WP

Name:

Exercise 1. A mass M = 1.0kg is attached to a pendulum. The system is initially in a position of equilibrium and is put into oscillation, with zero initial amplitude and initial velocity of 5.0cm/s, measuring a period of T=1.0s.

a) Write the time history and then draw its graph.

b) Write the position, restoring force, kinetic and potential energy of the mass at the time 2.5s.

c) If the initial mass is replaced with a mass of M = 2.0kg, how the answers to a and b change?

Accepted:

a) $A=v_0/\omega=0.008m$; $x(t)=A\sin(\omega\ t)=0.008\sin(6.28\ t)$ m

b) $x=0$; $F=-mgx=0N$; $E_P=0$ $E_K=0.001J$

c) a does not change, E_K doubles…

Correct:

a) $A=v_0/(L\omega)=0.032rad$; $\theta(t)=A\sin(\omega\ t)=0.032\sin(6.28\ t)$ rad

b) $\theta=0$; $F=-mg\theta=0N$; $E_P=0$ $E_K=0.001J$

c) a does not change, E_K doubles…

Exercise 2. Write the expression of a displacement sound wave (harmonic, plane and propagating along the x axis) for a source with frequency equal to 1000Hz, at a temperature of 20°, and with an amplitude of $8x10^{-9}$m. Write then the associated pressure wave, its sound intensity level (SIL) and its loudness. What will change if the frequency is 100Hz?

$s(x,t)=s\cos(kx-\omega t)=8x10^{-9}(\cos[(2\pi/0.343)x\ -(2\pi\ 1000)t]$ (m)

$P(x,t)=s(\rho\omega v)\sin(kx-\omega t)=(2x10^{-2}(\sin[(2\pi/0.343)x-(2\pi 1000)t]$ (N/m^2)

$LIS=20\log(P/p_0)=60dB$; 60 Phon

$s(x,t)=s\cos(kx-\omega t)=8x10^{-9}(\cos[(2\pi/3.43)x\ -(2\pi\ 100)t]$ (m)

$P(x,t)=s(\rho\omega v)\sin(kx-\omega t)=(2x10^{-3}(\sin[(2\pi/3.43)x-(2\pi 100)t]$ (N/m^2)

($LIS=20\log(P/p_0)=40dB$; 0-10 Phon)

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Exercise 3. The fundamental standing wave which is established in an air tube with both ends open, has a frequency equal to 440Hz. Assume that the air has a temperature of 20°.

a) What is the length of the tube?

b) How would change the fundamental frequency if the temperature falls to 1°?

c) Plot the envelope corresponding to pressure changes in the tube, associated to the third harmonic.

d) answer to a, b and c when the tube has one closed end.

a)$L=v/(2f)=0.39m$

b) $f_n=v_n/\lambda=(332/343)\ 440=426Hz$

c) $f_3=1320Hz$

d) $L=v/(4f)=0.195m$, $f_5=2200Hz$

Exercise 4. Consider a bass string of a piano, of length L = 2.0m and linear density μ=0.06kg/m.

a) If you want this string to vibrate with a fundamental frequency f_b=27.5Hz, which has to be the tension T applied?

b) Draw the profile of the string as it resonates at the second harmonic, calculating its frequency. What is the wavelength of the sound wave produced in the air (at 20°)

c) If all the strings of the piano were to be applied the same tension and had the same linear density μ, how long should be the string of the higher acute (f_a=3250Hz)?

a)$f_b=v/\lambda_b=(T/\mu)^{1/2}/2L_b$; $T=(2L_b\ f_b)^2\mu=726N$

b)$\lambda_a=v_s/\ f_2=343.1/55=6.24m$

c) $f_a=v/\lambda_a=(T/\mu)^{1/2}/2L_a$; $L_a=(T/\mu)^{1/2}/(2f_a)=1.7cm$

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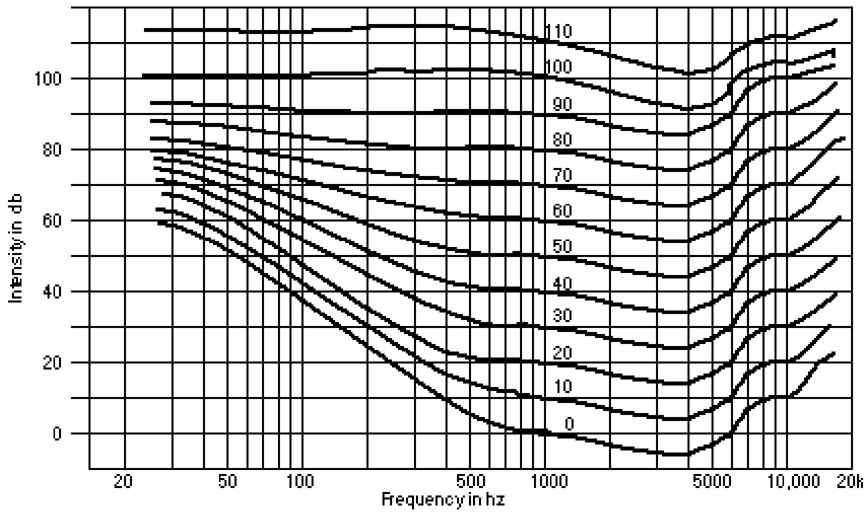
Exercise 5. Two sound sources produce, individually, sound intensity levels equal to 70 and 60 dB.

a) What is the ratio of the sound intensities of the two sources?

b) What is the sound intensity and sound intensity level (SIL) of the two sources combined?

c) What is the loudness of the two sources (individually and combined) if their frequency is 6000Hz?



a) $SIL_a - SIL_b = 10\log(I_a/I_0) - 10\log(I_b/I_0)$; $10 = 10\log(I_a/I_b)$; $I_a/I_b = 10$

b) $I_a = 10^{-5} W/m^2$; $I_{a+b} = 1.1*10^{-5} W/m^2$; $SIL_{a+b} = 10\log(I_{a+b}/I_0) = 70.4dB$

c) 70, 60 and about 72 Phon

Exercise 6. The siren of a factory produces a sound with a power equal to 12.5W at a frequency of 600Hz. a) If propagation takes place on spherical wavefronts, which will be the sound intensity level (SIL) 100m away from the siren? b) And the loudness? c) At what distance you have to perceive the same loudness when emission is at 6000Hz? d) At what distance should you be not to hear the siren?

a) $SIL = 10\log(I/I_0) = 10\log(P/(4\pi r^2)/I_0) = 80dB$

b) **About 80 Phon**

c) **the same**

d) $x = [(12.5/(4\pi I_0)]^{1/2} = 10^6 m$