Wave Physics **2021-10-20**

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Exercise 1. A mass M=2.0kg is attached to a spring. The system is initially in a position of equilibrium and is put into oscillation, with zero initial amplitude and initial velocity of 10.0cm/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 1.25s.

c) If the initial mass is replaced with a mass of M = 1.0kg, how the answers to a and b change?.

Exercise 2. Two sound sources produce, individually, SIL equal to 56 and 53 dB.

a) What is the expression of the **sound pressure wavefunctions** (plane and propagating along x; $p_0 = 2 \times 10^{-5} N/m^2$), if the emitted frequency is 1000Hz with a temperature of 0°?
b) What is the **ratio** of their **sound intensities**?
c) What is **SIL** of the two **combined** sources?

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Exercise 3. A guitar string, with linear density μ=0.005kg/m, is 60cm long, fixed at both ends, and the frequency of its fundamental mode is 400Hz.

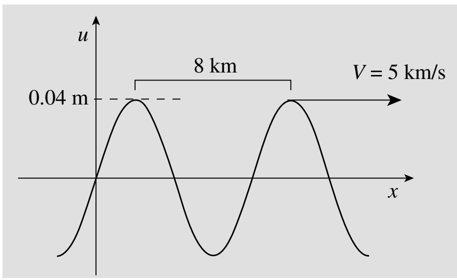
a) What is the **tension** applied to the string?

b) Draw the **profile** of the string when it resonates with the second harmonic, calculating its frequency.

c) What is the **wavelength** of the sound wave produced in the air (at 20 °) in case b?

d) If it is solicited by vibrations of amplitude 0.5cm and 200Hz frequency, write the expression of the **progressive** harmonic waves propagating on it (ignoring the phase).

Exercise 4. Figure plots a harmonic plane wave at t = 0, traveling in the x direction at 5 km/s. (a) Write down the **wavefunction** that describes **displacement**, u, as a function of x and t. (b) What is the maximum **strain** for this wave? (c) If it is a S-wave with a displacement in the y direction, derive the associated **strain** and **stress tensors** components



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Exercise 5. For Love waves in a layer over a halfspace, write their wavefunction expression in terms of vertical and horizontal wavenumbers.

1) Derive a **vertical wavelength** to show how the displacement oscillates with depth in the layer.

2) Derive a **vertical decay constant** for the halfspace, i.e. the vertical distance over which the displacement decays to e^{-1} of its value at the interface.

3a) Show how these values (from 1 and 2) vary **with apparent velocity for a given period**.

3b) For **different modes at given period**, interpret the result in terms of the rate at which the displacement **oscillates in the layer** and the **depth of penetration** in the halfspace.