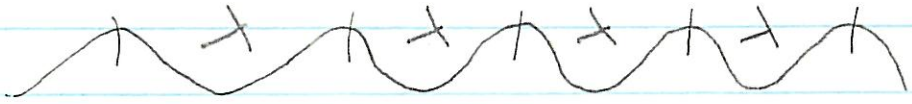
Chapter 16

16-3 

$\lambda = 32\,m$

(a) $5T = 50s \Rightarrow T = 10s$

(b) $f = \frac{1}{T} = 0.1\,Hz$

(c) $\lambda = 32\,m$

(d) $v = \lambda f = 32\,m \times 0.1\,Hz = 3.2\,m/s$

(e) Not enough information given

16-7 from figure in problem 26

$\lambda = 0.04\,m$, $T = 0.2s$

$$v = \frac{\lambda}{T} = \frac{0.04m}{0.2s} = 0.2\,m/s$$

16-13 $\mu = m/L = 7.8\times10^{-4}\,kg/m$

$\lambda = 65cm$, $f = 440\,Hz \Rightarrow v = \lambda f = 286\,m/s$

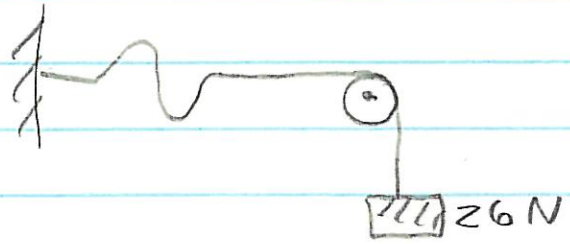
$$v = \sqrt{T/\mu} \Rightarrow T = \mu v^2$$

$$T = 7.8\times10^{-4} \cdot (286)^2 = 63.8N$$

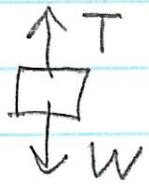
16-17

$\mu = 0.065\ kg/m$

(a)

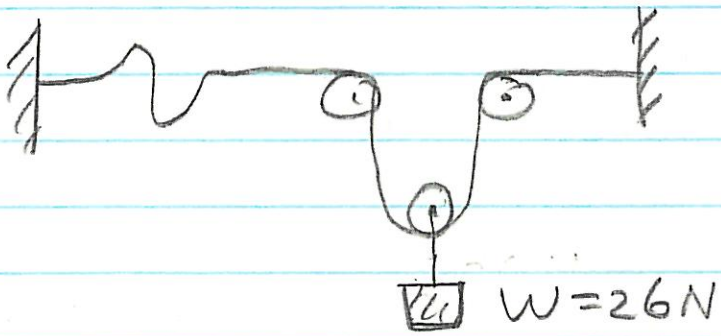


$T = 26N$



$$v = \sqrt{T/\mu} = \sqrt{\frac{26}{0.065}} = 20\,m/s$$

(b)



$2T = W$, $T = 13N$

$$v = \sqrt{\frac{13}{0.065}} \cong 14\,m/s$$

16-25

$A = 0.35m$, $v = 5.2 m/s$, $f = 14 Hz$

$$v = \lambda f \rightarrow \lambda = \frac{5.2}{14} = 0.37m$$

$$y_+(x,t) = A \sin\left(2\pi f t - \frac{2\pi x}{\lambda}\right)$$

$$= 0.35m \sin(88t - 17x)$$

16-26

$$y_+(x,t) = A \sin\left(2\pi f t - \frac{2\pi x}{\lambda}\right)$$

$A = 0.01m$, from problem 7, $\lambda = 0.04m$

$$f = \frac{1}{0.2} Hz$$

$$y_+(x,t) = 0.01m \sin\left(\frac{2\pi t}{0.2} - \frac{2\pi x}{0.04}\right)$$

$$= 0.01m \sin(31t - 157x)$$

16-27

$A = 0.37\,m$, $T = 0.77\,s$, $v = 12\,m/s$

$f = (0.77\,s)^{-1} = 1.3\,Hz$, $\lambda = \frac{v}{f} = 9.2\,m$

$$y_-(x,t) = A\sin\left(2\pi f t + \frac{2\pi x}{\lambda}\right)$$

$$= 0.37\,m \sin\left(2\pi \cdot 1.3 t + \frac{2\pi x}{9.2}\right)$$

$$= 0.37\,m \sin(8.2t + 0.68x)$$

16-29

(a) $v = \sqrt{T/\mu} = \sqrt{\frac{15}{0.85}} = 4.2\,m/s$

(b) $\lambda = v/f = 4.2/12 = 0.35\,m$

(c) $$y_-(x,t) = A\sin\left(2\pi f t + \frac{2\pi x}{\lambda}\right)$$

$$y_-(x,t) = 3.6\,cm \sin\left(2\pi \cdot 12 t + \frac{2\pi x}{0.35}\right)$$

$$= 3.6\,cm \sin(75t + 18x)$$

16-35

(a) $v_{rms} = \sqrt{\frac{3kT}{m}}$

$$m = \frac{39.9\ g/mole}{6.02\times10^{23}\ atoms/mole}$$

$$= 6.63\times10^{-23}\ g = 6.63\times10^{-26}\ kg$$

$$v_{rms} = \sqrt{\frac{3\cdot1.38\times10^{-23}\cdot 298K}{6.63\times10^{-26}}} = 431\ m/s$$

(b) $v_s = \sqrt{\frac{\gamma kT}{m}}$

$$= \sqrt{\frac{1.67\cdot1.38\times10^{-23}\cdot 298}{6.63\times10^{-26}}}$$

$$v_s = 322\ m/s$$

16-41

$$\Delta t = d / v_s$$

(a)

$$(\Delta t)_{air} = \frac{125\,m}{343\,m/s} = 0.36\,s$$

$$(\Delta t)_w = \frac{125}{1482} = 0.084\,s$$

$$(\Delta t)_h = \frac{125}{5040} = 0.0255\,s$$

$$(\Delta t)_h < (\Delta t)_w < (\Delta t)_{air}$$

(b) $0.084 - 0.025 = 0.06\,s$

$0.36 - 0.025 = 0.335\,s$

16-47

$$v_s = \sqrt{\frac{\gamma k T}{m}}$$

$$m_{Ne} = \frac{20.2}{N_A} = 3.36 \times 10^{-26}\ kg$$

$$m_{Kr} = \frac{83.8}{N_A} = 1.39 \times 10^{-25}\ kg$$

$$v_{Ne} = 2 v_{Kr}$$

$$\sqrt{\frac{\gamma k T_{Ne}}{m_{Ne}}} = 2 \sqrt{\frac{\gamma k T_{Kr}}{m_{Kr}}}$$

$$\frac{k T_{Ne}}{m_{Ne}} = 4 \frac{k T_{Kr}}{m_{Kr}}$$

$$T_{Ne} = 4 \frac{m_{Ne}}{m_{Kr}} T_{Kr}$$

$$= 4 \cdot \frac{20.2}{83.8} \cdot 293K$$

$$= 283K$$

16-53

$$I = \frac{P}{4\pi r^2} \rightarrow P = I \cdot 4\pi r^2$$

$$P = 3.6\times10^{-2}\ \frac{W}{m^2} \cdot 4\pi\,(3.8\,m)^2$$

$$= 6.53\ W$$

16-55

$$I_1 4\pi r_1^2 = I_2 4\pi r_2^2$$

$$2\times10^{-6} \cdot (120)^2 = 0.8\times10^{-6}\ r_2^2$$

$$r_2 = 190\,m$$

16-63

$$\beta_1 = 10\log(I_1/I_0)$$

$$\beta_2 = 10\log(I_2/I_1)$$

suppose, $I_2 > I_1$

$$\Delta\beta = \beta_2 - \beta_1 = 10\left[\log(I_2/I_0) - \log(I_1/I_0)\right]$$

$$= 10\ \log\left[\frac{I_2/I_0}{I_1/I_0}\right] = 10\log\left(\frac{I_2}{I_1}\right)$$

$$\log\left(\frac{I_2}{I_1}\right) = \frac{\Delta\beta}{10} = \frac{1}{10}$$

$$I_2/I_1 = 10^{0.1} = 1.26$$

16-65

$$\beta_1 = 10 \log (I_1/I_0)$$

$$\beta_2 = 10 \log (I_2/I_0)$$

$$\beta_2 - \beta_1 = 30\,dB = 10\left[\log\left(\frac{I_2}{I_0}\right) - \log\left(\frac{I_1}{I_0}\right)\right]$$

$$3\,dB = \log (I_2/I_1)$$

$$I_2/I_1 = 10^3$$

16-67

$$\beta_R = 10 \log (I_R/I_0)$$

$$\beta_J = 10 \log (I_J/I_0)$$

$$\beta_R - \beta_J = 115 - 95 = 20\,dB = 10 \log (I_R/I_J)$$

$$I_R/I_J = 10^2$$

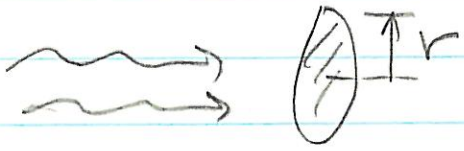
16-72

$\beta = 10 \log (I/I_0)$

$I = I_0 \, 10^{\beta/10}$

$= 1\times10^{-12} \frac{J}{s\,m^2} \, 10^{9}$

$I = 1\times10^{-3} \, J/s\,m^2$



Energy on Ear for 9 hrs $= 1\times10^{-3} \frac{J}{s\cdot m^2} \times 2\times10^{-4} \, m^2 \times 9\cdot60\cdot60$

$= 6.48\times10^{-3} \, J$

16-73

$\beta_A = \beta_B + 1.5$

$\beta_C = \beta_A + 2.7$

$\beta_A - \beta_B = 1.5$

$\beta_C - \beta_A = 2.7$

$+ \quad \beta_C - \beta_B = 4.2$

$= 10 \log (I_C / I_B)$

$I_C / I_B = 10^{4.2/10} = 2.63$