LF midterm 09.10.09

① $x = x_0 \sin \omega t$; $x_0 = 5\,cm$

$v = \omega x_0 \cos \omega t$

$a = -\omega^2 x_0 \sin \omega t$; $\omega^2 x_0 = 45\,cm/s^2$

$\Rightarrow \omega^2 = 9\,s^{-2} \Rightarrow v_{max} = \omega x_0 = 3\,s^{-1} \cdot 5\,cm = 15\,cm/s$ (A)

② Fra figur: $\lambda = 50\,cm = 0.50\,m$

$f = v/\lambda = \sqrt{S/\mu}/\lambda = \sqrt{100/0.040}/0.50$

$= (10/0.2)/0.50 = 100\,Hz$ (C)

③ $v = \sqrt{S/\mu} = 50\,m/s$ (C)

④ N2 $\Rightarrow m\ddot{x} = -b\dot{x} - kx + F_0 \cos(2\pi f t)$

$\Rightarrow m\ddot{x} + b\dot{x} + kx = F_0 \cos(2\pi f t)$

K2 $\Rightarrow L\ddot{q} + R\dot{q} + \frac{1}{C}q = V_0 \cos(2\pi f t)$

$\Rightarrow L \leftrightarrow m$, $R \leftrightarrow b$ osv.

$\Rightarrow \Delta f_{in} = b/2\pi m \leftrightarrow \Delta f_e = R/2\pi L$ (A)

⑤ Med C i ro blir strekk/sammenpressing av hver av fjærene lik utsvinget til hver av de to O-atomene. Dermed

$M\ddot{s} = -ks \Rightarrow \ddot{s} + \frac{k}{M}s = 0 \Rightarrow \omega = \sqrt{k/M}$ (B)

⑥ $\rho = 8940\,kg/m^3$, $Y = 128\,GPa = 128 \cdot 10^9\,N/m^2$

$\Rightarrow v = \sqrt{\frac{128 \cdot 10^9}{8940}} = 3784\,m/s$ (D)

(7) Fra formelsamling: $\frac{y_{r0}}{y_{t0}} = \frac{\sqrt{\mu_2} - \sqrt{\mu_1}}{2\sqrt{\mu_1}}$

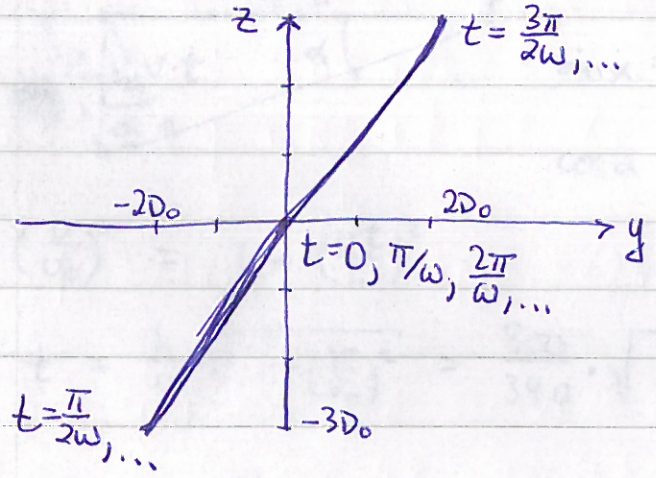
$$\left.\begin{aligned} v_i &= \sqrt{S/\mu_i} \quad ; \quad i = 1,2 \\ v_i &= \lambda_i f \quad ; \quad i = 1,2 \end{aligned}\right\} \Rightarrow \sqrt{\mu_i} = \frac{\sqrt{S}}{\lambda_i f} \quad ; \quad i = 1,2$$

$$\Rightarrow \frac{y_{r0}}{y_{t0}} = \frac{\frac{1}{\lambda_2} - \frac{1}{\lambda_1}}{\frac{2}{\lambda_1}} = \frac{\lambda_1 - \lambda_2}{2\lambda_2} \overset{\text{Fra figur!}}{=} \frac{4 - \frac{8}{6}}{2 \cdot \frac{8}{6}} = 1$$

(C)

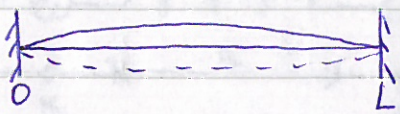
(8) $\vec{D}(x,t) = (2D_0\,\hat{y} + 3D_0\,\hat{z})\sin(kx - \omega t)$

Se på f.eks $x = 0$: $-(2\hat{y} + 3\hat{z})D_0 \sin\omega t$



Dvs lineær-polarisert

(B)

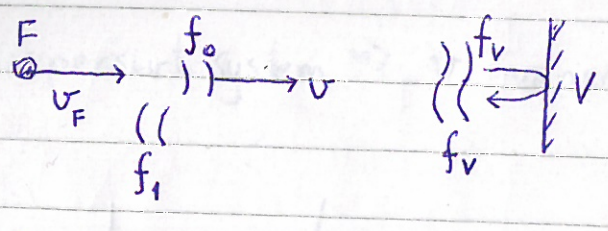
(9) 

$L = \frac{\lambda}{2} = 0{,}75\,\text{m}$

$$\Rightarrow f = \frac{v}{\lambda} = \frac{\sqrt{S/\mu}}{\lambda} = \frac{\sqrt{S \cdot L/m}}{2L} = \sqrt{\frac{S}{4mL}} = \sqrt{\frac{173}{4 \cdot 0{,}006 \cdot 0{,}75}}\ \text{Hz}$$

$= 98\,\text{Hz}$

(D)

(10) 

$$f_1 = (1 + v_F/v) f_v = (1 + v_F/v) \cdot \frac{f_0}{1 - v_F/v}$$

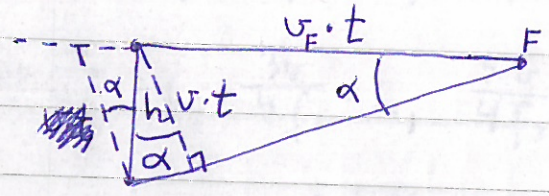
$$= \frac{1 + 10/340}{1 - 10/340} \cdot 100\ \text{kHz} = 106\ \text{kHz}$$

(B)

(11) $\Delta p = 0$ i begge ender $\Rightarrow L = \lambda/2$

$$v = \lambda f \Rightarrow L = v/2f = \frac{340}{2 \cdot 480} = 0{,}354\,\text{m} = 354\,\text{mm}$$

(C)

(12) 

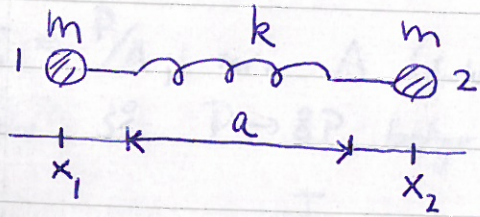
$$\sin\alpha = \frac{v}{v_F} = \sqrt{1 - \cos^2\alpha}$$

$$\cos\alpha = vt/h$$

$$\Rightarrow \left(\frac{v}{v_F}\right)^2 = 1 - \left(\frac{vt}{h}\right)^2$$

$$\Rightarrow t = \frac{h}{v}\sqrt{1 - \left(\frac{v}{v_F}\right)^2} = \frac{800}{340} \cdot \sqrt{1 - \frac{1}{1.75^2}} \simeq 1.9\,\text{s}$$

(B)

(13) 

Strekk i fjæra: $x_2 - x_1 - a = s$

$$\left.\begin{aligned} \Rightarrow m\ddot{x}_1 &= k(x_2 - x_1 - a) \\ m\ddot{x}_2 &= -k(x_2 - x_1 - a) \end{aligned}\right\} \Rightarrow m\ddot{s} = -2ks$$

$$\Rightarrow \ddot{s} + \frac{2k}{m} s = 0$$

$$\Rightarrow \omega = \sqrt{2k/m}$$

(D)

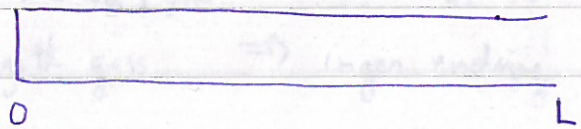
(4)

(14) Dispersivt system $\Rightarrow$ v varierer med f (B)

(15) $T_s = \frac{1}{f_s} = \frac{1}{|f_2 - f_1|}$; $f_1 = 440\ s^{-1}$, $T_s = 1\,s$

$\Rightarrow |f_2 - 440|\ s^{-1} = 1\ s^{-1} \Rightarrow f_2 = 439$ eller 441 Hz (D)

(16)



$\xi = 0$ $\qquad$ $\xi = max$

$\Rightarrow \frac{\lambda_1}{4} = L$, $\frac{\lambda_2 \cdot 3}{4} = L$, $\frac{\lambda_3 \cdot 5}{4} = L$, ..., $\frac{\lambda_n \cdot (2n-1)}{4} = L$

$\Rightarrow \frac{v}{4f_1} = L$, $\frac{3v}{4f_2} = L$, $\frac{5v}{4f_3} = L$, ..., $\frac{(2n-1)v}{4f_n} = L$

$\Rightarrow f_{n+1} - f_n = \frac{v}{4L}\{[2(n+1)-1] - [2n-1]\} = \frac{v}{4L} \cdot 2 = \frac{v}{2L}$

$\Rightarrow L = \frac{v}{2(f_{n+1} - f_n)} = \frac{340\ m/s}{2 \cdot 68\ 1/s} = 2{,}5\ m$ (C)

(17) $I = P/A$, men A (f.eks. din trommehinne) endres ikke, så $P \to 8P$ betyr $I \to 8I$. Dermed:

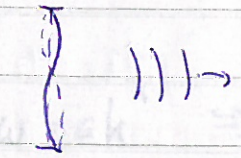
$\beta_1 = 10 \log \frac{I}{I_0}$, $\beta_2 = 10 \log \frac{8I}{I_0}$

$\Rightarrow \beta_2 - \beta_1 = 10 \log 8 = \underline{9\ dB}$ (B)

(5)

(18) Generell løsn. av $\frac{\partial^2 \xi}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 \xi}{\partial t^2}$ er

$\xi(x,t) = f(x - vt) + g(x + vt)$ (C)

(19)  Samme frekvens! (B)

(20) $v = \sqrt{\gamma k_B T / m}$ kun avh. av temperaturen for gitt gass $\Rightarrow$ ingen endring i lydhastigheten (B)

(21) $\xi(x,t) = \xi_0 \sin(kx - \omega t)$

$\Delta p = -B\, \partial\xi/\partial x = -\gamma p\, \partial\xi/\partial x$ (se formelark)

$\Rightarrow \frac{\partial \xi}{\partial t} = -\omega \xi_0 \cos(kx - \omega t)$

$\Delta p = -\gamma p k \xi_0 \cos(kx - \omega t)$

$\Rightarrow \frac{\Delta p}{\partial\xi/\partial t} = \frac{\gamma p k}{\omega} = \frac{\gamma p}{v} = \frac{\gamma p}{\sqrt{\gamma p/\rho}} = \sqrt{\gamma p \rho}$ (A)

(↑ formelark)

(22) $P = 50 \cdot 10^3$ W

$A = 4\pi r^2 = 4\pi \cdot (3000)^2$ m^2

$\Rightarrow I = \frac{P}{A} = \frac{50 \cdot 10^3}{4\pi \cdot 9 \cdot 10^6}$ W/m^2 $= 4{,}42 \cdot 10^{-4}$ W/m^2

$= 442 \cdot 10^{-6}$ W/m^2 $= 442\ \mu$W/m^2 (C)

(23) $I = P/A = P/4\pi r^2$

$\Rightarrow r = \sqrt{\frac{P}{4\pi I}} = \sqrt{\frac{50\cdot 10^3}{4\pi \cdot 10^{-6}}}\ m = 63078\ m \approx 63\ km$

B

(24) $\omega = ak^\alpha \Rightarrow v_f = \frac{\omega}{k} = ak^{\alpha-1} = a\left(\frac{2\pi}{\lambda}\right)^{\alpha-1}$

$= a'\lambda^{1-\alpha}$ $\Rightarrow$ ikke C

$v_g = \frac{d\omega}{dk} = \alpha a k^{\alpha-1} = \alpha \cdot v_f \Rightarrow$ A er riktig!

$v_g \neq v_f$ hvis $\alpha \neq 1 \Rightarrow$ B er feil

A

$v_g = a''\lambda^{1-\alpha} \Rightarrow v_g$ avtar med økende λ

hvis $\alpha > 0 \Rightarrow$ D er feil

(25) $\omega = \sqrt{gk} \Rightarrow v_f = \frac{\omega}{k} = \sqrt{g/k} = \sqrt{g\lambda/2\pi}$

$\Rightarrow$ Størst v_f for størst λ

$\Rightarrow$ Bølger med størst λ slår først mot land

C