ΑΠΑΝΤΗΣΕΙΣ ΦΥΣΙΚΗΣ ΚΑΤΕΥΘΥΝΣΗΣ ΕΞΕΤΑΣΕΙΣ 2013

ΘΕΜΑ Α

A_1 γ) A_2 γ) A_3 δ) A_4 γ)

A_5 α) → Σωστό

β) → Λάθος

γ) → Σωστό

δ) → Λάθος

ε) → Σωστό

ΘΕΜΑ Β

B_1 Τη στιγμή $t=0 \rightarrow q=Q$ Άρα $E=U_E=\frac{1}{2}\frac{Q^2}{C}$

$Q=C\cdot V_C=20\cdot10^{-6}\cdot20=400\cdot10^{-6}=4\cdot10^{-4}C$

$U_E=\frac{1}{2}\cdot\frac{(4\cdot10^{-4})^2}{2\cdot10^{-5}}=\frac{1}{2}\cdot\frac{16\cdot10^{-8}}{2\cdot10^{-5}} \Rightarrow \boxed{U_E=4\cdot10^{-3}J}$

Τη στιγμή $t_1 \rightarrow q=0 \rightarrow E=U_B=\frac{1}{2}L\cdot i^2=$

$=\frac{1}{2}\cdot\frac{1}{9}\cdot10^{-3}\cdot6^2=\frac{36}{18}\cdot10^{-3} \Rightarrow \boxed{U_B=2\cdot10^{-3}J}$

Άρα $\Delta E=E_{τελ}-E_{αρχ}=2\cdot10^{-3}-4\cdot10^{-3} \Rightarrow \boxed{\Delta E=-2\cdot10^{-3}J}$

Άρα σωστή η απάντηση (ii)

B2

Αρχικά: $\lambda_1 \rightarrow$ 4 υπερβολές απόσβεσης

$u = \lambda_1 \cdot f_1$ (ταχύτητα διάδοσης)

Τελικά: $\lambda_2 \rightarrow$ Πόσες υπερβολές απόσβεσης ανάμεσα K, Λ;

$(K\Lambda) = d = 2\lambda_1$

οι πηγές στα K, Λ

$f_2 = 3f_1$ Άρα $\underbrace{u}_{\text{σταθ.}} = \lambda_1 \cdot f_1 = \lambda_2 \cdot f_2 \Rightarrow$

$$\Rightarrow \lambda_1 \cdot f_1 = \lambda_2 \cdot 3f_1 \Rightarrow \lambda_1 = 3\lambda_2 \Rightarrow \boxed{\lambda_2 = \frac{\lambda_1}{3}}$$

Σχέση για να δημιουργηθούν υπερβολές απόσβεσης ανάμεσα στα K, Λ

$$-(K\Lambda) < (2N+1)\frac{\lambda_2}{2} < K\Lambda \Rightarrow$$

$$\Rightarrow -2\lambda_1 < (2N+1)\frac{\lambda_1/3}{2} < 2\lambda_1 \Rightarrow$$

$$\Rightarrow -2\lambda_1 < (2N+1)\cdot\frac{\lambda_1}{6} < 2\lambda_1 \Rightarrow$$

$$\Rightarrow -2 < \frac{2N+1}{6} < 2 \Rightarrow -12 < 2N+1 < 12 \Rightarrow$$

$$\Rightarrow -13 < 2N < 11 \Rightarrow -\frac{13}{2} < N < \frac{11}{2} \Rightarrow -6{,}5 < N < 5{,}5 \Rightarrow$$

$\Rightarrow -6, -5, \ldots, 5$ Άρα 12 σημεία

Σωστή η απάντηση (iii)

B3 Ισχύει η αρχή διατήρησης της στροφορμής.

$$L_{Αρχ} = L_{Τελ} \Rightarrow I_1 \cdot \omega_1 = (I_1 + I_2)\cdot\omega \Rightarrow$$

$$\Rightarrow I_1 \cdot \omega_1 = \left(I_1 + \frac{I_1}{4}\right)\cdot\omega \Rightarrow I_1\cdot\omega_1 = \frac{5}{4}I_1\cdot\omega \Rightarrow$$

$$\Rightarrow \boxed{\omega = \frac{4}{5}\omega_1}$$

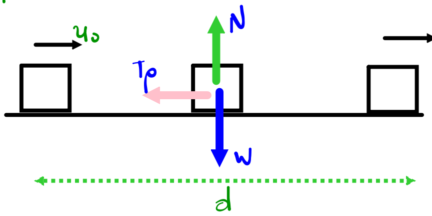
$$|\Delta L_1| = |L_{1Τελ} - L_{1Αρχ}| = |I_1\cdot\omega - I_1\cdot\omega_1| =$$

$$= \left|I_1\cdot\frac{4}{5}\omega_1 - I_1\cdot\omega_1\right| = \left|-\frac{1}{5}I_1\omega_1\right| = \frac{1}{5}L_1$$

Άρα σωστή απάντηση η (ii)

ΘΕΜΑ Γ

Γ1 Μελέτη κίνησης Σ_1 ΠΡΙΝ ΤΗ ΚΡΟΥΣΗ



Θ.Μ.Κ.Ε: $K_{\tau\varepsilon\lambda} - K_{APX} = W_{T_{\tau\rho}} + W_w + W_N \Rightarrow \frac{1}{2} m_1 u_1^2 - \frac{1}{2} m_1 u_0^2 = W_{T_{\tau\rho}} \Rightarrow$

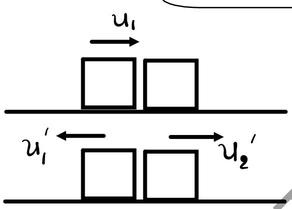
$\Rightarrow \frac{1}{2} m_1 u_1^2 - \frac{1}{2} m_1 u_0^2 = -T_{\tau\rho} \cdot d \Rightarrow \frac{1}{2} m_1 u_1^2 - \frac{1}{2} m_1 u_0^2 = -\mu \cdot N \cdot d$

$(\Sigma F_y = 0 \Rightarrow w = N \Rightarrow N = m_1 \cdot g)$

$\frac{1}{2} m_1 \cdot u_1^2 - \frac{1}{2} m_1 u_0^2 = -\mu \cdot m_1 \cdot g \cdot d \Rightarrow$

$\Rightarrow u_1^2 - u_0^2 = -2\mu \cdot g \cdot d \Rightarrow u_1^2 - u_0^2 = -2 \cdot 0{,}5 \cdot 10 \cdot 1 \Rightarrow$

$\Rightarrow \boxed{u_1^2 - u_0^2 = -10}$



Κρούση $m_1 - m_2 \rightarrow$ ΕΛΑΣΤΙΚΗ

$u_1' = \frac{m_1 - m_2}{m_1 + m_2} \cdot u_1$

$u_2' = \frac{2m_1}{m_1 + m_2} \cdot u_1$

$u_1' = \frac{m_1 - 2m_1}{m_1 + 2m_1} \cdot u_1 \Rightarrow -\sqrt{10} = \frac{-m_1}{3m_1} u_1 \Rightarrow \sqrt{10} = \frac{1}{3} u_1 \Rightarrow$

$\Rightarrow \boxed{u_1 = 3\sqrt{10}\ m/sec}$

Άρα $u_1^2 - u_0^2 = -10 \Rightarrow (3\sqrt{10})^2 - u_0^2 = -10 \Rightarrow 90 - u_0^2 = -10 \Rightarrow$

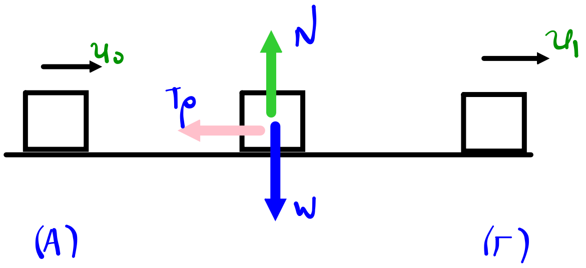
$\Rightarrow -u_0^2 = -100 \Rightarrow u_0^2 = 100 \Rightarrow \boxed{u_0 = 10\ m/sec}$

Γ2 $u_2' = \frac{2m_1}{m_1 + 2m_1} \cdot u_1 = \frac{2m_1}{3m_1} \cdot 3\sqrt{10} \Rightarrow \boxed{u_2' = 2\sqrt{10}\ m/sec}$

$$\frac{K_{2(ΜΕΤ)}}{K_{1(ΑΡΧ.)}} = \frac{\frac{1}{2} m_2 u_2'^2}{\frac{1}{2} m_1 \cdot u_1^2} = \frac{2m_1 \cdot (2\sqrt{10})^2}{m_1 \cdot (3\sqrt{10})^2} = \frac{2 \cdot 4 \cdot 10}{9 \cdot 10} = \frac{8}{9}$$

Άρα ποσοστό $\frac{K_{2(ΜΕΤΑ)}}{K_{1(ΑΡΧΗ)}} \cdot 100\% = \frac{8}{9} \cdot 100\% = \frac{800}{9}$

Γ3



(A)→(Γ) Ευθ. Ομαλά Επιβ. Κίνηση

$$u_1 = u_0 - \alpha\cdot t$$

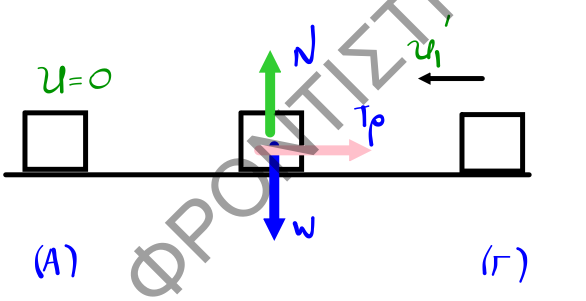
$$\Sigma F_x = m_1\cdot\alpha \Rightarrow -T_\rho = m_1\cdot\alpha \Rightarrow -\mu\cdot N = m_1\cdot\alpha \Rightarrow$$

$$\Rightarrow -\mu\cdot m_1\cdot g = m_1\cdot\alpha \Rightarrow -0{,}5\cdot 10 = \alpha \Rightarrow \alpha = -5\ m/s^2 \text{ (Επιβράδυνση)}$$

$$u_1 = u_0 - \alpha\cdot t \Rightarrow 3\sqrt{10} = 10 - 5\cdot t \Rightarrow 3\cdot 3{,}2 = 10 - 5t \Rightarrow$$

$$\Rightarrow 9{,}6 = 10 - 5t \Rightarrow 5t = 10 - 9{,}6 \Rightarrow 5t = 0{,}4 \Rightarrow t = \frac{0{,}4}{5} \Rightarrow$$

$$\Rightarrow \boxed{t = 0{,}08\ sec}$$



(Γ)→(A) Ευθύγραμμη ομαλά Επιβραδυνόμενη Κίνηση

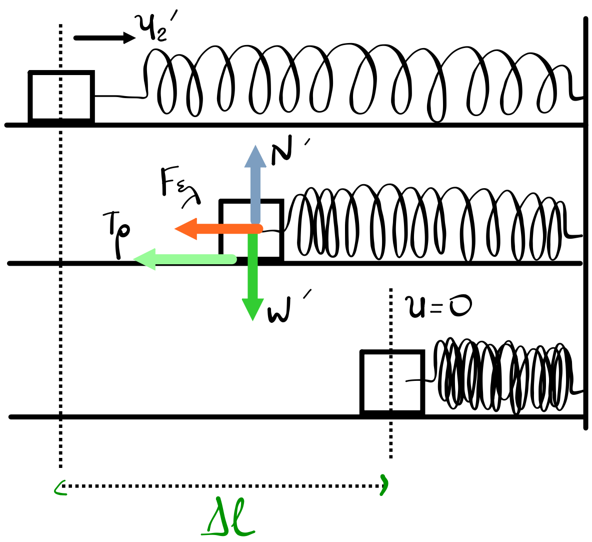
$$u = u_1' - \alpha'\cdot t'$$

$$\Sigma F = m_1\cdot\alpha' \Rightarrow -T_\rho = m_1\cdot\alpha' \Rightarrow \dots \Rightarrow \alpha' = -5\ m/sec^2 \text{ (Επιβράδυνση)}$$

$$0 = \sqrt{10} - 5\cdot t' \Rightarrow 5t' = 3{,}2 \Rightarrow t' = \frac{3{,}2}{5} \Rightarrow \boxed{t' = 0{,}64\ sec}$$

Συνολικός χρόνος κίνησης: $\boxed{t + t' = 0{,}08 + 0{,}64 = 0{,}72\ sec}$

Γ4



Θ.Μ.Κ.Ε. $K_{τελ}-K_{ΑΡΧ}=W_{T_\rho}+W_{N'}+W_{w'}+W_{F_{ελ}} \Rightarrow$

$$\Rightarrow 0-\frac{1}{2}m_2\cdot υ_2'^2 = -T_\rho\cdot Δ\ell + \left(U_{ελατ(αρχ)}-U_{ελατ(τελ)}\right) \Rightarrow$$

$$\Rightarrow -\frac{1}{2}1\cdot\left(2\sqrt{10}\right)^2 = -\mu\cdot N'\cdot Δ\ell - \frac{1}{2}k\cdot Δ\ell^2 \Rightarrow$$

$$\left(ΣF_y=0 \Rightarrow N'=w'=m_2\cdot g\right)$$

$$\Rightarrow \frac{1}{2}\cdot 4\cdot 10 = 0{,}5\cdot 1\cdot 10\cdot Δ\ell + \frac{1}{2}\cdot 105\cdot Δ\ell^2 \Rightarrow$$

$$\Rightarrow 40 = 10Δ\ell + 105Δ\ell^2 \Rightarrow 105Δ\ell^2 + 10Δ\ell - 40 = 0 \Rightarrow$$

$$\Rightarrow 21Δ\ell^2 + 2Δ\ell - 8 = 0$$

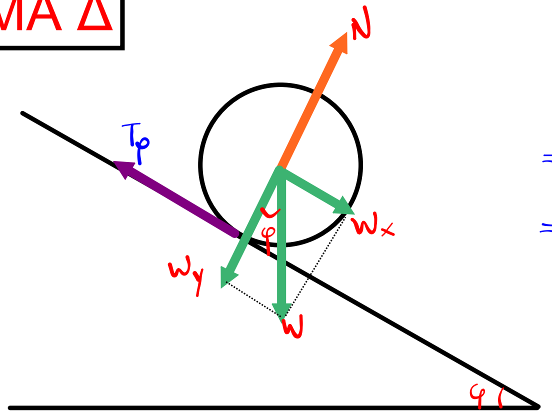
$$Δ = 2^2 - 4\cdot 21\cdot(-8) = 4 + 4\cdot 168 = 4(1+168) = 4\cdot 169 = 2^2\cdot 13^2$$

$$Δ\ell_{1,2} = \frac{-2\pm\sqrt{2^2\cdot 13^2}}{2\cdot 21} = \begin{cases} \dfrac{-2+26}{42} = \dfrac{24}{42} = \dfrac{4}{7} \\ -\dfrac{28}{42} \quad (\text{Απορ.}) \end{cases}$$

Άρα $\boxed{Δ\ell = \frac{4}{7}\,m}$

ΘΕΜΑ Δ

Δ1



$\Sigma F_x = M\cdot\alpha_{cm} \Rightarrow w_x - T_p = M\cdot\alpha_{cm} \Rightarrow$

$\Rightarrow w\cdot\eta\mu\varphi - T_p = M\cdot\alpha_{cm} \Rightarrow$

$\Rightarrow \boxed{M\cdot g\cdot\eta\mu\varphi - T_p = M\cdot\alpha_{cm}}$

$\Sigma\tau = I\cdot\alpha_{\gamma\omega\nu} \Rightarrow T_p\cdot R = I\cdot\alpha_{\gamma\omega\nu} \Rightarrow$

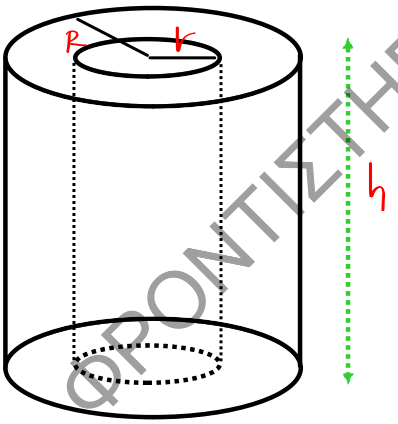
$\Rightarrow T_p\cdot R = \frac{1}{2}MR^2\cdot\alpha_{\gamma\omega\nu} \Rightarrow$

$\Rightarrow T_p = \frac{1}{2}M\cdot R\cdot\alpha_{\gamma\omega\nu} \xRightarrow{\alpha_{cm}=\alpha_{\gamma\omega\nu}\cdot R} \boxed{T_p = \frac{1}{2}M\cdot\alpha_{cm}}$

Άρα: $M\cdot g\cdot\eta\mu\varphi - \frac{1}{2}M\cdot\alpha_{cm} = M\cdot\alpha_{cm} \Rightarrow g\cdot\eta\mu\varphi = \alpha_{cm} + \frac{1}{2}\alpha_{cm} \Rightarrow$

$\Rightarrow g\,\eta\mu\varphi = \frac{3}{2}\alpha_{cm} \Rightarrow \boxed{\alpha_{cm} = \frac{2}{3}g\cdot\eta\mu\varphi}$

Δ2



Ισχύει $I_{KK} = I - I_r \Rightarrow$

$\Rightarrow \boxed{I_{KK} = \frac{1}{2}MR^2 - \frac{1}{2}M'\cdot r^2}$

Ισχύει: $d = \frac{M}{V} = \frac{M}{\pi R^2 h}$

επίσης: $d = \frac{M'}{V'} = \frac{M'}{\pi r^2 h}$

$\Rightarrow$

$\Rightarrow \frac{M}{\pi R^2 h} = \frac{M'}{\pi r^2\cdot h} \Rightarrow \frac{M}{R^2} = \frac{M'}{r^2} \Rightarrow \boxed{M' = M\cdot\frac{r^2}{R^2}}$

Άρα $I_{KK} = \frac{1}{2}MR^2 - \frac{1}{2}M\cdot\frac{r^2}{R^2}\cdot r^2 = \frac{1}{2}M\left(R^2 - \frac{r^4}{R^2}\right) \Rightarrow$

$\Rightarrow I_{KK} = \frac{1}{2}M\left(\frac{R^4 - r^4}{R^2}\right) \Rightarrow \boxed{I_{KK} = \frac{1}{2}M\cdot R^2\left(1 - \frac{r^4}{R^4}\right)}$

Δ3 Όταν επανατοποθετήσουμε το κομμάτι (έχοντας βάλει λιπαντικό) τότε έχουμε τα εξής:

Μεταφορική κίνηση: $\Sigma F_x = M\cdot \alpha_{cm}' \Rightarrow W_x - T_p = M\cdot \alpha_{cm}' \Rightarrow$

$$\Rightarrow \boxed{M\cdot g\cdot \eta\mu\varphi - T_p = M\cdot \alpha_{cm}'}$$

Στροφική κίνηση: $\Sigma\tau = I_{KK}\cdot \alpha_{\gamma\omega\nu}' \Rightarrow T_p\cdot R = \frac{1}{2}M R^2\left(1-\frac{r^4}{R^4}\right)\cdot \alpha_{\gamma\omega\nu}' \Rightarrow$

$$\Rightarrow T_p = \frac{1}{2}M\cdot R\cdot \alpha_{\gamma\omega\nu}'\left(1-\frac{r^4}{R^4}\right) \xRightarrow{\alpha_{cm}'=\alpha_{\gamma\omega\nu}'\cdot R}$$

$$\Rightarrow \boxed{T_p = \frac{1}{2}M\cdot \alpha_{cm}'\left(1-\frac{r^4}{R^4}\right)}$$

Συνεπώς: $M\cdot g\cdot \eta\mu\varphi - \frac{1}{2}M\cdot \alpha_{cm}'\left(1-\frac{r^4}{R^4}\right) = M\cdot \alpha_{cm}' \Rightarrow$

$$\Rightarrow g\cdot \eta\mu\varphi = \alpha_{cm}' + \frac{1}{2}\alpha_{cm}'\left(1-\frac{r^4}{R^4}\right) \Rightarrow$$

$$\Rightarrow g\cdot \eta\mu\varphi = \alpha_{cm}'\left(1+\frac{1}{2}\left(1-\frac{r^4}{R^4}\right)\right) \Rightarrow$$

$$\Rightarrow \boxed{\alpha_{cm}' = \frac{g\cdot \eta\mu\varphi}{\frac{3}{2} - \frac{r^4}{2R^4}}\ m/sec^2}$$

Δ4

$$\frac{K_{\mu\tau\varphi}}{K_{\pi\varepsilon\rho}} = \frac{\frac{1}{2} M \cdot u_{cm}^2}{\frac{1}{2} I_{KK} \cdot \omega^2} = \frac{M \cdot u_{cm}^2}{\frac{1}{2} M R^2 \cdot \left(1 - \left(\frac{r}{R}\right)^4\right) \cdot \omega^2} =$$

$$= \frac{u_{cm}^2}{\frac{1}{2} R^2 \left(1 - \left(\frac{R/2}{R}\right)^4\right) \omega^2} = \frac{u_{cm}^2}{\frac{1}{2} R^2 \left(1 - \frac{1}{16}\right) \omega^2} =$$

$$= \frac{u_{cm}^2}{\frac{1}{2} \cdot R^2 \cdot \frac{15}{16} \omega^2} = \frac{u_{cm}^2}{\frac{15}{32} \cdot R^2 \omega^2} = \frac{u_{cm}^2}{\frac{15}{32} \cdot u_{cm}^2} \Rightarrow$$

$$\Rightarrow \boxed{\frac{K_{\mu\tau\varphi}}{K_{\pi\varepsilon\rho}} = \frac{32}{15}}$$