4. A moving coil galvanometer with coil resistance $R_G$ produces full scale deflection when a current of $I_0$ is passed through it.

(a) Write down an expression for the voltage $(V_0)$ appearing across the terminals of the galvanometer in terms of $R_G$ and $I_0$ when it shows a full scale deflection.

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(b) When a voltage $(V_1)$ which is less than $V_0$ is appeared across the galvanometer it produces a deflection $\theta$. If $\theta_m$ is the full scale deflection of the galvanometer, write-down an expression for $V_1$ in terms of $\theta$, $\theta_m$ and $V_0$.

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(c) This galvanometer is to be converted to a voltmeter giving full scale deflection for a voltage $V_2$ which is much larger than $V_0$. If you are provided with a resistor having the suitable value $R_1$ show by drawing a diagram how you would connect this resistor to the galvanometer.

(d) Write down an expression for $R_1$ in terms of $V_2$, $I_0$ and $R_G$.

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(e) If $R_G$ = 20 Ω and $I_0$ = 10 mA find the value of the resistance $R_1$ necessary to convert this galvanometer to a voltmeter which gives a full scale deflection for 1 V.

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(f) Also calculate the values of resistances $R_2$ and $R_3$ that are necessary to convert this galvanometer to voltmeters which give full scale deflection for 10 V and 50 V respectively.

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(*g*) Using the resistance values calculated in (*e*) and (*f*) and the galvanometer mentioned above, draw a circuit diagram of a multi-range voltmeter which can be used to measure voltages in three different ranges of 0 – 1 V, 0 – 10 V and 0 – 50 V. Use a 3-way switch to select ranges.

(*h*) If this voltmeter is used in the 0 – 10 V range to measure a voltage of the order of 5 V appearing across a 2000 Ω resistor, would you expect to obtain the actual value? Explain your answer.

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