

TSOKOS READING ACTIVITY**Section 4-5 (5 Points)**

1. Essential Idea: When travelling waves meet they can superpose to form standing waves in which energy may not be transferred.
2. Nature Of Science: *Common reasoning process:* From the time of Pythagoras onwards the connections between the formation of standing waves on strings and in pipes have been modelled mathematically and linked to the observations of the oscillating systems. In the case of sound in air and light, the system can be visualized in order to recognize the underlying processes occurring in the standing waves.
3. International-Mindedness: The art of music, which has its scientific basis in these ideas, is universal to all cultures, past and present. Many musical instruments rely heavily on the generation and manipulation of standing waves.
4. Theory Of Knowledge:
 - a. There are close links between standing waves in strings and Schrodinger's theory for the probability amplitude of electrons in the atom. Application to superstring theory requires standing wave patterns in 11 dimensions.
 - b. What is the role of reason and imagination in enabling scientists to visualize scenarios that are beyond our physical capabilities?
5. Understandings:
 - a. The nature of standing waves
 - b. Boundary conditions
 - c. Nodes and antinodes
6. Applications And Skills:
 - a. Describing the nature and formation of standing waves in terms of superposition
 - b. Distinguishing between standing and travelling waves
 - c. Observing, sketching and interpreting standing wave patterns in strings and pipes
 - d. Solving problems involving the frequency of a harmonic, length of the standing wave and the speed of the wave
7. Guidance:
 - a. Students will be expected to consider the formation of standing waves from the superposition of no more than two waves
 - b. Boundary conditions for strings are: two fixed boundaries; fixed and free boundary; two free boundaries
 - c. Boundary conditions for pipes are: two closed boundaries; closed and open boundary; two open boundaries

- d. For standing waves in air, explanations will not be required in terms of pressure nodes and pressure antinodes
 - e. The lowest frequency mode of a standing wave is known as the first harmonic
 - f. The terms fundamental and overtone will not be used in examination questions
8. Data Booklet Reference: None
9. Utilization: Students studying music should be encouraged to bring their own experiences of this art form to the physics classroom.
10. Aims:
- a. Aim 3: students are able to both physically observe and qualitatively measure the locations of nodes and antinodes, following the investigative techniques of early scientists and musicians
 - b. Aim 6: experiments could include (but are not limited to): observation of standing wave patterns in physical objects (eg slinky springs); prediction of harmonic locations in an air tube in water; determining the frequency of tuning forks; observing or measuring vibrating violin/guitar strings
 - c. Aim 8: the international dimension of the application of standing waves is important in music
11. Read section 4-6, pg. 182-188, in your textbook.
12. Define the following terms:
- a. standing wave _____

 - b. node _____

 - c. antinode _____

 - d. harmonic _____

 - e. fundamental mode (first harmonic) _____

 - f. fundamental frequency _____

13. List 8 observations about standing waves:

- a. _____

- b. _____

- c. _____

- d. _____

- e. _____

- f. _____

- g. _____

- h. _____

14. Answer the following questions:

- a. Give the relationship between wavelength and string/tube length for multiple harmonics when both ends are nodes or both ends are antinodes. _____

- b. What is the relationship between the frequencies of all harmonics and the fundamental frequency? __

- c. What is the direction of motion of a particle on a string during a standing wave? _____

- d. What is the direction of motion of an air particle in a tube during a standing wave? _____

- e. What is the difference between standing waves in a pipe with both ends closed and those with both ends open? (*Saying “one has both ends closed and the other has both ends open” is not an acceptable answer. See, I know you better than you think!*) _____

- f. What is the difference in wavelength for a string with both ends fixed and one with one fixed and one free end? _____

- g. What is the relationship between nodes/antinodes and whether a pipe has a closed or open end? _____

- h. How does the movement of air molecules in a pipe relate to nodes and anti-nodes? _____

- i. Give the relationship between wavelength and string/tube length for multiple harmonics when one end is a node and the other is an antinode. _____

- j. What is the relationship of gas pressure in a tube and displacement nodes/antinodes? _____

- k. Explain how you can determine the speed of sound from a tube of water and a tuning fork? (Example 4.19) _____

l. You measure the length of a tube to determine the wavelength of the first harmonic. How can you then determine the frequency of the sound it makes? _____

m. Name a band or other musical group that has 'harmonic' or 'harmony' in its name. _____

n. Replicate Table 4.2 below

o. Did you really have to have two separate rows in the table? _____ ha, ha, ha

p. Regarding the Nature of Science, "Physics is _____"

15. This assignment may be typed or neatly printed. Drawings may be freehand, but try to make use of the 'Shapes' or 'Insert Clipart' functions of MS Word. If you submit this assignment electronically, the filename must be in the following format, "LastnameFirstinitialPerXReadActX-X". You do not need include a copy of the preliminary instructions with the assignment you hand in.