1. Balanis, Chapter 5, page 244, #5.1
The wave impedance of a dielectric medium
\[ \eta_i = \sqrt{\frac{\mu_0}{4\varepsilon_0}} = \frac{\eta_2}{2} \approx 189 \ (\Omega) \] (1.1)
, where \( \eta_2 \approx 377 \ (\Omega) \) is the wave impedance of air.

The reflection coefficient
\[ \Gamma^b = \frac{\eta_2 - \eta_i}{\eta_2 + \eta_i} = 0.33 \] (1.2)

The transmission coefficient
\[ T^b = \frac{2\eta_2}{\eta_2 + \eta_i} = 1.33 \] (1.3)

The incident E-field
\[ E'^i = (\hat{a}_y)E_0e^{-j\beta z} = (\hat{a}_y)(2 \times 10^{-3})e^{-j\beta z} \ (V/m) \] (1.4)

The reflected E-field
\[ E'^r = (\hat{a}_y)\Gamma^b E_0e^{-j\beta z} = (\hat{a}_y)(6.6 \times 10^{-4})e^{-j\beta z} \ (V/m) \] (1.5)

The transmitted E-field
\[ E'^t = (\hat{a}_y)T^b E_0e^{-j\beta z} = (\hat{a}_y)(2.66 \times 10^{-3})e^{-j\beta z} \ (V/m) \] (1.6)

Since in general
\[ \mathbf{H} = \frac{1}{\eta} \hat{\mathbf{k}} \times \mathbf{E} \] (1.7)

, where \( \hat{\mathbf{k}} \) is the unit vector in the direction of propagation, the H-fields come out to be
\[ H'^i = \frac{1}{\eta_i} \hat{a}_x \times E'^i = \frac{1}{\eta_i}(-\hat{a}_x)|E'^i| = (-\hat{a}_x)(1.06 \times 10^{-5})e^{-j\beta z} \ (A/m) \] (1.8)
\[ H'^r = \frac{1}{\eta_i}(-\hat{a}_x) \times E'^r = \frac{1}{\eta_i}(\hat{a}_x)|E'^r| = (\hat{a}_x)(3.49 \times 10^{-6})e^{-j\beta z} \ (A/m) \] (1.9)
\[ \mathbf{H'} = \frac{1}{\eta_2} \mathbf{\hat{a}}_z \times \mathbf{E'} = \frac{1}{\eta_2} \left( -\mathbf{\hat{a}}_z \right) \left| \mathbf{E'} \right| = \left( -\mathbf{\hat{a}}_z \right) \left( 7.06 \times 10^{-6} \right) e^{-j\beta z} \text{ (A/m)} \]  

(1.10)

And finally, the power densities

\[ S' = (\mathbf{\hat{a}}_z) \left| E' \right|^2 = (\mathbf{\hat{a}}_z) \left( 1.06 \times 10^{-8} \right) \text{ (W/m}^2) \]  

(1.11)

\[ S' = (-\mathbf{\hat{a}}_z) \left| \Gamma_b \right|^2 S' = (-\mathbf{\hat{a}}_z) \left( 1.15 \times 10^{-9} \right) \text{ (W/m}^2) \]  

(1.12)

\[ S' = (\mathbf{\hat{a}}_z) \left( 1 - \left| \Gamma_b \right|^2 \right) S' = (\mathbf{\hat{a}}_z) \left( 9.45 \times 10^{-9} \right) \text{ (W/m}^2) \]  

(1.13)

2. Balanis, Chapter 5, page 244, #5.2

The wave impedance of water

\[ \eta_2 = \sqrt{\frac{\mu_0}{81 \epsilon_0}} = \frac{\eta_1}{9} \]  

(1.14)

, where \( \eta_1 \) is the wave impedance of air.

The reflection coefficient

\[ \Gamma^b = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = -0.8 \]  

(1.15)

The transmission coefficient

\[ T^b = \frac{2\eta_2}{\eta_2 + \eta_1} = 0.2 \]  

(1.16)

The ratio of the reflected power density to the incident power density

\[ \frac{S'}{S'} = \left| \Gamma^b \right|^2 = 64\% \]  

(1.17)

The ratio of the transmitted power density to the incident power density

\[ \frac{S'}{S'} = \left| T^b \right|^2 \frac{\eta_1}{\eta_2} = (0.04)(9) = 36\% \]  

(1.18)

3. Balanis, Chapter 5, page 248, #5.17

<table>
<thead>
<tr>
<th>Interface</th>
<th>( \theta_b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) water to air</td>
<td>6.34°</td>
</tr>
<tr>
<td>(b) air to water</td>
<td>83.6°</td>
</tr>
<tr>
<td>(c) glass to air</td>
<td>18.4°</td>
</tr>
</tbody>
</table>
4. Balanis, Chapter 5, page 248, #5.19

In Figure 1 is shown the total transmission occurring at the air-water interface, where the reflected wave has no parallel polarized component included. This happens, according to the results of Example 5-3 on page 195 of the book, when
\[ \theta_i = \theta_{\text{raw}} = 83.66^\circ \]  
(1.19)

So,
\[ \tan(90 - \theta_{\text{raw}}) = \frac{10}{d_1} \]  
(1.20)
\[ \tan(90 - \theta_{\text{raw}}) = \frac{h_2}{d_2} \]  
(1.21)
\[ d_1 + d_2 = 10^4 \]  
(1.22)

Solving (1.20) through (1.22) for the unknowns
\[ d_1 = 9.0 \times 10^1 \text{(m)} \]  
\[ d_2 = 9.9 \times 10^3 \text{(m)} \]  
\[ h_2 = 1.1 \times 10^3 \text{(m)} \]  
(1.23)
5. Slater, page 166, #4

The total power radiated, according to (4.2) on page 159 of the book, is

$$P = \frac{\mu_0 \sqrt{\varepsilon_0 \mu_0 \omega^4 M^2}}{12\pi} \quad (1.24)$$

Let this be rewritten as

$$P = \frac{1}{2} R |I|^2 \quad (1.25)$$

where $R$ is the equivalent resistance, so

$$R = \frac{\mu_0 \sqrt{\varepsilon_0 \mu_0 \omega^4 M^2}}{6\pi} \frac{1}{|I|^2} \quad (1.26)$$

The dipole moment

$$M = qL \quad (1.27)$$

The current

$$I = \frac{dq}{dt} = j\omega q \quad (1.28)$$

Plug (1.27) and (1.28) into (1.26), and then

$$R = \frac{\mu_0 \sqrt{\varepsilon_0 \mu_0 \omega^4 L^2}}{6\pi} \quad (1.29)$$

The wavelength is

$$\lambda = \frac{c}{f} = \frac{2\pi}{\omega} \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \quad (1.30)$$

so the frequency comes out to be

$$\omega = \frac{2\pi}{\lambda} \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \quad (1.31)$$

Plug this into (1.29)

$$R = \frac{2\pi}{\frac{3}{3}} \frac{\mu_0}{\varepsilon_0} \frac{L^2}{\lambda^2} \quad (1.32)$$
6. Balanis, Chapter 6, page 306, #6.5
7. Balanis, Chapter 6, page 306, #6.18
8. Balanis, Chapter 6, page 307, #6.20