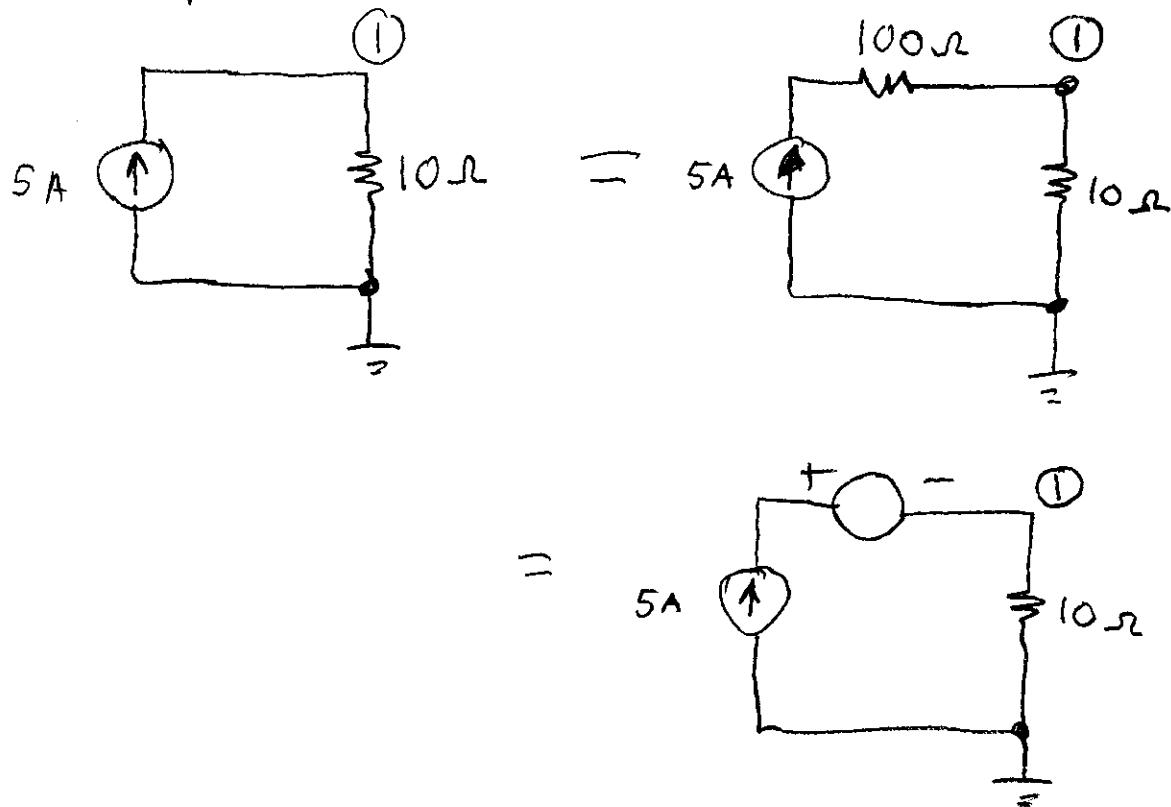


More analysis tricks

Adding stuff in series with a current source

You can arbitrarily put almost anything in series with a current source
 (except a current source).

Example:



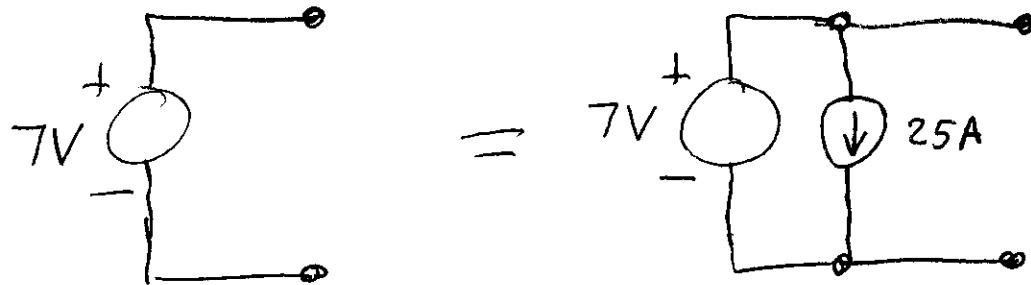
All have $V_1 = 2$ volts.

Same Norton equivalent circuit.

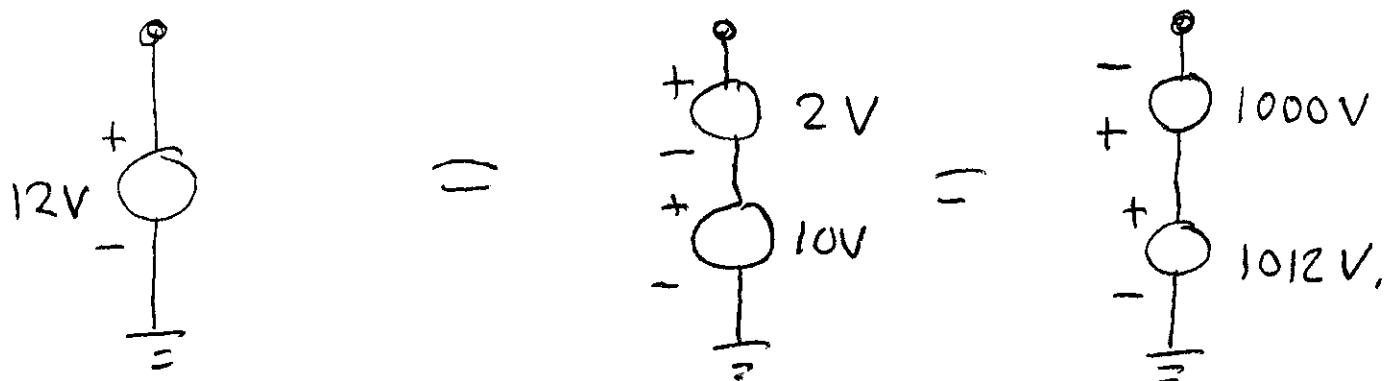
No Thevenin equivalent circuit

You can remove stuff in series with a current source, too.

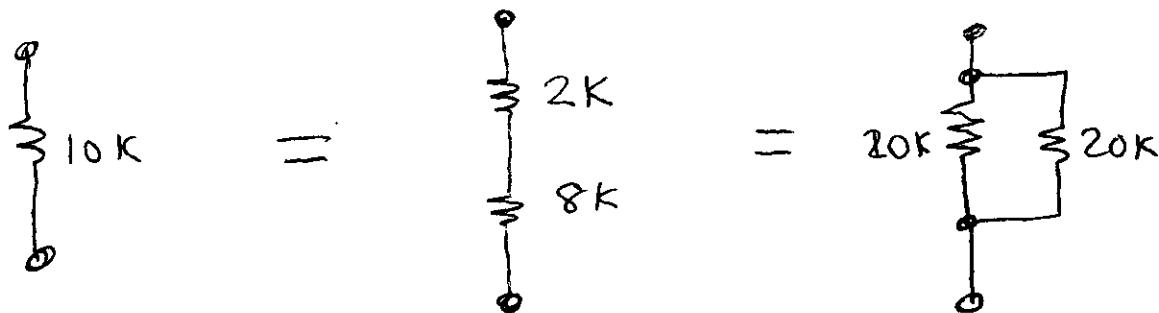
Adding stuff in parallel with a voltage source



Splitting a voltage source into two in series



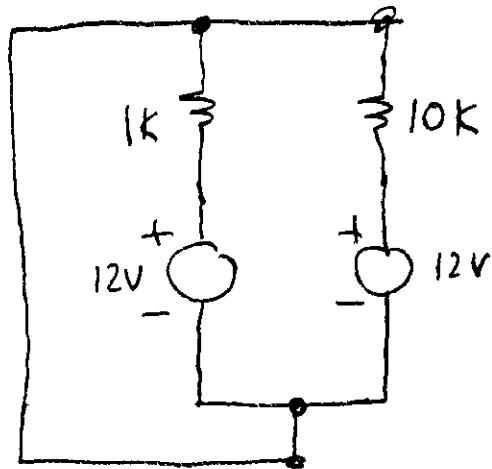
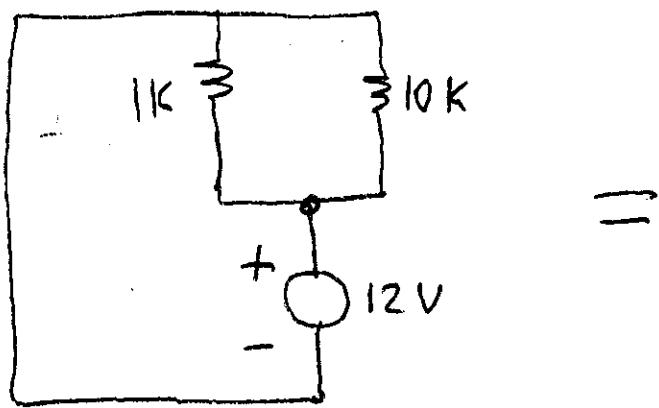
Splitting a resistor --



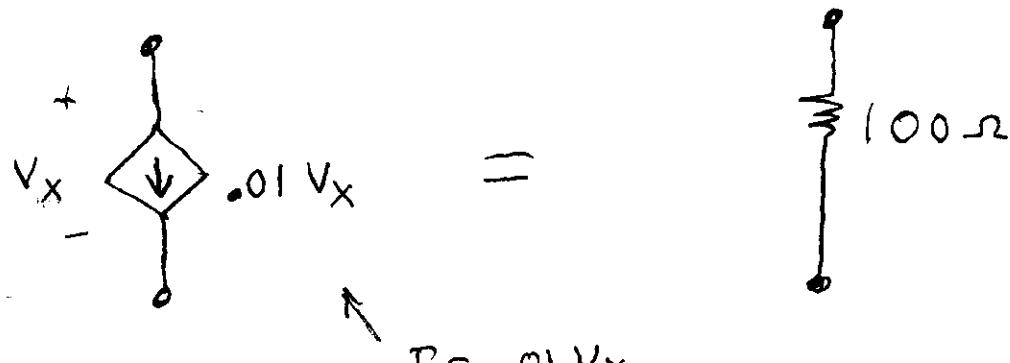
Reflecting a voltage source

4C
③

through a node -



Sometimes controlled sources are resistors:

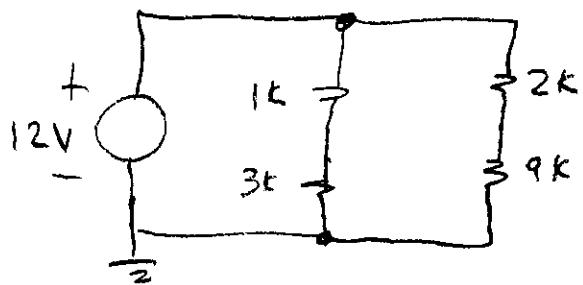
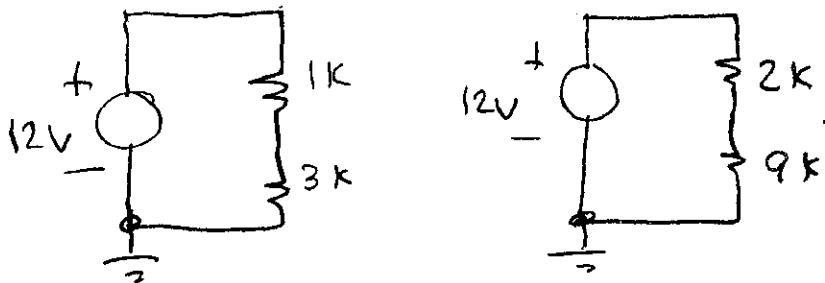


$$I = 0.01 V_x$$

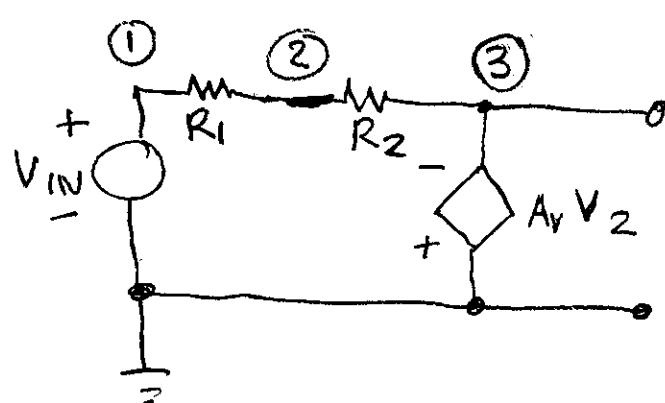
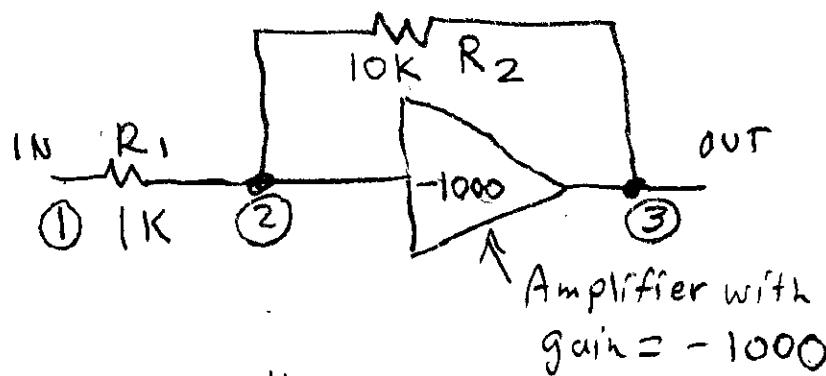
$$\Rightarrow R = \frac{V_x}{I} = \frac{V_x}{0.01 V_x} = 100 \Omega$$

4C
④

If two nodes always have the same voltage, we can connect them together



"Miller Effect"



Nodal analysis

$$\textcircled{1} \quad V_1 = V_{IN}$$

$$\textcircled{2} \quad \frac{V_2 - V_1}{R_1} + \frac{V_2 - V_3}{R_2} = 0$$

$$\textcircled{3} \quad V_3 = -A_V V_2 \Rightarrow V_2 = -\frac{V_3}{A_V}$$

$$\frac{-\frac{V_3}{A_V} - V_{IN}}{R_1} + \frac{-\frac{V_3}{A_V} - V_3}{R_2} = 0$$

Mult by $R_1 R_2$

$$-\frac{R_2}{A_V} V_3 - R_2 V_{IN} - \frac{R_1}{A_V} V_3 - R_1 V_3 = 0$$

$$V_3 \left(-\frac{R_2}{A_V} - \frac{R_1}{A_V} - R_1 \right) + V_{IN} (-R_2) = 0$$

$$V_3 \left(\frac{R_2}{A_V} + \frac{R_1}{A_V} + R_1 \right) = V_{IN} (-R_2)$$

$$\frac{V_3}{V_{IN}} = \frac{-R_2}{\frac{R_2}{A_V} + \frac{R_1}{A_V} + R_1}$$

The hard way \Rightarrow

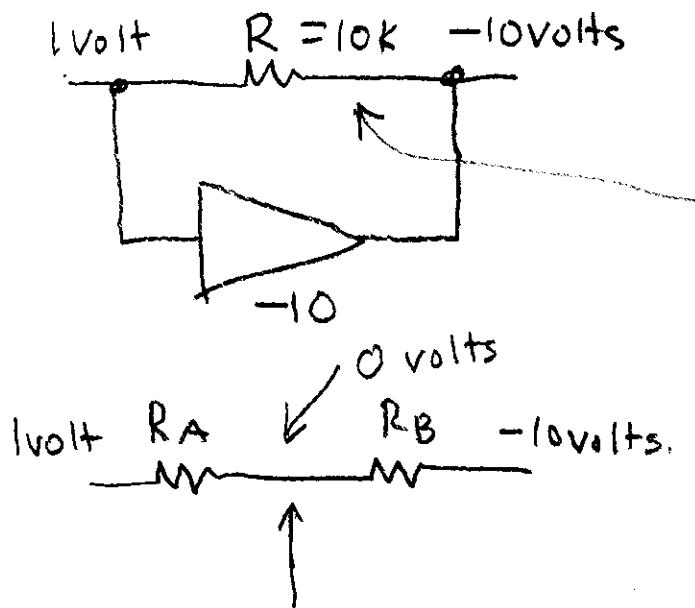
$$\frac{V_3}{V_{IN}} = \frac{-R_2 A_v}{R_2 + R_1 + R_1 A_v}$$

$$= \frac{-R_2 A_v}{R_2 + R_1(1+A_v)}$$

For this example:

$$\frac{V_3}{V_{IN}} = -\frac{10K(100)}{10K + 1K(100)} = -\frac{10 \times 10^6}{1.011 \times 10^6} = -9.89$$

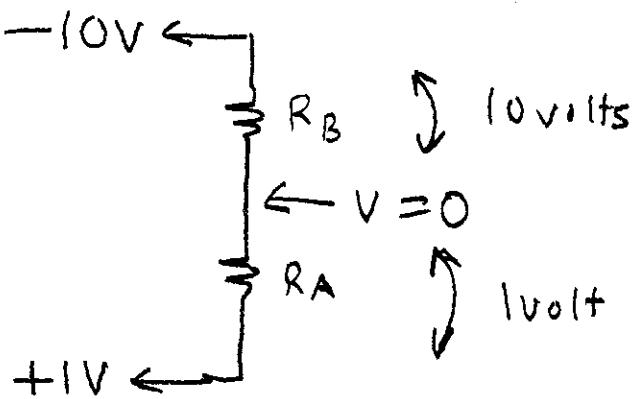
Now, derive the Miller Effect, by example



There is a place
inside this resistor
where the voltage
is 0.

What are R_A and R_B ?

$$R_A + R_B = 10K$$

4C
7use a --
Voltage divider:

$$\text{so } \frac{R_A}{R_B} = \frac{1}{10}$$

$$R_A = \frac{R_B}{10}$$

$$R_A + R_B = 10\text{K}$$

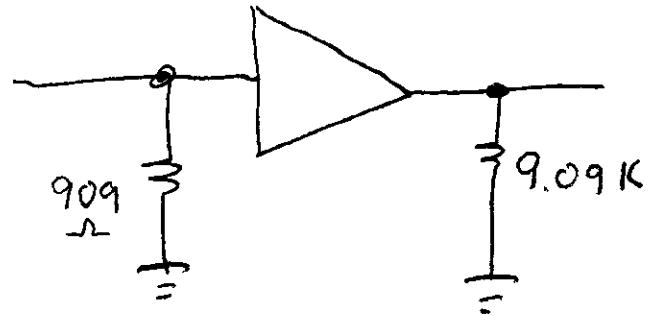
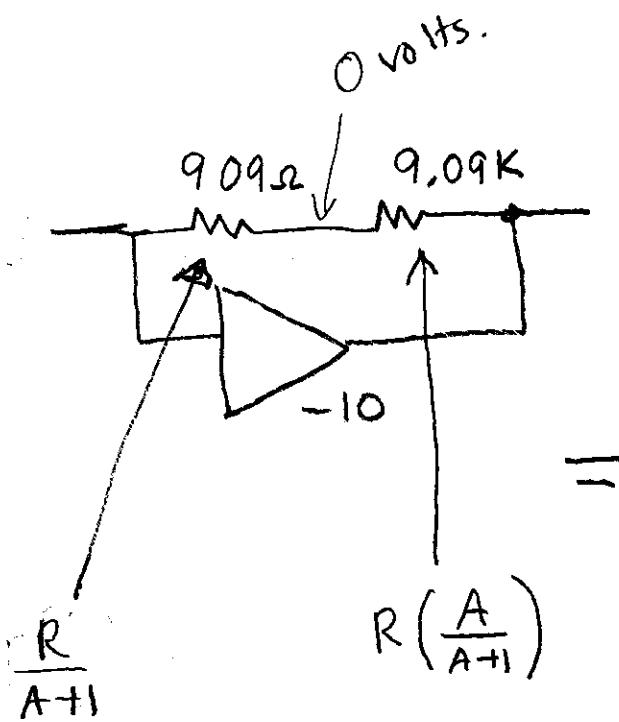
Combine

$$\frac{R_B}{10} + R_B = 10\text{K}$$

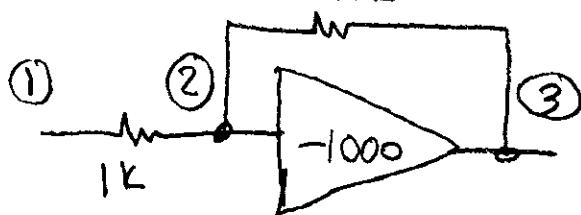
$$11R_B = 100\text{K}$$

$$R_B = \frac{100\text{K}}{11} = 9.09\text{ K}$$

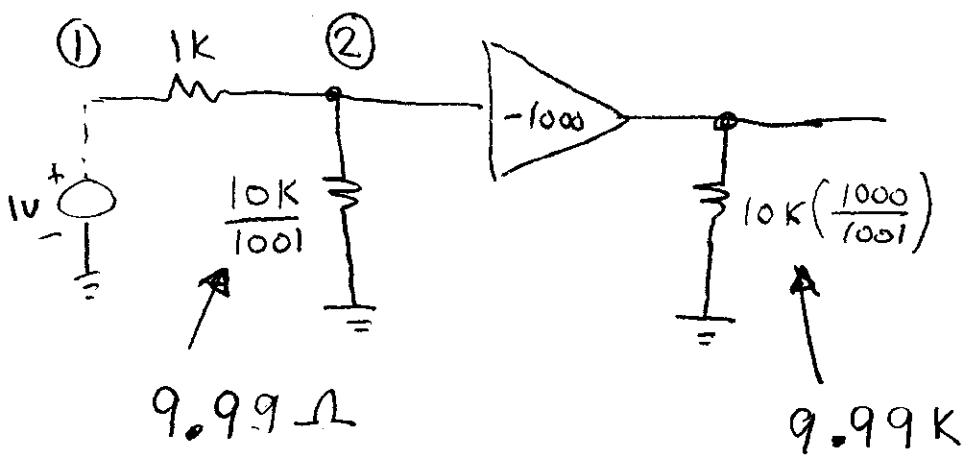
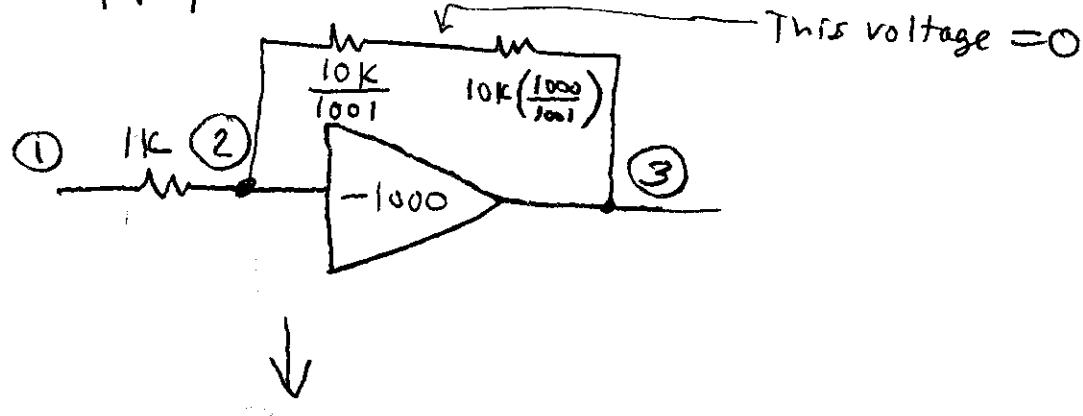
$$R_A = 909\text{ }\Omega$$



The circuit is



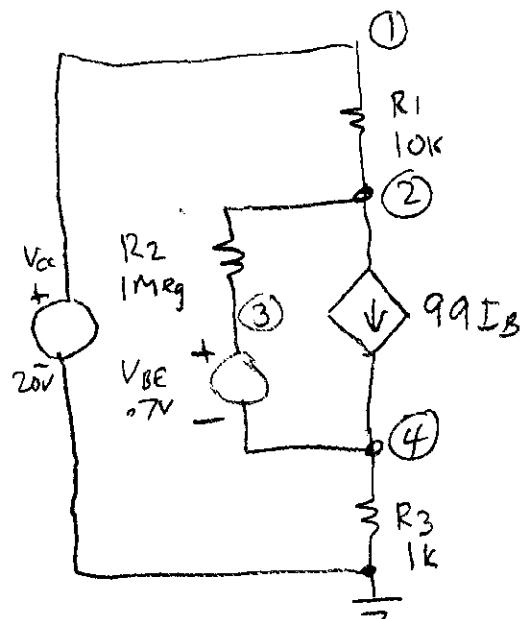
Apply "Miller Effect"



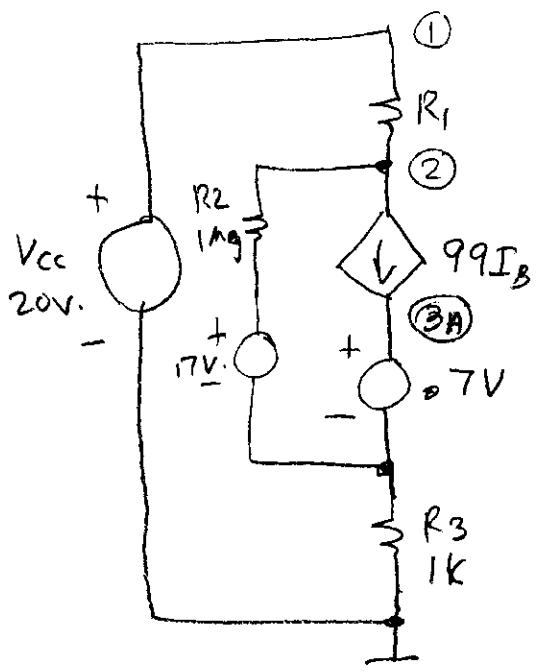
$$V_2 = V_{IN} \frac{9.99}{1000 + 9.99} = V_{IN} (.00989)$$

$$V_3 = -1000 V_2 = -9.89 V_{in}$$

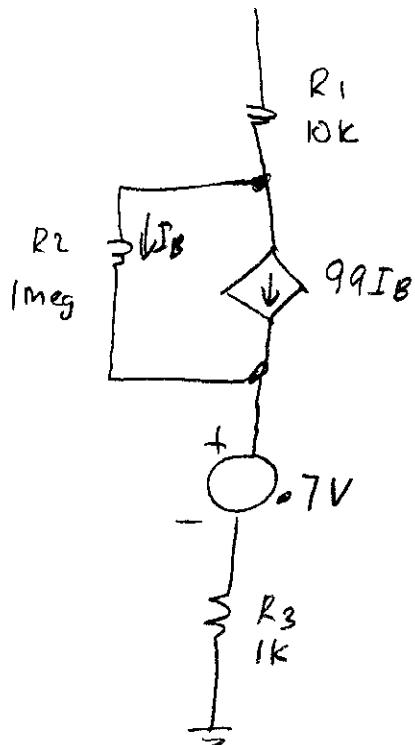
The quiz circuit:



Adding stuff in series with a current source

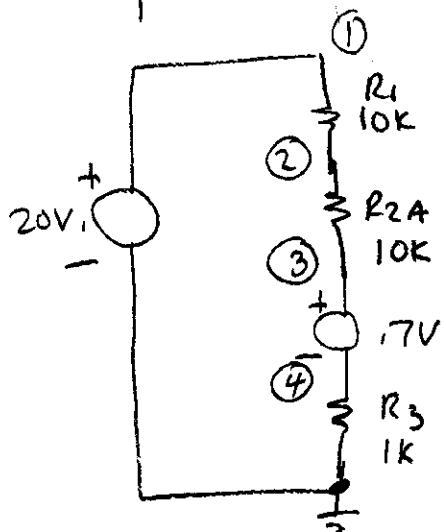


Reflect source thru node



Combine resistor + current source

$$R_L \xrightarrow{V_{IB}} 99I_B = \frac{R_2}{100}$$



If it's a big voltage divider --

4C
10

Loop analysis --

$$V_{R_1} + V_{R_{2A}} + .7 + V_{R_3} = 20$$

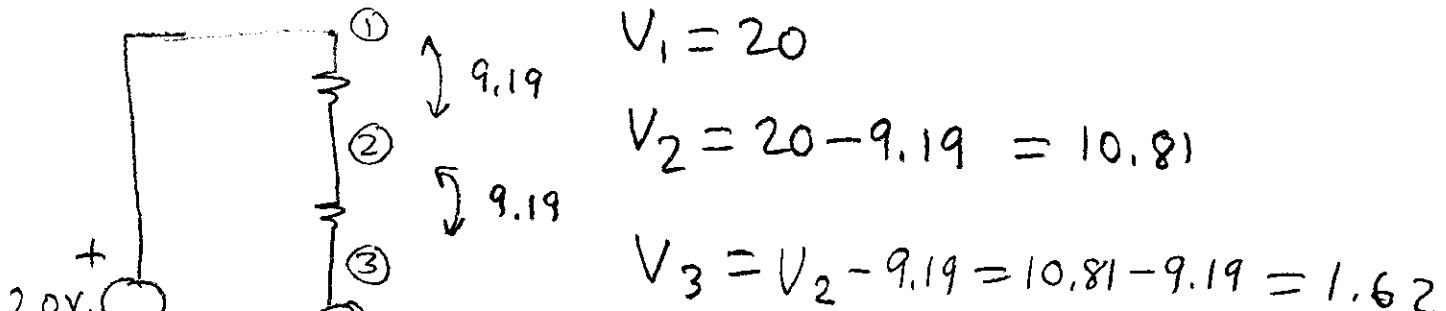
$$V_{R_1} + V_{R_{2A}} + V_{R_3} = 19.3$$

$$I(R_1 + R_{2A} + R_3) = 19.3$$

$$I = \frac{19.3}{R_1 + R_{2A} + R_3} = \frac{19.3}{10k + 10k + 1k} = \frac{19.3}{21k}$$

$$V_4 = I R_4 = \frac{19.3}{21k} \times 1k = \frac{19.3}{21} = .919$$

$$V_{R_{2A}} = V_{R_1} = 10V_4 = 9.19$$



↑
Same answer as model analysis.