Workshop Tutorials for Introductory Physics

WI2: **Waves**

A. Review of Basic Ideas:

Use the following words to fill in the blanks:
medium, travelling, travelling, energy, waves, velocity, period, oscillate, light, space, music, sound, wavelength, amplitude, people, standing

Waves

You are surrounded by ________ all the time. Everything you see and everything you hear, is actually a wave. The rods and cones in your eyes are sensitive to ________, which is a wave. The cilia in your cochlear respond to ________ waves which are vibrations in the air.

Some waves, like sound, need a ________ to propagate through, but electromagnetic waves, like light, don't. Which is why in ________ no-one can hear you scream, but they can see you scream.

Waves can be described by several quantities. The ________ is how long a single oscillation takes. The ________ is how far it is between peaks, the ________ is how fast the peaks travel and the ________ is how far from equilibrium the peaks are.

A wave is a disturbance in a material. The particles ________, but there is no net movement of matter. During a "Mexican wave" the disturbed particles are ________ and the disturbance travels around the venue. This is a ________ wave. Many waves you are familiar with, such as water waves, are travelling waves. Although there is no net movement of matter, waves do transmit _________.

Waves that stay in the same place are called ________ waves. These are easy to observe on strings. If you pluck a taut string you will get a standing wave. This is the basis of many musical instruments. The standing wave on the string causes a _________ wave in the air, which causes a standing wave on your ear drum, which is transmitted to the cochlear, which your brain interprets as _________.

B. Activity Questions:

1. Transverse waves
Examine the wave machine, and send a wave from the bottom to the top.
This is a torsional or "twisting wave". Explain why this is called a transverse wave.
How is it different to the transverses waves you are familiar with?

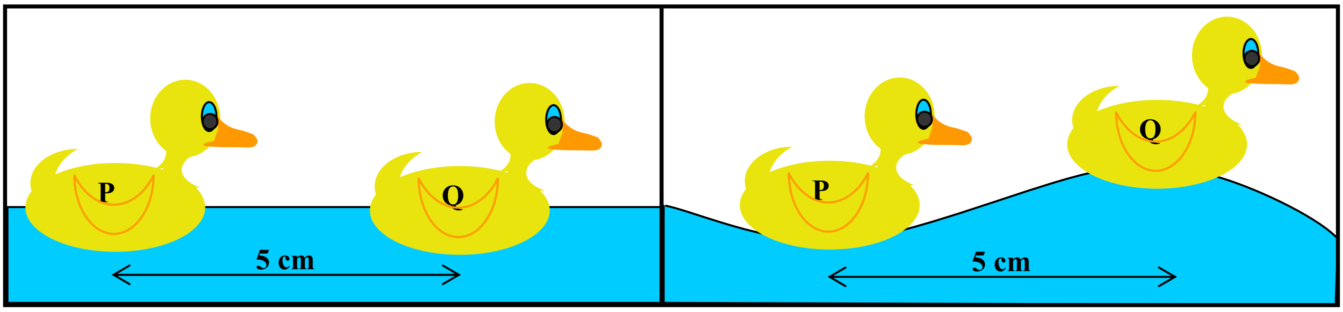
2. Longitudinal Waves
Send a wave along the length of the slinky.
Does the amplitude of the wave affect the speed at which it moves?
How can you change the wave speed?

3. Waves in rubber tubes
One tube is filled with water and the other with air.
Can you tell which is which by observing waves on these tubes?

4. Ripple tank I – making waves
Experiment with the different oscillators. What sort of shaped waves can you produce?
Using one oscillator and the stroboscope, try to measure the wavelength of the waves.
How does the wavelength change when you change the frequency of the oscillations?
Do you think the wave speed changes when you change the frequency?

C. Qualitative Questions:

1. Two rubber ducks, P and Q, are floating in the bathtub 5 cm apart (see below). You make waves by dropping things into the tub.



As the waves pass by the ducks you notice that when P is at its highest position, Q is at its lowest and vice versa.

a. What is the wavelength of the waves?
b. Can you make the waves travel faster by dropping in larger or smaller objects?
c. Can you make the waves travel faster by dropping in objects at a faster rate?

2. Many animals, such as scorpions and ant lions, use the movement of waves through the ground to find their prey. An animal moving along on the ground produces both a transverse travelling wave and a longitudinal travelling wave. The longitudinal waves travel faster than the transverse waves, and a scorpion can tell where an insect is by detecting the difference in arrival time for the two waves.

a. What is the difference between a transverse wave and a longitudinal wave?
b. For transverse waves transmitted through the ground, is the wave speed the same as the maximum speed of any part of the ground?
c. What about for longitudinal waves?
d. Why do longitudinal waves travel faster in the ground than transverse waves?

D. Quantitative Question:

Brent and Rebecca are trying to teach Barry the dog to jump over a rope. They each hold one end of the rope, keeping it stretched out taut. Brent suddenly jiggles the rope at his end sending a wave traveling along it towards Rebecca. The wave can be described the equation

$$y(x,t) = 0.02 \text{ m} \sin(63 \text{ m}^{-1}\, x - 2510 \text{ rad.s}^{-1}\, t)$$

a. What is the amplitude of this wave?
b. What is the wavelength of this wave?
c. What is the frequency of this wave?
d. What is the velocity of the wave?

When the wave reaches Rebecca it is reflected back along the rope towards Brent, without loss of amplitude.

e. Write the equation for this reflected wave.