hw 1

Tuesday, January 13, 2026 7:56 PM

p0.2 show $\vec{E}\times\vec{B}$ is perpendicular to $\vec{E}$ + $\vec{B}$

equation 0.2 shows:

$$\vec{k}\cdot\vec{r} = k_x x + k_y y + k_z z = |k||r|\cos\phi$$

from (0.3):

$$\vec{E}\times\vec{B} = (E_y B_z - E_z B_y)\hat{x} + \dots$$

so if $(\vec{E}\times\vec{B})\cdot\vec{E} = 0$ then they are $\perp$.

so lets try

$$(\vec{E}\times\vec{B})\cdot\vec{E} = (E_y B_z - E_z B_y)\cdot E_x - (E_x B_z - E_z B_x)\cdot E_y + (E_x B_y - E_y B_x)\cdot E_z$$

$$= E_x E_y B_z - E_x E_z B_y - E_x E_y B_z + E_y E_z B_x + E_x E_z B_y - E_y E_z B_x$$

$$= 0$$

and similarly for $\vec{B}$.

P0.3 Verify $A\times(B\times C) = B(A\cdot C) - C(A\cdot B)$

$$B\times C = (B_y C_z - B_z C_y)\hat{x} - (B_x C_z - B_z C_x)\hat{y} + (B_x C_y - B_y C_x)\hat{z}$$

now $A\times(B\times C)$. This is a mess so lets just focus on the x component of this for now. This x component needs to match up w/ the x-component on the other side which is:

$$B_x(A_x C_x + A_y C_y + A_z C_z) + C_x(A_x B_x + A_y B_y + A_z B_z)$$

so that is what we are going to look for

$$A\times(B\times C) = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ A_x & A_y & A_z \\ (B\times C)_x & (B\times C)_y & (B\times C)_z \end{vmatrix}$$

$$\hat{x}\left(A_y(B_x C_y - B_y C_x) - A_z(-B_x C_z + B_z C_x)\right)$$

$$\hat{x}\left(B_x A_y C_y + B_x A_z C_z - C_x A_y B_y - C_x A_z B_z\right)$$

so I can almost see this but some things are missing right? I need $B_x A_x C_x$ and a $C_x A_x B_x$. But those are the same thing! So I can add one and subtract the same thing and I am home free. ✓