

Nº 4.1.1

$$\hat{U} = U \cdot \sqrt{2} = 220 \cdot \sqrt{2} = \underline{\underline{311,12 \text{ V}}}$$

Nº 4.1.2

$$U = \frac{\hat{U}}{\sqrt{2}} = \frac{400}{\sqrt{2}} = \underline{\underline{282,84 \text{ V}}}$$

Nº 4.1.3

$$\hat{U} = U \cdot \sqrt{2} = 2000 \cdot \sqrt{2} = \underline{\underline{2,828 \text{ kV}}}$$

Nº 4.1.4

$$U = \frac{\hat{U}}{\sqrt{2}} = \frac{4000}{\sqrt{2}} = \underline{\underline{2,828 \text{ kV}}}$$

Nº 4.1.5

$$\hat{U} = U \cdot \sqrt{2} = 50 \cdot \sqrt{2} = \underline{\underline{70,71 \text{ kV}}}$$

Nº 4.1.6

$$I = \frac{\hat{I}}{\sqrt{2}} = \frac{7}{\sqrt{2}} = \underline{\underline{4,95 \text{ mA}}}$$

Nº 4.1.7

$$\hat{I} = I \cdot \sqrt{2} = 43 \cdot \sqrt{2} = \underline{\underline{60,81 \text{ A}}}$$

Nº 4.1.8

$$\hat{I} = I \cdot \sqrt{2} = 30 \cdot \sqrt{2} = \underline{\underline{42,42 \text{ kA}}}$$

Nº 4.1.9

$$\hat{U} = \frac{U \cdot \sqrt{2}}{2} = \frac{15,2 \cdot \sqrt{2}}{2} = \underline{\underline{10,748 \text{ kV}}}$$

Nº 4.1.10

$$\hat{U} = U \cdot \sqrt{2} = 230 \cdot \sqrt{2} = \underline{\underline{325,2 \text{ V}}}$$

Nº 4.1.11

$$\hat{U} = U \cdot \sqrt{2} = 150 \cdot \sqrt{2} = \underline{\underline{212,13 \text{ kV}}}$$

$$U = 2 \cdot \hat{U} = 2 \cdot 212,13 = \underline{\underline{424,26 \text{ kV}}}$$

N° 4.2.1

$$T = \frac{1}{f} = \frac{1}{50} = \underline{\underline{0,02 \text{ s}}}$$

N° 4.2.2

$$f = \frac{1}{T} = \frac{1}{0,0021} = \underline{\underline{476,19 \text{ Hz}}}$$

N° 4.2.3

$$T = \frac{1}{f} = \frac{1}{60} = \underline{\underline{0,0167 \text{ s}}}$$

N° 4.2.4

$$f = \frac{1}{T} = \frac{1}{0,1315} = \underline{\underline{7,604 \text{ MHz}}}$$

N° 4.2.5

$$T = \frac{1}{f} = \frac{1}{440} = \underline{\underline{2,27 \text{ ms}}}$$

N° 4.2.6

$$f = \frac{1}{T} = \frac{1}{25 \cdot 10^{-9}} = \underline{\underline{4 \cdot 10^7 \text{ Hz ou } 40 \text{ MHz}}}$$

N° 4.2.7

$$T = \frac{1}{f} = \frac{1}{1,05} = \underline{\underline{0,95 \text{ ms}}}$$

N° 4.2.8

$$f = \frac{1}{T} = \frac{1}{1,15 \cdot 10^{-9}} = \underline{\underline{869,6 \text{ MHz}}}$$

N° 4.2.9

$$T_1 = \frac{1}{f} = \frac{1}{50} = 0,02 \text{ s}$$

$$T_2 = \frac{1}{f} = \frac{1}{50,2} = 0,0199203 \text{ s}$$

$$\Delta T = T_1 - T_2 = 0,02 - 0,0199203 = \underline{\underline{79,7 \mu\text{s}}}$$

N° 4.2.10

$$f = \frac{1}{T} = \frac{1}{0,00119} = \underline{\underline{840,3 \text{ Hz}}}$$

Nº 4.2.11

$$a) T = \frac{1}{f} = \frac{1}{175000} = \underline{\underline{5,7 \mu s}}$$

$$T = \frac{1}{f} = \frac{1}{340000} = \underline{\underline{2,9 \mu s}}$$

$$b) 1 \Rightarrow 175 \text{ kHz}$$

$$2 \Rightarrow 208 \text{ kHz}$$

$$3 \Rightarrow 241 \text{ kHz}$$

$$4 \Rightarrow 274 \text{ kHz}$$

$$5 \Rightarrow 307 \text{ kHz}$$

$$6 \Rightarrow 340 \text{ kHz}$$

$$c) T_1 = \frac{1}{f} = \frac{1}{175000} = 5,7143 \mu s$$

$$T_2 = \frac{1}{f} = \frac{1}{204000} = 4,8077 \mu s$$

$$\Delta T = T_1 - T_2 = 5,7 - 4,8 = \underline{\underline{0,9066 \mu s}}$$

$$d) T_5 = \frac{1}{f} = \frac{1}{307000} = 3,32573 \mu s$$

$$T_6 = \frac{1}{f} = \frac{1}{340000} = 2,9412 \mu s$$

$$\Delta E = T_5 - T_6 = 3,3 - 2,9 = \underline{\underline{0,384 \mu s}}$$

Nº 4.2.12

$$T = \frac{1}{f} = \frac{1}{72,6} = \underline{\underline{0,0137 \mu s}}$$

Nº 4.2.13

$$2850 \frac{1}{\text{min}} = 47,5 \frac{1}{\text{sec}}$$

$$f = \frac{1}{\text{sec}} \cdot n = 47,5 \cdot 8 = \underline{\underline{380 \text{ Hz}}}$$

Nº 4.3.1

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 16,66 = \underline{\underline{104,7 \frac{1}{s}}}$$

Nº 4.3.2

$$f = \frac{\omega}{2 \cdot \pi} = \frac{314}{2 \cdot 3,14} = \underline{\underline{50 \text{ Hz}}}$$

Nº 4.3.3

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 93570000 = \underline{\underline{5,8792 \cdot 10^8 \frac{1}{s}}}$$

Nº 4.3.4

$$f = \frac{\omega}{2 \cdot \pi} = \frac{2512}{2 \cdot 3,14} = \underline{\underline{400 \text{ Hz}}}$$

Nº 4.3.5

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 800 = \underline{\underline{5027 \frac{1}{s}}}$$

Nº 4.3.6

$$f = \frac{\omega}{2 \cdot \pi} = \frac{6594}{2 \cdot 3,14} = \underline{\underline{1049 \text{ Hz}}}$$

Nº 4.3.7

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 175000 = \underline{\underline{1,1 \cdot 10^6 \frac{1}{s}}}$$

Nº 4.3.8

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 23 = \underline{\underline{144,5 \frac{1}{s}}}$$

Nº 4.3.9

$$f = \frac{\omega}{2 \cdot \pi} = \frac{552,64}{2 \cdot 3,14} = \underline{\underline{87,96 \text{ MHz}}}$$

Nº 4.3.10

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 300 = \underline{\underline{1885 \frac{1}{s}}}$$

$$\omega = 2 \cdot \pi \cdot f = 2 \cdot 3,14 \cdot 3000 = \underline{\underline{18850 \frac{1}{s}}}$$

Nº 4.4.1

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{200} = \underline{\underline{1500 \text{ km}}}$$

Nº 4.4.2

$$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8}{1100} = \underline{\underline{272,7 \text{ kHz}}}$$

Nº 4.4.3

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{9357 \cdot 10^6} = \underline{\underline{3,206 \text{ m}}}$$

Nº 4.4.4

$$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8}{387} = \underline{\underline{775,2 \text{ kHz}}}$$

Nº 4.4.5

$$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8}{0,01284} = \underline{\underline{23,36 \text{ GHz}}}$$

Nº 4.4.6

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{1060} = \underline{\underline{283 \text{ km}}}$$

Nº 4.4.7

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{9 \cdot 10^{15}} = \underline{\underline{33,33 \text{ nm}}}$$

Nº 4.4.8

$$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8}{4 \cdot 10^{-5}} = \underline{\underline{750 \text{ THz}}}$$

$$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8}{7,2 \cdot 10^{-5}} = \underline{\underline{416,7 \text{ THz}}}$$

Nº 4.5.1

$$U = Z \cdot I = 36 \cdot 2,42 = \underline{\underline{87,12 V}}$$

Nº 4.5.2

$$I = \frac{U}{Z} = \frac{326}{320} = \underline{\underline{0,7063 A}}$$

Nº 4.5.3

$$Z = \frac{U}{I} = \frac{116}{173} = \underline{\underline{0,67 \Omega}}$$

Nº 4.5.4

$$U = Z \cdot I = 1250 \cdot 0,0088 = \underline{\underline{11 V}}$$

Nº 4.5.5

$$I = \frac{U}{Z} = \frac{240}{18600} = \underline{\underline{12,9 mA}}$$

Nº 4.5.6

$$Z = \frac{U}{I} = \frac{224}{0,023} = \underline{\underline{9,74 k\Omega}}$$

Nº 4.5.7

$$I = \frac{U}{Z} = \frac{21,2}{1,56} = \underline{\underline{13,59 mA}}$$

Nº 4.5.8

$$Z = \frac{U}{I} = \frac{48}{320} = \underline{\underline{0,15 \Omega}}$$

Nº 4.6.1

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot 3,14 \cdot 50 \cdot 3,9 = \underline{\underline{1194 \Omega}}$$

Nº 4.6.2

$$L = \frac{XL}{2 \cdot \pi \cdot f} = \frac{475}{2 \cdot 3,14 \cdot 200} = \underline{\underline{0,378 H}}$$

Nº 4.6.3

$$f = \frac{XL}{2 \cdot \pi \cdot L} = \frac{16000}{2 \cdot \pi \cdot 3,19} = \underline{\underline{798,26 Hz}}$$

Nº 4.6.4

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 60 \cdot 0,21 = \underline{\underline{79,17 \Omega}}$$

Nº 4.6.5

$$L = \frac{XL}{2 \cdot \pi \cdot f} = \frac{9,8}{2 \cdot \pi \cdot 650} = \underline{\underline{2,4 mH}}$$

Nº 4.6.6

$$f = \frac{XL}{2 \cdot \pi \cdot L} = \frac{52,3}{2 \cdot \pi \cdot 0,5} = \underline{\underline{16,65 Hz}}$$

Nº 4.6.7

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 215 \cdot 0,0184 = \underline{\underline{24,86 \Omega}}$$

Nº 4.6.8

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 175000 \cdot 0,00058 = \underline{\underline{637,7 \Omega}}$$

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 340000 \cdot 0,00058 = \underline{\underline{1039 \Omega}}$$

Nº 4.6.9

$$XL = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 175000 \cdot 0,00475 = \underline{\underline{5223 \Omega}}$$

Nº 4.7.1

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 23 \cdot 2} = \underline{\underline{3456 \Omega}}$$

Nº 4.7.2

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} \Rightarrow C = \frac{1 \cdot 10^6}{W \cdot X_C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 2500 \cdot 42,5} = \underline{\underline{1,498 \mu F}}$$

Nº 4.7.3

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 50 \cdot 16} = \underline{\underline{198,94 \Omega}}$$

Nº 4.7.4

$$C = \frac{1 \cdot 10^6}{W \cdot X_C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 291 \cdot 720} = \underline{\underline{0,76 \Omega}}$$

Nº 4.7.5

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 800 \cdot 0,05} = \underline{\underline{3979 \Omega}}$$

Nº 4.7.6

$$C = \frac{1 \cdot 10^6}{W \cdot X_C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 475 \cdot 840} = \underline{\underline{0,3989 \mu F}}$$

Nº 4.7.7

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 12000 \cdot 0,022} = \underline{\underline{602,9 \Omega}}$$

Nº 4.7.8

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} \Rightarrow W = \frac{1 \cdot 10^6}{X_C \cdot C} = \frac{1 \cdot 10^6}{796 \cdot 4} = 314 \Omega$$

$$W = 2 \cdot \pi \cdot f \Rightarrow f = \frac{W}{2 \cdot \pi} = \frac{314}{2 \cdot \pi} = \underline{\underline{49,99 Hz}}$$

Nº 4.7.9

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 208000 \cdot 0,01} = \underline{\underline{76,51 \Omega}}$$

Nº 4.7.10

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 50 \cdot 3,7} = \underline{\underline{160,3 \Omega}}$$

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 1050 \cdot 8,7} = \underline{\underline{40,96 \Omega}}$$

Nº 4.7.11

$$X_C = \frac{1 \cdot 10^6}{W \cdot C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 50 \cdot 6} = 530,5 \Omega$$

$$I = \frac{U}{X_C} = \frac{225}{530,5} = 424 \text{ mA}$$

Nº 4.7.12

$$X_C = \frac{U}{I} = \frac{100}{0,078} = 1282 \Omega$$

$$C = \frac{1 \cdot 10^6}{W \cdot X_C} = \frac{1 \cdot 10^6}{2 \cdot \pi \cdot 50 \cdot 1282} = 2,483 \mu F$$

Nº 4.8.1

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{42^2 + 56^2} = \underline{\underline{70 \Omega}}$$

Nº 4.8.2

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{320^2 - 120^2} = \underline{\underline{296,6 \Omega}}$$

Nº 4.8.3

$$R = \sqrt{Z^2 - X_L^2} = \sqrt{375^2 - 360^2} = \underline{\underline{105 \Omega}}$$

Nº 4.8.4

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{400^2 + 3200^2} = \underline{\underline{3285 \Omega}}$$

Nº 4.8.5

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{24^2 - 1,414^2} = \underline{\underline{23,96 k\Omega}}$$

Nº 4.8.6

$$X_L = W \cdot L = 2 \cdot \pi \cdot 50 \cdot 1,2 = 377 \Omega$$

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{120^2 + 377^2} = \underline{\underline{395,64 \Omega}}$$

Nº 4.8.7

$$Z = \frac{U}{I} = \frac{220}{0,045} = 4888,8 \Omega$$

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{4888,8^2 - 820^2} = \underline{\underline{4819,6 \Omega}}$$

Nº 4.8.8

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{6,45^2 - 0,6^2} = 6,42 k\Omega$$

$$L = \frac{X_L}{2 \cdot \pi \cdot f} = \frac{6420}{2 \cdot \pi \cdot 50} = \underline{\underline{20,44 H}}$$

Nº 4.8.9

$$\text{a) } Z = \frac{U}{I} = \frac{380}{8,4} = \underline{\underline{45,24 \Omega}} \quad \text{c) } R = \frac{U}{I} = \frac{24,2}{8,4} = \underline{\underline{2,88 \Omega}}$$

$$\text{b) } X_L = \sqrt{Z^2 - R^2} = \sqrt{45,24^2 - 2,88^2} = \underline{\underline{45,15 \Omega}}$$

Nº 4.8.10

$$Z = \frac{U}{I} = \frac{220}{0,016} = 13750 \Omega$$

$$X_L = \sqrt{Z^2 - R^2} = \sqrt{13,75^2 - 1,8^2} = \underline{\underline{13,63 k\Omega}}$$

Nº 4.8.11

$$\text{a) } I = \frac{U}{R} = \frac{36}{420} = \underline{\underline{85,71 mA}} \quad \text{|| } X_L = W \cdot L = 2 \cdot \pi \cdot 50 \cdot 6,3 = 1979,2 \Omega$$

$$\text{b) } Z = \sqrt{R^2 + X_L^2} = \sqrt{420^2 + 1979,2^2} = 2023,3 \Omega \quad \text{|| } I = \frac{U}{Z} = \frac{220}{2023,3} = \underline{\underline{108 mA}}$$

Nº 4.9. 1

$$S = U \cdot I = 220 \cdot 0,18 = \underline{\underline{39,6 \text{ VA}}}$$

Nº 4.9. 2

$$I = \frac{S}{U} = \frac{220}{36} = \underline{\underline{5,5 \text{ A}}}$$

Nº 4.9. 3

$$U = \frac{S}{I} = \frac{400}{11} = \underline{\underline{36,36 \text{ V}}}$$

Nº 4.9. 4

$$S = U \cdot I = 228 \cdot 0,0131 = \underline{\underline{2,978 \text{ VA}}}$$

Nº 4.9. 5

$$I = \frac{S}{U} = \frac{5200}{16} = \underline{\underline{325 \text{ A}}}$$

Nº 4.9. 6

$$U = \frac{S}{I} = \frac{350000}{620} = \underline{\underline{564,5 \text{ A}}}$$

Nº 4.9. 7

$$S = U \cdot I = 226 \cdot 0,4 = \underline{\underline{90,4 \text{ VA}}}$$

Nº 4.9. 8

$$I = \frac{S}{U} = \frac{1800}{13} = \underline{\underline{138,46 \text{ A}}}$$

Nº 4.9. 9

$$S = U \cdot I = 180 \cdot 0,24 = \underline{\underline{43,2 \text{ VA}}}$$

Nº 4.9. 10

$$S = U \cdot I = 230 \cdot 0,0435 = \underline{\underline{10 \text{ VA}}}$$

Nº 4.9. 11

$$S = U \cdot I = 14,4 \cdot 7,6 = \underline{\underline{109,44 \text{ MVA}}}$$

Nº 4.9. 12

$$S = U \cdot I = 132 \cdot 91 = \underline{\underline{12,01 \text{ MVA}}}$$

Nº 4.9. 13

$$S = U \cdot I = 70 \cdot 28,6 = \underline{\underline{2,002 \text{ mVA}}}$$

Nº 4. 10.1

$$S = \sqrt{P^2 - Q^2} = \sqrt{11^2 - 4,2^2} = \underline{\underline{11,77 \text{ MVA}}}$$

ou

$$\tan \varphi = \frac{Q}{P} = \frac{4,2}{11} = 0,3818 \Rightarrow \cos \varphi = 0,9342$$

$$S = \frac{P}{\cos \varphi} = \frac{11}{0,9342} = \underline{\underline{11,77 \text{ MVA}}}$$

Nº 4. 10.2

$$Q = \sqrt{S^2 - P^2} = \sqrt{125^2 - 80^2} = \underline{\underline{96,05 \text{ var}}}$$

ou

$$\cos \varphi = \frac{P}{S} = \frac{80}{125} = 0,64 \Rightarrow \sin \varphi = 0,768$$

$$Q = S \cdot \sin \varphi = 125 \cdot 0,768 = \underline{\underline{96,05 \text{ var}}}$$

Nº 4. 10.3

$$P = \sqrt{S^2 - Q^2} = \sqrt{72^2 - 45^2} = \underline{\underline{56,2 \text{ W}}}$$

ou

$$\sin \varphi = \frac{Q}{S} = \frac{45}{72} = 0,625 \Rightarrow \cos \varphi = 0,78$$

$$P = S \cdot \cos \varphi = 72 \cdot 0,78 = \underline{\underline{56,2 \text{ W}}}$$

Nº 4. 10.4

$$S = \sqrt{P^2 - Q^2} = \sqrt{24,2^2 - 14,8^2} = \underline{\underline{28,37 \text{ VA}}}$$

ou

$$\tan \varphi = \frac{Q}{P} = \frac{14,8}{24,2} = 0,61 \Rightarrow \cos \varphi = 0,853$$

$$S = \frac{P}{\cos \varphi} = \frac{24,2}{0,853} = \underline{\underline{28,37 \text{ VA}}}$$

Nº 4. 10.5

$$\cos \varphi = \frac{P}{S} = \frac{13,2}{16} = 0,825 \Rightarrow \sin \varphi = 0,565$$

$$Q = S \cdot \sin \varphi = 16 \cdot 0,565 = \underline{\underline{9,042 \text{ kvar}}}$$

Nº 4. 10.6

$$\sin \varphi = \frac{Q}{S} = \frac{221}{421} = 0,524 \Rightarrow \cos \varphi = 0,851$$

$$P = S \cdot \cos \varphi = 421 \cdot 0,851 = \underline{\underline{358,33 \text{ kW}}}$$

Nº 4. 11. 1

$$\cos \varphi = \frac{P}{S} = \frac{170}{265} = \underline{\underline{0,64}}$$

Nº 4. 11. 2

$$P = S \cdot \cos \varphi = 2,2 \cdot 0,628 = \underline{\underline{1,382 \text{ kW}}}$$

Nº 4. 11. 3

$$S = \frac{P}{\cos \varphi} = \frac{620}{0,82} = \underline{\underline{756,1 \text{ kVA}}}$$

Nº 4. 11. 4

$$P = S \cdot \cos \varphi = 1,2 \cdot 0,82 = 984 \text{ kW}$$

$$Q = \sqrt{S^2 - P^2} = \sqrt{1,2^2 - 0,984^2} = \underline{\underline{686,8 \text{ kvar}}}$$

Nº 4. 11. 5

$$\cos \varphi = \frac{P}{S} = \frac{2}{3,1} = \underline{\underline{0,645}}$$

Nº 4. 11. 6

$$P = S \cdot \cos \varphi = 32 \cdot 0,8 = \underline{\underline{25,6 \text{ MW}}}$$

Nº 4. 11. 7

$$S = \frac{P}{\cos \varphi} = \frac{5,4}{0,78} = \underline{\underline{6,923 \text{ MVA}}}$$

Nº 4. 11. 8

$$\text{a)} \cos \varphi 0,75 \Rightarrow \sin \varphi = \underline{\underline{0,66}}$$

$$\text{b)} Q = S \cdot \sin \varphi = 82 \cdot 0,66 = \underline{\underline{54,15 \text{ var}}}$$

Nº 4. 11. 9

$$S = U \cdot I = 220 \cdot 2 = 440 \text{ VA}$$

$$\cos \varphi = \frac{P}{S} = \frac{400}{440} = \underline{\underline{0,91}}$$

Nº 4. 11. 10

$$\text{a)} S = U \cdot I = 224 \cdot 0,055 = \underline{\underline{12,32 \text{ VA}}}$$

$$\text{b)} \cos 0,12 \Rightarrow \sin \varphi = \underline{\underline{0,992}}$$

$$\text{c)} P = S \cdot \cos \varphi = 12,32 \cdot 0,12 = \underline{\underline{1,47 \text{ W}}}$$

$$\text{d)} Q = \sqrt{S^2 - P^2} = \sqrt{12,32^2 - 1,47^2} = \underline{\underline{12,23 \text{ var}}}$$

Nº 4. 11. 11

a) $S = U \cdot I = 380 \cdot 11 = \underline{4202 \text{ VA}}$

b) $\cos \varphi = \frac{P}{S} = \frac{620}{4202} = \underline{0,1475}$

c) $Q = \sqrt{S^2 - P^2} = \sqrt{4202^2 - 620^2} = \underline{4156 \text{ var}}$

Nº 4. 11. 12

a) $P = U \cdot I \cdot \cos \varphi = 225 \cdot 0,41 \cdot 0,52 = \underline{47,97 \text{ W}}$

$S = U \cdot I = 225 \cdot 0,41 = 92,25 \text{ VA}$

b) $Q = \sqrt{S^2 - P^2} = \sqrt{92,25^2 - 47,97^2} = \underline{78,8 \text{ var}}$

Nº 4. 11. 13

$S = U \cdot I = 220 \cdot 0,575 = 131,1 \text{ VA}$

$\cos \varphi = \frac{P}{S} = \frac{72}{131,1} = \underline{0,55}$

Nº 4. 11. 14

$P = U \cdot I = 395 \cdot 6,6 = \underline{2607 \text{ kW}}$

Nº 4. 11. 15

$S = U \cdot I = 230 \cdot 0,15 = 34,5 \text{ VA}$

$\cos \varphi = \frac{P}{S} = \frac{28}{34,5} = \underline{0,811}$

Nº 4. 11. 16

$S = U \cdot I = 220 \cdot 2,2 = \underline{484 \text{ VA}}$

$\cos \varphi = \frac{P}{S} = \frac{100}{484} = \underline{0,206}$

Nº 4. 11. 17

$I = \frac{S}{U} = \frac{21}{24} = \underline{875 \text{ mA}}$

Nº 4. 11. 18

$P = U \cdot I \cdot \cos \varphi \Rightarrow I = \frac{P}{U \cdot \cos \varphi} = \frac{750}{220 \cdot 0,8} = \underline{4,26 \text{ A}}$

Nº 4. 11. 19

$U = \frac{P}{I \cdot \cos \varphi} = \frac{10}{0,43 \cdot 0,5} = \underline{46,51 \text{ V}}$

Nº 4. 11. 20

$$\begin{aligned} \text{c)} P &= P + P = 40 + 10 = \underline{\underline{50 \text{ W}}} \\ \text{a)} S &= U \cdot I = 220 \cdot 0,43 = \underline{\underline{94,6 \text{ VA}}} \\ \text{b)} Q &= \sqrt{S^2 - P^2} = \sqrt{94,6^2 - 50^2} = \underline{\underline{80,3 \text{ var}}} \end{aligned}$$

Nº 4. 11. 21

$$\begin{aligned} \text{a)} S &= U \cdot I = 135 \cdot 2,1 = \underline{\underline{283,5 \text{ VA}}} \\ \text{b)} Q &= \sqrt{S^2 - P^2} = \sqrt{283,5^2 - 250^2} = \underline{\underline{133,68 \text{ var}}} \\ \text{c)} \cos \varphi &= \frac{P}{S} = \frac{250}{283,5} = \underline{\underline{0,88}} \end{aligned}$$

Nº 4. 11. 22

$$P = U \cdot I \cdot \cos \varphi \Rightarrow I = \frac{P}{U \cdot \cos \varphi} = \frac{280}{218 \cdot 0,366} = \underline{\underline{3,51 \text{ A}}}$$

Nº 4. 11. 23

$$U = \frac{P}{I \cdot \cos \varphi} = \frac{14}{0,18 \cdot 0,33} = \underline{\underline{235,7 \text{ V}}}$$

Nº 4. 11. 24

$$S = U \cdot I \Rightarrow I = \frac{S}{U} = \frac{1240}{66} = \underline{\underline{18,78 \text{ A}}}$$

Nº 4. 11. 25

$$\text{c)} I = \frac{S}{U} = \frac{3500}{3,5} = \underline{\underline{1 \text{ kA}}}$$

$$\text{a)} P = S \cdot \cos \varphi = 3500 \cdot 0,7 = \underline{\underline{2450 \text{ kW}}}$$

$$\text{b)} Q = \sqrt{S^2 - P^2} = \sqrt{3500^2 - 2450^2} = \underline{\underline{2499,5 \text{ kvar}}}$$

Nº 4.12.1

$$I = \sqrt{I_R^2 + I_C^2} = \sqrt{12^2 + 8^2} = \underline{14,42 \text{ A}}$$

Nº 4.12.2

$$I_C = \sqrt{I^2 - I_R^2} = \sqrt{32^2 - 10^2} = \underline{30,4 \text{ A}}$$

Nº 4.12.3

$$I_C = \sqrt{I^2 - I_R^2} = \sqrt{320^2 - 200^2} = \underline{249,8 \text{ A}}$$

Nº 4.12.4

$$I = \sqrt{I_C^2 + I_R^2} = \sqrt{6,5^2 + 8^2} = \underline{10,31 \text{ A}}$$

Nº 4.12.5

$$I = I_R \cdot \cos \varphi = 15 \cdot 0,707 = \underline{10,61 \text{ A}}$$

Nº 4.12.6

$$\cos \varphi = 0,4 \Rightarrow \sin \varphi = 0,9165$$

$$I_C = I \cdot \sin \varphi = 3,2 \cdot 0,9165 = \underline{2,93 \text{ A}}$$

Nº 4.12.7

$$I_R = I \cdot \cos \varphi = 432 \cdot 0,79 = \underline{341,3 \text{ A}}$$

Nº 4.12.8

$$\cos \varphi 0,2 \Rightarrow \sin \varphi = 0,97$$

$$I_C = I \cdot \sin \varphi = 5,4 \cdot 0,9797 = \underline{5,291 \text{ A}}$$

Nº 4.12.9

$$a) I_R = I \cdot \cos \varphi = 275 \cdot 0,62 = \underline{170,5 \text{ A}}$$

$$\cos \varphi 0,62 \Rightarrow \sin \varphi = 0,784$$

$$b) I_C = I \cdot \sin \varphi = 275 \cdot 0,784 = \underline{215,76 \text{ A}}$$

Nº 4.12.10

$$S = U \cdot I = 220 \cdot 2,5 = 550 \text{ VA}$$

$$a) \cos \varphi = \frac{P}{S} = \frac{450}{550} = \underline{0,818} \Rightarrow \sin \varphi = 0,574$$

$$b) I_R = I \cdot \cos \varphi = 2,5 \cdot 0,818 = \underline{2,045 \text{ A}}$$

$$c) I_C = I \cdot \sin \varphi = 2,5 \cdot 0,574 = \underline{1,437 \text{ A}}$$

Nº 4.12.M

$$\cos \varphi = \frac{P}{S} = \frac{2,6}{12} = 0,216$$

$$\cos 0,216 \Rightarrow \sin \varphi = 0,976$$

a) $I = \frac{S}{U} = \frac{12}{220} = \underline{\underline{54,54 \text{ mA}}}$

b) $I_R = I \cdot \cos \varphi = 54,54 \cdot 0,216 = \underline{\underline{11,82 \text{ mA}}}$

c) $I_C = I \cdot \sin \varphi = 54,54 \cdot 0,976 = \underline{\underline{53,26 \text{ mA}}}$

Nº 4.12.11

$$S = U \cdot I = 216 \cdot 0,58 = 125,28 \text{ VA}$$

$$\cos \varphi = \frac{P}{S} = \frac{105}{125,28} = \underline{\underline{0,838}}$$

$$\cos 0,838 \Rightarrow \sin \varphi = 0,5454$$

a) $I_R = I \cdot \cos \varphi = 0,58 \cdot 0,838 = \underline{\underline{486,1 \text{ mA}}}$

b) $I_C = I \cdot \sin \varphi = 0,58 \cdot 0,5454 = \underline{\underline{316,4 \text{ mA}}}$

Nº 4.13.1

$$W = P \cdot t = 1,2 \cdot 5,5 = \underline{\underline{6,6 \text{ kWh}}}$$

Nº 4.13.2

$$P = \frac{W}{t} = \frac{10,8}{6} = \underline{\underline{1,8 \text{ kW}}}$$

Nº 4.13.3

$$t = \frac{W}{P} = \frac{20}{2,4} = \underline{\underline{8 \frac{5}{6} \text{ h}}} = \underline{\underline{8 \text{ h } 20 \text{ min}}}$$

Nº 4.13.4

$$W = P \cdot t = 12 \cdot 9,33' = \underline{\underline{112 \text{ kvarh}}}$$

Nº 4.13.5

$$4 \text{ h } 45 \text{ min} = 4,75 \text{ h}$$

$$t = t \cdot n = 4,75 \cdot 30 = 142,5 \text{ h}$$

$$W = P \cdot t = 0,08 \cdot 142,5 = \underline{\underline{11,4 \text{ kWh}}}$$

Nº 4.13.6

$$8 \text{ h } 15 \text{ min} = 8,25 \text{ h}$$

$$W = P \cdot t = 0,18 \cdot 8,25 = \underline{\underline{1,485 \text{ kvarh}}}$$

Nº 4.13.7

$$2 \text{ h } 25 \text{ min} = 2,416 \text{ h}$$

$$P = \frac{W}{t} = \frac{3,8}{2,416} = \underline{\underline{1,49 \text{ kW}}}$$

Nº 4.13.8

a) $t = \frac{W}{P} = \frac{1}{0,025} = \underline{\underline{40 \text{ h}}}$

b) $t = \frac{W}{P} = \frac{1}{0,04} = \underline{\underline{25 \text{ h}}}$

c) $t = \frac{W}{P} = \frac{1}{0,075} = \underline{\underline{13 \text{ h } 20 \text{ min}}}$

d) $t = \frac{W}{P} = \frac{1}{0,1} = \underline{\underline{10 \text{ h}}}$

Nº 4.13.9

$$t - t_1 - t_2 = 8,15 - 6,15 = 2 \text{ h}$$

$$t = t_1 - t_2 = 18,30 - 17,1 = 1 \text{ h } 20 \text{ min}$$

$$t = t + t = 2 + 1,33 = 3,333 \text{ h}$$

$$P = P \cdot n = 46 \cdot 30 = 1,38 \text{ kW}$$

$$W = P \cdot t = 1,38 \cdot 3,33 = \underline{\underline{4,6 \text{ kWh}}}$$

Nº 4.13.10

$$P = \frac{W}{t} = \frac{14600}{24} = \underline{\underline{608,3 \text{ kvar}}}$$

Nº 4.13.11

$$t = \frac{W}{P} = \frac{4}{48} = 0,083 \text{ h}$$

$$t = \text{h} \cdot 60 = 0,083 \cdot 60 = \underline{\underline{5 \text{ min}}}$$

Nº 4.13.12

$$\frac{1}{25} \text{ de kW} = 0,04 \text{ kW}$$

$$P_1 = P_2 = \frac{0,04}{n} = \frac{0,04}{0,5} = 0,08 \text{ kW}$$

$$W = P \cdot t = 0,08 \cdot 370 = \underline{\underline{29,6 \text{ kWh}}}$$

Nº 4.13.13

$$S = U \cdot I = 225 \cdot 1,33 = 299,25 \text{ VA}$$

$$P = U \cdot I \cdot \cos \varphi = 225 \cdot 1,33 \cdot 0,8 = 239,4 \text{ W}$$

$$\cos \varphi 0,8 \Rightarrow \sin \varphi = 0,6$$

$$Q = S \cdot \sin \varphi = 299,25 \cdot 0,6 = 179,5 \text{ var}$$

$$\text{a) } W = P \cdot t = 0,2394 \cdot 24 = \underline{\underline{5,745 \text{ kWh}}}$$

$$\text{b) } W = P \cdot t = 0,1795 \cdot 24 = \underline{\underline{4,306 \text{ kvarh}}}$$

Nº 4.13.14

$$S = U \cdot I = 226 \cdot 11,9 = 2689,4 \text{ VA}$$

$$P = \frac{W}{t} = \frac{12}{5} = 2,4 \text{ kW}$$

$$\cos \varphi = \frac{P}{S} = \frac{1200}{2689,4} = \underline{\underline{0,892}}$$

Nº 4.13.15

$$S = \sqrt{P^2 + Q^2} = \sqrt{120^2 + 72^2} = 139,95 \text{ kVA}$$

$$\cos \varphi = \frac{P}{S} = \frac{120}{139,95} = \underline{\underline{0,857}}$$

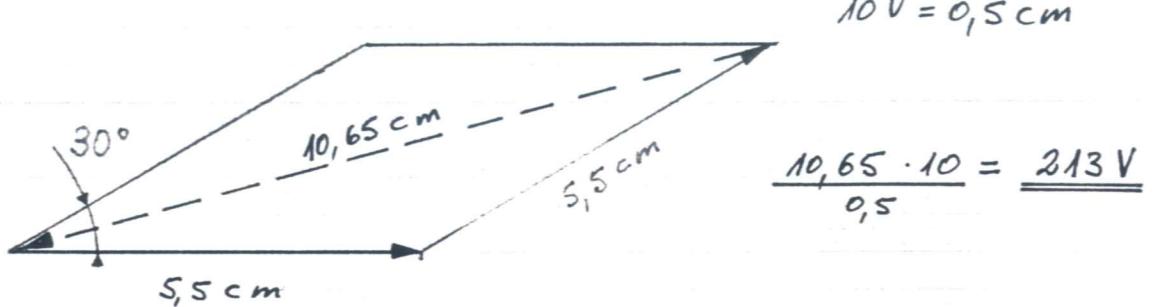
Nº 4.13.16

$$t = h \cdot n = 8 \cdot 30 = 240 \text{ h}$$

$$P = S \cdot \cos \varphi = 12 \cdot 0,42 = 5,04 \text{ W}$$

$$W = 0,00504 \cdot 240 = \underline{\underline{1,21 \text{ kWh}}}$$

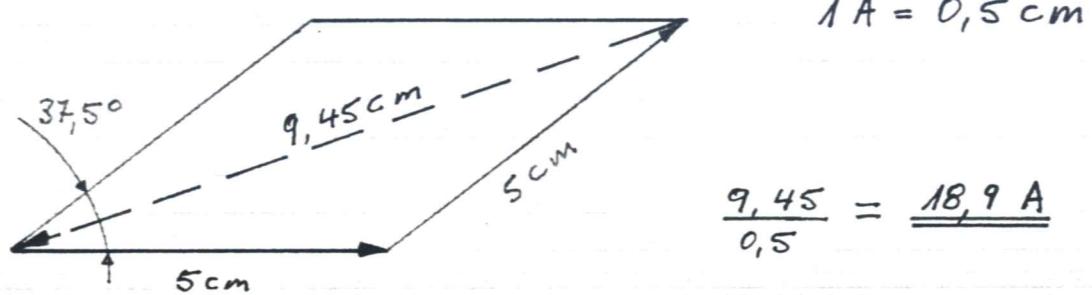
Nº 4.14.1



$$10V = 0,5 \text{ cm}$$

$$\frac{10,65 \cdot 10}{0,5} = \underline{\underline{213V}}$$

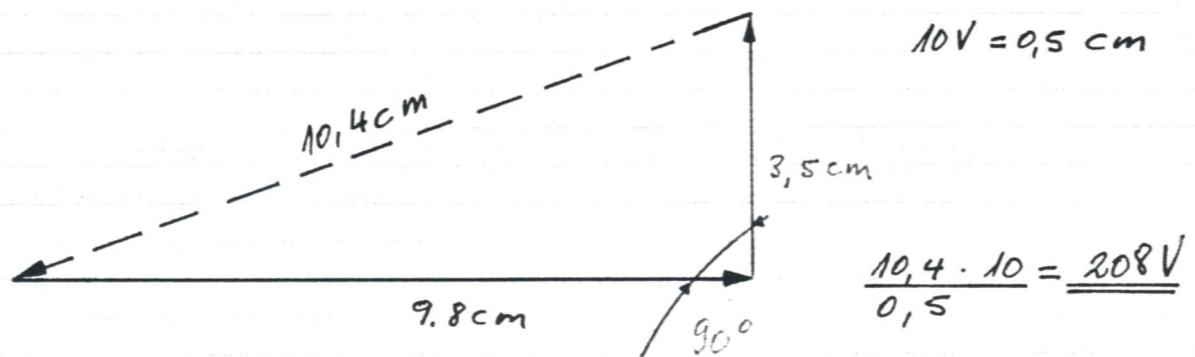
Nº 4.14.2



$$1A = 0,5 \text{ cm}$$

$$\frac{9,45}{0,5} = \underline{\underline{18,9A}}$$

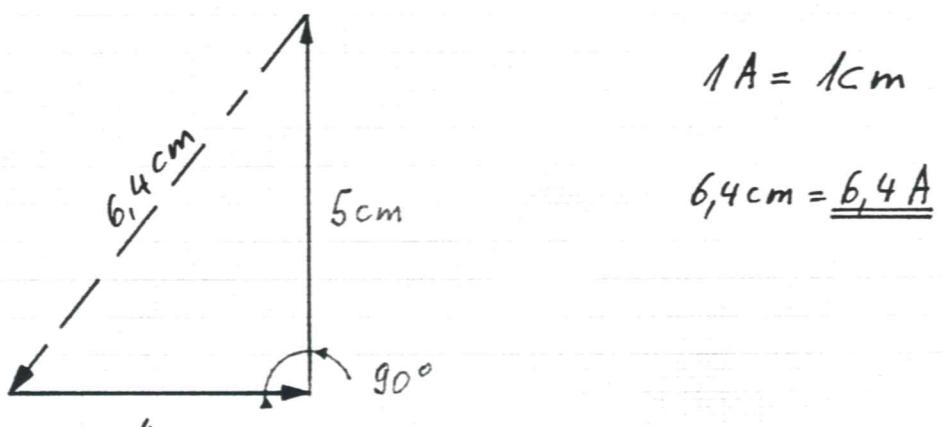
Nº 4.14.3



$$10V = 0,5 \text{ cm}$$

$$\frac{10,4 \cdot 10}{0,5} = \underline{\underline{208V}}$$

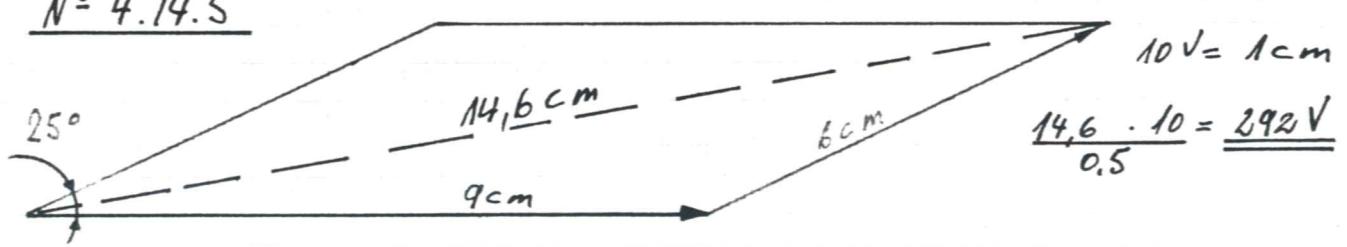
Nº 4.14.4



$$1A = 1\text{cm}$$

$$6,4\text{cm} = \underline{\underline{6,4A}}$$

Nº 4.14.5

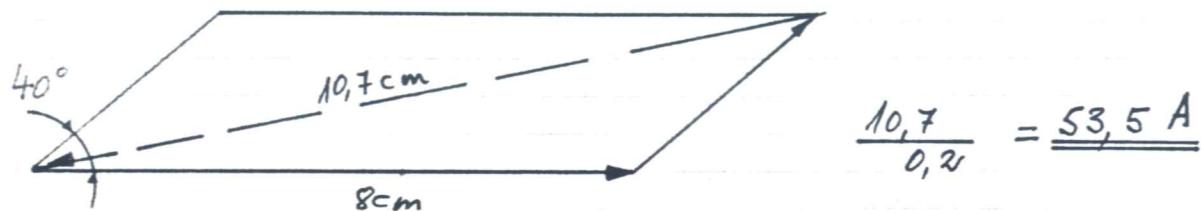


$$10V = 1\text{cm}$$

$$\frac{14,6 \cdot 10}{0,5} = \underline{\underline{292V}}$$

Nº 4.14.6

$$1A = 0,2 \text{ cm}$$



$$\frac{10,7}{0,2} = \underline{\underline{53,5 \text{ A}}}$$

Nº 4.14.7

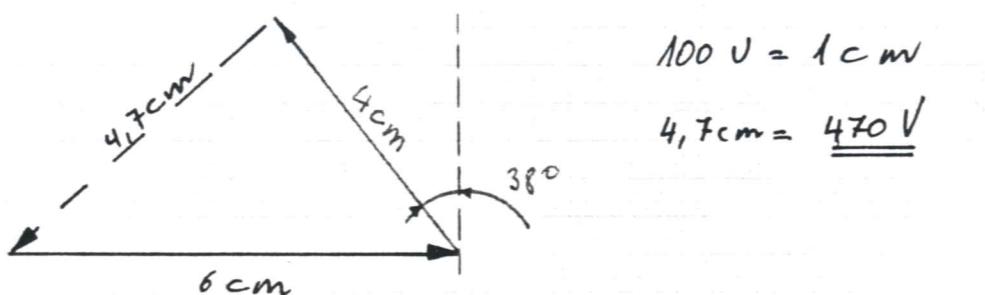
$$10 V = 1 \text{ cm}$$



$$7,7 \cdot 10 = \underline{\underline{77 \text{ V}}}$$

Nº 4.14.9

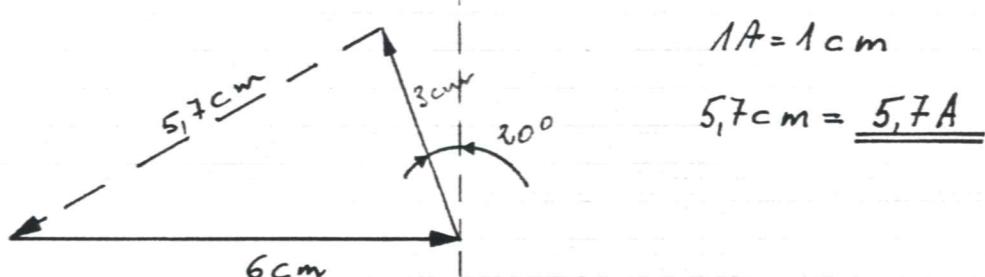
$$100 \text{ V} = 1 \text{ cm}$$



$$4,7 \text{ cm} = \underline{\underline{470 \text{ V}}}$$

Nº 4.14.10

$$1A = 1 \text{ cm}$$

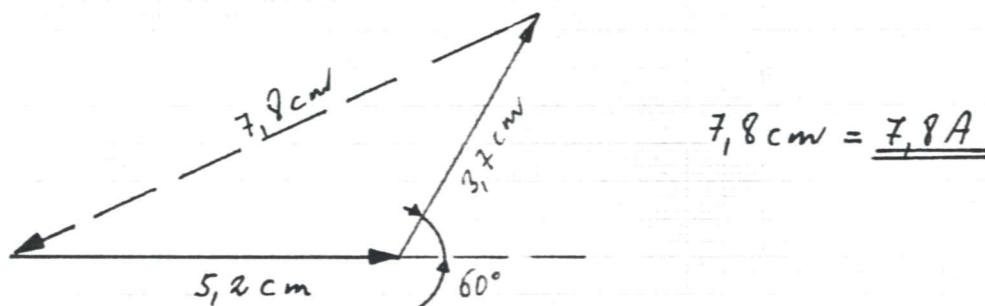


$$5,7 \text{ cm} = \underline{\underline{5,7 \text{ A}}}$$

8

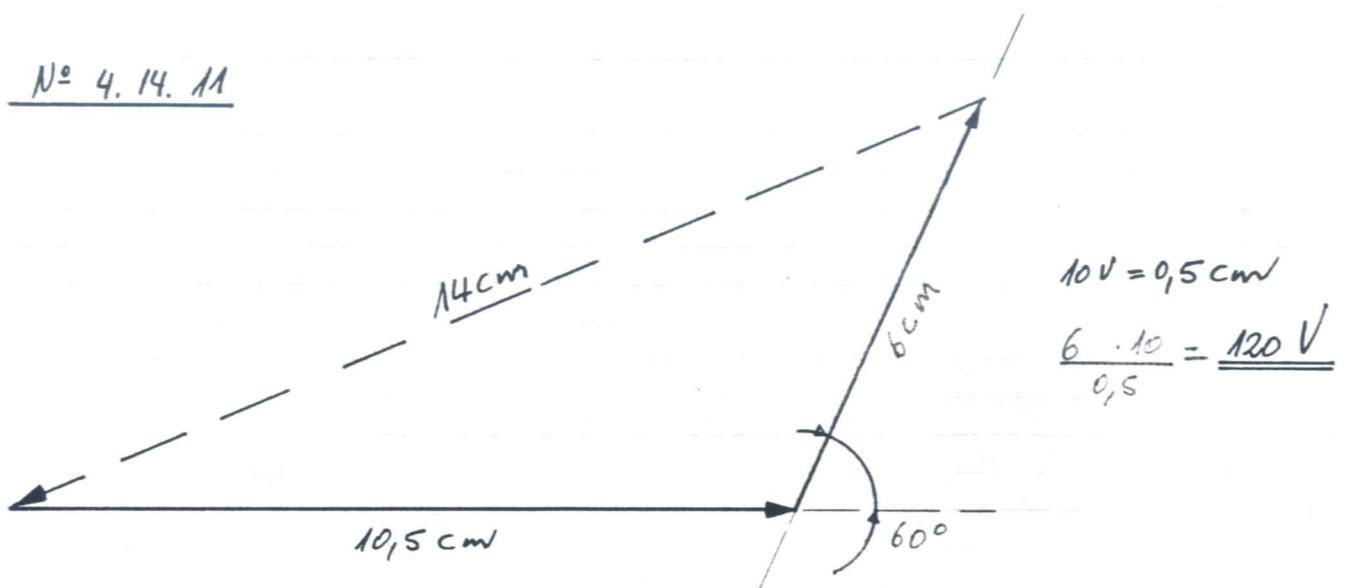
Nº 4.14.8

$$1A = 1 \text{ cm}$$



$$7,8 \text{ cm} = \underline{\underline{7,8 \text{ A}}}$$

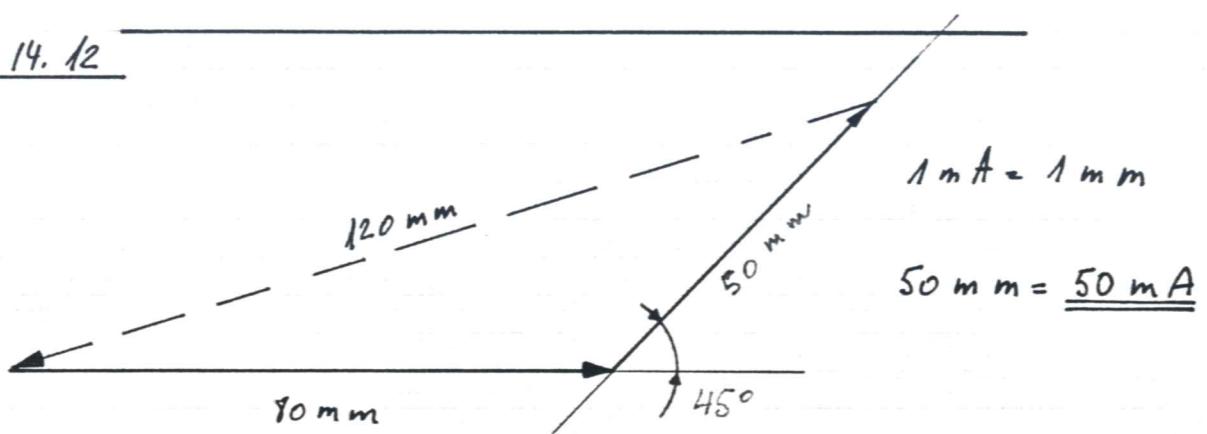
Nº 4. 14. 11



$$10 \text{ V} = 0,5 \text{ cm/V}$$

$$\frac{6 \cdot 10}{0,5} = \underline{\underline{120 \text{ V}}}$$

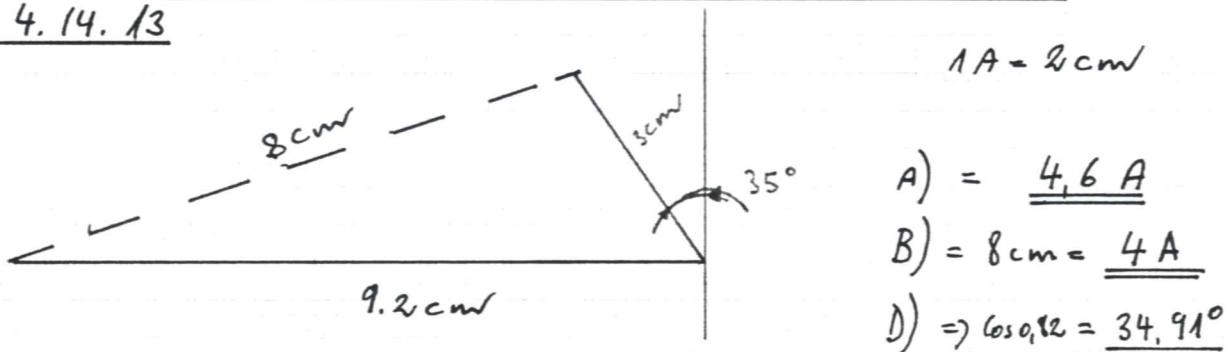
Nº 4. 14. 12



$$1 \text{ mA} = 1 \text{ mm}$$

$$50 \text{ mm} = \underline{\underline{50 \text{ mA}}}$$

Nº 4. 14. 13



$$1 \text{ A} = 2 \text{ cm}$$

$$A) = \underline{\underline{4,6 \text{ A}}}$$

$$B) = 8 \text{ cm} = \underline{\underline{4 \text{ A}}}$$

$$D) \Rightarrow \cos 0,35 = \underline{\underline{34,91^\circ}}$$

$$C) = 0,93$$

$$S = U \cdot I = 226 \cdot 4 = 904 \text{ VA}$$

$$Q = U \cdot I = 226 \cdot 1,5 = 339 \text{ var}$$

$$E) = 22^\circ$$

$$C \Rightarrow P = \sqrt{S^2 - Q^2} = \sqrt{904^2 - 339^2} = 838 \text{ W}$$

$$\cos \varphi = \frac{P}{S} = \frac{838}{904} = \underline{\underline{0,927}}$$