

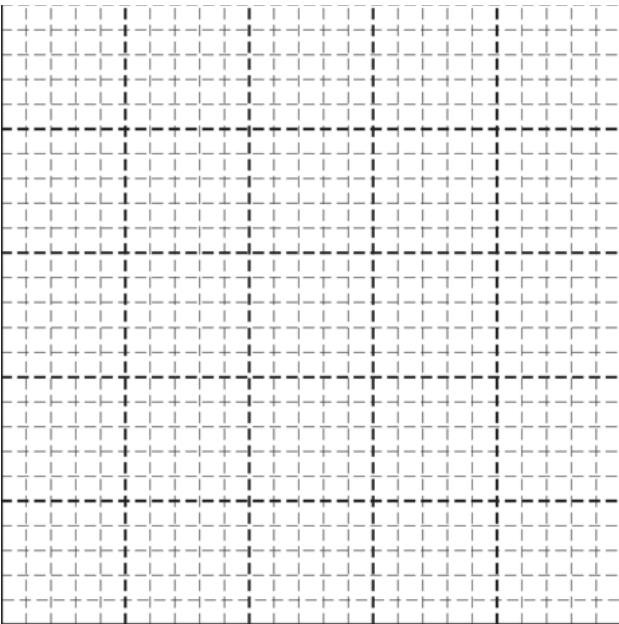
E&M.2.

A student performs an experiment to determine the emf $\mathcal{E}$ and internal resistance r of a given battery. The student connects the battery in series to a variable resistance R , with a voltmeter across the variable resistor, as shown in the figure above, and measures the voltmeter reading V as a function of the resistance R . The data are shown in the table below.

Trial #	Resistance (Ω)	Voltage (V)	$1/R$ ($1/\Omega$)	$1/V$ ($1/V$)
1	0.50	5.6	2.00	0.179
2	1.0	7.4	1.00	0.135
3	2.0	9.4	0.50	0.106
4	3.0	10.6	0.33	0.094
5	5.0	10.9	0.20	0.092
6	10	11.4	0.10	0.088

- (a)
- i. Derive an expression for the measured voltage V . Express your answer in terms of R , $\mathcal{E}$, r , and physical constants, as appropriate.
 - ii. Rewrite your expression from part (a)-i to express $1/V$ as a function of $1/R$.

- (b) On the grid below, plot data points for the graph of $1/V$ as a function of $1/R$. Clearly scale and label all axes, including units as appropriate. Draw a straight line that best represents the data.



- (c) Use the straight line from part (b) to obtain values for the following.
- i. $\mathcal{E}$
 - ii. r
- (d) Using the results of the experiment, calculate the maximum current that the battery can provide.
- (e) A voltmeter is to be used to determine the emf of the battery after removing the battery from the circuit. Two voltmeters are available to take this measurement—one with low internal resistance and one with high internal resistance. Indicate which voltmeter will provide the most accurate measurement.
- ____ The voltmeter with low resistance will provide the most accurate measurement.
- ____ The voltmeter with high resistance will provide the most accurate measurement.
- ____ The two voltmeters will provide equal accuracy.
- Justify your answer.