2011 A/L Structured Essay Question No (04)

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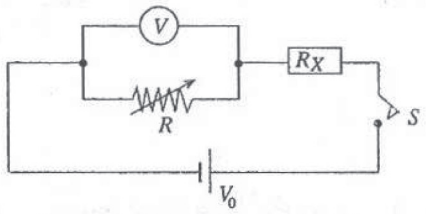

A student is asked to find the value R_x of an unknown resistor connected to the circuit shown, using a graphical method. R is a variable resistance provided by a resistance box. V is the reading of the voltmeter connected across R. The internal resistance of the voltmeter is large. Two new dry cells of voltage 1.5 V each is used to provide a voltage V_0 of 3 V. Assume that the internal resistance of such a dry cell battery is negligible.

(*a*) Indicate the polarity of the voltmeter by labeling its terminals with + and – signs.

(*b*) In order to plot a graph, the student is asked to take several voltmeter readings (V) by varying the resistance R.

(i) Write down an expression relating V, R, V_0 and R_X.

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(ii) Rearrange the variables in order to plot a straight line graph with $\frac{1}{V}$ on the Y axis.

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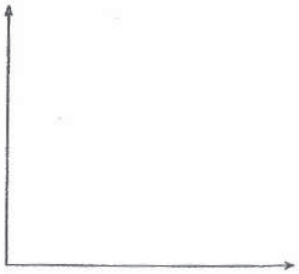
(iii) Draw a rough sketch of the expected curve. Label the axes.



(iv) How would you find the value of R_X from the graph?

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(v) How would you find the voltage V_0 of the battery using the graph?

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(*c*) You are given that the internal resistance of the voltmeter is 1500 Ω and the value of R_X is of the order of 100 Ω. Of the following ranges given, indicate with a tick (✓) the range of values that you would choose for R in order to obtain the straight line graph.

25 Ω – 500 Ω (.....)

25 Ω – 1500 Ω (.....)

25 Ω – 2000 Ω (.....)

Give the reason for your choice.

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(*d*) (i) How would you check experimentally whether the data have been affected by the possible run-down of the battery?

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(ii) If you have discovered that the battery has run-down, how would you design another battery which lasts longer time, using new 1.5 V cells to give 3 V, before repeating the experiment. (If necessary you may also draw a diagram to illustrate the answer.)

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