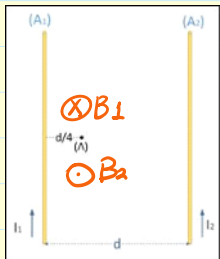


**ΘΕΜΑ Α**

A1 α A2 γ A3 γ A4 δ  
 A5 α λ β) I γ) λ δ) I ε) I

**ΘΕΜΑ Β**

**B1** i) Ψευδι απάντηση: β

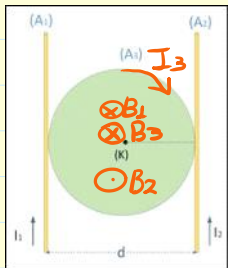


2ω σημείον

$$B_{ολ} = 0 \Rightarrow B_1 = B_2 \Rightarrow k\mu \cdot \frac{2I_1}{d/4} = k\mu \cdot \frac{2I_2}{3d/4}$$

$$\Rightarrow I_1 = \frac{I_2}{3} \Rightarrow \boxed{I_2 = 3I_1}$$

ii) Ψευδι απάντηση: γ



$$B_1 = k\mu \frac{2I_1}{d/2}$$

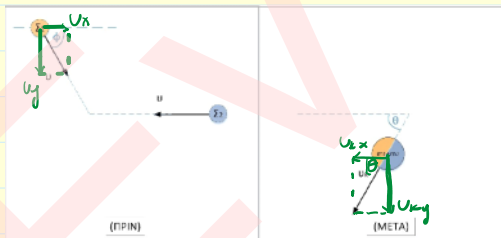
$$B_2 = k\mu \cdot \frac{2I_2}{d/2} \Rightarrow B_2 = k\mu \cdot \frac{6I_1}{d/2} > B_1$$

Άρα  $\vec{B}_3 \nearrow \vec{B}_1$

$$\sim B_{ολ} = 0 \Rightarrow B_1 + B_3 - B_2 = 0 \Rightarrow k\mu \cdot \frac{2I_1}{d/2} + k\mu \cdot \frac{2\pi I_3}{d/2} = k\mu \cdot \frac{2I_2}{d/2}$$

$$\Rightarrow I_1 + \pi \cdot I_3 = 3I_2 \Rightarrow \pi \cdot I_3 = 2I_1 \Rightarrow \boxed{I_3 = \frac{2I_1}{\pi}}$$

**B2** Ψευδι απάντηση: β



$$v_x = v \cdot \cos\theta = \frac{v}{2} \text{ και } v_y = v \cdot \sin\theta = \frac{\sqrt{3}}{2} \cdot v$$

$\sim$  A. Δ. Ο. (x'x) (±)

$$-m \cdot v_x + m \cdot v = 2m \cdot v_{cx}$$

$$\Rightarrow -\frac{v}{2} + v = 2 \cdot v_{cx} \Rightarrow \frac{v}{2} = 2 \cdot v_{cx}$$

$$\Rightarrow v_{cx} = \frac{v}{4}$$

$\sim$  A. Δ. Ο. (y'y) (↓+)

$$m \cdot v_y = 2m \cdot v_{cy} \Rightarrow \frac{v \cdot \sqrt{3}}{2} = 2 \cdot v_{cy} \Rightarrow v_{cy} = \frac{v \cdot \sqrt{3}}{4}$$

$$U_k = \sqrt{U_{kx}^2 + U_{ky}^2} = \sqrt{\frac{U^2}{16} + \frac{3U^2}{16}} = \sqrt{\frac{4 \cdot U^2}{16}} = \frac{U}{2}$$

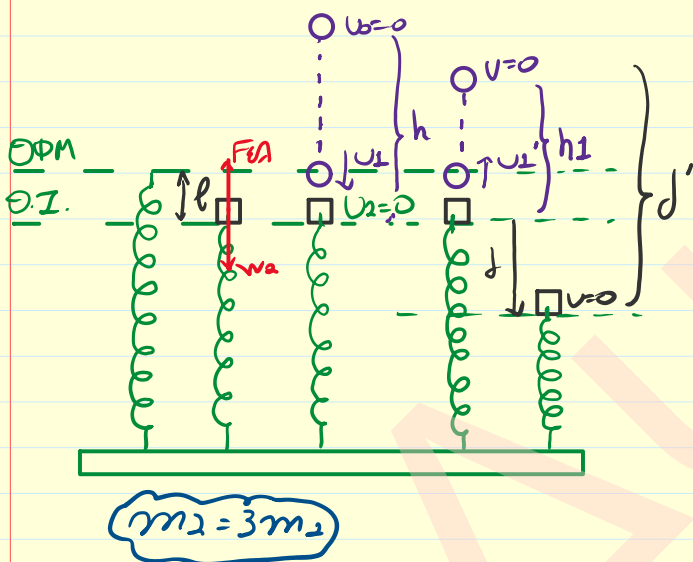
$$\bullet \text{ Κολύτρηση} = \frac{1}{2} m \cdot U^2 + \frac{1}{2} m \cdot U^2 = m \cdot U^2$$

$$\bullet \text{ Κολήματα} = \frac{1}{2} \cdot 2m \cdot U_k^2 = m \cdot \left(\frac{U}{2}\right)^2 = m \cdot \frac{U^2}{4}$$

$$Q_{\text{ΚΡΟΥΣΗΣ}} = \text{Κολύτρηση} - \text{Κολήματα} = m \cdot U^2 - \frac{m \cdot U^2}{4} = \frac{3}{4} m U^2$$

$$\pi = \frac{Q_{\text{ΚΡ.}}}{\text{ΚΑΤΡΥΝΙ}} \cdot 100\% = \frac{\frac{3}{4} m U^2}{m \cdot U^2} \cdot 100\% \Rightarrow \pi = 75\%$$

**B3** Ξωπή ατράντολι: α



$\Sigma I_1$ :

• Ο.Μ.Κ.Ε.

$$\frac{1}{2} m_1 \cdot v_1^2 - 0 = m_1 g \cdot h$$

$$\Rightarrow v_1 = \sqrt{2g \cdot h} = \sqrt{2g \cdot 8l} = \sqrt{16gl}$$

$$\bullet v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 = \frac{-2m_1}{4m_1} v_1 = -\frac{v_1}{2}$$

$$\bullet v_2' = \frac{2m_1}{m_1 + m_2} v_1 = \frac{2m_1}{4m_1} v_1 = \frac{v_1}{2}$$

$$\text{Θ.Ι.} : \Sigma F = 0 \Rightarrow k \cdot l = m_2 g \Rightarrow k = \frac{m_2 g}{l} \quad (1)$$

$\Sigma I_2$ : Ο.Μ.Κ.Ε. (ΑΝΟΔΟΣ)

$$0 - \frac{1}{2} m_1 v_1^2 = -m_1 g h_2 \Rightarrow h_2 = \frac{v_1^2}{2g} = \frac{v_1^2}{8g} = \frac{16gl}{8g} \Rightarrow h_2 = 2l$$

$\Sigma I_2$ :

$$W_{\text{ΕΑΡΧΙ}} = \frac{1}{2} k \cdot l^2$$

$$W_{\text{ΕΑΡΧΙ}} = \frac{1}{2} k \cdot (l + d)^2 = \frac{1}{2} k l^2 + k \cdot l \cdot d + \frac{1}{2} k \cdot d^2$$

$$W_{\text{ΕΑ}} = W_{\text{ΕΑΡΧΙ}} - W_{\text{ΕΑΡΧΙ}} = \frac{1}{2} k l^2 - \frac{1}{2} k l^2 - k \cdot l \cdot d - \frac{1}{2} k \cdot d^2$$

Ο.Μ.Κ.Ε.

$$0 - \frac{1}{2} m_2 v_2'^2 = + m_2 g \cdot d - \underbrace{k \cdot l \cdot d}_{\substack{\text{spring work} \\ \text{potential energy}}} - \frac{1}{2} k \cdot d^2$$

$$\stackrel{(1)}{=} - \frac{1}{2} m_2 \frac{v_1^2}{4} = m_2 g d - m_2 g d - \frac{1}{2} k \cdot d^2$$

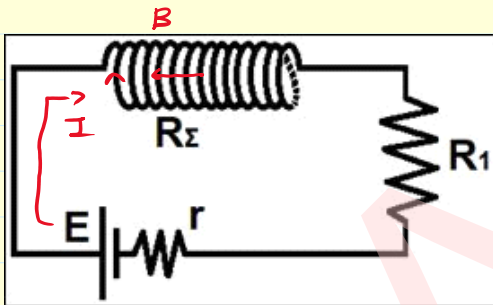
$$\Rightarrow \frac{1}{2} m_2 \frac{16 \cdot g l}{4} = \frac{1}{2} \cdot m_2 g \cdot d^2$$

$$\Rightarrow 4l^2 = d^2 \Rightarrow d = 2l$$

Άρα:  $d' = d + h_2 = 2l + 2l \Rightarrow d' = 4l$

### ΘΕΜΑ Γ

Γ1



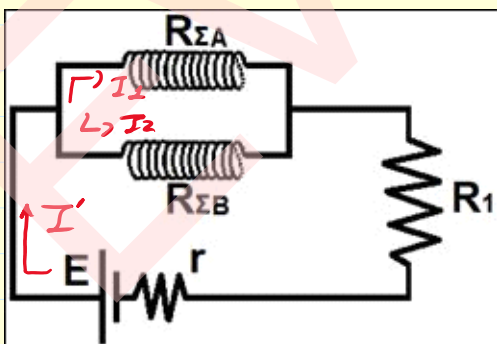
$$I = \frac{\mathcal{E}}{R_{\Sigma} + R_1 + r} = \frac{280}{40 + 25 + 5} = \frac{280}{70} = 4 \text{ A}$$

$$B = \mu_0 \cdot 4\pi \cdot I \cdot \frac{N}{l} \Rightarrow 8 \cdot 10^{-4} = 10^{-7} \cdot 4\pi \cdot 4 \cdot \frac{N}{10^{-2}}$$

$$\Rightarrow 8 \cdot 10^{-4} = 10^{-6} \cdot 4 \cdot N \Rightarrow N = 200 \text{ σπειρές}$$

Γ2  $\mu = \frac{B'}{B} = \frac{0,4}{8 \cdot 10^{-4}} \Rightarrow \mu = 500$

Γ3



$$R_{\Sigma A} = R_{\Sigma B} = \frac{R_{\Sigma}}{2} = 20 \Omega$$

$$R_{\Sigma A, \Sigma B} = \frac{R_{\Sigma A} \cdot R_{\Sigma B}}{R_{\Sigma A} + R_{\Sigma B}} = \frac{20 \cdot 20}{40} \Rightarrow R_{\Sigma A, \Sigma B} = 10 \Omega$$

$$R_{\Sigma \Gamma} = R_{\Sigma A, \Sigma B} + R_1 = 35 \Omega$$

$$R_{\text{ολ}} = R_{\Sigma \Gamma} + r = 40 \Omega$$

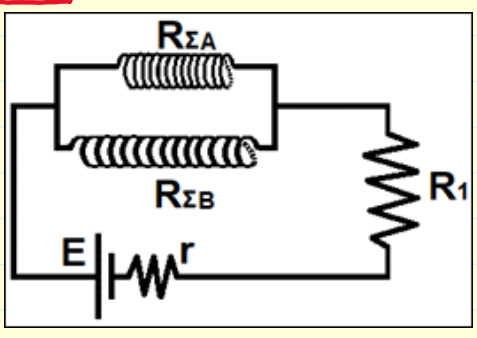
$$I' = \frac{\mathcal{E}}{R_{\text{ολ}}} = \frac{280}{40} = 7 \text{ A}$$

$$V_{\Sigma A} = V_{\Sigma B} \Rightarrow I_1 \cdot R_{\Sigma A} = I_2 \cdot R_{\Sigma B} \Rightarrow I_1 = I_2 = \frac{I'}{2} = 3,5 \text{ A}$$

$$\leadsto P_{\Sigma A} = I_2^2 \cdot R_{\Sigma A} = 3,5^2 \cdot 20 \Rightarrow P_{\Sigma A} = 245 \text{ W}$$

$$\leadsto B_{\Sigma A} = \mu_0 \cdot 4\pi \cdot I_2 \cdot \frac{N/2}{\ell/2} = 10^{-7} \cdot 4\pi \cdot 3,5 \cdot \frac{200}{10 \cdot 10^{-2}} \Rightarrow B_{\Sigma A} = 7 \cdot 10^{-4} \text{ T}$$

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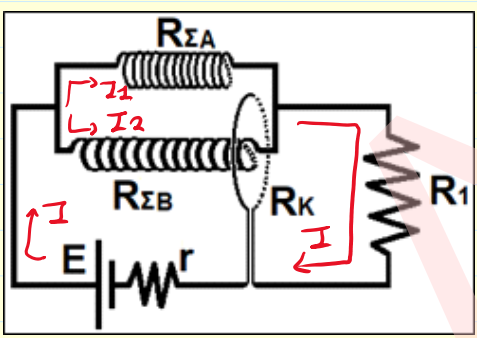


$$B_{\Sigma A}' = \frac{\mu_0 \cdot 4\pi \cdot I_1 \cdot \frac{N/2}{\ell/2}}{2} = 3,5 \cdot 10^{-4} \text{ T}$$

$$B_{\Sigma B}' = \frac{\mu_0 \cdot 4\pi \cdot I_2 \cdot \frac{N/2}{\ell}}{2} = \frac{10^{-7} \cdot 4\pi \cdot 3,5 \cdot 100}{2 \cdot 10 \cdot 10^{-2}} \Rightarrow B_{\Sigma B}' = 1,75 \cdot 10^{-4} \text{ T}$$

$$B_{\Sigma A}' - B_{\Sigma B}' = 1,75 \cdot 10^{-4} \text{ T}$$

15



$$R_{\Sigma A, \Sigma B} = 10 \Omega$$

$$R_{\text{ολ}} = R_{\Sigma A, \Sigma B} + R_1 + R_{\kappa} + r = 70 \Omega$$

$$I = \frac{\epsilon}{R_{\text{ολ}}} = \frac{280}{70} = 4 \text{ A}$$

$$I_1 = I_2 = \frac{I}{2} = 2 \text{ A}$$

$$B_{\text{ολ}} = 0 \Rightarrow B_{\Sigma B} (\text{ακρω}) = B_{\kappa} \Rightarrow \frac{\mu_0 \cdot 4\pi \cdot I_1 \cdot \frac{N/2}{\ell}}{2} = \frac{\mu_0 \cdot 2\pi \cdot I \cdot N}{\alpha}$$

$$\Rightarrow 2 \cdot 2 \cdot \frac{100}{40\pi \cdot 10^{-2}} = \frac{2 \cdot 4 \cdot 10}{\alpha} \Rightarrow 200 \cdot \alpha = 160\pi \cdot 10^{-1}$$

$$\Rightarrow \alpha = 8\pi \cdot 10^{-2} \text{ m}$$

**ΘΕΜΑ Δ**

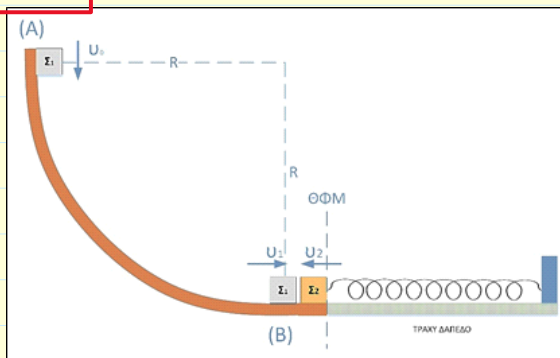
A. Δ. Μ. Ε. (A → B)

$$K_A + U_A = K_B + U_B$$

$$\Rightarrow \frac{1}{2} m_1 \cdot U_0^2 + m_1 \cdot g \cdot R = \frac{1}{2} m_1 U_1^2$$

$$\Rightarrow 16 + 20 \cdot R = 36$$

$$\Rightarrow R = 1m$$

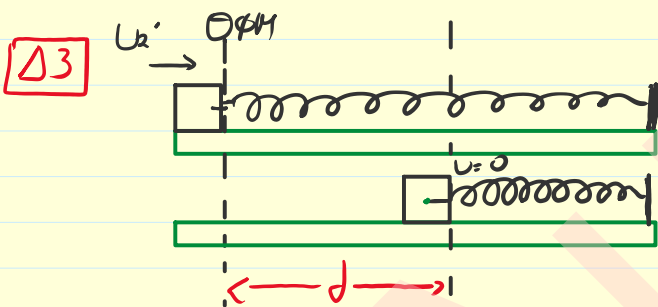


$$\Delta 2 \quad U_1' = \frac{m_1 - m_2}{m_1 + m_2} U_1 + \frac{2m_2}{m_1 + m_2} U_2 = \frac{-2}{4} \cdot (+6) + \frac{6}{4} \cdot (-2)$$

$$\Rightarrow U_1' = -6m/s \quad \rightarrow |U_1'| = 6m/s \quad (\leftarrow)$$

$$U_2' = \frac{2m_1}{m_1 + m_2} U_1 + \frac{m_2 - m_1}{m_1 + m_2} U_2 = \frac{2}{4} \cdot (+6) + \frac{2}{4} \cdot (-2)$$

$$\Rightarrow U_2' = 2m/s$$



$$W_{fca} = U_{cm}(v_{top}) - U_{cm}(v_{bot})$$

O.M.K.E.

$$0 - \frac{1}{2} m_2 U_2'^2 = -T_2 \cdot d - \frac{1}{2} k \cdot d^2$$

$$\Rightarrow -\frac{1}{2} 3 \cdot 2^2 = -\frac{2}{15} \cdot 30 \cdot d - 10 \cdot d^2$$

$$\Rightarrow 10 \cdot d^2 + 4d - 6 = 0$$

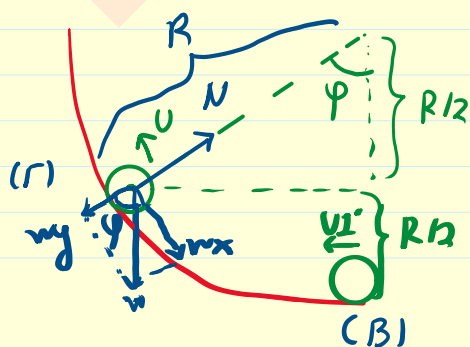
$$\begin{aligned} \sum F_y = 0 &\Rightarrow N_2 = m_2 g \\ T_2 = \mu \cdot N_2 &= \mu \cdot m_2 g = 4N \end{aligned}$$

$$\Delta = 4^2 - 4 \cdot 10 \cdot (-6) = 256$$

$$d_{1,2} = \frac{-4 \pm \sqrt{256}}{2 \cdot 10} = \frac{-4 \pm 16}{20}$$

$$\begin{cases} (+) & d = 0,6m \\ (-) & d = -1m: \text{Απορ.} \end{cases}$$

**Δ4**



$$\sigma_{sup} = \frac{R \sin \phi}{R} = \frac{1}{2}$$

$$W_y = W_1 \cdot \sigma_{sup} = 5N$$

A. Δ. Μ. Ε. (B → Γ)

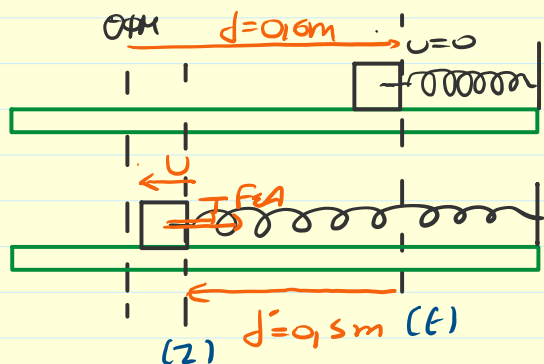
$$K_B + U_B = K_\Gamma + U_\Gamma$$

$$\Rightarrow \frac{1}{2} m_1 U_1'^2 = \frac{1}{2} m_1 U^2 + m_1 g \cdot \frac{R}{2}$$

$$\Rightarrow 36 = U^2 + 10 \Rightarrow U = \sqrt{26} \text{ m/s}$$

$$\sum F_R = m_1 \frac{U^2}{R} \Rightarrow N - m_1 g = m_1 \frac{U^2}{R} \Rightarrow N - 5 = 1 \cdot \frac{26}{1} \Rightarrow N = 31 \text{ N}$$

**Δ5**



ΘΜ. Κ. Ε. (ε → ζ)

$$\frac{1}{2} m_2 U^2 - 0 = -T_2 \cdot d' + U_{EA}(\alpha_{\text{pr}}) - U_{EA}(\zeta_{EA})$$

$$\Rightarrow \frac{1}{2} m_2 U^2 = -T_2 \cdot d' + \frac{1}{2} k \cdot d^2 - \frac{1}{2} k \cdot (d - d')^2$$

$$\Rightarrow \frac{1}{2} \cdot 3 \cdot U^2 = -4 \cdot 0.5 + 10 \cdot 0.6^2 - 10 \cdot 0.1^2$$

$$\Rightarrow 3 \frac{U^2}{2} = -2 + 3.6 - 0.1 \Rightarrow 3 \frac{U^2}{2} = 1.5 \Rightarrow U = 1 \text{ m/s}$$

$$\cdot \frac{dU_{EA}}{dt} = -F_{EA} \cdot U = -k \cdot (d - d') \cdot U = -20 \cdot 0.1 \cdot 1$$

$$\Rightarrow \frac{dU_{EA}}{dt} = -2 \text{ J/s}$$