Introduction to Waves and Light - Matthew Rickert

Purpose
This lesson is to introduce students to waves, and get them to understand that light is made of waves, and thus any properties of waves are also properties of light. This lesson can act as an introduction to the properties of light and how it interacts with matter (such as in a telescope).

Overview
-The lesson will start with having students demonstrate the different parts of a wave, and the difference between longitudinal and transverse waves using a slinky.
-The teacher will then present a power point presentation based discussion that incorporates videos, on interference and diffraction
-During the discussion, students will be filling out worksheets individual and compare their answers to each other's and come to a group consensus
-The lesson will end with students (in groups of 4-6) designing an experiment to test if light is made of waves or particles, and will present their experiment to the rest of the class.
-The teacher will conclude the lesson by explaining the historical experiments that showed that light is a wave, and demonstrate the double slit diffraction experiment. This can then be used as a lead in to a following lesson on the properties of light and how light interacts with matter

Student Outcomes
Students will be able to:
- identify the different parts of a wave, the difference between longitudinal and transverse waves, and will be able to use such vocabulary in describing the behavior and properties of waves
- understand and be able to predict the results of the interference of waves
- understand and be able to predict the results of diffraction
- be able to understand the combination of diffraction on interference
- think critically to design an experiment
- make a scientific presentation to their peers
- identify faults in an experimental design
- understand why identifying the lat was made of waves was a pinnacle scientific discovery

Standards Addressed
HS-PS4-4
HS-PS4-3,
HS-PS4-1

Time
~1 hr / 1-1.25 class 45 min class periods

Level
High school (grades 9-12), regular astronomy

Materials and Tools
Slinky-for demonstration to the class
Handouts
Powerpoint presentation and projector
-transparencies or blackboard could be used instead in conjunction with a TV
laser pointer, strip of aluminum foil with 2 parallel slits cut into it with a razor- used to demonstrate double slit diffraction, an actually optical bench set up can also be used if available

Preparation
1-Prepare/review powerpoint presentation in advance in preparation for presenting it to the class. This includes ensuring an Internet connection for the videos or downloading them ahead of time if no Internet is available
2-Print out handouts
3-cut 2 parallel slits ~2-3 mm apart in a small strip of aluminum foil using a razor. Shine the laser pointer through and ensure that you can see the resulting double slit diffraction pattern. If not then reposition the laser pointer and/or re-cut the slits

Prerequisites
Vocab: Our school requires "bellringers"- short work that the students do during the 1st ~5 min of class while the teacher attends to administrative tasks such as attendance and handing out materials. Our bellringers would be a list of vocabulary words that the students would have to define, these are then collected at the end of the week. It is useful to have the students define vocab words a day or week before a lesson is to be presented so that they have at least been exposed to any new vocabulary. For this lesson they were required to define the following words in the prior days bellringers: wavelength, frequency, diffraction, refraction, reflection, absorption, interference

Background
General content knowledge and skills students will need to succeed in this lesson. This should be written as if you are speaking to the students.

Teaching Notes
1. Prior to the lesson, have the students define related vocabulary words (see the prerequisites)
2. Begin with a quick "show of hands" of which students in the class have taken physics before. Those that will raise their hands will likely already know most of the vocabulary, so concentrate on ensuring that the students that didn't raise their hands understand the vocabulary
3. Call on students to come to the front of the class to demonstrate the different parts of a wave with a slinky and a to demonstrate a transverse and longitudinal wave
4. Handout worksheet packets

5. Give the power point presentation (see the attached slides). Have the students fill in their packets during the presentation. Have students fill out questions 3b, 4, & 6 and discuss with their groupmates before selecting students to draw their answers on the blackboard, discussing their answers with the entire class
6. After checking with the class to ensure that their are no questions, give the students time to work in groups in designing an experiment to test if light is a wave, it is useful to offer any groups whose design matched the historic experiments a prize, such as candy or extra credit
7. Have students present their experiments to the class, and guide the class in questioning each other's experiments and determining any flaws that they might have
8. Show the students the historical experiments, and demonstrate the double slit diffraction experiment

Assessment

-Bellringer activity: defining vocabulary words prior to the lesson
-Have individual students demonstrate to the entire class the different parts of a wave and the difference between a transverse and longitudinal wave using a slinky
-Packets- while students are making drawings on their packets, the teacher should walk around and visually gauge the students' understanding based on their drawings, should a lack of understanding be evident, the teacher can review the material, and then select individual students whose drawings had indicated a lack of understanding, to draw the answer again on the chalkboard
-Final presentations of the students' experimental designs

Additional Information

-When going over reflection, refraction, and absorption, be sure to stress how particles can also result in similar effects, as students had trouble in their experiments coming up with experiments that would actually differentiate between the effects of particles and waves