

1. Elektromagnetische Welle im Vakuum

$$E_x = 0; \quad E_y = 30 \cos(2\pi * 10^8 t - \frac{2\pi}{3} x); \quad E_z = 0$$

(a) $\omega = 2\pi * 10^8 \text{ 1/s}$

$$f = \frac{\omega}{2\pi} = \underline{\underline{10^8 \text{ 1/s}}}$$

(b) $k = \frac{2\pi}{3}$

$$\lambda = \frac{2\pi}{k} = \underline{\underline{3 \text{ m}}}$$

(c)

Direction: $\underline{\underline{\hat{x}}}$

(d)

2. Photonen-Ping-Pong

(a)

(b)

(c)

3. Stehende Wellen

$$\vec{E}(\vec{r}, t) = \text{Re} \left(\vec{E}_0 e^{i\vec{k}\vec{r} - i\omega t} \right)$$

(a)

$$\begin{aligned} \vec{E}_1(\hat{x}, t) &= \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{x} - i\omega t} \right) \\ \vec{E}_2(-\hat{x}, t) &= \text{Re} \left(\vec{E}_0 e^{-i\vec{k}\hat{x} - i\omega t} \right) \\ \vec{E} &= \vec{E}_1 + \vec{E}_2 = \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{x} - i\omega t} + e^{-i\vec{k}\hat{x} - i\omega t} \right) \end{aligned}$$

(b)

$$\begin{aligned} \vec{E}_1(\hat{x}, t) &= \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{x} - i\omega t} \right) \\ \vec{E}_2(\hat{y}, t) &= \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{y} - i\omega t} \right) \\ \vec{E} &= \vec{E}_1 + \vec{E}_2 = \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{y} - i\omega t} + e^{-i\vec{k}\hat{x} - i\omega t} \right) \end{aligned}$$

(c)

(d) $\omega_1 = 2\omega_2$

$$\begin{aligned} \vec{E}_1(\hat{x}, t) &= \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{x} - i\omega_1 t} \right) \\ \vec{E}_2(-\hat{x}, t) &= \text{Re} \left(\vec{E}_0 e^{-i\vec{k}\hat{x} - i\omega_2 t} \right) \\ \vec{E} &= \vec{E}_1 + \vec{E}_2 = \text{Re} \left(\vec{E}_0 e^{i\vec{k}\hat{x} - i2\omega_2 t} + e^{-i\vec{k}\hat{x} - i\omega_2 t} \right) \end{aligned}$$