Physics 47 – Optics

Name: SOLUTIONS

Quiz 1

(each question worth 2 pts)

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1) What does the quantity $\frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ represent?

$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ (speed of light in vacuum)

2) Write the direction of EM wave propagation in terms of its field components ($\vec{E}, \vec{B}$).

$\vec{S} \propto \vec{E} \times \vec{B}$ ($\vec{S} \parallel \vec{k}$ & $\vec{E}, \vec{B} \perp \vec{k}$)

3) What is the phase velocity of the following wave: $\psi(x,t) = A \sin(kx - \omega t + \pi/3)$

$v_p = \omega/k$

4) Which, if any, is a valid representation of the Laplacian operator (∇^2)?

ALL are valid.

(though it confused some people, so enabled easy grading mode)

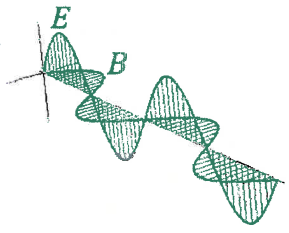
✓a. $\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ Cartesian

✓b. $\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2}{\partial \theta^2} + \frac{\partial^2}{\partial z^2}$ Cylindrical

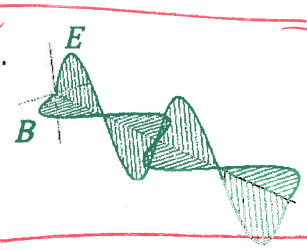
✓c. $\frac{1}{r}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{1}{r^2 \sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial}{\partial \theta}\right) + \frac{1}{r^2 \sin^2\theta}\frac{\partial^2}{\partial \phi^2}$ Spherical

5) Which, if any, is a valid representation of the $\vec{E}$ and $\vec{B}$ fields in a (polarized) EM wave propagating in the $+\hat{x}$ direction?

× a.

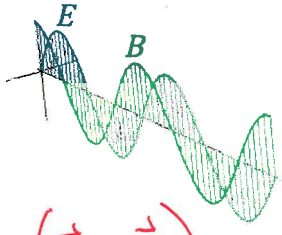


✓b.



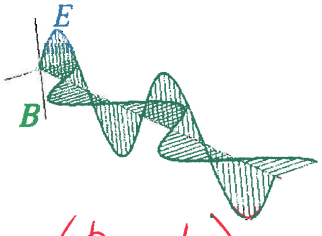
Remember: $\vec{S} = \frac{1}{\mu_0}\vec{E} \times \vec{B}$ and right-hand rule $\hat{E} \times \hat{B} = \hat{k}$

× c.



($\vec{E} \perp \vec{B}$)

× d.



($\phi_E = \phi_B$)