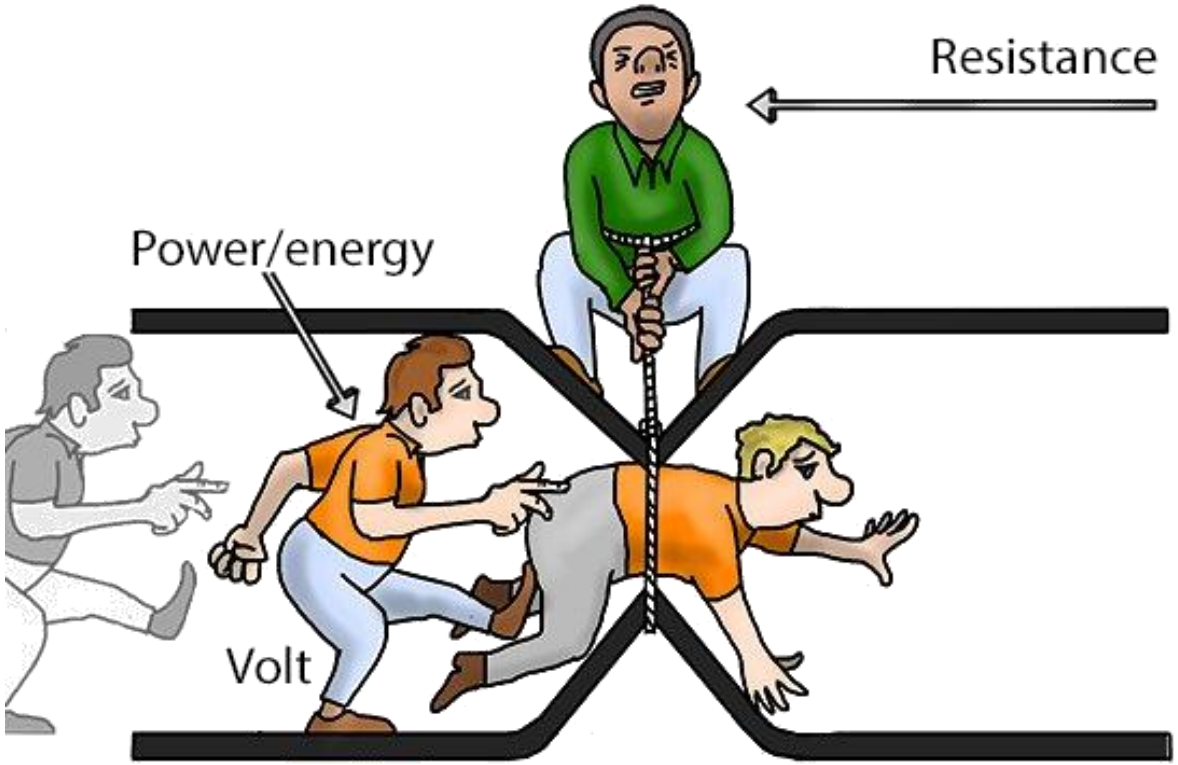
Physics – Grade 10



Unit One

Electricity

Chapter 4 – Resistors

Prepared & Presented by: Mr. Mohamad Seif

Think then Solve

Exercise 1:

Consider the circuit represented in the adjacent figure.

G is a generator that maintains across its terminals a constant voltage $V_{PN} = 12V$,

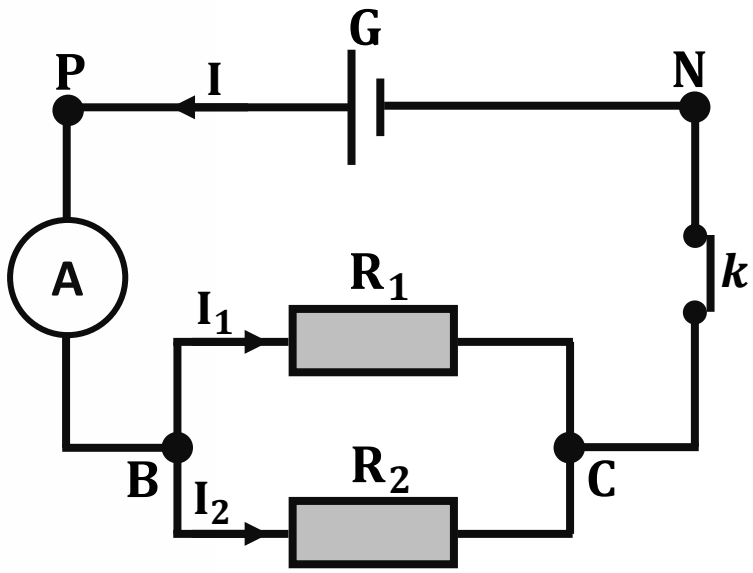
(A) is an ammeter of negligible resistance.

(R_1) is a resistor of resistance $R_1 = 30\Omega$;

and R_2 is a resistor of resistance R_2, and

(K) is a switch.

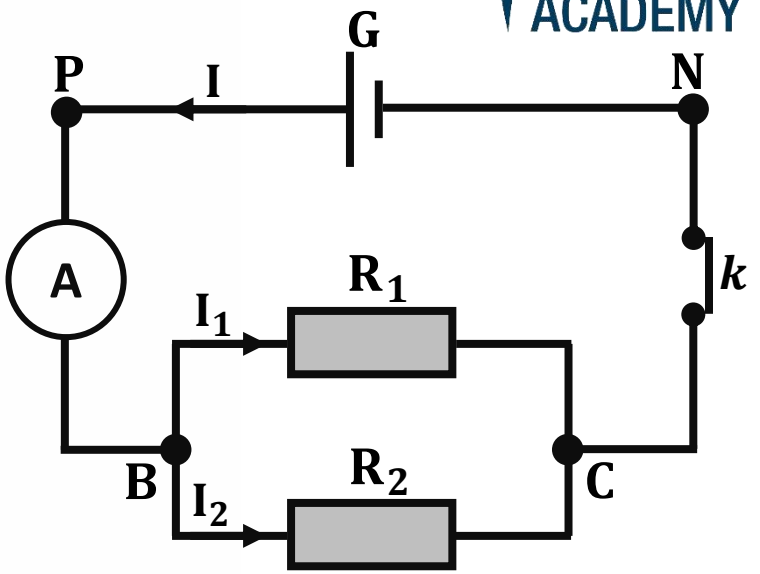
When we close (K), the ammeter (A) indicates 0.6 A



Exercise 1:

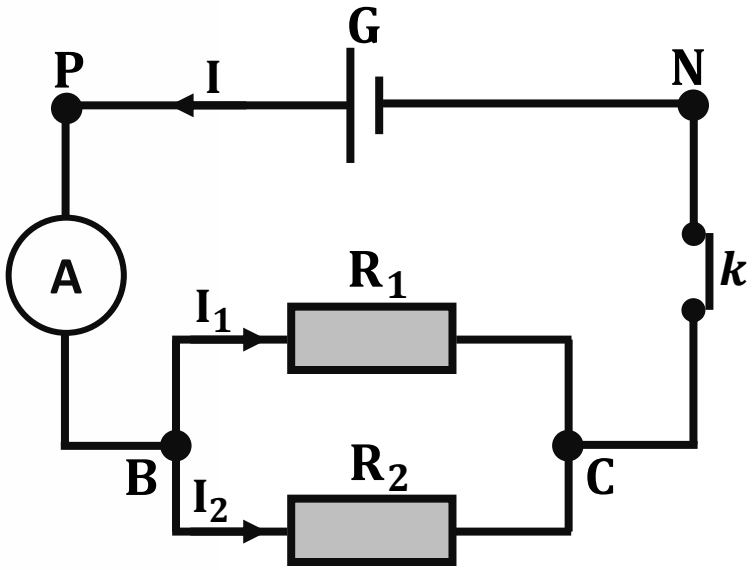
Part A: Determination of the value of V_{BC}:

1. The voltage across (A) is zero. Why?
2. The voltage across (K) is zero. Why?
3. Prove that the voltage $V_{BC} = 12V$.



Exercise 1:

$V_{PN} = 12V$; ammeter of negligible resistance; $R_1 = 30\Omega$; $R_2 = ?$; $I = 0.6A$.



1. The voltage across (A) is zero. Why?

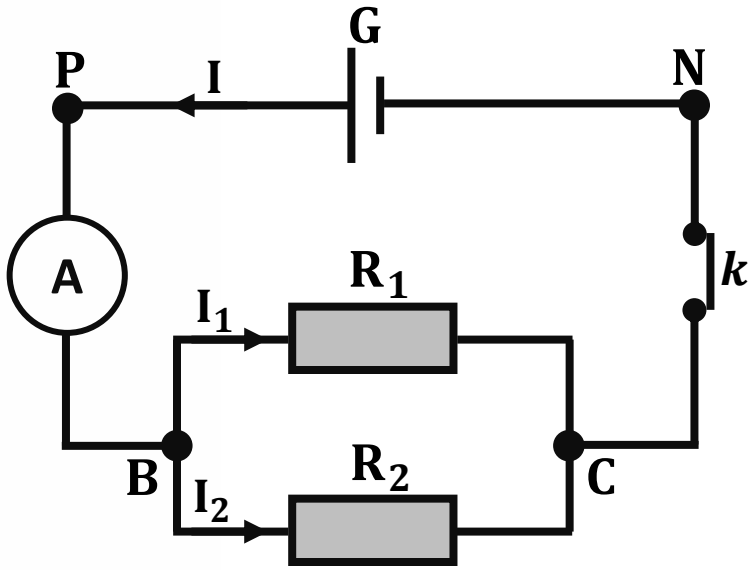
Since the ammeter is of negligible resistance, then the voltage across it is zero.

2. The voltage across (K) is zero. Why?

Because the switch is closed, then the voltage across it is zero.

Exercise 1:

$V_{PN} = 12V$; ammeter of negligible resistance; $R_1 = 30\Omega$; $R_2 = ?$; $I = 0.6A$.



3. Prove that the voltage $V_{BC} = 12V$.

$$V_{PN} = V_{PB} + V_{BC} + V_{CN}$$

$$12V = 0V + V_{BC} + 0V$$

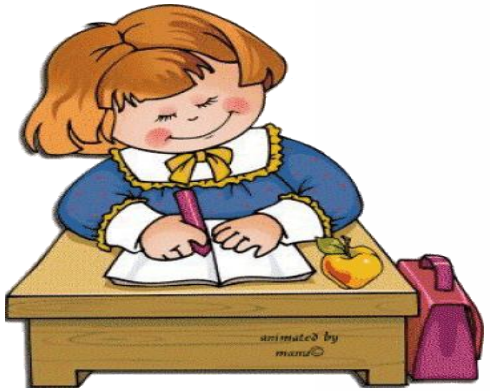
$$V_{BC} = 12V$$

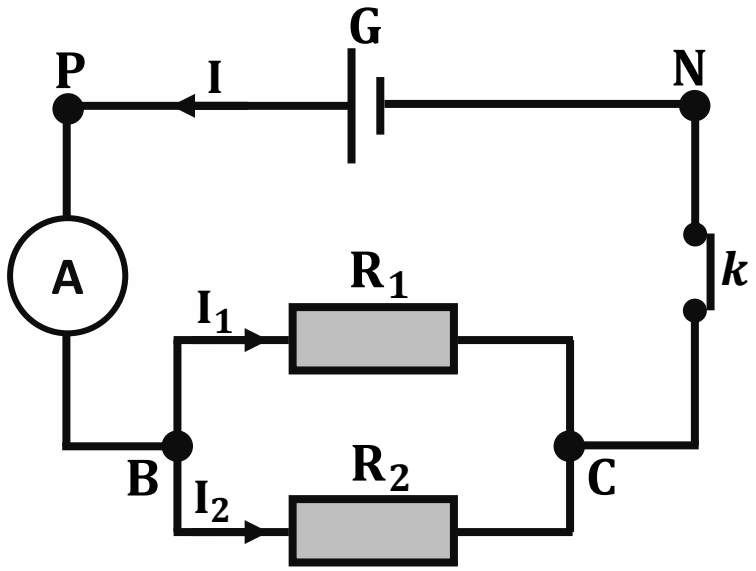
Exercise 1:

$V_{PN} = 12V$; ammeter of negligible resistance; $R_1 = 30\Omega$; $R_2 = ?$; $I = 0.6A$.

Part B: Determination of the value of R_2:

1. Determine the value of the current I_1 through R_1
2. Deduce the value of the current I_2 through R_2
3. Show that the value of R_2 is 60Ω.





Exercise 1:

$V_{PN} = 12V$; ammeter of negligible resistance; $R_1 = 30\Omega$; $R_2 = ?$; $I = 0.6A$.

1. Determine the value of the current I_1 through R_1

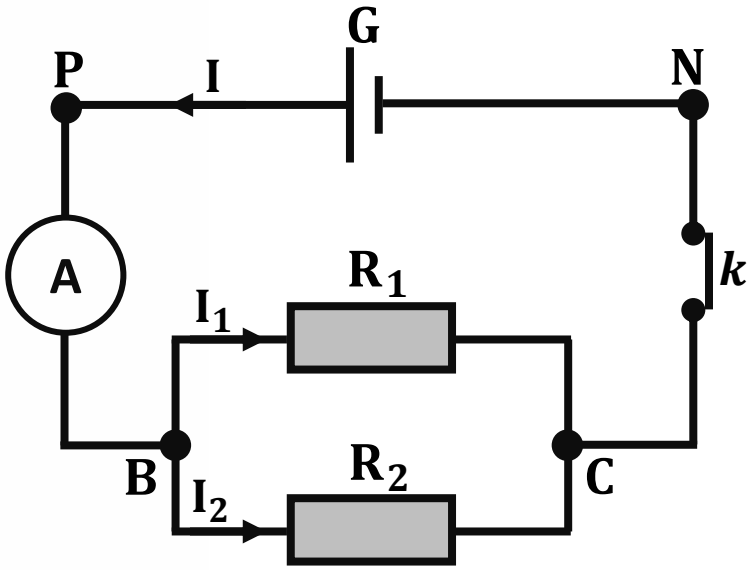
R_1 and R_2 are connected in parallel then:

$$V_{BC} = V_1 = V_2 = 12V$$

Using ohm's law then: $V_1 = R_1 \times I_1$

$$I_1 = \frac{V_1}{R_1} = \frac{12}{30}$$

$$I_1 = 0.4A$$



Exercise 1:

$V_{PN} = 12V$; ammeter of negligible resistance; $R_1 = 30\Omega$; $R_2 = ?$; $I = 0.6A$.

2. Deduce the value of the current I_2 through R_2

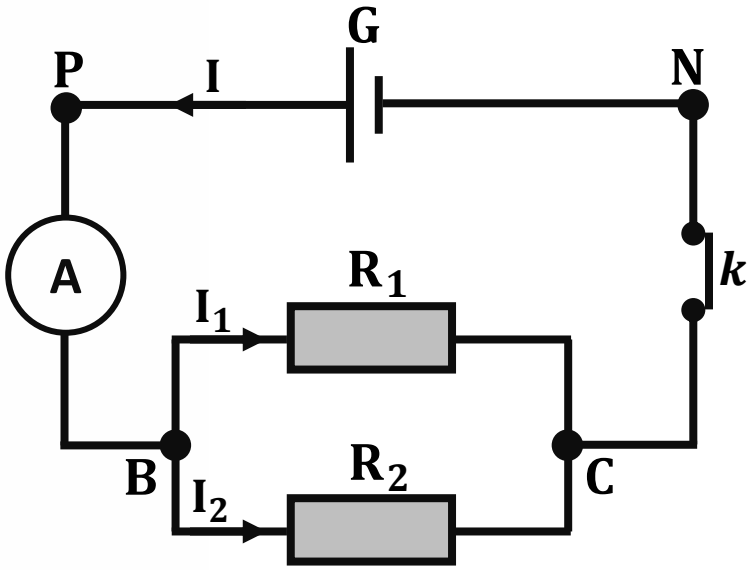
R_1 and R_2 are connected in parallel then:

$$I = I_1 + I_2$$

$$I - I_1 = I_2$$

$$0.6A - 0.4A = I_2$$

$$I_2 = 0.2A$$



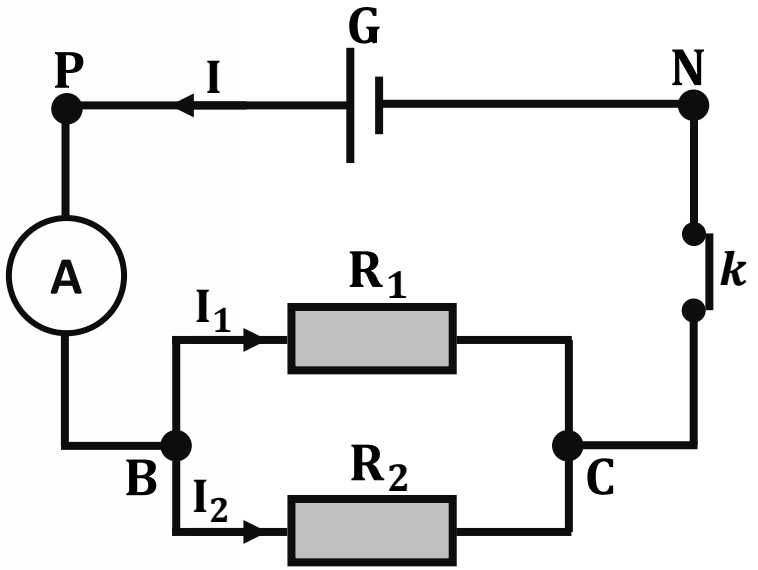
Exercise 1:

3. Show that the value of R_2 is 60Ω.

$$V_2 = R_2 \times I_2$$

$$R_2 = \frac{V_2}{I_2} = \frac{12V}{0.2A}$$

$$R_2 = 60\Omega$$



Exercise 1:

Part C: Equivalent resistance:

R_1 and R_2 can be replaced by a single resistor of resistance (R_{eq}).

1. Calculate the equivalent resistance by two methods.
2. An instrument allows a direct measurement of R. Name this instrument.

Exercise 1:

1.Calculate the equivalent resistance by two methods.

First method:

$$V_{PN} = R_{eq} \times I$$

$$R_{eq} = \frac{V_{PN}}{I} = \frac{12V}{0.6}$$

$$R_{eq} = 20\Omega$$

Second method:

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$R_{eq} = \frac{30 \times 60}{30 + 60}$$

$$R_{eq} = \frac{1800}{900}$$

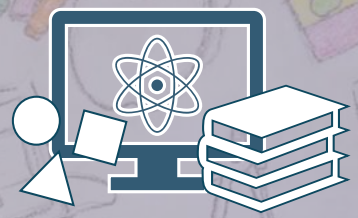
$$R_{eq} = 20\Omega$$

Exercise 1:

2.An instrument allows a direct measurement of R. Name this instrument.

The instrument that measures directly is ohmmeter

The End

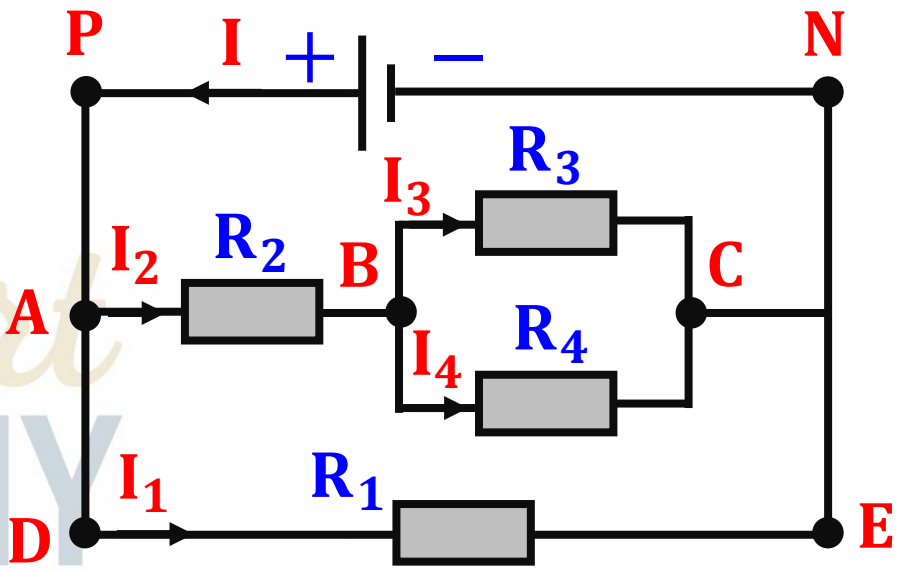


Think then Solve

Exercise 2:

The adjacent circuit diagram shows the combination of four resistors $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$ are connected to a generator of voltage $V_{PN} = 24V$.

1. Show that the resistance of the equivalent resistor to these four resistors is $R_{eq} = 10\Omega$.
2. Calculate I the intensity of the current delivered by the generator.
3. Calculate the intensity of the current traversing each resistor.

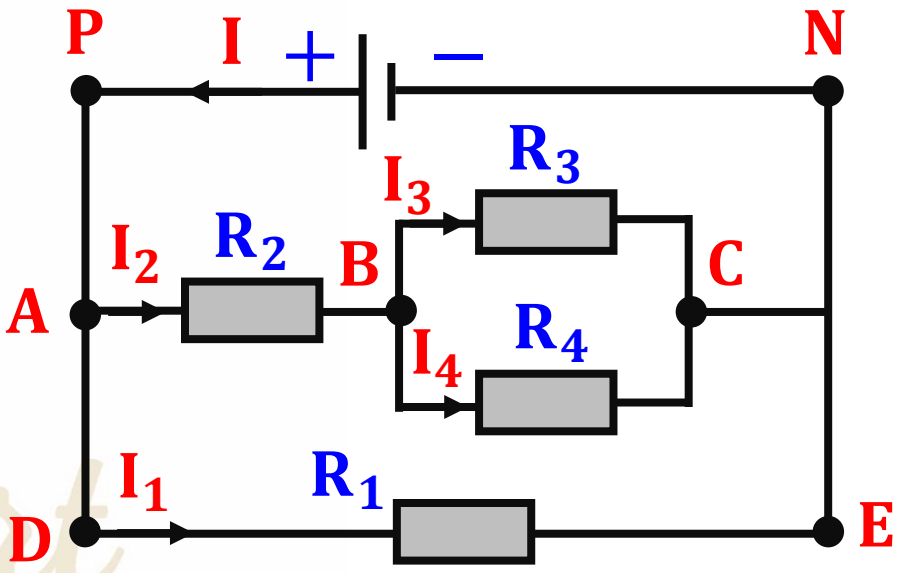


Exercise 2:

4.Determine V_{AC}, V_{AB} and V_{BC}.

5. It is required to replace R_2 by a conducting wire made of a metal of resistivity $\rho = 4 \times 10^{-5} \Omega m$ and of cross-sectional area $S = 1mm^2$.

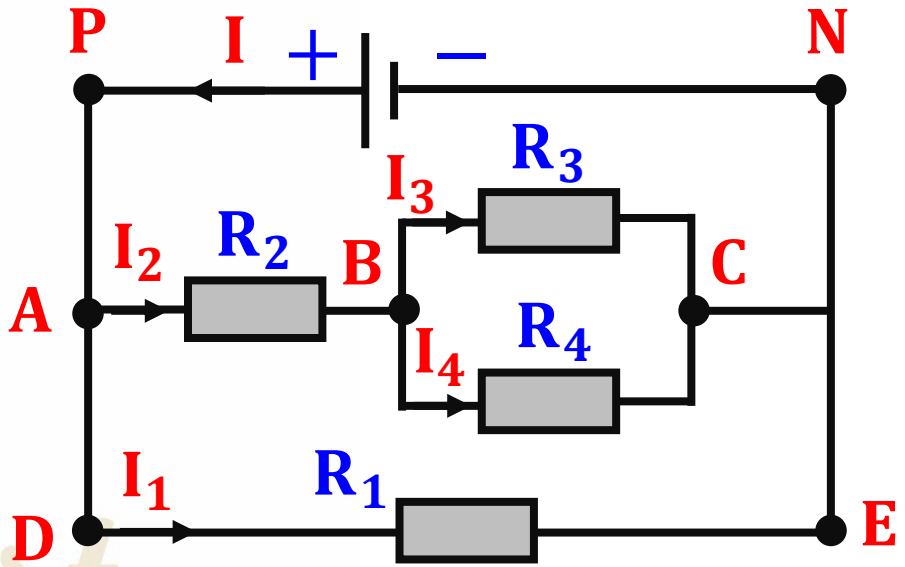
Calculate the length of this wire so that the resistance is kept constant.



Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$.

1. Show that the resistance of the equivalent resistor to these four resistors is $R_{eq} = 10\Omega$.



R_3 and R_4 connected in parallel then:

$$R_A = \frac{R_3 \times R_4}{R_3 + R_4} = \frac{20 \times 20}{20 + 20}$$

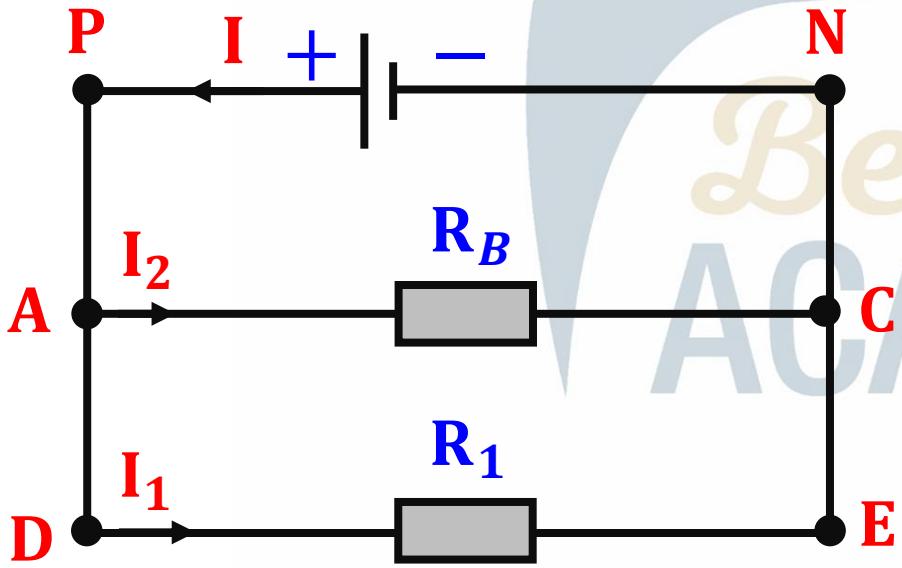
$$R_A = \frac{400}{40} = 10\Omega$$

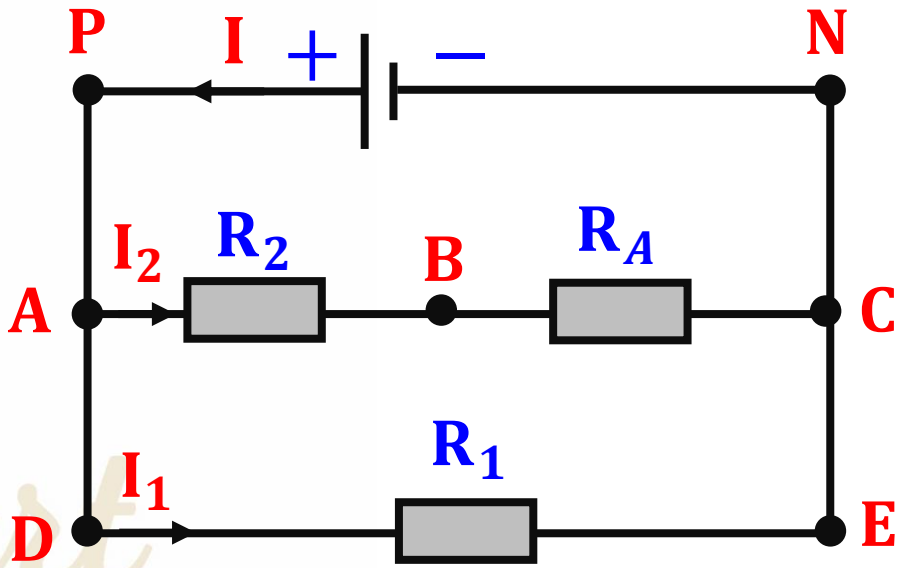
Exercise 2:

R_2 and R_A connected in series then:

$$R_B = R_A + R_2$$

$$R_B = 10 + 10 = 20\Omega$$



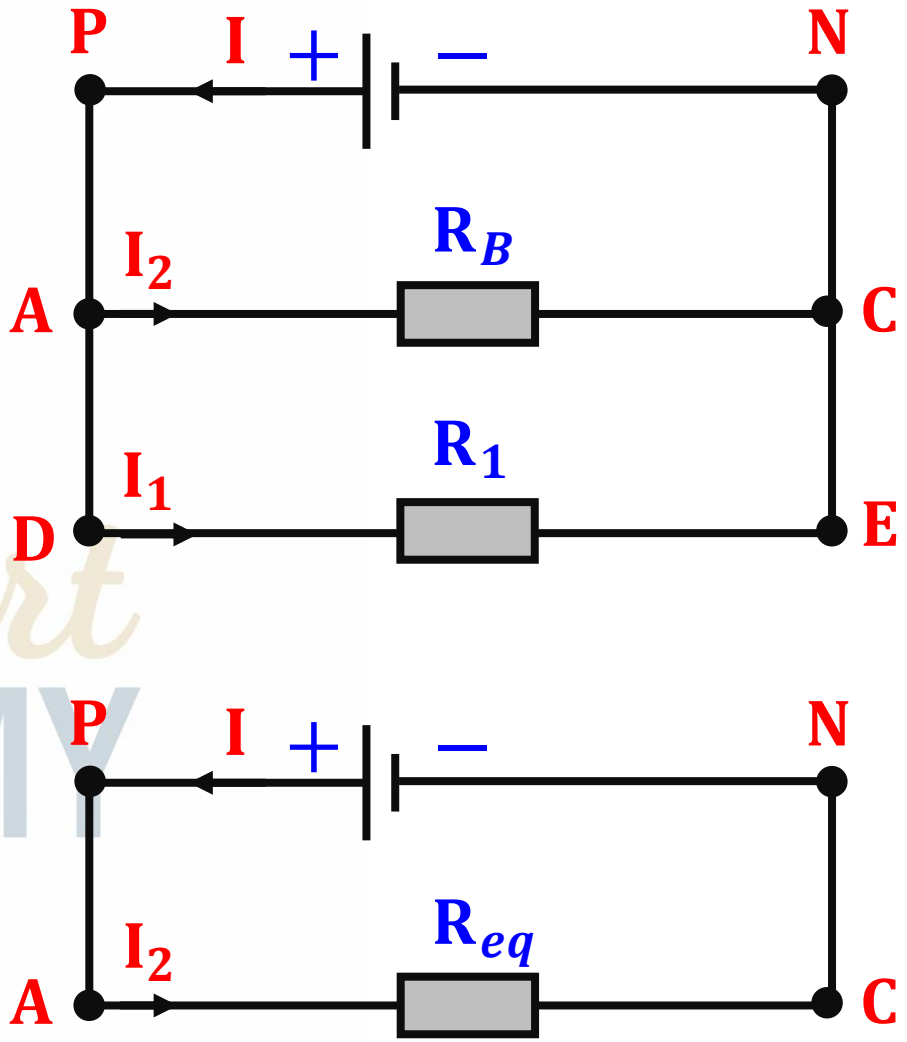


Exercise 2:

R_B and R_1 connected in parallel:

$$R_{eq} = \frac{R_1 \times R_B}{R_1 + R_B} = \frac{20 \times 20}{20 + 20}$$

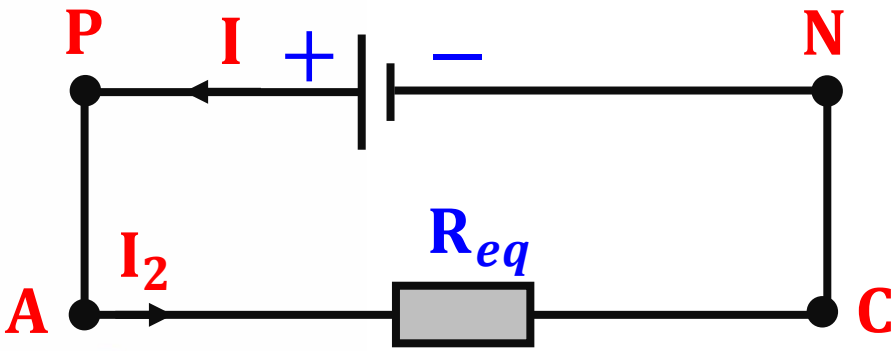
$$R_{eq} = \frac{400}{40} = 10\Omega$$



Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$.

2.Calculate I the intensity of the current delivered by the generator.



$$V_{PN} = R_{eq} \times I$$

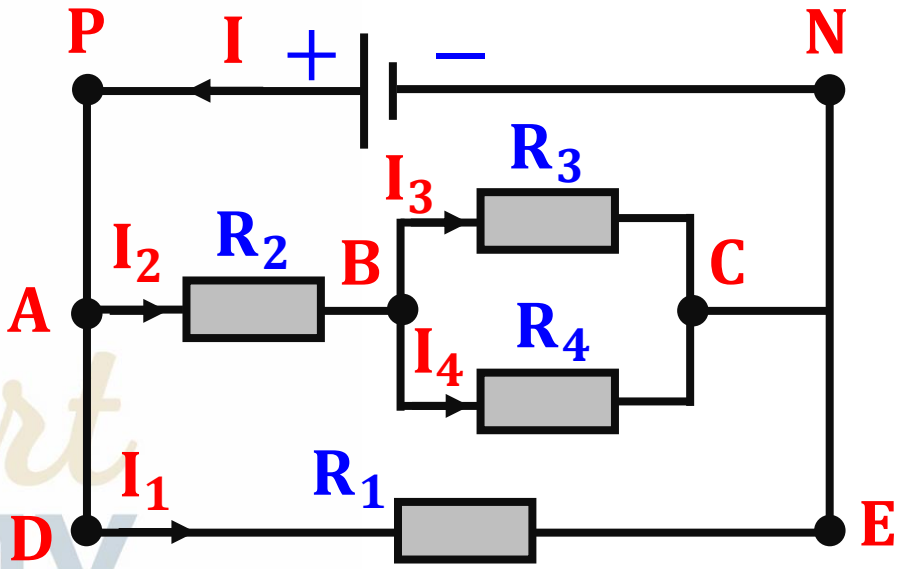
$$I = \frac{V_{PN}}{R_{eq}}$$

$$I = \frac{24}{10} \quad \Rightarrow \quad I = 2.4A$$

Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$.

2.Calculate the intensity of the current traversing each resistor



R_1 parallel with the generator then:

use law of uniqueness of voltage:

$$V_{PN} = V_{DE} = 24V$$

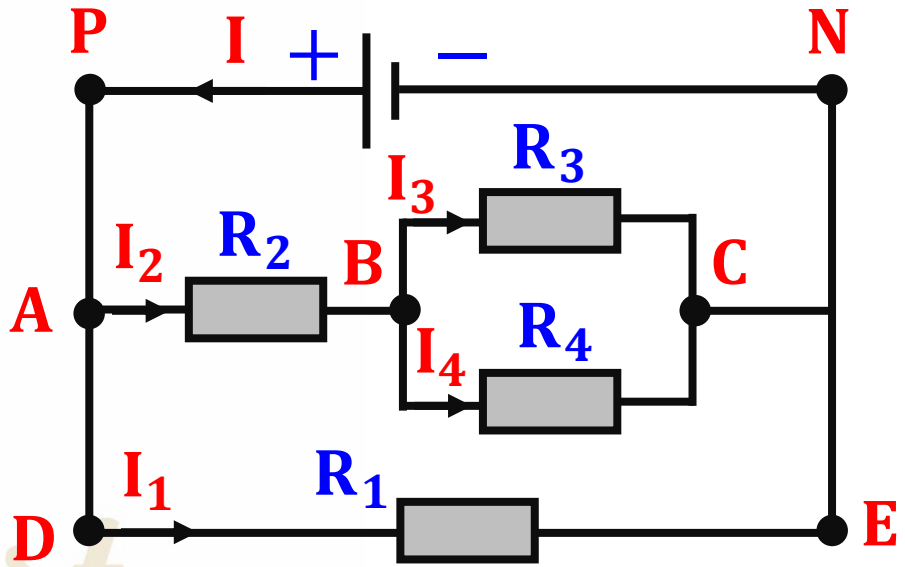
$$U_{DE} = R_1 \times I_1$$

$$I_1 = \frac{U_{DE}}{R_1} = \frac{24}{20} \Rightarrow I_1 = 1.2A$$

Exercise 2:

$V_{PN} = 24V; R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$.

Using law of addition of current then:



$$I = I_1 + I_2$$

$$2.4A = 1.2A + I_2$$

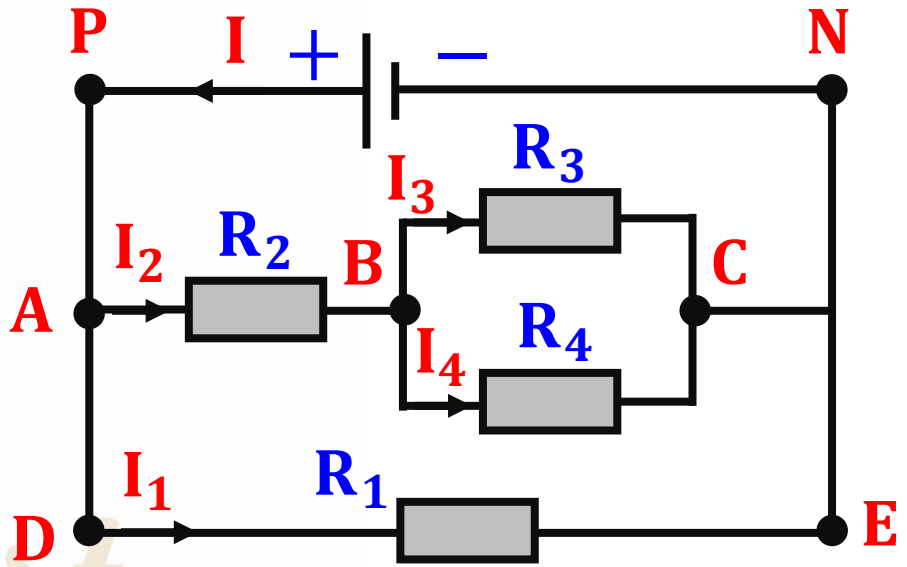
$$2.4 - 1.2 = I_2$$

$$I_2 = 1.2A$$

Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$.

Since R_3 and R_4 then: $I_3 = I_4$



$$I_2 = I_3 + I_4$$

$$1.2A = I_3 + I_3$$

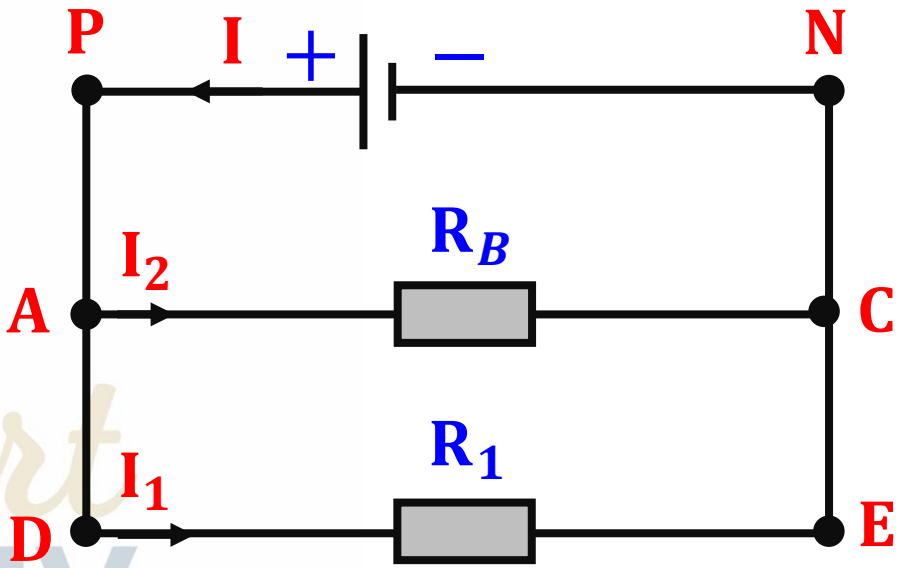
$$1.2A = 2I_3$$

$$I_3 = \frac{1.2}{2} \Rightarrow I_3 = I_4 = 0.6A$$

Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$; $I = 2.4A$; $I_1 = 1.2A$; $I_2 = 1.2A$; $I_3 = 0.6A$ and $I_4 = 0.6A$

4. Determine V_{AC}, V_{AB} and V_{BC}.



$$V_{AC} = R_B \times I_1$$

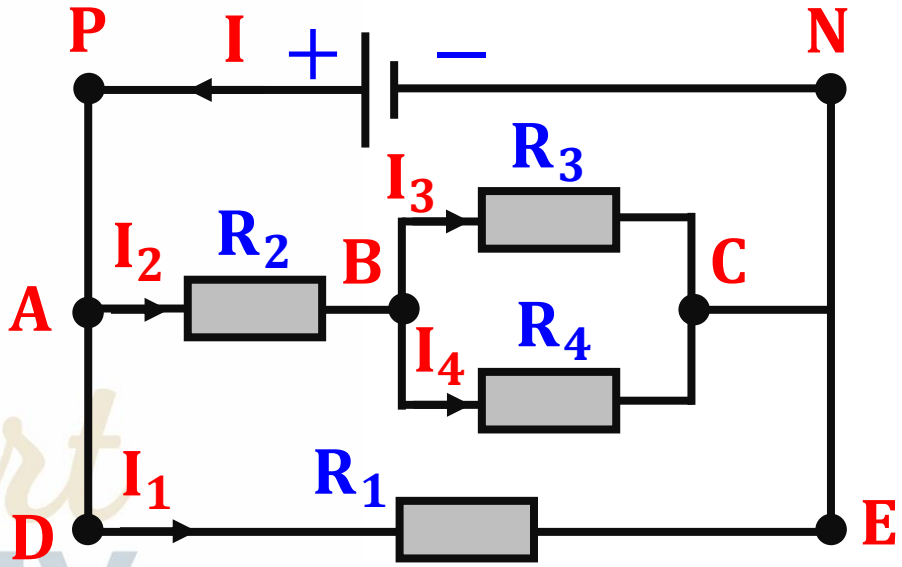
$$V_{AC} = 20 \times 1.2$$

$$V_{AC} = 24V$$

Exercise 2:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$; $I = 2.4A$;
$I_1 = 1.2A$; $I_2 = 1.2A$; $I_3 = 0.6A$ and $I_4 = 0.6A$

4. Determine V_{AC}, V_{AB} and V_{BC}.



$$V_{AB} = R_2 \times I_2$$

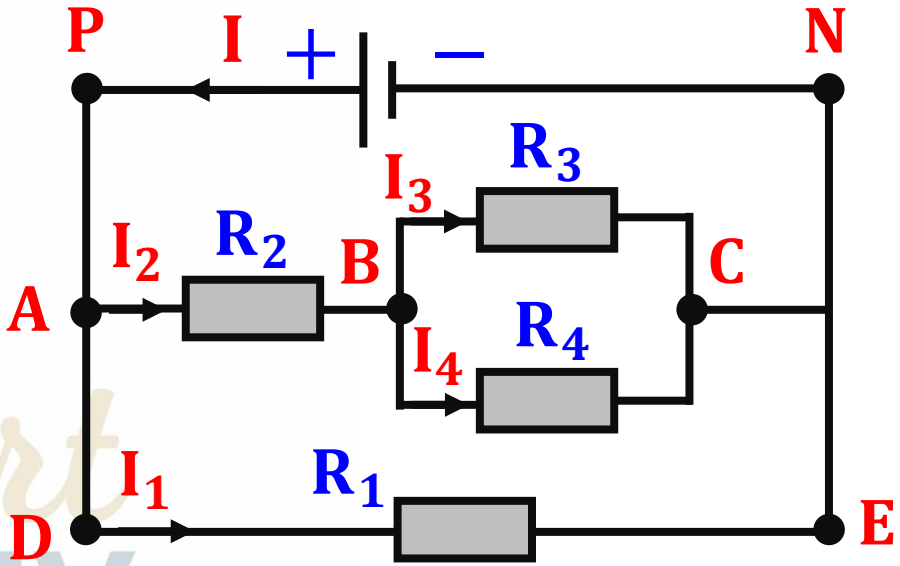
$$V_{AB} = 10 \times 1.2$$

$$V_{AB} = 12V$$

Exercise 3:

$V_{PN} = 24V$; $R_1 = R_3 = R_4 = 20\Omega$ and $R_2 = 10\Omega$; $I = 2.4A$; $I_1 = 1.2A$; $I_2 = 1.2A$; $I_3 = 0.6A$ and $I_4 = 0.6A$

4. Determine V_{AC}, V_{AB} and V_{BC}.



$$V_{BC} = R_3 \times I_3 = 20 \times 0.6$$

$$V_{BC} = 12V$$

Second method:

$$V_{AC} = V_{AB} + V_{BC}$$

$$24V = 12V + V_{BC}$$

$$V_{BC} = 12V$$

Exercise 2:

4. It is required to replace R_2 by a conducting wire made of a metal of resistivity $\rho = 4 \times 10^{-5} \Omega m$ and of cross-sectional area $S = 1mm^2$. Calculate the length of this wire so that the resistance is kept constant.

$$R_2 = \frac{\rho \times L}{S}$$

$$\frac{R_2}{1} = \frac{\rho \times L}{S}$$

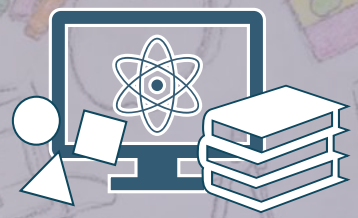
$$R_2 \times S = \rho \times L$$

$$L = \frac{R_2 \times S}{\rho}$$

$$L = \frac{10 \times 1 \times 10^{-6}}{4 \times 10^{-4}}$$

$$L = 0.025m = 2.5cm$$

The End

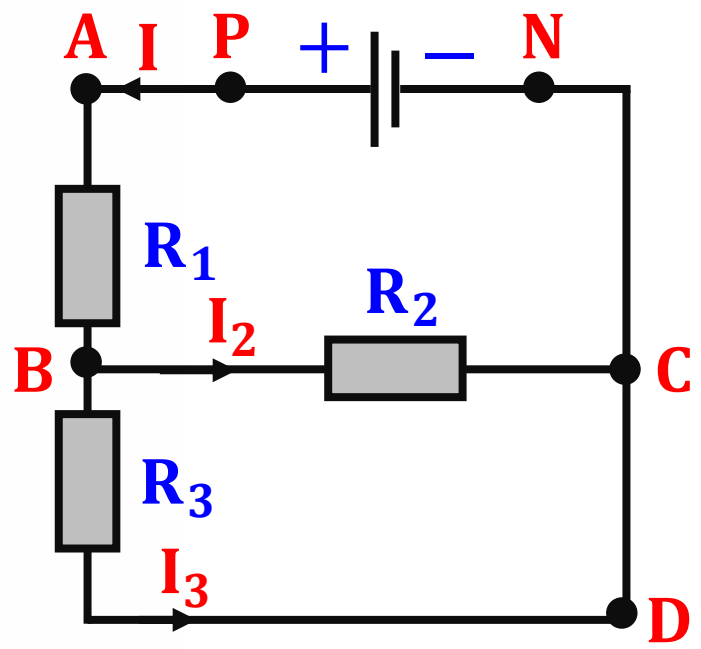


Think then Solve

Exercise 3

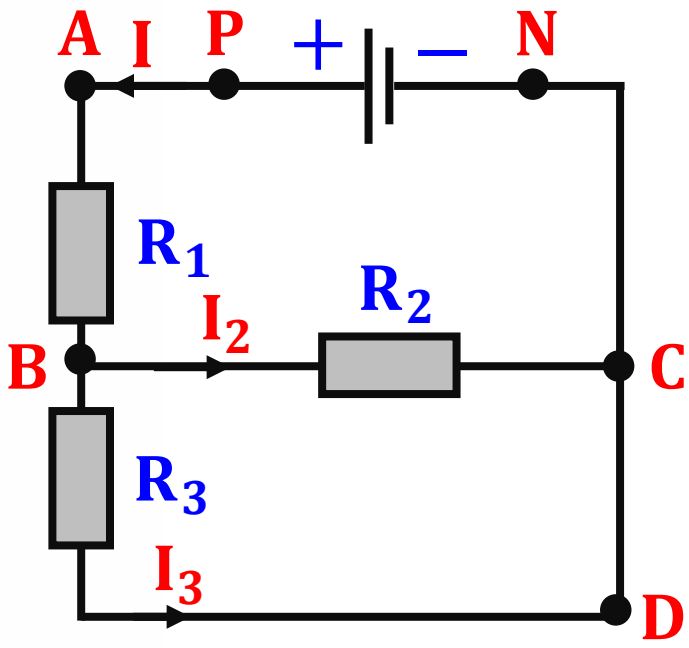
Consider the electric circuit that consists of a dry cell of voltage $V_{PN} = 12V$ and three resistors $R_1 = 1.6\Omega$, $R_2 = 4\Omega$ and $R_3 = 6\Omega$ as shown in figure 1.

1. Calculate the equivalent resistance of the circuit.
2. Calculate the main current I.
3. Calculate the voltage V_{AB} across R_1.
4. Determine V_{BC} then deduce the voltage V_{BD} across R_3.



Exercise 3

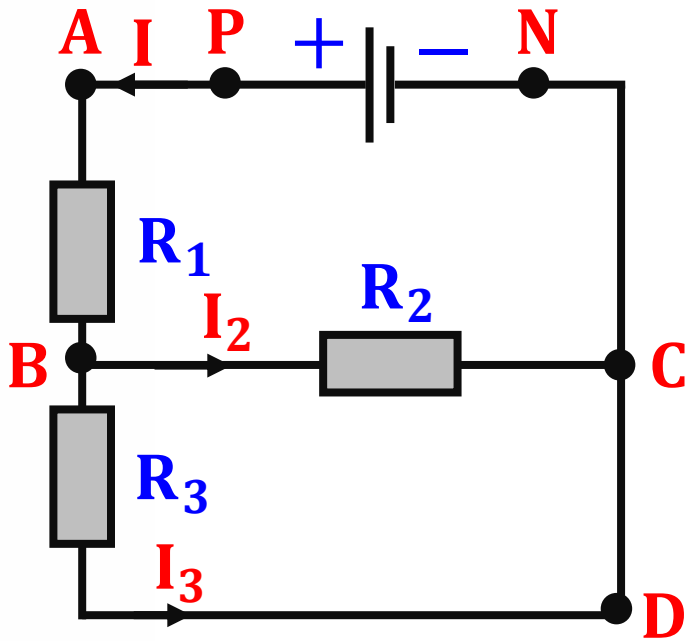
5. Calculate the current I_2 traversing R_2 and the current I_3 traversing R_3
6. Calculate the power consumed by R_1. Deduce the energy dissipated in 1 minute.
7. In what form does this energy appear?



Exercise 3

$V_{PN} = 12V; R_1 = 1.6\Omega; R_2 = 4\Omega$ and $R_3 = 6\Omega$

1. Calculate the equivalent resistance of the circuit.



R_2 and R_3 are connected in parallel then:

$$R_A = \frac{R_2 \times R_3}{R_2 + R_3} = \frac{4 \times 6}{4 + 6} = \frac{24}{10} = 2.4\Omega$$

R_A and R_1 are connected in series then:

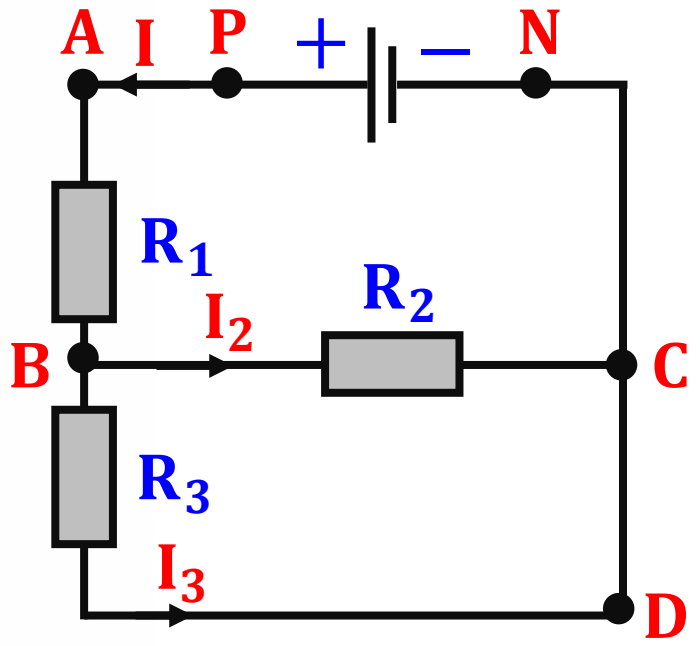
$$R_{eq} = R_1 + R_A$$

$$R_{eq} = 1.6 + 2.4 \qquad R_{eq} = 4\Omega$$

Exercise 3

$V_{PN} = 12V; R_1 = 1.6\Omega; R_2 = 4\Omega$ and $R_3 = 6\Omega$

2. Calculate the main current I.



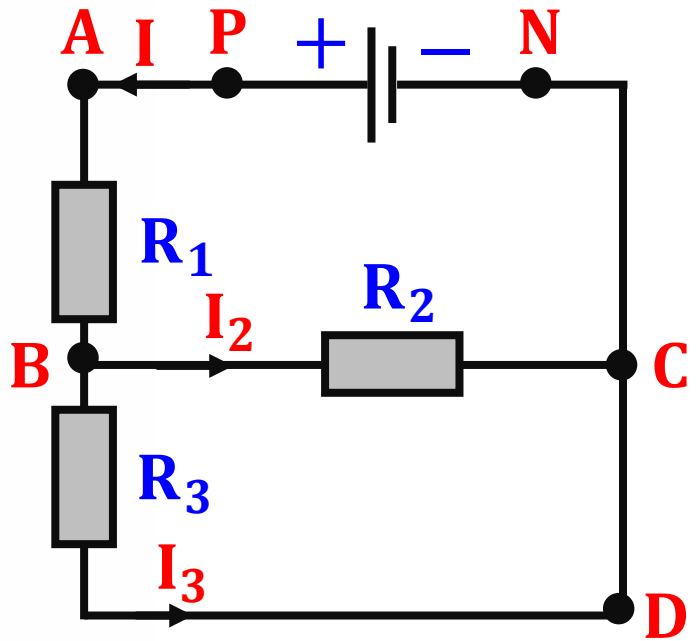
$$U_{PN} = R_{eq} I$$

$$I = \frac{U_{PN}}{R_{eq}} = \frac{12V}{4}$$

$$I = 3A$$

Exercise 3

$V_{PN} = 12V; R_1 = 1.6\Omega; R_2 = 4\Omega$ and $R_3 = 6\Omega$



3. Calculate the voltage V_{AB} across R_1.

$$V_{AB} = R_1 I$$

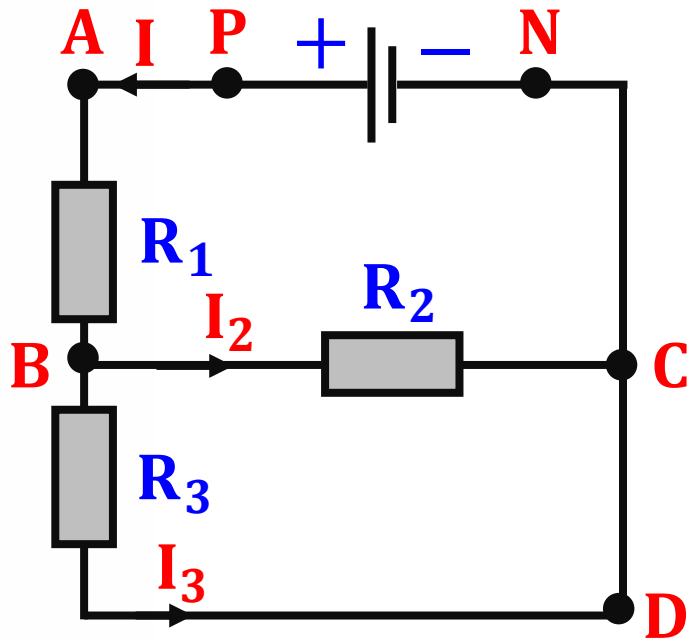
$$V_{AB} = 1.6 \times 3$$

$$V_{AB} = 4.8V$$

Exercise 3

$V_{PN} = 12V; R_1 = 1.6\Omega; R_2 = 4\Omega$ and $R_3 = 6\Omega$

4. Determine V_{BC} then deduce the voltage across R_3.



$$V_{PN} = V_{AB} + V_{BC} + V_{CN}$$

$$12V = 4.8V + V_{BC} + 0V$$

$$V_{BC} = 7.2V$$

Since R_2 and R_3 are in parallel:

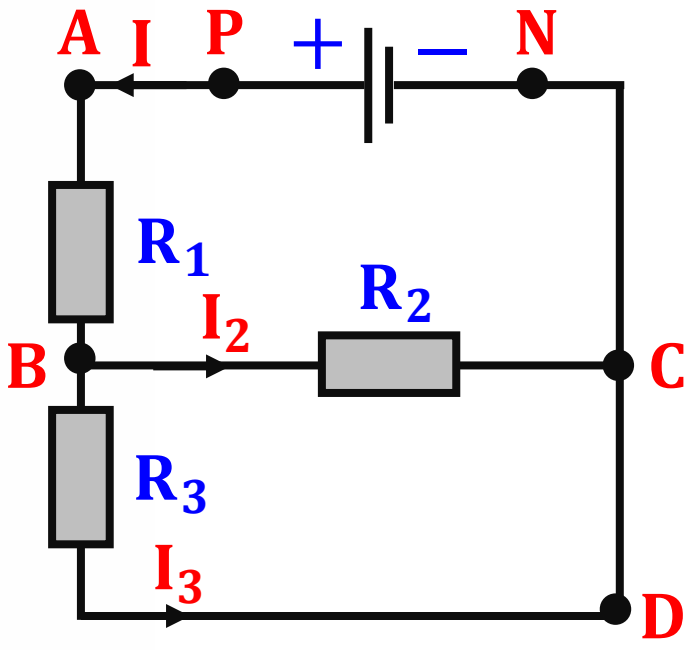
$V_{BC} = V_{BD} = 7.2V$ Law of uniqueness of voltage in parallel

Exercise 3

$V_{PN} = 12V; R_1 = 1.6\Omega; R_2 = 4\Omega$ and $R_3 = 6\Omega$

5. Calculate the current I_2 traversing R_2 and the current I_3 traversing R_3.

$$V_{BC} = R_2 \times I_2 \Rightarrow I_1 = \frac{V_{BC}}{R_2} = \frac{7.2V}{4} = 1.8A$$



At junction point B:

$$I = I_1 + I_2 \Rightarrow I - I_1 = I_2$$

$$3A - 1.8A = I_2$$

$$I_2 = 1.2A$$

Exercise 3

$V_{PN} = 12V$; $R_1 = 1.6\Omega$; $R_2 = 4\Omega$ and $R_3 = 6\Omega$

6. Calculate the power consumed by R_1. Deduce the energy in joules, dissipated in 1 minute.

The consumed power is:

$$P = V_{AB} \times I$$

$$P = 4.8 \times 3$$

$$P = 14.4W$$

The dissipated energy:

$$E = P \times t$$

$$E = 14.4 \times (1 \times 60)$$

$$E = 864J$$

Exercise 3

7. In what form does this energy appear?

The energy appears by joules effect as a heat

The End