

# Calcul pour électricien solutions

Nº 3.1.1

A en mm <sup>2</sup>	I en A	J en $\frac{A}{mm^2}$
1	6	6
1,5	10	6,66
2,5	16	6,4
4	20	5
6	25	4,16
10	40	4
16	63	3,93

Nº 3.1.2

$$J = \frac{I}{A} \Rightarrow A = \frac{I}{J} = \frac{82}{2,9} = \underline{\underline{28,27}} \Rightarrow 35 \text{ mm}^2$$

Nº 3.1.3

$$J = \frac{I}{A} \Rightarrow I = J \cdot A = 18 \cdot 16 = \underline{\underline{288 \text{ A}}}$$

Nº 3.1.4

$$J = \frac{I}{A} = \frac{430}{35} = \underline{\underline{12,28 \text{ A}}}$$

Nº 3.1.5

$$J = \frac{I}{A} \Rightarrow A = \frac{I}{J} = \frac{385}{12} = \underline{\underline{32,08 \text{ cm}^2}}$$

Nº 3.1.6

$$A = \phi^2 \cdot 0,785 = 2,5^2 \cdot 0,785 = 4,9 \text{ mm}^2$$

$$J = \frac{I}{A} \Rightarrow I = J \cdot A = 2,2 \cdot 4,9 = \underline{\underline{10,79 \text{ A}}}$$

Nº3. 1.7

$$A = \phi^2 \cdot 0,785 = 0,1^2 \cdot 0,785 = 0,00785 \text{ mm}^2$$

a)  $J = \frac{I}{A} = \frac{2,8}{0,00785} = \underline{\underline{356,68 \frac{A}{mm^2}}}$

b)  $J = \frac{I}{A} = \frac{3,1}{0,00785} = \underline{\underline{394,9 \frac{A}{mm^2}}}$

c)  $J = \frac{I}{A} = \frac{2,4}{0,00785} = \underline{\underline{305,73 \frac{A}{mm^2}}}$

Nº3. 1.8

$$J = \frac{I}{A} \Rightarrow I = J \cdot A = 35 \cdot 17,8 = \underline{\underline{623 A}}$$

$$I = A \cdot J = 35 \cdot 20 = \underline{\underline{700 A}}$$

Nº3. 1.9

$$8,5 \frac{A}{cm^2} = 0,85 \frac{A}{mm^2}$$

$$J = \frac{I}{A} \Rightarrow A = \frac{I}{J} = \frac{32}{0,85} = \underline{\underline{37,64 \text{ mm}^2}}$$

$$A = \phi^2 \cdot 0,785 \Rightarrow \phi = \sqrt{\frac{A}{0,785}} = \sqrt{\frac{37,64}{0,785}} = \underline{\underline{6,92 \text{ mm}}}$$

Nº3. 1.10

$$A = \phi^2 \cdot 0,785 = 4,8^2 \cdot 0,785 = 18,08 \text{ mm}^2$$

$$18,3 \text{ kA} = 18300 \text{ A}$$

$$J = \frac{I}{A} = \frac{18300}{18,08} = \underline{\underline{1011,81 \frac{A}{mm^2}}}$$

Nº3. 1.11

$$A' = \phi^2 \cdot 0,785 = 40^2 \cdot 0,785 = 1256 \text{ mm}^2$$

$$A'' = \phi^2 \cdot 0,785 = 36^2 \cdot 0,785 = 1017,36 \text{ mm}^2$$

$$\Delta A = A' - A'' = 1256 - 1017,36 = 238,64 \text{ mm}^2$$

$$J = \frac{I}{A} \Rightarrow I = J \cdot A = 2,38 \cdot 238,64 = \underline{\underline{567,96 \text{ A}}}$$

Nº 3.1.12

$$A = \phi^2 \cdot 0,785 = 0,12^2 \cdot 0,785 = 0,011 \text{ mm}^2$$

$$J = \frac{I}{A} \Rightarrow I = J \cdot A = 3,4 \cdot 0,011 = \underline{\underline{0,038 A}}$$


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Nº 3.1.13

$$J - \frac{I}{A} = \text{a) } \frac{460}{95} = \underline{\underline{4,84 \frac{A}{mm^2}}}$$

$$\text{b) } \frac{335}{95} = \underline{\underline{3,52 \frac{A}{mm^2}}}$$

$$\text{c) } \frac{295}{95} = \underline{\underline{3,10 \frac{A}{mm^2}}}$$

$$\text{d) } \frac{295}{95} = \underline{\underline{3,10 \frac{A}{mm^2}}}$$

Nº 3.1.14

$$A = \phi^2 \cdot 0,785 = 2,84^2 \cdot 0,785 = 6,33 \text{ mm}^2$$

$$A_{\text{totale}} = A \cdot n = 6,33 \cdot 19 = 120,29 \text{ mm}^2$$

$$\text{a) Cuirre: } J = \frac{I}{A} = \frac{840}{120,29} = \underline{\underline{2,82 \frac{A}{mm^2}}}$$

$$\text{b) Aluminium: } J = \frac{I}{A} = \frac{265}{120,29} = \underline{\underline{2,2 \frac{A}{mm^2}}}$$

$$\text{c) \%} = 100 - \left( \frac{265 \cdot 100}{840} \right) = \underline{\underline{22,05 \%}}$$


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Nº 3.2.1

$$I = \frac{U}{R} = \frac{220}{40,5} = \underline{\underline{5,43 \text{ A}}}$$

Nº 3.2.2

$$U = R \cdot I = 3,82 \cdot 16,5 = \underline{\underline{63,08 \text{ V}}}$$

Nº 3.2.3

$$R = \frac{U}{I} = \frac{8}{18} = \underline{\underline{0,44 \Omega}}$$

Nº 3.2.4

$$I = \frac{U}{R} = \frac{4,12}{60} = \underline{\underline{80,33 \text{ mA}}}$$

Nº 3.2.5

$$U = R \cdot I = 165 \cdot 8,5 = \underline{\underline{412,5 \text{ V}}}$$

Nº 3.2.6

$$R = \frac{U}{I} = \frac{48}{62} = \underline{\underline{0,77 \Omega}}$$

Nº 3.2.7

$$I = \frac{U}{R} = \frac{11,9}{2,8} = \underline{\underline{4,25 \text{ A}}}$$

Nº 3.2.8

$$U = R \cdot I = 0,0432 \cdot 39,5 = \underline{\underline{1,7 \text{ A}}}$$

Nº 3.2.9

$$R = \frac{U}{I} = \frac{5,8}{3,15} = \underline{\underline{1,84 \Omega}}$$

Nº 3.2.10

$$I = \frac{U}{R} = \frac{6,5}{0,424} = \underline{\underline{15,33 \text{ A}}}$$

Nº 3.2.11

$$I = \frac{U}{R} = \frac{185}{16} = \underline{\underline{11,56 \text{ mA}}}$$

$\frac{\text{unité}}{k} \Rightarrow m$

Nº 3.2.12

$$U = R \cdot I = 0,086 \cdot 12 = 1,032 \text{ V}$$

Nº 3.2.13

$$R = \frac{U}{I} = \frac{12,9}{0,92} = \underline{\underline{14,02 \text{ k}\Omega}}$$

$\frac{\text{unité}}{\text{m}} \Rightarrow \text{k}$

Nº 3.2.14

$$I = \frac{U}{R} = \frac{287,5}{11,5} = \underline{\underline{35 \text{ mA}}}$$

$\frac{\text{unité}}{\text{k}} \Rightarrow \text{mA}$

Nº 3.2.15

$$R = \frac{U}{I} = \frac{1,65}{6,6} = \underline{\underline{0,25 \text{ m}\Omega}}$$

$\frac{\text{unité}}{\text{k}} \Rightarrow \text{m}\Omega$

Nº 3.2.16

$$U = R \cdot I = 9,2 \cdot 14,5 = \underline{\underline{133,4 \text{ V}}}$$

$\text{m} \cdot \text{k} \Rightarrow \text{unité}$

Nº 3.2.17

$$R = \frac{U}{I} = \frac{12}{0,107} = \underline{\underline{112,1 \Omega}}$$

Nº 3.2.18

$$I = \frac{U}{R} = \frac{2,24}{1,26} = \underline{\underline{177,8 \mu\text{A}}}$$

$\frac{\text{unité}}{\text{M}} = \mu$

Nº 3.2.19

$$U = R \cdot I = 2,6 \cdot 560 = \underline{\underline{1456 \text{ V}}}$$

$\text{M} \cdot \mu \Rightarrow \text{unité}$

Nº 3.2.20

$$R = \frac{U}{I} = \frac{10,2}{10,4} = \underline{\underline{0,98 \Omega}}$$

$\frac{\text{k}}{\text{k}} = \text{unité}$

N° 3.3.1

$$It = I_1 + I_2 + I_3 + I_4 = 18,2 + 9,6 + 21,7 + 17,1 = \underline{\underline{66,6 \text{ A}}}$$

Sens : de gauche à droite.

N° 3.3.2

$$It = I_1 + I_2 + I_3 + I_4 + I_5 = 902 + 1027 + 189 + 503 + 998 = \underline{\underline{3513 \text{ A}}}$$

N° 3.3.3

$$It = I_1 + I_2 + (2 \cdot I_3) = 2,8 + 2,3 + (2 \cdot 1,25) = \underline{\underline{7,6 \text{ A}}}$$

N° 3.3.4

$$It = 2 \cdot I_1 + 2 \cdot I_2 + 4 \cdot I_3 + 4 \cdot I_5 + I_6 + I_7 = \\ 2 \cdot 3,33 + 2 \cdot 0,53 + 4 \cdot 0,4 + 4 \cdot 0,25 + 0,5 + 2,5 = \underline{\underline{18,93 \text{ A}}}$$

N° 3.3.5

Sens du crt. = Entrant.

$$I'^{\text{tot. sortant}} = 210 + 187 = 397 \text{ A}$$

$$I'^{\text{tot. Entrant}} = 120 + 178 = 298 \text{ A}$$

$$I_1 = \Delta I = I' - I'' = 397 - 298 = \underline{\underline{99 \text{ A}}}$$

N° 3.3.6

$$I'^{\text{tot. entrant}} = 12,1 + 9,3 + 48,2 = 69,6 \text{ A}$$

$$I''^{\text{tot. sortant}} = 76,1 + 17,8 = 93,9 \text{ A}$$

I est entrant et égal à  $\Delta I$

$$I = I' - I'' = 93,9 - 69,6 = \underline{\underline{24,3 \text{ A}}}$$

N° 3.3.7

$$I = I \text{ déb.} - I \text{uti.} = 24,3 - (3,6 + 9,8 + 5,5) = \underline{\underline{5,3 \text{ A}}}$$

N° 3.3.8

$$I_1 = Itot. - I_3 = 8,21 - 5,67 = \underline{\underline{2,54 \text{ A}}}$$

$$I_2 = Itot. = \underline{\underline{8,21 \text{ A}}}$$

N<sup>o</sup> 3.3.9

$$I_1 = C \rightarrow d + C \rightarrow b = 83 + 72 = \underline{\underline{155 \text{ A}}}$$

$$I_3 = 211 - 72 = \underline{\underline{139 \text{ A}}}$$

$$I_2 = 920 - I_3 = 920 - 139 = \underline{\underline{781 \text{ A}}}$$

$$I_4 = 83 + I_2 = 83 + 781 = \underline{\underline{864 \text{ A}}}$$

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N<sup>o</sup> 3.3.10

$$I_{\text{tot. entrants}} = 13,5 + 30,2 = 43,7 \text{ A}$$

$$I_{\text{tot. sortants}} = 14,8 + 12,4 = 27,2 \text{ A}$$

$$\Delta I = I' - I'' = 43,7 - 27,2 = \underline{\underline{16,5 \text{ A}}}$$

$I$  est sor tant!

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N<sup>o</sup> 3.3.11

$$I_1 = 168 + 77 = \underline{\underline{91 \text{ mA}}}$$

$$I_3 = 301 + I_1 = 301 + 91 = \underline{\underline{392 \text{ mA}}}$$

$$I_2 = 301 - 77 = \underline{\underline{224 \text{ mA}}}$$

$I_1$  va de droite à gauche !

$I_2$  est sortant !

$I_3$  est entrant !

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Nº 3.4.1

$$\gamma \cdot \varphi = \sim 1$$

$$\frac{\Omega \cdot \text{mm}^2}{\text{m}} \cdot \frac{\text{m}}{\Omega \cdot \text{mm}^2} = \frac{1}{1} \sim 1 \text{ (nombre neutre)}$$

$$0,0175 \cdot 57 = \underline{\underline{0,9975}}$$

$$0,495 \cdot 2,06 = \underline{\underline{0,991}}$$

$$1,08 \cdot 0,926 = \underline{\underline{1}}$$

Nº 3.4.2

$$\gamma = \frac{1}{\varphi} = \frac{1}{1114} = \underline{\underline{0,8977}} \frac{\text{m Sm}}{\text{mm}^2}$$

Nº 3.4.3

$$\varphi = \frac{1}{\gamma} = \frac{1}{0,0285} = \underline{\underline{35,09}} \frac{\Omega \cdot \text{mm}^2}{\text{m}}$$

Nº 3.4.4

$$\gamma = \frac{1}{\varphi} = \frac{1}{0,0245} = \underline{\underline{40,82}} \frac{\text{Sm}}{\text{mm}^2}$$

Nº 3.4.5

$$\varphi = \frac{1}{\gamma} = \frac{1}{3,21} = \underline{\underline{0,3115}} \frac{\text{M}\Omega \cdot \text{mm}^2}{\text{m}}$$

Nº 3.4.6

$$\gamma = \frac{1}{\varphi} = \frac{1}{0,075} = \underline{\underline{13,3}} \frac{\text{Sm}}{\text{mm}^2}$$

Nº 3.4.7

$$\gamma = \frac{1}{\varphi} = \frac{1}{55} = \underline{\underline{18,18}} \frac{\text{m Sm}}{\text{mm}^2}$$

Nº 3.4.8

$$\gamma = \frac{1}{\varphi} = \frac{1}{0,0255} = \underline{\underline{39,21}} \frac{\text{Sm}}{\text{mm}^2}$$

Nº 3.5.1

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 100}{16} = \underline{\underline{0,109 \Omega}}$$

Nº 3.5.2

$$A = \phi^2 \cdot 0,785 = 32^2 \cdot 0,785 = 803,84 \text{ mm}^2$$

$$l = 0,915 \text{ m}$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l} = \frac{1,05 \cdot 803,84}{0,915} = \underline{\underline{922,9 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

Nº 3.5.3

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{0,42 \cdot 2,5}{0,0175} = \underline{\underline{60 \text{ m}}}$$

Nº 3.5.4

$$R = \frac{\varphi \cdot l}{A} \Rightarrow A = \frac{\varphi \cdot l}{R} = \frac{0,0175 \cdot 52}{0,062} = \underline{\underline{14,68 \text{ mm}^2}}$$

A normalisé  $\Rightarrow 16 \oplus$

Nº 3.5.5

$$A = \phi^2 \cdot 0,785 = 0,85^2 \cdot 0,785 = 0,5671 \text{ mm}^2$$

$$A = \phi^2 \cdot 0,785 = 0,075^2 \cdot 0,785 = 0,0044 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 28,6}{0,56} = \underline{\underline{0,882 \Omega}}$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 1780}{0,0044} = \underline{\underline{7051 \Omega}}$$

Nº 3.5.6

$$A = \phi^2 \cdot 0,785 = 0,7^2 \cdot 0,785 = 0,384 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{1,65 \cdot 0,384}{0,0175} = \underline{\underline{36,28 \text{ m}}}$$

Nº 3.5.7

$$R = \frac{\varphi \cdot l}{A} \Rightarrow A = \frac{\varphi \cdot l}{R} = \frac{0,0175 \cdot 0,85}{0,000425} = \underline{\underline{35 \text{ mm}^2}}$$

$$\text{N}^{\circ} 3.5.8 \quad \varphi \text{ du Brouze} = 0,0185 \frac{\Omega \cdot \text{mm}^2}{\text{m}}$$

$$A = \phi^2 \cdot 0,785 = 3^2 \cdot 0,785 = 7,065 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l \cdot 2}{A} = \frac{0,0185 \cdot 1820 \cdot 2}{7,065} = \underline{\underline{9,537 \Omega}}$$

N<sup>o</sup> 3.5.9

$$0,527 \Omega/\text{km} \Rightarrow 0,000527 \frac{\Omega \cdot \text{m}}{35 \text{ mm}^2}$$

$$\varphi = A \cdot \underline{\underline{\Omega \cdot \text{m}}} = 0,000527 \cdot 35 = 0,01845 \frac{\Omega \cdot \text{mm}^2}{\text{m}}$$

N<sup>o</sup> 3.5.10

$$A = \phi^2 \cdot 0,785 = 1,8^2 \cdot 0,785 = 2,54 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{1,8 \cdot 2,54}{0,0175} = \underline{\underline{261,7 \text{ m}}}$$

N<sup>o</sup> 3.5.11

$$R = \frac{\varphi \cdot l \cdot 2}{A} \Rightarrow A = \frac{\varphi \cdot l \cdot 2}{R} = \frac{0,0175 \cdot 120 \cdot 2}{2,1} = \underline{\underline{20 \text{ mm}^2}}$$

soit 2,5  $\neq$  normalisé

N<sup>o</sup> 3.5.12

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 82}{16} = \underline{\underline{0,0896 \Omega}}$$

N<sup>o</sup> 3.5.13

$$A = l \cdot L = 6 \cdot 6 = 36 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l} = \frac{1,05 \cdot 36}{0,6} = \underline{\underline{63 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

N<sup>o</sup> 3.5.14

$$A = \phi^2 \cdot 0,785 = 1,2^2 \cdot 0,785 = 1,13 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{44 \cdot 1,13}{0,91} = \underline{\underline{54,68 \text{ m}}}$$

N<sup>o</sup> 3.5.15

$$R = \frac{\varphi \cdot l}{A} \Rightarrow A = \frac{\varphi \cdot l}{R} = \frac{0,029 \cdot 12}{0,000375} = \underline{\underline{928 \text{ mm}^2}}$$

Nº 3.5.16

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0328 \cdot 50000}{600} = \underline{\underline{2,73 \Omega}}$$

Nº 3.5.17

$$A = \phi^2 \cdot 0,785 = 0,05^2 \cdot 0,785 = 0,0019 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{11200 \cdot 0,0019}{0,0175} = \underline{\underline{1257 \text{ m}}}$$

Nº 3.5.18

$$A = \phi^2 \cdot 0,785 = 0,8^2 \cdot 0,785 = 0,502 \text{ mm}^2$$

$$\text{Lacet : } R = \frac{\varphi \cdot l}{A} \cdot 2 = \frac{0,0175 \cdot 520 \cdot 2}{0,502} = \underline{\underline{36,25 \Omega}}$$

$$\text{Fil : } R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 520}{0,502} = \underline{\underline{18,125 \Omega}}$$

Nº 3.5.19

$$A = \phi^2 \cdot 0,785 = 0,03^2 \cdot 0,785 = 0,0007 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{6250 \cdot 0,0007}{0,707} = \underline{\underline{6,248 \text{ m}}}$$

Nº 3.5.20

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l} = \frac{0,1697 \cdot 1}{0,35} = \underline{\underline{0,4849 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

$$Y = \frac{1}{\varphi} = \frac{1}{0,484} = \underline{\underline{2,06 \frac{\text{s} \cdot \text{m}}{\text{mm}^2}}}$$

Nº 3.5.21

$$A = \phi^2 \cdot 0,785 = 0,65^2 \cdot 0,785 = 0,33 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l} = \frac{1,25 \cdot 0,33}{1} = \underline{\underline{0,4148 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

il s'agit de Nickelline !

Nº 3.5.22

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 140}{25} = \underline{\underline{0,098 \Omega}}$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow A = \frac{\varphi \cdot l}{R} = \frac{0,029 \cdot 140}{0,098} = \underline{\underline{41,40 \text{ mm}^2 \text{ soit } 50^4}}$$

Nº 3.5.23

$$A = \phi^2 \cdot 0,785 = 0,2^2 \cdot 0,785 = 0,0314 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 5}{0,0314} = \underline{2,786 \Omega}$$

$$R_c = \frac{R}{n} = \frac{2,786}{798} = \underline{3,492 \text{ m}\Omega}$$


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Nº 3.5.24

$$l = \phi \text{ moyen} \cdot \pi \cdot n = 0,085 \cdot 3,14 \cdot 2900 = 307,87 \text{ m}$$

$$A = \phi^2 \cdot 0,785 = 0,65^2 \cdot 0,785 = 0,3316 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 307,87}{0,3316} = \underline{16,24 \Omega}$$


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Nº 3.5.25

$$A = \phi^2 \cdot 0,785 = 0,6^2 \cdot 0,785 = 0,2826 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{340 \cdot 0,2826}{0,0175} = 5490,5 \text{ m}$$

$$l = \frac{l}{2} = \frac{5490,5}{2} = \underline{2745,25 \text{ m}}$$


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Nº 3.5.26

$$A = \phi^2 \cdot 0,785 \cdot n = 0,15^2 \cdot 0,785 \cdot 42 = 0,74 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l \cdot z}{A} = \frac{0,0175 \cdot 40 \cdot 2}{0,74} = \underline{1,88 \Omega}$$


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Nº 3.5.27

$$A = \phi^2 \cdot 0,785 = 0,22^2 \cdot 0,785 = 0,037 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\varphi} = \frac{32 \cdot 0,037}{0,0175} = \underline{69,47 \text{ m}}$$

$$l \text{ spire} = \phi \cdot \pi = 0,02 \cdot 3,14 = 0,0628 \text{ m}$$

$$n = \frac{l}{l \cdot \text{spire}} = \frac{69,47}{0,0628} = \underline{1106 \text{ spires}}$$


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Nº 3.6.1

$$\gamma = \frac{1}{R} = \frac{1}{11,2} = \underline{\underline{0,08929 \text{ S}}}$$

Nº 3.6.2

$$R = \frac{1}{\gamma} = \frac{1}{0,428} = \underline{\underline{2,336 \Omega}}$$

Nº 3.6.3

$$\gamma = \frac{1}{R} = \frac{1}{1,17} = \underline{\underline{0,8547 \text{ S}}}$$

Nº 3.6.4

$$R = \frac{1}{\gamma} = \frac{1}{2,33} = \underline{\underline{0,4291 \Omega}}$$

Nº 3.6.5

$$\gamma = \frac{1}{R} = \frac{1}{0,084} = \underline{\underline{11,904 \text{ S}}}$$

Nº 3.6.6

$$R = \frac{1}{\gamma} = \frac{1}{1680} = \underline{\underline{0,5952 \text{ m}\Omega}}$$

Nº 3.6.7

$$\gamma = \frac{1}{R} = \frac{1}{6800} = \underline{\underline{0,1471 \text{ mS}}}$$

Nº 3.6.8

$$R = \frac{1}{\gamma} = \frac{1}{4,35} = \underline{\underline{229,88 \Omega}}$$

Nº 3.6.9

$$\gamma = \frac{1}{R} = \frac{1}{16000} = \underline{\underline{0,0625 \text{ mS}}}$$

Nº 3.6.10

$$\gamma = \frac{1}{R} = \frac{1}{2,5} = \underline{\underline{400 \text{ S}}}$$

Nº 3.7.1

$$\begin{aligned}
 A &= \phi^2 \cdot 0,785 = 0,4^2 \cdot 0,785 = 0,1256 \text{ mm}^2 \\
 &\quad " \qquad \qquad \qquad = 0,6^2 \cdot 0,785 = 0,2826 \text{ mm}^2 \\
 &\quad " \qquad \qquad \qquad = 0,8^2 \cdot 0,785 = 0,5024 \text{ mm}^2 \\
 &\quad " \qquad \qquad \qquad = 1^2 \cdot 0,785 = 0,785 \text{ mm}^2 \\
 \sqrt{\frac{1''}{A}} &= \sqrt{\frac{1}{0,0175 \cdot 1000}} = \underline{\underline{7,16 \text{ mS}}} \\
 &\quad " \qquad \qquad \qquad = \sqrt{\frac{1}{0,0175 \cdot 1000}} = \underline{\underline{16,12 \text{ mS}}} \\
 &\quad " \qquad \qquad \qquad = \sqrt{\frac{1}{0,0175 \cdot 1000}} = \underline{\underline{28,65 \text{ mS}}} \\
 &\quad " \qquad \qquad \qquad = \sqrt{\frac{1}{0,0175 \cdot 1000}} = \underline{\underline{44,77 \text{ mS}}}
 \end{aligned}$$

Nº 3.7.2

$$R = \frac{1}{y} = \frac{1}{24,5} = 0,0408 \Omega$$

$$R = \frac{\Phi \cdot l}{A} = A = \frac{\Phi \cdot l \cdot 2}{R} = \frac{0,0175 \cdot 18,5 \cdot 2}{0,0408} = \underline{\underline{15,86 \text{ mm}^2}} \Rightarrow 16 \frac{1}{2}$$

Nº 3.7.3

$$R = \frac{\Phi \cdot l}{A} = \frac{0,033 \cdot 12200}{147} = 2,7387 \Omega$$

$$y = \frac{1}{R} = \frac{1}{2,7387} = \underline{\underline{0,3651 \text{ S}}}$$

Nº 3.7.4

$$R = \frac{1}{y} = \frac{1}{0,147} = 6,802 \Omega$$

$$A = \phi^2 \cdot 0,785 = 1^2 \cdot 0,785 = 0,785 \text{ mm}^2$$

$$R = \frac{\Phi \cdot l}{A} \Rightarrow l = \frac{R \cdot A}{\Phi} = \frac{6,802 \cdot 0,785}{0,43} = \underline{\underline{12,42 \text{ m}}}$$

N° 3.7.5

$$\varphi = \frac{1}{y} = \frac{1}{1.22} = 0,819 \frac{\Omega \cdot \text{mm}^2}{\text{m}}$$

$$A = \phi^2 \cdot 0,785 = 0,7^2 \cdot 0,785 = 0,384 \text{ mm}^2$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,81967 \cdot 22}{0,3848451} = 46,85 \Omega$$

$$y = \frac{1}{R} = \frac{1}{46,85} = \underline{\underline{21,34 \text{ mS}}}$$

N° 3.7.6

$$R = \frac{1}{y} = \frac{1}{3,4} = 0,294 \Omega$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l} = \frac{0,294 \cdot 2,5}{42} = \underline{\underline{0,0175 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

c'est du cuirre!

N° 3.7.7

$$R = \frac{1}{y} = \frac{1}{0,07143} = 13,99972 \Omega$$

$$R = \frac{\varphi \cdot l}{A} \Rightarrow \varphi = \frac{R \cdot A}{l \cdot 2} = \frac{13,99 \cdot 0,75}{21 \cdot 2} = \underline{\underline{0,25 \frac{\Omega \cdot \text{mm}^2}{\text{m}}}}$$

N° 3.7.8

$$\varphi \text{ de l'aluminium} = 0,029 \frac{\Omega \cdot \text{mm}^2}{\text{m}}$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,029 \cdot 85}{50} = 0,0493 \Omega$$

$$y_{\text{Alu}} = \frac{1}{R} = \frac{1}{0,0493} = \underline{\underline{20,28 \text{ S}}}$$

$$y_{\text{Cu}} = \frac{1}{R} = \frac{1}{0,02975} = 33,61 \text{ S}$$

$$\% = 100 - \frac{20,28 \cdot 100}{33,61} = \underline{\underline{41,66 \%}}$$

Nº 3.8.1

$$\Delta \theta = t_2 - t_1 = 85 - 20 = 65 \text{ } ^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta \theta) = 18 \cdot (1 + 0,004 \cdot 65) = \underline{\underline{22,68 \Omega}}$$

$$\Delta R = R_2 - R_1 = 22,68 - 18 = \underline{\underline{4,68 \Omega}}$$

Nº 3.8.2

$$\Delta \theta = t_2 - t_1 = 20 - 3 = 17 \text{ } ^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 - \alpha \cdot \Delta \theta) = 0,0184 \cdot (1 - 0,0004 \cdot 17) = \underline{\underline{0,01838 \Omega}}$$

Nº 3.8.3

$$\Delta \theta = t_2 - t_1 = 56 - 20 = 36 \text{ } ^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 - \alpha \cdot \Delta \theta) = 0,0061 \cdot (1 - 0,0018 \cdot 36) = \underline{\underline{0,005704 \Omega}}$$

Nº 3.8.4

$$\Delta \theta = t_2 - t_1 = 55 - 20 = 35 \text{ } ^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta \theta) \Rightarrow R_1 = \frac{R_2}{1 + \alpha \cdot \Delta \theta} = \frac{0,163}{1 + 0,004 \cdot 35} = \underline{\underline{0,14298 \Omega}}$$

Nº 3.8.5

$$\Delta \theta = t_2 - t_1 = 71 - 20 = 51 \text{ } ^\circ\text{C}$$

$$\Delta R = R_2 - R_1 = 3,063 - 2,317 = \underline{\underline{0,746 \Omega}}$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \alpha = \frac{\Delta R}{R_1 \cdot \Delta \theta} = \frac{0,746}{2,317 \cdot 51} = \underline{\underline{0,006313 \frac{\Omega}{\Omega \cdot ^\circ\text{C}}}}$$

Nº 3.8.6

$$\Delta R = R_2 - R_1 = 9,847 - 7,64 = 2,207 \text{ m}\Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \Delta \theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{2,207}{7,64 \cdot 0,004} = 72,21 \text{ } ^\circ\text{C}$$

$$\theta = \Delta \theta + 20 = 72,21 + 20 = \underline{\underline{92,21 \text{ } ^\circ\text{C}}}$$

Nº 3.8.7

$$\Delta\theta = t_2 - t_1 = 52 - 20 = 32^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta\theta) = 9,89 \cdot (1 + 0,004 \cdot 5) = 10,08 \Omega$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta\theta) = 10,08 \cdot (1 + 0,004 \cdot 32) = \underline{\underline{11,379 \Omega}}$$

Nº 3.8.8

$$\Delta\theta = t_2 - t_1 = 20 - -18 = 38^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 - \alpha \cdot \Delta\theta) = 0,442 \cdot (1 - 0,004 \cdot 38) = \underline{\underline{0,3748 \text{ m}\Omega}}$$

Nº 3.8.9

$$\Delta\theta = t_2 - t_1 = 20 - -10 = 30^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 - \alpha \cdot \Delta\theta) \Rightarrow R_1 = \frac{R_2}{1 - \alpha \cdot \Delta\theta} = \frac{0,23}{1 - 0,004 \cdot 30} = \underline{\underline{0,2613 \Omega}}$$

Nº 3.8.10

$$\Delta R = R_2 - R_1 = 48,4 - 40,2 = 8,2 \Omega$$

$$\Delta\theta = t_2 - t_1 = 950 - 20 = 930^\circ\text{C}$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta\theta \Rightarrow \alpha = \frac{\Delta R}{R_1 \cdot \Delta\theta} = \frac{8,2}{40,2 \cdot 930} = 0,0002193 \frac{\Omega}{\Omega \cdot ^\circ\text{C}}$$

Nº 3.8.11

$$\Delta R = R_2 - R_1 = 20,6 - 17 = 3,6 \Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta\theta \Rightarrow \Delta\theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{3,6}{17 \cdot 0,004} = 52,94^\circ\text{C}$$

$$\theta = \Delta\theta + 20 = 52,94 + 20 = \underline{\underline{72,94^\circ\text{C}}}$$

Nº 3.8.12

$$\Delta\theta = t_2 - t_1 = 1100 - 20 = 1080^\circ\text{C}$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta\theta) \Rightarrow R_1 = \frac{R_2}{1 + \alpha \cdot \Delta\theta} = \frac{48}{1 + 0,00022 \cdot 1080} = \underline{\underline{38,78 \Omega}}$$

Nº 3.8.13

$$R_1 = 100 \Omega \quad , \quad R_2 = 110 \Omega$$

$$\Delta R = R_2 - R_1 = 110 - 100 = 10 \Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \Delta \theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{10}{100 \cdot 0,004} = \underline{\underline{25^\circ C}}$$

Nº 3.8.14

$$\Delta \theta = t_2 - t_1 = 70 - 20 = 50^\circ C$$

$$R_2 = R_1 \cdot (1 + \alpha \cdot \Delta \theta) \Rightarrow R_1 = \frac{R_2}{1 + \alpha \cdot \Delta \theta} = \frac{12,6}{1 + 0,004 \cdot 50} = \underline{\underline{10,5 \Omega}}$$

Nº 3.8.15

$$\Delta R = R_2 - R_1 = 0,02 - 0,0175 = 0,0025 \Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \Delta \theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{0,0025}{0,0175 \cdot 0,004} = 35,71^\circ C$$

$$\theta = \Delta \theta + 20 = 35,71 + 20 = \underline{\underline{55,71^\circ C}}$$

Nº 3.8.16

$$\Delta \theta' = t_2 - t_1 = 55 - 20 = 35^\circ C$$

$$\Delta \theta'' = t_2 - t_1 = 20 - (-10) = 30^\circ C$$

$$R = \frac{Q \cdot l}{A} = \frac{0,033 \cdot 1200}{300} = 1,32 \Omega$$

$$R_2 \text{ at } (55^\circ C) = R_1 \cdot (1 + \alpha \cdot \Delta \theta) = 1,32 \cdot (1 + 0,004 \cdot 35) = 1,5048 \Omega$$

$$R_2 \text{ at } (-10^\circ C) = R_1 \cdot (1 - \alpha \cdot \Delta \theta) = 1,32 \cdot (1 - 0,004 \cdot 30) = 1,144 \Omega$$

a)  $\Delta R = R - R = 1,5048 - 1,144 = \underline{\underline{0,3608 \Omega}}$

b)  $\% = 100 - \left( \frac{1,144 \cdot 100}{1,5048} \right) = \underline{\underline{14\%}}$

c)  $\% = 100 - \left( \frac{1,32 \cdot 100}{1,5048} \right) = \underline{\underline{12\%}}$

Nº 3.8.17

$$R = \frac{U}{I} = \frac{230}{0,43} = 534,88 \Omega$$

$$\Delta R = R_2 - R_1 = 534,88 - 42 = 492,88 \Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \Delta \theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{492,88}{42 \cdot 0,00506} = \underline{\underline{2321^\circ C}}$$

Nº 3.8.18

$$\Delta R = R_2 - R_1 = 95 - 57,3 = 37,7 \Omega$$

$$\Delta \theta = t_2 - t_1 = 160 - 20 = 140^\circ\text{C}$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \alpha = \frac{\Delta R}{R_1 \cdot \Delta \theta} = \frac{37,7}{57,3 \cdot 140} = \underline{\underline{0,0047 \frac{\Omega}{\Omega \cdot ^\circ\text{C}}}}$$

c'est du Fer

Nº 3.8.19

$$R_1 = \frac{U}{I} = \frac{220}{0,2} = 1100 \Omega$$

$$R_2 = \frac{U}{I} = \frac{220}{0,15} = 1466,6 \Omega$$

$$\Delta R = R_2 - R_1 = 1466,6 - 1100 = 366,6 \Omega$$

$$\Delta R = R_1 \cdot \alpha \cdot \Delta \theta \Rightarrow \Delta \theta = \frac{\Delta R}{R_1 \cdot \alpha} = \frac{366,6}{1100 \cdot 0,004} = 83,33^\circ\text{C}$$

$$\theta - \Delta \theta + 20 = 83,33 + 20 = \underline{\underline{103,33^\circ\text{C}}}$$

Nº 3.9.20

$$\Delta \theta = t_2 - t_1 = 350 - 20 = 330^\circ\text{C}$$

a)  $R_2 = R_1 \cdot (1 + \alpha \cdot \Delta \theta) = 50 \cdot (1 + 0,00001 \cdot 330) = \underline{\underline{50,165 \Omega}}$

b)  $R_2 = R_1 \cdot (1 + \alpha \cdot \Delta \theta) = 50 \cdot (1 + 0,00506 \cdot 330) = \underline{\underline{133,49 \Omega}}$

c) 1)  $\% = 100 - \left( \frac{50,165 \cdot 100}{50} \right) = \underline{\underline{0,33 \%}}$

2)  $\% = 100 - \left( \frac{133,49 \cdot 100}{50} \right) = \underline{\underline{166,98 \%}}$

Nº 3.9.1.1

$$R = R \cdot n = 242 \cdot 5 = \underline{\underline{1210 \Omega}}$$

Nº 3.9.1.2

$$R = \frac{R_e}{n} = \frac{13,26}{6} = \underline{\underline{2,21 \Omega}}$$

Nº 3.9.1.3

$$n = \frac{Rt}{R} = \frac{145,6}{11,2} = \underline{\underline{13 \text{ pièces}}}$$

Nº 3.9.1.4

$$R = \frac{Rt}{n} = \frac{3260}{15} = \underline{\underline{217,33' \Omega}}$$

Nº 3.9.1.5

$$Rt = R_1 + R_2 + R_3 + R_4 + R_5 = 16 + 2 + 7 + 8 + 20,3 = \underline{\underline{53,3 \Omega}}$$

Nº 3.9.1.6

$$R_1 = Rt - (R_2 + R_3 + R_4) = 41,7 - (11,2 + 16,3 + 4,9) = \underline{\underline{9,3 \Omega}}$$

Nº 3.9.1.7

$$Rt = R_1 + R_2 = 4800 + 78 = \underline{\underline{4878 k\Omega}}$$

Nº 3.9.1.8

$$R = \frac{Rt - R}{2} = \frac{47,1 - 46,3}{2} = \underline{\underline{0,4 \Omega}}$$

Nº 3.9.1.9

$$UR = R \cdot I = 200 \cdot 1,3 = 260 V$$

$$U_{lpe} = U - UR = 390 - 260 = \underline{\underline{120 V}}$$

Nº 3.9.1.10

$$UR = R \cdot I = 5,55 \cdot 5,4 = 29,97 V$$

$$U_{lpe} = U - UR = 225 - 29,97 = \underline{\underline{195,03 V}}$$

Nº 3.9.1.11

$$I_{\max.} = \frac{U}{R} = \frac{220}{268} = 0,82 \text{ A}$$

$$\text{a)} R_{\text{add}} = \frac{U - UR}{I_{\max.}} = \frac{250 - 220}{0,82} = \underline{\underline{36,54 \Omega}}$$

$$\text{b)} R_t = R + R_{\text{add.}} = 268 + 36,54 = \underline{\underline{304,54 \Omega}}$$

$$\text{c)} I = \frac{U}{R_t} = \frac{250}{304,54} = \underline{\underline{0,82 \text{ A}}}$$


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Nº 3.9.1.12

Pour  $0 \Omega \rightarrow U = 220 \text{ V}$

$$\text{Pour } 20 \Omega : I = \frac{U}{R_t} = \frac{220}{40} = 2,75 \text{ A}$$

$$U = R \cdot I = 60 \cdot 2,75 = \underline{\underline{165 \text{ V}}}$$

$$\text{Pour } 40 \Omega : I = \frac{U}{R_t} = \frac{220}{100} = 2,2 \text{ A}$$

$$U = R \cdot I = 60 \cdot 2,2 = \underline{\underline{132 \text{ V}}}$$

$$\text{Pour } 60 \Omega : I = \frac{U}{R_t} = \frac{220}{120} = 1,83 \text{ A}$$

$$U = R \cdot I = 60 \cdot 1,83 = \underline{\underline{110 \text{ V}}}$$

$$\text{Pour } 80 \Omega : I = \frac{U}{R_t} = \frac{220}{140} = 1,57 \text{ A}$$

$$U = R \cdot I = 60 \cdot 1,57 = \underline{\underline{94,28 \text{ V}}}$$

$$\text{Pour } 100 \Omega : I = \frac{U}{R_t} = \frac{220}{160} = 1,375 \text{ A}$$

$$U = R \cdot I = 60 \cdot 1,375 = \underline{\underline{82,5 \text{ V}}}$$


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Nº 3.9.1.13

$$\text{a)} U_1 = R \cdot I = 4200 \cdot 0,018 = \underline{\underline{75,6 \text{ V}}}$$

$$\text{b)} U_3 = R \cdot I = 1360 \cdot 0,018 = \underline{\underline{24,48 \text{ V}}}$$

$$\text{c)} U = U_1 + U_2 + U_3 = 75,6 + 24 + 24,48 = \underline{\underline{124,08 \text{ V}}}$$

$$\text{d)} I_1 = I = \underline{\underline{18 \text{ mA}}}$$

$$\text{e)} I_1 = I = \underline{\underline{18 \text{ mA}}}$$


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Nº 3.9.1.14

a)  $R_t = R_1 + R_2 + R_3 + R_4 = 81 + 49 + 20 + 100 = 250 \Omega$

c)  $I = \frac{U}{R} = \frac{220}{250} = 0,88 A$

b)  $U_1 = R_1 \cdot I = 81 \cdot 0,88 = \underline{\underline{71,28 V}}$

$U_2 = R_2 \cdot I = 49 \cdot 0,88 = \underline{\underline{43,12 V}}$

$U_3 = R_3 \cdot I = 20 \cdot 0,88 = \underline{\underline{17,6 V}}$

$U_4 = R_4 \cdot I = 100 \cdot 0,88 = \underline{\underline{88 V}}$

Nº 3.9.1.15

$R_t = R_1 + R_2 + R_3 = 60 + 120 + 180 = 360 \Omega$

a)  $U_t = R_t \cdot I = 360 \cdot 0,025 = \underline{\underline{9 V}}$

b)  $U_1 = R_1 \cdot I = 60 \cdot 0,025 = \underline{\underline{1,5 V}}$

$U_2 = R_2 \cdot I = 120 \cdot 0,025 = \underline{\underline{3 V}}$

$U_3 = R_3 \cdot I = 180 \cdot 0,025 = \underline{\underline{4,5 V}}$

c)  $60, 120, 180, \Rightarrow \underline{\underline{1.2.3}}$

d)  $1,5, 3, 4,5, \Rightarrow \underline{\underline{1.2.3}}$

e)  $U_{\text{chute}} \text{ est proportionnel à } R!$ Nº 3.9.1.16

$R' = R_1 + R_2 + R_4 + R_5 = 1200 + 700 + 3200 + 4200 = 20,1 k\Omega$

$U_{\text{ch.}} = U_t - U_3 = 110 - 20,4 = 89,6 V$

$I = \frac{U_{\text{ch.}}}{R'} = \frac{89,6}{20,1} = 4,457 \text{ mA}$

$R_3 = \frac{U}{I} = \frac{20,4}{4,457} = \underline{\underline{4,577 k\Omega}}$

Nº 3.9.1.17

b)  $R_t = R_1 + R_2 + R_3 = 240 + 120 + 350 = \underline{\underline{710 \Omega}}$

c)  $I = \frac{U}{R} = \frac{224}{710} = \underline{\underline{0,315 A}}$

%

N° 3.9.1.17 suite

$$a) U_1 = R_1 \cdot I = 240 \cdot 0,315 = \underline{\underline{75,718 V}}$$

$$U_2 = R_2 \cdot I = 120 \cdot 0,315 = \underline{\underline{37,859 V}}$$

$$U_3 = R_3 \cdot I = 350 \cdot 0,315 = \underline{\underline{110,422 V}}$$

$$d) R_e = R_1 + R_3 = 240 + 350 = 590 \Omega$$

$$I = \frac{U}{R} = \frac{224}{590} = 0,379 A$$

$$U_1 = R_1 \cdot I = 240 \cdot 0,379 = \underline{\underline{91,118 V}}$$

$$U_2 = R_2 \cdot I = 120 \cdot 0,379 = \underline{\underline{45,588 V}}$$

$$e) U_t = U = \underline{\underline{224 V}}$$

N° 3.9.1.18

$$R_t = \frac{U}{I} = \frac{120}{3,2} = 37,5 \Omega$$

$$R = \frac{R_t}{n} = \frac{37,5}{4} = \underline{\underline{9,375 \Omega}}$$

N° 3.9.1.19

$$R_{four} = \frac{U}{I} = \frac{220}{6,75} = 32,592 \Omega$$

$$R_l = \frac{P \cdot l \cdot 2}{A} = \frac{0,0175 \cdot 57 \cdot 2}{1,5} = 1,33 \Omega$$

$$R_t = R_{four} + R_l = 32,592 + 1,33 = 33,922 \Omega$$

$$I = \frac{U}{R_t} = \frac{224}{33,922} = 6,603 A$$

$$U_{four} = R_{four} \cdot I = 32,592 \cdot 6,603 = \underline{\underline{215,21 V}}$$

Nº 3.9.2.1

$$R_e = \frac{R}{n} = \frac{80,6}{2} = \underline{\underline{40,3 \Omega}}$$

Nº 3.9.2.2

$$R_e = \frac{R}{n} \Rightarrow R = R_e \cdot n = 58,2 \cdot 2 = 116,4 \Omega$$

Nº 3.9.2.3

$$R_e = \frac{R}{n} = \frac{242}{2} = \underline{\underline{121 \Omega}}$$

$$\text{"} \quad \frac{242}{3} = \underline{\underline{80,6 \Omega}}$$

$$\text{"} \quad \frac{242}{4} = \underline{\underline{60,5 \Omega}}$$

$$\text{"} \quad \frac{242}{5} = \underline{\underline{48,4 \Omega}}$$

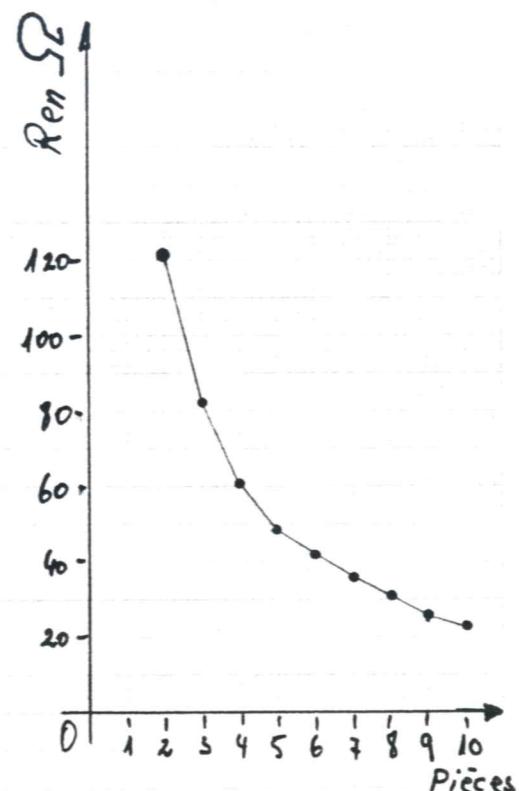
$$\text{"} \quad \frac{242}{6} = \underline{\underline{40,33 \Omega}}$$

$$\text{"} \quad \frac{242}{7} = \underline{\underline{34,57 \Omega}}$$

$$\text{"} \quad \frac{242}{8} = \underline{\underline{30,25 \Omega}}$$

$$\text{"} \quad \frac{242}{9} = \underline{\underline{26,8 \Omega}}$$

$$\text{"} \quad \frac{242}{10} = \underline{\underline{24,2 \Omega}}$$



Nº 3.9.2.4

$$R_e = \frac{R}{n} \Rightarrow R = R_e \cdot n = 27,4 \cdot 7 = \underline{\underline{191,8 \Omega}}$$

Nº 3.9.2.5

$$R_e = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{21,7} + \frac{1}{200}} = \underline{\underline{19,57 \Omega}}$$

Nº 3.9.2.6

$$R_e = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

### Nº 3.9.2.6 Suite

$$\Rightarrow R_e \cdot R_1 + R_2 = R_1 \cdot R_e$$

$$\Rightarrow R_e \cdot R_1 + R_e \cdot R_2 = R_1 \cdot R_2$$

$$\Rightarrow R_e \cdot R_1 = R_1 \cdot R_2 - R_e \cdot R_2$$

$$\Rightarrow R_e \cdot R_1 = R_2 \cdot R_1 - R_e \cdot R_2$$

$$\Rightarrow R_2 = \frac{R_e \cdot R_1}{R_1 - R_e} = \frac{22 \cdot 18}{22 - 18} = \underline{\underline{99 \Omega}}$$

### Nº 3.9.2.7

$$R_e = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{4,2} + \frac{1}{12,4} + \frac{1}{0,24} + \frac{1}{12,4} = \underline{\underline{219 \Omega}}$$

### Nº 3.9.2.7

$$R_e = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{4,2} + \frac{1}{12,4} + \frac{1}{0,24} + \frac{1}{12,4} = \underline{\underline{219 \Omega}}$$

### Nº 3.9.2.8

$$R_e' = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{42,1 \cdot 320}{421 + 320} = 181,8 \Omega$$

$$R_x = (\text{idem 3.9.2.6}) \Rightarrow R_x = \frac{R_e \cdot R_e'}{R_e' - R_e} = \frac{62 \cdot 181,8}{181,8 - 62} = \underline{\underline{94,09 \Omega}}$$

### Nº 3.9.2.9

a)  $R_e = \frac{R}{n} = \frac{40,2}{2} = \underline{\underline{20,1 \Omega}}$

b)  $R = R_e = \underline{\underline{40,2}}$

c)  $I = \frac{U}{R} = \frac{220}{20,1} = \underline{\underline{10,94 A}}$

d)  $I = \frac{U}{R} = \frac{220}{40,2} = \underline{\underline{5,47 A}}$

N° 3.9.2.10

$$a) R_e = \frac{R}{n} = \frac{1210}{24} = \underline{\underline{50,41 \Omega}}$$

$$b) I = \frac{P}{U} = \frac{40}{220} = \underline{\underline{0,1818 A}}$$

$$c) I = \frac{P \cdot n}{U} = \frac{40 \cdot 24}{220} = \underline{\underline{4,36 A}}$$


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N° 3.9.2.11

$$a) I = \frac{P}{U} = \frac{100}{220} = \underline{\underline{0,454 A}}$$

$$b) R = \frac{U^2}{P} = \frac{220^2}{100} = \underline{\underline{484 \Omega}}$$


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N° 3.9.2.12

$$a) R_e = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{1,24} + \frac{1}{1,86} = \underline{\underline{0,744 m\Omega}}$$

$$c) U = R \cdot I = 0,744 \cdot 1,05 = \underline{\underline{0,7812 V}}$$

$$b) I_1 = \frac{U}{R_1} = \frac{0,781}{1,24} = \underline{\underline{630 A}}$$

$$I_2 = \frac{U}{R_2} = \frac{0,781}{1,86} = \underline{\underline{420 A}}$$

d) 1,5 fois plus soit  $\underline{\underline{2 \div 3}}$

e) 1,5 fois moins soit  $\underline{\underline{3 \div 2}}$

f) I inversement proportionnel à R

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N° 3.9.2.13

$$I_1 = \frac{U}{R} = \frac{36}{36} = \underline{\underline{1 A}}$$

$$I_2 = I_{\text{tot}} - I_1 = 1,6 - 1 = \underline{\underline{0,6 A}}$$

$$R_2 = \frac{U}{I_2} = \frac{36}{0,6} = \underline{\underline{60 \Omega}}$$


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Nº 3.9.2.14

$$R_e = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}} = \frac{1}{\frac{1}{40} + \frac{1}{2} + \frac{1}{12} + \frac{1}{50} + \frac{1}{8}} = 1,327 \text{ m}\Omega$$

$$U = R \cdot I = 1,327 \cdot 0,904 = \underline{\underline{1,2 \text{ mV}}}$$

$$I_1 = \frac{U}{R_1} = \frac{1,2}{40} = \underline{\underline{30 \text{ mA}}}$$

$$I_2 = \frac{U}{R_2} = \frac{1,2}{2} = \underline{\underline{600 \text{ mA}}}$$

$$I_3 = \frac{U}{R_3} = \frac{1,2}{12} = \underline{\underline{100 \text{ mA}}}$$

$$I_4 = \frac{U}{R_4} = \frac{1,2}{50} = \underline{\underline{24 \text{ mA}}}$$

$$I_5 = \frac{U}{R_5} = \frac{1,2}{8} = \underline{\underline{150 \text{ mA}}}$$

Nº 3.9.2.15

$$\text{a) } R_e = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{1210} + \frac{1}{806} + \frac{1}{484} = \underline{\underline{241,94 \Omega}}$$

$$\text{b) } I = \frac{U}{R_e} = \frac{220}{241,94} = \underline{\underline{0,909 \text{ A}}}$$

$$\text{c) } I_1 = \frac{U}{R_1} = \frac{220}{1210} = \underline{\underline{0,1818 \text{ A}}}$$

$$I_2 = \frac{U_2}{R_2} = \frac{220}{806} = \underline{\underline{0,2729 \text{ A}}}$$

$$I_3 = \frac{U}{R_3} = \frac{220}{484} = \underline{\underline{0,4545 \text{ A}}}$$

Nº 3.9.2.16

$$I_1 = \frac{U}{R_1} = \frac{48}{670} = 71,64 \text{ mA}$$

$$I_2 = \frac{U}{R_2} = \frac{48}{400} = 120 \text{ mA}$$

$$I_3 = I_e - (I_1 + I_2) = 282 - (71,64 - 120) = 40,36 \text{ mA}$$

N° 3.9.2.16 Suite

$$R_3 = \frac{U}{I_3} = \frac{48}{40,36} = \underline{\underline{1189 \Omega}}$$

$$R_e = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{670} + \frac{1}{400} + \frac{1}{1189} = \underline{\underline{206,88 \Omega}}$$

N° 3.9.2.17

Position	$R$ en $\Omega$	$I = \frac{U}{R}$ en A
1	760	0,5
2	580	0,655
3	530	0,716
4	350	1,085
5	230	1,652
6	188,8	2,737
7	118,8	3,197
8	78,3	4,849

Nº 3.9.3.1

$$R_t = R_1 + R_2 + R_3 = 120 + 120 + 120 = \underline{\underline{360 \Omega}}$$



$$R_e = \frac{R}{n} = \frac{120}{3} = \underline{\underline{40 \Omega}}$$



$$R_t = R \cdot n = 120 \cdot 2 = 240 \Omega$$

$$R_e = \frac{R_t \cdot R_3}{R_t + R_3} = \frac{240 \cdot 120}{240 + 120} = \underline{\underline{80 \Omega}}$$



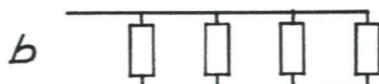
$$R_e = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{120 \cdot 120}{120 + 120} = \underline{\underline{60 \Omega}}$$

$$R_t = R_e + R_3 = 60 + 120 = \underline{\underline{180 \Omega}}$$


---

Nº 3.9.3.2

$$R_t = R \cdot n = 200 \cdot 4 = \underline{\underline{800 \Omega}}$$



$$R_e = \frac{R}{n} = \frac{200}{4} = \underline{\underline{50 \Omega}}$$

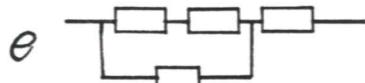


$$R_p = \frac{R_{t1} \cdot R_{t2}}{R_{t1} + R_{t2}} = \frac{400 \cdot 400}{400 + 400} = \underline{\underline{200 \Omega}}$$



$$R_t = R \cdot n = 200 \cdot 3 = 600 \Omega$$

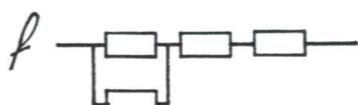
$$R_e = \frac{R_t \cdot R_4}{R_t + R_4} = \frac{600 \cdot 200}{600 + 200} = \underline{\underline{150 \Omega}}$$



$$R_t = R_1 + R_2 = 200 + 200 = 400 \Omega$$

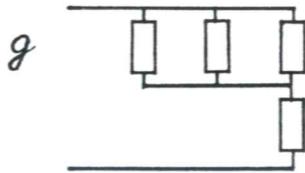
$$R_e = \frac{R_t \cdot R_3}{R_t + R_3} = \frac{400 \cdot 200}{400 + 200} = 133,3' \Omega$$

$$R_t = R_e + R_4 = 133,3' + 200 = \underline{\underline{333,3' \Omega}}$$



$$R_e = \frac{R}{n} = \frac{200}{2} = 100 \Omega$$

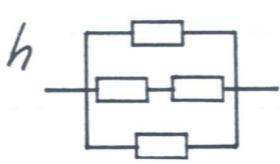
$$R_t = R_e + R_3 + R_4 = 100 + 200 + 200 = \underline{\underline{500 \Omega}}$$



$$R_e = \frac{R}{n} = \frac{200}{3} = 66,6' \Omega$$

$$R_t = R_e + R_4 = 66,6' + 200 = \underline{\underline{266,6 \Omega}}$$

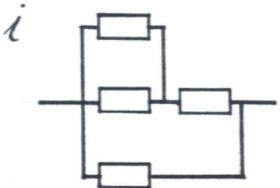
### Nº 3.9.3.2 Suite



$$R_t = R \cdot n = 200 \cdot 2 = 400 \Omega$$

$$R_e' = \frac{R}{n} = \frac{200}{2} = 100 \Omega$$

$$R_e = \frac{1}{\frac{1}{R_e'} + \frac{1}{R_t}} = \frac{1}{\frac{1}{400} + \frac{1}{100}} = \underline{\underline{80 \Omega}}$$



$$R_e' = \frac{R}{n} = \frac{200}{2} = 100 \Omega$$

$$R_t = R_e' + R_3 = 100 + 200 = 300 \Omega$$

$$R_e = \frac{R_t \cdot R_4}{R_t + R_4} = \frac{300 \cdot 200}{300 + 200} = \underline{\underline{120 \Omega}}$$

### Nº 3.9.3.3

a:  $R_{t1} = R_1 + R_2 = 20 + 30 = 50 \Omega$

$$R_{t2} = R_3 + R_4 = 40 + 50 = 90 \Omega$$

$$R_e = \frac{R_{t1} \cdot R_{t2}}{R_{t1} + R_{t2}} = \frac{50 \cdot 90}{50 + 90} = \underline{\underline{32,14 \Omega}}$$

b:  $R_t = R_1 + R_2 + R_3 = 20 + 30 + 40 = 90 \Omega$

$$R_e = \frac{R_t \cdot R_4}{R_t + R_4} = \frac{90 \cdot 50}{90 + 50} = \underline{\underline{32,14 \Omega}}$$

c:  $R_e' = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{20 \cdot 30}{20 + 30} = 12 \Omega$

$$R_t = R_e' + R_3 + R_4 = 12 + 40 + 50 = \underline{\underline{102 \Omega}}$$

d:  $R_{t'} = R_1 + R_2 = 20 + 30 = 50 \Omega$

$$R_e = \frac{1}{\frac{1}{R_{t'}} + \frac{1}{R_3} + \frac{1}{R_4}} = \frac{1}{\frac{1}{50} + \frac{1}{40} + \frac{1}{50}} = \underline{\underline{15,38 \Omega}}$$

e:  $R_e' = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{20 \cdot 40}{20 + 40} = 13,33 \Omega$

$$R_t = R_e' + R_3 = 13,33 + 30 = 43,33 \Omega$$

$$R_e = \frac{R_t \cdot R_4}{R_t + R_4} = \frac{43,33 \cdot 50}{43,33 + 50} = \underline{\underline{23,21 \Omega}}$$

Nº 3.9.3.4

$$R_e' = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{580 \cdot 120}{580 + 120} = 99,42 \Omega$$

$$R_t = R_e' + R_3 = 99,42 + 33 = \underline{\underline{132,42 \Omega}}$$


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Nº 3.9.3.5

$$R_e' = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{18} + \frac{1}{60} = 13,84 \Omega$$

$$R_t = R_e' + R_3 + R_4 + R_5 = 13,84 + 7,5 + 1,4 + 32 = \underline{\underline{54,746 \Omega}}$$


---

Nº 3.9.3.6

$$R_e = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{24} + \frac{1}{20} = 10,909 \Omega$$

$$I_1 = \frac{U}{R} = \frac{38}{24} = 1,675 A$$

$$I_2 = \frac{U}{R} = \frac{38}{20} = 1,9 A$$

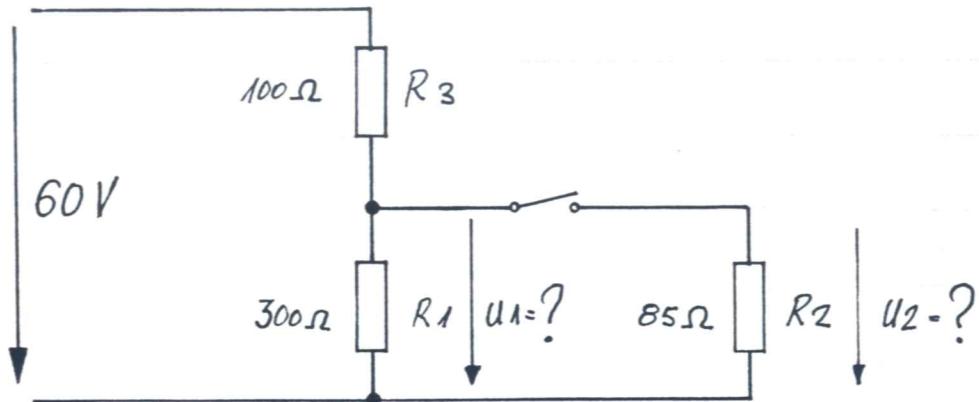
$$I_t = I_1 + I_2 = 1,675 + 1,9 = 3,575 A$$

$$U_3 = R_3 \cdot I_t = 6 \cdot 3,575 = 21,45 V$$

$$U_t = U_3 + U_1 = 21,45 + 38 = \underline{\underline{59,45 V}}$$


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### 3.9.3 N° 7



a)  $\circ \circ$   $R = R_1 + R_3 = 100 + 300 = 400 \Omega$

$$I = \frac{U}{R} = \frac{60}{400} = 0,15 \text{ A}$$

$$U_1 = R_1 \cdot I = 300 \cdot 0,15 = \underline{\underline{45 \text{ V}}}$$

$$U_2 = \underline{\underline{0 \text{ V}}} \text{ "pas de circuit"}$$

b)  $\circ \circ$   $R_E = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{300 \cdot 85}{300 + 85} = 66,23 \Omega$

$$R = R_E + R_1 = 66,23 + 100 = 166,23 \Omega$$

$$I = \frac{U}{R} = \frac{60}{166,23} = 0,36 \text{ A} \quad \text{--- OK ---}$$

$$U_3 = R_3 \cdot I = 100 \cdot 0,36 = 36 \text{ V}$$

$$U_1 = U_2 = U - U_3 = 60 - 36 = \underline{\underline{24 \text{ V}}}$$

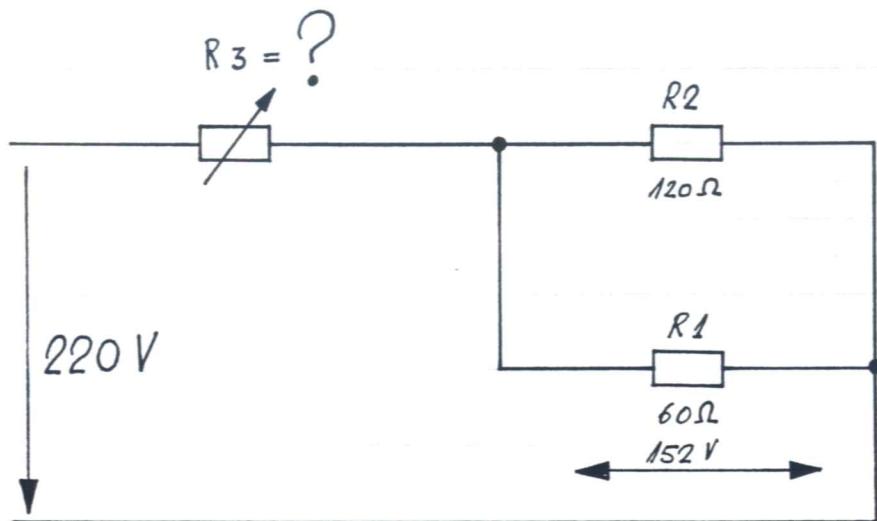
$$I_1 = \frac{U_1}{R_1} = \frac{24}{300} = 0,08 \text{ A}$$

Preuve:

$$I_2 = \frac{U_2}{R_2} = \frac{24}{85} = 0,282$$

$$I_t = I_1 + I_2 = 0,08 + 0,282 = 0,36 \text{ A} \quad \text{---}$$

3.9.3 № 8



$$I_1 = \frac{U_1}{R_1} = \frac{152}{60} = 2,53 \text{ A}$$

$$I_2 = \frac{U_2}{R_2} = \frac{152}{120} = 1,26 \text{ A}$$

$$I_t = I_1 + I_2 = 2,53 + 1,26 = 3,79 \text{ A} \quad \xrightarrow{\text{OK}}$$

$$U_3 = U - U_1 = 220 - 152 = 68 \text{ V}$$

$$R_3 = \frac{U_3}{I} = \frac{68}{3,79} = \underline{\underline{17,94 \Omega}}$$

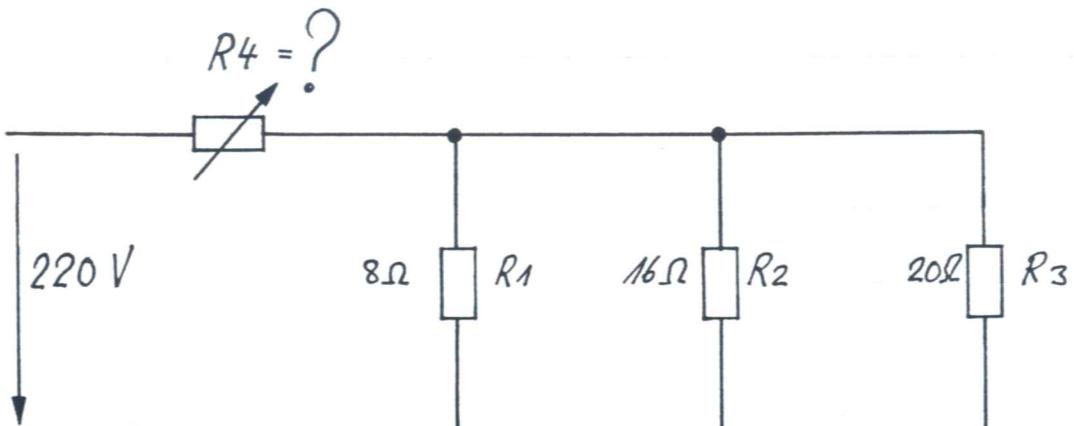
PREUVE:

$$R_e = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{60 \cdot 120}{60 + 120} = 40 \Omega$$

$$R_t = R_e + R_3 = 40 + 17,94 = 57,94 \Omega$$

$$I = \frac{U}{R} = \frac{220}{57,94} = \underline{\underline{3,79 \text{ A}}}$$

3. 9. 3 № 9



$$R_e = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\frac{1}{8} + \frac{1}{16} + \frac{1}{20}} = 4,21 \Omega$$

$$R_t = \frac{U}{I} = \frac{220}{6,2} = 35,48 \Omega$$

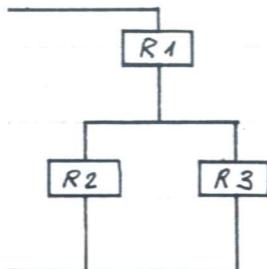
$$R_4 = R_t - R_e = 35,48 - 4,21 = \underline{\underline{31,27 \Omega}}$$

PREUVE:

$$U_1 = R_e \cdot I = 4,21 \cdot 6,2 = 26,1 V$$

$$U_4 = U - U_1 = 220 - 26,1 = 193,9 V$$

$$I = \frac{U_4}{R_4} = \frac{193,9}{31,27} = 6,2 A$$

Nº 3.9.3. 10

$$R_{e'} = \frac{R_2 \cdot R_3}{R_2 + R_3} = \frac{3600 \cdot 1000}{3600 + 1000} = 782,6 \Omega$$

$$a) R_t = R_{e'} + R_1 = 782 + 17,4 = \underline{\underline{800 \Omega}}$$

$$b) I_1 = I_t = \frac{U}{R_t} = \frac{36}{800} = \underline{\underline{45 mA}}$$

$$e) U_{ch} = R_1 \cdot I = 17,4 \cdot 0,045 = \underline{\underline{0,783 V}}$$

$$c) U_2 = U_3 = U - U_{ch} = 36 - 0,783 = \underline{\underline{35,217 V}}$$

$$d) I_3 = \frac{U_3}{R_3} = \frac{35,217}{3,6} = \underline{\underline{9,78 mA}}$$

$$c) I_2 = \frac{U_2}{R_2} = \frac{35,217}{1} = \underline{\underline{35,217 mA}}$$

Nº 3.9.3. 11

$$a) R_e = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{10 \cdot 420}{10 + 420} \cdot 2 = \underline{\underline{19,53 \Omega}}$$

$$b) U = \frac{U}{2} = \frac{226}{2} = \underline{\underline{118 V}}$$

$$c) R_e = \frac{R_1 \cdot R_2 + R_3}{R_1 + R_2} = \frac{10 \cdot 420}{10 + 420} + 420 = \underline{\underline{429,76 \Omega}}$$

$$d) I = \frac{U}{R} = \frac{226}{429,76} = \underline{\underline{525 mA}}$$

$$U_{R_3} = R_3 \cdot I = 420 \cdot 0,525 = \underline{\underline{220,86 V}}$$

$$U_{R_2} = U - U_{R_3} = 226 - 220,86 = \underline{\underline{5,14 V}}$$

Nº 3.9.3. 12

$$R_1 \cdot R_3 = R_2 \cdot R_4$$

$$R_1 = \frac{R_2 \cdot R_4}{R_3} = \frac{1,8 \cdot 630}{3,2} = \underline{\underline{354,37 \Omega}}$$

N° 3.9.3.13

$$U_R = R \cdot I = 1 \cdot 12 = 12 V$$

$$U_2 = U_{R1} = U_t - U_R = 72 - 12 = 60 V$$

$$I_{R1} = I_t - I_2 = 12 - 8 = 4 mA$$

$$R_1 = \frac{U}{I} = \frac{60}{4} = \underline{\underline{15 k\Omega}}$$

---

Nº 3. 10. 1

$$18 \text{ min} = 18 \cdot 60 = 1080 \text{ s}$$

$$Q = I \cdot t = 25 \cdot 1080 = \underline{\underline{27000 \text{ As}}}$$

$$Q = \frac{A_s}{3600} = \frac{27000}{3600} = \underline{\underline{7,5 \text{ Ah}}}$$


---

Nº 3. 10. 2)

$$34 \text{ min} = 34 \cdot 60 = 1860 \text{ s}$$

$$2,2 \text{ Ah} = 2,2 \cdot 3600 = 7920 \text{ As}$$

$$Q = I \cdot t \Rightarrow I = \frac{Q}{t} = \frac{7920}{1860} = \underline{\underline{4,258 \text{ A}}}$$


---

Nº 3. 10. 3

$$150 \text{ Ah} = 150 \cdot 3600 = 540000 \text{ As}$$

$$Q = I \cdot t \Rightarrow t = \frac{Q}{I} = \frac{540000}{180} = 3000 \text{ s}$$

$$t \text{ min} = \frac{S}{60} = \frac{3000}{60} = \underline{\underline{50 \text{ min}}}$$


---

Nº 3. 10. 4

$$45 \text{ kA} = 0,045 \text{ MA}$$

$$Q = I \cdot t = 0,045 \cdot 24 = \underline{\underline{1,08 \text{ MAh}}}$$


---

Nº 3. 10. 5

$$11,62 \text{ Ah} = 11,62 \cdot 3600 = 41832 \text{ As}$$

$$10 \text{ min} = 10 \cdot 60 = 600 \text{ s}$$

$$I = \frac{Q}{t} = \frac{41832}{600} = \underline{\underline{69,72 \text{ A}}}$$


---

Nº 3. 10. 6

$$360 \text{ mA} = 0,36 \text{ A}$$

$$t = \frac{Q}{I} = \frac{86,4}{0,36} = \underline{\underline{240 \text{ s}}} = \underline{\underline{4 \text{ min.}}}$$


---

Nº 3.11.1

$$Q = I \cdot t = 40 \cdot 1 = 40 \text{ Ah}$$

$$\text{a) } m = Q \cdot C = 40 \cdot 1,0945 = \underline{\underline{43,78}} \text{ g}$$

$$\text{b) } m = \frac{Q \cdot C \cdot 97}{100} = \frac{40 \cdot 1,0945 \cdot 97}{100} = \underline{\underline{42,46}} \text{ g}$$


---

Nº 3.11.2

$$1t = 1'000'000 \text{ g}$$

$$Q = \frac{m}{m/\text{Ah}} = \frac{1'000'000}{0,3354} = \underline{\underline{2,98 \text{ MAh}}}$$


---

Nº 3.11.3

$$42 \text{ min} = \frac{42}{60} = 0,7 \text{ h}$$

$$C_2 = \frac{C \cdot 80}{100} = \frac{2,3716 \cdot 80}{100} = 1,8973 \text{ g/Ah}$$

$$Q = \frac{m}{m/\text{Ah}} = \frac{1,4}{1,8973} = 4,427 \text{ Ah}$$

$$I = \frac{Q}{t} = \frac{4,427}{0,7} = \underline{\underline{6,324 \text{ A}}}$$


---

Nº 3.11.4

$$I = A \cdot I/\text{dm}^2 = 500 \cdot 0,14 = 70 \text{ A dm}^{-2}$$

$$Q = \frac{m \cdot 3600}{60} = \frac{5,14 \cdot 3600}{60} = 308,4 \text{ g}$$

$$C = \frac{Q}{A} = \frac{308,4}{70} = \underline{\underline{4,406 \text{ g Ah}}}$$


---

Nº 3.11.5

$$3,2 \text{ min} = \frac{3,2}{60} = 0,053 \text{ h}$$

$$m = I \cdot C \cdot t \cdot n = 60 \cdot 0,6468 \cdot 0,053 \cdot 0,15 = \underline{\underline{0,3105 \text{ g}}}$$


---

Nº 3.11.6

$$36 \text{ min} = \frac{36}{60} = 0,6 \text{ h}$$

$$I = A/\text{dm}^2 \cdot \text{dm}^2 = 0,8 \cdot 5 = 4 \text{ A}$$

$$m = I \cdot C \cdot t \cdot n = 4 \cdot 2,2142 \cdot 0,6 \cdot 0,9 = \underline{\underline{4,7826 \text{ g}}}$$

---

Nº 3.11.7.

$$50 \text{ cm}^2 = 0,5 \text{ dm}^2$$

$$51,4 \text{ mg} = 0,0514 \text{ g}$$

$$I = A \cdot A/\text{dm}^2 = 0,5 \cdot 1,4 = 0,7 \text{ A}$$

$$m = I \cdot C \cdot t \Rightarrow t = \frac{m}{I \cdot C} = \frac{0,0514}{0,7 \cdot 4,024} = 0,018 \text{ h}$$

$$0,018 \text{ h} \cdot 60 = \underline{\underline{1,094 \text{ min}}}$$

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Nº 3.11.8

$$90 \text{ min} = 1,5 \text{ h}$$

$$I = A/\text{dm}^2 \cdot \text{dm}^2 = 0,4 \cdot 450 = 180 \text{ A}$$

$$Q = I \cdot t = 180 \cdot 1,5 = 270 \text{ Ah}$$

$$m = C \cdot Q \cdot N = 1,0945 \cdot 270 \cdot 0,97 = \underline{\underline{286,65 \text{ gr}}}$$

---

Nº 3.12.1.1

$$P = U \cdot I = 36 \cdot 6,8 = \underline{\underline{244,8 \text{ W}}}$$

Nº 3.12.1.2

$$I = \frac{P}{U} = \frac{450}{110} = \underline{\underline{4,09 \text{ A}}}$$

Nº 3.12.1.3

$$U = \frac{P}{I} = \frac{5,2}{35} = \underline{\underline{148 \text{ mV}}}$$

Nº 3.12.1.4

$$P = U \cdot I = 110 \cdot 0,16 = \underline{\underline{28,8 \text{ W}}}$$

Nº 3.12.1.5

$$I = \frac{P}{U} = \frac{102000}{615} = \underline{\underline{165,85 \text{ A}}}$$

Nº 3.12.1.6

$$U = \frac{P}{I} = \frac{720}{2,3} = \underline{\underline{313,04 \text{ V}}}$$

Nº 3.12.1.7

$$P = U \cdot I = 12,5 \cdot 6,5 = \underline{\underline{81,25 \text{ W}}}$$

Nº 3.12.1.8

$$I = \frac{P}{U \cdot Z} = \frac{85}{12} \cdot 2 = \underline{\underline{14,16 \text{ A}}} \Rightarrow 16 \text{ A normalisé!}$$

Nº 3.12.1.9

$$P = U \cdot I = 11,2 \cdot 3,2 = \underline{\underline{35,84 \text{ MW}}}$$

Nº 3.12.1.10

$$I = \frac{P}{U} = \frac{0,2}{240} = \underline{\underline{0,83 \text{ mA}}}$$

Nº 3.12.1.11

$$U = \frac{P}{I} = \frac{5}{12} = \underline{\underline{416,6 \text{ V}}}$$

Nº 3.12.1.12

$$P = U \cdot I = 380 \cdot 0,6 = \underline{\underline{228 \text{ mW}}}$$

Nº 3.12.1.13

$$I = \frac{P}{U} = \frac{20}{220} = \underline{\underline{90,9 \text{ mA}}}$$

Nº 3.12.1.14

$$P = U \cdot I = 5,2 \cdot 152 = \underline{\underline{790,4 \text{ W}}}$$

Nº 3.12.1.15

$$I = \frac{P}{U} = \frac{300}{13} = \underline{\underline{23,07 \text{ A}}}$$

Nº 3.12.1.16

$$U = \frac{P}{I} = \frac{1,8}{35} = \underline{\underline{51,4 \text{ mV}}}$$

Nº 3.12.1.17

$$P = U \cdot I = 1650 \cdot 930 = \underline{\underline{15345 \text{ MW}}}$$

Nº 3.12.1.18

$$I = \frac{P}{U} = \frac{2000}{220} = \underline{\underline{9,09 \text{ A}}}$$

Nº 3.12.1.19

$$I = \frac{P}{U} + I_1 = \frac{93}{12} + 6,2 = \underline{\underline{13,95 \text{ A}}}$$

Nº 3.12.1.20

$$P_{\text{tot}} = (2 \cdot 45) + (2 \cdot 4) + (2 \cdot 35) + (4 \cdot 5) + (4 \cdot 3) + 20 = 220 \text{ W}$$

$$I = \frac{P}{U} = \frac{220}{12} = 18,33 \text{ A}$$

$$I_{\text{Tot}} = 6,5 + 4 = 6,5 \text{ A} + 18,33 = 24,833 \text{ A}$$

$$\bar{I} = I - I_f = 25 - 24,833 = \underline{\underline{0,1667 \text{ A}}}$$

La batterie se charge

Nº 3.12.2.1

$$R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} = \frac{110^2}{7300} = \underline{\underline{1,65 \text{ W}}}$$


---

Nº 3.12.2.2

$$R = \frac{U^2}{P} \Rightarrow U = \sqrt{P \cdot R} = \sqrt{2400 \cdot 60} = \underline{\underline{379,47 \text{ V}}}$$


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Nº 3.12.2.3

$$R = \frac{U^2}{P} = \frac{220^2}{150} = \underline{\underline{322,6 \Omega}}$$


---

Nº 3.12.2.4

$$R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} \cdot 4 = \frac{38,2^2}{12,2} \cdot 4 = \underline{\underline{478,43 \text{ W}}}$$


---

Nº 3.12.2.5

$$R = \frac{U^2}{P} \Rightarrow U = \sqrt{P \cdot R} = \sqrt{0,2 \cdot 800000} = \underline{\underline{400 \text{ V}}}$$


---

Nº 3.12.2.6

$$R = \frac{U^2}{P} = \frac{171^2}{6340} = \underline{\underline{4,61 \Omega}}$$


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Nº 3.12.2.7

$$R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} = \frac{240^2}{45000} = \underline{\underline{1,28 \text{ W}}}$$


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Nº 3.12.2.8

$$R = \frac{U^2}{P} = \frac{220^2}{0,6} = \underline{\underline{80,666 \text{ k}\Omega}}$$


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Nº 3.12.2.9

$$R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} = \frac{48,2^2}{380} = \underline{\underline{6,11 \text{ W}}}$$


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Nº 3.12.2.10

$$R = \frac{U^2}{P} = \frac{163^2}{0,125} = \underline{\underline{212552 \Omega}}$$


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Nº 3.12.2.11

$$R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} = \frac{180^2}{1,5} = \underline{\underline{21,6 \text{ mW}}}$$


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Nº 3.12.3.1

$$R = \frac{U^2}{P} = \frac{220^2}{35} = 1382,68 \Omega$$

$$\text{Nelle } P = \frac{U^2}{R} = \frac{220^2}{1382,68} = \underline{\underline{32,5 \text{ W}}}$$

Nº 3.12.3.2

$$R = \frac{U^2}{P} = \frac{220^2}{1200} = 40,33 \Omega$$

$$\text{Nelle } U = \frac{220 \cdot 104}{100} = 228,8 \text{ V}$$

$$\text{Nelle } P = \frac{Nelle U^2}{R} = \frac{228,8^2}{40,33} = \underline{\underline{1297,92 \text{ W}}}$$

Nº 3.12.3.3

$$R = \frac{U^2}{P} = \frac{220^2}{1500} = 32,26 \Omega$$

$$\text{Nelle } P = \frac{U^2}{R} = \frac{380^2}{32,26} = \underline{\underline{4475,3 \text{ W}}}$$

Nº 3.12.3.4

$$R = \frac{U^2}{P} = \frac{380^2}{2400} = 60,16 \Omega$$

$$\text{Nelle } P = \frac{U^2}{R} = \frac{220^2}{60,16} = \underline{\underline{804,43 \text{ W}}}$$

Nº 3.12.3.5

$$R = \frac{U^2}{P} = \frac{220^2}{1000} = 48,4 \Omega$$

$$R = \frac{U^2}{P} \Rightarrow \text{Nelle } U = \sqrt{P \cdot R} = \sqrt{926 \cdot 48,4} = \underline{\underline{211,7 \text{ V}}}$$

Nº 3.12.3.6

$$R = \frac{U^2}{P} = \frac{220^2}{100} = 484 \Omega$$

$$I = \frac{U}{R} = \frac{228}{484} = \underline{\underline{0,47 \text{ A}}}$$

N° 3.12.3.7

$$a) R = \frac{U^2}{P} \Rightarrow P = \frac{U^2}{R} = \frac{100^2}{20000} = \underline{\underline{0,5 \text{ W}}}$$

$$b) P = \frac{U^2}{R} = \frac{400^2}{20000} = \underline{\underline{8 \text{ W}}}$$

$$c) 200 \div 100 \div 400 \Rightarrow \underline{\underline{2 \div 1 \div 4}}$$

$$d) 2 \div 0,5 \div 8 \Rightarrow \cdot 2 \Rightarrow \underline{\underline{4 \div 1 \div 16}}$$

N° 3.12.3.8

Je suppose : 400 V

$$R = \frac{U^2}{P} = \frac{400}{1800} = 88,88 \Omega$$

$$\text{Nelle } P_{\bar{a}} + 10\% = \frac{U + 10\%}{R}^2 = \frac{400 + 10\%}{88,88}^2 = \underline{\underline{2178 \text{ W}}}$$

$$\text{Nelle } P_{\bar{a}} - 10\% = \frac{U - 10\%}{R}^2 = \frac{400 - 10\%}{88,88}^2 = \underline{\underline{1458 \text{ W}}}$$

$$\% = 100 - \left( \frac{100 \cdot 2178}{1800} \right) = \underline{\underline{21\%}}$$

$$\% = 100 - \left( \frac{100 \cdot 1458}{1800} \right) = \underline{\underline{19\%}}$$

Nº 3.13.1.1

$$P = R \cdot I^2 = 12 \cdot 4,5^2 = \underline{\underline{243 \text{ W}}}$$

Nº 3.13.1.2

$$P = R \cdot I^2 \Rightarrow I = \sqrt{\frac{P}{R}} = \sqrt{\frac{820}{210}} = \underline{\underline{1,97 \text{ A}}}$$

Nº 3.13.1.3

$$P = R \cdot I^2 \Rightarrow R = \frac{P}{I^2} = \frac{5,6}{40^2} = \underline{\underline{3,5 \text{ m}\Omega}}$$

Nº 3.13.1.4

$$P = R \cdot I^2 = 0,00162 \cdot 600^2 = \underline{\underline{583,2 \text{ W}}}$$

Nº 3.13.1.5

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{5}{400000}} = \underline{\underline{3,536 \text{ mA}}}$$

Nº 3.13.1.6

$$P = R \cdot I^2 \Rightarrow R = \frac{P}{I^2} = \frac{620}{3,4^2} = \underline{\underline{53,63 \Omega}}$$

Nº 3.13.1.7

$$P = R \cdot I^2 = 0,825 \cdot 32^2 = \underline{\underline{844,8 \text{ W}}}$$

Nº 3.13.1.8

$$R = \frac{P}{I^2} = \frac{3,2}{12^2} = \underline{\underline{22,2 \text{ m}\Omega}}$$

Nº 3.13.1.9

$$P = R \cdot I^2 = 0,00272 \cdot 45^2 = \underline{\underline{5,508 \text{ W}}}$$

Nº 3.13.1.10

$$P = R \cdot I^2 = 15000 \cdot 0,025^2 = \underline{\underline{9,375 \text{ W}}}$$

Nº 3.13.1.11

$$A = l \cdot L = 10 \cdot 100 = 1000 \text{ mm}^2$$

$$R = \frac{\rho \cdot l}{A} = \frac{0,0175 \cdot 1}{1000} = 0,0175 \text{ m}\Omega$$

3.13. 1. 11 Suite

$$P = R \cdot I^2 = 0,0000175 \cdot 5000^2 = \underline{\underline{437,5 \text{ W/m}}}$$

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N° 3.13.1.12

$$A = l \cdot L = 3 \cdot 5 = 15 \text{ mm}^2$$

$$I = J \cdot A = 3 \cdot 15 = 45 \text{ A}$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 16,8}{15} = 0,0196 \Omega$$

$$P = R \cdot I^2 = 0,0196 \cdot 45^2 = \underline{\underline{39,69 \text{ W}}}$$

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N° 3.13.1.13

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 1700}{16} = 1,859 \Omega$$

$$P = R \cdot I^2 \cdot 3 = 1,859 \cdot 110^2 \cdot 3 = \underline{\underline{67,495 \text{ kW}}}$$

---

Nº 3.13.2.1

$$P = R \cdot I^2 \Rightarrow R = \frac{P}{I^2} = \frac{2}{5^2} = 0,08 \Omega$$

a)  $P = R \cdot I^2 = 0,08 \cdot 0^2 = \underline{\underline{0 \text{ W}}}$

b)  $" = 0,08 \cdot 1^2 = \underline{\underline{0,08 \text{ W}}}$

c)  $" = 0,08 \cdot 2^2 = \underline{\underline{0,32 \text{ W}}}$

d)  $" = 0,08 \cdot 3^2 = \underline{\underline{0,72 \text{ W}}}$

e)  $" = 0,08 \cdot 4^2 = \underline{\underline{1,28 \text{ W}}}$

---

Nº 3.13.2.2

$$R = \frac{P}{I^2} = \frac{12800}{420^2} = 0,07256 \Omega$$

$$I_1 = I - 10\% = 420 - 10\% = 378 \text{ A}$$

$$I_2 = I + 10\% = 420 + 10\% = 462 \text{ A}$$

a)  $P = R \cdot I^2 = 0,072 \cdot 378^2 = \underline{\underline{10,368 \text{ kW}}}$

b)  $P = R \cdot I^2 = 0,072 \cdot 462^2 = \underline{\underline{15,488 \text{ kW}}}$

c)  $\alpha = 100 - \left( \frac{10368 \cdot 100}{12800} \right) = \underline{\underline{19 \%}}$

"b"  $100 + \left( \frac{15488 \cdot 100}{12800} \right) = \underline{\underline{21 \%}}$

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Nº 3.13.2.3

$$I_{\text{nominal}} = 63 \text{ A}$$

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 100}{16} = 0,1093 \Omega$$

a)  $P = R \cdot I^2 = 0,109 \cdot 63^2 = \underline{\underline{1,302 \text{ kW}}}$

b)  $I_{\text{nominal}} = \frac{I}{2} = \frac{63}{2} = 31,5 \text{ A}$

$$P = 3 \cdot R \cdot I^2 \cdot 2 = 3 \cdot 0,109 \cdot 31,5^2 \cdot 2 = \underline{\underline{651,16 \text{ W}}}$$


---

Nº 3.14.1

$$n = \frac{P_2}{P_1} = \frac{306,2}{949} = \underline{\underline{0,322}} \text{ ou } \underline{\underline{32,27\%}}$$

Nº 3.14.2

$$P_2 = P_1 \cdot n = 1240 \cdot 0,94 = \underline{\underline{1165,6 \text{ kW}}}$$

Nº 3.14.3

$$P_1 = \frac{P_2}{n} = \frac{3000}{0,91} = \underline{\underline{3296,7 \text{ kW}}}$$

Nº 3.14.4

$$P_1 = \frac{P_2}{n} = \frac{4000}{0,84} = 4761,9 \text{ W}$$

$$\text{Pertes} = P_1 - P_2 = 4761,9 - 4000 = \underline{\underline{761,9 \text{ W}}}$$

Nº 3.14.5

$$P_1 = U \cdot I = 24 \cdot 5,5 = 132 \text{ W}$$

$$n = \frac{P_2 \cdot 100}{P_1} = \frac{75 \cdot 100}{132} = \underline{\underline{56,82\%}}$$

Nº 3.14.6

$$P_2 = P_1 \cdot N = 46 \cdot 0,88 = \underline{\underline{40,48 \text{ W}}}$$

Nº 3.14.7

$$P_1 = \frac{P_2}{n} = \frac{5000}{0,79} = 6329,11 \text{ W}$$

$$I = \frac{P}{U} = \frac{6329,11}{220} = \underline{\underline{28,78 \text{ A}}}$$

Nº 3.14.8

$$P_2 = U \cdot I = 224 \cdot 68 = 15,232 \text{ kW}$$

$$\text{Pertes} = P_1 - P_2 = 18 - 15,232 = \underline{\underline{2,768 \text{ kW}}}$$

$$\text{Pertes en \%} = \frac{2768 \cdot 100}{18000} = \underline{\underline{15,37\%}}$$

Nº 3.14.9

$$P_1 = U \cdot I = 800 \cdot 212 = 169600 \text{ W}$$

$$P_2 = U \cdot I = 762 \cdot 212 = 161544 \text{ W}$$

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Nº 3.14.9. Suite

$$n = \frac{P_2 \cdot 100}{P_1} = \frac{161544 \cdot 100}{169600} = \underline{\underline{95,25 \%}}$$

Nº 3.14.10

$$P_1 = U \cdot I = 228 \cdot 16,1 = 3670,8 \text{ W}$$

$$P_2 = P_1 \cdot n = 3670,8 \cdot 0,62 = \underline{\underline{2275,89 \text{ W}}}$$

Nº 3.14.11

a)  $P_1 = P_2 = \frac{185}{n} = \underline{\underline{201,08 \text{ kW}}}$

b)  $I = \frac{P_2}{U_2} = \frac{185000}{480} = \underline{\underline{385,4 \text{ A}}}$

c)  $U_1 = \frac{P_1}{I} = \frac{201080}{385,4} = \underline{\underline{521,72 \text{ V}}}$

Nº 3.14.12

a)  $P_2 = U \cdot I = 218 \cdot 20 = \underline{\underline{4360 \text{ W}}}$

b)  $Rl = 2 \cdot R = 2 \cdot 0,25 = 0,5 \Omega$

$$P = R \cdot I^2 = 0,5 \cdot 20^2 = \underline{\underline{200 \text{ W}}}$$

c)  $P_1 = P_2 + P = 4360 + 200 = \underline{\underline{4560 \text{ W}}}$

d)  $n = \frac{P_2}{P_1} \cdot 100 = \frac{4360}{4560} \cdot 100 = \underline{\underline{95,61 \%}}$

Nº 3.14.13

$$P_1 = \frac{P_2}{n} = \frac{8,7}{0,71} = \underline{\underline{12,25 \text{ Wh}}}$$

Nº 3.15.1

$$7h\ 48\text{ min} = 7,8\text{ h}$$

$$W = P \cdot t = 1,2 \cdot 7,8 = \underline{\underline{9,36\text{ kWh}}}$$

Nº 3.15.2

$$t = \frac{W}{P} = \frac{1000}{25} = \underline{\underline{40\text{ h}}}$$

$$t = \frac{W}{P} = \frac{1000}{40} = \underline{\underline{25\text{ h}}}$$

$$t = \frac{W}{P} = \frac{1000}{75} = \underline{\underline{13,33\text{ h}}}$$

$$t = \frac{W}{P} = \frac{1000}{100} = \underline{\underline{10\text{ h}}}$$

Nº 3.15.3

$$\Delta W = W_1 - W_2 = 1428 - 1250 = 178\text{ kWh}$$

$$\Delta t = t_1 - t_2 = 11,45 - 6,45 = 5\text{ h}$$

$$P = \frac{W}{t} = \frac{178}{5} = \underline{\underline{35,6\text{ kW}}}$$

Nº 3.15.4

$$8h\ 12\text{ min} = 8,2\text{ h}$$

$$W = P \cdot t = 92 \cdot 8,2 = \underline{\underline{754,4\text{ Wh}}}$$

Nº 3.15.5

$$W = P \cdot t \Rightarrow t = \frac{W}{P} = \frac{32}{4,2} = 7,619\text{ h}$$

$$\underline{\underline{7,61\text{ h}}} = \underline{\underline{7h\ 37\text{ min}\ 8\text{ sec.}}}$$

Nº 3.15.6

$$W = P \cdot t \Rightarrow P = \frac{W}{t} = \frac{7680}{24} = \underline{\underline{320\text{ kW}}}$$

$$\% = \frac{320 \cdot 100}{1840} = \underline{\underline{17,39\%}}$$

Nº 3.15. 7

$$t = n \cdot 24 = 365 \cdot 24 = 8760 \text{ h}$$

$$W = P \cdot t = 0,01 \cdot 8760 = \underline{\underline{87,6 \text{ kWh}}}$$


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Nº 3.15. 8

$$W = P \cdot t \Rightarrow t = \frac{W}{P} = \frac{253000}{62} = 4080 \text{ h}$$

a) Jours =  $\frac{t}{24} = \frac{4080}{24} = \underline{\underline{170 \text{ Jours}}}$

$$P_{2\omega} = P_1 \cdot n = 62 \cdot 0,65 = 40,3 \text{ MW}$$

$$W = P \cdot t \Rightarrow t = \frac{W}{P} = \frac{253000}{40,3} = 6277,9 \text{ h}$$

b) Jours =  $\frac{t}{24} = \frac{6277,9}{24} = \underline{\underline{261,57 \text{ Jours}}}$

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Nº 3.15. 9

$$P = \frac{W}{t} = \frac{120000}{24} = \underline{\underline{5000 \text{ kW}}}$$


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Nº 3.15. 10

$$P = P \cdot \% - 2000 \cdot 0,54 = 1080 \text{ kW}$$

$$W = P \cdot t = 1080 \cdot 30 \cdot 24 = \underline{\underline{777,6 \text{ MWh}}}$$


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Nº 3.15. 11

$$2 \text{ mois} = 60 \text{ jours}$$

$$W/\text{jour} = \frac{W}{60} = \frac{83}{60} = \underline{\underline{1,383 \text{ kWh}}}$$

$$W/\text{personne} = \frac{W/2}{2} = \frac{1,383}{2} = \underline{\underline{0,691 \text{ kWh}}}$$


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Nº 3.16.1

$$Coût = W \cdot ct = 14,5 \cdot 5,5 = \underline{\underline{79,75 \text{ ct.}}}$$

Nº 3.16.2

$$\text{Prix} = \frac{4270,21}{66620} = \underline{\underline{0,064 \text{ Fr}}} = \underline{\underline{6,41 \text{ ct/kWh}}}$$

Nº 3.16.3

$$W = \frac{Fr}{Fr/\text{kWh}} = \frac{52}{0,08} = \underline{\underline{650 \text{ kWh}}}$$

Nº 3.16.4

$$W = P \cdot t = 2 \cdot 50 = 100 \text{ kWh}$$

$$Coût = W \cdot ct = 100 \cdot 0,09 = \underline{\underline{9 \text{ Fr.}}}$$

Nº 3.16.5

$$\text{Prix} = \frac{985,20}{20920} = \underline{\underline{4,709 \text{ ct/kWh}}}$$

Nº 3.16.6

$$W = \frac{1}{0,11} = 9,09 \text{ kWh}$$

$$t = \frac{W}{P} = \frac{9,09}{0,04} = \underline{\underline{227,3 \text{ h}}}$$

Nº 3.16.7

$$1h 36 \text{ min} = 1,6h$$

$$W = P \cdot t = 1,25 \cdot 1,6 = 2 \text{ kWh}$$

$$Coût = W \cdot ct = 2 \cdot 9 = \underline{\underline{18 \text{ ct.}}}$$

Nº 3.16.8

$$t = 8h 40 \text{ m} = 8,66 \text{ h}$$

$$Coût = P \cdot t \cdot ct = 0,060 \cdot 8,66 \cdot 35 = \underline{\underline{18,2 \text{ ct.}}}$$

Nº 3.16.9

$$\text{a) haut-} \frac{94,15}{180} = \underline{\underline{10,69 \text{ ct/kWh}}}$$

$$\text{bas} = \frac{43,20}{720} = \underline{\underline{6 \text{ ct/kWh}}}$$

$$\text{Prix} = \frac{160,55}{1600} = \underline{\underline{10,03 \text{ ct/kWh}}}$$

Nº 3.17.1

$$1 \text{ kWh} = 3600000 \text{ J}$$

$$W = P \cdot t = 14200 \cdot 3600 = \underline{\underline{51120 \text{ kJ}}}$$

Nº 3.17.2

$$P = \frac{W}{t} = \frac{12000000}{3600000} = \underline{\underline{3,33 \text{ kWh}}}$$

Nº 3.17.3

$$W = P \cdot t = 4000 \cdot 3600 = \underline{\underline{14400 \text{ kJh}}}$$

Nº 3.17.4

$$P = \frac{W}{t} = \frac{90000000}{3600} = \underline{\underline{25 \text{ kW}}}$$

Nº 3.17.5

$$W = P \cdot t = 9 \cdot 3600 = \underline{\underline{32400 \text{ J}}}$$

Nº 3.17.6

$$P = \frac{W}{t} = \frac{1000000000}{3600000} = \underline{\underline{277,8 \text{ kW}}}$$

Nº 3.17.7

$$Q = m \cdot c \cdot \Delta\theta = 250 \cdot 4190 \cdot 57 = \underline{\underline{59707 \text{ kJ}}}$$

Nº 3.17.8

$$\Delta\theta = t_2 - t_1 = 132 - 20 = 112 \text{ }^{\circ}\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 16 \cdot 482 \cdot 112 = \underline{\underline{863,7 \text{ kJ}}}$$

Nº 3.17.9

$$\Delta\theta = t_2 - t_1 = 32 - 15 = 17 \text{ }^{\circ}\text{C}$$

$$m = l \cdot p = 240 \cdot 0,98 = 223,2 \text{ l}$$

$$Q = m \cdot c \cdot \Delta\theta =$$

$$223,2 \cdot 1680 \cdot 17 = \underline{\underline{6375 \text{ kJ}}}$$

Nº 3.17.10

$$\Delta\theta = 66 \text{ }^{\circ}\text{C} \quad 1 \text{ kWh} = 3600000 \text{ J}$$

$$Q = m \cdot c \cdot \Delta\theta \Rightarrow m = \frac{Q}{c \cdot \Delta\theta} = \frac{3600000}{4190 \cdot 66} = \underline{\underline{13,02 \text{ l}}}$$

N° 3.17.11

$$1 \text{ kWh} = 3'600'000 \text{ J} \quad \Delta\theta = 1^\circ\text{C}$$

a) eau  $m = l \cdot p = 1 \cdot 1 = 1 \text{ kg}$

$$m = \frac{Q}{c \cdot \Delta\theta} = \frac{3'600'000}{4190 \cdot 1} = \underline{\underline{859,18 \text{ l}}}$$

b) huile  $m = l \cdot p = 1 \cdot 0,93 = 0,93 \text{ kg}$

$$m = \frac{Q}{c \cdot \Delta\theta} = \frac{3'600'000}{1670 \cdot 0,93} = \underline{\underline{2317,9 \text{ l}}}$$

c) glycerine  $m = l \cdot p = 1 \cdot 1,27 = 1,27 \text{ kg}$

$$m = \frac{Q}{c \cdot \Delta\theta} = \frac{3'600'000}{2430 \cdot 1,27} = \underline{\underline{1166,5 \text{ l}}}$$

d) Mercure  $m = l \cdot p = 1 \cdot 13,6 = 13,6 \text{ kg}$

$$m = \frac{Q}{c \cdot \Delta\theta} = \frac{3'600'000}{138 \cdot 13,6} = \underline{\underline{1918 \text{ l}}}$$

N° 3.17.12

$$m = l \cdot p = 520 \cdot 0,83 = 431,6 \text{ kg}$$

$$Q = m \cdot c \cdot \Delta\theta \Rightarrow \Delta\theta = \frac{Q}{m \cdot c} = \frac{65000'000}{481,6 \cdot 2100} = 71,71^\circ\text{C}$$

$$t_2 = t_1 + \Delta\theta = 18 + 71,71 = \underline{\underline{89,71^\circ\text{C}}}$$

N° 3.17.13

$$Q = m \cdot c \cdot \Delta\theta = 150 \cdot 4190 \cdot 12,3 = \underline{\underline{7730,5 \text{ kJ}}}$$

N° 3.17.14

$$\Delta\theta = t_2 - t_1 = 58 - 16 = 42^\circ\text{C}$$

$$Q_1 = m \cdot c \cdot \Delta\theta = 240 \cdot 4190 \cdot 42 = 42285,2 \text{ kJ}$$

$$Q_2 = \frac{Q_1}{n} = \frac{42285,2}{0,76} = \underline{\underline{55572,6 \text{ kJ}}}$$

$$W = \frac{Q_2}{\text{J/kWh}} = \frac{55572,6}{3'600'000} = \underline{\underline{15,43 \text{ kWh}}}$$

N° 3.17.15

$$Q = P \cdot t \cdot \text{J/kWh} = 2,5 \cdot 24 \cdot 3'600'000 = \underline{\underline{216 \text{ MJ}}}$$

Nº 3. 17. 16

$$m = 30 \cdot 1000 = 30000 \text{ kg}$$

$$\Delta\theta = t_2 - t_1 = 22 - 15 = 7^\circ\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 30000 \cdot 4190 \cdot 7 = \underline{\underline{879,9 \text{ MJ}}}$$

$$W = \frac{Q}{J/kWh} = \frac{87900000}{3600000} = 244,4 \text{ kWh}$$

$$P = \frac{W}{t} = \frac{244,4}{24} = \underline{\underline{10,18 \text{ kW}}}$$


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Nº 3. 17. 17

$$\Delta\theta = t_2 - t_1 = 76 - 10 = 66^\circ\text{C}$$

$$P_2 = P_1 \cdot n = 1800 \cdot 0,55 = 990 \text{ W}$$

$$Q = m \cdot c \cdot \Delta\theta = 3,2 \cdot 4190 \cdot 66 = 884928 \text{ J}$$

$$t = \frac{Q}{P_2} = \frac{884928}{990} = \underline{\underline{893,86 \text{ sec} = 14,9 \text{ min}}}$$


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Nº 3. 17. 18

$$W = P \cdot t \cdot n = 1400 \cdot 5 \cdot 3600 \cdot 0,94 = 23688000 \text{ J}$$

$$Q = m \cdot c \cdot \Delta\theta \Rightarrow \Delta\theta = \frac{Q}{m \cdot c} = \frac{23688000}{75 \cdot 4190} = 75,37^\circ\text{C}$$

$$t_1 = 5^\circ\text{C}$$

$$t_2 = t_1 + \Delta\theta = 5 + 75,37 = \underline{\underline{80,37^\circ\text{C}}}$$


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Nº 3. 17. 19

$$\Delta\theta = t_2 - t_1 = 85 - 10 = 75^\circ\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 5 \cdot 4190 \cdot 75 = 1571,25 \text{ kJ}$$

$$0,5 \text{ kWh} = \frac{3600000}{2} = 1800000 \text{ J}$$

$$n = \frac{Q}{W} = \frac{1571250}{1800000} = \underline{\underline{0,8729 \text{ ou } 89,27\%}}$$


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Nº 3. 17. 20

$$t = \frac{8}{60} = 0,13 \text{ h}$$

$$W = P \cdot t = 10 \cdot 0,13 = 1,33 \text{ Wh}$$

$$\frac{3600000 \cdot 0,00183}{1} = 4800 \text{ J}$$


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Nº 3.17.21

$$m = l \cdot p = 4 \cdot 0,79 = 3,16 \text{ kg}$$

$$\Delta\theta = t_2 - t_1 = 42 - 24 = 18^\circ\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 3,16 \cdot 2430 \cdot 18 = 138218,4 \text{ J}$$

$$12 \text{ min} = \frac{12}{60} = 0,2 \text{ h}$$

$$1 \text{ kWh} = 3600000 \text{ J} \Rightarrow 138218,4 \text{ J} = 0,03839 \text{ kWh}$$

$$W = P \cdot t \Rightarrow P = \frac{W}{t} = \frac{0,03839}{2} = 0,19197 \text{ kW}$$

$$P_1 = \frac{P_2}{n} = \frac{191,97}{0,9} = \underline{\underline{213,3 \text{ W}}}$$


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Nº 3.17.22

$$Q_1 = Q_2 = \frac{200000}{0,92} = 217391,3 \text{ J}$$

$$W = P \cdot t = 250 \cdot 60 = 15000 \text{ W/min ou J/min}$$

$$t = \frac{Q}{W/\text{min}} = \frac{217391,3}{15000} = \underline{\underline{14,44 \text{ min}}}$$


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Nº 3.17.23

$$18 \text{ min} = 1080 \text{ sec} \quad m = 0,32 \text{ kg}$$

$$W = P \cdot t = 120 \cdot 1080 = 129600 \text{ J}$$

$$Q_2 = W \cdot n = 129600 \cdot 0,8 = 103680 \text{ J}$$

$$Q = m \cdot c \cdot \Delta\theta \Rightarrow \Delta\theta = \frac{Q}{m \cdot c} = \frac{103680}{0,32 \cdot 400} = 810^\circ\text{C}$$

$$t_2 = t_1 + \Delta\theta = 810 + 20 = \underline{\underline{830^\circ\text{C}}}$$


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Nº 3.17.24

$$25 \text{ min} = 1500 \text{ sec}$$

$$\Delta\theta = t_2 - t_1 = 85 - 15 = 70^\circ\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 8 \cdot 4190 \cdot 70 = 2346400 \text{ J}$$

$$W = P \cdot t = 2000 \cdot 1500 = 3000000 \text{ J}$$

$$n = \frac{Q}{W} = \frac{2346400}{3000000} = \underline{\underline{0,78 \text{ ou } 78,21\%}}$$


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Nº 3.17. 25

$$m = 680 \text{ kg} \quad \Delta\theta = t_2 - t_1 = 68 - 12 = 56^\circ\text{C}$$

$$6h 30\text{ min} = 23400 \text{ sec.}$$

$$Q = m \cdot c \cdot \Delta\theta = 680 \cdot 4190 \cdot 56 = 1,5956 \cdot 10^8 \text{ J}$$

$$W = \frac{Q}{n} = \frac{1,5956}{0,92} = 1,7343 \cdot 10^8 \text{ J}$$

$$W = P \cdot t \Rightarrow P = \frac{W}{t} = \frac{1,7343 \cdot 10^8}{23400} = \underline{\underline{7,412 \text{ kWh}}}$$

Nº 3.17. 26

$$\Delta\theta = t_2 - t_1 = 360 - 20 = 340^\circ\text{C}$$

$$Q = m \cdot c \cdot \Delta\theta = 7,5 \cdot 380 \cdot 340 = 969000 \text{ J}$$

$$W = \frac{Q}{n} = \frac{969000}{0,78} = 1242307,7 \text{ J}$$

$$W = P \cdot t \Rightarrow t = \frac{W}{P} = \frac{1242307,7}{620} = \underline{\underline{2003,7 \text{ sec} = 33,4 \text{ min}}}$$

Nº 3.17. 27

$$P = R \cdot I^2 = 0,52 \cdot 21^2 = 229,32 \text{ W}$$

$$W = P \cdot t = 229,32 \cdot 60 = \underline{\underline{1295 \text{ kJ/h}}}$$

Nº 3.17. 28

$$P = R \cdot l = 29 \cdot 12,4 = 359,6 \text{ W}$$

$$W = P \cdot t = 359,6 \cdot 3600 = \underline{\underline{1295 \text{ kJ/h}}}$$

Nº 3.17. 29

$$P = U \cdot I = 28,4 \cdot 28 = 795,2 \text{ W}$$

$$W = P \cdot t = 795,2 \cdot 24 \cdot 3600 = \underline{\underline{68,705 \text{ MJ}}}$$

Nº 3.17. 30

$$R = \frac{\varphi \cdot l}{A} = \frac{0,0175 \cdot 100}{10} = 0,175 \Omega$$

$$P = R \cdot I^2 = 0,175 \cdot 40^2 = 280 \text{ W}$$

$$W = P \cdot t = 280 \cdot 3600 = \underline{\underline{1,008 \text{ MJ/h}}}$$