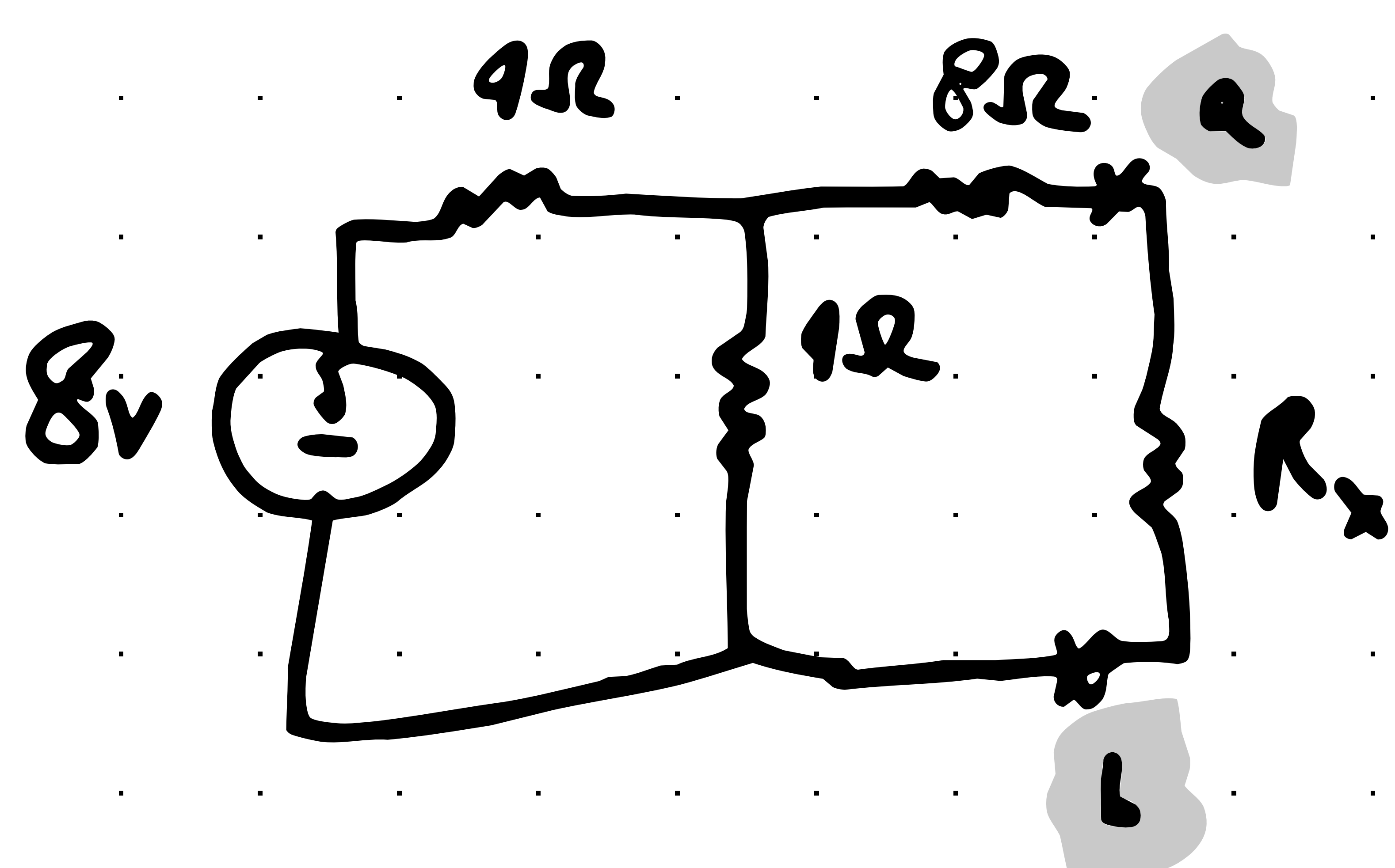
Thevenin and Norton's theorems

Ex

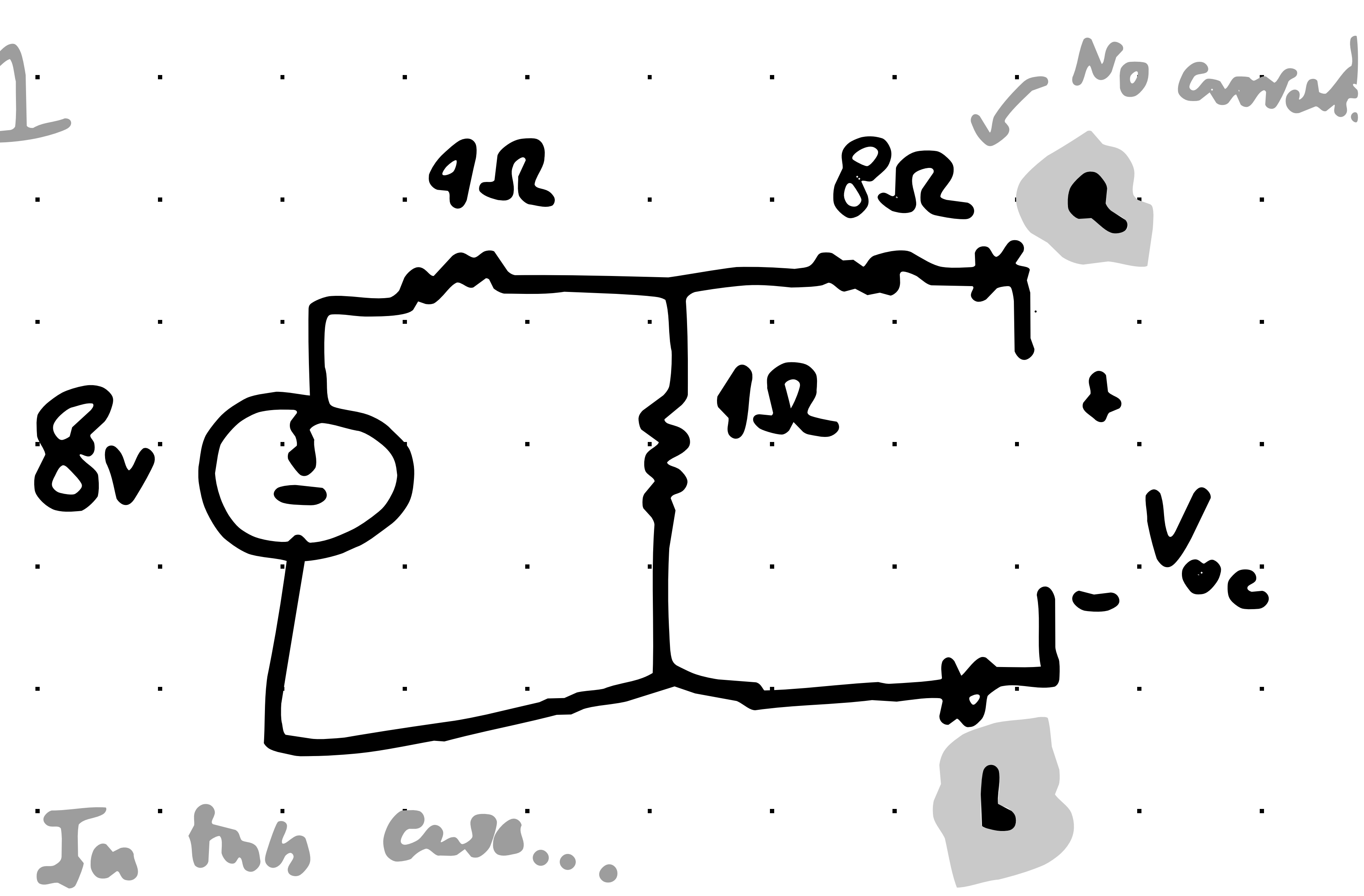


Find Thev and Norton equation between a and b.

Solution Using Method 1

To Calculate V_{Th}

open the circuit



In this case...

$$V_{oc} = V_{4\Omega}$$

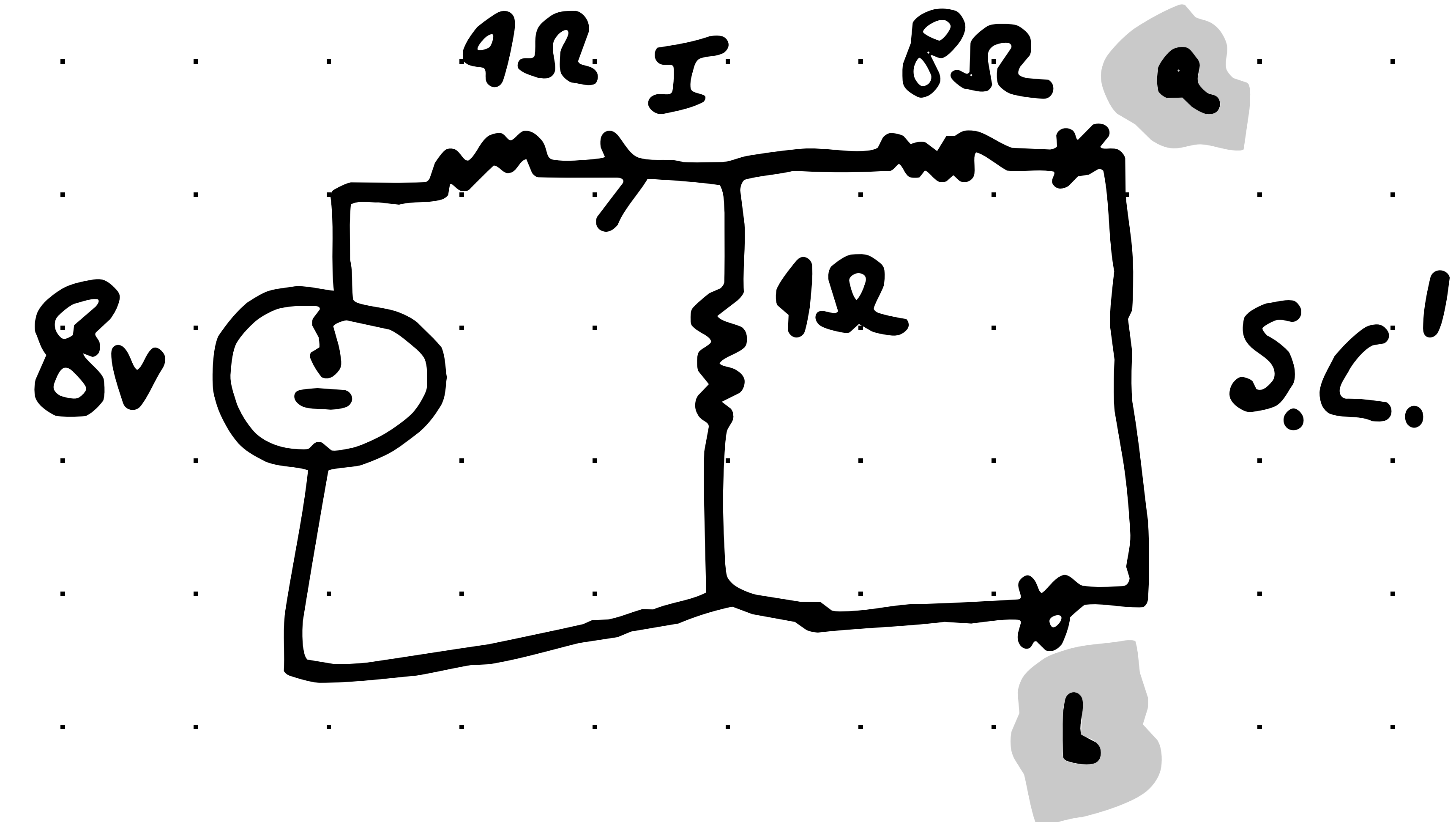
$$i = \frac{8}{4+4} = 1A$$

$$V_{oc} = 1(4) = 4V$$

$$V_{Th} = V_{oc} = 4v$$

To Calculate I_{Norton}

Short Two Resistors!



$$R_{eq} = 8 // 4 + 4$$

$$\frac{(8)(1)}{8+4} + 4 = 6.7\Omega$$

$$I = \frac{8}{6.7} = 1.19A$$

Using current divider... $I_N = I \frac{4}{4+8} = 0.398A$

$$I_N = I_{sc} = 0.398A$$

Calculate R_{Thev}

Using Method 1

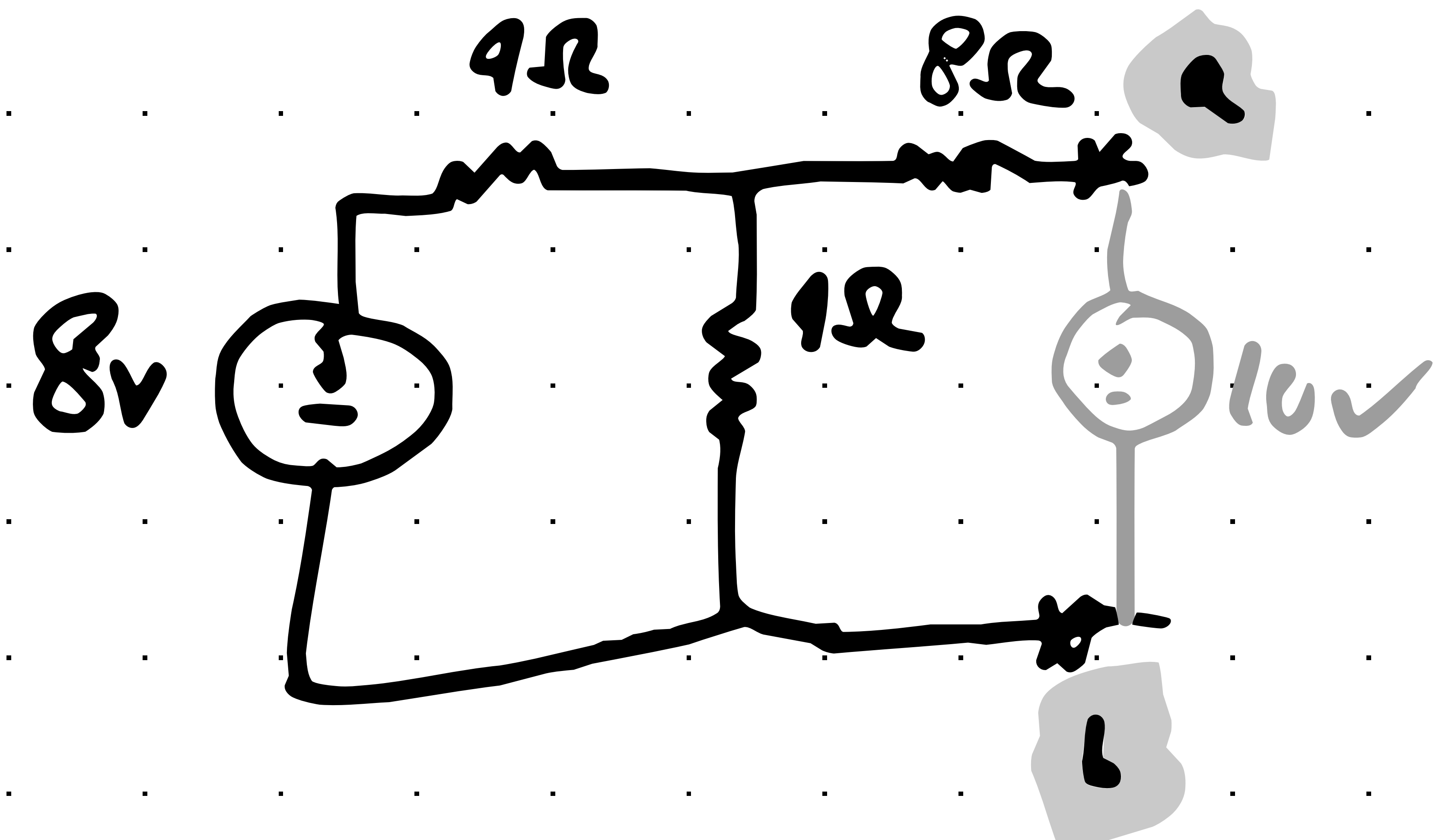
$$R_{Thev} = \frac{V_{Th}}{I_N} \quad \frac{4}{(0.398)} = 10\Omega$$

Using Method Two:

Remove all independent Voltage Sources

Inject ANY voltage Source into the spot of R_x. All we care about is the ratio

Let's say 10V



$$R_{TH} = R_N = \frac{V_{injected}}{I} = \frac{10}{I}$$

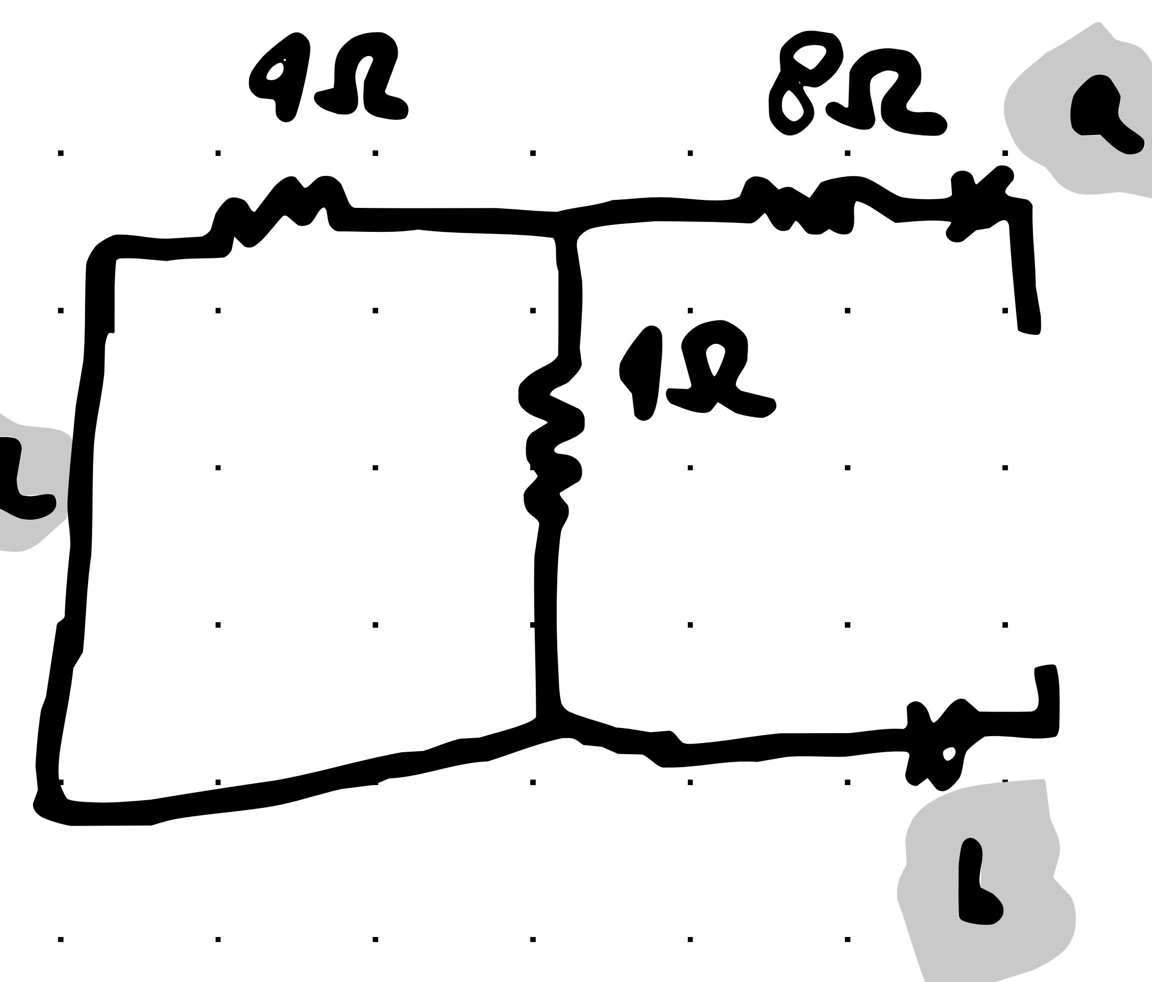
$$R_{eq} = (4 // 4) + 8 = \frac{4(4)}{4+4} + 8 = \underline{10\Omega}$$

$$I = \frac{V}{R} = \frac{10}{10} = \underline{1 Amp}$$

$$R_{TH} = R_N = \frac{10}{I} = \frac{10}{1} = \boxed{10\Omega}$$

Using Method 3

$R_T = 4 // 4 + 8 = \frac{4 \times 4}{4+4} + 8 = 10\Omega$



$R_{TH} = R_N = R_T = 10\Omega$

Now, This method **ONLY WORKS** if you have an independent source. It is very similar to Method 2, but without the voltage injection.

Maximum Power Transfer

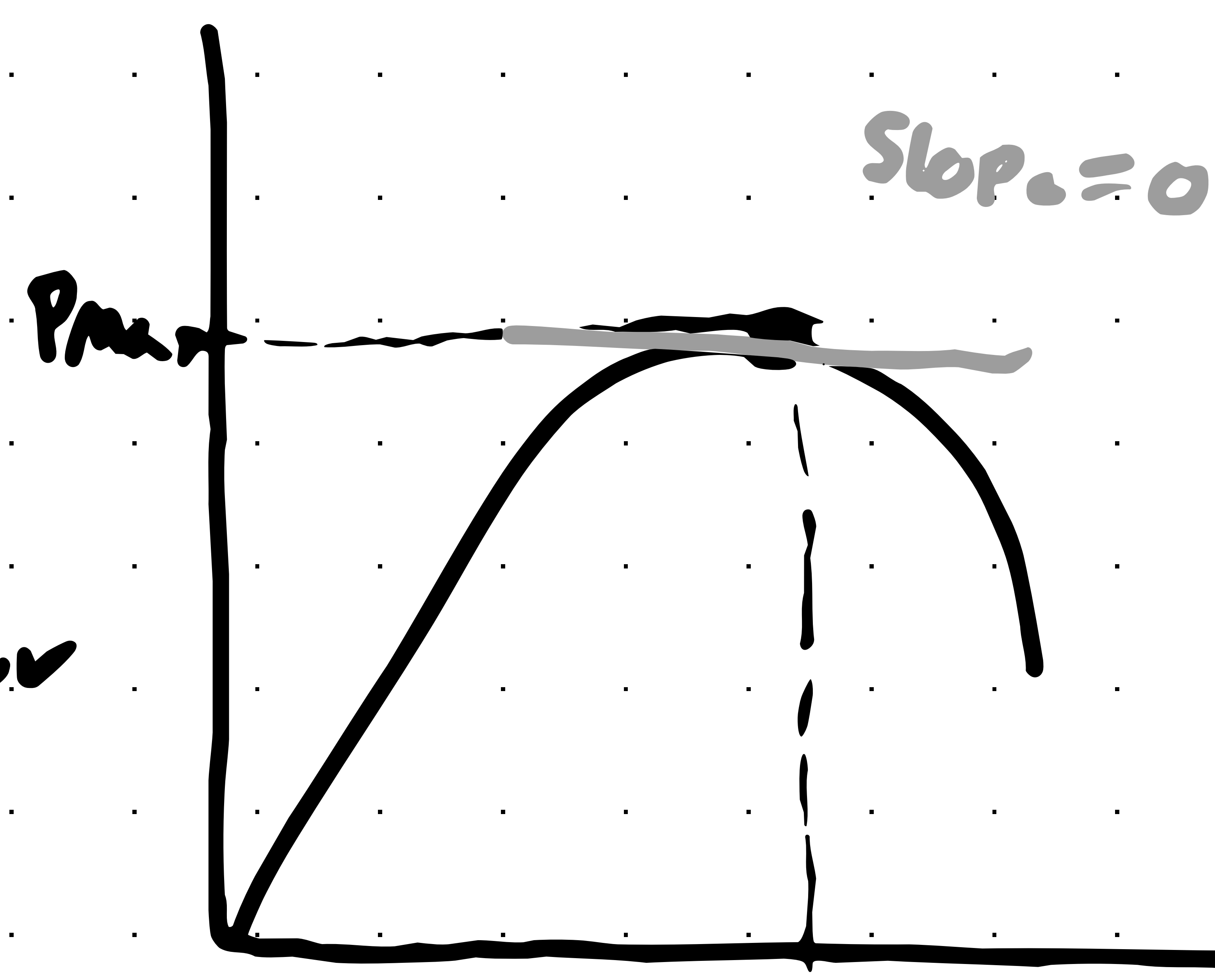
$$i = \frac{V_{TH}}{R_{TH} + R_L}$$

$$P = i^2 R_L$$

(Right?)

Let's do some substitution...

$$P = \left(\frac{V_{TH}}{R_{TH} + R_L}\right)^2 R_L$$



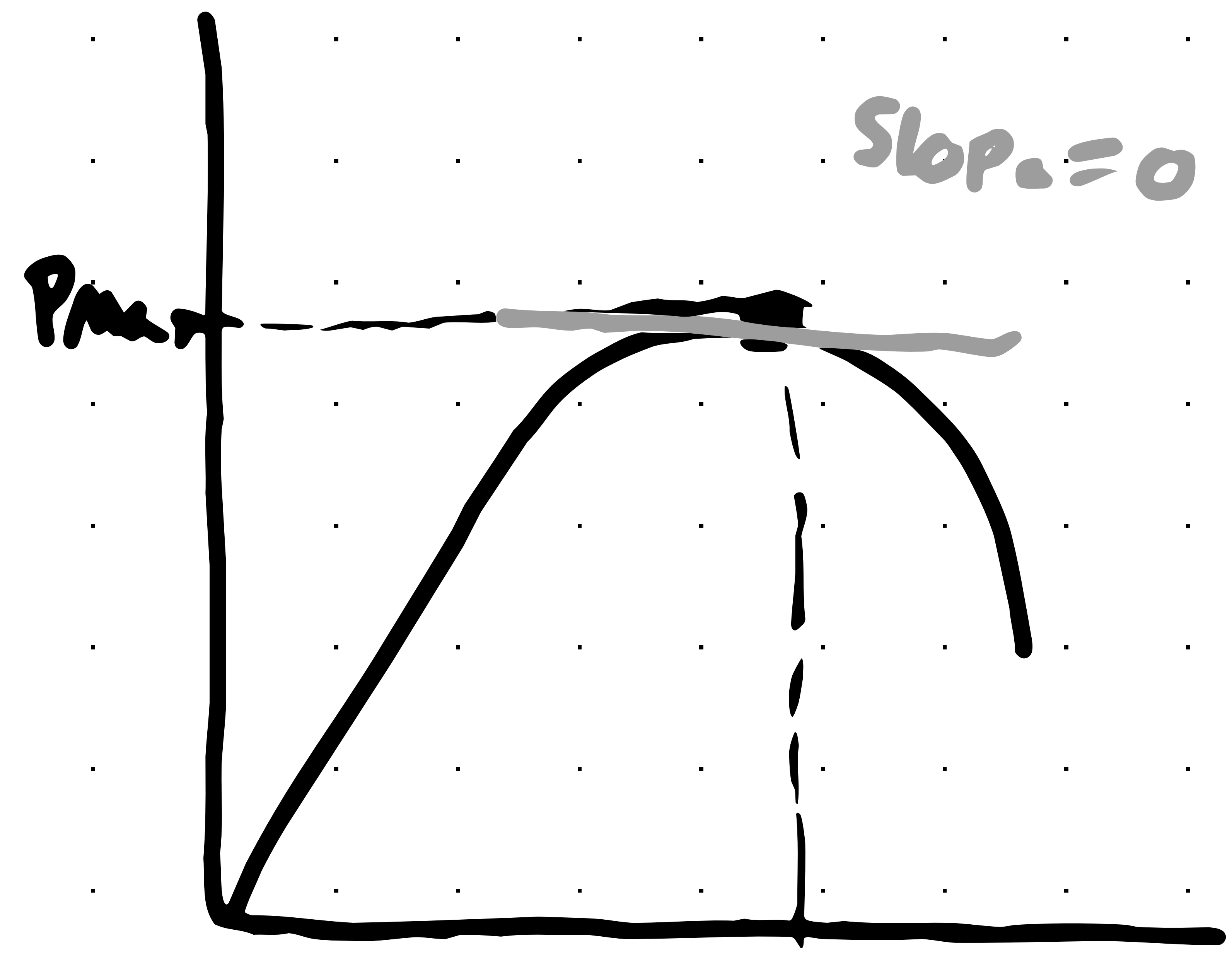
Let's think about this for a second...

If we raise the resistance, the power will increase, but only to a certain point!

This is known as the Max power point

How do we find the max power point?

We can find the first derivative, and set it equal to zero.



There is a lot of math to say!

For max power:

$$\boxed{R_L = R_{TH}}$$

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