**Light Waves and Color Review**

From <http://www.physicsclassroom.com/reviews/light/lightprint.cfm>

**Part A: Multiple Choice**

1. Which of the following statements are true statements about interference?

1. Interference occurs when two (or more) waves meet while traveling along the same medium.
2. Interference can be constructive or destructive.
3. Interference of two waves at a given location results in the formation of a new wave pattern that has a greater amplitude than either of the two interfering waves.
4. The meeting of a trough of one wave with a trough of another wave results in destructive interference.
5. The only way for two waves to interfere constructively is for a crest to meet a crest or a trough to meet a trough.
6. It is only a theory that light can interfere destructively; the theory is based on the assumption that light is a wave and most waves exhibit this behavior. Experimental evidence supporting the theory has not yet been observed.

2. Which of the following statements are true statements about two-point light source interference patterns?

1. Two-point light source interference patterns consist of alternating nodal and antinodal lines.
2. If projected onto a screen, two-point light source interference patterns would be viewed as alternating bright and dark spots with varying gradients of light intensity in between.
3. As the distance between the sources is decreased, the distance between the nodal and antinodal lines is decreased.
4. As the wavelength of the laser light is decreased, the distance between the nodal and antinodal lines is decreased.
5. A nodal point would be formed if a trough of one wave meets a trough of another wave.
6. Antinodal points are points where the medium is undergoing no vibrational motion.
7. Suppose point P is a point where a wave from one source travels a distance of 2.5 wavelengths before meeting up with a wave from another source which travels a distance of 3.5 wavelengths. Point P would be a nodal point.
8. Suppose point Q is a point where a wave from one source travels a distance of 2 wavelengths before meeting up with a wave from another source which travels a distance of 3.5 wavelengths. Point Q would be a nodal point.
9. Suppose point R is a point where a wave from one source travels a distance of 2 wavelengths before meeting up with a wave from another source which travels a distance of 3 wavelengths. Point R would be a nodal point.
10. If the path difference for points on the first nodal line is 4 cm, then the wavelength would be 6 cm. (NOTE: the first nodal line is considered to be the first nodal line to the left or right from the central antinodal line.)

3. Which of the following statements are true statements about nodal and antinodal points in light interference patterns?

1. Antinodes result from constructive interference.
2. Nodes result from destructive interference.
3. The nodal points on an interference pattern are positioned along lines; these lines are called nodal lines.
4. The central line on the interference pattern is a nodal line.
5. Points on nodal lines are represented by bright spots if projected onto a screen.
6. The path difference for points on the central antinodal line would be 0.
7. The path difference for points on the first antinodal line would be 1 cm.
8. (This question presumes that the interference pattern is a water interference pattern.) If the path difference for points on the first antinodal line is 5 cm, then the path difference for points on the second antinodal line would be 7 cm.
9. (This question presumes that the interference pattern is a water interference pattern.) If the path difference for points on the first antinodal line is 5 cm, then the path difference for points on the third antinodal line would be 15 cm.
10. (This question presumes that the interference pattern is a water interference pattern.) If the path difference for points on the first antinodal line is 6 cm, then the path difference for points on the second nodal line would be 9 cm. (NOTE: the second nodal line is considered to be the second nodal line to the left or right from the central antinodal line.)
11. (This question presumes that the interference pattern is a water interference pattern.) If the path difference for points on the first nodal line is 4 cm, then the path difference for points on the third nodal line would be 12 cm. (NOTE: the third nodal line is considered to be the third nodal line to the left or right from the central antinodal line.)

4. Which of the following statements are true statements about Thomas Young's experiment?

1. Young's experiment provided evidence that light exhibits particle-like behavior.
2. Young's experiment depends upon the use of white light from two sources.
3. The two sources of light in Young's experiment could be two different light bulbs.
4. For Young's equation to be geometrically valid, the distance from the sources to the screen must be much greater than the slit separation distance.
5. For Young's equation to be geometrically valid, the wavelength of the light must be much greater than the slit separation distance.
6. Thomas Young measured the distance from an antinodal point (of known number) to each of the two sources, computed a path difference and calculated the wavelength of light.
7. Thomas Young was able to determine the wavelength of a light wave.

5. Light that is vibrating in a single plane is referred to as \_\_\_\_\_ light

a. electromagnetic b. transverse c. unpolarized d. polarized

6. Light that is vibrating in a variety of planes is referred to as \_\_\_\_\_ light

a. electromagnetic b. transverse c. unpolarized d. polarized

7. Light usually vibrates in multiple vibrational planes. It can be transformed into light vibrating in a single plane of vibration. The process of doing this is known as \_\_\_\_.

a. translation b. interference c. polarization d. refraction

8. Light is passed through a Polaroid filter whose transmission axis is aligned horizontally. This will have the effect of \_\_\_\_.

a. making the light one-half as intense and aligning the vibrations into a single plane.

b. aligning the vibrations into a single plane without any effect on its intensity.

c. merely making the light one-half as intense; the vibrations would be in every direction.

d. ... nonsense! This will have no effect on the light itself; only the filter would be affected.

9. Light is passed through a Polaroid filter whose transmission axis is aligned horizontally. It then passes through a second filter whose transmission axis is aligned vertically. After passing through both filters, the light will be \_\_\_\_\_\_.

a. polarized b. unpolarized

c. entirely blocked d. returned to its original state.

10. Which of the following are effective methods of polarization? Include all that apply.

a. Passing light through a Polaroid filter.

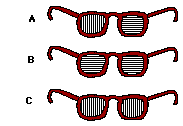
b. Reflection of light off a nonmetallic surface.

c. Passing light from water to air.

d. Passing light through a birefringent material such as Calcite.

e. Turning the light on and off at a high frequency.

f. Interfering light from one source with a second source.



11. Consider the three pairs of sunglasses to the right. Which pair of glasses is capable of eliminating the glare from a road surface? (The transmission axes are shown by the straight lines.)

12. **TRUE or FALSE:**

White and black are actual colors of light.

a. True b. False

13. The three primary colors of light are \_\_\_\_.

a. white, black, gray b. blue, green, yellow

c. red, blue, green d. red, blue, yellow

e. ... nonsense! There are more than three primary colors of light.

14. The three secondary colors of light are \_\_\_\_.

a. cyan, magenta, green

b. cyan, magenta, and yellow

c. orange, yellow, violet

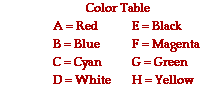
d. red, blue, yellow

e. ... nonsense! There are more than three secondary colors of light.

15. Combining red and green light (with equal intensity) makes \_\_\_\_ light; combining red and blue light (with equal intensity) makes \_\_\_\_ light; and combining blue and green light (with equal intensity) makes \_\_\_\_ light. Choose the three colors in respective order.

a. brown, purple, aqua b. brown, magenta, yellow

c. yellow, magenta, brown d. yellow, magenta, cyan

16. Demonstrate your understanding of color addition by completing the following color equations. Select colors from the Color Table at the right.

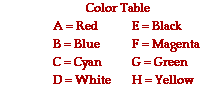
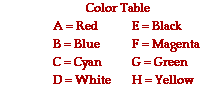
a. Red + Blue = \_\_\_\_\_

b. Red + Green = \_\_\_\_\_

c. Green + Blue = \_\_\_\_\_

d. Red + Blue + Green = \_\_\_\_\_

e. Blue + Yellow = \_\_\_\_\_

17. Demonstrate your understanding of color subtraction by completing the following color equations. Select colors from the Color Table at the right.

a. White - Blue = \_\_\_\_\_

b. White - Red = \_\_\_\_\_

c. White - Green = \_\_\_\_\_

d. White - Blue - Green = \_\_\_\_\_

e. White - Yellow = \_\_\_\_\_ f. Red + Green - Green = \_\_\_\_\_

g. Yellow - Green = \_\_\_\_\_ h. Yellow - Red = \_\_\_\_\_

i. White - Magenta = \_\_\_\_\_ j. White - Cyan = \_\_\_\_\_

k. Yellow + Blue - Cyan = \_\_\_\_\_ l. Yellow + Cyan + Magenta = \_\_\_\_\_

m. Yellow + Cyan - Magenta = \_\_\_\_\_ n. Yellow + Cyan - Blue - Red = \_\_\_\_\_

18. Sunsets often have a reddish-orange color associated with them. This is attributable to the phenomenon of \_\_\_\_\_.

a. polarization b. diffraction c. dispersion d. refraction

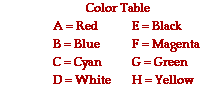
19. A filter serves the function of \_\_\_\_.

a. subtracting color(s) from the light which is incident upon it

b. adding color(s) to the light which is incident upon it

c. removing nicotine from light so that we can live longer lives

d. confusing physics students who are studying color, causing them to live shorter lives

20. Express your understanding of filters by answering the following questions. Choose the best answer(s) from the Color Table shown at the right.

a. A red filter is capable of transmitting \_\_\_\_ light (if it is incident upon the filter).

b. A blue filter is capable of transmitting \_\_\_\_ light (if it is incident upon the filter).

c. A green filter is capable of transmitting \_\_\_\_ light (if it is incident upon the filter).

d. A red filter will absorb \_\_\_\_ light (if it is incident upon the filter).

e. A blue filter will absorb \_\_\_\_ light (if it is incident upon the filter).

f. A yellow filter will absorb \_\_\_\_ light (if it is incident upon the filter).

g. A magenta filter will absorb \_\_\_\_ light (if it is incident upon the filter).

h. A white object is illuminated with white light and viewed through a green filter. The object will appear \_\_\_\_\_.

i. A white object is illuminated with white light and viewed through a blue filter. The object will appear \_\_\_\_\_.

j. A white object is illuminated with white light and viewed through a cyan filter. The object will appear \_\_\_\_\_.

k. A blue object is illuminated with white light and viewed through a green filter. The object will appear \_\_\_\_\_.

l. A cyan object is illuminated with white light and viewed through a cyan filter. The object will appear \_\_\_\_\_.

m. A cyan object is illuminated with white light and viewed through a green filter. The object will appear \_\_\_\_\_.

n. A yellow object is illuminated with white light and viewed through a green filter. The object will appear \_\_\_\_\_.

o. A yellow object is illuminated with white light and viewed through a magenta filter. The object will appear \_\_\_\_\_.

p. A yellow object is illuminated with yellow light and viewed through a yellow filter. The object will appear \_\_\_\_\_.

q. A yellow object is illuminated with yellow light and viewed through a blue filter. The object will appear \_\_\_\_\_.

r. A yellow object is illuminated with blue light and viewed through a yellow filter. The object will appear \_\_\_\_\_.

s. A blue object is illuminated with blue light and viewed through a yellow filter. The object will appear \_\_\_\_\_.

t. A yellow object is illuminated with yellow light and viewed through a red filter. The object will appear \_\_\_\_\_.

u. A yellow object is illuminated with yellow light and viewed through a green filter. The object will appear \_\_\_\_\_.

v. A yellow object is illuminated with green light and viewed through a yellow filter. The object will appear \_\_\_\_\_.

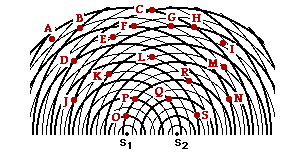
w. A yellow object is illuminated with green light and viewed through a green filter. The object will appear \_\_\_\_\_.

x. A yellow object is illuminated with green light and viewed through a red filter. The object will appear \_\_\_\_\_.

y. A yellow object is illuminated with green light and viewed through a cyan filter. The object will appear \_\_\_\_\_.

z. A red object is illuminated with yellow light and viewed through a cyan filter. The object will appear \_\_\_\_\_.

**Part B: Diagramming, Analysis, Calculations**

21. Two point sources are vibrating together (in phase) at the same frequency to produce a two-point source interference pattern. The diagram at the right depicts the two-point source interference pattern. The crests are represented by thick lines and the troughs by thin lines. Several points on the pattern are marked by a dot and labeled with a letter. Use the diagram to answer the following questions.

a. Which of the labeled points are antinodal points?

b. Which of the labeled points are nodal points?

c. Which of the labeled points are formed as a result of constructive interference?

d. Which of the labeled points are located on the central antinodal line?

e. Which of the labeled points are located on the first antinodal line?

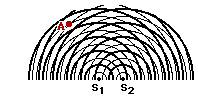
f. Which of the labeled points are located on the second antinodal line?

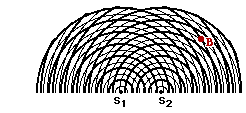
g. Which of the labeled points are located on the third antinodal line?

h. Which of the labeled points are located on the first nodal line (using the notation that the first nodal line is the nodal line directly to the left or the right of the central antinodal line)?

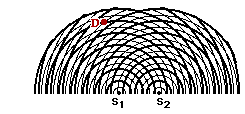
i. Which of the labeled points are located on the second nodal line (using the notation that the second nodal line is the second nodal line directly to the left or the right of the central antinodal line)?

j. Which of the labeled points are located on the third nodal line (using the notation that the third nodal line is the third nodal line directly to the left or the right of the central antinodal line)?

22. Consider the interference pattern at the right. (The crests are represented by thick lines and the troughs by thin lines.) If the distance from S1 to point A is 49.5 cm and the distance from S2 to point A is 60.5 cm, then what is the wavelength?

23. Consider the interference pattern at the right. (The crests are represented by thick lines and the troughs by thin lines.) If the distance from S1 to point B is 50.2 cm and the distance from S2 to point A is 34.5 cm, then what is the wavelength?

24. Two point sources are vibrating in phase to produce an interference pattern. The wavelength of the waves is 7.60 cm. Point C is a point on the third nodal line. The distance from S1 (the nearest source) to point C is 65.6 cm. Determine the distance from S2 to point C.



25. Consider the interference pattern at the right. (The crests are represented by thick lines and the troughs by thin lines.) The distance from S1 to point D is 47.2 cm. What is the wavelength? What is the distance from S2 to point D? (HINT: Use the diagram.)

26. Laser light is directed towards a pair of slits that are 2.50 x 10-2 mm apart. The light shines on a screen 8.20 meters away and an interference pattern is observed. A point on the 3rd antinode is observed to be 39.6 cm away from the central antinode. What is the wavelength of the laser light in units of nanometers? (1 m = 109 nm)

27. This same laser light (from Question 26) is reflected off the grooves in a compact disc. The disc is 4.5 meters from the screen where its interference pattern is projected. Antinode 1 is found to be 1.2 meters from the central antinode. What is the spacing between the "grooves" of the CD?

28. Different colors of paper are illuminated with different primary colors of light. Determine the colors of light absorbed by the paper (if any), the colors of light reflected by the paper (if any), and the appearance of the paper.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Color of**  **Light** | ***Color of***  **Paper** | **Colors**  **Absorbed** | **Colors**  **Reflected** | **Appearance** |
| a. | White | White |  |  |  |
| b. | Cyan | White |  |  |  |
| c. | Yellow | White |  |  |  |
| d. | Red | Yellow |  |  |  |
| e. | Red | Blue |  |  |  |
| f. | Red | Cyan |  |  |  |
| g. | Red | Red |  |  |  |
| h. | Magenta | Red |  |  |  |
| i. | Yellow | Red |  |  |  |
| j. | Cyan | Red |  |  |  |
| k. | Cyan | Blue |  |  |  |
| l. | Yellow | Blue |  |  |  |
| m. | Yellow | Green |  |  |  |
| n. | Yellow | Cyan |  |  |  |
| o. | Yellow | Magenta |  |  |  |