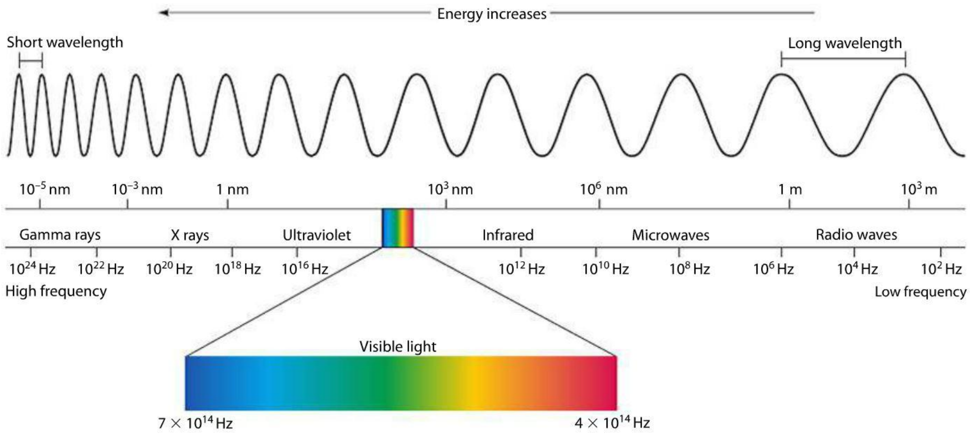
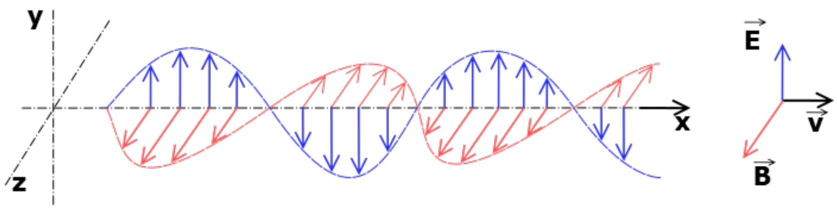
Podmienky ukončenia predmetu: - účasť na cvičeniach (max. 2 povolené absencie)
- ! splnenie odpovedníku zo základov matematiky do najbližšieho cvičenia (tj. 8.3.) !
- splnenie odpovedníku z optiky
- odovzdanie riešení zo zápočtových príkladov z kvantovej mechaniky

Doporučná literatúra: - Halliday, Resnic, Walker: Fyzika
- Fyzika pro gymnázia (Optika, Fyzika mikrosvěta)

Elektromagnetické žiarenie



prevziate z https://www.miniphysics.com/electromagnetic-spectrum_25.html



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smer šírenia a polarizácia vektoru elektrickej intenzity

2

$f = 5.45 \cdot 10^{14}\,\mathrm{Hz}$

$\epsilon_0 = 8.854 \cdot 10^{-12}\,\mathrm{Fm}^{-1}$

$\mu_0 = 4\pi \cdot 10^{-7}\,\mathrm{Jm}^{-1}$

a) $c = ?$

$\lambda = ?$

$\boxed{c = \sqrt{\frac{1}{\varepsilon_0 \mu_0}}}$ $\boxed{c = \lambda f}$

$c = \sqrt{\frac{1}{8{,}854 \cdot 10^{-12} \cdot 4\pi \cdot 10^{-7}}} \doteq 299\,795\,637{,}7\ \mathrm{m s^{-1}} = 2{,}998 \cdot 10^{8}\ \mathrm{m s^{-1}} = 3 \cdot 10^{5}\ \mathrm{km s^{-1}}$ dôležité číslo !

$\lambda = \frac{c}{f} = \frac{2{,}998 \cdot 10^{8}}{5{,}45 \cdot 10^{14}} \doteq 5{,}5 \cdot 10^{-7}\ \mathrm{m} = 550\ \mathrm{nm}$ zelená farba

b) $\bar{E} = \bar{E}(\bar{r}, t)$

$\bar{B} = \bar{B}(\bar{r}, t)$

"meriame" v čase t a mieste $\mathbf{r} = (x, y, z)$

$\bar{E}_0 = (0, E_0, 0)$

$\bar{B}_0 = (0, 0, B_0)$

$\bar{k} = (k, 0, 0)$

$\bar{k} \cdot \bar{r} = (k, 0, 0) \cdot (x, y, z) = kx$

obecný smer šírenia vlny: $\bar{E}(\bar{r}, t) = \bar{E}_0 \exp\{i(\bar{k} \cdot \bar{r} - \omega t)\}$

$\bar{B}(\bar{r}, t) = \bar{B}_0 \exp\{i(\bar{k} \cdot \bar{r} - \omega t)\}$

vlnový vektor $\bar{k} = (k_x, k_y, k_z)$ ← smer šírenia vlny

$|\bar{k}| = \frac{2\pi}{\lambda}$

$\bar{k} \cdot \bar{r} = (k_x, k_y, k_z) \cdot (x, y, z)^T = k_x x + k_y y + k_z z$

kruhová frekvencia $\omega = \frac{2\pi}{T} = 2\pi f$

2π T → perióda $T = \frac{1}{f}$

$$\bar{E}(\bar{r},t) = \bar{E}_0 \exp\{i(kx-\omega t)\} = (0, E_0, 0)\exp\{i(kx-\omega t)\}$$

$$\bar{B}(\bar{r},t) = \bar{B}_0 \exp\{i(kx-\omega t)\} = (0, 0, B_0)\exp\{i(kx,\omega t)\}$$

c) $\Delta F(\bar{r},t) = \frac{1}{v^2}\frac{\partial^2}{\partial t^2} F(\bar{r},t)$; $\Delta_{\bar{r}} F(x,y,z,t) = \frac{\partial^2 F}{\partial x^2} + \frac{\partial^2 F}{\partial y^2} + \frac{\partial^2 F}{\partial z^2}$; $F = F(x) \longrightarrow \frac{dF}{dx}$

Vlnová rovnica

Laplacov operátor

$F = F(x,y) \longrightarrow \frac{\partial F}{\partial x}$

parciálna derivácia

$$\Delta \bar{A}(\bar{r},t) = \Delta \bar{A}(x,y,z,t) = (\Delta A_x(x,y,z,t), \Delta A_y(x,y,z,t), \Delta A_z(x,y,z,t))$$

- $\bar{E} = (0, E_y, 0)$; $E_y(x,t) = E_0 \exp\{i(kx-\omega t)\}$

$$\Delta E_y = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} E_y$$

ΔE_y : $\frac{\partial^2}{\partial x^2} E_0 \exp\{i(kx-\omega t)\} = \frac{\partial}{\partial x} E_0 ik \exp\{i(kx-\omega t)\} = E_0(ik)(ik)\exp\{i(kx-\omega t)\} = -E_0 k^2 \exp\{i(kx-\omega t)\}$

$\frac{d}{dx} e^{\alpha x} = \alpha e^{\alpha x}$ $\qquad i = \sqrt{-1}$

$$\frac{\partial^2}{\partial y^2} E_0 \exp\{i(kx-\omega t)\} = 0$$

$$\frac{\partial^2}{\partial z^2} E_0 \exp\{i(kx-\omega t)\} = 0$$

$\frac{\partial^2 E_y}{\partial t^2}$: $\frac{\partial^2}{\partial t^2} E_0 \exp\{i(kx-\omega t)\} = \frac{\partial}{\partial t} E_0 (-i\omega)\exp\{i(kx-\omega t)\} = E_0(-i\omega)(-i\omega)\exp\{i(kx-\omega t)\}$

$$= -E_0 \omega^2 \exp\{i(kx-\omega t)\}$$

$$-E_0 k^2 \exp\{i(kx-\omega t)\} = -\frac{1}{c^2} E_0 \omega^2 \exp\{i(kx-\omega t)\}$$

$$k^2 = \frac{1}{c^2}\omega^2$$

$$c^2 = \frac{\omega^2}{k^2}$$

$$c^2 = c^2$$

$$\boxed{c = \lambda f = \frac{2\pi}{k}\cdot\frac{\omega}{2\pi} = \frac{\omega}{k}}$$