16.47 *

Eq. (16.4) $\quad p(x,t) = BkA\sin(kx-\omega t)$

Eq. (16.1) $\quad y(x,t) = A\cos(kx-\omega t)$

a) The statement is true, p is max where y is zero.

b) $A = 10\,\mu m \qquad \lambda = 0.25\,m \qquad v = 344\,m/s \qquad B = 1.42\times10^5\,Pa$

$$p_{max} = BkA = 1.42\times10^5\,Pa\left(\frac{2\pi}{0.25\,m}\right)10\times10^{-6}\,m$$

$$\cong 35.7\,Pa$$

see over for graph

$$p = -B\frac{\partial y}{\partial x} \qquad p_{max} = B\frac{\Delta y}{\Delta x} = (1.42\times10^5\,Pa)\frac{20\times10^{-6}\,m}{0.125\,m}$$

$$\Rightarrow p_{max} \cong 22.72\,Pa$$

Presure Amp is not the same.

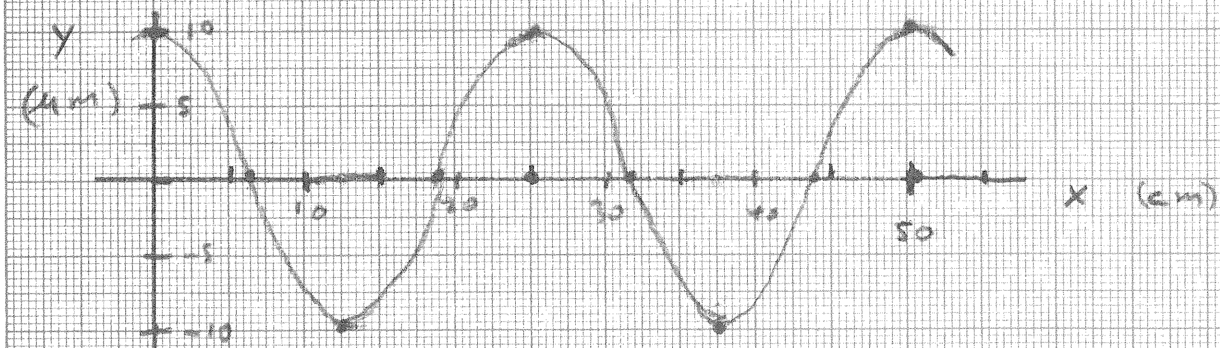
d) The statement is not true in general.

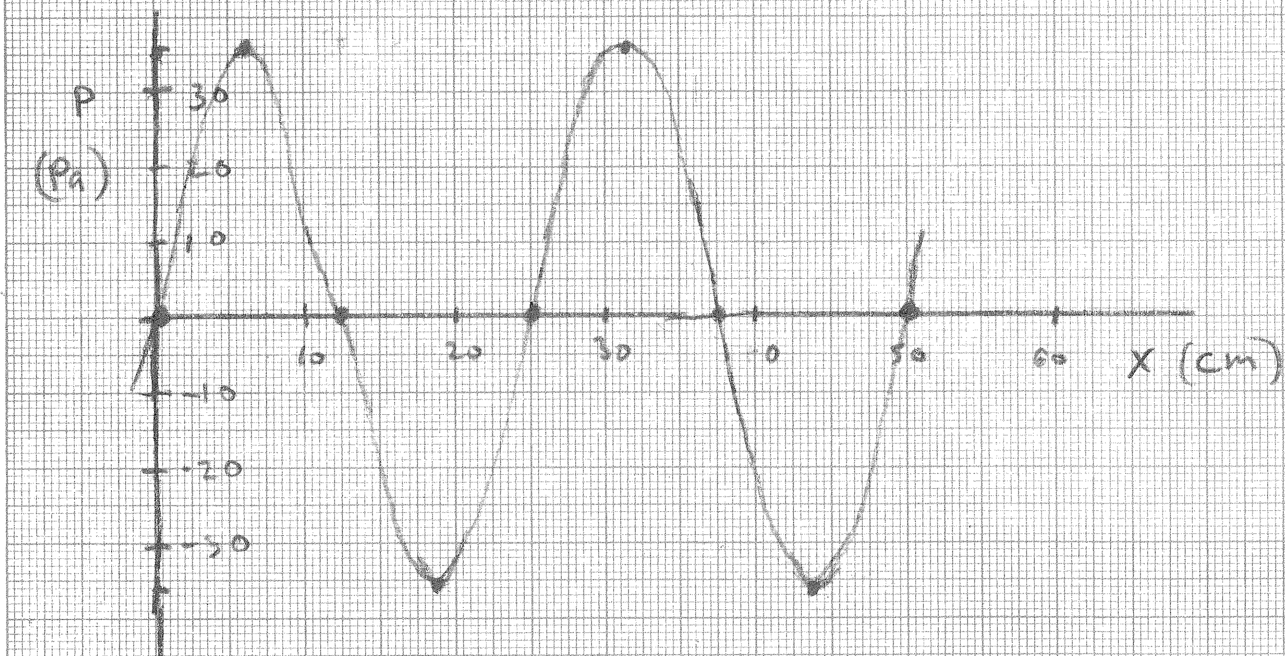
Pressure can be greatest at non zero displacements.

16.47 b)

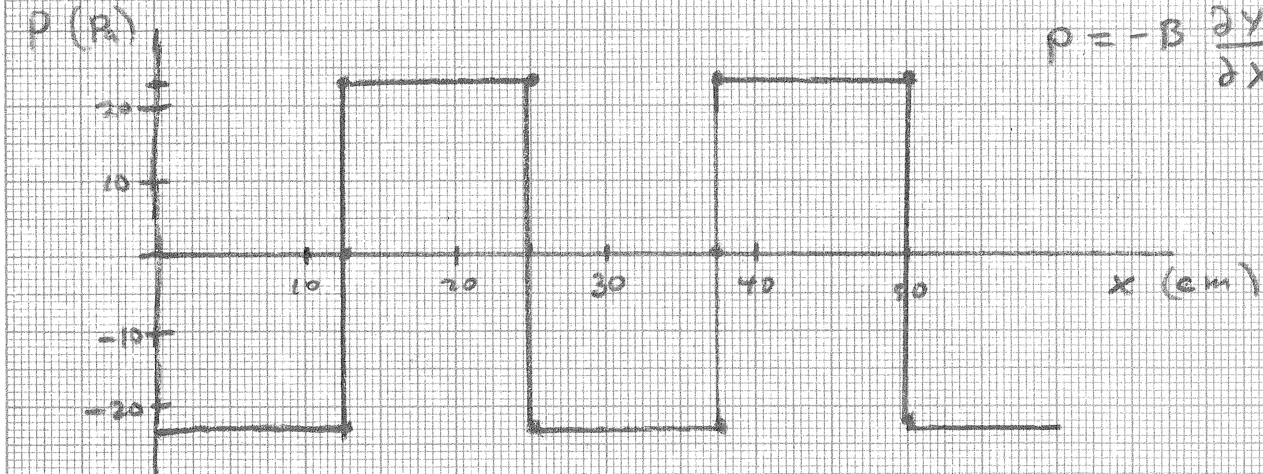
$$y(x,t) = A\cos\left(\frac{2\pi}{\lambda}x - \omega t\right)$$

$t = 0$

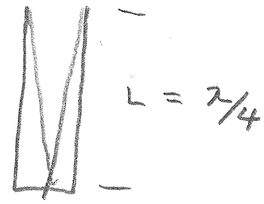




$$p = -B\frac{\partial y}{\partial x}$$



16.60 $\quad F_4 \quad f = 349\ Hz$



a)

$v = 344\ m/s$

$$L = \frac{\lambda}{4} = \frac{v}{f}\,\frac{1}{4} = \frac{344\ m/s}{349\ 1/s\,(4)} \cong \boxed{0.986\ m}$$

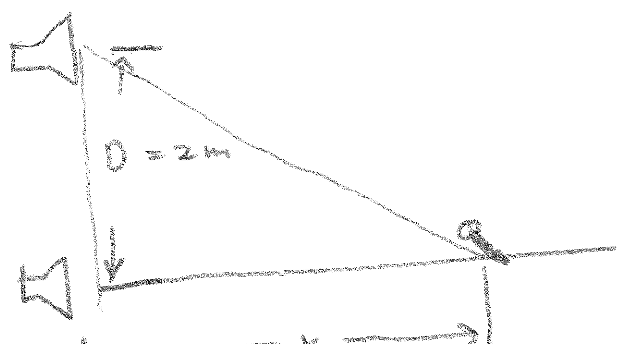
b)

$$f = \frac{v}{\lambda} = \frac{v}{4L} = \frac{\sqrt{\frac{\gamma R T}{M}}}{4L} \qquad f \propto \sqrt{T} \Rightarrow f^2 \propto T$$

$$T' = T\left(\frac{f'}{f}\right)^2 = \left\{\left[(20 + 273.15)K\right]\left(\frac{370\ Hz}{349\ Hz}\right)^2 - 273\right\}°C$$

$$\cong \boxed{56.3\ °C}$$

16.62*^ (extra)



$f = 784\ Hz$

$v = 344\ m/s$

$\lambda = \frac{v}{f}$

$\lambda = \frac{344\ m/s}{784\ Hz} \cong .439\ m$

a) path diff. $d = \sqrt{D^2 + x^2} - x$

$d = n\frac{\lambda}{2}$ $\quad$ n odd $\Rightarrow \sqrt{D^2+x^2} - x = n\frac{\lambda}{2}$

$\Rightarrow D^2 + x^2 = \left(x + n\frac{\lambda}{2}\right)^2 \Rightarrow D^2 + \cancel{x^2} = \cancel{x^2} + n\lambda x + \frac{n^2\lambda^2}{4}$

$\Rightarrow n\lambda x = D^2 - \frac{n^2\lambda^2}{4} \Rightarrow x = \frac{D^2}{n\lambda} - \frac{n\lambda}{4}$ $\quad$ n odd

16.62*^ a) (continued)

$$\Rightarrow \quad x = \frac{(2m)^2}{n(.439m)} - n\frac{.439m}{4} \cong \frac{9.12m}{n} - n\,0.110\,m$$

$\Rightarrow$

$n=1$	$x \cong 9.01\,m$
$n=3$	$x \simeq 1.71\,m$
$n=5$	$x \simeq 1.27\,m$
$n=7$	$x \simeq 0.53\,m$
$n=9$	$x \simeq 0.026\,m$

with negitive x values the path diff $= \sqrt{D^2+x^2} + x$
which will give x values that are the
negitive of the above from $\sqrt{D^2+x^2} + x = n\frac{\lambda}{2}$

n = odd.

b)

path diff $= \sqrt{D^2+x^2} - x = n\lambda$ n is any integer

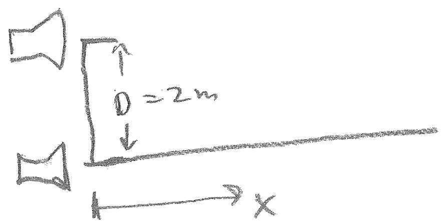
$$\Rightarrow \quad D^2+x^2 = (x+n\lambda)^2 = x^2 + 2n\lambda x + n^2x^2$$

$$\Rightarrow \quad \frac{D^2 - n^2\lambda^2}{2n\lambda} = x \Rightarrow x = \frac{D^2}{2n\lambda} - \frac{n\lambda}{2}$$

$$\Rightarrow \quad x \cong \frac{(2m)^2}{2\left(\frac{344\,m/s}{784\,1/s}\right)n} - n\frac{(344\,m/s)}{2(784\,1/s)} \cong \frac{4.558139\,m}{n} - n(0.21938\,m)$$

$\Rightarrow \quad n = 1,2,3,4$ $\boxed{x = 4.34m,\ 1.84m,\ 0.861m,\ 0.262m}$

16.62 *^ c)



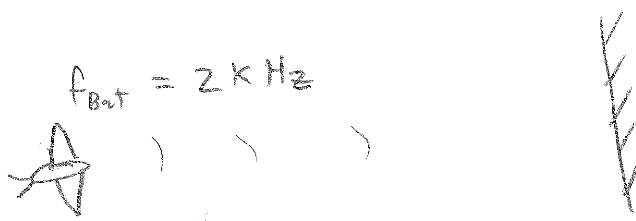
The max path diff is at $x = 0$ so $d = D$

$$d = D = \frac{\lambda}{2} = \frac{v}{f}\frac{1}{2} \Rightarrow f_{low} = \frac{v}{2D} = \frac{344\,m/s}{2\,(2m)}$$

$\Rightarrow f_{low} = 86\ Hz$ The freq must be below 86 Hz for no destructive interference.

16.64

$f_{Bat} = 2\,KHz$



$\vec{v_s} = |v_L|$

$$f_{beat} = f_L - f_{Bat} \Rightarrow f_L = f_{Bat} + f_{beat}$$

$$f_L = \frac{v + v_L}{v - v_s} f_{Bat} = \frac{v + v_s}{v - v_s} f_{Bat}$$

$$\Rightarrow f_{Bat} + f_{beat} = \frac{v + v_s}{v - v_s} f_{Bat} \Rightarrow v + v_s = (v - v_s)\left(1 + \frac{f_{beat}}{f_{Bat}}\right)$$

$$\Rightarrow v_s + v - v\left(1 + \frac{f_{beat}}{f_{Bat}}\right) + v_s\left(1 + \frac{f_{beat}}{f_{Bat}}\right) = 0$$

$$\Rightarrow v_s\left(2 + \frac{f_{beat}}{f_{Bat}}\right) = v\,\frac{f_{beat}}{f_{Bat}} \Rightarrow v_s = v\,\frac{\frac{f_{beat}}{f_{Bat}}}{2 + \frac{f_{beat}}{f_{Bat}}}$$

16.64 (continued)

$$v_s = \frac{v\left(\frac{10}{2000}\right)}{2 + \left(\frac{10}{2000}\right)} = v\,\frac{1}{401}$$

$$\cong (344\ m/s)\,\frac{1}{401} \cong \boxed{0.858\ m/s}$$