c) \( T = 2.0 \text{ max from the graph} \)

\[ \omega = \frac{2\pi}{T} = \frac{3.14 \times 10^3 \text{ rad/s}}{2} = 1.57 \times 10^3 \text{ rad/s} \]

b) \( \omega = \frac{\omega}{k} \Rightarrow k = \frac{\omega}{343 \text{ m/s}} = \frac{3.14 \times 10^3 \text{ rad/s}}{343 \text{ m/s}} = 9.15 \text{ rad/m} \]

\( k = 9.2 \text{ rad/m} \)

a) From (17-15) we have \( \Delta P = (5 \text{ Pa}) S_m \)

\( \Rightarrow S_m = \frac{\Delta P}{(5 \text{ Pa})} = \frac{9.0 \times 10^{-3} \text{ Pa}}{343 \text{ m/s} \cdot 1.21 \text{ kg/m}^3 \cdot 3.14 \times 10^3 \text{ rad/s}} \)

\( S_m = 6.1 \times 10^{-9} \text{ m} \)

\[ \omega' = 3.1 \times 10^3 \text{ rad/s} \]

d) \( S_m' = S_m \cdot \frac{343 \text{ m/s} \cdot 1.21 \text{ kg/m}^3}{320 \text{ m/s} \cdot 1.35 \text{ kg/m}^3} = 0.961 \cdot S_m \)

\( S_m' = 5.9 \times 10^{-9} \text{ m} \)

e) \( k' = \frac{\omega'}{V_o} = \frac{3.14 \times 10^3 \text{ rad/s}}{320 \text{ m/s}} = 9.8 \text{ rad/m} \)
17.18. Intensity minimum $\Rightarrow$ extra path through the bend must produce a relative phase shift of $\pi$, $3\pi$, $5\pi$, etc.

- Smallest relative $\Rightarrow$ shortest difference between two paths $\Rightarrow$ phase shift must be $\pi$, and therefore the path length difference must be $\frac{\pi}{2}$. 

\[ \Delta L = \pi r - 2r = \frac{\pi}{2} \]

Since $r = 40 \text{ cm}$ we have that

\[ r (\pi - 2) = 20.0 \text{ cm} \]

\[ r = 17.5 \text{ cm} \]
50 dB per vertical division on the scale for the plot. Since the two curves are always 50 dB apart (i.e., the ratio of their intensities does not depend on position), the two curves must be at the same location.

a) $10 \log \left( \frac{I_1}{I_2} \right) = 50 \text{ dB}$

$\Rightarrow \log \left( \frac{I_1}{I_2} \right) = 0.5$ dB

$I_1 = I_2 \cdot 10^{0.5} = \sqrt{10} \cdot I_2$

$I_1/I_2 = 3.2$

b) As noted above, the difference between the two curves is constant.
a) According to the generalized Doppler effect formula (17.47), the reflector will detect a frequency given by:

\[ f' = f - \frac{v_w + v_A}{v_w - v_A} = 1200 \text{ Hz} \times \frac{329 \text{ m/s} + 65.8 \text{ m/s}}{329 \text{ m/s} - 29.9 \text{ m/s}} \]

\[ f' = 1.58 \times 10^3 \text{ Hz} \]

\[ \lambda = \frac{329 \text{ m/s}}{1580 \text{ Hz}} \]

\[ \lambda = 0.208 \text{ m} \]

b) To be a detector monitored at the observer, it appears that there is a source at the reflector of the above frequency, and this detector would see:

\[ f'' = f' \cdot \frac{329 \text{ m/s} + 29.9 \text{ m/s}}{329 \text{ m/s} - 65.8 \text{ m/s}} = 1.3636 \times 1580 \text{ Hz} \]

\[ f'' = 2150 \text{ Hz} \]

d1 \[ \lambda = \frac{329 \text{ m/s}}{2150 \text{ Hz}} = 0.153 \text{ m} \]
18.10 $U = 100 \text{m/s}$

\[ \frac{\Delta d}{d} = \alpha \Delta T \]

\[ \frac{\Delta d}{\Delta c} = U_{\text{source}} = d \alpha_{\text{V}} \frac{\Delta T}{\Delta t} \]

where $\Delta t$ is a time interval and $\Delta T$ is a temperature change

$\alpha_{\text{V}} = 2.3 \times 10^{-6} / \degree \text{C}$ (from Table 18-2)

\[ 100 \times 10^{-9} \text{m/s} = 2.00 \times 10^{-2} \text{m} \cdot 2.3 \times 10^{-6} / \degree \text{C} \cdot \frac{\Delta T}{\Delta t} \]

\[ \Rightarrow \frac{\Delta T}{\Delta t} = \frac{50 \times 10^{-4} \text{mV/m/s}}{2.3 \times 10^{-6} / \degree \text{C}} = 0.217 \degree \text{C/s} \]

\[ \frac{dT}{dt} = 0.217 \text{ K/s} \]

Remember: $1 \degree \text{C} = 1 \degree \text{K}$ when talking about temperature differences.
As heat is exchanged, between the ball and the hoop:

The hoop expands and the ball shrinks.

\[ D = D_0 \left(1 + \alpha_v |T_f - T_0|\right) \quad d = d_0 \left(1 - \alpha_A |T_f - T_0|\right) \]

\[ = D_0 \left(1 + \alpha_v (T_f - T_0)\right) \quad d = d_0 \left(1 - \alpha_A (T_f - T_0)\right) \]

Where \( T_0 = 0.00^\circ C \) = initial \( T \) of the Cu, \( T_i \) is the initial temperature of the Al. At \( T_f \) we are told:

\[ D = d \text{ (the ball just passes through the hoop)} \]

\[ D_0 \left(1 + \alpha_v T_f\right) = d_0 \left(1 - \alpha_A T_f + T_f \alpha_Ae\right) \]

\[ T_f \left(\alpha_v D_0 - \alpha_A d_0\right) = d_0 - d_0 \alpha_A T_i - D_0 \]

\[ T_f = \frac{25400m \left(1 - 1.3 \times 10^{-6} \cdot 100^\circ C\right)}{(17 \times 10^{-6}) 25400m - 1.3 \times 10^{-6} (2.5^\circ C) + T_0} \]

\[ = 50.38^\circ C \]

b) The heat capacity of the sphere is \( C_v \cdot M_v \) and that of the ring is \( C_v \cdot M_v \). Any heat lost by the sphere must go into the ring hence:

\[ M_A R \cdot C_{Al} \left(100 - T_f\right) = M_v \cdot C_v \left(T_f - 0^\circ C\right) \]

\[ M_A R = \frac{209}{0.0427 \text{ cal/g} \cdot \text{hr}} \quad 50.38^\circ C \quad (100 - 50.38)^\circ C \]

\[ M_A = 8.72 \text{ gram} \]

Note. The sphere is not solid since a solid sphere of radius 1.272 cm would have a volume of

\[ \frac{4}{3} \pi r^3 = 8.58 \text{ cm}^3 \]

And a solid Al sphere of the diameter would have a mass of 23.2 gram!