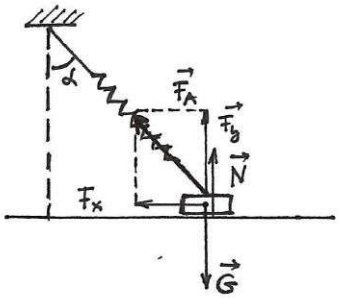
VERMES MIKLÓS Fizikaverseny

III. forduló
2019. április 6.
XI. osztály

JAVÍTÓKULCS

I. feladat



$F_y = G$ $\quad (N = 0)$ 0,5 p

$k(l - l_0)\cos\alpha = mg$ 1 p

$\cos\alpha = l_0/l \quad \rightarrow \quad l = l_0/\cos\alpha$ 0,5 p

$kl_0(1/\cos\alpha - 1)\cos\alpha = mg$

$kl_0(1 - \cos\alpha) = mg$ $\quad tg\alpha = A/l_0 \quad \Rightarrow$ 1 p

$$\Rightarrow \quad \tan(\alpha)=\frac{\sin(\alpha)}{\cos(\alpha)}=\frac{\sqrt{1-(\cos(\alpha))^2}}{\cos(\alpha)}$$

$\Rightarrow \quad tg^2\alpha\cos^2\alpha = 1-\cos^2\alpha$

$$\cos^2\alpha \quad \frac{1}{1+(\tan(\alpha))^2}=\frac{1}{1+\frac{A^2}{l_0^2}}=\frac{l_0^2}{l_0^2+A^2}$$ 1 p

$$kl_0\left(1-\frac{l_0}{\sqrt{l_0^2+A^2}}\right)=mg$$ 1 p

$$\frac{m}{k}=\frac{l_0}{g}\cdot\left(1-\frac{l_0}{\sqrt{l_0^2+A^2}}\right)$$ 2 p $\qquad T=2\pi\sqrt{\frac{m}{k}}$ 0,5 p

$$T_2=2\pi\sqrt{\frac{l_0}{g}\cdot\left(1-\frac{l_0}{\sqrt{l_0^2+A^2}}\right)}$$ 1 p

$$T_1=2\pi\sqrt{\frac{m}{k}}$$ 0,5 p

$$T_2=T_1\sqrt{1-\frac{l_0}{\sqrt{l_0^2+A^2}}}$$ $\qquad T_2 < T_1$ 1 p

II. feladat

a)

$v = \sqrt{\frac{E}{\rho}} = \sqrt{\frac{EV}{m}}$ 1 p

$V/T = V_0/T_0$ $V = V_0 \cdot T/T_0 = V_0 \cdot (t + 1/\alpha)/T_0 = V0 \cdot (\alpha t + 1)/\alpha T_0 = V_0(1 + \alpha t)$ 1 p

$v = \sqrt{\frac{EV_0}{m}} \cdot \sqrt{1 + \alpha t} = c\sqrt{1 + \alpha t}$ 1 p

$l_k = (2k - 1) \cdot \lambda/4$ $l_k = (2k - 1) \cdot c/4v$ → $v_k = (2k - 1) \cdot c/4l_k$

$l_k = (2k - 1) \cdot c_0/4v \cdot \sqrt{1 + \alpha t}$ $n = 1, 2, 3$ 1 p

$l_1 = 0{,}363\ m$ 0,5 p

$l_2 = 3l_1 = 1{,}089\ m$ 0,5 p

$l_3 = 5l_1 = 1{,}815\ m$ 0,5 p

b) $l_2 + \Delta l = 3c_0/4v\sqrt{1 + \alpha t}$ $(l_2 + \Delta l) \cdot 4/3 \cdot v/c_0 = \sqrt{1 + \alpha t}$

$((l_2 + \Delta l)2 \cdot 16/9 \cdot v^2/c_0^2 - 1) \cdot 1/\alpha = t$ 2 p

$$t_1 = \left(\frac{(l_2 + \Delta l)^2 \cdot 16}{9} \cdot \frac{v^2}{c_0^2} - 1 \right) \frac{1}{\alpha} = 67{,}72\,^oC$$ 1 p

$\Delta t = t_1 - t = 10{,}39^oC$ melegítjük

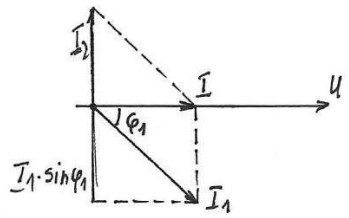
$$t_2 = \left(\frac{(l_2 - \Delta l)^2 \cdot 16}{9} \cdot \frac{v^2}{c_0^2} - 1 \right) \frac{1}{\alpha} = 47{,}097\,^oC$$ 1 p

$\Delta t_2 = t_2 - t = -10{,}23^oC$ lehűtjük, ha közelítjük a dugattyút. 0,5 p

III. feladat

a) rajz 0,5 p

$I_1 \cdot \sin\varphi_1 = I_2$ 0,5 p



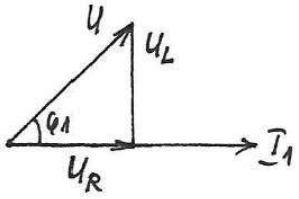
rajz 0,25 p

$I_1 = U/Z_1$ 0,25 p

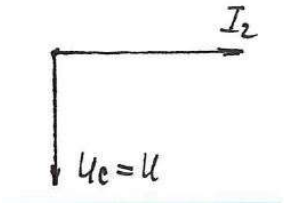
$Z_1 = \sqrt{R^2 + X_L^2}$ 0,25 p

$X_L = \omega L = 2\pi\nu L = 8\ \Omega$ $Z_1 = 10\ \Omega$ 0,25 p

$\sin\varphi_1 = U_L/U = IX_L/IZ_1 = X_L/Z_1 = 0{,}8$ 0,5 p



rajz 0,25 p

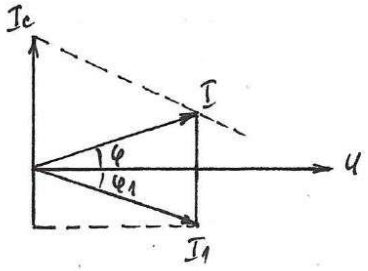


$I_2 = U_C/X_C = U/X_C$ 0,25 p
$U/Z_1 \bullet X_L/Z_1 = U/X_C$ 0,25 p $\Rightarrow$ $X_C = Z_1^2/X_L$ 0,25 p
$\Rightarrow$ $c = X_L/(\omega Z_1^2)$ $\Rightarrow$ $c_0 = 1/(2\pi)\bullet 10^{-4} = 15{,}9\ \mu F$ 0,5 p

b)

$I_L = I_C$ $\Rightarrow$ $U/Z_1 = U/X_C$ 0,5 p $\Rightarrow$
$\omega C_1 = 1/Z_1$ $\Rightarrow$ $C_1 = 1/\omega Z_1 = 10^{-3}/16\pi = 19{,}9\ \mu F$ 0,5 p

rajz 0,5 p



$tg\varphi = (I_C - I_L \sin\varphi)/I_L \cos\varphi$ 0,5 p
$I_L = I_C$ $\rightarrow$ $tg\varphi = (1 - \sin\varphi_1)/\cos\varphi_1$ 0,25 p
$\sin\varphi_1 = X_L/Z_1$ $\cos\varphi_1 = R/Z_1$ 0,25 p
$tg\varphi = (1 - X_L/Z_1)/(R/Z_1) = (Z_1 - X_L)/R = 1/3$ 0,5 p

c)

1) $I = I_1 \cos\varphi_1$ $I_1 = U/Z_1$ $\rightarrow$ $U = (IZ_1)/\cos\varphi_1$ 0,5 p
$\cos\varphi_1 = R/Z_1$ $\rightarrow$ $U = (IZ_1^2)/R = (20\bullet 100)/6 = 1/3\bullet 10^3 V$ 0,5 p
$U_L = I_1 X_L = (U/Z_1)\bullet X_L = 800/3 = 266{,}6\ V$ 0,5 p

2) $I_L \cos\varphi_1 = I\cos\varphi$ $I_L = I\bullet(\cos\varphi/\cos\varphi_1)$ 0,5 p $\cos\varphi = \dfrac{1}{\sqrt{1+tg^2\varphi}} = \dfrac{3}{\sqrt{10}}$ 0,25 p

$\cos\varphi_1 = R/Z_1 = 0{,}6$ $\rightarrow$ $I_2 = \dfrac{20\cdot\frac{3}{\sqrt{10}}}{\frac{6}{10}} = 10\sqrt{10}\,A$ 0,25 p

$U = I_L \cdot Z_1 = 100\sqrt{10}\,V = 316{,}22\,V$ 0,25 p

$U_L = I_L \cdot X_L = 10\sqrt{10}\cdot 8 = 80\sqrt{10}\,V = 252{,}98\,V$ 0,25 p