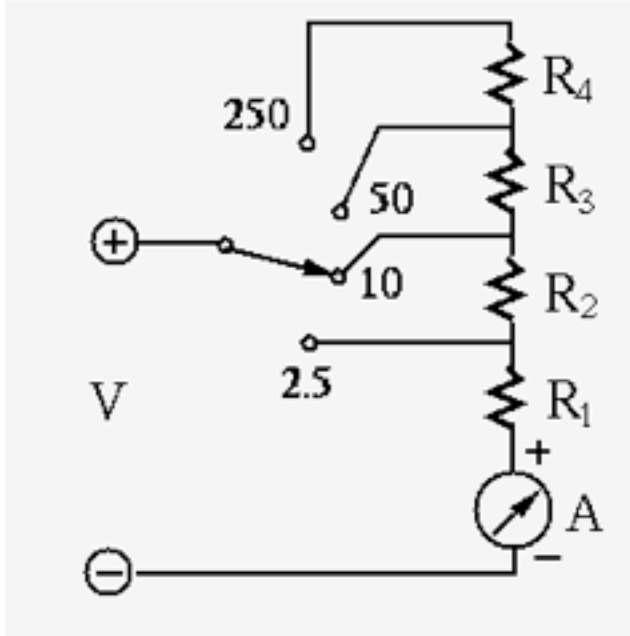
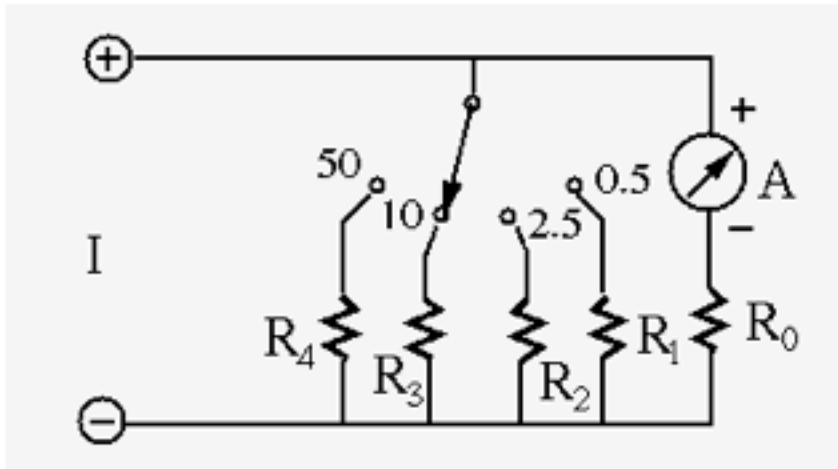


Design a multimeter that can measure DC voltage, current and resistance with different scales. Specifically, you are given an analog meter A with a needle display, which reaches full scale when a DC current of $I = 100\ \mu A = 10^{-4}\ A$ goes through it. The internal resistance of the meter is $10\ \Omega$. In addition, you need some multi-position rotary switches to select different scales for each of the three types of measurements, and resistors with any values needed in your design.

- Voltage measurement: measure voltages in these ranges (all in volts): 0-2.5, 0-10, 0-50, 0-250. Use a 4-position rotary switch to select one of the four ranges as shown in the figure below. For example, when the range of 0-10 is selected, the needle display will reach full scale when the voltage being measured is 10 V. The circuit is shown below. Determine all resistances labeled.



- Current measurement: measure currents in these ranges (all in mA): 0-0.5, 0-2.5, 0-10, 0-50. Use a 4-position rotary switch to select one of the four ranges as shown in the figure below. For example, when the range of 0-10 is selected, the needle display will reach full scale when a 10 mA current is measured. Determine all resistances labeled. Use $R_0 = 1\ K\Omega$.



- Resistance measurement: The circuit for resistance measurement is provided as shown below, where $V_1 = 1.5V$. Determine the values for the resistors labeled as R_0 , R_1 , R_{10} , R_{100} and R_{1000} and V_2 so that the needle display of the meter is full scale ($I = 100\ \mu A$) when the resistor $R = 0$ being measured (between the two leads labeled + and -) is zero, or half scale ($I = 50\ \mu A$) when the value of R and the position of the two synchronized rotary switches are given in each of the four cases shown in the table:

positions	$\times 1$	$\times 10$	$\times 100$	$\times 1K$
R values	$20\ \Omega$	$200\ \Omega$	$2000\ \Omega$	$20\ K\Omega$

