a) v_p $\quad v_p = \frac{1}{\sqrt{\varepsilon\mu}} = 113{,}311 \cdot 10^6 \ m/s$

b) $k_e = \omega \cdot \sqrt{\mu \cdot \varepsilon} = 2\pi f \sqrt{\mu_r \mu_0 \varepsilon_r \varepsilon_0} = 2\pi \, 20 MHz \sqrt{\mu_0 \, 7 \, \varepsilon_0} = 1{,}109 \ \frac{rad}{m}$

$j\underline{k}_z = jk_e \cdot \sqrt{1 - js} = \underbrace{0{,}1063}_{\alpha} + j\underbrace{1{,}116}_{\beta} \ \frac{rad}{m}$

$D = 20 \log\left(\frac{E_0}{E_0 e^{-\alpha}}\right) = 0{,}923 \ dB$

c) $z = z_0 = 8m$

$\underline{\vec{E}}_e(z=8) = E_0 \cdot e^{-jk_z z} = \underline{E}_0 e^{-\alpha z_0} e^{-j\beta z_0} \vec{e}_x$

$\vec{e}_e(z_0, t) = \underline{E}_0 e^{-\alpha z_0} \cos(\omega t - \beta z) \vec{e}_x$

d) metall : $E_{tang} \overset{!}{=} 0 \Rightarrow$ TEW : $\underline{E} \overset{!}{=} 0$

allg: $e(z,t) = c_1 f_1(z - vt) + c_2 f_2(z + vt)$

$e_1(z,t) = E_0 e^{-\alpha z} \cos(k(z - \underbrace{\tfrac{\omega}{\beta}}_{v} t))$

$e_2 = e_r(z,t) = E_0 e^{-\alpha z} \cos(\beta z + \omega t)$ $\quad e_r(z_0, t) = E_0 e^{-\alpha z_0} \cos(\beta z_0 + \omega t)$

Probe: @z_0 soll $e = 0$ sein

$e = e_1 + e_2 = E_0 e^{-\alpha z_0} \cos(\beta z_0 - \omega t) + E_0 e^{-\alpha z_0} \cos(\beta z_0 + \omega t) =$