April 23, 2019

Hvorfor kommer alltid bølgene rett inn mot stranda?

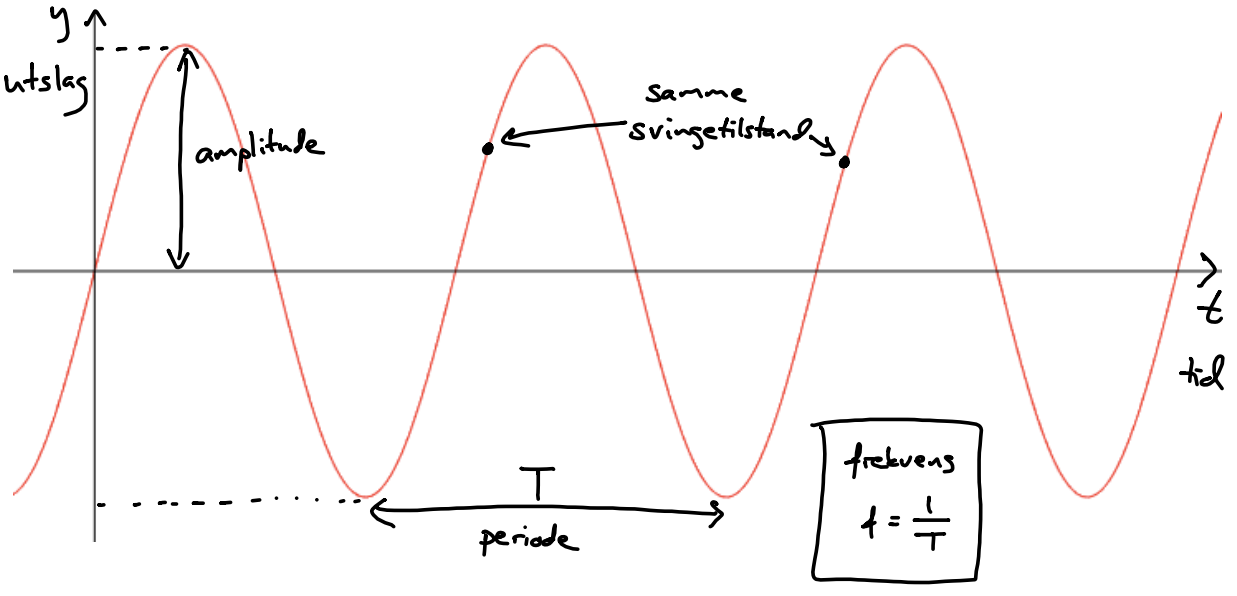
Bølger er svingninger som brer seg

IMG_8090.MOV

Svingningen til en fjærpendel

http://physics.bu.edu/~duffy/HTML5/mass_on_spring_graphs.html

Matematisk beskrivelse av svingning



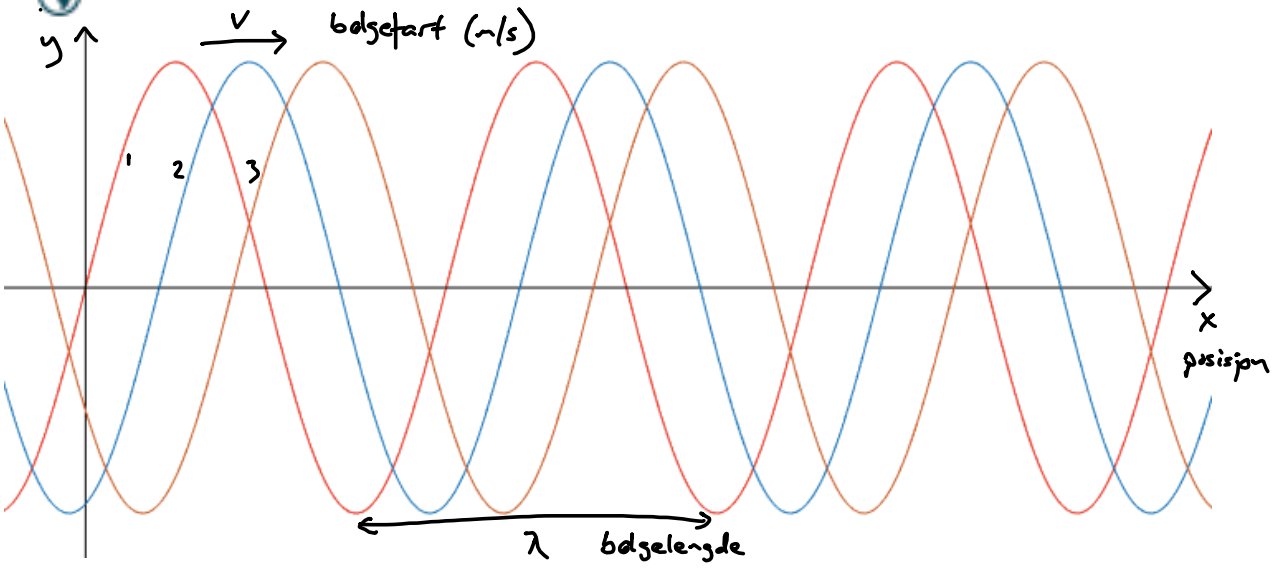
frekvens

$f = \frac{1}{T}$

$[f] = \frac{1}{s} = Hz$ hertz

Bølgefart

http://physics.bu.edu/~duffy/HTML5/wave.html



$s = vt$

$\lambda = vT$

$$v = \frac{\lambda}{T} = \lambda f$$

Eksempel: A 440 Hz λ?

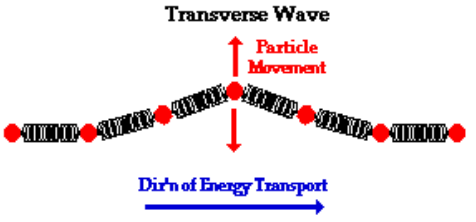
lydfart i luft 340 m/s

$v = \lambda f$ $f = 440\,Hz$

$$\lambda = \frac{v}{f} = \frac{340\,m/s}{440\,1/s} = 0{,}77\,m$$

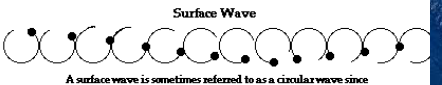
Bølgetyper:

Tversbølger



Langsbølger

Overflatebølger



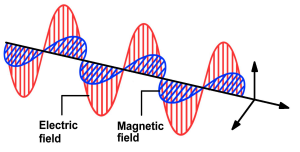
http://www.acs.psu.edu/drussell/Demos/waves/wavemotion.html

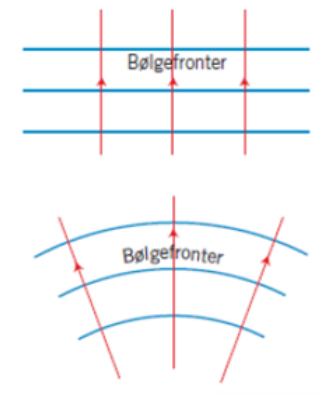
Lydbølger

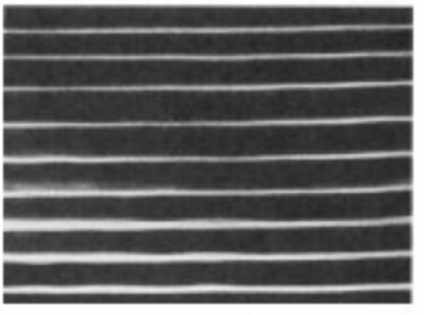
Jordskjelv

http://www.britannica.com/EBchecked/topic/532925/seismic-wave

Elektromagnetiske bølger

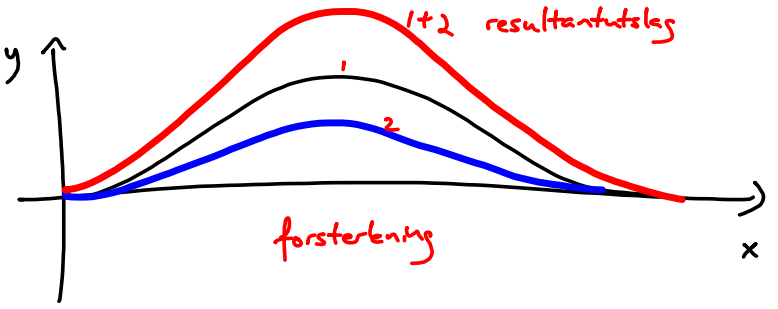


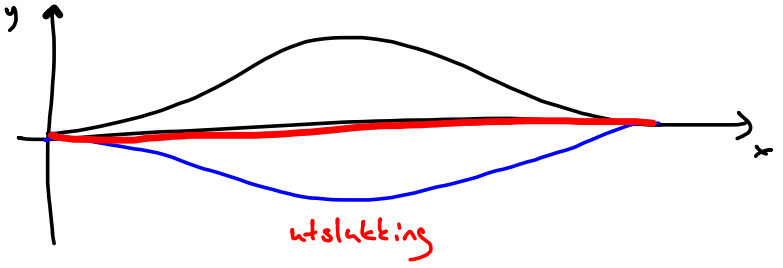

Bølgefronter
Bølgefronter



Forsterking, utslukning og overlagring

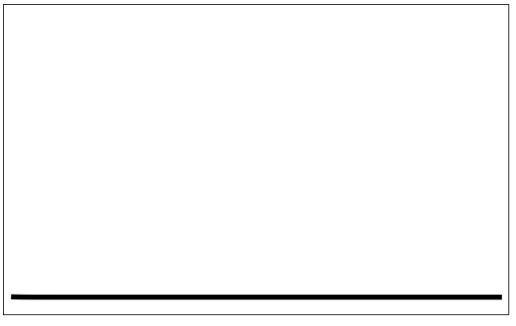
IMG_8094.MOV



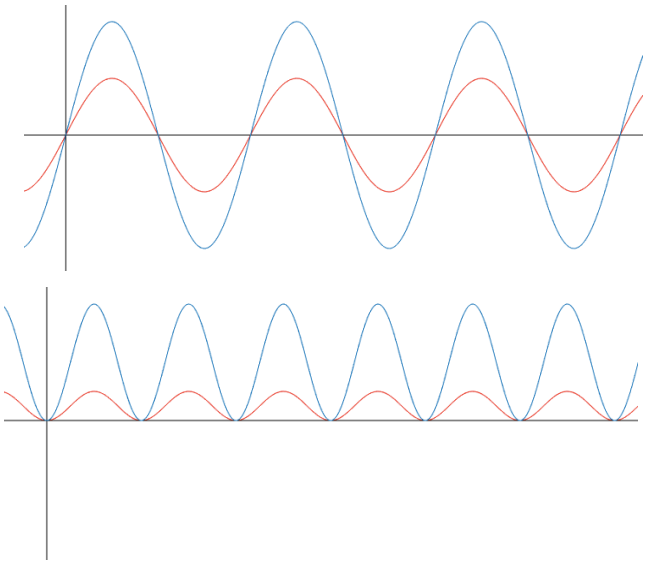


overlagring
↓
algebraisk sum
av utslag

Overlagring



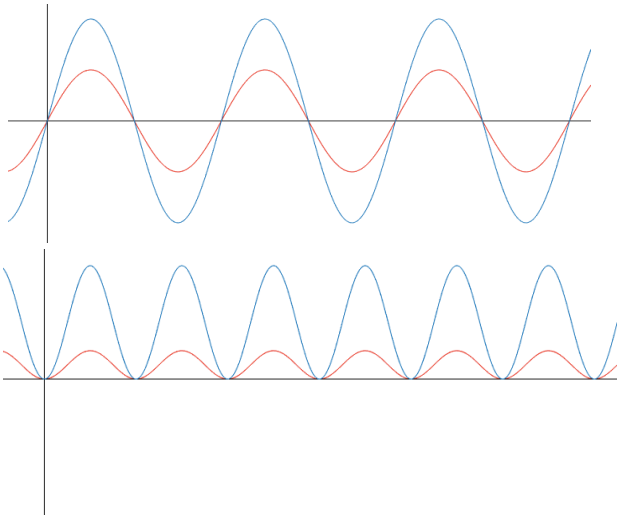
Bølger og energi



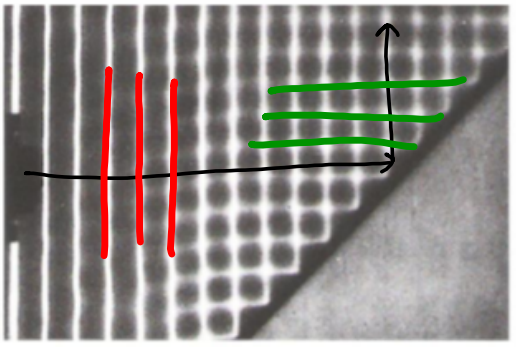
$E \propto A^2$

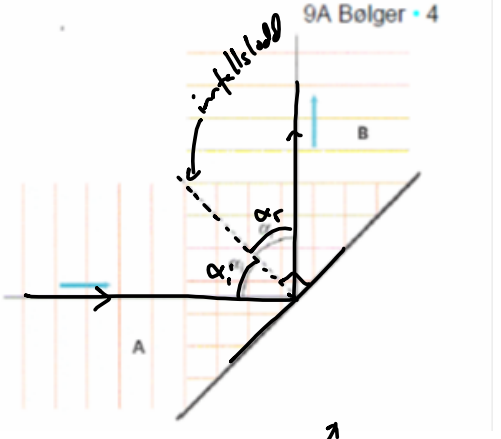
energi — utslag

Bølger og energi



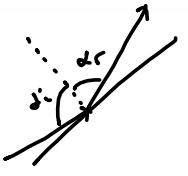
Refleksjon av bølger





refleksjon

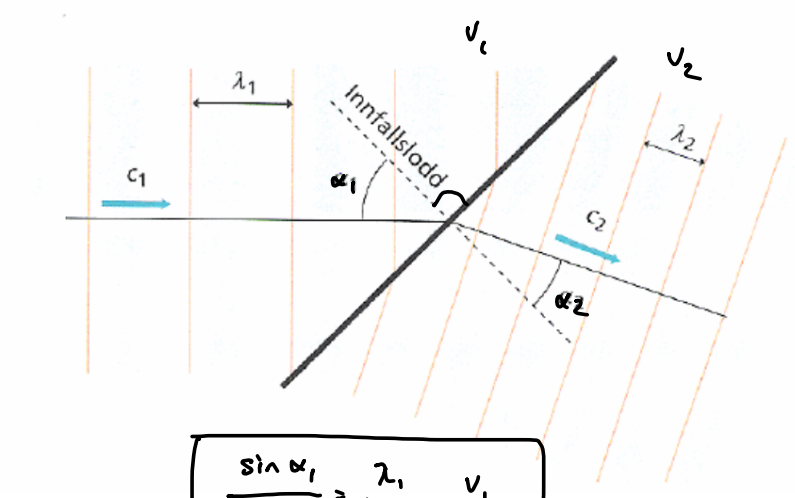
$\alpha_i = \alpha_r$



Brytning av bølger

- https://youtu.be/Bf1k9-4bb4w

Brytning av bølger



$$\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$

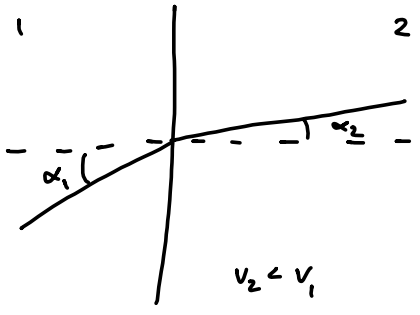
$f_1 = f_2$

$v = \lambda f$

$f = \frac{v}{\lambda}$

$\frac{v_1}{\lambda_1} = \frac{v_2}{\lambda_2}$ $\quad \lambda_1 > \lambda_2$ $\quad v_1 > v_2$

Eksempel



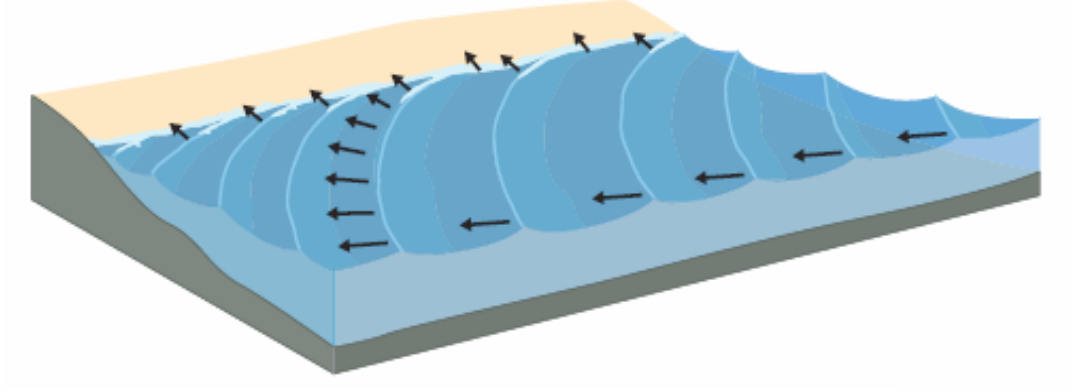
$\alpha_1 = 28^\circ$ $\quad v_2 = 12\ m/s$

$\alpha_2 = 15^\circ$ $\quad v_1 = ?$

$$\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{v_1}{v_2}$$

$$v_1 = \frac{\sin\alpha_1}{\sin\alpha_2} v_2 = 22\ m/s$$

Hvorfor kommer alltid bølgene rett inn mot stranda?

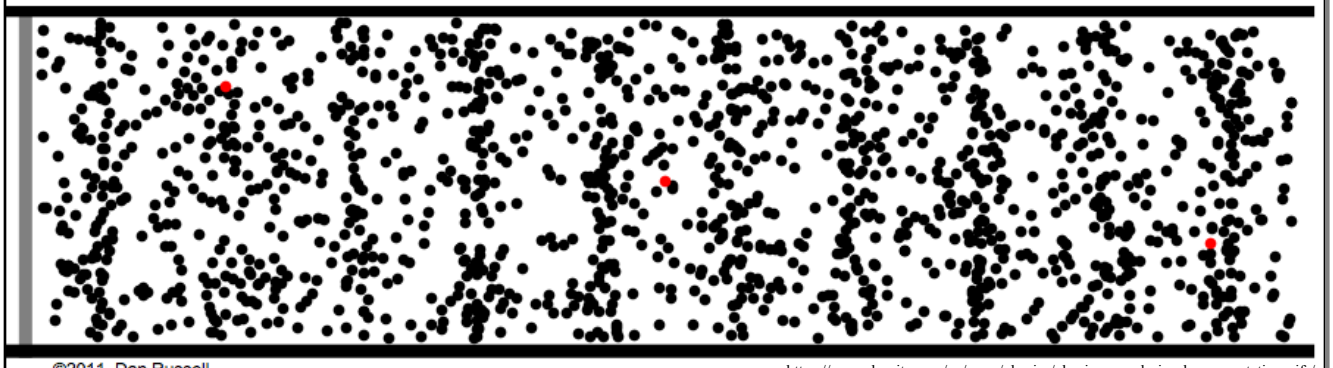


Kan du knuse glass med lyd?

https://www.flickr.com/photos/davedugdale/5080257300

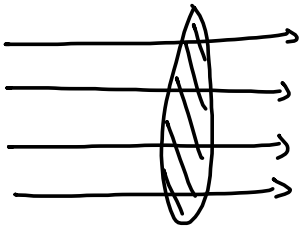
https://youtu.be/sH7XSX10QkM

Lyd er trykkbølger



https://www.docsity.com/en/news/physics/physics-sound-visual-representation-gifs/

Lydintensitet



$$I = \frac{\text{Effekt}}{\text{Areal}} = \frac{P}{A}$$

Lydintensitetsnivå

$$L = 10 \cdot \log\left(\frac{I}{I_0}\right) \text{dB}$$

dB: decibel

$I_0 = 10^{-12}\ \text{W/m}^2$: normal høreterskelen

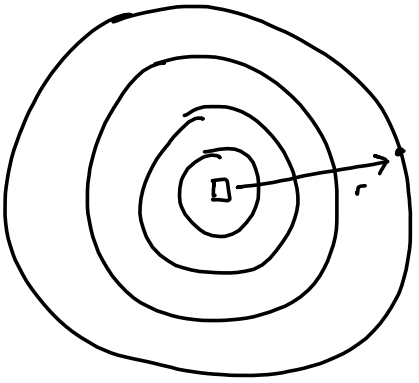
Lydintensitet og lydintensitetsnivå

$\frac{I}{\mathrm{W/m^2}}$	$\frac{L}{\mathrm{dB}}$	
10^{2}	140	Smertegrense for hørselen
10	130	Flymotor 50 m unna, propeller og jet
1	120	Ubehagelig for hørselen
10^{-1}	110	Sterk industristøy. Diskotek
10^{-2}	100	Pressluftbor. Stort orkester
10^{-3}	90	Mindre verksteder
10^{-4}	80	1 svømmehall. Sterkt trafikkert gate
10^{-5}	70	Cocktailselskap
10^{-6}	60	Radio, stuevolum
10^{-7}	50	Konversasjon. Stille gater
10^{-8}	40	Fortrolig samtale
10^{-9}	30	Hvisking
10^{-10}	20	Tikking av ur. Skogsus. Øresus
10^{-11}	10	Rasling av ospeløv
10^{-12}	0	Høreterskelen

faktor 10 forskjell?

Eksempel

En høytaler har effekten 1,0 W og sender lyd like sterkt i alle retninger. Hva er lydintensitetsnivået 10 m borte?



$r = 10\,m$

$P = 1{,}0\,W$

$I = \frac{P}{A}$

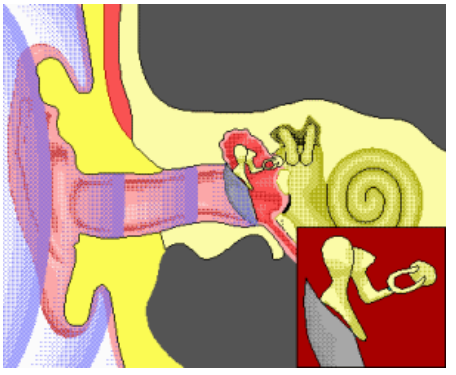
$A = 4\pi r^2$

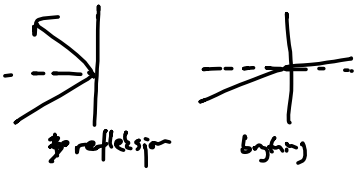
$$I = \frac{P}{A} = \frac{1{,}0\,W}{4\pi\,(10\,m)^2} = 8{,}0 \cdot 10^{-4}\,W/m^2$$

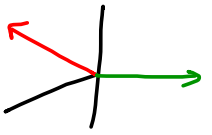
$$L = 10 \cdot \log\frac{I}{I_0}\,dB = 10 \cdot \log\frac{8{,}0 \cdot 10^{-4}\,W/m^2}{10^{-12}\,W/m^2} = 89\,dB$$

Overgang mellom forskjellige media: Akustisk impedans

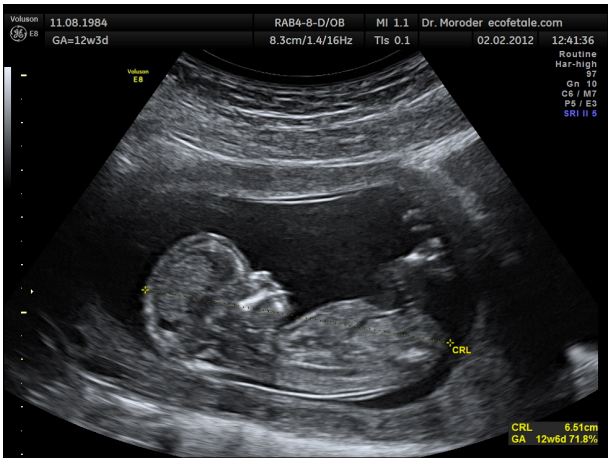
tissue interface	reflected fraction (in %)	transmitted fraction (in %)
water/soft tissue	0.23	99.77
fat/muscle	1.08	98.92
bone/muscle	41.23	58.77
soft tissue/bone	43.50	56.50
bone/fat	48.91	51.09
soft tissue/lung	63.64	36.36
air/muscle	98.01	1.99
air/water	99.89	0.11
air/soft tissue	99.90	0.10







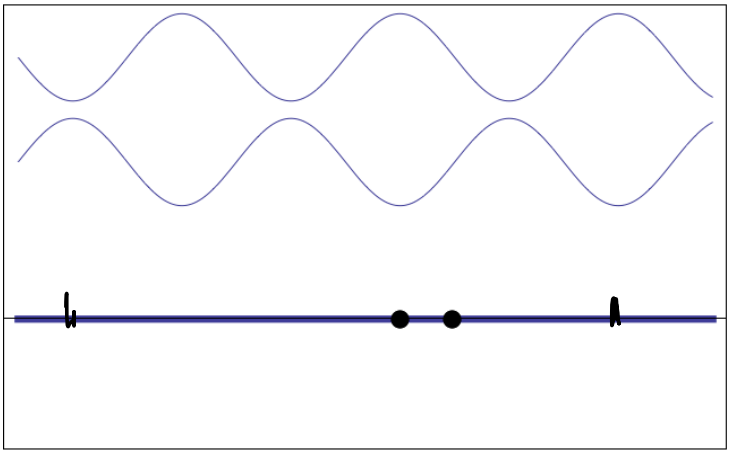
Ultralydavbildning

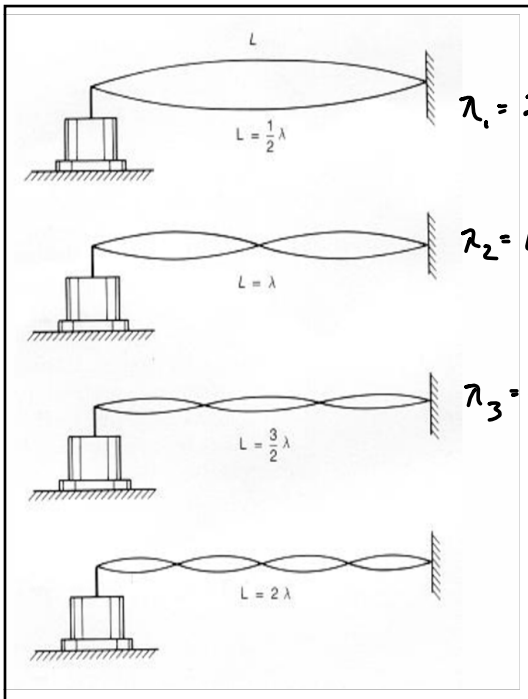


https://commons.wikimedia.org/wiki/File:CRL_Crown_rump_lengh_12_weeks_ecografia_Dr._Wolfgang_Moroder.jpg

$f > 20\,kHz$

Stående bølger





$\lambda_1 = 2L$

$\lambda_2 = L$

$\lambda_3 = \frac{2}{3}L$

Grunntone og overtoner

$v = f\lambda$

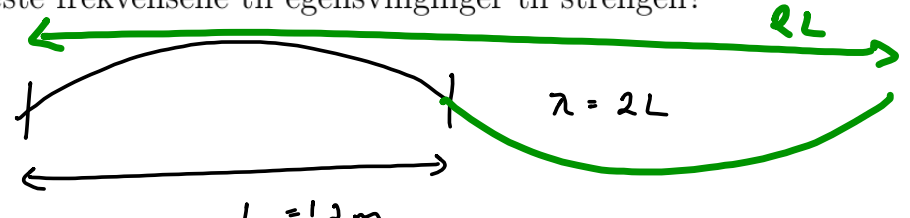
$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$ grunntone

$f_2 = \frac{v}{L}$

Gitarstreng A 440 Hz

1. overtone 880 Hz

En streng har lengden 1,2 m og farten til bølger på strengen er 230 m/s. Hva er de tre laveste frekvensene til egensvingniger til strengen?



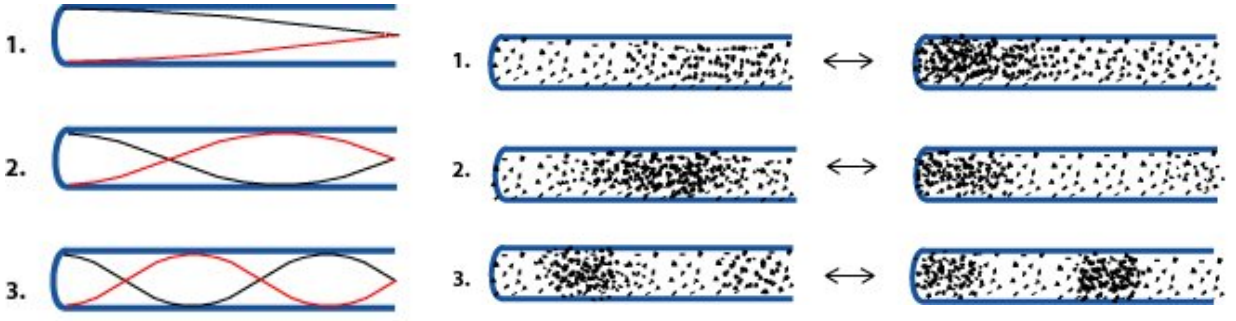
$v = 230\ m/s$

$$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L} = \frac{230\ m/s}{2{,}4\ m} = 96\ Hz$$

$$f_2 = 2 \cdot f_1 = 192\ Hz$$

$$f_3 = \frac{3}{2} f_1 = 288\ Hz$$

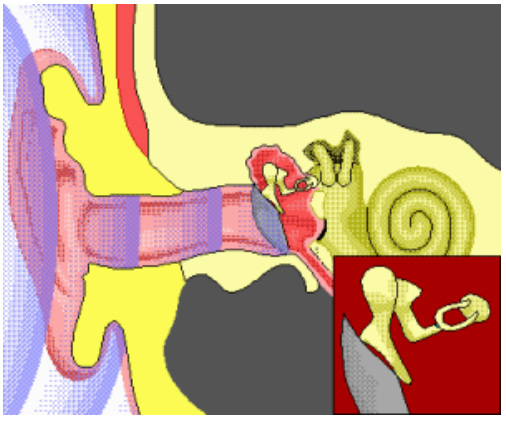
Stående bølger i blåseinstrumenter

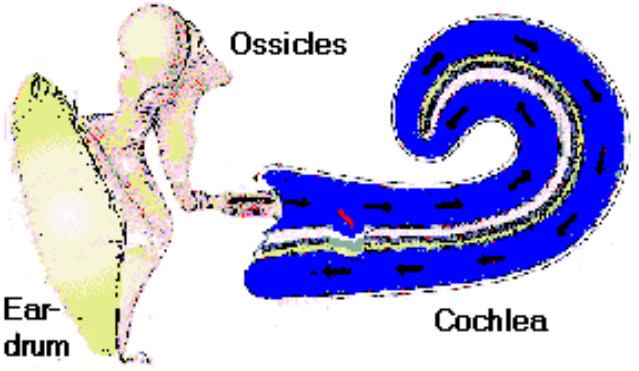


Resonans

http://youtu.be/3mclp9QmCGs

Hørselen





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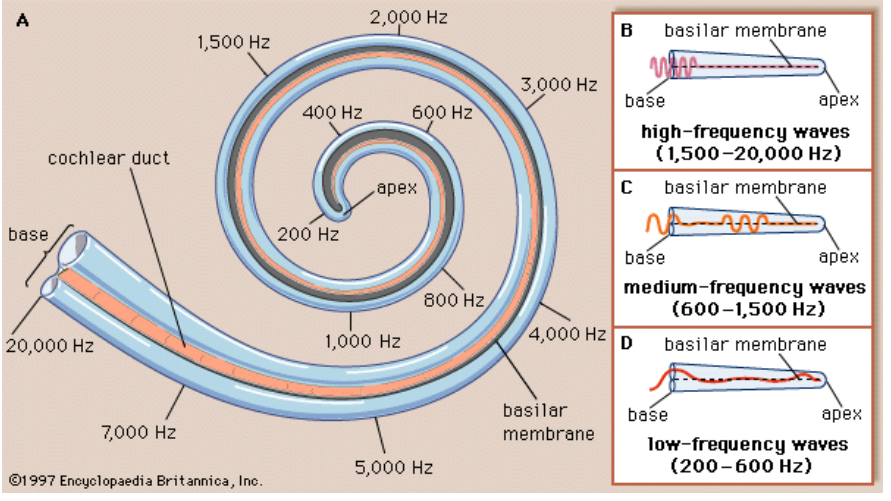
Frekvensdeteksjon i øret



BMtocataAndFugue.mp4

Kan du knuse glass med lyd?

https://www.flickr.com/photos/davedugdale/5080257300

https://youtu.be/CdUoFIZSuX0