The electric fields of two EM waves in vacuum are both described by:

$$\mathbf{E} = E_0 \sin(kx - \omega t)\hat{y}$$

The "wave number" k of wave 1 is larger than that of wave 2, $k_1 > k_2$. Which wave has the larger frequency f?

A. Wave 1
B. Wave 2
C. impossible to tell

ANNOUNCEMENTS

- Projects graded! Sync to see your detailed grades.
- Projected grades sent out
- Homework 9 will be posted by tomorrow morning (Apologies, I'm jet lagged)

For a wave on a 1d string that hits a boundary between 2 strings of different material we get,

$$\widetilde{f}(z<0) = \widetilde{A}_I e^{i(k_1)z-\omega t} + \widetilde{A}_R e^{i(-k_1 z-\omega t)}$$
$$\widetilde{f}(z>0) = \widetilde{A}_T e^{i(k_2)z-\omega t}$$

where continuity (BCs) give,

$$\widetilde{A}_R = \left(\frac{k_1 - k_2}{k_1 + k_2}\right)\widetilde{A}_I$$
$$\widetilde{A}_T = \left(\frac{2k_1}{k_1 + k_2}\right)\widetilde{A}_I$$

Is the transmitted wave in phase with the incident wave?

A) Yes, always B) No, never C) Depends

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Is the reflected wave in phase with the incident wave?

A) Yes, always B) No, never C) Depends

In matter we have,

$$\nabla \cdot \mathbf{D} = \rho_f \qquad \nabla \cdot \mathbf{B} = 0$$
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{E}}{\partial t} \qquad \nabla \times \mathbf{H} = \mathbf{J}_f + \frac{\partial \mathbf{D}}{\partial t}$$

with

$$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P} \qquad \mathbf{H} = \mathbf{B}/\mu_0 - \mathbf{M}$$

If there are no free charges or current, is $\nabla \cdot \mathbf{E} = 0$?

A. Yes, always
B. Yes, under certain conditions (what are they?)
C. No, in general this will not be true
D. ??

In linear dielectrics, $\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P} = \varepsilon \mathbf{E}$. In a linear dielectric is $\varepsilon > \varepsilon_0$?

A. Yes, always
B. No, never
C. Sometimes, it depends on the details of the dielectric.

In a non-magnetic, linear dielectric,

$$v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu\varepsilon_r\varepsilon_0}} = \frac{c}{\sqrt{\varepsilon_r}}$$

How does v compare to c?

A. $v > c$ always
B. $v < c$ always
C. It depends

For our reflected and transmitted waves, how many unknowns have we introduced?

$$\mathbf{E}_R = \widetilde{E_R}\, e^{i(k_R z - \omega_R t)} \hat{n}_R$$
$$\mathbf{E}_T = \widetilde{E_T}\, e^{i(k_T z - \omega_T t)} \hat{n}_T$$

A. 2
B. 4
C. 8
D. 12
E. None of the above

For our reflected and transmitted waves, how many unknowns have we introduced?

$$\mathbf{E}_R = \widetilde{E_R}\, e^{i(k_I z - \omega_I t)} \hat{n}_I$$
$$\mathbf{E}_T = \widetilde{E_T}\, e^{i(k_T z - \omega_I t)} \hat{n}_I$$

A. 2
B. 4
C. 8
D. 12
E. None of the above