Problem / ch. 11

11.1

a) $t_{roundtrip} = 1.5\ s \rightarrow t_{oneway} = \frac{1.5}{2} = 0.75\ s$

$$x = vt = (343\ m/s)(0.75\ s) = \boxed{257.2\ m}$$

b) $I = 1.0 \times 10^{-5}\ W/m^2 \qquad r = 1\ m$

Using $I = \frac{P}{4\pi r^2} \rightarrow P = I(4\pi r^2)$

$$= (1.0 \times 10^{-5})(4\pi \times 1^2)$$

$$P = 12.56 \times 10^{-5}\ \text{watts}$$

for $r = 257.2\ m$

$$I = \frac{P}{4\pi r^2} = \frac{12.56 \times 10^{-5}\ \text{Watts}}{(4\pi)(257.2)^2} = 1.5 \times 10^{-10}\ W/m^2$$

11.6

String 1 : $\mu_1 = \frac{78\ g}{15\ m} = 5.2\ g/m$

a) $V_1 = \sqrt{\frac{F_1}{\mu_1}} = \sqrt{\frac{180 N}{0.0052\ kg/m}} = \boxed{186\ m/s}$

String 2 : $\mu_2 = \frac{58}{15} = 3.9\ g/m$

$$V_2 = \sqrt{\frac{F_2}{\mu_2}} = \sqrt{\frac{160}{0.0039}} = \boxed{203\ m/s}$$

b) $t_2 = \frac{15\ m}{203\ m/s} = 0.07\ s \qquad t_1 = \frac{15\ m}{186} = 0.08\ s$

$$\boxed{\Delta t = 0.01\ s}$$

11.14

$\lambda = 30\ cm \qquad V = 120\ m/s$

$\lambda = \frac{V}{f} \rightarrow f = \frac{V}{\lambda} = \frac{120\ m/s}{0.3\ cm} = 400\ Hz$

11.16

$\lambda_1 = 400 \times 10^{-9}\ m \qquad \lambda_2 = 700 \times 10^{-9}\ m$

$V_{light} = 3 \times 10^{8}\ m/s$

$f_1 = \frac{V_{light}}{\lambda_1} = \frac{3 \times 10^{8}\ m/s}{400 \times 10^{-9}} = 7.5 \times 10^{14}\ Hz$ (Violet)

$f_2 = \frac{V_{light}}{\lambda_2} = \frac{3 \times 10^{8}\ m/s}{700 \times 10^{-9}} = 4.3 \times 10^{14}\ Hz$ (Red)

11.22

$y(x,t) = (4\ mm)\ \sin(wt - kx)$

$w = 6 \times 10^{2}\ rad/s \qquad k = 6\ rad/m$

a) $A = ? \rightarrow A = 4\ mm$

b) and c and d

$V = ? \rightarrow w = \frac{2\pi}{T} \rightarrow T = \frac{2\pi}{6 \times 10^{2}} = 0.01\ s$

$k = \frac{2\pi}{\lambda} \rightarrow \lambda = \frac{2\pi}{6} = 1.05\ m$

$\rightarrow V = \frac{\lambda}{T} = \frac{1.05}{0.01} =$

$\boxed{V = 104.7\ m/s}$

e) To the right.

11.25

$Y(x,t) = A\cos(\omega t + kx)$, $V = 10\ m/s$

a) To the left

b) $A = 2\ mm$

$\lambda = 4\ cm \Rightarrow \lambda = \frac{V}{f} \rightarrow$

$$f = \frac{V}{\lambda} = \frac{10\ m/s}{0.04\ m} = 250\ Hz$$

$$\omega = 2\pi f = (2\pi)(250) = \boxed{1570\ rad/s}$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.04} = \boxed{157\ rad/m}$$

c) Notice at $x = 0$, $Y(0,t) = 0 \Rightarrow$

$$\Rightarrow A\cos(\omega t + \underbrace{\cancel{k(0)}}_{0}) = 0$$

$$\cos\omega t = 0 = \cos\frac{\pi}{2}$$

$t_1 = \frac{\pi}{2\omega} = 0.001\ s$, also at

$t_2 = 0.001 + T$

$T = \frac{1}{f} = 0.004\ s$

$\Rightarrow t_2 = 0.005\ s$

and

$t_3 = 0.001 + 2T$

$= 0.009\ s$

11.32

We need to figure out where each pulse is at $t = 0.6, 0.8$ and 0.9 s.

We use $x = vt = (2.5\ m/s)(0.6) = 1.5\ m$

Thus pulse 1 moves 1.5 m to right and ends up at

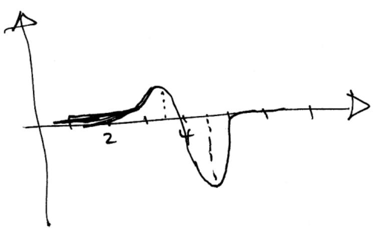
$x_1 = 2 + 1.5 = 3.5\ m$

Pulse 2 moves 1.5 m to left and ends up at

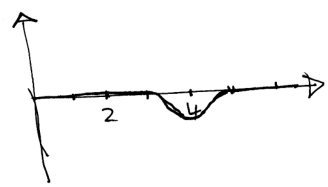
$x_2 = 6 - 1.5 = 4.5\ m$

Therefore:

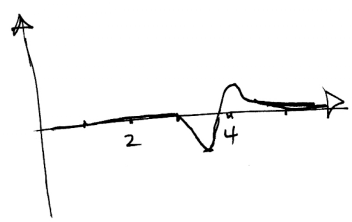
$t = 0.6\ s \begin{cases} x_1 = 3.5\ m \\ x_2 = 4.5\ m \end{cases}$



$t = 0.8\ s \begin{cases} x_1 = 4\ m \\ x_2 = 4\ m \end{cases}$



$t = 0.9\ s \begin{cases} x_1 = 4.3\ m \\ x_2 = 3.8\ m \end{cases}$



11.42 $A_1 = 6$ cm $A_2 = 3$ cm

a) Intensity depends on Power = P which depends on $(\text{Amplitude})^2$. To have P maximized, we need to make Amplitude maximized $\Rightarrow A_{total} = A_1 + A_2 = 6+3 = 9$ cm.

For this to happen, the two waves must be in phase, i.e.

$\Delta\phi = 0, 2\pi, \ldots$ or $0^\circ, 360^\circ, \ldots$

b) P will be minimized if Amplitude is minimized. This happens if

$A_{total} = 6-3 = 3$ cm

Then the two waves are out of phase

$\Delta\phi = \pi\ \ 3\pi, \ldots$

or $180^\circ, 540^\circ, \ldots$

11.43

Intensity is proportional to $(\text{Amplitude})^2$.

When the two waves combine, $A = A_1 + A_2$.

but $$I_1 \propto A_1^2$$ $$I_2 \propto A_2^2 \Rightarrow \frac{I_1}{I_2} = \left(\frac{A_1}{A_2}\right)^2$$

or $$\frac{A_1}{A_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{25}{15}} = 1.29$$

Thus $$A = A_1 + A_2 = 1.29\,A_2 + A_2 = 2.29\,A_2$$

$$\frac{I}{I_2} = \frac{A^2}{A_2^2} = \frac{(2.29A_2)^2}{A_2^2} = 5.25$$

$$\Rightarrow I = (I_2)(5.25)$$
$$= (15)(5.25) = 79 \text{ mW}/\text{m}^2$$

11.49

$l = 2\ m$

fundamental harmonic

This tell us that $\lambda = 2l = 4m$

but $\lambda = \frac{V}{f} \rightarrow 4 = \frac{V}{27.5} \rightarrow$

$$\boxed{V = 110\ m/s}$$

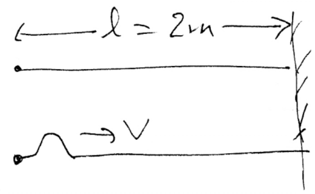
Also $V = \sqrt{\frac{F}{\mu}} \rightarrow 110 = \sqrt{\frac{300}{\mu}} \rightarrow$

$\mu = 0.025\ kg/m$

$m = (0.025\ kg/m)(2m)$

$= 0.05\ kg = 50$ grams

11. 56



$V = ?$ using $\Delta x = V \Delta t$

$$2m = V(0.05)$$

$$\Rightarrow \boxed{V = 40 \ m/s}$$

$$\lambda = \frac{V}{f} \rightarrow (2 \times 2m) = \frac{40 \ m}{f}$$

$$f = \frac{40}{4} = 10 \ Hz$$