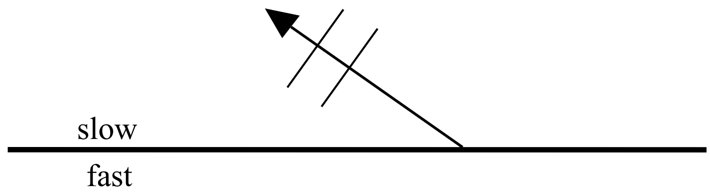
Name ______________________________ Date ___________ Period______

Waves Unit 11B, Worksheet 3

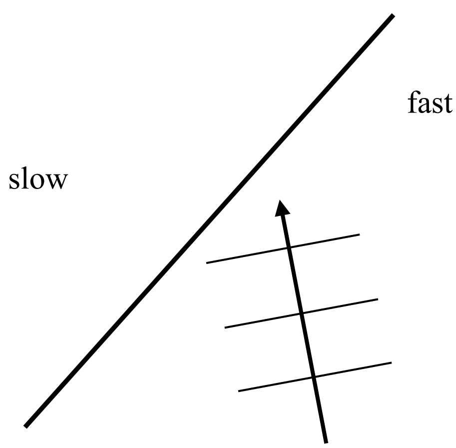
Part A: Refraction

1. The refracted ray and two wavefronts are shown below. Draw in the incident ray, the normal and all of the missing wavefronts. Label the incident and refracted rays and angles.

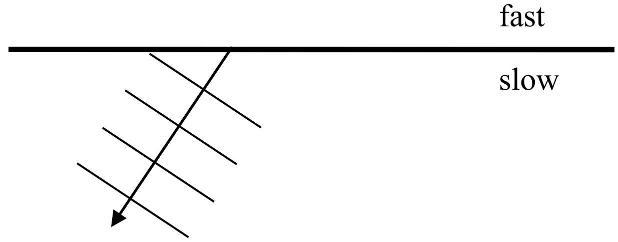


Part B: Reflection and Refraction (since this <u>is</u> what really happens)

2. The incident ray and 3 wavefronts are shown below. Draw in the refracted and the reflected wavefronts. Also draw the normal, the reflected and the refracted ray. Label the incident, reflected, refracted rays and angles.



3. The reflected ray and wavefronts are shown below. Draw in the incident and refracted wavefronts, the normal, the incident and refracted rays. Label the incident, reflected, refracted rays and angles.



4. a. How does the incident **frequency** compare to the **reflected** frequency? How do you know?

   b. How does the incident **wavelength** compare to the reflected wavelength? How do you know?

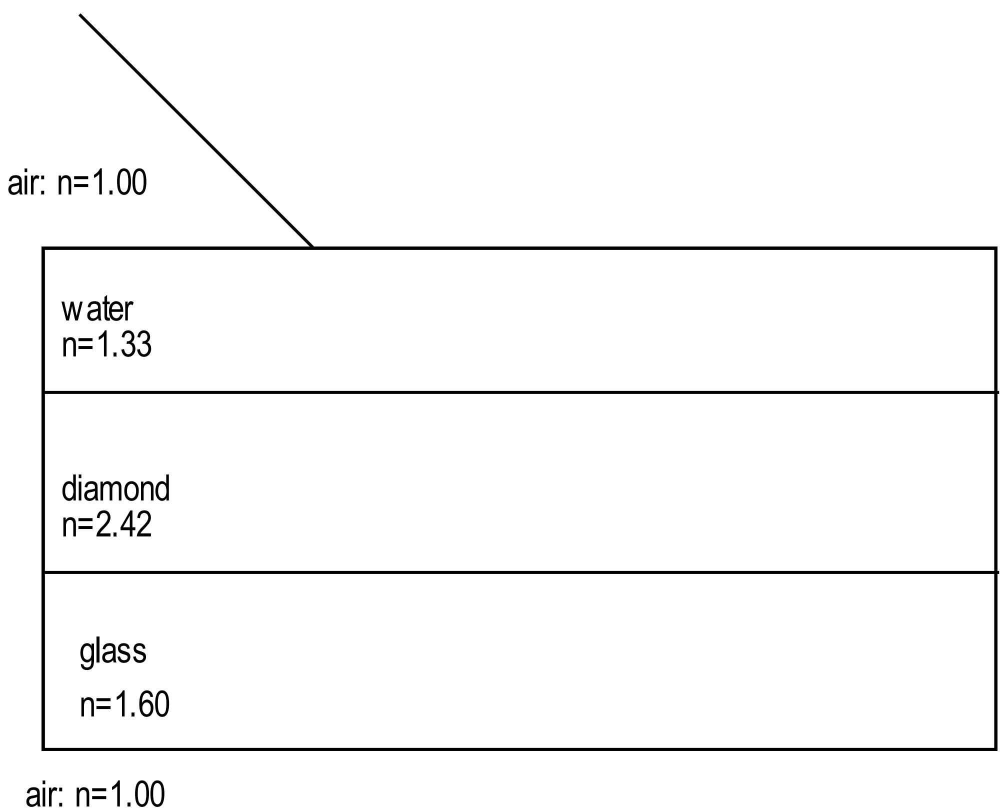
   c. How does the incident **wave speed** compare to the reflected wave speed? How do you know?

   d. How does the incident **frequency** compare to the **refracted** frequency? How do you know?

   e. How does the incident **wavelength** compare to the refracted wavelength? How do you know?

   f. How would the incident **wave speed** compare to the refracted wave speed if the refracted ray had a larger angle to the normal than the incident ray? How do you know?

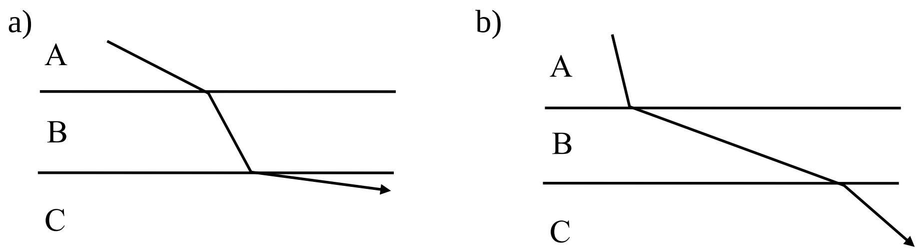
5. Light enters at 45.0 degrees to the normal as shown below. Using the information given, sketch in the angles and the path of the light beam as it travels through the various media. Show all work for full credit.
(Take the light out the bottom.)



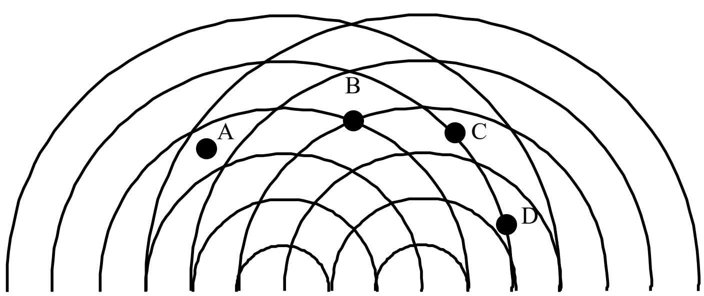
6 What is the speed of light in the glass?

7. What is the critical angle for light going from glass to air?

8. Below is light traveling through three materials. Rank the speed of light in each of the materials from fastest to slowest. Also rank the index of refraction of each material from highest to lowest.

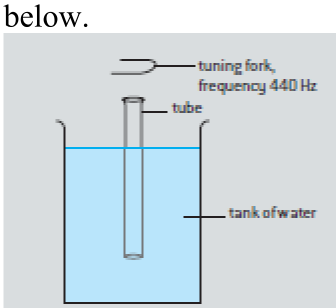


1. On the diagram below the dark lines are crests. Identify the type of interference at the lettered points. Also identify the phase of the waves that are meeting at that point. (crest, trough, or in between)



2. **a)** Describe *two* ways in which standing waves differ from travelling waves.

   b) An experiment is carried out to measure the speed of sound in air, using the apparatus shown below.



A tube that is open at both ends is placed vertically in a tank of water until the top of the tube is just at the surface of the water. A tuning fork of frequency 440 Hz is sounded above the tube. The tube is slowly raised out of the water until the loudness of the sound reaches a maximum for the first time, due to the formation of a standing wave.

(i) Explain the formation of a standing wave in the tube.
(ii) State the position where a node will always be produced.
(iii) The tube is raised a little further. Explain why the loudness of the sound is no longer at a maximum.

c) The tube is raised until the loudness of the sound reaches a maximum for a second time. Between the two positions of maximum loudness the tube has been raised by 36.8 cm. The frequency of the sound is 440 Hz. Estimate the speed of sound in air.

11.Minnie Sota hits the end of a tight string 1.2 m long with a hammer. String is attached at both ends. Sketch the standing wave on the string for the following situations. The speed of waves in the string is 6,500. m/s.

MODE	DIAGRAM	WAVELENGTH	FREQUENCY
Fundamental frequency (1st harmonic)	________________		
2nd overtone (3rd harmonic)	________________		
Resonating with 4 nodes	________________		
Resonating with 4 antinodes	________________		

12. Justin Credable is singing in a shower that measures 2.40 meters from floor to ceiling, and notices his voice causes the shower to resonate with a fundamental frequency of 73 Hz.

a. Sketch the standing wave and calculate the speed of sound in the shower?

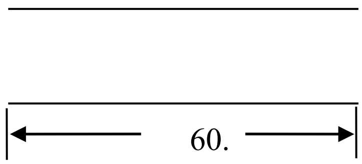
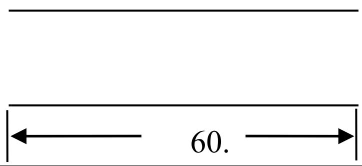
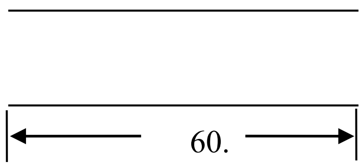
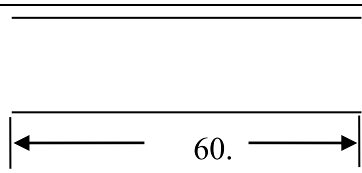
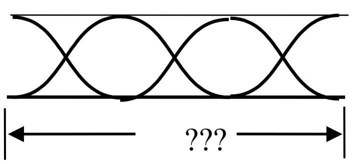
b. Sketch the standing wave for the first overtone and calculate the frequency.

13. Sketch the standing wave pattern on a resonating object that has a fixed boundary on one end and a free boundary on the other. The length of the resonating object is 90.0 cm.

MODE	DIAGRAM	Number of Waves	WAVELENGTH
Fundamental frequency (1^{st} harmonic)	Fixed boundary Free boundary		
Resonating with 2 nodes	Fixed boundary Free boundary		
Resonating with 3 antinodes	Fixed boundary Free boundary		
Resonating in 5^{th} mode	Fixed boundary Free boundary		

14. Amy Noacid performs a physics lab to determine the speed of sound inside a tube. She blocks off one end of the 120.0 cm tube with a book and places a microphone at the other end. When she snaps her finger she determines the time for the sound to get back to the microphone is 0.00695 s. What was the speed of sound that day?

15.This time fill in the chart for a tube open on both ends.
a. Sketch the indicated mode of vibration for this setup
b. Determine the unknown value in each box
c. Place the name of each mode in the frequency box

MODE	DIAGRAM	WAVELENGTH	FREQUENCY	WAVE SPEED
1st				340. m/s
2nd				340. m/s
3rd				340. m/s
4th				340. m/s
??		134 cm	256 Hz	

16. Patty Melt is holding a tuning fork over a tube that has been inserted into a container of water. The first resonance is at 45.2 cm, and the speed of sound in air that day is 345 m/s.
a. What is the frequency of the fork?

b. She then raises the tube until she gets a second resonance. How much of the tube is now out of the water?

17. A pipe open on both ends is resonating to produce a note. What could you do that would cause the same pipe to produce a note of a different frequency? Describe the change that each one would produce in the pitch of the sound. (Hint: you should be able to identify at least four changes that affect the pitch.)