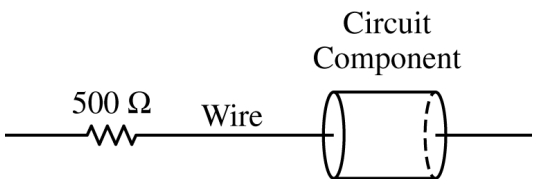
2. (12 points, suggested time 25 minutes)

Students are given an unknown circuit component that is connected in series to a resistor with known resistance 500 Ω.

(a) The students are asked to experimentally determine whether the component is a resistor or an uncharged capacitor.

i. Complete the following diagram to show how to use standard circuit equipment to determine whether the component is a resistor or an uncharged capacitor.




ii. Describe an experimental procedure to determine whether the component is a resistor or an uncharged capacitor. Refer to the circuit equipment in the diagram drawn in part (a)(i).

iii. What results would the students expect if the component is an uncharged capacitor? Support your answer in terms of potential difference and charge.

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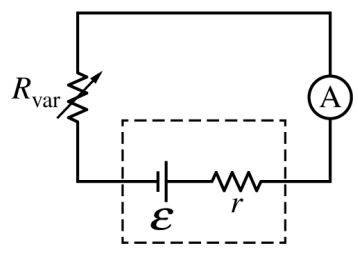
Continue your response to **QUESTION 2** on this page.




The students conduct a different experiment to determine the emf $\mathcal{E}$ of a battery that is not ideal and has internal resistance $r = 30\,\Omega$. The battery is connected to a variable resistor in a circuit, as shown. The students measure the current $I$ through the circuit for different values of resistance $R_{var}$ of the variable resistor that is connected to the battery. The following table contains the data collected.

| $I$ (A) | $R_{var}$ (Ω) | | |
|---|---|---|---|
| 0.087 | 200 | | |
| 0.060 | 300 | | |
| 0.042 | 450 | | |
| 0.027 | 700 | | |
| 0.016 | 1200 | | |

(b)

i. Write an equation describing the circuit in terms of $\mathcal{E}$, $I$, $r$, and $R_{var}$.

ii. Which quantities could be graphed to yield a straight line that could be used to calculate a numerical value for the emf $\mathcal{E}$ of the battery?

Horizontal Axis:_____ Vertical Axis:_____

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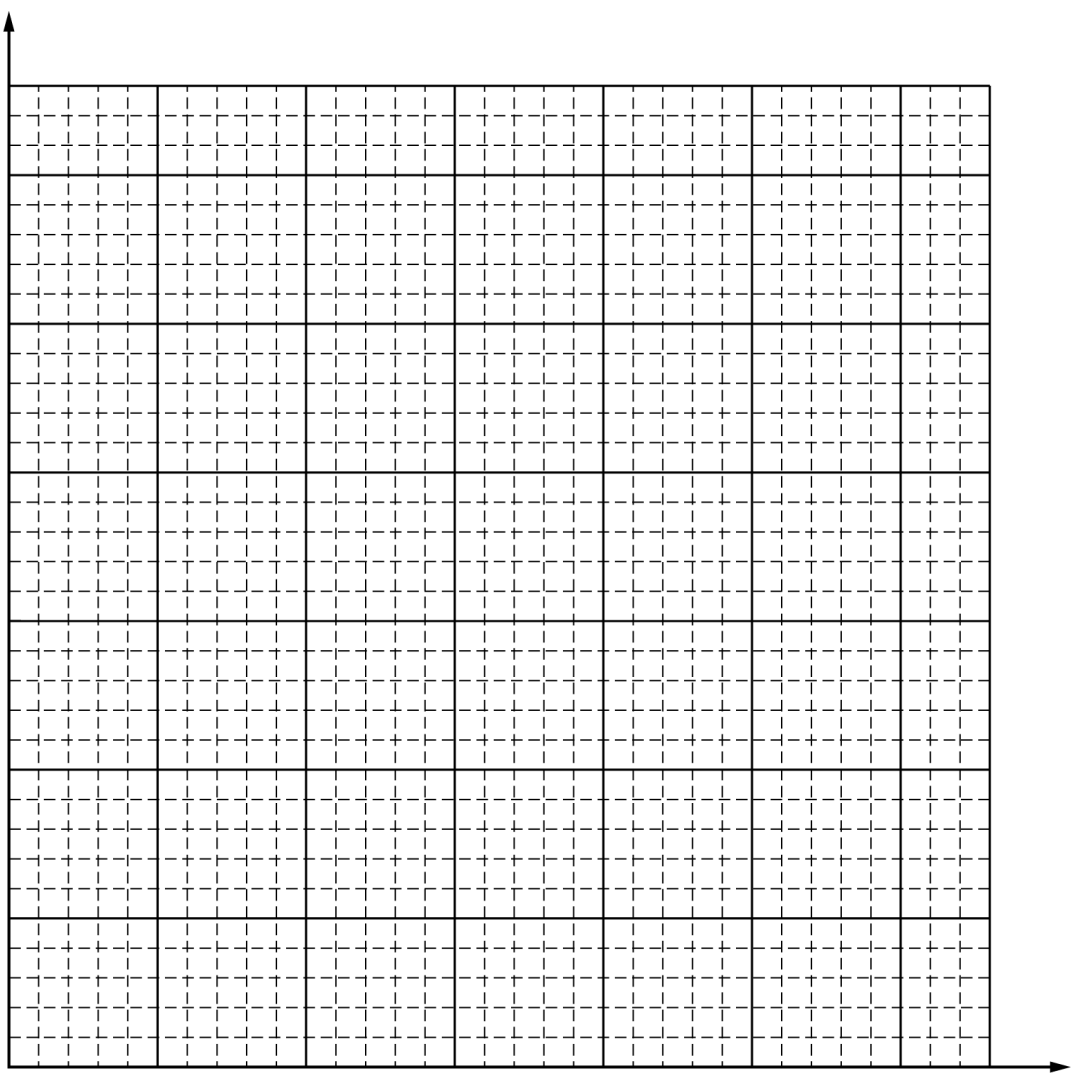
Continue your response to **QUESTION 2** on this page.

iii. Plot the data points for the quantities indicated in part (b)(ii) on the following graph. Clearly scale and label all axes, including units. Draw a straight line that best represents the data.
You may use the blank columns in the table for any quantities you graph other than the given data.



iv. Using the graph from part (b)(iii), determine the emf $\mathcal{E}$ of the battery.

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