Physics 201 - Homework 2

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February 2, 2011

15.41

(a)

See figure 15.26(c) in the textbook.

(b)

$$A = A_{sw}/2 = 5.6/2 = 2.8\,\text{cm}$$

(c)

$$L = \frac{3\lambda}{2}$$

$$\lambda = \frac{2\pi}{k} = 184.8\,\text{cm}$$

$$L = \frac{3 \times 184.8}{2} = 277.2\,\text{cm}$$

(d)

$$\lambda = 184.8\,\text{cm}$$

$$f = \frac{\omega}{2\pi} = \frac{50}{2\pi} = 7.96\,\text{Hz}$$

$$T = \frac{2\pi}{\omega} = \frac{1}{f} = 0.13\,\text{s}$$

$$v = \frac{\omega}{k} = \frac{50}{0.034} = 1470.59\,\text{cm/s}$$

(e)

$$v_{y,max} = A\omega = 5.6 \times 50 = 280\,\text{cm/s}$$

(f)

$$L = \frac{8\lambda}{2} \Rightarrow \lambda = \frac{2L}{8}$$

$$k = \frac{2\pi}{\lambda} = 2\pi(\frac{8}{2L}) = 0.091\,\text{cm}^{-1}$$

$$\omega = vk = 1470.59 \times 0.091 = 133.8\,\text{s}^{-1}$$

$$y = 5.6\,\text{cm}\sin(0.091\,\text{cm}^{-1}x)\sin(133.8\,\text{s}^{-1}t)$$

15.47

(a)

$$L = \frac{\lambda}{2} \Rightarrow \lambda = 2L = 127\,\text{cm}$$

$$v = f\lambda = 245 \times 127 = 31115\,\text{cm/s} = 311.15\,\text{m/s}$$

(b)

$$v = \sqrt{\frac{F}{\mu}}$$

$$v' = \sqrt{\frac{F'}{\mu}} = \sqrt{\frac{1.01F}{\mu}} = \sqrt{1.01}v$$

$$f'\lambda = \sqrt{1.01}f\lambda$$

$$f' = \sqrt{1.01}f = \sqrt{1.01} \times 245 = 246.22\,\text{Hz}$$

(c)

$$f = 245\,\text{Hz (The Same)}$$

$$\lambda = \frac{v}{f} = \frac{344}{245} = 1.404\,\text{m (Longer)}$$

15.53

(a)

$$v_{y,max} = A\omega = Avk = A\sqrt{\frac{F}{\mu}}\left(\frac{2\pi}{\lambda}\right) = \frac{2\pi A}{\lambda}\sqrt{\frac{FL}{M}}$$

(b)

Increase by a factor of 4.

$$v'_{y,max} = \frac{2\pi A}{\lambda}\sqrt{\frac{4FL}{M}} = \sqrt{4}v_{y,max} = 2v_{y,max}$$

16.44

(a)

$$\lambda_{infront} = \frac{v - v_s}{f_s} = \frac{344 - 25}{400} = 0.7975\,\text{m}$$

(b)

$$\lambda_{behind} = \frac{v + v_s}{f_s} = \frac{344 + 25}{400} = 0.9225\,\text{m}$$

(c)

$$f_L = \left(\frac{v + v_L}{v + v_s}\right) f_s = \left(\frac{344 + 0}{344 - 25}\right) \times 400 = 431.35\,\text{Hz}$$

(d)

$$f_L = \left(\frac{v + v_L}{v + v_s}\right) f_s = \left(\frac{344 + 0}{344 + 25}\right) \times 400 = 372.9\,\text{Hz}$$

16.81

(a)

$$f_L = \left(\frac{v + v_L}{v + v_s}\right) f_s$$

$$f_L = \left(\frac{v + v_W}{v - v_W}\right) f_0$$

$$f_{beat} = \Delta f = f_L - f_0 = \left(\frac{v + v_W}{v - v_W}\right) f_0 - f_0$$

$$f_{beat} = f_0\left(\frac{v + v_W}{v - v_W} - 1\right) = f_0\left(\frac{v + v_W - v + v_W}{v - v_W}\right) = f_0\left(\frac{2v_W}{v - v_W}\right)$$

(b)

$$f_L = \left(\frac{v - v_W}{v + v_W}\right) f_0$$

$$f_{beat} = \Delta f = f_0 - f_L = f_0 - \left(\frac{v - v_W}{v + v_W}\right) f_0$$

$$f_{beat} = f_0 \left(1 - \frac{v - v_W}{v + v_W}\right) = f_0 \left(\frac{v + v_W - v + v_W}{v + v_W}\right) = f_0 \left(\frac{2v_W}{v + v_W}\right)$$