

Midterm Bølgefysikk 10.10.2008. LF (Version 0)

① $x = x_0 \sin \omega t$, $v = \omega x_0 \cos \omega t$, $a = -\omega^2 x_0 \sin \omega t$
 $\Rightarrow (v\omega)^2 + a^2 = (\omega^2 x_0)^2 \Rightarrow x_0^2 = v^2/\omega^2 + a^2/\omega^4 \Rightarrow$ (D)

② $\lambda = 80 \text{ m}$; $v = \frac{\Delta x}{\Delta t} = \frac{20 \text{ m} + N \cdot 80 \text{ m}}{50 \text{ s}} = (4 + 16N) \text{ m/s}$
 $= \dots, -60, (-44), -28, -12, 4, 20, 36, 52, \dots$
 $\Rightarrow$ (D)

③ $f = v/\lambda = 44/80 \text{ Hz} = 0.55 \text{ Hz} \Rightarrow$ (B)

④ $v_g = d\omega/dk = \frac{1}{2} \sqrt{g} k^{-1/2} = \frac{1}{\sqrt{4}} \sqrt{\frac{g}{k}} = \sqrt{\frac{g\lambda}{8\pi}} = \sqrt{\frac{9.8}{8\pi}} \text{ m/s}$
 $\Rightarrow t = x/v_g = (300 / \sqrt{9.8/8\pi}) \text{ s} \approx 480 \text{ s} \approx 8 \text{ min.} \Rightarrow$ (B)

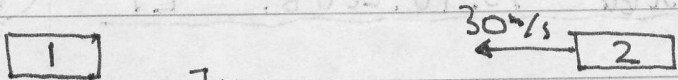
⑤ $v_f = \omega/k = \sqrt{g/k} = 2v_g \Rightarrow t = \frac{x}{v_f - v_g} = \frac{x}{v_g} = \frac{10}{\sqrt{9.8/8\pi}} \text{ s} \approx 16 \text{ s} \Rightarrow$ (B)

⑥ $v = \sqrt{8k_B T/m} = \sqrt{\frac{5}{3} \cdot 1.38 \cdot 10^{-23} \cdot 30 / 4 \cdot 1.67 \cdot 10^{-27}} \text{ m/s}$
 $= \sqrt{\frac{50 \cdot 1.38}{4 \cdot 1.67}} \cdot 100 \text{ m/s} \sim \sqrt{10} \cdot 100 \text{ m/s} \Rightarrow$ noe over $300 \text{ m/s} \Rightarrow$ (A)

⑦ $I(r) \sim 1/r$ for cylinderbølger $\Rightarrow \frac{I(4)}{I(20)} = 5$
 $40 = 10 \log I(20) - 10 \log I_0$
 $x = 10 \log I(4) - 10 \log I_0 = 10 \log 5 + 10 \log I(20) - 10 \log I_0$
 $\Rightarrow x - 40 = 10 \log 5 \approx 7 \Rightarrow x = 47 \text{ dB} \Rightarrow$ (A)

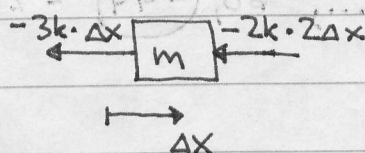
⑧ $(\pm)\vec{k}$ er forpl. retning $\Rightarrow$ (D)
 Her: $-\vec{k}$ (pga $\vec{k} \cdot \vec{r} + \omega t$ i fasen)
 $\uparrow$

(9) $\lambda_1 = 2L = 7.50 \text{ m}$, $v = \sqrt{S/\mu} = \sqrt{S \cdot L / m}$
 $f_1 = v/\lambda_1 = \frac{1}{2L} \sqrt{\frac{SL}{m}} = \sqrt{\frac{S}{4mL}} = \sqrt{\frac{225}{4 \cdot 0.031 \cdot 3.75}} \text{ Hz} \approx \underline{22 \text{ Hz}} \Rightarrow \textcircled{D}$

(10) 
 $f_1 = \frac{750}{1 - 30/340} = 823 \text{ Hz}$
 $f_2 = \frac{1 + 30/340}{1} \cdot 750 = 816 \text{ Hz} \Rightarrow \textcircled{C}$

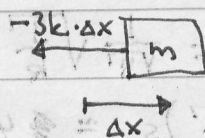
(11) $L = 3 \cdot \frac{\lambda_3}{2} = \frac{3}{2} \cdot \frac{v}{f_3} = 1.5 \cdot \frac{340}{4080} \text{ m} = \underline{125 \text{ mm}} \Rightarrow \textcircled{C}$

(12) Symm. mode:



$\Rightarrow m(\ddot{\Delta x}) = -7k\Delta x \Rightarrow \omega_s^2 = 7k/m$

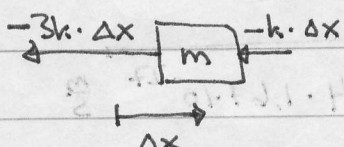
Antisymm. mode:



$\Rightarrow \omega_a^2 = 3k/m$

$\Rightarrow \omega_s / \omega_a = \sqrt{7/3} \approx 1.53$

$\Rightarrow \textcircled{B}$

(13) 
 $\Rightarrow m\ddot{x} = -4k\Delta x$
 $\Rightarrow \omega^2 = 4k/m \Rightarrow \textcircled{D}$

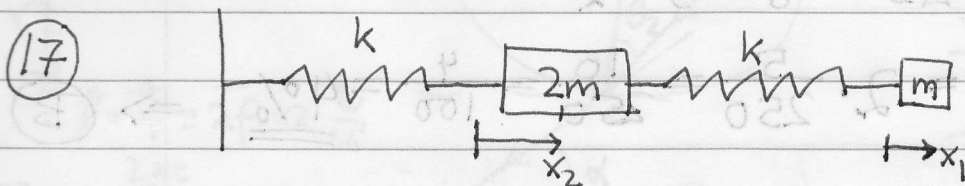
(14) $p = \mu \left(\int_{-a}^0 dx + \int_0^a dx \right) \left(\frac{\partial \xi}{\partial t} \cdot \frac{\partial \xi}{\partial x} \right)$

$(-a, 0): \frac{\partial \xi}{\partial x} = +\frac{\xi_0}{a}, \frac{\partial \xi}{\partial t} = -\frac{\xi_0}{a/v}$
 $(0, a): \frac{\partial \xi}{\partial x} = -\frac{\xi_0}{a}, \frac{\partial \xi}{\partial t} = +\frac{\xi_0}{a/v}$

$\Rightarrow p = \mu \cdot \frac{\xi_0}{a} \cdot \frac{\xi_0 v}{a} \cdot (a+a) = \underline{2\mu \xi_0^2 \frac{a}{v}} \Rightarrow \textcircled{C}$

$$(15) \quad v_f = \omega/k = \sqrt{\frac{4s}{m}} \sin\left(\frac{2\pi}{d/2} \cdot \frac{d}{2}\right) / \left(\frac{2\pi}{d/2}\right) \sim \sin 2\pi = 0 \Rightarrow (A)$$

$$(16) \quad v_g = d\omega/dk = \frac{d}{2} \cdot \sqrt{\frac{4s}{m}} \cdot \cos 2\pi = \sqrt{\frac{sd^2}{m}} \Rightarrow (B)$$



$$2m \ddot{x}_2 = -kx_2 + k(x_1 - x_2) = -2kx_2 + kx_1$$

$$m \ddot{x}_1 = -k(x_1 - x_2) = -kx_1 + kx_2$$

Prøver $x_1 = A \cos \omega t$ og $x_2 = B \cos \omega t$!

$$\Rightarrow -2m\omega^2 B = -2kB + kA \Rightarrow -2m\omega^2 + 2k = k \cdot \frac{A}{B}$$

$$-m\omega^2 A = -kA + kB \Rightarrow (-m\omega^2 + k) \cdot \frac{A}{B} = k$$

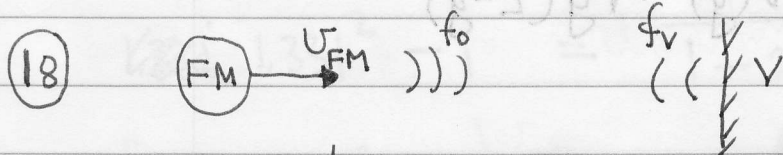
Fra den første av disse to:

$$\frac{A}{B} = \frac{2k - 2m\omega^2}{k} \Rightarrow (k - m\omega^2) \cdot \frac{2k - 2m\omega^2}{k} = k$$

$$\Rightarrow 2k^2 - 4km\omega^2 + 2m^2\omega^4 = k^2$$

$$\Rightarrow 2m^2\omega^4 - 4km\omega^2 + k^2 = 0$$

$$\Rightarrow \omega^2 = \frac{4km \pm \sqrt{16k^2m^2 - 8k^2m^2}}{4m^2} = \frac{k}{m} \pm \frac{k}{m} \cdot \frac{\sqrt{2}}{2} = \frac{k}{m} \left(1 \pm \frac{1}{\sqrt{2}}\right) \Rightarrow (A)$$



$$f_V = \frac{1}{1 - v_{FM}/v} \cdot f_0$$

$$f_1 = \frac{1 + v_{FM}/v}{1} \cdot f_V = \frac{1 + \alpha}{1 - \alpha} \cdot f_0$$

$$\Rightarrow \frac{1 + \alpha}{1 - \alpha} = \frac{f_1}{f_0} = \beta \Rightarrow 1 + \alpha = \beta(1 - \alpha) = \beta - \beta\alpha \Rightarrow \alpha + \beta\alpha = \beta - 1$$

$$\Rightarrow \alpha = \frac{\beta - 1}{\beta + 1} = \frac{f_1 - f_0}{f_1 + f_0} = \frac{5000}{100000} = 5\% \Rightarrow (C)$$

(19) $f_s = \Delta f = 5 \text{ Hz}$

$$f = v/\lambda = \frac{1}{\lambda} \sqrt{SL/m} = a \cdot \sqrt{S}$$

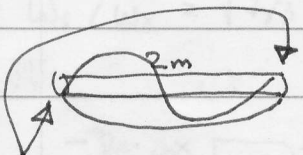
$$\Delta f = a \cdot \frac{1}{2} S^{-1/2} \cdot \Delta S = f \cdot \frac{\Delta S}{S} \cdot \frac{1}{2}$$

$$\Rightarrow \frac{\Delta S}{S} = 2 \frac{\Delta f}{f} = 2 \cdot \frac{5}{250} = \frac{10}{250} = \frac{4}{100} = \underline{\underline{4\%}} \Rightarrow \textcircled{B}$$

(20) (A) $\omega(k) \neq a \cdot k \Rightarrow v_f = \omega/k$ ikke konst.

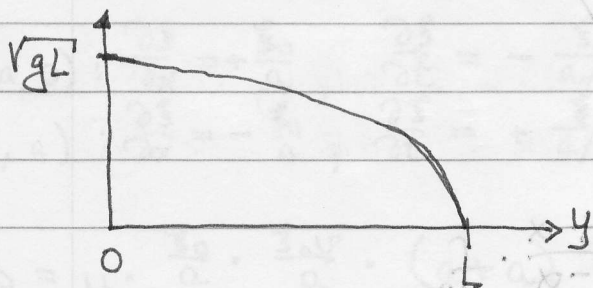
(21) (D) $\omega \sim \sqrt{k} \Rightarrow v_f \sim k^{-1/2} \sim \lambda^{1/2}$
 $\Rightarrow v_f$ øker med λ (også v_g øker med λ).

(22) A er lin. pol., B er lin. pol., C er sirk. pol.
 (læng. y) (læng. $\hat{y} + \hat{z}$) (højredr.?) $\Rightarrow \textcircled{C}$
 (D er sum av høyredr. og venstredr. sirk. pol.,
 som blir i alt lin. pol.)

(23)  $\lambda_1 = 4m$ ~~ikke~~
 $\lambda_2 = 2m \Rightarrow f_2 = 340/2 = 170 \text{ Hz}$
 $\Delta p = 0, \xi = \xi_{\max}$

$$\Rightarrow \textcircled{C}$$

(24) $S(y) = \mu \cdot (L-y) \cdot g \Rightarrow v(y) = \sqrt{g(L-y)}$



$$\Rightarrow \textcircled{C}$$

(25) Felles S $\Rightarrow v(r) = \sqrt{S/\mu}$, $v(t) = \sqrt{S/4\mu} = \frac{1}{2} v(r)$
 $\Rightarrow$ kun $\textcircled{B}$ passer med dette!