

PHYSICS II
Winter 2000-2001

HOMEWORK III-KEY

Chapter 15; 2, 7, 24, 30, 35, 65

$$\begin{aligned} 15-2 \quad (a) \quad y(x, t) &= y(x - vt) = \frac{a(x - vt)}{4 + b(x - vt)^2} \\ &= \frac{(4.00\text{cm})(x - (250.\text{cm/s})t)}{4 + (1.00\text{cm}^{-2})(x - (250.\text{cm/s})t)^2} \end{aligned}$$

$$\begin{aligned} 15-7 \quad (a) \quad f &= \frac{\omega}{2\pi} = \frac{12.0\text{rad/s}}{2\pi} = 1.91\text{Hz} \\ T &= \frac{1}{f} = \frac{1}{1.91\text{Hz}} = 0.524\text{s} \\ \lambda &= \frac{2\pi}{k} = \frac{2\pi}{\pi\text{cm}^{-1}} = 2.00\text{cm} \end{aligned}$$

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

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

$$= 1.53\text{cm}$$

$$(c) \quad v = \frac{\omega}{k} = \frac{12.0\text{rad/s}}{\pi\text{cm}^{-1}} = 3.82\text{cm/s}, -x \text{ direction}$$

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

$$\begin{aligned} \frac{\partial y}{\partial t}(1.00\text{m}, 1.80\text{s}) &= \\ &= (4.00\text{cm})(12.0\text{rad/s}) \cos\left[\left(\pi\text{cm}^{-1}\right)(100.\text{cm}) + (12.0\text{rad/s})(1.80\text{s})\right] \end{aligned}$$

$$= -44.4 \text{ cm/s}$$

15-24 (a) $A = 2.00\text{cm}$; $\lambda = 4.00\text{m}$
 $\mu = 0.500\text{kg/m}$

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

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

$$\phi = \pi/4\text{rad}$$

$$\left[A/t : \frac{\phi}{2\pi} = \frac{x}{\lambda} = \frac{0.500\text{m}}{4.00\text{m}} = \frac{1}{8} \right]$$

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

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

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

$$= 42.1 \text{ rad/s}$$

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

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

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

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

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

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

$$= 0.589\text{W}$$

15-35

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

$$(b) \quad y(x,t) = 2A \cos\left[\frac{\Delta\phi}{2}\right] \sin\left[kx - \omega t + \frac{1}{2}\left[\frac{\pi}{3} - \frac{\pi}{4}\right]\right]$$
$$= (10.0\text{cm}) \cos\left[\frac{7\pi}{24}\right] \sin\left[(12.0\text{m}^{-1})x - \left[180.\frac{\text{rad}}{\text{s}}\right]t + \frac{\pi}{24}\right]$$

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

15-65

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

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

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

$$L = \frac{v}{2(f_{n+1} - f_n)} = \frac{80.0\text{m/s}}{2(75.0\text{Hz} - 50.0\text{Hz})}$$
$$= 1.60\text{m}$$