Physics 116
Winter 2006
OEV.

Solutions to selected problems
from Chapter 14 (3rd Edition).

$\boxed{14\text{-}5}$  $v = \lambda f = 0.27\,m \times 4.5\,\frac{1}{s} = 1.215\,m/s$

a) $\Delta x = v\,\Delta t \Rightarrow 1.215\,\frac{m}{s} \times 0.50\,s = 0.608\,m$

b)  ← knot   Knot moves "up and down" – Question in problem is not very clear because "how far has the knot traveled" could be interpreted "forward", which is zero meters – The up and down motion is

$$\text{Number of "cycles"} = \frac{0.5\ \text{second}}{\frac{1}{4.5}\ \text{seconds}} = 2.25\ \text{cycles} = 2\tfrac{1}{4}\ \text{cycles}$$

So the distance travelled is $4\,\frac{\text{amplitudes}}{\text{cycle}} \times 2\frac{1}{4}\ \text{cycles} \times \frac{0.12\,m}{\text{amplitude}} =$

$= 1.08\ m$ –

c) The speed of the wave is unchanged by changes in the amplitude. So (a) is the same – With half the amplitude, 0.06 m instead of 0.12 m, the distance traveled by knot is half –

$\boxed{14\text{-}9}$ $\Delta t = \frac{\Delta x}{v} = \frac{\Delta x}{\sqrt{\frac{T}{M/L}}}$ with $\Delta x = L$

$$\Delta t = \frac{9.5\,m}{\sqrt{\frac{8.6\,N}{0.032\,kg/9.5\,m}}} = 0.188\,s$$

$\frac{\pi}{5} = \frac{2\pi}{\lambda} \Rightarrow \lambda = 2 \times 5 = 10\,cm$

$\frac{\pi}{12\,s} = \frac{2\pi}{T} \Rightarrow T = 2 \times 12\,s = 24\,s$

$\boxed{14\text{-}16}$ $y = (15\,cm)\cos\left(\frac{\pi}{5.0\,cm}x - \frac{\pi}{12\,s}t\right)$

a) Amplitude $= 0.15\,m = 15\,cm$; b) $\lambda = 2 \times 0.05\,m = 10\,cm$; c) $T = 12\,s \times 2 = 24\,s$

d) $v = \frac{\lambda}{T} = \frac{2 \times 0.05\,m}{2 \times 12\,s} = 0.0042\,m/s$ e) Wave travels in $+x$ direction, check the (–) sign – If wave moves in $(-x)$ direction sign would have been (+)

$\boxed{14\text{-}17}$ Continuation of previous problem.
A graphic solution is in the back of the book, better than what I can draw here.

(a) Note that for $t=0$ equation is a cosine
$$X = (15\,cm)\cos\frac{2\pi x}{10\,cm}$$

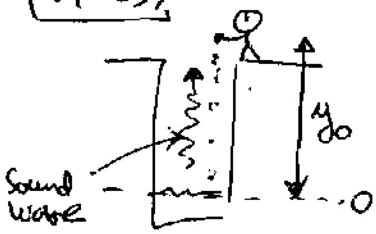
(b) 3 seconds is $\frac{1}{8}$ of the period ($45° \equiv \frac{\pi}{4}$), moved to the right

(c) 6 seconds is $\frac{1}{4}$ of the period ($90° \equiv \frac{\pi}{2}$) moved to the right from $t=0$, so now it looks like a <u>sine</u> $[\cos(\theta - 90°) = \sin\theta]$

(d) If point moves from $y=0$ to $y=15\,cm$ it moves <u>one</u> amplitude, and the least amount of time is $\frac{1}{4}$ period $= \frac{24\,s}{4} = 6$ seconds

---

$\boxed{14\text{-}23}$



Problem has two parts. First rock has to go down to water level, a distance "y_o". Sound is then generated, which travels back to person at 343 m/s. But this speed is very high! If I call $y=0$ the water level, calculate y_o

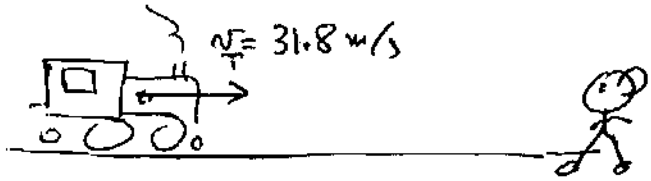
(a) $0 = y_o - \frac{1}{2}gt_1^2 \leftarrow$ uniform accelerated motion.

If we neglect the time it takes sound to come back to person.
$$y_o = \frac{1}{2}t_1^2 g = \frac{1}{2}\times(1.5\,s)^2\,(9.81\,m/s^2) = 11 \text{ meters.}$$
(Sound would take $\frac{11\text{ meters}}{343\,m/s} = \underline{0.032\,s}$ to come up!

(b) $t = \sqrt{\frac{2y_o}{g}}$, so if one doubles the depth the time it takes the rock to reach the bottom increases by $\sqrt{2} = 1.4$, not twice
So $t < 3$ seconds

$\boxed{14\text{-}27}$ decibels $= 10\log\frac{I_2}{I_1}$
$$2.5\,db = 10\log\frac{I_2}{38.0\,W/m^2} \Rightarrow \frac{2.5}{10} = \log_{10}\frac{I_2}{38\,\frac{W}{m^2}} \Rightarrow I_2 = 38\frac{W}{m^2}\times 10^{0.25}$$
$$\underline{I_2 = 67.6\,W/m^2}$$

14.35



Source moving, observer stationary

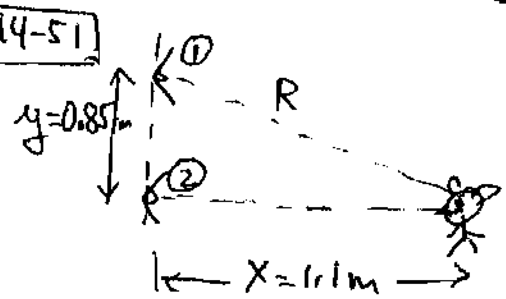
Using Eqn (14-10) $\Rightarrow f_{new} = f_{source} \dfrac{1}{1 - \dfrac{v_{train}}{v_{sound}}}$

$$= 136\,\text{Hz} \frac{1}{1 - \dfrac{31.8\,\text{m/s}}{343\,\text{m/s}}} = 149.9\ \text{Hz}$$

14-47 Very good picture at end of book in solution for this problem - Waves superimpose - Check also Prob. 49 and its solution -

---

14-51



Constructive interference means that waves from ① and ② will be in phase at the site of the person -

The minimum difference in frequencies will occur when there are N cycles along path X, and N+1 along path R.

$$R = (N+1)\lambda \ , \ X = N\lambda \Rightarrow N = \frac{X}{\lambda}$$

$$\text{So } R = \frac{X}{\lambda}\lambda + \lambda \Rightarrow \lambda = R - X = \sqrt{y^2 + x^2} - x$$

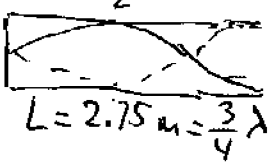
$$= \sqrt{(0.85)^2 + (1.1)^2} - 1.1 = 0.29\ \text{m}$$

$$f = \frac{v_{sound}}{\lambda} = \frac{343\,\text{m/s}}{0.29\,\text{m}} = 1{,}182\ \text{Hz} \simeq 1.2\ \text{kHz}$$

14-57

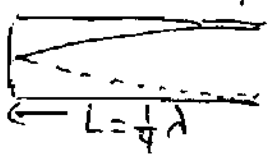
$$\Rightarrow \lambda = 2L \Rightarrow f = \frac{v}{\lambda} = \frac{343\,\text{m/s}}{2 \times 3.5\,\text{m}} = 49\ \text{Hz}$$

14-63



(a) $f = \dfrac{v}{\lambda} = \dfrac{3v}{4L} = \dfrac{3 \times 343\,\text{m/s}}{4 \times 2.75\,\text{m}} = 93.5\ \text{Hz}$

(b)



$f = \dfrac{v}{\lambda} = \dfrac{v}{4L} = \dfrac{343\,\text{m/s}}{4 \times 2.75\,\text{m}} = 31.2\ \text{Hz}$