Name: _____

Class: _____

Due Date: _____

Physics Topic 30 – Wavefronts, Rays, Reflection, and Refraction

Answer the following questions. The solutions to this worksheet can be found on the YouTube channel Go Physics Go.

1. C: Define *wavefront.*

2. C: Define *ray.*

3. E: **Use a pencil and ruler!** Draw three wavefronts and six rays after a small rock falls vertically and hits water.

4. E: **Use a pencil and ruler!** Draw two wavefronts and eight rays after a long thin rod falls horizontally and hits water.

5. C: Define *superposition.*

6. C: **Use a pencil and ruler!** Draw a before, during, and after image of two pulses on a rope traveling in opposite directions which go through constructive interference.

Before interference	
During interference	
After interference	

7. C: **Use a pencil and ruler!** Draw a before, during, and after image of two pulses on a rope traveling in opposite directions which go through destructive interference.

Before interference	
During interference	
After interference	

8. C: **Use a pencil and ruler!** Draw a before and after image of a single pulse wave on a string striking and being reflected from a vertical pole with a *fixed end*.

Before	
After	

9. C: **Use a pencil and ruler!** Draw a before and after image of a single pulse wave on a string striking and being reflected from a vertical pole with a *free/loose end*.

Before	
After	

10. C: What is the equation, units, and meaning of *index of refraction n*? What is the range of values for the *refractive index* of an object? What is the *refractive index* for a vacuum?

11. E: The speed of light in a vacuum is $3.00 \times 10^8 \ \frac{\text{m}}{\text{s}}$ while the speed of light in a diamond is measured to be $1.24 \times 10^8 \ \frac{\text{m}}{\text{s}}$. What is the index of refraction of diamond?

12.E: The index of refraction of light in water is $n_{\text{water}} = 1.33$. What is the speed of light in water?

13.E: Light, which has a wavelength of $\lambda = 450.\,\text{nm}$, is moving through Carbon Tetrachloride with a speed of $2.056 \times 10^8\ \frac{\text{m}}{\text{s}}$.

a. What is the index of refraction of Carbon Tetrachloride?

b. What is the frequency of this light wave as it passes through the Carbon Tetrachloride?

c. What will be the corresponding wavelength of this light wave in air?

14.E: Light, which has a wavelength of $625\ \text{nm}$ in air, enters flint glass. The index of refraction of flint glass is approximately 1.63.

a. What is the speed of light in flint glass?

b. What will be the wavelength of this light within the flint glass?

c. What is the frequency of this light within the flint glass?

d. What is the frequency of this light in air?

15.C: **Use a pencil and ruler!** Define *reflection* and draw a labeled figure.

16.C: State the equation for the *law of reflection*.

17.C: **Use a pencil and ruler!** Define *refraction* and draw a labeled figure. (Do not confuse *refraction* with *rarefaction*!)

Play with these simulations:
https://physics.bu.edu/~duffy/HTML5/refraction_block.html
https://physics.bu.edu/~duffy/HTML5/refraction.html

18.C: Describe and state the equation for refraction: *Snell's law*.

19.C: **Use a pencil and ruler!** Draw a detailed image of a ray traveling from a fast medium to a slow medium.

20.C: **Use a pencil and ruler!** Draw a detailed image of a ray traveling from a slow medium to a fast medium.

21.C: **Use a pencil and ruler!** Define *dispersion* and draw a labeled figure.

22. E: A wave, which has a wavelength of 1.40 m and a wave speed of 4.80 m/s, enters a second medium where the wavelength is reduced to 0.900 m. What will be the wave speed in the second medium?

23. A wave moving with a speed of 38.0 cm/s and having a wavelength of 4.50 cm strikes an interface at an angle of 57.0° relative to the normal. In the second medium the speed of the wave is reduced to 24.0 cm/s.

    a. What will be the angle of the wave in the second medium?

    b. What will be the wavelength in the second medium?

    c. What will be the frequency of this wave in the first medium?

    d. What will be the frequency of this wave in the second medium?

    e. Which medium has a higher index of refraction?

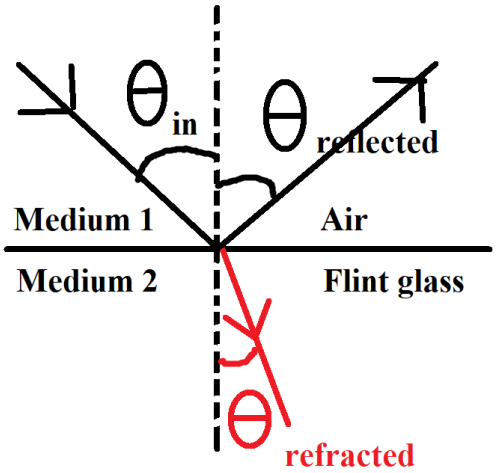
24.E: A wave moving with a speed of 1.25 m/s strikes an interface at an incident angle of 82.0°. After passing through the interface the angle shifts to 55.0° and the wavelength becomes 5.60 cm.

a. What will be the speed of this wave in the second medium?

b. What will be the wavelength in the first medium?

c. What will be the frequency in the second medium?

25.E: A light ray, which has a wavelength of 580 nm, strikes a horizontal interface going from air into flint glass. Given that the angle between the incident light ray and the normal to the interface is 47.0°. The index of refraction of flint glass is approximately 1.63.



a. What will be the corresponding angle in the flint glass?

b. What will be the wavelength of this light within the flint glass?

c. What will be the frequency of this light within the flint glass?

d. Some of the light reflects at the interface. What will be the angle between the reflected light ray and the normal to the interface?

26.E: A light beam traveling through glycerol, which has an index of refraction of 1.48, encounters an interface at an angle of 67.0° relative to the normal to the surface. The corresponding angle in the second medium is measured to be 50.5°. What is the index of refraction of the second medium?

27. E: A light wave moving through an unknown medium encounters an interface at an angle of 52.0° and then refracts to an angle of 45.2° into Lucite, which has an index of refraction of 1.50. What is the index of refraction of the first medium?

28. C: **Use a pencil and ruler!** Define *total internal reflection* and *critical angle*. Draw a labeled figure.

    Play with this simulation:
    https://www.thephysicsaviary.com/Physics/Programs/Labs/RefractionLab/index.html

29. E: A light beam is moving from flint glass into water. What is the critical angle between these two mediums? The index of refraction of flint glass is 1.63 while the index of refraction of water is 1.33.

30.E: Determine the critical angle between the following two media:

a. diamond ($n = 2.42$) and water ($n = 1.33$)

b. alcohol ($n = 1.36$) and Lucite ($n = 1.50$)

c. Hot air ($n = 1.02$) and room temperature ($n = 1.00$)