Problem 8)

a) $\rho_p = 0 \quad \rightarrow \quad \varepsilon_a\sqrt{\mu_b\varepsilon_b - (ck_x/\omega)^2} = \varepsilon_b\sqrt{\mu_a\varepsilon_a - (ck_x/\omega)^2}$ where $k_x = (\omega/c)\sqrt{\mu_a\varepsilon_a}\sin\theta_{Bp}$. Therefore,

$\varepsilon_a^2(\mu_b\varepsilon_b - \mu_a\varepsilon_a\sin^2\theta_{Bp}) = \varepsilon_b^2(\mu_a\varepsilon_a - \mu_a\varepsilon_a\sin^2\theta_{Bp}) \rightarrow \sin^2\theta_{Bp} = (\varepsilon_b/\mu_a)(\varepsilon_a\mu_b - \varepsilon_b\mu_a)/(\varepsilon_a^2 - \varepsilon_b^2)$

$\rightarrow \cos^2\theta_{Bp} = 1 - \sin^2\theta_{Bp} = (\varepsilon_a/\mu_a)(\varepsilon_a\mu_a - \varepsilon_b\mu_b)/(\varepsilon_a^2 - \varepsilon_b^2)$

$\rightarrow \tan^2\theta_{Bp} = (\varepsilon_b/\varepsilon_a)(\varepsilon_a\mu_b - \varepsilon_b\mu_a)/(\varepsilon_a\mu_a - \varepsilon_b\mu_b).$

b) $\rho_s = 0 \quad \rightarrow \quad \mu_a\sqrt{\mu_b\varepsilon_b - (ck_x/\omega)^2} = \mu_b\sqrt{\mu_a\varepsilon_a - (ck_x/\omega)^2}$ where $k_x = (\omega/c)\sqrt{\mu_a\varepsilon_a}\sin\theta_{Bs}$. Therefore,

$\mu_a^2(\mu_b\varepsilon_b - \mu_a\varepsilon_a\sin^2\theta_{Bs}) = \mu_b^2(\mu_a\varepsilon_a - \mu_a\varepsilon_a\sin^2\theta_{Bs}) \rightarrow \sin^2\theta_{Bs} = (\mu_b/\varepsilon_a)(\mu_a\varepsilon_b - \mu_b\varepsilon_a)/(\mu_a^2 - \mu_b^2)$

$\rightarrow \cos^2\theta_{Bs} = 1 - \sin^2\theta_{Bs} = (\mu_a/\varepsilon_a)(\varepsilon_a\mu_a - \varepsilon_b\mu_b)/(\mu_a^2 - \mu_b^2)$

$\rightarrow \tan^2\theta_{Bs} = -(\mu_b/\mu_a)(\varepsilon_a\mu_b - \varepsilon_b\mu_a)/(\varepsilon_a\mu_a - \varepsilon_b\mu_b).$

c) In the above expressions for $\tan^2\theta_{Bp}$ and $\tan^2\theta_{Bs}$, the second and third terms are identical. As for the first terms, the signs of ε_a and μ_a are generally the same, and so are the signs of ε_b and μ_b. Therefore, the signs of $\tan^2\theta_{Bp}$ and $\tan^2\theta_{Bs}$ are going to be opposite, that is, if one is positive, the other will be negative. Since tangent-squared needs to be positive, it will be *impossible* to have Brewster's angles for both p- and s-light.