P7.1

$k = k_0\sqrt{\frac{\mu_0\varepsilon_c}{\mu_0\varepsilon_0}} = k_0\sqrt{1+i\frac{\sigma}{\omega\varepsilon_0}}$.

$k_{tx} = k\sin\theta_i$

$\therefore k_{tz} = \sqrt{k^2-k_{tx}^2} \approx k_0\sqrt{i\frac{\sigma}{\omega\varepsilon_0}} = k_0\sqrt{\frac{\sigma}{2\omega\varepsilon_0}}(1+i) = k_{zR} + ik_{zI}$

$\therefore \tan\theta_t = \frac{k_{tx}}{k_{zR}} = \sqrt{\frac{2\omega\varepsilon_0}{\sigma}}\sin\theta_i \approx 0$

P7.2

$R = \frac{1-p}{1+p}$ TE: $p = \frac{\mu_i k_{tx}}{\mu_t k_{ix}}$

$T = \frac{2}{1+p}$ TM: $p = \frac{\varepsilon_i k_{tx}}{\varepsilon_t k_{ix}}$

当垂直入射时，$k_{tx} = k_{ix} = 0$

$\therefore R=1, T=2$ ∴相同.

当一般情况时，k_{tx}、$k_{ix} \neq 0$

由于μ_i/μ_t，$\varepsilon_i/\varepsilon_t$并不相同 ∴不相同.

P7.3

$\vec{E}_R = R(\frac{1}{\sqrt2}\hat{x} + \frac{1}{\sqrt2}\hat{z} + i\hat{y})e^{i\vec{k}_R\cdot\vec{r}}$

$\vec{n}\times(\vec{E}_1-\vec{E}_2) = 0$

$\therefore \vec{E}_i + \vec{E}_R = 0$

$\therefore (\frac{1}{\sqrt2}\hat{x} + \frac{1}{\sqrt2}\hat{z} + i\hat{y})e^{i\vec{k}_i\cdot\vec{r}} + R(\frac{1}{\sqrt2}\hat{x} + \frac{1}{\sqrt2}\hat{z} + i\hat{y})e^{i\vec{k}_R\cdot\vec{r}} = 0$

$$\begin{cases} k_{iz} = -k_{Rz} \\ k_{Rx} = k_{ix} \\ z = 0 \end{cases}$$

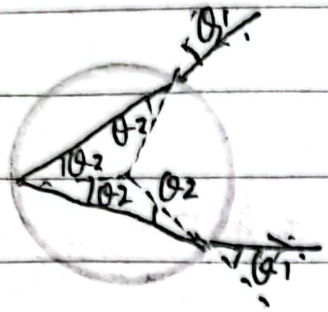
$\therefore 1+R=0$ $R=-1$

$\therefore \vec{E}_R = -(\frac{1}{\sqrt2}\hat{x} + \frac{1}{\sqrt2}\hat{z} + i\hat{y})e^{i\frac{1}{\sqrt2}k_0x + i\frac{1}{\sqrt2}k_0z}$

圆偏振方向相反.

P7.4

(a)



由左图，$\varphi = 2\theta_2 - 2(\theta_1 - \theta_2)$

$= 2(2\theta_2 - \theta_1)$

(b)

~~$\frac{d\varphi}{d\theta_1}$~~ $\sin\theta_1 = n\sin\theta_2$ $\quad \therefore \theta_2 = \arcsin(\frac{\sin\theta_1}{n})$

$\therefore \varphi = 2(2\arcsin\frac{\sin\theta_1}{n} - \theta_1)$

当 $\frac{d\varphi}{d\theta_1} = 0$ 时，$\frac{d\varphi}{d\theta_1}[2\arcsin\frac{\sin\theta_1}{n} - \theta_1] = 0$

$\therefore \theta_1 = \arcsin(\sqrt{\frac{4-n^2}{3}})$

当 $n = \frac{4}{3}$ 时，$\sin\theta = 0.86$

$\therefore \varphi \approx 42^\circ$

(c)

$\theta_1 = 59.58^\circ$，$\theta_2 = 40.42^\circ$ $\quad \therefore \varphi_{max} = 42.52^\circ$，$\theta_3 = 137.5^\circ$

$\theta_1 = 58.89^\circ$ $\theta_2 = 39.64^\circ$ $\quad \therefore \varphi_{max} = 40.78^\circ$，$\theta_2 = 139^\circ$

P8.1

$n_i \sin\theta_i = n_t \sin\theta_t$, $\theta_t = 90°$

$\therefore \sin\theta_i = \frac{n_t}{n_i} \approx 0.9999861887 \approx 1$

下方空气层密度较低，且临界角几乎为90°，几乎不发生全反射，故易在下方形成折射的虚像，导致海市蜃楼

P8.2

(a) $\theta_B = \arctan\left(\frac{n_2}{n_1}\right) = \arctan\left(\frac{\frac{\sqrt{\mu_0 \varepsilon_t}}{\sqrt{\mu_0 \varepsilon_0}}}{\frac{\sqrt{\mu_0 \varepsilon_0}}{\sqrt{\mu_0 \varepsilon_0}}}\right) = \arctan 3 \approx 71.57°$

(b) 垂直于入射面的分量会被反射，平行于入射面的分量发生折射.

$E = E_\perp r_\perp + E_\parallel r_\parallel$

$r_\perp = \frac{n_1\cos\theta_i - n_2\cos\theta_t}{n_1\cos\theta_i + n_2\cos\theta_t}$

$r_\parallel = \frac{n_2\cos\theta_i - n_1\cos\theta_t}{n_2\cos\theta_i + n_1\cos\theta_t}$

当 $\theta_i = \theta_B$ 时，$r_\parallel = 0$

$\therefore$ 垂直于入射平面的电场分量会被反射，平行于入射平面的电场分量会折射.

P8.4

$n_1 \sin\theta_i = n_2 \sin\theta_t$, $\theta_i + \theta_t = \frac{\pi}{2}$

$\therefore \theta_B = \arctan\left(\frac{n_2}{n_1}\right) \approx 55.59^\circ$

$\vec{E}$平行于入射平面的分量能通过，原因与P8.2相同

P8.5

(a) $\theta_B = \arctan\left(\frac{n_2}{n_1}\right) = \arctan\left(\frac{1}{\sqrt{3}}\right) = 30^\circ$

(b)

1. $\cancel{\theta_i =} \theta_t = \arctan\left(\frac{k_{tz}}{k_{tx}}\right)$

$n_1 \sin\theta_i = n_2 \sin\theta_t$

$\therefore \theta_i = \arcsin\left[\frac{n_2}{n_1}\sin\theta_t\right] = \arcsin\left[\frac{n_2}{n_1}\sin\left(\arctan\frac{k_{tz}}{k_{tx}}\right)\right]$.

2. 左旋

3. 右旋

4. $\vec{E_t} = \vec{E}_{ty} + \vec{E}_{tM}$

TE: $\begin{cases} R_E = \frac{1-p}{1+p} \\ T_E = \frac{2}{1+p} \end{cases}$ $p = \frac{\mu_i k_{tx}}{\mu_t k_{ix}} = \frac{k_{tx}}{k_{ix}}$

TM: $\begin{cases} R_M = \frac{1-p}{1+p} \\ T_M = \frac{2}{1+p} \end{cases}$ $p = \frac{\varepsilon_i k_{tx}}{\varepsilon_t k_{ix}} = 3\frac{k_{tx}}{k_{ix}}$

$\vec{E_i} = \hat{y}\frac{E_0}{T_E} e^{i\vec{k_i}\cdot\vec{r}} + E_0 \cdot \frac{1}{T_M} \frac{\hat{z} - \hat{x}\sqrt{3}}{2\sqrt{2}} e^{i\vec{k_i}\cdot\vec{r} - i\frac{\pi}{2}}$

$\vec{E_r} = \hat{y}\frac{R_E}{T_E} e^{i\vec{k_i}\cdot\vec{r}} + E_0 \cdot \frac{R_M}{T_M} \frac{\hat{z} - \hat{x}\sqrt{3}}{2\sqrt{2}} e^{i\vec{k_i}\cdot\vec{r} - i\frac{\pi}{2}}$.