D.C voltmeters:-

(1) A basic D'Arsonval movement with a full scale deflection of 50μA & internal resistance of 500Ω is used as a voltmeter. Determine the value of the multiplier resistance needed to measure a voltage range of 0-10V.

Sol:- Given $R_S = \frac{V}{I_m} - R_m$

$= \frac{10}{50\mu A} - 500$

$= 0.2 \times 10^6 - 500$

$= 200K - 500$

$= 199.5K\Omega$

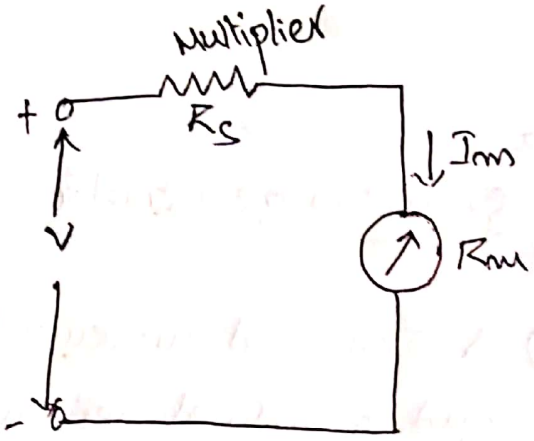


Fig:- Basic dc voltmeter

(2) Calculate the value of multiplier resistance on the 50V range of a dc voltmeter that uses a 500μA meter movement with an internal resistance of 1KΩ

Sol:- The sensitivity of 500μA meter movement is given by

$S = 1/I_m$

$= 1/500\mu A$

$= 2K\Omega/V.$

The value of the multiplier resistance can be calculated by

$R_S = S \times range - R_m$

$= 2K\Omega/V \times 50V - 1K\Omega$

$= 100K\Omega - 1K\Omega$

$= 99K\Omega$

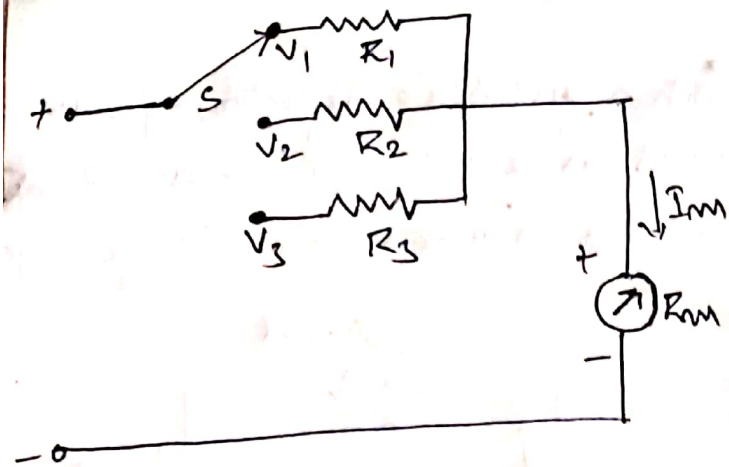


fig:- Multirange voltmeter

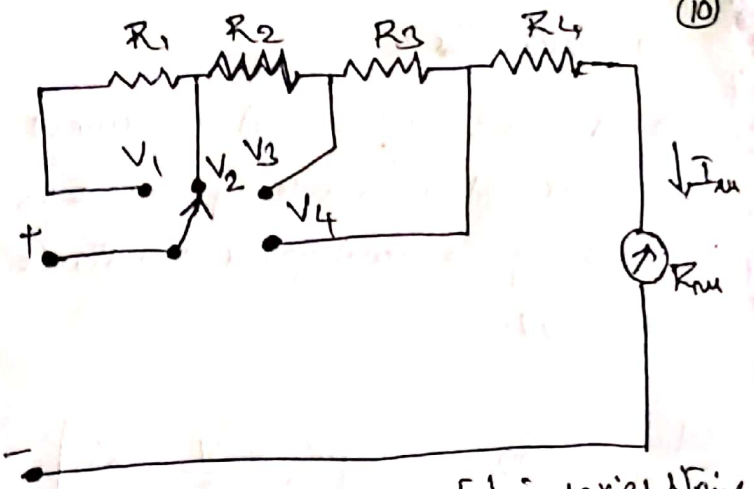


fig:- Multipliers connected in series string

③ A D'Arsonval movement with a full scale deflection current of 50μA & internal resistance of 500Ω is to be converted into a multi-range voltmeter. Determine the value of multiplier required for 0-20V, 0-50V & 0-100V.

Sol:- Given $I_m = 50\mu A$ & $R_m = 500\Omega$

case1:- for range 0-20V

$$R_S = \frac{V}{I_m} - R_m$$

$$= \frac{20}{50\times10^{-6}} - 500$$

$$= 0.4\times10^{6} - 500$$

$$= 400K - 500$$

$$= 399.5K\Omega$$

case2:- for range 0-50V

$$R_S = \frac{V}{I_m} - R_m$$

$$= \frac{50}{50\times10^{-6}} - 500$$

$$= 1\times10^{6} - 500$$

$$= 1000K - 500$$

$$= 999.5K\Omega$$

case3:- For range 0-100V

$$R_S = \frac{V}{I_m} - R_m$$

$$= \frac{100}{50\times10^{-6}} - 500$$

$$= 2000K - 500 = 1999.5K\Omega$$

Excercise prob 10mA

(4) Convert a basic D'Arsonval movement with an internal resistance of 100Ω & a full scale deflection of 10mA into a multirange dc voltmeter with ranges from 0-5V, 0-50V & 0-100V.

Sol:- ~~Ref diag~~. Above 2nd diagram is Ref diagram.

Given $I_m = 10mA$, $R_m = 100\Omega$

Step 1:- for a 5V (V_3) the total ckt resistance

$$R_t = \frac{V}{I_{fsd}} = \frac{5}{10mA} = 0.5K\Omega$$

$$\therefore R_3 = R_t - R_m$$

$$= 500\Omega - 100\Omega$$

$$= 400\Omega$$

Step 2:- for a 50V (V_2) position

$$R_t = \frac{V}{I_{fsd}}$$

$$= \frac{50}{10mA}$$

$$= 5K\Omega$$

$$\therefore R_2 = R_t - (R_3 + R_m)$$

$$= 5K\Omega - (400\Omega + 100\Omega)$$

$$= 5K\Omega - 500\Omega$$

$$= 4.5K\Omega$$

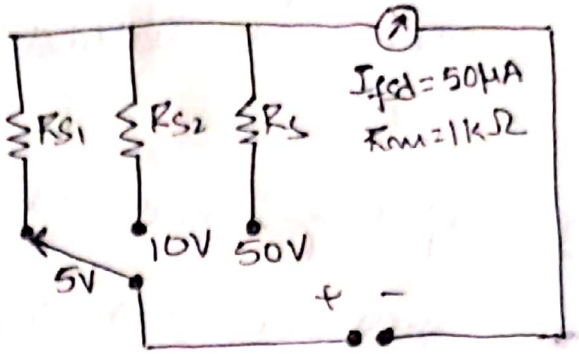
Step 3:- for a 100V range (V_1) position

$R_t = \frac{V}{I_{fsd}} = \frac{100}{10mA} = 10K\Omega$; $\therefore R_1 = R_t - (R_2 + R_3 + R_m)$

$= 10K\Omega - (4.5K\Omega + 400\Omega + 100\Omega)$

$= 5K\Omega$

(5) Calculate the value of multiplier resistance for the multiple range dc voltmeter CKT is shown.



Sol: The Sensitivity of the meter movement is given as follows.

$$S = \frac{1}{I_{fsd}}$$

$$= \frac{1}{50\mu A}$$

$$= 20K\Omega/V$$

The value of the multiplier resistance can be calculated as follows

for 5V range

$$R_{S_1} = S \times V - R_m$$

$$= 20K \times 5 - 1K$$

$$= 100K - 1K$$

$$= 99K\Omega$$

for 10V range $R_{S_2} = S \times V - R_m$

$$= 20K \times 10 - 1K$$

$$= 200K - 1K$$

$$= 199K\Omega$$

for 50V range

$$R_{S_3} = S \times V - R_m$$

$$= 20K \times 50 - 1K$$

$$= 1000K - 1K$$

$$= 999K\Omega$$

Excercise problem

RS1 - 3V

RS2 - 10V

RS3 = 30V

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Sol: 59kΩ

199kΩ

599kΩ