# INTRODUCTORY NOTES ON

# AAPT/PTRA TEACHING ABOUT WAVES IN ONE-DIMENSION TEACHER RESOURCE

This AAPT/PTRA Teacher Resource is an introduction to properties of waves. Topics that typically follow this are Two-Dimensional Waves, Properties of Sound, and Properties of Light and Other Electromagnetic Radiation.

The basic tools for student laboratory activities and demonstrations include Slinky<sup>TM1</sup>, Snakey, Shrive Rib Wave Machine, Dominos, Video (e.g., Ztec Physics Cinema Classics), Physlets, applets, animations/simulations, and Ranking Tasks.

"... For amber waves of grain,"<sup>2</sup> When you see a wave moving across a wheatfield your eye can clearly follows the movement from one side of the field to the other, but it is not the movement of any matter or object from one side of the field to the other. Since no stock of wheat move except back and fourth about its fixed position, this phenomena is different and is call a wave, it is a moving distrubance.

# OUTLINE OF WORKSHOP

**STORY LINE:** Creation of waves, propagation of waves, waves interaction with waves (interference, superposition), waves interaction with matter (e.g., reflection, refraction, absorption, and diffraction).

This Teacher Resource contains laboratory activities typically using a slinky and/or snakey springs. For most activities there is a DVD Video or Internet simulation to accompany the laboratory activity. The teacher can do the laboratory activity first and then reinforce concepts introduced with the simulation or video, or reverse and do simulation or video first, followed by the slinky and/or snakey hands-on laboratory activity. If the wave phenomena is difficult to see (e.g., destructive interference), it often helps students by showing the simulation or video first so the students become accustom to the phenomena being observed.

#### Waves are produced by vibration.

(Activity with - Slinky) Laboratory Activity #2. Using a Slinky<sup>TM</sup> to illustrate basic terms (medium, wavelength, speed, frequency, and amplitude) and properties (propagation, reflection, and phase) of waves.

## Movement of waves from Point A to Point B (i.e., propagation):

- Definition of wave as a moving disturbance often produced by a vibrating object. (Activity with Slinky, People Wave, DVD, PHYSLET)
- Properties of Waves vs. Properties of Particles (Activity with Slinky<sup>TM</sup>: Compare & Contrast)
- Using Slinky or People Wave to show examples of Transverse Waves vs. Longitudinal Waves
- Definition of Wavelength, Amplitude (Activity with Slinky, People Wave, DVD, PHYSLET)

<sup>&</sup>lt;sup>1</sup> Use a super or a double length Slinky<sup>TM</sup>. The Slinky<sup>TM</sup> should be about 16 cm to 20 cm long and 7.0 to 7.3 cm in diameter. See for example Sargent Welch #WL3339, Fisher #S65993 or PASCO #SE-8760

<sup>&</sup>lt;sup>2</sup> Katharine Lee Bates, an English professor at Wellesley College, 1893, 1913

- Waves produced by Vibration. Laboratory Activity #2. Measurement of Frequency and Period and reciprocal relationship between Frequency and Period. Laboratory Activities #4, #6, #8. #9, and #10.
- Distinguish among pulse, continuous wave, and periodic wave (Activity with Slinky: Compare & Contrast, DVD, PHYSLET)
- Role of Medium for Wave Propagation. Laboratory Activity #5. (Activity with Slinky, DVD, PHYSLET)
- Introduction to reflection of a wave. Activity #7

## Using Slinky to Measure Speed of Propagation for a Wave

- Speed Equation: Speed = Distance Traveled/Time. Activity #4
- Wave Equation: Speed = Wavelength \* Frequency Laboratory Activity #4, #6, #8. #9, and #10.
- Show that Wavelength \* Frequency & Distance Traveled/time are related Pace Yourself Laboratory Activity #4.

#### What Affects The Speed of a Wave?

- Frequency? (Activity with Slinky, DVD, PHYSLET)
- Amplitude? (Activity with Slinky, DVD, PHYSLET)
- Reflection? (Activity with Slinky, DVD, PHYSLET)
- Density of the medium? (Activity with Slinky, DVD, PHYSLET)
- Tension of the medium? (Activity with Slinky, DVD, PHYSLET)
- Speed = Square Root of (Tension/Density) Laboratory Activity #[To be added]
- Longitudinal versus Transverse (Activity with Slinky, DVD, PHYSLET)

#### Transmission (AKA Refraction) of a Wave:

- Into a medium where wave travels slower (Activity with Slinky, DVD, PHYSLET)
- Into a medium where the wave travels faster (Activity with Slinky, DVD, PHYSLET)
- Effect of medium on (Compare wave properties in incident and reflecting mediums) (Activity with Slinky, DVD, PHYSLET)
  - ✓ Amplitude
  - ✓ Frequency
  - ✓ Speed
  - ✓ Wavelength
  - ✓ Phase

#### Reflection of Waves vs. Reflection of Particles (Activity with Slinky: Compare & Contrast):

- Reflection from a Fixed End (Activity with Slinky, DVD, PHYSLET)
- Reflection from a Free End (Activity with Slinky, DVD, PHYSLET)
- Reflection from a slow medium (Activity with Slinky, DVD, PHYSLET)
- Reflection from a fast medium (Activity with Slinky, DVD, PHYSLET)

#### Interaction of Waves:

- Principal of Superposition (Activity with Slinky, DVD, PHYSLET)
- Constructive Interference Antinodes (Activity with Slinky, DVD, PHYSLET)
- Destructive Interference Nodes (Activity with Slinky, DVD, PHYSLET)
- Standing wave patterns Internodal distance is half a wavelength. (Activity with Slinky, DVD, PHYSLET)
- Using Standing Wave Pattern to measure speed of wave. Laboratory Activity #9 and #10
- Investigation with Slinky of whether waves reflect off each other or pass through each other.
- Resonance (Segue to PTRA Sound & Light Teacher Resources) (Activity with Slinky, DVD, PHYSLET)

## **Miscellaneous Topics:**

- Beats
- Polarization
- Resonance

The Physics Cinema Classics has many videos that are useful for demonstration and measurement of waves. Physics Cinema Classics is available from Ztek http://www.ztek.com/physics/physics.html. To use a Ztek DVD:

- 1. Insert DVD (A F)
- 2. Select Beginning of Disc
- 3. After startup information select topic (e.g., Wave Propagation)
- 4. Select Lesson (e.g., "01 Wave Vocabulary")
- 5. Select video of photo (e.g., "Simple wave movement using a slinky on table."
- 6. Use remote icon in normal manner.