1. Napišite jednadžbe za polja **E** i **B** elektromagnetskog vala u vakuumu koji ima prosječnu vrijednost Poyntingovog vektora 0.5 W/m^2 i valnu duljinu 600 nm. Val se širi u smjeru jediničnog vektora $(-\mathbf{i} + \mathbf{j}) / \sqrt{2}$, a polje **B** je u x–y ravnini. (**5 bodova**)

Rješenje: $\mathbf{E} = 19.4\ \text{V/m}\ \sin(3.14 \cdot 10^{15}\ \text{s}^{-1}\ t - 7.40 \cdot 10^{6}\ \text{m}^{-1}(-x+y))\ \mathbf{k}$
$\mathbf{B} = 45.8\ \text{nT}\ \sin(3.14 \cdot 10^{15}\ \text{s}^{-1}\ t - 7.40 \cdot 10^{6}\ \text{m}^{-1}(-x+y))\ (\mathbf{i} + \mathbf{j})$

2. Foton frekvencije 10^{19} Hz Comptonski se raspršuje na mirnom elektronu pod kutom 60°. Izrazite kinetičku energiju odbijenog elektrona u jedinicama keV. (**4 boda**)

Rješenje: $T = 1.6$ keV

3. (**3 boda**) ZBIRKA, PRIMJER 6.15,

Rješenje: $\Delta x = 15\ \text{mm}$

4. Izotopska zastupljenost uranovih izotopa u Zemljinoj kori danas je 0.72 % ($^{235}_{92}\text{U}$) i 99.28 % ($^{238}_{92}\text{U}$). Pretpostavljajući da je njihov omjer u vrijeme nastanka Zemljine kore bio jedinica, izračunajte starost Zemljine kore! Vrijeme poluživota $^{235}_{92}\text{U}$ je $7.038 \cdot 10^{8}$ godina, a vrijeme poluživota $^{238}_{92}\text{U}$ je $4.468 \cdot 10^{9}$ godina. (**3 boda**)

Rješenje: $t = 5.94 \cdot 10^{9}$ godina

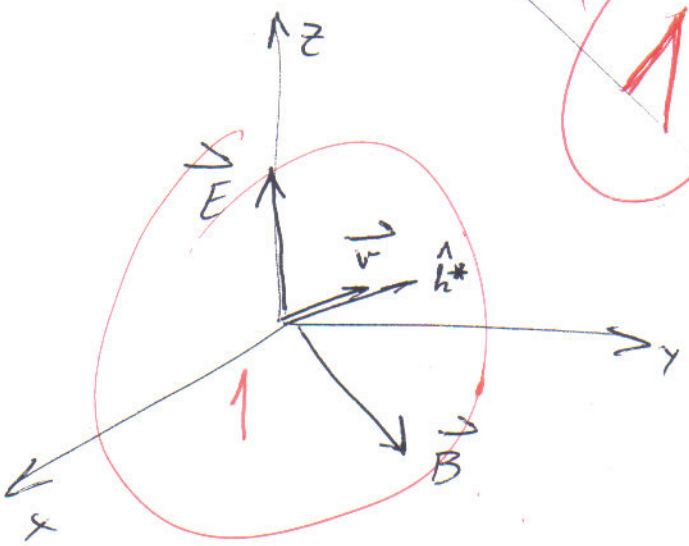
$\overline{S} = 0{,}5 \frac{W}{m^2}$

$\lambda = 600\ nm$

$\hat{h}^* = \frac{-\hat{i} + \hat{j}}{\sqrt{2}}$

$\vec{E} = ?$

$\vec{B} = ?$



1

$\boxed{\vec{E} = \vec{B} \times \vec{v}}$ $\quad \boxed{\vec{v} = c\,\hat{h}^*}$

$\boxed{\overline{S} = \frac{E_0 B_0}{2\mu}}$ $\quad \boxed{E_0 = c B_0}$ $\Rightarrow$ $B_0 = \sqrt{\frac{2\mu \overline{S}}{c}} = 64{,}7\ nT$ (1)

$E_0 = 19{,}4\ V/m$

$\vec{E} = E_0 \hat{k} \sin(\omega t - \vec{k} \cdot \vec{r})$

$\vec{B} = B_0 \frac{\hat{i} + \hat{j}}{\sqrt{2}} \sin(\omega t - \vec{k} \cdot \vec{r})$

$\vec{k} \cdot \vec{r} = \frac{-\hat{i} + \hat{j}}{\sqrt{2}} \cdot \frac{2\pi}{\lambda} \cdot \vec{r} = 7{,}40 \cdot 10^6\ m^{-1}(-x + y)$ (1)

$\boxed{\omega = \frac{2\pi}{T}}$ $\quad \boxed{c = \frac{\lambda}{T}}$ $\Rightarrow$ $\omega = \frac{2\pi c}{\lambda} = 3{,}14 \cdot 10^{15}\ s^{-1}$ (1)

$\vec{E} = 19{,}4 \frac{V}{m} \sin(3{,}14 \cdot 10^{15} s^{-1} t - 7{,}40 \cdot 10^6 m^{-1}(-x+y))\,\hat{k}$

$\vec{B} = 45{,}8\ nT \sin(3{,}14 \cdot 10^{15} s^{-1} t - 7{,}40 \cdot 10^6 m^{-1}(-x+y))(\hat{i} + \hat{j})$

5 BODOVA

$\nu = 10^{19}\ Hz$

$\vartheta = 60^\circ$

$T = ?$

2

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

$$\frac{h}{mc} = 2.42\ pm$$

$$\Delta\lambda = 2 \cdot 2{,}42 \cdot 10^{-12} \sin^2 30^\circ = 1{,}21 \cdot 10^{-12}\ m$$

1

$$c = \lambda\nu \qquad \Delta\lambda = \lambda' - \lambda$$

$$\Delta\lambda = \frac{c}{\nu'} - \frac{c}{\nu} \qquad \frac{1}{\nu'} = \frac{\Delta\lambda}{c} + \frac{1}{\nu} \qquad \nu' = 0.961 \cdot 10^{19}\ Hz$$

1

$$h\nu + mc^2 = h\nu' + \gamma mc^2 \quad \text{ZSE}$$

$$T = \gamma mc^2 - mc^2$$

1

$$T = h(\nu - \nu')$$

$$T = 2.569 \cdot 10^{-16}\ J$$

$$T = 1.6\ keV$$

1

4 BODA

PRIMJER 6.15

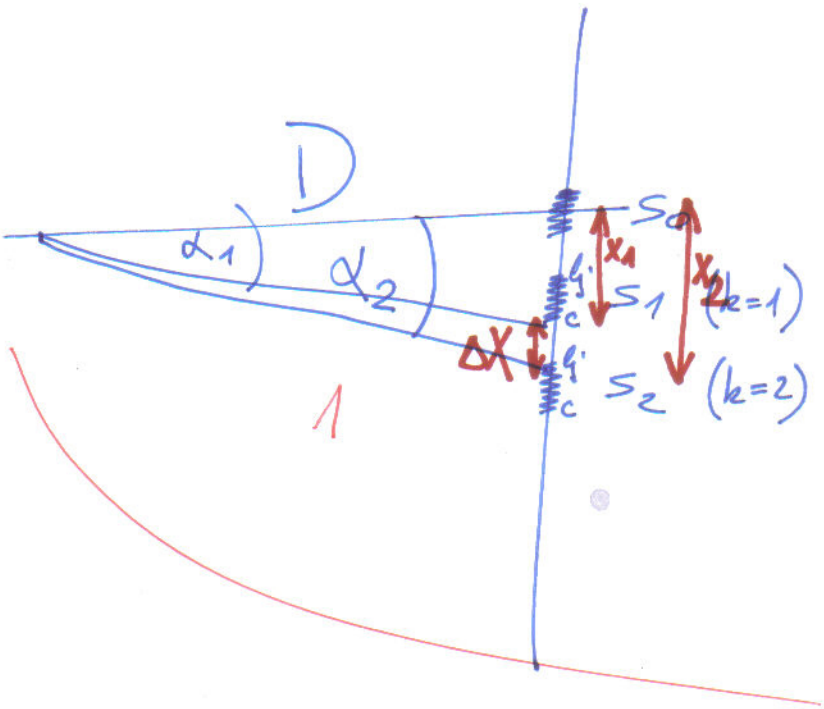
3

$$d = \frac{1mm}{250} = 4\mu m$$

$D = 1{,}5\,m$

$\lambda_c = 760\,nm = 0{,}76\,\mu m$

$\lambda_{g'} = 400\,nm = 0{,}4\,\mu m$



$\Delta X =$

$$k\lambda = d \sin\alpha$$

1

$1 \cdot \lambda_c = d \sin\alpha_1 \Rightarrow \alpha_1 = \sin^{-1}\left(\frac{\lambda_c}{d}\right)$

$2 \cdot \lambda_{g'} = d \sin\alpha_2 \Rightarrow \alpha_2 = \sin^{-1}\left(\frac{2\lambda_{g'}}{d}\right)$

$$tg\alpha_1 = \frac{x_1}{D} \Rightarrow x_1 = D\,tg\alpha_1$$

$$tg\alpha_2 = \frac{x_2}{D} \Rightarrow x_2 = D\,tg\alpha_2$$

1

$$\Delta X = x_2 - x_1 = D\,(tg\alpha_2 - tg\alpha_1)$$

za $\alpha \ll 1 \Rightarrow tg\alpha \approx \sin\alpha \Rightarrow \Delta X = D\left(\frac{2\lambda_{g'}}{d} - \frac{\lambda_c}{d}\right)$

$$\Delta X = \frac{D}{d}(2\lambda_{g'} - \lambda_c)$$

$\Delta X = 15\,mm$

3 BODA

$$\frac{N_5}{N_5 + N_8} = 0{,}0072$$

$N_{05} / N_{08} = 1$

$T_5 = 7{,}038 \cdot 10^8$ god

$T_8 = 4{,}468 \cdot 10^9$ god

$t = ?$

$$N = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{T_{1/2}}$$

$$N_5 = N_{05} e^{-\ln 2 \frac{t}{T_5}}$$

$$N_8 = N_{08} e^{-\ln 2 \frac{t}{T_8}} \quad / : \quad / \ln$$

$$\ln\left(N_8 / N_5\right) = \ln 2 \left(\frac{1}{T_5} - \frac{1}{T_8}\right) t$$

$$t = \frac{T_8 \cdot T_5}{T_8 - T_5} \cdot \frac{\ln\left(N_8 / N_5\right)}{\ln 2}$$

$$\frac{N_5}{N_5 + N_8} \quad / \cdot N_5 \;=\; 0{,}0072 \qquad 0{,}0072 = \frac{1}{1 + N_8/N_5} \qquad N_8 / N_5 = 137{,}89$$

$$t = 5{,}94 \cdot 10^9 \text{ god}$$

$1{,}8 \cdot 10^{17}$

4

1

1

1

1

3 BODA