1. $\Delta \vec{E}_{\parallel} = 0 \Rightarrow \tilde{E}_{0I} + \tilde{E}_{0R} = \tilde{E}_{0T}$

$\Delta B_{\perp} = 0 \Rightarrow \frac{\sin\theta_I}{v_1}\left(\tilde{E}_{0I} + \tilde{E}_{0R}\right) = \frac{\sin\theta_T}{v_2}\tilde{E}_{0T}$

$\Delta \vec{B}_{\parallel} = 0 \Rightarrow \frac{\cos\theta_I}{\mu_1 v_1}\left(\tilde{E}_{0I} - \tilde{E}_{0R}\right) = \frac{\cos\theta_T}{\mu_2 v_2}\tilde{E}_{0T}$

$$\Rightarrow \begin{aligned} \tilde{E}_{0I} - \tilde{E}_{0R} &= \alpha\beta\tilde{E}_{0T} \\ \tilde{E}_{0I} + \tilde{E}_{0R} &= \tilde{E}_{0T} \end{aligned}$$

$$\Rightarrow \boxed{\begin{aligned} \tilde{E}_{0T} &= \frac{2}{1+\alpha\beta}\tilde{E}_{0I} \\ \tilde{E}_{0R} &= \frac{1-\alpha\beta}{1+\alpha\beta}\tilde{E}_{0I} \end{aligned}}$$

2. a. $\vec{E} = -\nabla V - \partial \vec{A}/\partial t = \boxed{\frac{\lambda_0}{2\pi\varepsilon_0 s}\hat{s}}$

$\vec{B} = \nabla \times \vec{A} = \boxed{0}$

b. This is the field of a line charge. Want λ such that $\vec{A}' = A + \nabla\lambda = 0$

$\Rightarrow \nabla\lambda = \frac{\lambda_0 t}{2\pi\varepsilon_0 s}\hat{s}$

$\Rightarrow \boxed{\lambda(\vec{r}, t) = \frac{\lambda_0 t}{2\pi\varepsilon_0}\ln(s)}$

check $V' = -\partial\lambda/\partial t = -\frac{\lambda_0}{2\pi\varepsilon_0}\ln(s)$ //

3. $$\vec{E} = \frac{q}{4\pi\varepsilon_0} \frac{1 - v^2/c^2}{(1 - v^2\sin^2\theta/c^2)^{3/2}} \frac{\hat{R}}{R^2}$$

$$\vec{B} = \frac{1}{c^2} \vec{v} \times \vec{E}$$

a. $$\boxed{\begin{aligned} \vec{E} &= \frac{2q}{4\pi\varepsilon_0 r^2} \frac{1 - v^2/c^2}{(1 - v^2\sin^2\theta/c^2)^{3/2}} \hat{r} \\ \vec{B} &= 0 \end{aligned}}$$

b. $$\boxed{\vec{E} = 0}$$

$$\vec{B} = \frac{2qv}{4\pi\varepsilon_0 r^2 c^2} \frac{1 - v^2/c^2}{(1 - v^2\sin^2\theta/c^2)^{3/2}} \hat{z} \times \hat{r}$$

$$\Rightarrow \boxed{\vec{B} = \frac{2\mu_0 q v}{4\pi r^2} \frac{(1 - v^2/c^2)\sin\theta}{(1 - v^2\sin^2\theta/c^2)^{3/2}} \hat{\varphi}}$$

4. $$\vec{p} = qR(\cos(wt)\hat{x} + \sin(wt)\hat{y})$$

$$\vec{S}_x = \frac{\mu_0}{c}\left\{\frac{qRw^2}{4\pi} \frac{\sin\theta_x}{r} \cos(w(t - r/c))\right\}^2 \hat{r}$$

$$\vec{S}_y = \frac{\mu_0}{c}\left\{\frac{qRw^2}{4\pi} \frac{\sin\theta_y}{r} \sin(w(t - r/c))\right\}^2 \hat{r}$$

$$\begin{aligned} \sin^2\theta_x &= 1 - \cos^2\theta_x \\ &= 1 - \sin^2\theta\cos^2\varphi \\ \sin^2\theta_y &= 1 - \sin^2\theta\sin^2\varphi \end{aligned}$$

$$\Rightarrow \vec{S} = \vec{S}_x + \vec{S}_y$$

$$\Rightarrow \boxed{\vec{S} = \frac{\mu_0 q^2 R^2 w^4 \hat{r}}{16\pi^2 c r^2}\Big[(1 - \sin^2\theta\cos^2\varphi)\cos^2(w(t - r/c)) + (1 - \sin^2\theta\sin^2\varphi)\sin^2(w(t - r/c))\Big]}$$

$$\boxed{\langle\vec{S}\rangle = \frac{\mu_0 q^2 R^2 w^4 \hat{r}}{16\pi^2 c r^2}\left[\frac{1 + \cos^2\theta}{2}\right]}$$