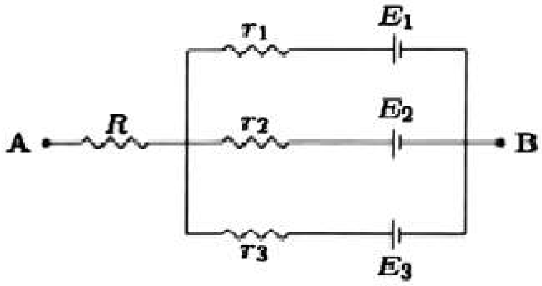
Q 10

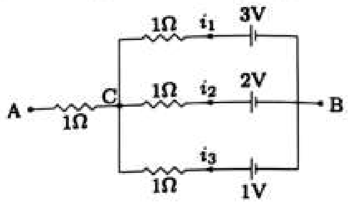
In the circuit shown in figure $E_1 = 3$ V, $E_2 = 2$ V, $E_3 = 1$ V and $R = r_1 = r_2 = r_3 = 1\ \Omega$. **(1981)**



(a) Find the potential difference between the points A and B and the currents through each branch.

(b) If r_2 is short circuited and the point A is connected to point B, find the currents through E_1, E_2, E_3 and the resistor R.

Sol. Let i_1, i_2, and i_3 be the currents through the batteries $E_1 = 3$ V, $E_2 = 2$ V, $E_3 = 1$ V, respectively.



There is no current through $R = 1\ \Omega$. Apply Kirchhoff's junction law at node C to get

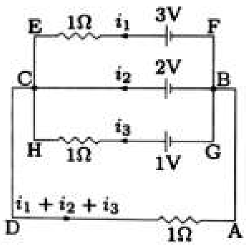
$$i_1 + i_2 + i_3 = 0. \quad (1)$$

Apply Kirchhoff's loop law in the upper and lower loops, to get

$$3 - i_1 + i_2 - 2 = 0, \quad (2)$$
$$2 - i_2 + i_3 - 1 = 0. \quad (3)$$

Solve equations (1)–(3) to get $i_1 = 1$ A, $i_2 = 0$ A, and $i_3 = -1$ A. Since $i_2 = 0$ A and current through R is zero, $V_{AB} = V_{CB} = E_2 = 2$ V.

The circuit after shorting $r_2 = 1\ \Omega$ and connecting point A to B is shown in the figure.



Apply Kirchhoff's loop law in loops $ABCDA$, $FECBF$, and $BCHGB$ to get

$$2 - (i_1 + i_2 + i_3) = 0, \quad (4)$$
$$3 - i_1 - 2 = 0, \quad (5)$$
$$2 + i_3 - 1 = 0. \quad (6)$$

Solve equations (4)–(6) to get $i_1 = 1$ A, $i_2 = 2$ A, and $i_3 = -1$ A. The current through the resistor R is $i_1 + i_2 + i_3 = 1 + 2 - 1 = 2$ A.

Ans. (a) 2 V, 1 A, 0, −1 A (b) 1 A, 2 A, −1 A, 2 A □