PROPAGATION AND REFRACTION OF PERIODIC WAVES

Name _____

1. a. The terms below are often used to characterize periodic waves. Give a physical interpretation of each term. (For example, a physical interpretation of *speed,* in the case of uniform motion of an object, might be, "the distance the object moves in one unit of time." "How fast the object is moving" would *not* be an acceptable interpretation.)

   - period *(T)*

   - frequency *(f* or ν*)* (*Note:* "The reciprocal of the period" or "$1/T$" is *not* an interpretation.)

   - wavelength (λ)

   b. Show that the equation for the wave speed, $v = \lambda f$, comes directly from the definition of speed, in the case of uniform motion. (*Hint:* Recall the interpretation of speed from part a.)

   c. Explain why T, λ, and f (or ν) should *not* be applied to a *pulse*. (*Hint:* How is the interpretation of λ different from the width of a pulse?)

   d. For each of the periodic functions below, indicate the wavelength on the diagram.

   i.

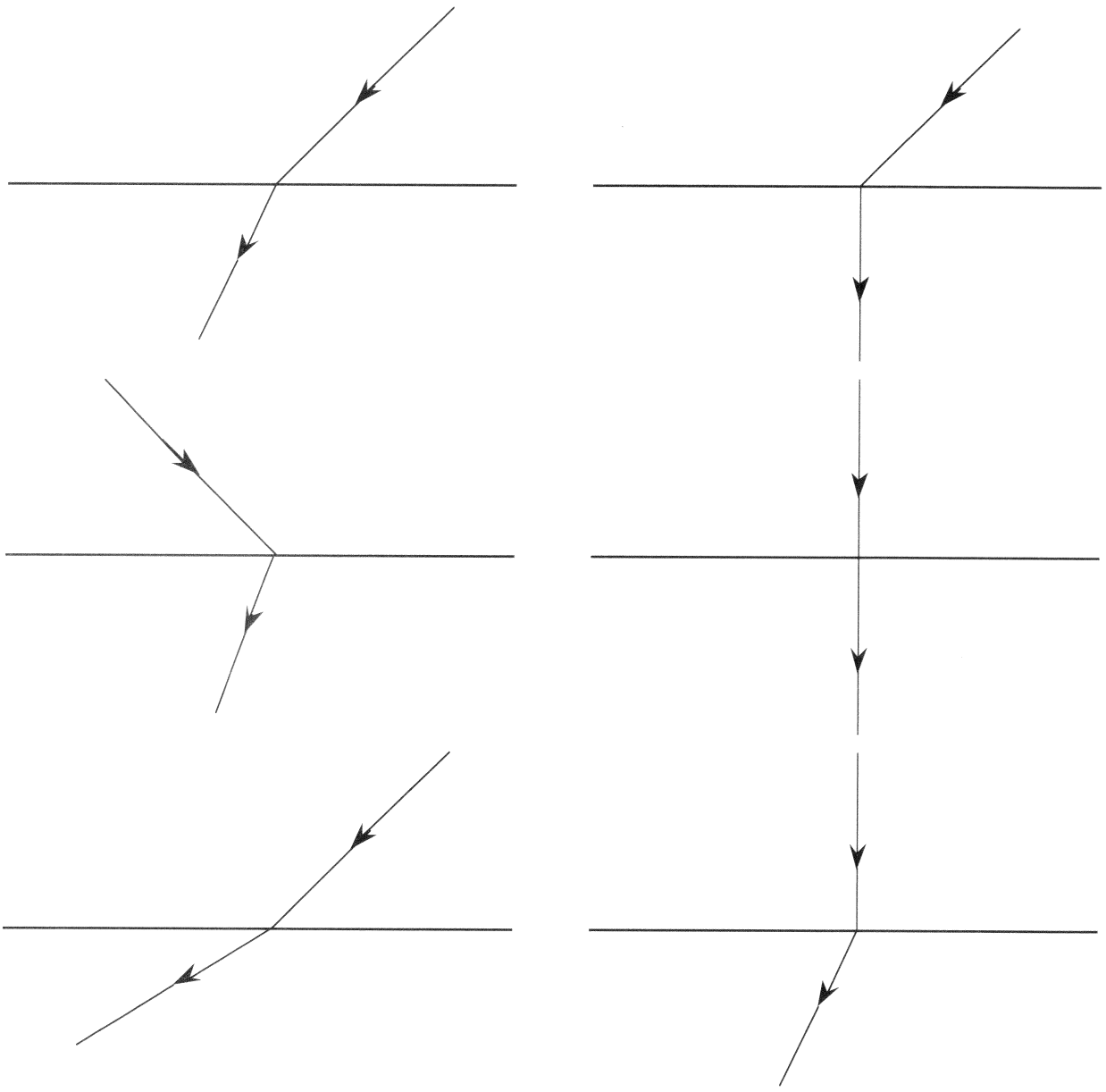
   ii.

2. Determine whether each of the ray diagrams below has a flaw.

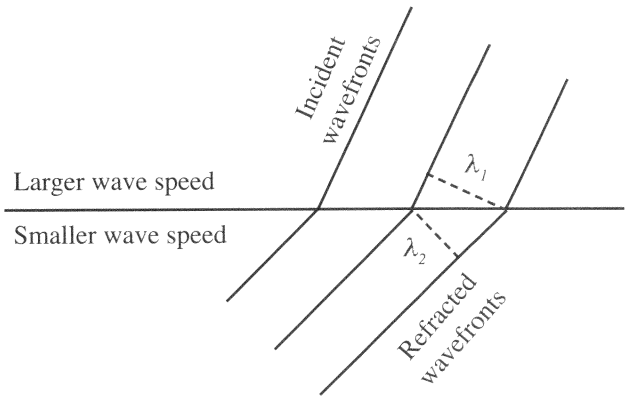
   If a diagram *has a flaw,* clearly describe how the physical situation is not consistent with observations that you made in tutorial (*e.g.*, a crest is transmitted as a crest).

   If a diagram *has no flaw:*

   - Use a straightedge to draw incident and transmitted wavefronts that are consistent with the rays and boundary shown.
   - If possible, determine in which medium the waves travel more quickly. If it is not possible to make this comparison, explain why not.



3. The diagram at right illustrates refraction of a wave as it propagates from a medium of larger wave speed to a medium of smaller wave speed.



   a. Use trigonometry to determine the mathematical relationship between the angle of incidence (θ_1), the angle of refraction (θ_2), the wavelength of the incident wave (λ_1), and the wavelength of the refracted wave (λ_2). Show your work.

   b. Starting from the equation that you wrote above, derive a mathematical formula relating θ_1, θ_2, v_1, and v_2, where v_1 and v_2 are the speeds of the incident and refracted wave, respectively. Show your work.

   c. Suppose the speed of the refracted wave were half that of the incident wave. Determine the angle of refraction for the following angles of incidence: 10°, 20°, 40°, and 80°.

      Does the angle of refraction double when the angle of incidence doubles?

   d. Would the relationship that you developed in parts a and b also apply to a wave passing from a medium of smaller wave speed to a medium of larger wave speed? Explain why or why not.