Kapitel 14

14.7.

a) $T = {}^{1}/_{f} = 0.167\ s$

b) $\omega = 2\pi f = 37.7\ rad$

c) $m = \frac{k}{\omega^2} = 0.0844\ kg$

14.9. $x(t) = A\cos\omega t$

a) $x(t) = 0.160\ m\ \Rightarrow \cos\omega\, t = \frac{0.160}{0.320} = \frac{1}{2} \Rightarrow \omega t = \frac{\pi}{3} \Rightarrow t = \frac{\pi}{3\omega} = \frac{\pi T}{6\pi} = \frac{T}{6} = 0.150\ s$

b) $x(t) = 0 \Rightarrow \cos\omega\, t = 0 \Rightarrow \omega t = \frac{\pi}{2} \Rightarrow t = \frac{\pi}{2\omega} = \frac{\pi T}{4\pi} = \frac{T}{4} = 0.225\ s$

$0.225 - 0.150 = 0.075\ s$

14.24. $E = ½mv_x^2 + ½kx^2 = ½kA^2 \qquad T = 2\pi\sqrt{\frac{m}{k}}$

$v_x = \sqrt{\frac{k}{m}\cdot(A^2 - x^2)} = \frac{2\pi}{T}\sqrt{(A^2 - x^2)} = 0.377\ m/s$

$a_x = \frac{F_x}{m} = -\frac{kx}{m} = -\frac{4\pi^2 x}{T^2} = -0.617\,\frac{m}{s^2}$

14.27. $E = \frac{1}{2}kA^2 = \frac{1}{2}mv_x^2 + \frac{1}{2}kx^2 \qquad -kx = ma_x$

a) $v_{x,max} = \omega A = \sqrt{\frac{k}{m}}\cdot A = 1.20\ m/s$

b) $v_x = \sqrt{\frac{k}{m}\cdot(A^2 - x^2)} = \pm 1.11\ m/s$

c) $a_{x,max} = \omega^2 A = \frac{k}{m}A = 36\ m/s^2$

d) $a_x = -\frac{kx}{m} = +13.5\ m/s^2$

e) $E = \frac{1}{2}kA^2 = 0.360\ J$

Kapitel 15

15.6

a) $v = \frac{\lambda}{T} = \frac{6.0}{5.0} = 1.2\ m/s$

b) $A = \frac{0.62}{2} = 0.31\ m$

c) *Allt blir detsamma utom amplituden som blir* $0.15\ m$

15.8 $y(x,t) = A\cos 2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)$

a) $A = 6.50\ mm$

b) $\lambda = 28.0\ cm$

c) $f = \frac{1}{T} = 27.8\ Hz$

d) $v = f\lambda = \frac{\lambda}{T} = 7.78\ m/s$

e) $-\ framför\ tidstermen\ \Rightarrow längs\ den\ positiva\ x\text{-}axeln$

15.19 $\mu = \frac{0.0165}{0.750} kg/m$

a) $v = \sqrt{\frac{F}{\mu}} = f\lambda \Rightarrow F = \mu(f\lambda)^2 = 18.7\ N$

b) $v = f\lambda = 29.1\ m/s$

15.23 $P_{av} = \frac{1}{2}\mu(\omega A)^2 v = \frac{F(\omega A)^2}{2v} \Rightarrow A = \sqrt{\frac{2vP_{av}}{F\omega^2}} = 4.51\ mm$

15.40 $f_n = \frac{nv}{2L}; \quad \lambda_n = {}^{2L}/_{n}$

a) $f_1 = \frac{v}{2L} = 16.0\ Hz; \quad \lambda_1 = 2L = 3.00\ m$

b) $f_3 = 3f_1 = 48.0\ Hz; \quad \lambda_3 = {}^{\lambda_1}/_{3} = 1.00\ m$

c) $f_4 = 4f_1 = 64.0\ Hz; \quad \lambda_4 = {}^{\lambda_1}/_{4} = 0.75\ m$

15.49

a) $v = 2Lf_1 = 311\ m/s$

b) $v = \sqrt{\frac{F}{\mu}}\ om\ F\ ökar\ med\ 1\%\ ökar\ v\ med\ en\ faktor\ \sqrt{1.01}\ och\ därmed\ även\ f_1$
$f_1' = f_1 \cdot \sqrt{1.01} = 246\ Hz$

c) $v = f\lambda\ \ frekvensen\ påverkas\ inte \Rightarrow \frac{\lambda_{luft}}{\lambda} = \frac{v_{luft}}{v} \Rightarrow \lambda_{luft} = 1.40\ m$

Kapitel 16

16.15 $B_{luft} = 1.42 \cdot 10^5\ Pa; \quad \rho_{luft} = 1.20\ kg/m^3$

a) $I = \frac{1}{2}\rho(\omega A)^2 v = \frac{1}{2}\sqrt{\rho B}(\omega A)^2 \Rightarrow A = \sqrt{\frac{2I}{\sqrt{\rho B}\omega^2}} = 9.44 \cdot 10^{-11}\ m; \quad \lambda = \frac{v}{f} = \frac{1}{f}\sqrt{\frac{B}{\rho}} = 0.434\ m$

b) $A = \sqrt{\frac{2I}{\sqrt{\rho B}\omega^2}} = 5.64 \cdot 10^{-9}\ m$
$\lambda = \frac{1}{f}\sqrt{\frac{B}{\rho}} = 0.101\ m$

c) De mycket tätare vattenmolekylerna behöver en mindre amplitud för att överföra samma mängd energi.

16.26 $f_n = \frac{nv}{2L}; \quad \lambda_n = {}^{2L}/_{n} \quad öppen\ pipa$

$f_n = \frac{nv}{4L}; \quad \lambda_n = {}^{4L}/_{n} \quad n\ udda \quad sluten\ pipa$
$v = 344\ m/s$

a) $L = \frac{v}{2f_1} = 28.9\ cm$

b) $\lambda_1 = 4L = 1.16\ m$

c) $f_1 = \frac{v}{4L} = 297\ Hz$

16.36 $v = 344\ m/s$

$|r_A - r_B| = (n + ½)\lambda; \quad \lambda = \frac{v}{f} \Rightarrow |r_A - r_B| = 2.00 \cdot (n + ½)$
$Minsta\ värdet\ på\ r_B\ hittas\ då\ r_B < r_A \Rightarrow r_B = r_A - 2.00 \cdot (n + ½)$
$Minsta\ värdet\ på\ r_B\ hittas\ när\ n = 3 \Rightarrow r_B = 1.00\ m$

16.40 $v = 344\ m/s$

$f = \frac{v}{\lambda} \qquad f_{beat} = |f_A - f_B| = \left|\frac{v}{\lambda_A} - \frac{v}{\lambda_B}\right| = 16.2\ Hz$

16.45 $f' = f \cdot \frac{v - v_L}{v - v_S} \qquad v = 344\ m/s$

a) $f' = 392 \cdot \frac{344 - 15.0}{344} = 375\ Hz$ b) $f' = 392 \cdot \frac{344 + 15.0}{344 + 35.0} = 371\ Hz$

c) $f_{beat} = |f_a - f_b| = 4\ Hz$

16.49 $f' = f \cdot \frac{v - v_L}{v - v_S} \qquad v = 344\ m/s$

$v - v_L = v\frac{f'}{f} \Rightarrow v_L = v\left(1 - \frac{f'}{f}\right) = 19.8\ m/s$

16.50 $f' = f \cdot \frac{v - v_L}{v - v_S} \qquad v = 344\ m/s$

a) $f' = 262 \cdot \frac{344 + 18}{344 - 30} = 302\ Hz$ b) $f' = 262 \cdot \frac{344 - 18}{344 + 30} = 228\ Hz$

16.55 $v = 344\ m/s; \quad v_S = 1.70 \cdot v$

a) $\sin\alpha = \frac{v}{v_S} \Rightarrow\ \alpha = \sin^{-1}\frac{1}{1.70} = 36.0°$

b) $\tan\alpha = \frac{H}{x} \Rightarrow x = \frac{H}{\tan\alpha} \qquad \Delta t = \frac{x}{v_S} = \frac{H}{1.70 \cdot v\tan\alpha} = 2.24\ s$

Kapitel 35

35.9 $d\sin\theta = m\lambda; \quad \gg y \Rightarrow \sin\theta \approx \tan\theta = \frac{y_m}{R} \quad \Rightarrow \quad d = \frac{20 \cdot \lambda R}{y_{20}} = 1.14\ mm$

$\left(\theta = \tan^{-1}\frac{y_m}{R} = 0.51° \text{ är } en\ liten\ vinkel;\ \tan 0.51° = 0.00883;\ \sin 0.51° = 0.00883\right)$

35.10 $R \gg y \Rightarrow y_{m+½} = \frac{(m+½)\cdot\lambda R}{d} \Rightarrow \Delta y = \frac{\lambda R}{d} \Rightarrow d = \frac{\lambda R}{\Delta y} = 193\mu m$

35.11 $d\sin\theta = (m + ½)\lambda;\ \ d \gg \lambda \Rightarrow y_{m+½} = \frac{(m+½)\cdot\lambda R}{d}\ \Rightarrow\ \Delta y = \frac{\lambda R}{d} = 833\mu m$

35.16 $d \gg \lambda \Rightarrow y_m = \frac{m\lambda R}{d}$

$\Delta y_1 = \frac{(\lambda_1 - \lambda_2)R}{d} = 3.17\ mm$

35.25 $Destruktiv\ reflektion\ (båda\ reflektionerna\ mot\ tätare\ medium) \Rightarrow 2t = (m + ½)\frac{\lambda}{n}$

$Minst\ om\ m = 0 \Rightarrow t = \frac{\lambda}{4n} = \frac{650}{4 \cdot 1.42} = 114\ nm$

35.36

a) $y_1 = m \cdot \frac{\lambda_1}{2} = 818 \cdot \frac{606}{2} = 247854\ nm = 248\ \mu m$

$y_2 = -m \cdot \frac{\lambda_2}{2} = 818 \cdot \frac{502}{2} = -205318\ nm = -205\ \mu m$

b) $Total\ förflyttning\ 248 - 205 = 43\ \mu m$

Kapitel 36

36.1 $a\sin\theta = m\lambda; \quad = 1; \quad R \gg y \Rightarrow \lambda = \frac{ay}{R} = 506\ nm$

36.4 $a\sin\theta = m\lambda; \quad = \pm 1; \quad R \gg y \Rightarrow \Delta y_{\pm 1} = \frac{2R\lambda}{a} = 5.91\ mm$

36.12

a) $a\sin\theta = m\lambda; \quad = \pm 1; \quad a \gg \lambda \Rightarrow \Delta y_{\pm 1} = \frac{2R\lambda}{a} = 10.9\ mm$

b) $\Delta y_{1,2} = \frac{R\lambda}{a} = 5.43\ mm$

36.15

a) $a\sin\theta = m\lambda; \quad = 1; \quad a \gg \lambda \Rightarrow y_1 = \frac{R\lambda}{a} = 6.75\ mm$

b) $I = I_0 \frac{\sin^2\left(\frac{\beta}{2}\right)}{\left(\frac{\beta}{2}\right)^2}; \quad \beta = \frac{2\pi a \sin\theta}{\lambda}$

$den\ sökta\ vinkeln\ ges\ av \quad a\sin\theta = ½\lambda \Rightarrow \beta = \frac{2\pi ½\lambda}{\lambda} = \pi \Rightarrow$

$I = I_0 \frac{\sin^2\left(\frac{\pi}{2}\right)}{\left(\frac{\pi}{2}\right)^2} = I_0 \frac{4}{\pi^2} = 2.43 \cdot 10^{-6}\ W/m^2$

36.24 $I = I_0 \left[\cos^2\left(\frac{\phi}{2}\right)\right] \frac{\sin^2\left(\frac{\beta}{2}\right)}{\left(\frac{\beta}{2}\right)^2}; \quad = \frac{2\pi d \sin\theta}{\lambda}; \quad \beta = \frac{2\pi a \sin\theta}{\lambda}$

$R \gg y \Rightarrow \sin\theta \approx \tan\theta = \frac{y}{R} \Rightarrow \sin\theta = 0.0012$

$\phi = \frac{2\pi d \sin\theta}{\lambda} = 8.4956\ rad; \quad \beta = \frac{2\pi a \sin\theta}{\lambda} = 5.7611\ rad$

$I = I_0 \left[\cos^2\left(\frac{8.4956}{2}\right)\right] \frac{\sin^2\left(\frac{5.7611}{2}\right)}{\left(\frac{5.7611}{2}\right)^2} = I_0 \cdot 0.2008 \cdot \frac{0.0666}{8.298} = 0.001612 \cdot I_0 = 8.06 \cdot 10^{-7}\ W/m^2$

36.29

a) $d\sin\theta = m\lambda \Rightarrow N = \frac{10^{-2}}{d} = \frac{10^{-2} \cdot \sin\theta}{m\lambda} = 4790$ ritsar/cm

$d = \frac{m\lambda}{\sin\theta} = 2.0856\ \mu m$

b) $\theta_1 = \sin^{-1}\frac{\lambda}{d} = 19.1°; \quad \theta_2 = \sin^{-1}\frac{2\lambda}{d} = 40.8°;$

c) $\theta_4 = \sin^{-1}\frac{4\lambda}{d}\ men\ \frac{4\lambda}{d} = 1.31 > 1, d.v.s.\ 4{:}\ de\ ordningen\ syns\ inte$

36.30 $d\sin\theta = m\lambda \Rightarrow d = \frac{3\lambda_1}{\sin\theta_1}$

$\sin\theta_2 = \frac{2\lambda_2}{d} = \frac{2\lambda_2 \sin\theta_1}{3\lambda_1} = 0.3453 \Rightarrow \theta_2 = 20.2°$

36.37

a) $R_1 = mN = 1 \cdot 3.50 \cdot 5.00 \cdot 10^3 = 17500$

b) $\lambda_1 = 589.00\ nm; \quad \lambda_2 = 589.59\ nm; \quad \Delta\lambda = 0.59\ nm$

$\frac{\lambda}{\Delta\lambda} = \frac{589}{0.59} = 998 \ll 17500 \quad Gittret\ löser\ lätt\ upp\ linjerna$

c) $R_2 = 2 \cdot R_1 = 35000; \quad \Delta\lambda = \frac{\lambda}{R_2} = 0.0168\ nm$

$\lambda + \Delta\lambda = 587.8170\ nm\ (i); \qquad \lambda - \Delta\lambda = 587.7834\ nm\ (ii)$

$587.7834\ nm < \lambda < 587.8170\ nm\ (iii)$

36.38 $\frac{\lambda}{\Delta\lambda} = \frac{587.8892}{0.1780} = 3303\ d.v.s.\ gittret\ måste\ ha\ en\ upplösningsförmåga\ på\ minst\ 3303$

$R = mN \Rightarrow gittret\ måste\ ha\ minst\ 3303\ ritsar \Rightarrow \frac{3303}{1.20} = 2752\ ritsar/cm$

$Det\ behövs\ minst\ 2752\ ritsar/cm$

36.47 $\theta = \frac{1.22\lambda}{D};\ \theta \approx tan\theta = \frac{x}{R} \Rightarrow D = \frac{1.22\lambda R}{x} = 1.45\ m$