Q- In a region of free space the electric field at an instant of time is E =(80.0i + 32.0j – 64.0k)N/C and the magnetic field is B = (0.200i + 0.0800j + 0.290k) micro-Tesla.
a) Show that the two fields are perpendicular to each other.
b) Determine the Poynting vector for these fields.

a) If two vectors are perpendicular to each other than their scalar (dot) product is zero.

Now $\vec{E} \bullet \vec{B} = E_x B_x + E_y B_y + E_z B_z$

Or $\vec{E} \bullet \vec{B} = 80.0 * 0.200 + 32.0 * 0.0800 + (-64.0) * 0.290 = 0$ [10^{-6} is common to all]

Hence the two fields are perpendicular to each other.

b)Determine the Poynting vector for these fields.

The pointing vector is given by

$$\vec{S} = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right)$$

Now $\left(\vec{E} \times \vec{B}\right) = \left[\left(32 * 0.29 + 0.08 * 64\right)\hat{i} + \left(-64 * 0.2 - 0.29 * 80\right)\hat{j} + \left(80 * 0.08 - 0.2 * 32\right)\hat{k}\right] * 10^{-6}$

$= \left[14.4 * \hat{i} - 36.0 * \hat{j} + 0 * \hat{k}\right] * 10^{-6}$ [10^{-6} is because of unit micro-Tesla]

Hence the pointing vector will be

$$\vec{S} = \frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right) = \frac{1}{4\pi * 10^{-7}}\left[14.4 * \hat{i} - 36.0 * \hat{j} + 0 * \hat{k}\right] * 10^{-6}$$

Or $\vec{S} = 0.8 * \left[14.4 * \hat{i} - 36.0 * \hat{j}\right]$ (W/m^2)