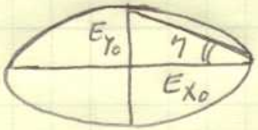
a) $\vec{\sigma} = \hat{z}$ ← Homogeneous plane-wave must have real $\vec{\sigma}$, with length 1.

$\vec{\sigma}\cdot\vec{E}_0 = 0 \Rightarrow \sigma_x E_{x0} + \sigma_y E_{y0} + \sigma_z E_{z0} = 0 \Rightarrow E_{z0} = 0 \Rightarrow \vec{E}_0 = E_{x0}\hat{x} + E_{y0}\hat{y}$

$Z_0 \vec{H}_0 = \vec{\sigma}\times\vec{E}_0 = \hat{z}\times(E_{x0}\hat{x} + E_{y0}\hat{y}) = E_{x0}\hat{y} - E_{y0}\hat{x} \Rightarrow \vec{H}_0 = \frac{1}{Z_0}(E_{x0}\hat{y} - E_{y0}\hat{x})$

b) E_{x0} and E_{y0} must be "in phase" for the beam to be linearly polarized; in other words, if $E_{x0} = |E_{x0}|e^{i\phi_{x0}}$ and $E_{y0} = |E_{y0}|e^{i\phi_{y0}}$, then the condition for linear polarization is $\phi_{x0} = \phi_{y0}$.

c) Let $E_{x0} = |E_{x0}|e^{i\phi_{x0}}$ and $E_{y0} = |E_{y0}|e^{i\phi_{y0}}$. The condition for circular polarization is: $|E_{x0}| = |E_{y0}|$ and $\phi_{x0} - \phi_{y0} = \pm 90°$. In other words, $E_{x0} = \pm i E_{y0}$.

d) 

$\tan\eta = \frac{|E_{y0}|}{|E_{x0}|}$ → polarization ellipticity $\eta = \tan^{-1}\frac{|E_{y0}|}{|E_{x0}|}$

e) $\langle \vec{S}(\vec{r},t)\rangle = \frac{1}{2}Re(\vec{E}\times\vec{H}^*) = \frac{1}{2}Re\left\{\vec{E}_0 \cancel{e^{ik_0(\vec{\sigma}\cdot\vec{r}-ct)}} \times \vec{H}_0^* \cancel{e^{-ik_0(\vec{\sigma}\cdot\vec{r}-ct)}}\right\}$

$= \frac{1}{2Z_0}Re\left\{(E_{x0}\hat{x} + E_{y0}\hat{y})\times(-E_{y0}^*\hat{x} + E_{x0}^*\hat{y})\right\} = \frac{1}{2Z_0}\left(|E_{x0}|^2 + |E_{y0}|^2\right)\hat{z}$