Name:________________________ **Wave reflections**

A uniform string of length 2.5m and mass of 0.01 kg is placed under a tension of 10N.

a) What is the frequency of the fundamental?

The wave length of the fundamental = 5m $\lambda = 2L$

$v = \sqrt{\frac{T}{\mu}}$ $\mu = \frac{0.01\,kg}{2.5\,m} = 0.004\,kg/m$ $v = \sqrt{\frac{10N}{0.004\,kg/m}}$

$= 50\,m/s$

$\nu = \frac{v}{\lambda} = \frac{50\,m/s}{5\,m} = 10\,Hz$

b) If the string is plucked transversely and is then touched at a point 0.5 m from one end, what frequencies persist?

before touching the guitar string, all frequencies are integer multiples of the fundamental

10 Hz, 20 Hz, 30 Hz, etc.

but now we have an additional constraint it must also be a harmonic for a string of length $L = 2.0\,m$

fundamental with $L = 2.0m$ $\lambda = 4.0\,m$ $\nu = \frac{50\,m/s}{4\,m} = 12.5\,Hz$

but this isn't also a harmonic of the original string.

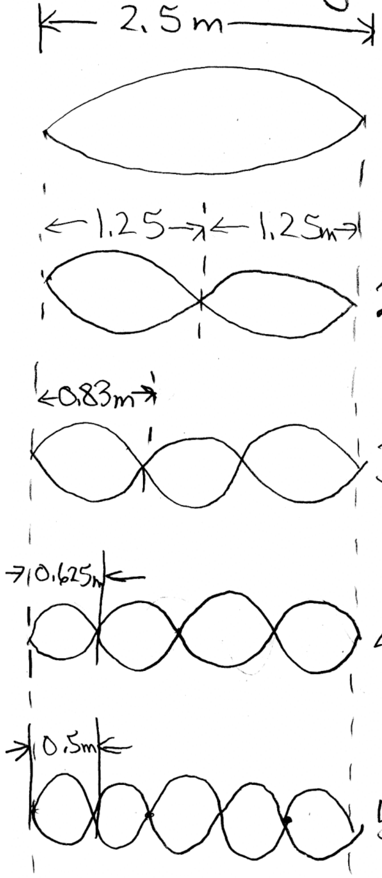
next frequency (second harmonic) = 25Hz

again, not also a harmonic of $L = 2.5m$ string

The lowest harmonic they share is 50Hz. It is an integer multiple of both fundamentals. Thus all frequencies that are integer multiples of 50Hz persist after you touch the string.

50, 100, 150, 200 Hz, ...

A visual way of thinking about this!



fundamental

2nd harmonic $2.5/2 = 1.25$m spacing between nodes

3rd harmonic $2.5/3 = 0.83$m spacing between nodes

4th harmonic 0.625m spacing between nodes

5th harmonic 0.5m spacing between nodes

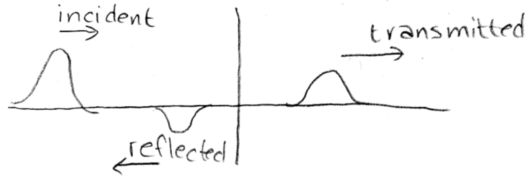
Thus there is a node 0.5m from the end of the string so you do not disturb this harmonic when you touch it with your finger.

Any harmonic with a node 0.5m from the end of the string will persist.

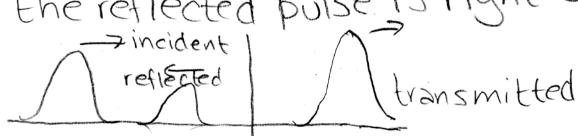
Wave reflections:

Sketch what would happen if a) a pulse propagated from a light rope to a heavy rope b) a pulse propagated from a heavy rope to a light rope, and c) a pulse propagating on a rope encountered a junction with a light thread.

a)(partially transmitted and partially reflected– reflected pulse upside down)



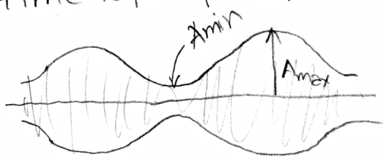
b) the reflected pulse is right side up



c) this is just like the free end discussed in your book

An incident sinusoidal wave with amplitude A_i is only partially reflected from a boundary, with the amplitude of the reflected wave being A_r. Suppose we took a time lapse photograph of the resulting superposition of the incident and reflected waves. What would this photograph look like? Draw the envelope, what is the ratio of the maximum and minimum of the envelope? How does this compare with the result in the case of complete reflection.

time lapse photo:



$$\frac{A_{min}}{A_{max}} = \frac{A_{incident} - A_{reflected}}{A_{incident} + A_{reflected}}$$

There are no "nodes" as in the case of complete reflection

in a complete reflection $|A_r| = |A_i|$ so there are points where the two waves always completely cancel or add constructively. Since $|A_r| \neq |A_i|$ in the case of an incomplete reflection, there are no points where the left going wave and the right going wave always completely cancel.