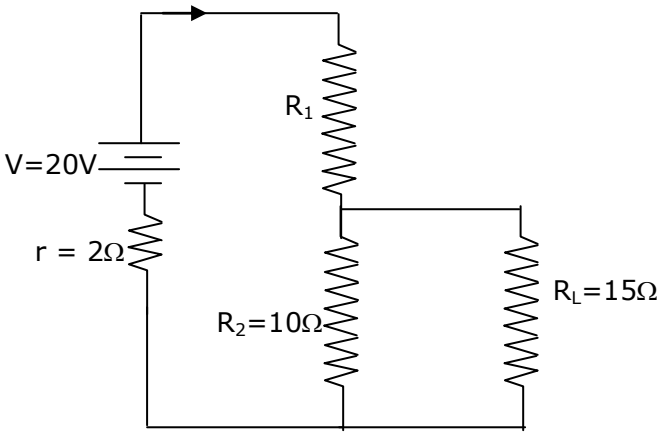
Q- A 20V battery has an internal resistance r = 2 ohms. Design a voltage divider supplying 5V (Open circuit) from the end-points of resistor R_2 = 10 ohms. Find the load current when R_L = 15 ohms is connected to the R_2 of the divider and the voltage under load.

When the load resistance in not connected the r, R_1 and R_2 are in series with the battery and the total resistance will be

$$R = r + R_1 + R_2$$

The current in the circuit will be

$$I = \frac{V}{r + R_1 + R_2}$$



The potential difference across R_2 will be according to Ohm's law

$$V_2 = I*R_2 = \frac{V * R_2}{r + R_1 + R_2}$$

Substituting the values in above equation we have

$$5 = \frac{20*10}{2 + R_1 + 10}$$

Or $R_1 = (200 - 60)/5$ **= 28 Ω**

Now when the load is connected parallel to 10 Ω resistance, the equivalent resistance of the combination will be

$$R' = \frac{R_2 * R_L}{R_2 + R_L} = \frac{10*15}{10+15} = 6\Omega$$

Now this resistance is in series with R_1 and r hence the total resistance of the circuit will be

$$R = R_1 + R' + r$$

Or $R = 28 + 6 + 2 = 36\Omega$

Hence the current through the battery in this case will be

$$I_1 = 20/36 \text{ A}$$

Thus potential difference across the parallel combination of R_2 and R_L will be given by the loop rule as

$$V = V_L + (R_1 + r)*I_1$$

Or $20 = V_L + (28 + 2)*(20/36)$

Gives $V_L = 20 - 16.667 = 3.333$ V

Hence current through the load will be

$$I_L = V_L/R_L = 3.333/15 = 0.222 \text{ A}$$