FIZ2 - DODATNE AUDITORNE

① Svjetlost upada okomito na opt. reš. 2. maksimum za $\lambda_1 = 0{,}65\ \mu m$ vidi se pod kutom od 45°. Pod kojim se kutem vidi max. 3. reda za $\lambda_2 = 0{,}5\ \mu m$?

VJEROJATNO zad. s opt. reš.

$d \sin\alpha_1 = m_1 \lambda_1 \quad m=2$

$\Rightarrow d = 1{,}84\ \mu m$

$d \sin\alpha_2 = m_2 \lambda_2$

$\sin\alpha_2 = \frac{3\lambda_2}{d}$

$\alpha_2 = 54{,}7°$

② Dvije difr. rešetke A i B nalaze se na istoj udaljenosti od zastora.

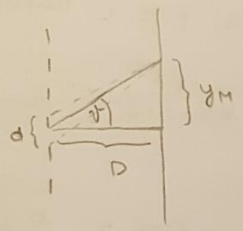
$\sin\vartheta \approx \operatorname{tg}\vartheta$

$y_A = 2{,}7\ cm$

$y_B = 3{,}2\ cm$

} udaljenost između max.

$\frac{1}{d_A} = 2000\ m^{-1} \quad \frac{1}{d_B} = ?$



$\operatorname{tg}\vartheta = \frac{y_M}{D}$

$\sin\vartheta = \frac{\Delta x}{d}$

$\Rightarrow \frac{y_M}{D} = \frac{\Delta x}{d}$

$\frac{k}{2}\Delta x = m\pi \qquad k = \frac{2\pi}{\lambda}$

$\frac{2\pi}{2\lambda}\Delta x = m\pi$

$\Delta x = m\lambda$

$\frac{y_M}{D} = \frac{m\lambda}{d}$

$\frac{y_{MA}}{D} = \frac{m\lambda}{d_A}$

$\frac{y_{MB}}{D} = \frac{m\lambda}{d_B}$

$\frac{y_{MA}}{y_{MB}} = \frac{d_B}{d_A}$

$\frac{1}{d_B} = \frac{1}{d_A}\frac{y_{MB}}{y_{MA}} = 2370\ m^{-1}$

③ Crno tijelo ima oblik sfere $R = 1\ m$, $t = 25°C$. Odredi snagu kojom zrači.

$P = ?$

$I = \sigma T^4$

$\frac{P}{S} = \sigma T^4$

$P = 4\pi R^2 \sigma T^4 = 5262\ W$

④ $T_s = 5700\ K$ (sunce)

$T_z = 20°C$ (Zemlja)

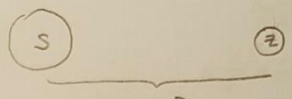
$R_s = 7 \cdot 10^5\ km$

$D = ?$

Odrediti udaljenost na kojoj treba biti Zemlja da bi zračila kao crno tijelo.

$I = \sigma T^4$

$P_s = 4\pi R_s^2 \sigma T_s^4$ $\qquad P_z = 4\pi R_z^2 \sigma T_z^4$



$I = \frac{P_s}{4\pi D^2} = \frac{P_A}{R_z^2 \pi} \rightarrow \frac{4\pi R_s^2 \sigma T_s^4}{4\pi D^2} = \frac{4\pi R_z^2 \sigma T_z^4}{R_z^2 \pi}$

$4\pi D^2$ ... dijela sfera

$R_z^2 \pi$ ... samo površina

$P_A = P_z$

P_A ... snaga apsorpcije

$D^2 = \frac{T_s^4}{T_z^4} \frac{R_s^2}{4}$

$D = \left(\frac{T_s}{T_z}\right)^2 \frac{R_s}{2} = 1375 \cdot 10^6\ km$

⑤ Crno tijelo zrači za 1 min energiju $5{,}7 \cdot 10^9\ J$.

Valna duljina max. gustoće zračenja je 710 nm.

$S = ?$

$P = \frac{E}{t} = 95 \cdot 10^6\ W$ $\qquad \lambda_M T = k_W$

$P = S \sigma T^4$

$S = \frac{P}{\sigma T^4} = \frac{P}{\sigma k_W^4} \lambda_M^4 = 6\ m^2$

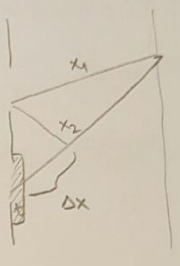
(6) Youngov pokus

$\lambda = 480$ nm

$n = 1,56$

2. min se pomakne na mjesto 5. max kad prekrijemo folijom (n)

$t = ?$ (debljina folije)



$\Delta x = m\lambda = 5\lambda$ (kad nema folije)

$x_1 - (x_2 - t) + nt = \frac{2m-1}{2}\lambda$ minimum

$$\begin{cases} x_1 - x_2 = 5\lambda \\ x_1 - x_2 + t - nt = \frac{3}{2}\lambda \end{cases}$$

$$5\lambda + t(1-n) = \frac{3}{2}\lambda$$

$$t = 3\,\mu m$$

(7) $E_{m_1} = -0,85$ eV

$E_{m_2} = -3,4$ eV

$\lambda = ?$

$E_\gamma = E_{m_1} - E_{m_2} = 2,55$ eV

$E = h\nu$

$E_\gamma = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E_\gamma} = 487,2$ nm

(8) $E = 0,2$ MeV

COMPTONOVO RASPRŠENJE

$p = \frac{h}{\lambda}$ za foton

$\Delta\lambda = \lambda' - \lambda = 2\frac{h}{mc}\sin^2\frac{\vartheta}{2}$

$E_\gamma' = 0,9\,E_\gamma$ (energija se smanji 10%)

$\vartheta = ?$

$\lambda = \frac{hc}{E}$ $\lambda' = \frac{hc}{E'}$

$$hc\left(\frac{1}{E'} - \frac{1}{E}\right) = 2\frac{h}{mc}\sin^2\frac{\vartheta}{2}$$

$$c\left(\frac{1}{0,9E} - \frac{1}{E}\right) = \frac{c}{E}\frac{1}{9} = 2\frac{1}{mc}\sin^2\frac{\vartheta}{2}$$

$$\sin^2\frac{\vartheta}{2} = \frac{1}{2}\frac{1}{9}\frac{mc^2}{E}$$

$\vartheta = 44,3°$

(9)

$F(r) = -kr$

$v = ?\quad r = ?\quad E = ?$

$n = 2\quad E_2 = ?$

$mvr = n\hbar$

$v = \frac{n\hbar}{mr}$

$F = F_c$

$kr = \frac{mv^2}{r}$

$kr = \frac{m}{r}\frac{n^2\hbar^2}{m^2 r^2}$

$r^4 = \frac{n^2\hbar^2}{km}$

$v^2 = \frac{n^2\hbar^2}{m^2}\frac{\sqrt{km}}{km} = \sqrt{\frac{k}{m}}\frac{n\hbar}{m}$

$E = U + K = \frac{kr^2}{2} + \frac{mv^2}{2} = \frac{k}{2}\frac{n\hbar}{\sqrt{km}} + \frac{m}{2}\sqrt{\frac{k}{m}}\frac{n\hbar}{m} = \sqrt{\frac{k}{m}}\,n\hbar$

$E_2 = 2\sqrt{\frac{k}{m}}\,\hbar$

$U = -\int F\,dr = \frac{kr^2}{2}$

(10) $\Delta\lambda_{MAX} = 4{,}85 \cdot 10^{-12}\ m$

$m = ?$

Comptonovo razpršenje:

$\Delta\lambda = 2\frac{h}{mc}\sin^2\frac{\vartheta}{2}$

$\Delta\lambda_{max} = 2\frac{h}{mc}$

$m = \frac{2h}{\Delta\lambda_{max}\, c} = 9{,}1 \cdot 10^{-31}\ kg$

(11) $m = 1{,}49\ \mu g\ \ {}^{13}_{7}N$

$t_{1/2} = 10\ min$

$A(t) = -\frac{dN}{dt} = \lambda N(t)\qquad A = N_0\,\lambda e^{-\lambda t}$

$N(t) = N_0 e^{-\lambda t}\qquad \lambda = \frac{1}{\tau} = \frac{\ln 2}{t_{1/2}}$

$N_0 = N_A\frac{m}{M} = 6{,}9 \cdot 10^{16}$

$\frac{A}{N_0}\frac{t_{1/2}}{\ln 2} = e^{-\lambda t}$

$\ln\frac{A}{N_0}\frac{t_{1/2}}{\ln 2} = -\frac{\ln 2}{t_{1/2}}t$

$t = 7{,}7\ h$

(12) $^{14}_{6}C$ $m = 5{,}9 \cdot 10^{-7}\ g$ $A = \lambda N$ $N = N_A \frac{m}{M}$

$A = 10^5\ s^{-1}$

$t_{1/2} = ?$

$\lambda = \frac{N}{A} = \frac{\ln 2}{t_{1/2}}$

$t_{1/2} = \frac{\ln 2 \cdot A}{N} = \dots$