1) .
   1) β
   2) γ
   3) β
   4) δ
   5) .
      1) Σ
      2) Λ
      3) Σ
      4) Λ
      5) Λ

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2) .

1) $$\begin{pmatrix} f_1 = f_s \dfrac{\upsilon}{\upsilon+\upsilon_s} \\ f_2 = f_s \dfrac{\upsilon}{\upsilon-\upsilon_s} \end{pmatrix} \rightarrow \frac{f_1}{f_2} = \frac{\upsilon-\upsilon_s}{\upsilon+\upsilon_s} = \frac{\upsilon - \dfrac{\upsilon}{10}}{\upsilon + \dfrac{\upsilon}{10}} = \frac{\dfrac{9}{10}}{\dfrac{11}{10}} = \frac{9}{11} \rightarrow iii$$

2) $$\upsilon_{\max} = 2A\cos\left(\frac{2\pi}{\lambda}x\right)\omega = 2Ac\,os\left(\frac{2\pi}{\lambda}\frac{9\lambda}{8}\right)\frac{2\pi}{T} = 2A\cos(2,25\pi)\frac{2\pi}{T} = = 2A\cos\left(\frac{\pi}{4}\right)\frac{2\pi}{T} = \frac{2\sqrt{2}\pi A}{T} \rightarrow i$$

3) $$\begin{bmatrix} \begin{pmatrix} A_A = 2A_B \\ A_A\upsilon_A = A_B\upsilon_B \end{pmatrix} \rightarrow 2\upsilon_A = \upsilon_B \rightarrow 4\tfrac{1}{2}\rho\upsilon_A^2 = \tfrac{1}{2}\rho\upsilon_B^2 \rightarrow 4\Lambda = \Lambda_B \\ p_A + \Lambda = p_B + \Lambda_B \rightarrow p_A - p_B = \Lambda_B - \Lambda \end{bmatrix} \rightarrow p_A - p_B = 3\Lambda \rightarrow ii$$

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3) .

1) $$\upsilon_{\Gamma 1} = \sqrt{2gR} = 10\ \frac{m}{s}$$

$$\upsilon_1^2 = \upsilon_{1\Gamma}^2 - 2as_1 = \upsilon_{1\Gamma}^2 - 2\mu g s_1 \rightarrow \upsilon_1 = 8\ \frac{m}{s}$$

2) $$\xrightarrow{+} \begin{pmatrix} \upsilon_1' = \dfrac{m_1-m_2}{m_1+m_2}\upsilon_1 + \dfrac{2m_2}{m_1+m_2}\upsilon_2 = \dfrac{-2m_1}{4m_1}8 + \dfrac{6m_1}{4m_1}(-4) = -4-6 = -10\ \dfrac{m}{s} \\ \upsilon_2' = \dfrac{2m_1}{m_1+m_2}\upsilon_1 + \dfrac{m_2-m_1}{m_1+m_2}\upsilon_2 = \dfrac{2m_1}{4m_1}8 + \dfrac{2m_1}{4m_1}(-4) = 4-2 = 2\ \dfrac{m}{s} \end{pmatrix}$$

3) $$\xrightarrow{+} \Delta p_2 = m_2\upsilon_2' - m_2\upsilon_2 = m_2(\upsilon_2' - \upsilon_2) = 3[2-(-4)] = 18\ kg\frac{m}{s}$$

4) $\frac{\Delta K_1}{K_1} = \frac{K_1' - K_1}{K_1} = \frac{K_1'}{K_1} - 1 = \left(\frac{\upsilon_1'}{\upsilon_1}\right)^2 - 1 = \left(\frac{8}{10}\right)^2 - 1 = \frac{16}{25} - 1 = \frac{9}{25} = 56,25\%$

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4) .

1) Ισορροπία κυλίνδρου: $\begin{pmatrix} TR = f_s R \rightarrow T = f_s \\ T + f_s = Mg\sin\phi \end{pmatrix} \rightarrow T = \frac{1}{2} Mg\sin\phi = 5\ N$ και από

ισορροπία σώματος : $ka = mg\sin\phi + T \rightarrow a = \frac{mg\sin\phi + T}{k} = \frac{5+5}{100} = 0,1\ m$

2) Η θέση ισορροπίας του σώματος θα είναι $\beta = \frac{mg\sin\phi}{k} = \frac{5}{100} = 0,05\ m$ πάνω από τη θέση από την οποία ξεκινά την ταλάντωση. Έτσι:

$A = a - \beta = 0,05\ m,\ \omega = \sqrt{\frac{k}{m}} = 10\ \frac{rad}{s} \rightarrow x = 0,05\ \sin\left(10\text{t} + \frac{3\pi}{2}\right)(SI)$

3) $F = -Dx = -kx = -5\ \sin\left(10\text{t} + \frac{3\pi}{2}\right)(SI)$

4) $\begin{pmatrix} Mg\sin\phi - f_s = Ma_{cm} \\ f_s R = \frac{1}{2} MR^2 \frac{a_{cm}}{R} \rightarrow f_s = \frac{1}{2} Ma_{cm} \end{pmatrix} \rightarrow a_{cm} = \frac{2}{3} g\sin\phi = \frac{10}{3}\ \frac{m}{s},\ a_\gamma = \frac{a_{cm}}{R} = \frac{100}{3}\ \frac{rad}{s^2},\ f_s = \frac{10}{3}\ N$

$\theta = \frac{\omega^2}{2a_\gamma} \rightarrow \omega = \sqrt{2a_\gamma \theta} = \sqrt{2\frac{100}{3}\frac{12}{\pi}2\pi} = 40\ \frac{rad}{s},\ L = I\omega = \frac{1}{2} MR^2\omega = 0,4\ kg\frac{m^2}{s}$

5) $\frac{\Delta K}{\Delta t} = \frac{\Delta K_M}{\Delta t} + \frac{\Delta K_\pi}{\Delta t} = F_{o\lambda}\upsilon_{cm} + \tau_{o\lambda}\omega = Ma_{cm}\left(a_{cm}t\right) + Ia_\gamma\left(a_\gamma t\right) = \frac{200}{3} + \frac{100}{3} = 100\ \frac{J}{s}$

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