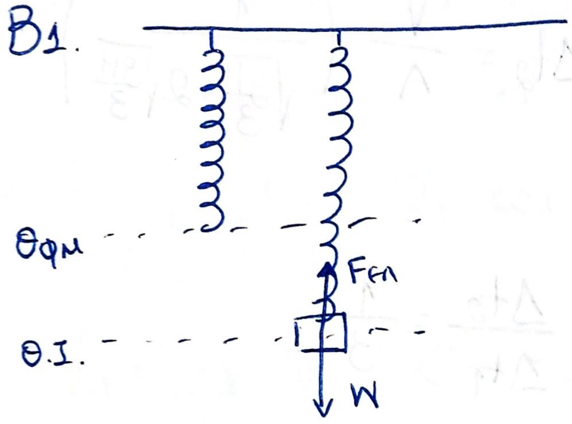
ΦΥΣΙΚΗ

ΘΕΜΑ Α

A1. γ A2. δ A3. γ A4. β A5. α.1 β.2 γ.1 δ.2 ε.2

ΘΕΜΑ Β

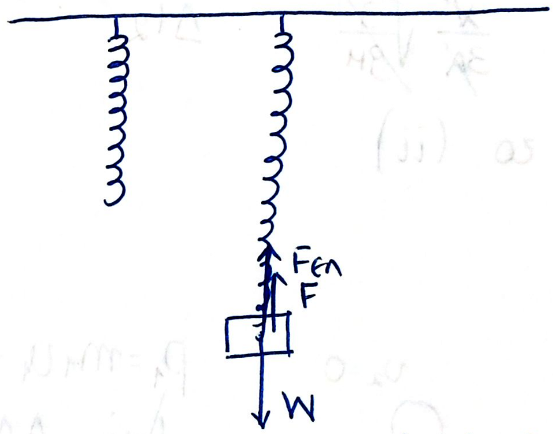
Β1.



Θ.Ι.: $\Sigma F = 0 \Rightarrow F_{ελ} = W \Rightarrow k\Delta l_1 = mg \Rightarrow \Delta l_1 = \frac{mg}{k}$

Πείραμα 1ο: $A_1 = \Delta l_1 = \frac{mg}{k}$ (1)

Πείραμα 2ο:



Ν.Θ.Ι: $\Sigma F = 0 \Rightarrow F_{ελ} + F = W \Rightarrow k\Delta l_2 + mg = mg \Rightarrow k\Delta l_2 = 0 \Rightarrow \Delta l_2 = 0$

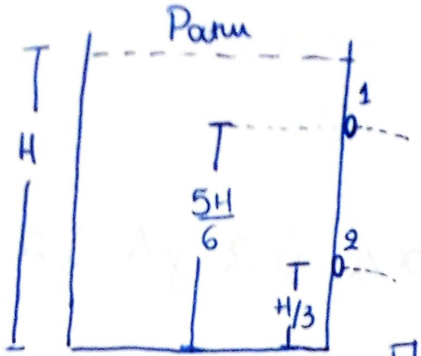
Άρα η νέα α.α.τ. γίνεται γύρω από τη Θ.Φ.Μ (Ν.Θ.Ι.) και έχει ακραία θέση τη Θ.Ι. πριν ασκηθεί η δύναμη F.

Άρα $A_2 = \Delta l_1 = \frac{mg}{k}$ (2)

Από (1),(2) έχουμε ότι $A_1 = A_2$

Σωστή απάντηση το (i)

B2.



Οπή (1)

Bernoulli επ−1 : $\cancel{P_{atm}} + \frac{1}{2}\rho \cancel{u_{επ}^2}^{\,0} + \cancel{\rho} gH = \cancel{P_{atm}} + \frac{1}{2}\cancel{\rho} u_1^2 + \cancel{\rho} g\frac{5H}{6}$

$$u_1^2 = g\frac{2H}{6} \Rightarrow u_1 = \sqrt{\frac{gH}{3}}$$

$$\Pi_1 = A\cdot u_1 \Rightarrow \frac{V}{\Delta t_1} = A\cdot u_1 \Rightarrow \Delta t_1 = \frac{V}{A\sqrt{\frac{gH}{3}}} = \frac{V}{A}\sqrt{\frac{3}{gH}} \quad (1)$$

Οπή (1)+(2)

Από Toricelli: $u_2 = \sqrt{2g\frac{2H}{3}} = \sqrt{\frac{4gH}{3}}$

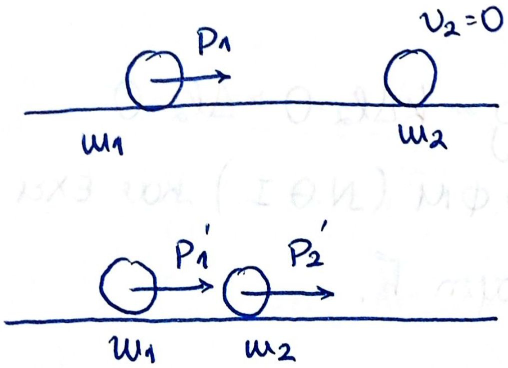
$$\Pi = A\cdot u_1 + A\cdot u_2 \Rightarrow \frac{V}{\Delta t_2} = A\left(\sqrt{\frac{gH}{3}} + \sqrt{\frac{4gH}{3}}\right) \Rightarrow \Delta t_2 = \frac{V}{A}\left(\frac{1}{\sqrt{\frac{gH}{3}} + 2\sqrt{\frac{gH}{3}}}\right) \Rightarrow$$

$$\Delta t_2 = \frac{V}{A}\left(\frac{1}{3\sqrt{\frac{gH}{3}}}\right) = \frac{V}{A3}\sqrt{\frac{3}{gH}} \quad (2)$$

Από $\frac{(1)}{(2)} \Rightarrow \frac{\Delta t_1}{\Delta t_2} = \frac{\frac{\cancel{V}}{\cancel{A}}\cancel{\sqrt{\frac{3}{gH}}}}{\frac{\cancel{V}}{3\cancel{A}}\cancel{\sqrt{\frac{3}{gH}}}} \Rightarrow \frac{\Delta t_1}{\Delta t_2} = 3 \Rightarrow \frac{\Delta t_2}{\Delta t_1} = \frac{1}{3}$

Σωστή απάντηση το (ii)

B3.



$p_1 = m_1 u_1 \Rightarrow u_1^2 = \frac{p_1^2}{m_1^2}$ όμοια $u_1'^2 = \frac{p_1'^2}{m_1^2}$

Από ΑΔΟ

$$P_{ΑΡΧ} = P_{ΤΕΛ} \Rightarrow p_1 + \cancel{p_2}^{\,0} = p_1' + p_2' \Rightarrow$$

$$p_1 = \frac{p_1}{5} + p_2' \Rightarrow p_2' = \frac{4p_1}{5}$$

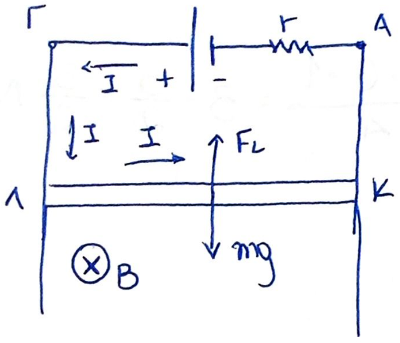
$$\Pi\% = \frac{|\Delta K|}{K_{1ΑΡΧ}}\cdot 100\% = \frac{K_{1ΑΡ} - K_{1ΤΕΛ}}{K_{1ΑΡΧ}}\cdot 100\% = \left(1 - \frac{K_{1Τ}}{K_{1ΑΡΧ}}\right)\cdot 100\% =$$

$$= \left(1 - \frac{\frac{1}{2}m_1 u_1'^2}{\frac{1}{2}m_1 u_1^2}\right)\cdot 100\% = \left(1 - \frac{\cancel{\frac{1}{2}}\frac{p_1'^2}{\cancel{m_1}}}{\cancel{\frac{1}{2}}\frac{p_1^2}{\cancel{m_1}}}\right)\cdot 100\% = \left(1 - \frac{\frac{\cancel{p_1^2}}{25}}{\cancel{p_1^2}}\right)\cdot 100\% =$$

$$= \left(1 - \frac{1}{25}\right)\cdot 100\% = \frac{24}{\cancel{25}}\cdot \cancel{100}^{\,4}\% = 24\cdot 4\% = 96\%$$

Σωστή απάντηση το (iii)

ΘΕΜΑ Γ



Γ1. Ακίνητη άρα ισορροπεί:

$$\Sigma F=0 \Rightarrow F_L = W \Rightarrow BI\ell = mg \Rightarrow B=\frac{mg}{I\ell} \Rightarrow$$

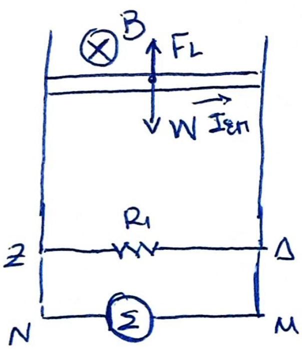
$$B=\frac{mg}{\frac{E}{R_{ολ}}\ell} = \frac{R_{ολ}\, mg}{E\cdot \ell} = \frac{(R_{ΚΛ}+r)\, mg}{E\ell} \Rightarrow$$

$$B=\frac{(2+1)\cdot 0,3\cdot 10}{9\cdot 1} = \frac{3\cdot 3}{9} = 1T$$

$$I=\frac{E}{R_{ολ}} = \frac{9}{3} = 3A.$$

Από κανόνα δεξιού χεριού αφού η F_L είναι προς τα επάνω για να ισορροπεί το B είναι από τον αναγνώστη προς τη σελίδα.

Γ2.



Αφού ανοίγω το δ1 παύει να υπάρχει E, άρα και I. Άρα ο ΚΛ αρχίζει να κατέρχεται εξαιτίας του W. Εμφανίζεται Iεπ και F_L ώστε να αντισταθεί στην κίνηση. Επομένως αφού $\Sigma F = m\alpha \Rightarrow$

$$W - F_L = m\alpha \overset{(4)}{\Rightarrow}$$

$$W - \frac{B^2 \upsilon \cdot \ell^2}{R_{ολ}} = m\alpha$$

$$F_L = B\cdot I_{επ}\cdot \ell \quad (1)$$

$$I_{επ} = \frac{E_{επ}}{R_{ολ}} \quad (2)$$

$$E_{επ} = \left|\frac{d\Phi}{dt}\right| N = \frac{d(BA)}{dt} N = B\cdot \upsilon \cdot \ell \quad (3)$$

$$(1)\underset{(3)}{\overset{(2)}{\Rightarrow}} F_L = \frac{B^2 \upsilon \ell^2}{R_{ολ}} \quad (4)$$

ο αγωγός κατέρχεται επιταχυνόμενα με μειούμενη επιτάχυνση μέχρι να αποκτήσει $\upsilon_{ορ}$. Από εκείνη τη στιγμή και έπειτα εκτελεί Ε.Ο.Κ.

$\upsilon_{ορ}$ όταν $\alpha=0 \Rightarrow \Sigma F=0 \Rightarrow F_L = mg \Rightarrow \frac{B^2 \upsilon_{ορ} \ell^2}{R_{ολ}} = mg \Rightarrow \upsilon_{ορ} = \frac{mg R_{ολ}}{B^2 \cdot \ell^2}$ (5)

Για συσκευή $P_\Sigma = \frac{V_\Sigma^2}{R_\Sigma} \Rightarrow R_\Sigma = \frac{V_\Sigma^2}{P_\Sigma} = \frac{6^2}{6} = 6\Omega$

$R_{1,\Sigma} = \frac{R_1 \cdot R_\Sigma}{R_1 + R_\Sigma} = \frac{3\cdot 6}{3+6} = 2\Omega \qquad R_{ολ} = R_{1,\Sigma} + R_{ΚΛ} = 2+2 = 4\Omega$

$$⑤ \rightarrow u_{op} = \frac{0,3 \cdot 10 \cdot 4}{1^2 \cdot 1^2} = 12\, m/s$$

Γ3. $$\frac{dp}{dt} = \Sigma F = W - F_L = mg - \frac{B^2 u_{op}/2\, \ell^2}{R_{o\lambda}} = 0,3 \cdot 10 - \frac{1 \cdot 6 \cdot 1}{4} = 3 - \frac{3}{2} = \frac{3}{2}\, N$$

Γ4. Όταν $u = u_{op}$ τότε:

$$I_{\varepsilon\pi} = \frac{Bu\ell}{R_{o\lambda}} = \frac{1 \cdot u_{op} \cdot 1}{4} = \frac{12}{4} = 3A$$

Η τάση στο R_1 και στη συσκευή είναι η πολική τάση άρα

$$V_\Pi = V_{Z\Delta} = V_{NM} = \mathcal{E}_{\varepsilon\pi} - I_{\varepsilon\pi} \cdot R_{K\Lambda} \quad ⑥$$

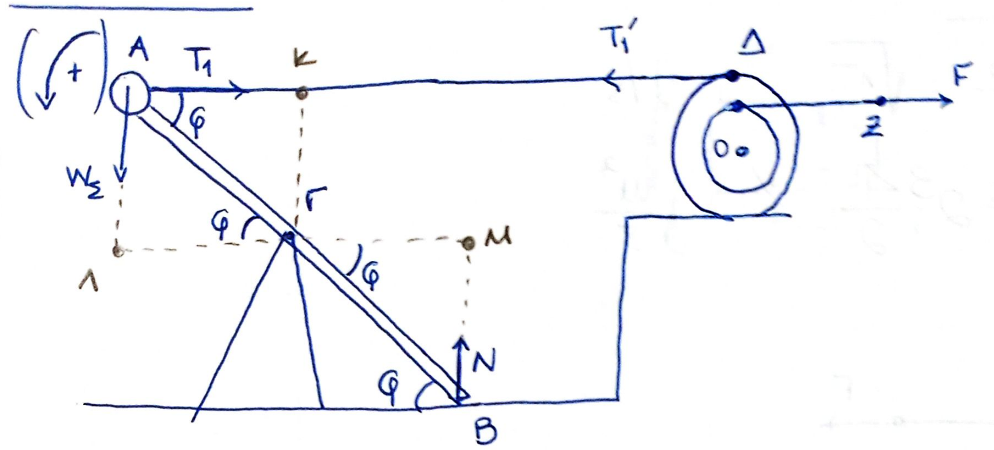
$$\mathcal{E}_{\varepsilon\pi} = B u_{op} \ell = 1 \cdot 12 \cdot 1 = 12V$$

$$⑥ \Rightarrow V_{NM} = 12 - 3 \cdot 2 = 6V$$

Άρα $P_\Sigma = \frac{V_{NM}^2}{R_\Sigma} = \frac{6^2}{6} = 6W$

Άρα η συσκευή λειτουργεί κανονικά.

ΘΕΜΑ Δ



Δ1. $\Sigma\tau_\Gamma = 0 \Rightarrow T_1 \cdot K\Gamma - W_\Sigma \Gamma\Lambda = N \cdot \Gamma M \Rightarrow$

$$T_1 \cdot \eta\mu\varphi \cdot \frac{\cancel{\ell}}{\cancel{2}} - W_\Sigma \sigma\upsilon\nu\varphi \frac{\cancel{\ell}}{\cancel{2}} = N \cdot \sigma\upsilon\nu\varphi \frac{\cancel{\ell}}{\cancel{2}} \Rightarrow$$

$$10{,}5 \cdot 0{,}8 - m_\Sigma g \cdot 0{,}6 = N \cdot 0{,}6 \Rightarrow$$

$$\frac{10{,}5 \cdot \cancel{8}^{4}}{\cancel{6}_{3}} - 10 \cdot \cancel{6} = N \cdot \cancel{6} \Rightarrow$$

$$N = \frac{42}{3} - 10 = 14 - 10 \Rightarrow N = 4\,N$$

Δ2. $\frac{\Delta L}{\Delta t} = \Sigma\tau_\Gamma = I_\rho \cdot \alpha_\gamma = \frac{1}{12} M L^2 \alpha_\gamma = \frac{1}{\cancel{12}} \cdot \cancel{3 \cdot 4} \cdot 3 = 3\ N \cdot m$

ΣΥΣΤΗΜΑ: $\Sigma\tau_\Gamma = I_\Sigma \cdot \alpha_\gamma \Rightarrow W_\Sigma \cdot \frac{\ell}{2} \sigma\upsilon\nu\varphi = 2 \cdot \alpha_{\gamma\omega\nu} \Rightarrow$

$$\alpha_{\gamma\omega\nu} = \frac{1 \cdot 10 \cdot \frac{\cancel{2}}{\cancel{2}} \cdot 0{,}6}{2} = 3\,rad/s^2$$

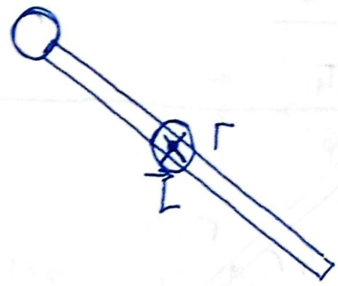
Δ3. $|\Delta L| = |L_{\tau\varepsilon\lambda} - L_{\alpha\rho\chi}| = |-I_\Sigma \cdot \frac{\omega}{2} - I_\Sigma \cdot \omega| = I_\Sigma \frac{3\omega}{2}$ (2)

$$I_\Sigma = I_\rho + m\left(\frac{\ell}{2}\right)^2 = \frac{1}{12} M L^2 + m \frac{\ell^2}{4} = \frac{1}{12} 3 \cdot 4 + 1 \cdot \frac{\cancel{4}}{\cancel{4}} = 1 + 1 = 2\ kgm^2$$

ΘΜΚΕ $t = 0 \rightarrow \varepsilon\Delta$: $K_{\tau\varepsilon\lambda} - \cancel{K_{\alpha\rho\chi}}^{0} = \Sigma W \Rightarrow \frac{1}{2} I_\Sigma \omega^2 = mg \cdot h \Rightarrow \omega = \sqrt{\frac{2mgh}{I_\Sigma}}$ (1)

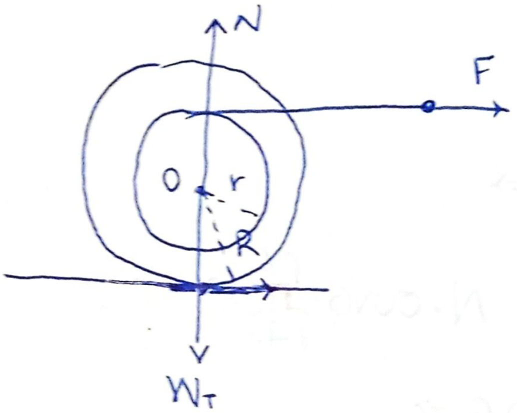
$h = \eta\mu\varphi \cdot l = 0{,}8 \cdot 2 = 1{,}6\,m$.

$(1) \Rightarrow \omega = \sqrt{\frac{\cancel{2} \cdot 1 \cdot 10 \cdot 1{,}6}{\cancel{2}}} = \sqrt{16} = 4\ rad/s$



$(2) \Rightarrow |\Delta L| = I_\Sigma \cdot \frac{3\omega}{2} = 2 \cdot \frac{3 \cdot 4}{2} = 12\ kg\frac{m^2}{s}$

Δ4.



$\Sigma\tau_0 = I_T \cdot \alpha_\gamma \Rightarrow F \cdot r - T_{\sigma\tau} \cdot R = \frac{1}{2} M_T R^2 \alpha_{\gamma\omega\nu} \Rightarrow Fr - T_{\sigma\tau}R = \frac{1}{2} M_T R \alpha_{\alpha\mu}$ (3)

$\Sigma F_x = M_T \alpha_{\alpha\mu} \Rightarrow F + T_{\sigma\tau} = M_T \alpha_{\alpha\mu} \Rightarrow -T_{\sigma\tau} = F - M_T\alpha_{\alpha\mu}$ (4)

$(3) \overset{(4)}{\Rightarrow} F \cdot r + (F - M_T\alpha_{\alpha\mu})R = \frac{1}{2} M_T R \alpha_{\alpha\mu} \Rightarrow$

$Fr + FR - M_T\alpha_{\alpha\mu}R = \frac{1}{2} M_T R \alpha_{\alpha\mu} \Rightarrow$

$F(R+r) = \frac{3}{2} M_T R\, \alpha_{\alpha\mu} \Rightarrow \alpha_{\alpha\mu} = \frac{2F(R+r)}{3M_T R} = \frac{2 \cdot 12 (0{,}4 + 0{,}3)}{3 \cdot 7 \cdot 0{,}4}$

$= \frac{2 \cdot \cancel{12} \cdot \cancel{0{,}7}}{\cancel{3} \cdot \cancel{7} \cdot \cancel{0{,}4}} = 2\ m/s^2$

Δ5. $0 \to 2s$: $\Delta x = \frac{1}{2} \alpha_{\alpha\mu} t^2 = \frac{1}{2} 2 \cdot 2^2 = 4\,m$.

$\Delta\theta = \frac{1}{2} \alpha_{\gamma\omega\nu} t^2 = \frac{1}{2} \frac{\alpha_{\alpha\mu}}{R} t^2 = \frac{1}{2} \frac{2}{0{,}4} \cdot 4 = 10\ rad$

$W_F = W_{F\mu\epsilon\tau} + W_{F\pi\epsilon\rho} = F \cdot \Delta x + F \cdot r\Delta\theta = 12 \cdot 4 + 12 \cdot 0{,}3 \cdot 10 =$

$= 12 \cdot 7 = 84\,J$.