1. a. $\vec{E} = \tilde{E}_0 e^{i(\vec{k}\cdot\vec{r}-\omega t)} \hat{n}$

$\vec{B} = \frac{k}{\omega} \tilde{E}_0 e^{i(\vec{k}\cdot\vec{r}-\omega t)} (\hat{k}\times\hat{n})$

$\Rightarrow E^2 = |\tilde{E}_0|^2 \quad , \quad B^2 = \frac{k^2}{\omega^2} |\tilde{E}_0|^2$

$u_B / u_E = \frac{\frac{1}{2} B^2/\mu}{\frac{1}{2}\varepsilon E^2} = \frac{1}{\mu\varepsilon}\cdot\frac{k^2}{\omega^2} = \boxed{1}$

b. $R = \langle S_R \rangle / \langle S_I \rangle$

$= \frac{1}{2} v\varepsilon E_{0R}^2 / \frac{1}{2} v\varepsilon E_{0I}^2 = E_{0R}^2 / E_{0I}^2$

$= \left(1-\beta / 1+\beta\right)^2$

$T = \frac{1}{2} c\varepsilon_0 E_{0T}^2 / \frac{1}{2} v\varepsilon E_{0I}^2$

$= \frac{c\varepsilon_0}{v\varepsilon}\left(\frac{2}{1+\beta}\right)^2$

w/ $\beta = \frac{\mu_1 n_2}{\mu_2 n_1} = \frac{\mu}{\mu_0 n} = \frac{\mu}{\mu_0}\cdot\sqrt{\frac{\mu_0\varepsilon_0}{\mu\varepsilon}}$

$= \sqrt{\frac{\mu\varepsilon_0}{\mu_0\varepsilon}}$

2. a. $\vec{E} = -\nabla V - \partial\vec{A}/\partial t$

$= -\partial V/\partial x\,\hat{x} - \partial\vec{A}/\partial t$

$= \frac{B}{(x-vt)^2}\hat{x} - \frac{Bv^2}{c^2(x-vt)^2}$

$= \frac{B(1-v^2/c^2)\hat{x}}{(x-vt)^2}$

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

2. b. $\nabla\cdot\vec{A} = \partial A_x/\partial x = -\frac{Bv}{c^2(x-vt)^2} \neq 0$

$\mu_0\varepsilon_0\, \partial V/\partial t = \frac{1}{c^2}\frac{Bv}{(x-vt)^2} \Rightarrow \boxed{\text{Lorenz}}$

2.c. $V_{LW} = \frac{1}{4\pi\varepsilon_0} \frac{qc}{(c\Delta r - \vec{\Delta r} \cdot \vec{v})} = \frac{1}{4\pi\varepsilon_0} \frac{q}{\Delta r(1 - v/c)}$

on x-axis

$\Delta r = x - v t_r$

w/ $t_r = t - \Delta r / c$

$\Rightarrow \Delta r = x - vt + v \Delta r / c$

$\Rightarrow \Delta r = (x - vt) / (1 - v/c)$

$$\Rightarrow V_{LW} = \frac{q}{4\pi\varepsilon_0} \frac{1}{x - vt} \quad //$$

$$\vec{A}_{LW} = \frac{\vec{v}}{c^2} V_{LW} \quad //$$

3.a. $\vec{p} = qd\cos(\omega t)\hat{z}$

$\ddot{\vec{p}}(t_0) = -qd\omega^2 \cos(\omega t_0)\hat{z}$ w/ $t_0 = t - r/c$

$$\vec{S}(r,t) \simeq \frac{\mu_0 \ddot{p}^2}{16\pi^2 c} \frac{\sin^2\theta}{r^2}\hat{r}$$

$$= \frac{\mu_0 q^2 d^2 \omega^4 \cos^2(\omega t_0)}{16\pi^2 c} \frac{\sin^2\theta}{r^2}\hat{r}$$

3.b. $a = \ddot{z} = -d\omega^2 \cos^2(\omega t)$

for $v \ll c$ $\vec{S}_{rad}(\vec{r}, t) = \frac{\mu_0 q^2 a^2}{16\pi^2 c} \frac{\sin^2\theta}{\Delta r^2} \hat{\Delta r}$

for $d \ll r$, $\vec{\Delta r} \sim \vec{r}$

$$\Rightarrow \vec{S}_{rad} \sim \frac{\mu_0 q^2 d^2 \omega^4 \cos^2(\omega t_r)}{16\pi^2 c} \frac{\sin^2\theta}{r^2}\hat{r}$$

w/ $t_r = t - r/c$