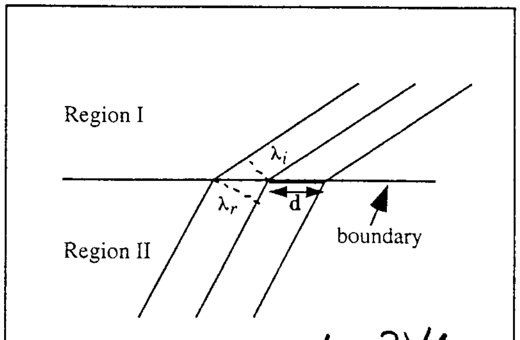
Physics 123
Spring 2000

Supplemental Problem 2

Name: SOLUTION
Tutorial Section:

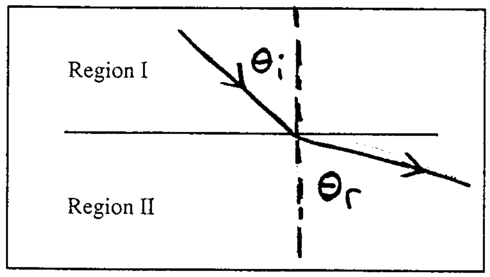
The diagrams at right illustrate the refraction of a wave as it travels from one medium (Region I) to another (Region II.) The wavelength of the refracted waves (λ_r) is twice the wavelength of the incident waves (λ_i).



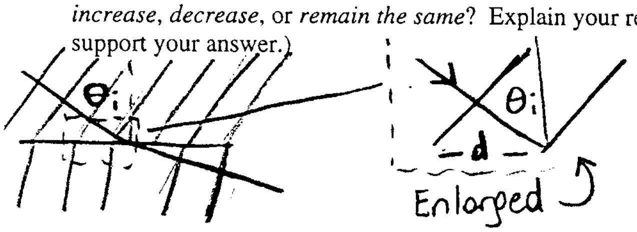
A. Determine the ratio of the wave speed in region I to the wave speed in region II. Explain your reasoning.

Since The frequency for the waves is the same and the wavelength doubles the velocity must double ∴ $V_r = 2V_i$

B. In the diagram at right, sketch rays indicating the direction in which the waves are propagating. Indicate the angle of incidence (θ_i) and the angle of refraction (θ_r). (Recall, these angles are measured between the direction of propagation and the normal to the boundary.)



C. The distance **d** shown in the figure above is the distance between two adjacent crests of the incident (and refracted) waves on the boundary between the two media. As the angle θ_i increases, does **d** *increase*, *decrease*, or *remain the same*? Explain your reasoning. (You may want to include a sketch to support your answer.)



since the wavelength remains the same as θ_i increases the distance d would decrease

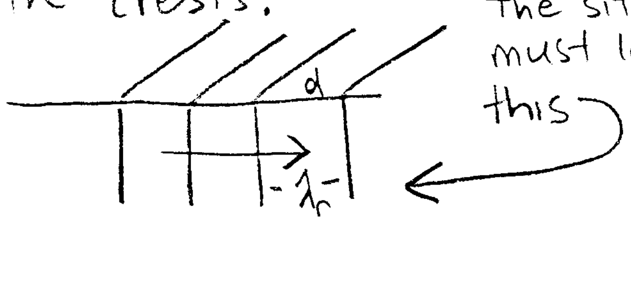
D. As the angle θ_i increases does the angle θ_r increase, decrease, or remain the same? Base your answer on your response to part C.

As we saw in tutorial as the θ_i increases the refracted wave moves farther and farther from the normal → so it also increases.

E. What is the minimum possible value of **d** for which the crests of the incident waves are aligned with those of the refracted waves? Explain how you can tell. (*Hint:* What is the direction of propagation for the refracted waves when **d** has its minimum value?)

The distance d cannot be smaller than the wavelength of the refracted waves otherwise it would be impossible to line up crests with crests.

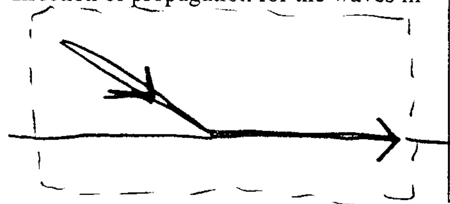
The situation must look like this

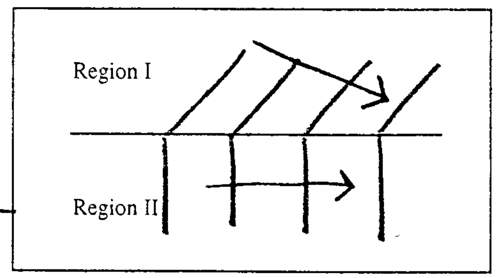


Name SOLUTION

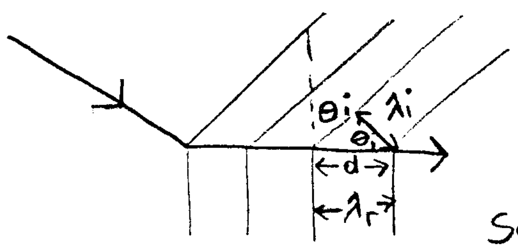
Tutorial Section:

F. Sketch the wavefronts for the situation in which the distance **d** has its minimum value. Include rays indicating the direction of propagation for the waves in your sketch.





G. Calculate the angle θ_i for which **d** has its minimum value. Show all work.



$$\sin\theta_i = \frac{\lambda_i}{d} = \frac{\lambda_i}{\lambda_r}$$

so $\sin\theta_i = 1/2$ so $\theta = 30°$

H. Is it possible to have a transmitted wave for angles of incidence greater than the angle you have found in G? Explain why or why not.

It is not possible since if θ_i gets bigger d gets smaller and if d gets smaller than λ_r there is no way to have crests line up with crests → This is the <u>critical angle</u>.