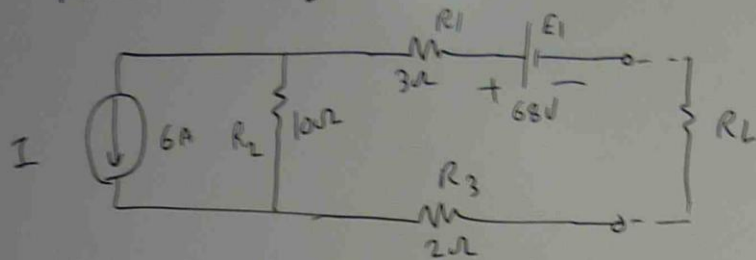
$\therefore R_L = 15\Omega$

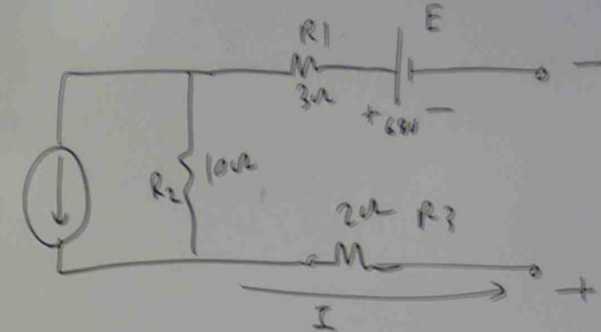
$$P_{L\,max} = \frac{E_{th}^2}{4 R_{th}}$$

$$= \frac{128^2}{4 \times 15}$$

$$= 237.07 \text{ WATT}$$

Ex FIND THE VALUE OF R_L IN FIGURE FOR MAXIMUM POWER TO R_L AND DETERMINE THE MAXIMUM POWER

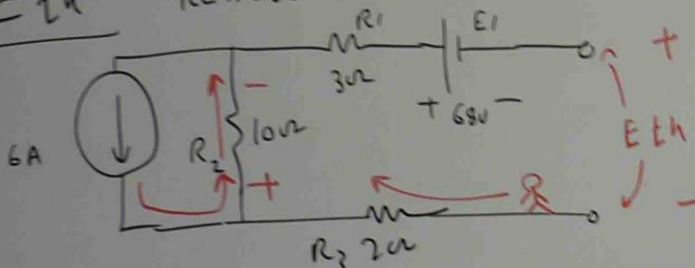




$128V = E_{th}$

Eth

REMOVE LOAD RESISTANCE



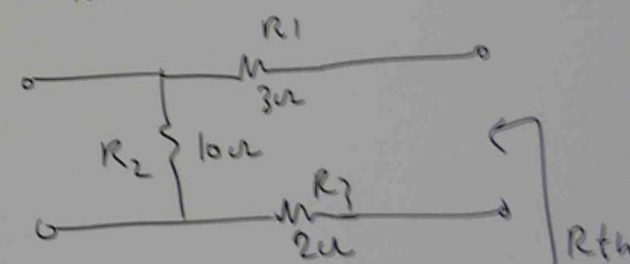
$$(+6\times10) + (+68) + E_{th} = 0$$

$$128 + E_1 = 0$$

$$E_1 = -128$$

Rth

KILL THE SOURCE



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$$= \frac{128^2}{4 \times 15}$$

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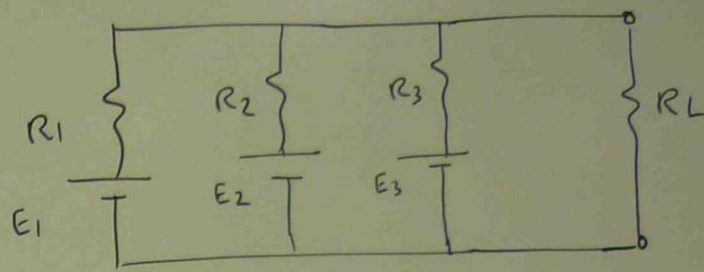
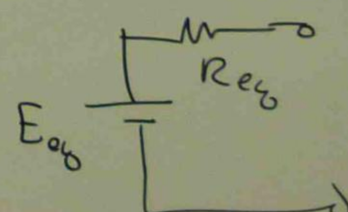
MILLMAN'S THEOREM

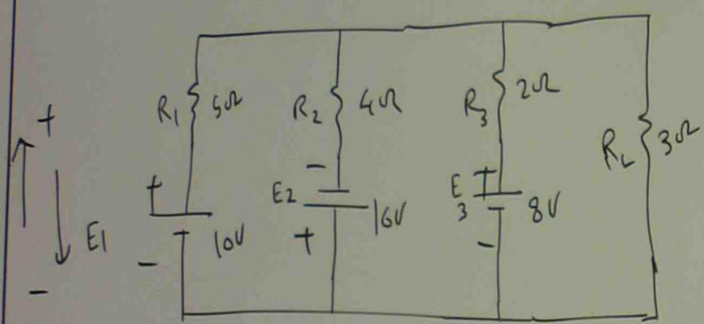


$$E_{eq} = \frac{\pm \frac{E_1}{R_1} \pm \frac{E_2}{R_2} \pm \frac{E_3}{R_3}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$



Ex USING MILLMAN'S THEOREM, FIND THE CURRENT THROUGH AND VOLTAGE ACROSS THE R_L



$$E_{eq} = \frac{\left(+\frac{E_1}{R_1}\right) + \left(-\frac{E_2}{R_2}\right) + \left(+\frac{E_3}{R_3}\right)}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$= \frac{\left(\frac{10}{5}\right) + \left(-\frac{16}{4}\right) + \left(\frac{8}{2}\right)}{\frac{1}{5} + \frac{1}{4} + \frac{1}{2}}$$

$$E_{eq} = \frac{2 - 4 + 4}{0.2 + 0.25 + 0.5}$$

$$= \frac{2}{0.95}$$

$$= 2.105\,V$$

$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$= \frac{1}{\frac{1}{5} + \frac{1}{4} + \frac{1}{2}}$$

$$= \frac{1}{0.2 + 0.25 + 0.5}$$

$$= \frac{1}{0.95} = 1.053\,\Omega$$