PHYSICS III
Winter 2000-2001

HOMEWORK III-KEY Chapter 15; 2, 7, 24, 30, 35, 65

15-2 (a) $$y(x,t) = y(x - vt) = \frac{a(x - vt)}{4 + b(x - vt)^2}$$

$$= \frac{(4.00cm)(x - (250.cm/s)t)}{4 + (1.00cm^{-2})(x - (250.cm/s)t)^2}$$

15-7 (a) $$f = \frac{\omega}{2\pi} = \frac{12.0rad/s}{2\pi} = 1.91Hz$$

$$T = \frac{1}{f} = \frac{1}{1.91Hz} = 0.524s$$

$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{\pi cm^{-1}} = 2.00cm$$

(b) $$y(x,t) = A\sin(kx + \omega t)$$

$$y(1.00m,1.80s) = (4.00cm)\sin\left[(\pi cm^{-1})(100.cm) + (12.0rad/s)(1.80s)\right]$$

= 1.53cm

(c) $$v = \frac{\omega}{k} = \frac{12,0rad/s}{\pi cm^{-1}} = 3.82cm/s, -x \text{ direction}$$

(d) $$\frac{\partial y}{\partial t} = A\omega\cos(kx + \omega t)$$

$$\frac{\partial y}{\partial t}(1.00m,1.80s) =$$

$$(4.00cm)(12.0rad/s)\cos\left[(\pi cm^{-1})(100.cm) + (12.0rad/s)(1.80s)\right]$$

= -44.4 cm/s

15-24 (a) $A = 2.00cm; \lambda = 4.00m$

$\mu = 0.500kg/m$

$$v = \sqrt{F/\mu} = \sqrt{\frac{3.60N}{0.500kg/m}} = 2.68m/s$$

(b) $$\sin\phi = \frac{y_0}{A} = \frac{1.41cm}{2.00cm} = 0.707$$

$\phi = \pi/4 rad$

$$\left[Alt.: \frac{\phi}{2\pi} = \frac{x}{\lambda} = \frac{0.500m}{4.00m} = \frac{1}{8}\right]$$

$$\left(\phi = \left[\frac{1}{8}2\pi = \pi/4 \ \ rad\right]\right)$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{4.00m} = \left[\frac{\pi}{2}\right]m^{-1}$$

$$\omega = 2\pi f = 2\pi\left(\frac{v}{\lambda}\right) = 2\pi\left[\frac{26.8m/s}{4.00m}\right]$$

$$= 42.1 \ rad/s$$

$$y(x,t) = (2.00cm)\sin\left[\left(\frac{\pi}{2}m^{-1}\right)x + (42.1 \ \ rad/s)t + \frac{\pi}{4}\right]$$

15-30 (a) $$|v| = \frac{\omega}{k} = \frac{94.3 \ rad/s}{5.24m^{-1}} = 18.0m/s$$

(b) $$f = \frac{\omega}{2\pi} = \frac{94.3 \ rad/s}{2\pi} = 15.0Hz$$

(c) $$\mu = \frac{F}{v^2} = \frac{7.78N}{(18.0m/s)^2} = 2.40\,x\,10^{-2}kg/m$$

$$P = \frac{1}{2}\mu\omega^2A^2v$$

$$= \frac{1}{2}(2.40\,x\,10^{-2}kg/m)(9.43rad/s)^2(1.75\,x\,10^{-2}m)^2(18.0m/s)$$

$$= 0.589W$$

15-35

$$(a) \quad \Delta\phi = \frac{\pi}{3} - \left[-\frac{\pi}{4}\right] = \left[\frac{7}{12}\pi\right] rad$$

$$(b) \quad y(x,t) = 2A\cos\left[\frac{\Delta\phi}{2}\right]\sin\left[kx - \omega t + \frac{1}{2}\left[\frac{\pi}{3} - \frac{\pi}{4}\right]\right]$$

$$= (10.0cm)\cos\left[\frac{7\pi}{24}\right]\sin\left[\left(12.0m^{-1}\right)x - \left[180.\frac{rad}{s}\right]t + \frac{\pi}{24}\right]$$

$$(c) \quad y(2.00m, 1.70s) = 4.67cm$$

15-65

$$v = \sqrt{F/\mu} = \sqrt{\frac{384N}{0.060kg/m}} = 80.0m/s$$

$$f_n = n\left[\frac{v}{2L}\right];\ f_{n+1} = (n+1)\left[\frac{v}{2L}\right]$$

$$f_{n+1} - f_n = (n+1-n)\left(\frac{v}{2L}\right) = \frac{v}{2L}$$

$$L = \frac{v}{2(f_{n+1} - f_n)} = \frac{80.0m/s}{2(75.0Hz - 50.0Hz)}$$

$$= 1.60m$$