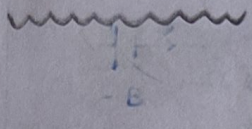
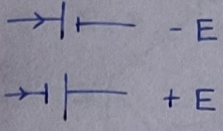
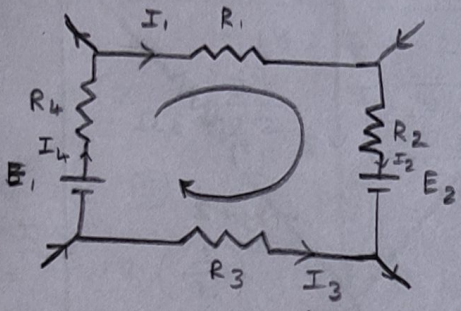
CONVENTIONS :





Ex :



$-I_1R_1$

$-I_2R_2$

$-E_2$

$+I_3R_3$

$+E_1$

$-I_4R_4$

$$-I_1R_1 - I_2R_2 - E_2 + I_3R_3 + E_1 - I_4R_4 = 0$$

Gustave Robert Kirchhoff's

i) Point/ Current rule :

$$i_1 + i_2 + i_3 - i_4 = 0$$

" In any electrical network, the algebraic sum of the currents meeting at a junction is zero.

ii) Voltage rule :

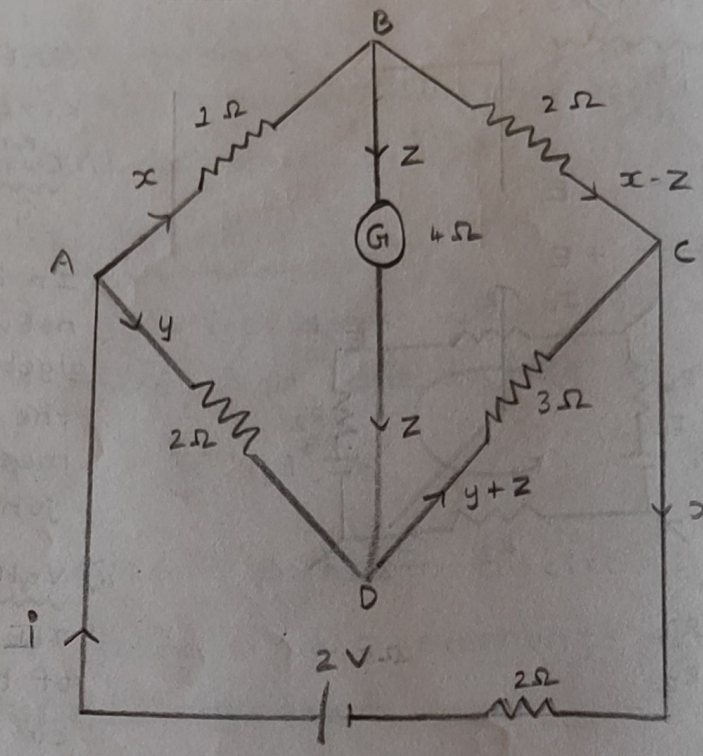
"The algebraic sum of the products of current and resistance in eac of the conductor in any closed pat mesh in a networ plus the algebrai sum of the emf in that path is equal to zero."

In Battery :

* Current flows from positive to negative, the battery is discharging.

* Current flows from negative to positive, the battery is charging.

12.9.24



$i = x + y$

$x - z + y + z$
$= x + y$
$= i$

L1 : (ADCA)

$-2y - 3(y+z) - 2(x+y) + 2 = 0$

$-2y - 3y - 3z - 2x - 2y + 2 = 0$

$-2x - 7y - 3z + 2 = 0 \rightarrow (1)$

L2 : (ABDA) :

$-x + 2y - 4z = 0 \rightarrow (2)$

L3 : (ABCDA) :

$-x - 2(x-z) + 3(y+z) + 2y = 0$

$-x - 2x + 2z + 3y + 3z + 2y = 0$

$-3x + 5y + 5z = 0 \rightarrow (3)$

(1) $\Rightarrow$ $-2x - 7y - 3z = -2$

(2) $\times 2 \Rightarrow$ $-2x + 4y - 8z = 0$

(+) (−) (+) (−)

$-11y + 5z = -2 \rightarrow (4)$

$② \times 3 \Rightarrow -3x + 6y - 12z = 0$

$③ \Rightarrow -3x + 5y + 5z = 0$ (+) (−) (−)

$y - 17z = 0 \rightarrow ⑤$

$④ \Rightarrow -11y + 5z = -2$

$⑤ \times 11 \Rightarrow 11y - 187z = 0$

$+182z = +2$

$z = \frac{2}{182_{91}}$; $\boxed{z = \frac{1}{91} A}$

Sub in ⑤ ;

$y - 17\left(\frac{1}{91}\right) = 0$

$\boxed{y = \frac{17}{91} A}$

Sub in ② ;

$-x + 2\left(\frac{17}{91}\right) - 4\left(\frac{1}{91}\right) = 0$

$-91x + 34 - 4 = 0$

$+91x = +30$

$\boxed{x = \frac{30}{91} A}$

$i = x + y = \frac{30}{91} + \frac{17}{91} = \frac{47}{91} A$

Drop $= 2 \times 0.515$
$= 1.03$

$V = V - Drop$
$= 2 - 1.03 = 0.97$

$R = \frac{V}{I} = \frac{0.97}{0.515} = 1.88 \Omega$

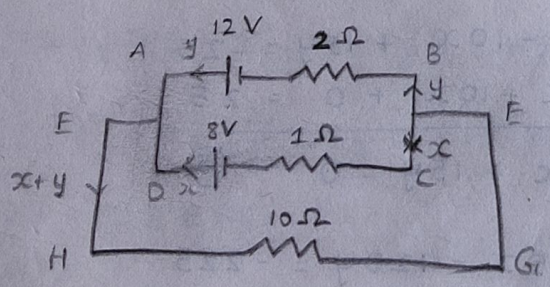
$x = 0.329$

$y = 0.186$

$z = 0.010$

$i = x + y$
$= 0.329 + 0.186$
$= 0.515 A$

Q)



Loop : ADCBA:

$+12 + 8 + x - 2y = 0$

$x - 2y = -4 \rightarrow ①$

Loop : EDCFGHE:

$-8 + x + 10(x+y) = 0$

$11x + 10y = 8 \rightarrow ②$

$x = 3/4$
$y = 1.625$

$① \times 5 \Rightarrow 5x - 10y = -20$

$② \Rightarrow 11x + 10y = 8$

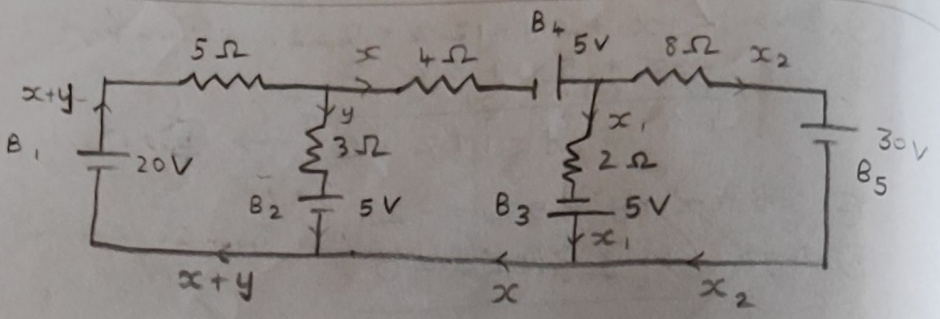
$16x = -12$

$x = -\frac{12}{16}$

$\boxed{x = -\frac{3}{4}}$

Sub in ① ; $2y = -\frac{3}{4} +$

$\left(-\frac{3}{4}\right) - 2y = -4$; $2y = \frac{-3+16}{4}$



Loop 1.

$$20 - 5(x+y) - 3y - 5 = 0 \;;\quad 20 - 5x - 5y - 3y - 5 = 0.$$
$$-5x - 8y = -15 \rightarrow (1)$$

Loop 2:

$$-4x + 5 - 2x_1 + 5 - 5 + 3y = 0$$
$$-4x - 2x_1 + 3y = -5 \rightarrow (2)$$

Loop 3:

$$-8x_2 - 30 + 5 + 2x_1 = 0 \rightarrow (3)$$
$$2x_1 - 8x_2 - 25 = 0 \rightarrow (3)$$

Let $\boxed{x_2 = x - x_1}$

Sub in (3);

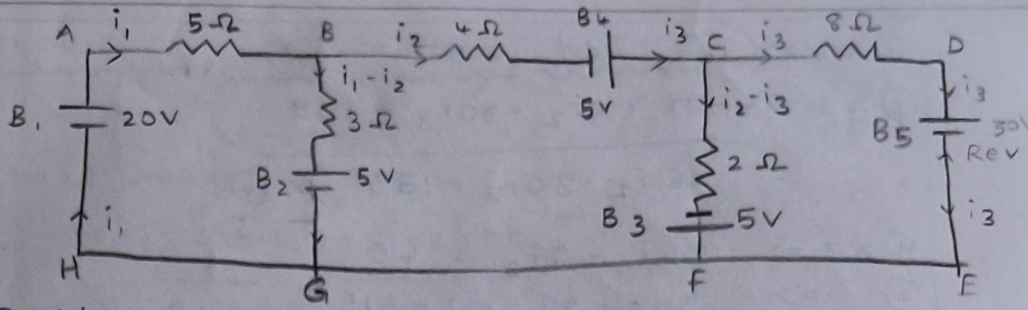
$$2x_1 - 8(x - x_1) - 25 = 0$$
$$2x_1 - 8x + 8x_1 - 25 = 0$$
$$-8x + 10x_1 = 25 \rightarrow (4)$$

$$(2) \times 5 \Rightarrow \quad -20x - 10x_1 + 15y = -25$$
$$(4) \Rightarrow \quad -8x + 10x_1 + 0 = 25$$
$$-28x + 15y = 0 \rightarrow (5)$$

$$(1) \times 15 \Rightarrow \quad -75x - 120y = -225$$
$$(5) \times 8 \Rightarrow \quad -224x + 120y = 0$$
$$+299x = +225 \;;\quad \boxed{x = \frac{225}{299}}$$

Sub in (5);

$$-28\left(\frac{225}{299}\right) + 15y = 0$$
$$-6300 + 4485y = 0 \;;\quad y = \frac{6300}{4485} \;;\quad \boxed{y = \frac{420}{299}}$$



Battery :

$B_1 \rightarrow i_1 \rightarrow 2.56\ A$ (Discharging)

$B_2 \rightarrow i_1 - i_2 \rightarrow 0.74\ A$ (Charging)

$B_3 \rightarrow i_2 - i_3 \rightarrow 4.96\ A$ (Discharging)

$B_4 \rightarrow i_2 \rightarrow 1.82\ A$ (Discharging)

$B_5 \rightarrow i_3 \rightarrow -3.13\ A$ (Discharging)

LOOP 1) ABGHA :

$$-5i_1 - 3(i_1 - i_2) - 5 + 20 = 0$$

$$-5i_1 - 3i_1 + 3i_2 + 15 = 0$$

$$-8i_1 + 3i_2 = -15$$

$$8i_1 - 3i_2 = 15 \rightarrow (1)$$

LOOP 2) : BCFGB :

$$-4i_2 + 5 - 2(i_2 - i_3) + 5 + 5 + 3(i_1 - i_2) = 0$$

$$-4i_2 + 5 - 2i_2 + 2i_3 + 5 + 5 + 3i_1 - 3i_2 = 0$$

$$3i_1 - 9i_2 + 2i_3 = -15 \rightarrow (2)$$

Loop 3) : CDEFC :

$$-8i_3 - 30 - 5 + 2(i_2 - i_3) = 0$$

$$-8i_3 - 35 + 2i_2 - 2i_3 = 0$$

$$2i_2 - 10i_3 = 35 \rightarrow (3)$$

① × 2 ⇒ $16 i_1 - 6 i_2 = 30$

③ × 3 ⇒ $0 + 6 i_2 - 30 i_3 = 105$

$16 i_1 - 30 i_3 = 135 \rightarrow ④$

① × 3 ⇒ $24 i_1 - 9 i_2 = 45$

② ⇒ $3 i_1 - 9 i_2 + 2 i_3 = -15$

$21 i_1 - 2 i_3 = 60 \rightarrow ⑤$

④ ⇒ $16 i_1 - 30 i_3 = 135$

⑤ × 15 ⇒ $315 i_1 - 30 i_3 = 900$

$+299 i_1 = +765$

$$i_1 = \frac{765}{299} \quad \text{(or)} \quad i_1 = 2.56 \text{ A}$$

Sub in ①;

$8 i_1 - 3 i_2 = 15$

$8\left(\frac{765}{299}\right) - 3 i_2 = 15$

$6120 - 897 i_2 = 4485$

$897 i_2 = 1632$

$$i_2 = \frac{1632}{897} \quad \text{(or)} \quad i_2 = 1.82 \text{ A}$$

Sub in ③ i

$2\left(\frac{1632}{897}\right) - 10 i_3 = 35$

$3264 - 8970 i_3 = 31395$

$-8970 i_3 = +28131$

$$i_3 = -\frac{28131}{8970}$$

$$i_3 = -3.13 \text{ A}$$