P38.4 For destructive interference,
\[
\sin \theta = \frac{\lambda}{a} = \frac{5.00 \text{ cm}}{\lambda} = 0.139
\]
and \[
\theta = 7.98^\circ
\]
\[
d = \frac{\lambda}{\tan \theta}
\]
gives \[
d = 1. \tan \theta \times (6.50 \text{ m}) \tan 7.98^\circ = 0.512 \text{ m}
\]
\[
d = \left( \frac{91.2 \text{ cm}}{100 \text{ cm}} \right)
\]

P38.11 \[
\sin \theta = \frac{\lambda}{a} = \frac{5.00 \times 10^{-7} \text{ m}}{5.00 \times 10^{-1} \text{ m}} = \left[ 1.0 \times 10^{-3} \text{ rad} \right]
\]

P38.13 Undergoing diffraction from a circular opening, the beam spreads into a cone of half-angle \[
\theta_{\text{me}} = 1.22 \frac{\lambda}{D} = 1.22 \left( \frac{632.8 \times 10^{-7} \text{ m}}{0.005 \text{ m}} \right) = 1.54 \times 10^{-4} \text{ rad}.
\]
The radius of the beam ten kilometers away is, from the definition of radian measure,
\[
r_{\text{beam}} = \theta_{\text{me}} (1.00 \times 10^9 \text{ m}) = 1.54 \text{ m}
\]
and its diameter is \[
d_{\text{beam}} = 2r_{\text{beam}} = 3.09 \text{ m}
\]

P38.20 \[
1.22 \frac{\lambda}{D} = \frac{d}{l}.
\]
\[
D = 2.10 \text{ m}
\]
\[
l = 9.000 \text{ m}
\]
\[
d = 1.22 \left( \frac{0.0200 \text{ m}}{2.10 \text{ m}} \right)(9.000 \text{ m}) = 0.464 \text{ m}
\]

P38.22 \[
\sin \theta = 0.350;
\]
\[
d = \frac{\lambda}{\sin \theta} = \frac{632.8 \text{ nm}}{0.350} = 1.81 \times 10^3 \text{ nm}
\]
Line spacing = \[
\left[ \frac{1.81 \text{ pm}}{1} \right]
\]