Physics 200 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Notes: 25.3-25.4 Refraction and Total Internal Reflection

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1. The changing of a light ray’s direction (loosely called bending) when it passes through variations in matter is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. In Einstein’s theory of relativity, the speed of light c was found not to depend on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of the source or the observer.

3. The speed of light is so important that its value in a \_\_\_\_\_\_\_\_\_\_\_\_ is one of the most fundamental constants in nature. However, the speed of light does vary in a precise manner with the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ it passes through.

4. The first real evidence that light traveled at a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ speed came from the Danish astronomer Ole Roemer in the late 17th century. Roemer had noted that the average orbital period of one of Jupiter’s moons, as measured from Earth, varied depending on whether Earth was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Jupiter as they orbited the Sun. He correctly concluded that the apparent change in period was due to the change in distance between Earth and Jupiter and the \_\_\_\_\_\_\_\_\_\_\_\_\_ it took \_\_\_\_\_\_\_\_\_\_\_\_\_ to travel this distance.

5. c =

6. The speed of light through matter is \_\_\_\_\_\_\_\_\_\_\_\_than it is in a vacuum, because light interacts with the \_\_\_\_\_\_\_\_\_\_\_\_ in a material. The speed of light depends strongly on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, since its interaction with different atoms, crystal lattices, and other substructures varies. The speed of light through a material is equal to:

 where n = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Since the speed of light is always \_\_\_\_\_\_\_\_\_\_\_\_ than c in matter and equals c only in a vacuum, the index of refraction is always \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than or equal to one.

7. The change in direction of a light ray depends on how the speed of light \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when it crosses from one medium to another. No change in the speed of light means no bending.

8. Snell’s Law:

8.5 Conceptually, you can understand the turning of a refracting ray if you think of the ray as a car traveling from a fast road surface to a slow one (or vice versa).

9. Total Internal Reflection

A. When the second medium has an index of refraction \_\_\_\_\_\_\_\_\_\_\_ than the first, you can get total internal reflection where all of the light is reflected back into the medium.

B. C 

C. Examples:

 i.

 ii.

 iii.

**Practice** - 25.3-25.4 Refraction and Total Internal Reflection

1. What is the speed of light in water?

3, What is the speed of light in crown glass?

5. In what substance in Table 25.1 is the speed of light 2.290 x 108 m/s?

7. A scuba diver training in a pool looks at his instructor. What angle does the ray from the instructor’s face make with the perpendicular to the water at the point where the ray enters? The angle between the ray in the water and the perpendicular to the water is 25.0º.

9. Suppose you have an unknown clear substance immersed in water, and you wish to identify it by finding its index of refraction. You arrange to have a beam of light enter it at an angle of 45.0º, and you observe the angle of refraction to be 40.3º. What is the index of refraction of the substance and its likely identity?

13. What is the critical angle for light going from diamond to air?

15. Suppose you are using total internal reflection to make an efficient corner reflector. If there is air outside and the incident angle is 45.0º (so that the beam is making a right angle turn), what must be the minimum index of refraction of the material from which the reflector is made?

17. A ray of light, emitted beneath the surface of an unknown liquid with air above it, undergoes total internal reflection. If the diagram shows a light ray reflecting at the critical angle, what is the index of refraction for the liquid, and its likely identification?

**Answers**:

1. 2.25 x 108 m/s 3. 1.97 x 108 m/s 5. 1.31, ice 7. 34.8 s 6. 1.28 s 7.3o

9. 1.46, fused quartz 13. 24.4o 15. 1.41 17. 1.50, benzene