UNIVERZITET U NIŠU
ELEKTRONSKI FAKULTET
PREDMET: FIZIKA **18. 9. 2026.**

ISPIT

1. Metak brzine 300 m/s nailazi na drvenu tablu i prolazi kroz nju. Ako je brzina metka prilikom izlaska iz table 200 m/s, njena debljina 10 cm i sila otpora kroz drvo $F = kv^2$, gde je k pozitivna konstanta, odrediti vreme prolaska metka kroz gredu.

2. Odrediti količinu toplote koju treba dovesti ledu mase m = 5 g na temperaturi t_1 = -5 °C da bi se pretvorio u paru temperature t_2 = 120 °C pri normalnom atmosferskom pritisku. Specifični toplotni kapacitet vodene pare je c_p = 2.09 J(gK)$^{-1}$, vode c_v = 4.18 J(gK)$^{-1}$, leda c_l = 2.51 J(gK)$^{-1}$. Poznato je q_t = 334.88 Jg^{-1}, q_k = 2262.4 Jg^{-1}.

3. Telo mase 20 g obešeno je o dve opruge krutosti k_1 = 0.2 Nm^{-1} i k_2 = 0.3 Nm^{-1}, koje su u jednom slučaju spojene redno, a u drugom paralelno. Odrediti: (a) odnos perioda vertikalnih oscilacija ovog tela u navedenim slučajevima; (b) odnos kinetičkih energija, po isteku t = 0.6 s od početnog trenutka, kada se telo nalazilo u ravnotežnom položaju.

4. Kolika je frekvencija drugog višeg harmonika čelične žice dužine l = 1 m i prečnika d = 0.1 mm koja je jednim svojem krajem učvršćena za oslonac, a na drugom kraju je opterećena tegom mase m = 10.5 kg? Gustina čelika je ρ = 7.8 gcm^{-3}, a ubrzanje Zemljine teže g = 9.81 ms^{-2}.

5. U toku vremenskog intervala od 3 s registrovan je određeni broj γ-čestica koje emituje radioaktivni izvor. U toku narednog vremenskog intervala koji je dva puta duži, registrovano je 1.5 puta više γ-čestica. Koliki je period poluraspada ovog izvora?

Predmetni nastavnici

1. $v_0 = 300 \frac{m}{s}$

$v_1 = 200 \frac{m}{s}$

$D = 10\,cm$

$F = kv^2, \quad k > 0$

$t = ?$

$F = kv^2$

$F = -ma = -m\frac{dv}{dt}$

$kv^2 = -m\frac{dv}{dt} \mid$

$-\frac{k}{m}dt = \frac{1}{v^2}dv \mid \int$

$\int_0^t -\frac{k}{m}dt = \int_{v_0}^{v_1} \frac{dv}{v^2}$

$-\frac{k}{m}t = -\frac{1}{v}\Big|_{v_0}^{v_1} = -\frac{1}{v_1} + \frac{1}{v_0}$

$\frac{k}{m}t = \frac{1}{v_1} - \frac{1}{v_0} = \frac{v_0 - v_1}{v_0 v_1}$

$t = \frac{v_0 - v_1}{v_0 v_1} \cdot \frac{m}{k}$

$kv^2 = -m\frac{dv}{dt}\cdot\frac{dx}{dx} = -m\cancel{\dot{x}}\frac{dv}{dx}$

$kv = -m\frac{dv}{dx}$

$-\frac{k}{m}dx = \frac{dv}{v} \mid \int$

$\int_0^D -\frac{k}{m}dx = \int_{v_0}^{v_1}\frac{dv}{v}$

$-\frac{k}{m}D = \ln v_1 - \ln v_0 = \ln\frac{v_1}{v_0}$

$\frac{m}{k} = -\frac{D}{\ln\frac{v_1}{v_0}} = \frac{D}{\ln\frac{v_0}{v_1}}$

$t = \frac{v_0 - v_1}{v_0 v_1} \cdot \frac{D}{\ln\frac{v_0}{v_1}}$

$t = \frac{300 - 200}{300 \cdot 200} \cdot \frac{0{,}1}{\ln\frac{300}{200}}$

$t = 4{,}11 \cdot 10^{-4}\,s$

2. $m = 5g$

$t_1 = -5°C$

$t_2 = 120°C$

$c_p = 2{,}09 \frac{J}{gK}$

$c_v = 4{,}18 \frac{J}{gK}$

$c_l = 2{,}51 \frac{J}{gK}$

$q_t = 334{,}88 \frac{J}{g}$

$q_k = 2262{,}4 \frac{J}{g}$

$Q = ?$

$Q = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$

Q_1 – TOPLOTA ZAGREVANJA LEDA DO $0°C$

$Q_1 = m c_l (0 - t_1)$

Q_2 – TOPLOTA TOPLJENJA LEDA

$Q_2 = m q_t$

Q_3 – TOPLOTA ZAGREVANJA VODE OD $0°C$ DO $100°C$

$Q_3 = m c_v (100 - 0)$

Q_4 – TOPLOTA ISPARAVANJA

$Q_4 = m q_k$

Q_5 – TOPLOTA ZAGREVANJA VODENE PARE DO $120°C$

$Q_5 = m c_p (120 - 100)$

$Q = m c_l (0 - t_1) + m q_t + m c_v (100 - 0) + m q_k + m c_p (120 - 100)$

$Q = 5 \cdot 2{,}51 \cdot 5 + 5 \cdot 334{,}88 + 5 \cdot 4{,}18 \cdot 100 + 5 \cdot 2262{,}4 + 5 \cdot 2{,}09 \cdot 20$

$Q = 15348{,}15\ J$

3. $m = 20g$

$k_1 = 0.2 \frac{N}{m}$

$k_2 = 0.3 \frac{N}{m}$

a) $\frac{T_r}{T_p} = ?$

b) $\frac{E_{kr}}{E_{kp}} = ?$

$t = 0.9s$

$A = A_1 = A_2$

(I) $k_r = \frac{k_1 \cdot k_2}{k_1 + k_2} = \frac{0,2 \cdot 0,3}{0,2 + 0.3} = 0.12 \frac{N}{m}$

(II) $k_p = k_1 + k_2 = 0.5 \frac{N}{m}$

a) $T_r = 2\pi \sqrt{\frac{m}{k_r}} \Rightarrow \frac{T_r}{T_p} = \frac{2\pi\sqrt{\frac{m}{k_r}}}{2\pi\sqrt{\frac{m}{k_p}}} = \sqrt{\frac{k_p}{k_r}} = \sqrt{\frac{0.5}{0.12}}$

$T_p = 2\pi \sqrt{\frac{m}{k_p}}$

$$\boxed{\frac{T_r}{T_p} = 2,04}$$

b) $E_{kr} = \frac{m \cdot v^2}{2} = \frac{m \cdot A^2 \cdot \omega_r^2 \cdot \cos^2 \omega_r t}{2}$

$E_{kp} = \frac{m A^2 \cdot \omega_p^2 \cdot \cos^2 \omega_2 t}{2}$

$\frac{E_{kr}}{E_{kp}} = \frac{\frac{m \cdot A^2 \cdot \omega_r^2 \cdot \cos^2 \omega_r t}{2}}{\frac{m \cdot A^2 \cdot \omega_p^2 \cdot \cos^2 \omega_p t}{2}} = \frac{\omega_r^2 \cdot \cos^2 \omega_r t}{\omega_p^2 \cdot \cos^2 \omega_p t}$

$\omega = \frac{2\pi}{T} = \frac{2\pi}{2\pi\sqrt{\frac{m}{k_e}}} = \sqrt{\frac{k_e}{m}}$

$\omega_r = \sqrt{\frac{k_r}{m}} = \sqrt{\frac{0.12}{20 \cdot 10^{-3}}} = 2,45 \frac{rad}{s}$

$\omega_p = \sqrt{\frac{k_p}{m}} = \sqrt{\frac{0.5}{20 \cdot 10^{-3}}} = 5 \frac{rad}{s}$

$$\boxed{\frac{E_{kr}}{E_{kp}} = 2,49 \cdot 10^{-3}}$$

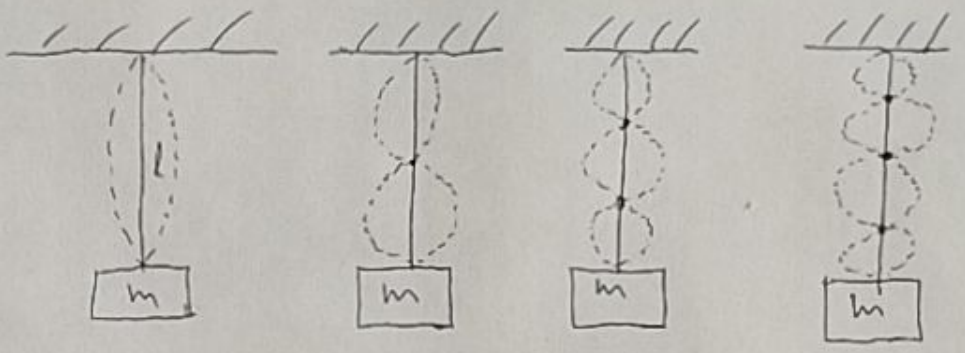
4. $l = 1\,m$

$d = 0{,}1\,mm$

$m = 10{,}5\,kg$

$\rho_c = 7{,}8\ \frac{g}{cm^3}$

$g = 9{,}81\ \frac{m}{s^2}$



$l = \frac{\lambda}{2}$ $\quad l = 2\frac{\lambda}{2}$ $\quad l = 3\frac{\lambda}{2}$ $\quad l = 4\frac{\lambda}{2}$

$$\boxed{l = n\frac{\lambda}{2}}$$

$n = 1 \rightarrow$ ОСНОВЕН ТОН

$n = 2 \rightarrow$ 1. В. Х.

$n = 3 \rightarrow$ 2. В. Х.

5

$$3\,\lambda = \lambda \cdot \nu$$

$$\lambda = \frac{2}{3}l$$

4 $\quad \lambda = \sqrt{\frac{F}{\mu}}$, $\quad F = mg$

$\mu = \frac{m_z^v}{l}$ $\quad$ 3

$m_z^v = \rho_c^v \cdot V_z^v$

3

$V_z^v = \left(\frac{d}{2}\right)^2 \pi \cdot l$

$\mu = \frac{\rho_c^v \cdot \left(\frac{d}{2}\right)^2 \pi \cdot l}{l}$

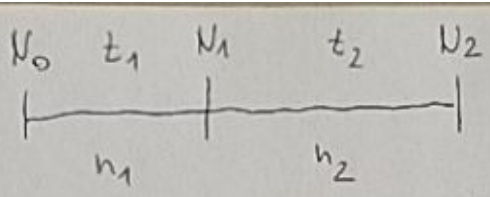
$\lambda = \sqrt{\frac{m \cdot g}{\rho_c^v \cdot \left(\frac{d}{2}\right)^2 \pi}}$

$\nu = \frac{\sqrt{\frac{m \cdot g}{\rho_c^v \cdot \left(\frac{d}{2}\right)^2 \pi}}}{\frac{2}{3}l}$

$$\boxed{\nu = 1936\ Hz}$$ 2

5. $t_1 = 3s$ n_1

$t_2 = 6s$ $n_2 = 1{,}5 \cdot n_1$



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$T = \frac{\ln(2)}{\lambda}$ t_1:

$n_1 = \Delta N = N_0 - N_1 = N_0 \cdot e^{-\lambda t_1}$ 4

$e^{-\lambda t_1} = 0{,}82 \quad / \ln$

t_2:

$-\lambda t_1 = \ln(0{,}82)$

$\lambda = \frac{\ln(0{,}82)}{-t_1}$

$n_2 = N_1 - N_2 = N_0 \cdot e^{-\lambda t_1} - N_0 \cdot e^{-\lambda \cdot 3 t_1}$

$n_2 = N_0 \left(e^{-\lambda t_1} - \left(e^{-\lambda t_1}\right)^3\right)$ 4

$\lambda = 0{,}066 \frac{1}{s}$

$e^{-\lambda t_1} = x$

$T = 10{,}5\,s$ 2

~~$\frac{n_1}{n_2} = \frac{N_0 (1-x)}{N_0 \cdot x (1-x^2)}$~~

$\frac{n_1}{n_2} = \frac{N_0 (1-x)}{N_0 \cdot x (1-x^2)} = \frac{1-x}{x(1-x)(1+x)} = \frac{1}{x+x^2}$ 4

$\frac{1}{1{,}5} = \frac{1}{x+x^2}$

$x^2 + x - 1{,}5 = 0$

$x_{1/2} = \frac{-1 \pm \sqrt{1 - 4 \cdot 1 \cdot (-1{,}5)}}{2}$ 4

$x_1 = 0{,}82$

$x_2 = -1{,}82$