Homework II **PH112** CHJ

Solutions for Chapter 13, Problems: 5, 19
Solutions for Chapter 14, Problems: 6, 11, 16, 45

13-5. a)

$$\mathbf{r} = (0.500\ m)\ \hat{\mathbf{i}} + (0.600\ m)\ \hat{\mathbf{j}} + (0.800\ m)\ \hat{\mathbf{k}}$$

$$\hat{\mathbf{o}} = \mathbf{r} \times \mathbf{F} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 0.500 & 0.600 & 0.800 \\ 0 & 10.0 & 0 \end{vmatrix}$$

$$\mathbf{r} = -(8.00\ N.m)\ \hat{\mathbf{i}} + (5.00\ N.m)\ \hat{\mathbf{k}}$$

13-5. b)

$$\mathbf{r'} = (0.900\ m)\ \hat{\mathbf{i}} + (0.300\ m)\ \hat{\mathbf{j}} + (0.800m)\ \hat{\mathbf{k}}$$

$$\hat{\mathbf{o}}_p = \mathbf{r'} \times \mathbf{F} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 0.900 & 0.300 & 0.800 \\ 0 & 10.0 & 0 \end{vmatrix}$$

$$\mathbf{r'} = -(8.00\ N \cdot m)\ \hat{\mathbf{i}} + (9.00\ N \cdot m)\ \hat{\mathbf{k}}$$

13-19 a)

$\Delta L = 0$ $\quad I_w = 0.300 kg \cdot m^2$ $\quad I_s = 2.00 kg \cdot m^2$

$\omega_w = 18.8\ rad/s$ $\quad I_w \omega_w \hat{\mathbf{k}} + I_s \omega_s = 0$

$$\omega_s = -\left[\frac{I_w}{I_s}\right]\omega_w \hat{\mathbf{k}} = -\left[\frac{0.300}{2.00}\right]18.8\ \hat{\mathbf{k}} = -(2.83\ rad/s)$$

14-6.

T = 5.00s $\quad$ A = 30.0cm

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{5.00s} = 1.26 rad/s$$

$$x = A\cos(\omega t + \Phi)$$

$$\phi = \cos^{-1}\left[\frac{X}{A}\right] - \omega t$$

$$= \cos^{-1}\left[\frac{23.5cm}{30.0cm}\right] - \left[1.26\frac{rad}{s}\right](2.87s)$$

$$= -2.94rad$$

$$x' = A\cos(\omega t' + \Phi) = (30.0cm)\cos\left[\left(1.26\frac{rad}{s}\right)(3.00s) - 2.94rad\right] = 20.2cm$$

14-11.

$$x(t) = (20.0cm)\cos\left[\left(12\pi\frac{rad}{s}\right)t - \left(\frac{\pi}{3}rad\right)\right]$$

a) A = 20.0 cm $\quad \omega = 12\pi rad/s; \quad T = \frac{2\pi}{\omega} = \frac{2\pi}{12\pi rad/s} = 0.167s$

$$f = \frac{1}{T} = \frac{1}{0.167s} = 6.00Hz$$

b) $|v_{max}| = A\omega = (20.0cm)(12\pi rad/s) = 754cm/s$

$|a_{max}| = A\omega^2 = (20.0cm)(144\pi^2 rad^2/s^2)$ = 2.84 x 10^4cm/s^2

c) $v(t) = -A\omega\sin(\omega t + \phi) = -v_{max}\sin(\omega t + \phi)$

$$= -(754cm/s)\sin\left(\left(12\pi\frac{rad}{s}\right)t - \left(\frac{\pi}{3}rad\right)\right)$$

$$v(0.150s) = -\left(754\frac{cm}{s}\right)\sin\left[\left(12\pi\frac{rad}{s}\right)(0.150s) - \frac{\pi}{3}\right]$$

14-16. a) $x(t) = (5.00cm)\cos\left[\left(24.0\frac{rad}{s}\right)t - (\pi/8)rad\right]$

$x(0.0) = x_0 = 4.62cm$

$$v(t) = -(120.cm/s)\sin\left[\left(24.0\frac{rad}{s}\right)t - \pi/8\right]$$

v(0.0) = v_0 = +45.9cm/s

$|v_{max}| = A\omega = 120.cm/s$

a(t) = -(2.88 x 10^3cm/s^2)cos$\left[\left(24.0\frac{rad}{s}\right)t - \pi/8\right]$

$|a_{max}| = 2.88x10^3 cm/s^2$

a) k = mω^2 = (0.250kg)$\left(24.0\frac{rad}{s}\right)^2 = 144N/m$

b) x(t) = +2.50cm = (5.00cm)cos$\left[\left(24.0\frac{rad}{s}\right)t - \pi/8\right]$

$\left(24.0\frac{rad}{s}\right)t - \pi/8 = \cos^{-1}\left(\frac{2.50cm}{5.00cm}\right) = 1.05rad$

t = 6.00 x 10^{-2}s

This is the first time after t = 0 at which the mass is at x = +2.50cm

v(t) = -Aωsin(ωt + ϕ) v(0.060s) = -104 cm/s

a(t) = -Aω^2cos(ωt + ϕ) = -ω^2x

a(0.060s) = -$\left(24.0\frac{rad}{s}\right)^2$(+2.50*cm*) = - 1.44 x 103cm/s2

14-45. a) $mv_0 = (m + \mathbf{M})v$

$$v = \frac{mv_0}{m + \mathbf{M}} = \frac{(0.025kg)(272m/s)}{(10.025kg)} = 0.678\text{m/s}$$

$$\omega = A\sqrt{\frac{k}{m+M}} = v_{max}$$

$$k = (m + M)\frac{v^2}{A^2} = (10.025kg)\frac{(0.678m/s)^2}{(0.150m)^2} = 205\text{N/m}$$

a) $K_{max} = \frac{1}{2}(m + \mathbf{M})v_{max}^2 = \frac{1}{2}(10.025kg)(0.678m/s)^2 = 2.31\text{J}$