In matter we have,

$$\nabla \cdot \mathbf{D} = \rho_f \qquad \nabla \cdot \mathbf{B} = 0$$

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

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

A light rope (small m/L) is fused to a heavy rope (large m/L). If I wiggle the **light** rope,

A. most of the wiggles are reflected back; very few wiggles transmit through the heavy rope
B. some of the wiggles are reflected back; some of the wiggles transmit through the heavy rope
C. very few of the wiggles are reflected back; most of the wiggles transmit through the heavy rope
D. ???

A light rope (small m/L) is fused to a heavy rope (large m/L). If I wiggle the **heavy** rope,

A. most of the wiggles are reflected back; very few wiggles transmit through the light rope
B. some of the wiggles are reflected back; some of the wiggles transmit through the light rope
C. very few of the wiggles are reflected back; most of the wiggles transmit through the light rope
D. ???

How do the speed of the waves compare in the light rope (v_l) and heavy rope (v_H)?

A. $v_l < v_H$

B. $v_l = v_H$

C. $v_l > v_H$

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

An EM wave is normally incident on a boundary between two materials ($n_1 \ll n_2$). If the incident wave starts in **material 1**,

A. most of the wave is reflected back; very little of the wave transmits through material 2
B. some of the wave is reflected back; some of the wave transmits through material 2
C. very little of the wave is reflected back; most of the wave transmits through material 2
D. ???

An EM wave is normally incident on a boundary between two materials ($n_1 \ll n_2$). If the incident wave starts in **material 2**,

A. most of the wave is reflected back; very little of the wave transmits through material 1
B. some of the wave is reflected back; some of the wave transmits through material 1
C. very little of the wave is reflected back; most of the wave transmits through material 1
D. ???

An EM wave is normally incident on a boundary between two materials (n_1 is close to n_2). If the incident wave starts in **material 1**,

A. most of the wave is reflected back; very little of the wave transmits through material 1
B. some of the wave is reflected back; some of the wave transmits through material 1
C. very little of the wave is reflected back; most of the wave transmits through material 1
D. ???

An EM wave is normally incident on a boundary between two materials ($n_1 \ll n_2$). If the incident wave starts in **material 2**,

A. most of the wave is reflected back; very little of the wave transmits through material 1
B. some of the wave is reflected back; some of the wave transmits through material 1
C. very little of the wave is reflected back; most of the wave transmits through material 1
D. ???

An EM wave is normally incident on a boundary between two materials (n_1 is close to n_2). If the incident wave starts in **material 1**,

A. most of the wave is reflected back; very little of the wave transmits through material 1
B. some of the wave is reflected back; some of the wave transmits through material 1
C. very little of the wave is reflected back; most of the wave transmits through material 1
D. ???

Claim: For a wave heading towards a boundary between two media at an oblique angle, $\omega_I = \omega_R = \omega_T$.

A. True

B. False

Claim: For a wave heading towards a boundary between two media at an oblique angle, at the boundary,

$$\mathbf{k}_I \cdot \mathbf{r} = \mathbf{k}_R \cdot \mathbf{r} \neq \mathbf{k}_T \cdot \mathbf{r}.$$

A. True

B. False