Physics Cinema Classics C Standing Waves Title 24 Wires Title 25 Wave Machine and Title 26 Slinky to Accompany Activities #10 Standing Waves and # 7 Reflection and Interference

Objectives:

- Students will use distances between nodes and antinodes on a standing wave to determine wavelengths.
- Students will determine the causes (reflection and interference) and effect (standing wave) of wave behaviors.

Description

In Title 24 Chapters 1 - 6, examples of standing waves are introduced in a current-bearing brass welding rod that vibrates transversely in a magnetic field. Title 25 demonstrates the propagation and reflection of wave pulses and the production of standing waves on a wave machine. The machine is designed for the propagation of torsional waves in a horizontal direction. The same concepts introduced in Title 24 are shown again in Title 26, using a Slinky instead of metal rods.

Teacher Information

The A1 audio tracks on Title 24 Chapter 2 and Title 26 Chapter 1 ask that wavelengths be determined, but no scale is shown. Use last frame on Title 24 Chapter 2 to make an estimated scale, because of blurred images in Title 24, it is difficult to use. In Title 26 use the diameter of a standard slinky, about 7.5 cm, for scaling. The waves in the straight wire and in the wave machine are very suitable for introducing the concepts of node and antinode. Title 25 is most useful for showing standing waves produced by reflection.

Discussion Questions (to use with students while they view these sections)

Frames	Questions and Comments
24.2	Nodes are places where there is no displacement. How many nodes are seen? *Three: one at the magnet, one at the rod and one in between.* Antinodes are positions of maximum displacement. How many antinodes are seen? *Three: one in the middle between each air of nodes, and one at the free end of the rod.* How many wavelengths are shown in this mode of vibration? *1.25 One wavelength between the 3 nodes and one quarter of a wavelength from the supporting rod to the free end.*
24. 2 - 3	How many nodes? *Two* How many antinodes? *Two* How many wavelengths? *0.75 wavelengths*
24.5 – 6	How many nodes? *Three* How many antinodes? *Three:* How many wavelengths? *1.25*

Name(s): ________________________ Date: ________ Period: ________

Student Handout to Physics Cinema Classics C Standing Waves Title 24 Wires Title 25 Wave Machine and Title 26 Slinky to Accompany Activity #10 Standing Waves and Reflections

Problem: What determines the wavelength, frequency, and wave speed of a torsional wave?

Procedure:
Preview Title 24 to become familiar with the way the standing wave is produced. Either audio is suitable.

1. What happens to the pulse when it hits the fixed end (see Title25 Lesson 3)?
   ____
2. How is the standing wave produced?
   ____
   ____
3. Play 25.2, stopping at some point to determine the following: (Use step function and filming rate to determine oscillations in a given period of time.) Explain what values you used to determined your values.
   Wavelength in m (scale): ______________________
   Frequency in Hz or s-1: ______________________
   ____
   ____
4. Wave speed in m/s: (Show your substituted equation.)

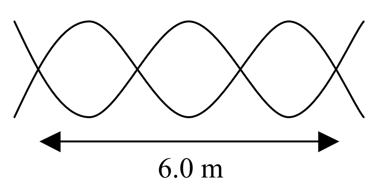
5. Play 25.4, stopping at some point to determine the following: (Use step function and filming rate to determine oscillations in a given period of time.) Explain what values you used to determined your values.

   Wavelength in m (scale): ______________________

   Frequency in Hz or s-1: ______________________
   ____
   ____

5. Wave speed in m/s: ______________________ (Show your substituted equation.)

6. Using the diagram to the right and the fact that the speed of the wave in the spring is 12 m/s, determine the frequency of vibration. Show the substituted equations you use to solve the problem. ____________



Name(s): ________________________ Date: _________ Period: _________

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Name(s): ______________________ Date: ________ Period: ________

Teacher's Answers to Student Worksheet

Problem: What determines the wavelength, frequency, and wave speed of a torsional wave?

Procedure:
Preview Title 24 to become familiar with the way the standing wave is produced. Either audio is suitable.

1. What happens to the pulse when it hits the fixed end (see Title25 Chapter 3)?
   It reflects back in the opposite direction. There is no obvious difference in speed. There is a phase inversion, but it may not be immediately obvious to the student.

2. How is the standing wave produced?
   There is a superposition of the wave propagated from the right and the reflection from the fixed end. Nodes occur at places where destructive interference occurs. Consecutive nodes are one-half wavelength apart from each other.

3. Play 25.2, stopping at some point to determine the following:
   Wavelength in m (scale): *On a 25" monitor, 39cm corresponds to 1 m. Peak-to-peak measurement is about 22cm corresponding to 0.56m*

(Use step function and filming rate to determine oscillations in a given period of time.)

Frequency in Hz or s^{-1}: *3 oscillations/37 frames * 24 frames/s = 1.9 Hz*

4. Wave speed in m/s: $f * \lambda = 0.56m * 1.9\ Hz = 1.1\ m/s$

5. Play 25.4, stopping at some point to determine the following:

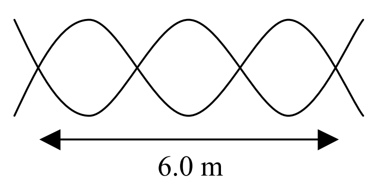
   Wavelength in m (scale): *On a 25" monitor, 32 cm corresponds to 1.75 m. Peak-to-peak measurement is about 6.5cm corresponding to 0.36m*

(Use step function and filming rate to determine oscillations in a given period of time.)

Frequency in Hz or s^{-1}: *1 oscillations/20 frames * 24 frames/s = 1.2 Hz*

6. Wave speed in m/s: $f * \lambda = 0.56m * 1.2\ Hz = 0.43\ m/s$

7. Using the diagram to the right and the fact that the speed of the wave in the spring is 12m/s, determine the frequency of vibration. Show the substituted equations you use to solve the problem. ____________



1.5 Wavelengths (node to node to node) =6.0 m. Therefore 1.0 λ =4.0 m
speed/wavelength =frequency. Therefore 12 m/s divided by 4.0 m = 3.0 Hz =f