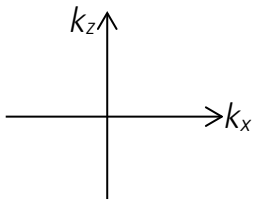
Quiz 04: Normal modes

The normal mode solutions of Maxwell's equations in homogeneous media in the frequency domain are plan waves:

$$\underline{\mathbf{E}}(\mathbf{r},\omega) = \underline{\mathbf{E}}(\mathbf{k},\omega)\exp\left(\mathbf{i}\mathbf{k}\mathbf{r}\right) \text{ with } \mathbf{k} = \mathbf{k}' + \mathbf{i}\mathbf{k}''.$$

1) Define a plane of constant amplitude. [1 point]
2) How is $\underline{\mathbf{E}}(\mathbf{k},\omega)$ related to $\mathbf{k}$ for a material with $\varepsilon(\omega) \neq 0$? [1 point]
3) Show that the relation, which you gave as your answer in (2), is required by Maxwell's equations. [4 points]
4) Please draw the typical shape of $\mathbf{k}$ in the x-z-plane and indicate the quantity of any crossings with the axes. [4 points]



5*) What is the relation between $\mathbf{k}$ and the wavelength λ_m of a plane wave in a medium? [2 points]

You have 10 minutes!

Make sure that you indicate your seminar group on your answer sheet!