20.10

$\omega = 21.0$ rad/s , $\lambda = 1.60$ m

(a) $k = 2\pi/\lambda$

(b) $v = \lambda f = \lambda\omega/2\pi$

20.11

$v = 185$ m/s . $k = 1.10$ rad/m

(a) $\lambda = 2\pi/k$

(b) $v = \lambda f$, $\Rightarrow f = v/\lambda = v\frac{k}{2\pi}$

20.12

$k = 2.7$ /m , $\omega = 124$ /s

(a) $f = \omega/2\pi = 19.7$ /s

(b) $\lambda = 2\pi/k = 2.33$ m

(c) $v = \lambda f = 45.9$ m/s

20.13

$k = 6.20$ /m , $\omega = 61.0$/s

(a) $f = \omega/2\pi = 61/2\pi$ Hz

(b) $\lambda = 2\pi/k = 2\pi/6.20$ m

(c) $v = \lambda f$

20.36

$f = 600$ Hz . $V_s = 90$ km/hr . The source is moving.

(a) $f_+ = \frac{f}{1-V_s/V} = \frac{600\text{Hz}}{1-25\text{m/s}/343\text{m/s}}$

(b) $f_- = \frac{f}{1+V_s/V} = \frac{600\text{ Hz}}{1+25\text{m/s}/343\text{m/s}}$

20.37

$f = 785$ Hz , $f_+ = 893$ Hz . The source is approaching.

$f_+ = \frac{f}{1-V_s/V}$, $V_s = \frac{f_+ - f}{f_+}v = \left(\frac{108}{893}\right)(343\text{ m/s})$

20.38

(a) You need to lower the ~~[illegible]~~ frequency heard, so you need to move away from your friend

(b) $f_- = (1-\frac{v_o}{v})f$. v_o is the speed of the observer, you. $v = 343$ m/s

You need to make $f_- < 20$ kHz ,

$v_o = v(1-f_-/f_0)$ $\therefore V_{o,min} = (343\text{ m/s})(1-20\text{kHz}/21\text{ kHz})$

20.39

$f = 420$ Hz , $V_s = 26.4$ m/s , $v = 339$ m/s ,

The source is moving.

(a) The source is approaching.

$f_+ = f/(1-V_s/v) = (420 \text{ Hz})/(1-26.4/339)$

(b) The observer is moving and approaching

$V_o = 26.4$ m/s , $f_+ = (1+V_o/v) f = (1+26.4/339)(420 \text{ Hz})$

20.52 V_p = speed of P wave $\Delta t = 2.0$ min

V_s = speed of S wave

Let d be the distance between the source of the earthquake and the detector.

$t_p = d/v_p$, $t_s = d/v_s$, $t_s - t_p = \Delta t$, $d/v_s - d/v_p = \Delta t$

$$d = \frac{\Delta t}{1/v_s - 1/v_p} = \frac{V_s V_p}{V_p - V_s} \Delta t$$

20.56 $A = 2.0$ cm , $k = 12.57$/m , $\omega = 638$ /s , $\mu = 5.0$ g/m

(a) $v = \sqrt{\frac{T_s}{\mu}}$, $v = \frac{\omega}{k}$, $\Rightarrow T_s = \mu\left(\frac{\omega}{k}\right)^2$

(b) Amplitude which is A. $= 2.0$ cm

(c) $\frac{\partial D}{\partial t} = A\omega \cos(kx + \omega t)$, $\left(\frac{\partial D}{\partial t}\right)_{max} = A\omega = (2.0 \text{ cm})(638 \text{ /s})$