This part of the experiment is prepared with Online LaTeX Editor Overleaf, and the circuits are drawn in LTspice. Visit the website for the code here:
https://www.overleaf.com/read/dcxnnrnyypxt#b70098

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1. PRELIMINARY WORK

1.1 Use source transformation to simplify the circuit given in Fig. 1 and obtain an equivalent circuit with respect to terminals a and b. Calculate the equivalent resistance between a and b (R_{ab}).

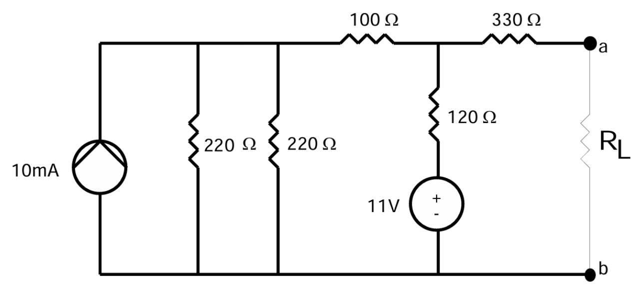
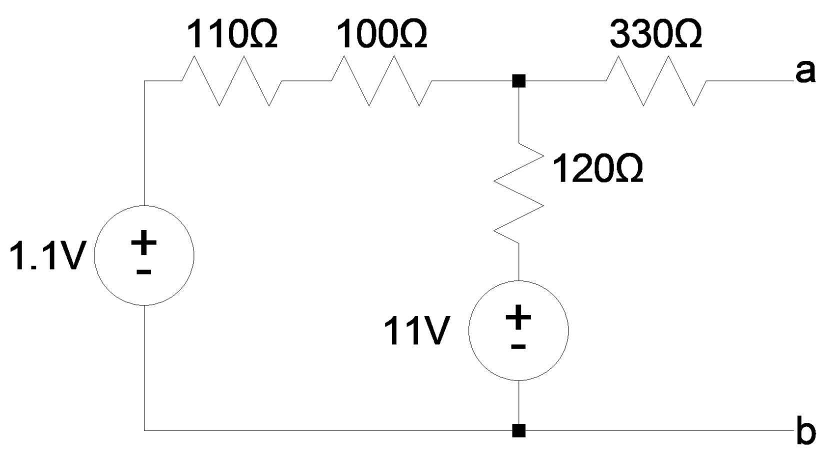


Figure 1.

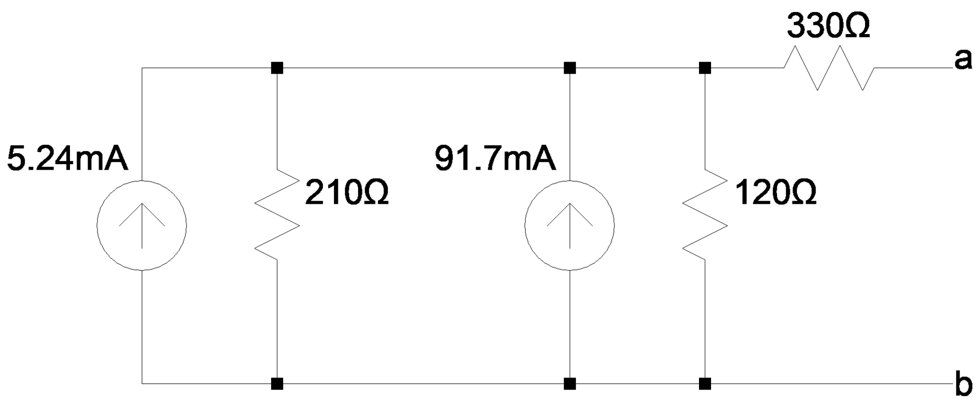
Answer: The two 220Ω resistors are in parallel, therefore the equivalent resistance is $R_{eq} = 220\Omega \parallel 220\Omega = 110\Omega$. We may now transform the current source into a voltage source.

$V_{VS} = I_{CS} \cdot R = 10mA \cdot 110\Omega = 1.1V$



The 110Ω and 100Ω resistors are in series, that is, $R_{eq} = 100\Omega + 110\Omega = 210\Omega$. Since two voltage sources, with their associated resistors, are in parallel, we may transform them into current sources.

$$I_{left} = \frac{V_{left}}{210\Omega} = \frac{1.1V}{210\Omega} = 5.24mA \quad I_{right} = \frac{V_{right}}{120\Omega} = \frac{11V}{120\Omega} = 91.7mA$$



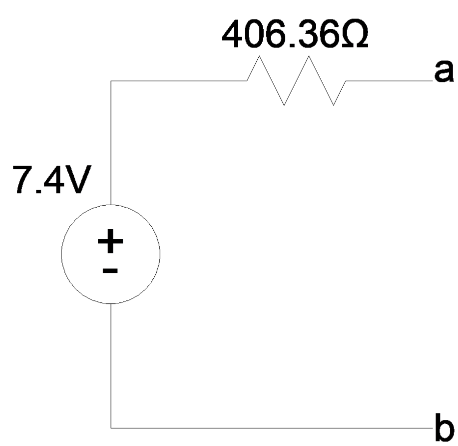
The 210Ω and 120Ω resistors are in parallel. $R_{eq} = 210\Omega \,||\, 120\Omega = 76.36\Omega$. Two current sources can be merged.

$I_{CS} = (91.7 + 5.24)\text{mA} = 96.9\text{mA}$

Eventually, transform the current source into a voltage source.

$V_{VS} = 96.9\text{mA} \cdot 76.36\Omega = 7.4\text{V}$

The equivalent resistance becomes $R_{eq} = (76.36 + 330)\Omega = 406.36\Omega$



$\boxed{R_{ab} = 406.36\Omega}$

1.2 For the circuit given in Fig. 2, calculate V_{ab} and I_{ab} for V_{in} = 2V, 4V, 6V, 8V, and 10V. Sketch V_{ab} vs. V_{in} and comment on the plot.

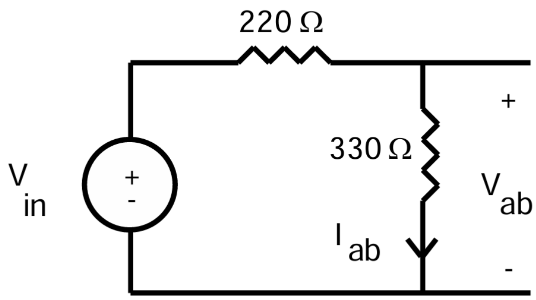


Figure 2.

Answer: Calculations and the graph are below.

$$V_{in} = 2V \;\rightarrow\; V_{ab} = 2V \cdot \frac{330}{220+330} = 1.2V \qquad I_{ab} = \frac{2V}{(220+330)\Omega} = 3.63mA$$

$$V_{in} = 4V \;\rightarrow\; V_{ab} = 4V \cdot \frac{330}{220+330} = 2.4V \qquad I_{ab} = \frac{4V}{(220+330)\Omega} = 7.27mA$$

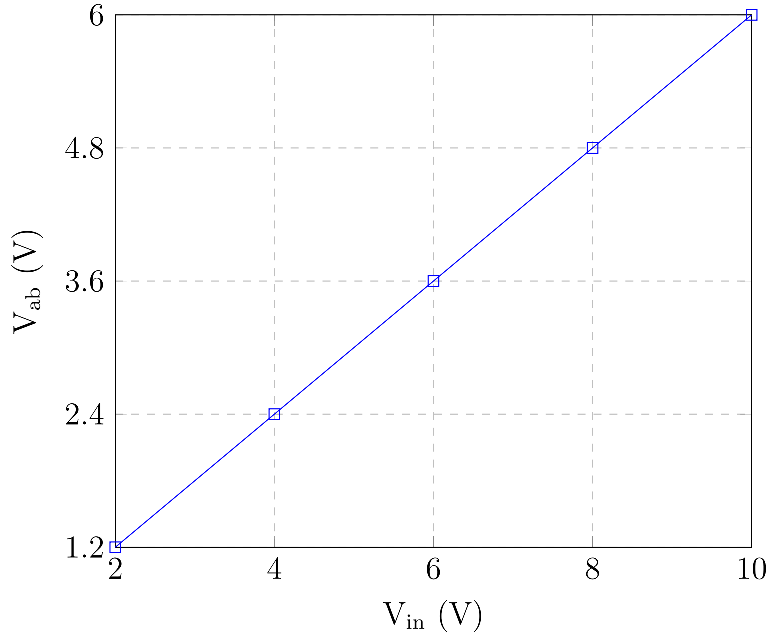
$$V_{in} = 6V \;\rightarrow\; V_{ab} = 6V \cdot \frac{330}{220+330} = 3.6V \qquad I_{ab} = \frac{6V}{(220+330)\Omega} = 10.9mA$$

$$V_{in} = 8V \;\rightarrow\; V_{ab} = 8V \cdot \frac{330}{220+330} = 4.8V \qquad I_{ab} = \frac{8V}{(220+330)\Omega} = 14.5mA$$

$$V_{in} = 10V \;\rightarrow\; V_{ab} = 10V \cdot \frac{330}{220+330} = 6.0V \qquad I_{ab} = \frac{10V}{(220+330)\Omega} = 18.1mA$$

V_{in} (V)	2	4	6	8	10
V_{ab} (V)	1.2	2.4	3.6	4.8	6.0
I_{ab} (mA)	3.63	7.27	10.9	14.5	18.1

Graph 1: The relation between V_{in} and V_{ab}



The voltage across the resistor changes linearly in accordance with the voltage provided by the source.

1.3 Current divider circuit in Fig. 3. Calculate I_{in}, I_1, and I_2, for V_{in} = 0.66V, 1.32V, 1.98V, 3.3V, and 3.64V. Sketch I_{in} vs I_1 and I_{in} vs I_2.

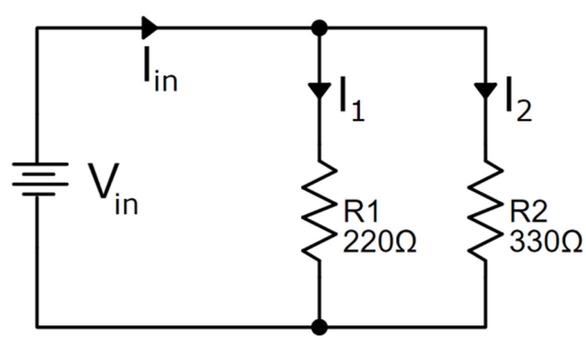


Figure 3.

Answer: Calculations and the graph are below.

$R_{eq} = 220\Omega \,||\, 330\Omega = 132\Omega$

$$V_{in} = 0.66V \rightarrow I_{in} = \frac{0.66V}{132\Omega} = 5mA \qquad I_1 = 5mA \cdot \frac{330}{220+330} = 3mA \qquad I_2 = 2mA$$

$$V_{in} = 1.32V \to I_{in} = \frac{1.32V}{132\Omega} = 10mA \quad I_1 = 10mA \cdot \frac{330}{220+330} = 6mA \quad I_2 = 4mA$$

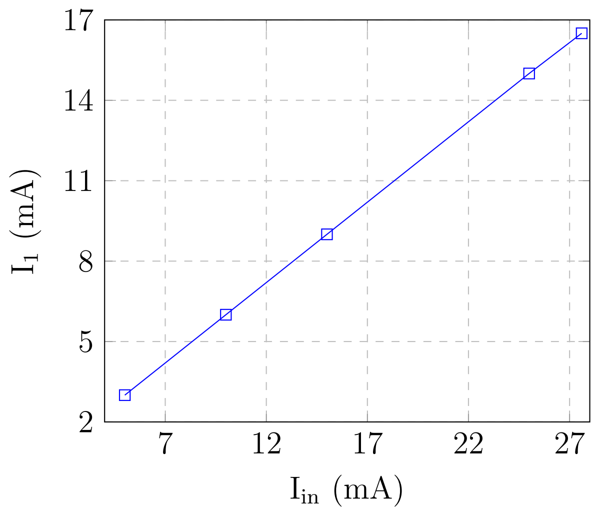
$$V_{in} = 1.98V \to I_{in} = \frac{1.98V}{132\Omega} = 15mA \quad I_1 = 15mA \cdot \frac{330}{220+330} = 9mA \quad I_2 = 6mA$$

$$V_{in} = 3.3V \to I_{in} = \frac{3.3V}{132\Omega} = 25mA \quad I_1 = 25mA \cdot \frac{330}{220+330} = 15mA \quad I_2 = 10mA$$

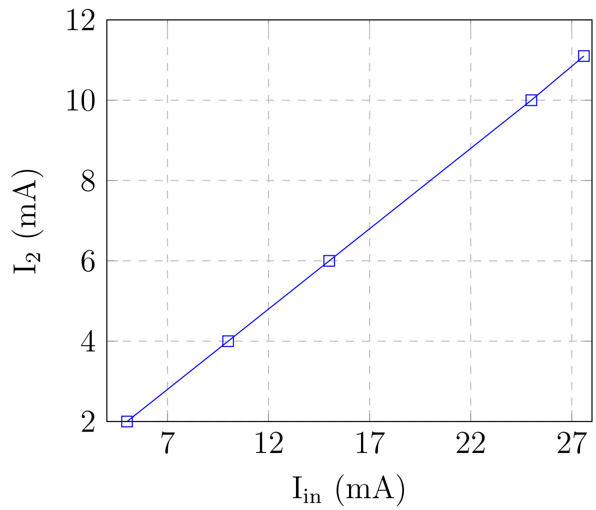
$$V_{in} = 3.64V \to I_{in} = \frac{3.64V}{132\Omega} = 27.6mA \quad I_1 = 27.6mA \cdot \frac{330}{220+330} = 16.5mA \quad I_2 = 11.1mA$$

V_{in} (V)	0.66	1.32	1.98	3.3	3.64
I_{in} (mA)	5	10	15	25	27.6
I_1 (mA)	3	6	9	15	16.5
I_2 (mA)	2	4	6	10	11.1

Graph 2: The relation between I_{in} and I_1



Graph 3: The relation between I_{in} and I_2



Similar to the answer in **1.2**, the relation between the currents is linear.

1.4 Using the superposition principle, find V_{ab} given in Fig. 4.

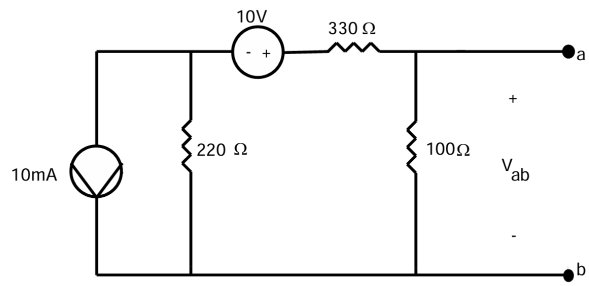
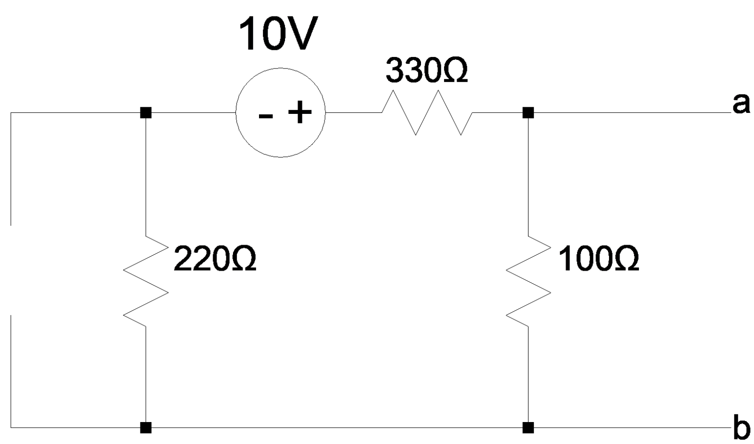


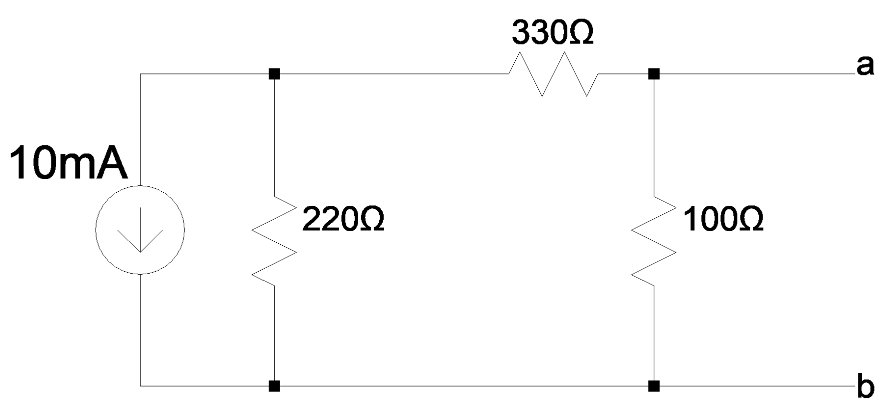
Figure 4.

Answer: First, let's open-circuit the current source, then benefit from the voltage divider.



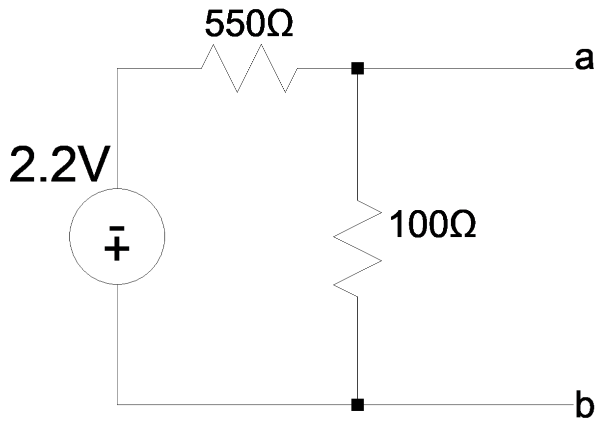
$$V'_{ab} = 10\text{V} \cdot \frac{100}{100 + 220 + 330} = 1.54\text{V}$$

Second, we'll short-circuit the voltage source.



The source transformation method, and the voltage divider afterwards, will help us solve the problem.

$V_{VS} = 10\text{mA} \cdot 220\Omega = 2.2\text{V}$



$$V''_{ab} = -2.2\text{V} \cdot \frac{100}{100 + 220 + 330} = -0.34\text{V}$$

This time, we need to put a minus because the current enters from the other terminal of the resistor (passive sign convention).

Using the superposition theorem, we add up the individual responses of independent sources.

$V_{ab} = V'_{ab} + V''_{ab} = 1.54\text{V} - 0.34\text{V} = 1.2\text{V}$

$\boxed{V_{ab} = 1.2\text{V}}$