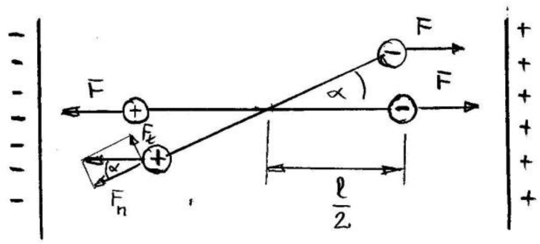
CLASA a XII - a * Rezolvări şi bareme*

Problema I

$$F_{rev} = -F\sin\alpha \simeq -qE\alpha$$

$$\alpha = \frac{x}{\frac{l}{2}}$$



1 punct

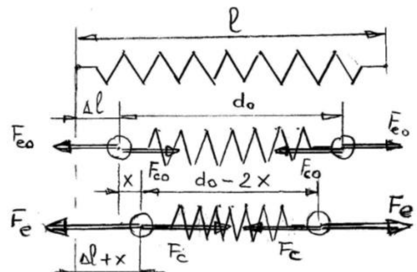
$$\Rightarrow F_{rev} = -\frac{2qE}{l}x = -kx$$

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{ml}{2qE}}$$ 1punct

În starea de echilibru forța elastică (F_{eo}) este egală cu forța coulombiană (F_{co})

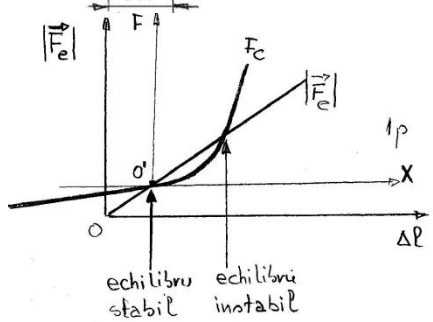
$$F_{eo} = F_{co}$$

$$\left.\begin{aligned} k\Delta l &= \frac{1}{4\pi\varepsilon_0}\frac{q^2}{(l-2\Delta l)^2} \\ l-2\Delta l &= d_0 \end{aligned}\right\}$$ 1 punct



1 punct

$$\Rightarrow k\Delta l = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{d_0^2}$$



1 punct

În timpul oscilației:

$$\left.\begin{aligned} \left|\vec{F_e}\right| &= k(\Delta l + x) \\ \left|\vec{F_c}\right| &= \frac{1}{4\pi\varepsilon_0}\frac{q^2}{d_0\left(1-\frac{2x}{d_0}\right)^2} \end{aligned}\right\}$$ 1 punct

$$\left.\begin{aligned} \frac{2x}{d_0} \ll 1 &\Rightarrow \frac{1}{\left(1-\frac{2x}{d_0}\right)^2} \simeq 1 + 2\frac{2x}{d_0} \\ \left|\vec{F_c}\right| &= \frac{q^2}{4\pi\varepsilon_0 d_0^2}\left(1+\frac{4x}{d_0}\right) \end{aligned}\right\}$$ 1 punct

$$\left.\begin{aligned} F_{rev} &= F_c - F_e = \frac{q^2}{4\pi\varepsilon_0 d_0^2} + \frac{q^2}{4\pi\varepsilon_0 d_0^2}\frac{4x}{d_0} - k(\Delta l + x) \\ \Rightarrow F_{rev} &= -\left(k - \frac{4q^2}{4\pi\varepsilon_0 d_0^3}\right)x = -K_e x \end{aligned}\right\}$$ 1 punct

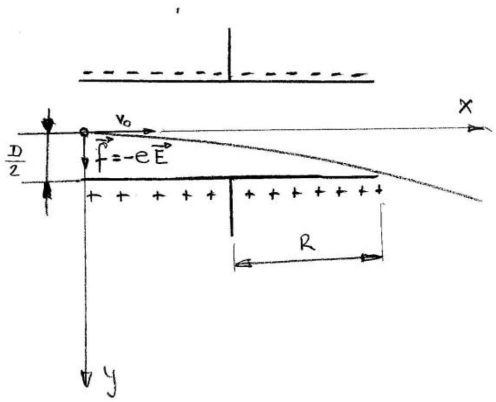
$$T = 2\pi\sqrt{\frac{m}{K_e}}$$ 1 punct

Problema II

$$h\upsilon = L_{extr.} + \frac{mv_0^2}{2}$$

$$v_0^2 = \frac{2}{m}\left(h\frac{c}{\lambda} - L_{extr.}\right) \quad (1)$$

1 punct



1 punct

$$\frac{D}{2} = \frac{1}{2}at^2 = \frac{1}{2}\frac{eE}{m}t^2$$

$$2R = v_0 t \Rightarrow t = \frac{2R}{v_0}$$

1 punct

$$D = \frac{eE}{m}\cdot\frac{4R^2}{v_0^2}$$ 1 punct

$$v_0^2 = \frac{eE}{mD}\cdot 4R^2 \quad (2)$$ 1 punct

Din (1) și (2) $\Rightarrow \frac{2}{m}\left(\frac{hc}{\lambda} - L_{extr.}\right) = \frac{eE}{mD}4R^2$ 1 punct

$$\lambda_{\max} = \frac{hc}{L_{extr.} + \frac{2eER^2}{D}}$$ 1 punct

$$\lambda_{\max} = \frac{hc}{L_{extr.}\left(1 + \frac{2eER^2}{DL_{extr.}}\right)}$$ 1 punct

unde $\frac{hc}{L_{extr.}} = \lambda_{\text{prag rosu}} \Rightarrow \lambda_{\max} < \lambda_{\text{prag rosu}} \Rightarrow$ fotoelectronul iese dintre plăci pentru $\lambda \le \lambda_{\max}$ 1 punct

Problema III

Fie l_0 lungimea proprie a riglei (în sistemul S` în care ea este în repaus).

În sistemul S, considerat în repaus, faţă de care rigla se mişcă cu viteza *v*, lungimea riglei are valoarea:

$$l^* = l_0\sqrt{1-\frac{v^2}{c^2}}\ .$$ 1 punct

Semnalele care ajung simultan la observator au pornit de la capetele riglei la momentele t_1 şi t_2, timp în care rigla străbate distanţa $V(t_2-t_1)$, observatorul înregistrând o lungime aparentă l_0 .

Momentul t când undele luminoase ajung la observator pot fi calculate ca fiind:

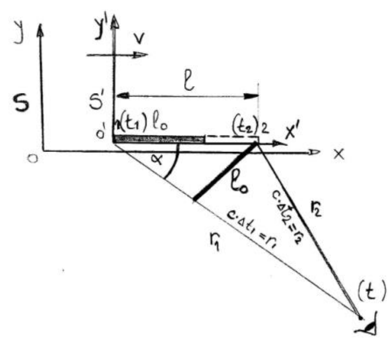
$$\left.\begin{aligned} t &= t_1+\Delta t_1 = t_1+\frac{r_1}{c} \\ t &= t_2+\Delta t_2 = t_2+\frac{r_2}{c} \end{aligned}\right| \Rightarrow t_1+\frac{r_1}{c} = t^2+\frac{r_2}{c} \Rightarrow t_2-t_1 = \frac{r_1}{c}-\frac{r_2}{c}$$ 1 punct

$$t_2-t_1 = \frac{1}{c}(r_1-r_2)$$

Dar $l = l^*+v(t_2-t_1) = l^*+\frac{v}{c}(r_1-r_2)$ iar $r_1-r_2 \simeq l\cos\alpha$

$$\Rightarrow l = l_0\sqrt{1-\frac{v^2}{c^2}}+\frac{v}{c}l\cos\alpha \qquad l\left(1-\frac{v}{c}\cos\alpha\right) = l_0\sqrt{1-\frac{v^2}{v^2}}$$ 1 punct

Dar lungimea aparentă înregistrată poate fi scrisă ca: $l_0 = l\sin\alpha \Rightarrow l = \frac{l_0}{\sin\alpha}$ 1 punct



$$\Rightarrow \frac{l_0}{\sin\alpha}\left(1-\frac{v}{c}\cos\alpha\right) = l_0\sqrt{1-\frac{v^2}{c^2}}\Bigg|^2$$

$$\frac{1}{\sin^2\alpha}\left(1-\frac{v}{c}\cos\alpha\right)^2 = 1-\frac{v^2}{c^2}$$

$$\frac{1}{\sin^2\alpha}\left(1-2\frac{v}{c}\cos\alpha+\frac{v^2}{c^2}\cos^2\alpha\right) = 1-\frac{v^2}{c^2}\ \Big|\sin^2\alpha$$

$$1-2\frac{v}{c}\cos\alpha+\frac{v^2}{c^2}\cos^2\alpha = \sin^2\alpha-\frac{v^2}{c^2}\sin^2\alpha$$

$$\frac{v^2}{c^2}\underbrace{\left(\sin^2\alpha+\cos^2\alpha\right)}_{1}-2\frac{v}{c}\cos\alpha+1-\sin^2\alpha = 0$$ 1 punct

$$\frac{v^2}{c^2}-2\frac{v}{c}\cos\alpha+\cos^2\alpha = 0\Big|c^2$$

$$v^2-2vc\cdot\cos\alpha+c^2\cdot\cos^2\alpha = 0$$ 4 puncte

$$\Delta = 4c^2\cos^2\alpha-4c^2\cos^2\alpha = 0$$

$$v = \frac{-b}{2a} = \frac{+2c\cdot\cos\alpha}{2} = c\cdot\cos\alpha$$

NOTĂ: Se acordă câte un punct din oficiu pentru fiecare problemă. Orice altă rezolvare corectă se punctează corespunzător.