1. This is trivial by matching (10.64) and (8.11) and using the skin depth formula (8.8).
2. From (10.66), we have

$$\alpha_{\pm}(1) = -2\left\{\frac{j_1(x) - i\left(\frac{Z_s}{Z_0}\right)\left[\frac{j_1(x)}{x} + j_1'(x)\right]}{h_1^{(1)}(x) - i\left(\frac{Z_s}{Z_0}\right)\left[\frac{h_1^{(1)}(x)}{x} + h_1^{(1)\prime}(x)\right]}\right\} \tag{1}$$

$$\beta_{\pm}(1) = -2\left\{\frac{j_1(x) - i\left(\frac{Z_0}{Z_s}\right)\left[\frac{j_1(x)}{x} + j_1'(x)\right]}{h_1^{(1)}(x) - i\left(\frac{Z_0}{Z_s}\right)\left[\frac{h_1^{(1)}(x)}{x} + h_1^{(1)\prime}(x)\right]}\right\} \tag{2}$$

When $x = ka \ll 1$,

$$j_1(x) \to \frac{x}{3} \qquad h_1^{(1)}(x) \to -\frac{i}{x^2} \tag{3}$$

(1) and (2) turn into

$$\alpha_{\pm}(1) \to -2\left[\frac{\frac{x}{3} - i\frac{k\delta}{2}(1-i)\cdot\frac{2}{3}}{-\frac{i}{x^2} - i\frac{k\delta}{2}(1-i)\cdot\frac{i}{x^3}}\right] = -\frac{2i}{3}(ka)^3\left[\frac{\left(1-\frac{\delta}{a}\right) - i\frac{\delta}{a}}{\left(1+\frac{\delta}{2a}\right) + i\frac{\delta}{2a}}\right] \tag{4}$$

$$\beta_{\pm}(1) \to -2\left[\frac{\frac{x}{3} - i\frac{2}{k\delta(1-i)}\cdot\frac{2}{3}}{-\frac{i}{x^2} - i\frac{2}{k\delta(1-i)}\cdot\frac{i}{x^3}}\right] \approx \frac{4i}{3}(ka)^3 \tag{5}$$

where in $\beta_{\pm}(1)$, we dropped the $x/3$ term in the numerator and the $-i/x^2$ term in the denominator since they are negligible compared to the other term.

3. Keeping the $l = 1$ order for the differential scattering cross section in (10.63) gives

$$\frac{d\sigma_{\rm sc}}{d\Omega} = \frac{\pi}{2k^2}\cdot 3\Big\{|\alpha_{\pm}(1)|^2\left|\mathbf{X}_{1,\pm1}\right|^2 + |\beta_{\pm}(1)|^2\left|\mathbf{n}\times\mathbf{X}_{1,\pm1}\right|^2$$
$$\mp i\alpha_{\pm}(1)\beta_{\pm}^*(1)\left[\mathbf{X}_{1,\pm1}\cdot\left(\mathbf{n}\times\mathbf{X}_{1,\pm1}^*\right)\right] \pm i\alpha_{\pm}^*(1)\beta_{\pm}(1)\left[\mathbf{X}_{1,\pm1}^*\cdot\left(\mathbf{n}\times\mathbf{X}_{1,\pm1}\right)\right]\Big\} \tag{6}$$

With the explicit form

$$\mathbf{X}_{1,1} = \sqrt{\frac{3}{16\pi}}e^{i\phi}\left(\hat{\boldsymbol{\theta}} + i\cos\theta\,\hat{\boldsymbol{\phi}}\right) \qquad \mathbf{n}\times\mathbf{X}_{1,1}^* = \sqrt{\frac{3}{16\pi}}e^{-i\phi}\left(\hat{\boldsymbol{\phi}} + i\cos\theta\,\hat{\boldsymbol{\theta}}\right) \tag{7}$$

(6) becomes

$$\frac{d\sigma_{\rm sc}}{d\Omega} = \frac{9}{32k^2}\left\{\left[|\alpha_{\pm}(1)|^2 + |\beta_{\pm}(1)|^2\right]\left(1+\cos^2\theta\right) + 4\,\mathrm{Re}\left[\alpha_{\pm}(1)\beta_{\pm}^*(1)\right]\cos\theta\right\} \tag{8}$$

Up to the desired order, we have

$$|\alpha_{\pm}(1)|^2 = \frac{4}{9}(ka)^6\left[\frac{\left(1-\frac{\delta}{a}\right)^2 + \left(\frac{\delta}{a}\right)^2}{\left(1+\frac{\delta}{2a}\right)^2 + \left(\frac{\delta}{2a}\right)^2}\right] \approx \frac{4}{9}(ka)^6\left(1-\frac{2\delta}{a}\right)\left(1-\frac{\delta}{a}\right) \approx \frac{4}{9}(ka)^6\left(1-\frac{3\delta}{a}\right) \tag{9}$$

$$|\beta_{\pm}(1)|^2 = \frac{16}{9}(ka)^6 \tag{10}$$

$$\mathrm{Re}\left[\alpha_{\pm}(1)\beta_{\pm}^*(1)\right] = -\frac{8}{9}(ka)^6\,\mathrm{Re}\left[\frac{\left(1-\frac{\delta}{a}\right) - i\frac{\delta}{a}}{\left(1+\frac{\delta}{2a}\right) + i\frac{\delta}{2a}}\right] \approx -\frac{8}{9}(ka)^6\left(1-\frac{3\delta}{2a}\right) \tag{11}$$

By collecting all the terms in (8), we have

$$\frac{d\sigma_{\text{sc}}}{d\Omega} \approx \frac{k^4 a^6}{8}\left[\left(5-\frac{3\delta}{a}\right)\left(1+\cos^2\theta\right)-8\left(1-\frac{3\delta}{2a}\right)\cos\theta\right] \tag{12}$$

4. By (10.61), the absorption cross section is

$$\sigma_{\text{abs}} = \frac{\pi}{2k^2}\sum_{l=1}^{\infty}(2l+1)\left[2-|\alpha_{\pm}(1)+1|^2-|\beta_{\pm}(1)+1|^2\right) \tag{13}$$

With only $l=1$ terms, it becomes

$$\sigma_{\text{sc}} \approx \frac{\pi}{2k^2}\cdot 3\left[-|\alpha_{\pm}(1)|^2-|\beta_{\pm}(1)|^2-2\operatorname{Re}\alpha_{\pm}(1)-2\operatorname{Re}\beta_{\pm}(1)\right] \tag{14}$$

where by (4) and (5),

$$\operatorname{Re}\alpha_{\pm}(1) = \frac{2}{3}(ka)^3\operatorname{Im}\left[\frac{\left(1-\frac{\delta}{a}\right)-i\frac{\delta}{a}}{\left(1+\frac{\delta}{2a}\right)+i\frac{\delta}{2a}}\right] \approx -\frac{2}{3}(ka)^3\frac{3\delta}{2a} \tag{15}$$

$$\operatorname{Re}\beta_{\pm}(1) = 0 \tag{16}$$

From (9) and (10), we see $|\alpha_{\pm}(1)|^2, |\beta_{\pm}(1)|^2$ are of higher order $(ka)^6$, which are negligible in the presence of $(ka)^3$ from $\operatorname{Re}\alpha_{\pm}(1)$. Thus (14) can be approximated as

$$\sigma_{\text{abs}} \approx 3\pi k a^2\delta \tag{17}$$

5. If $\delta = a$, $\alpha_{\pm}(1)$ can be evaluated exactly from (4)

$$\alpha_{\pm}(1) = -\frac{2}{3}(ka)^3\left(\frac{1}{\frac{3}{2}+\frac{i}{2}}\right) \qquad \Longrightarrow \qquad \operatorname{Re}\alpha_{\pm}(1) = -\frac{2}{5}(ka)^3 \tag{18}$$

Comparing with (15), we see that for $\delta = a$, the absorption cross section is 2/5 of the approximation to the first order of δ/a.