C:2

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CHAPTER 22: The Wave Nature of Light

Select the term that best completes each of the following statements. Place the letter of the term you choose in the space provided for the answer.

1. Newton's corpuscular theory could not satisfactorily explain
   a. refraction
   b. reflection
   c. diffusion
   d. interference
   look up A 1. A

2. According to the corpuscular theory, as light enters glass the speed of light should
   a. increase
   b. decrease
   c. remain the same
   d. decrease, then increase
   look up A 2. A

3. The fact that a light wave can pass through a 10 cm opening without being diffracted to any great extent indicates that the wavelength of the light is
   a. exactly 10 cm
   b. slightly more than 10 cm
   c. much more than 10 cm
   d. much less than 10 cm
   ✓ 3. D

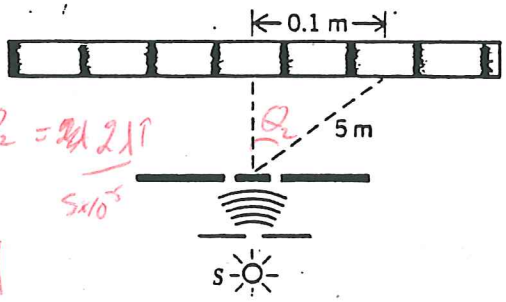
4. On a water surface, two sources generate waves that overlap each other. The regions in which there is no wave motion are
   a. nodal lines
   b. maximums
   c. troughs
   d. crests
   ✓ 4. A

5. A single-slit diffraction pattern is produced by a beam of light. The distance between any two adjacent minimums may be increased by
   a. changing to light of a lower frequency
   b. changing to light of a higher frequency
   c. increasing the width of the slit
   d. increasing the intensity of the light
   ✓ 5. A

$d \sin\theta = m\lambda$ $\sin\theta = \frac{m\lambda}{d}$

Study the information below; then complete statements 6-8.

Light of given wavelength passes through a narrow slit and then passes through two slits 5×10^{-5} m apart. The pattern that appears on the screen is shown in the diagram.



$\frac{x}{5} = \sin\theta_2 = \frac{m\lambda}{d}$ $\frac{d \sin\theta_2}{2} = \lambda$

6. The wavelength of the light is
   a. 1×10^{-6} m
   b. 5×10^{-7} m
   c. 5×10^{3} m
   d. 1.25×10^{-3} m
   ✓ 6. B

7. If light of a longer wavelength is used, the maximums on the pattern will
   a. move closer to the center
   b. move away from the center
   c. retain their present positions
   d. increase in intensity
   ✓ 7. B

8. If the distance between the slits is decreased, the minimums on the pattern will
   a. move closer to the center
   b. move away from the center
   c. retain their present positions
   d. increase in intensity
   ✓ 8. B

same effect as $\lambda\uparrow$

Select the term that best completes each of the following statements.

9. Among the following, the one *least* useful as evidence of wave motion is
   a. a fluttering TV picture
   b. an Arago spot
   c. a sharp shadow
   d. a fuzzy shadow

   omit 9.....

10. An electric motor vibrates two point sources in phase at frequency f, and generates an interference pattern in a ripple tank. If the frequency is changed to $2f$, the number of nodal lines in the pattern in the tank will
   a. increase
   b. decrease
   c. remain the same
   d. vary continuously

   omit 10.....

11. Two rays will interfere constructively with maximum amplitude if the path difference between them is
   a. $n\lambda$
   b. $n\lambda/2$
   c. $n\lambda/4$
   d. $n\lambda/8$

   ✓ 11. A

12. Two point sources, 8 cm apart and operating in phase in a ripple tank, produce an interference pattern. A point on the first nodal line is 12 cm from the center line and 80 cm from a point midway between the two sources. The wavelength of the waves in the pattern is
   a. 1.2 cm
   b. 2.4 cm
   c. 3.6 cm
   d. 4.8 cm

   same as double slit →

   ✓ 12. B

13. Interference between the component rays of a single broad wavefront results in
   a. refraction
   b. reflection
   c. diffusion
   d. diffraction

   omit 13...

14. A beam of light of a single wavelength passes perpendicularly through a slit whose width is 1.0×10^{-4} m. A pattern appears on a screen 1.0 m from the slit. If the distance from the first maximum to the center line is 5.0×10^{-3} m, the wavelength of the light is
   a. 1000 Å
   b. 4000 Å
   c. 5000 Å
   d. 3333 Å

   $\lambda = 10^{-10}$ m

   ✓ 14. C

15. The resultant amplitude of waves passing through a single slit is zero when the path difference between the waves is
   a. $\lambda/8$
   b. $\lambda/4$
   c. $\lambda/2$
   d. λ

   ✓ 15. C

16. Light bends around sharp corners as a result of
   a. refraction
   b. reflection
   c. diffraction
   d. dispersion

   ✓ 16. C

17. In an experiment with a double slit, the first maximum appears at an angle θ_1 from the center line. If the space between the slits is halved, the first maximum now appears at an angle of θ_2 from the center line. The relation between θ_1 and θ_2 is
   a. $\theta_1 = \theta_2$
   b. $\theta_2 = 2\theta_1$
   c. $\sin\theta_1 = 2\sin\theta_2$
   d. $\sin\theta_2 = 2\sin\theta_1$

   ✓ 17. D

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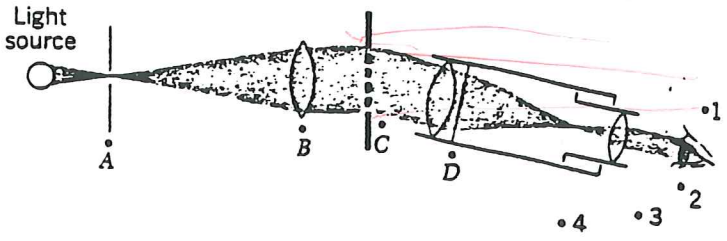
Study the information below; then complete statements 18-20.

The diagram represents a diffraction grating spectroscope. The grating has 5000 lines/cm.



18. The diffraction grating is located nearest to point
    a. *A*
    b. *B*
    c. *C*
    d. *D*

    ✓18. C

19. If an observer is looking at the second-order spectrum and wants to look at the first-order spectrum, she should move the eyepiece toward point
    a. 1
    b. 2
    c. 3
    d. 4

    ✓19. A

20. The value of sin θ for the second-order green line (λ = 5000 Å) is
    a. 0.25
    b. 0.50
    c. 0.75
    d. 1.00

    ✓20. B

$2\lambda = d \sin\theta$

$1 \times 10^{-6} = 2 \times 10^{-6} \sin\theta$

$.5 = \sin\theta$

Select the term that best completes each of the following statements.

8. Light of wavelength λ is directed at a thin soap film. The light will experience complete destructive interference if the film thickness is
   a. $\lambda/8$
   b. $\lambda/4$
   c. $\lambda/2$
   d. $3\lambda/4$

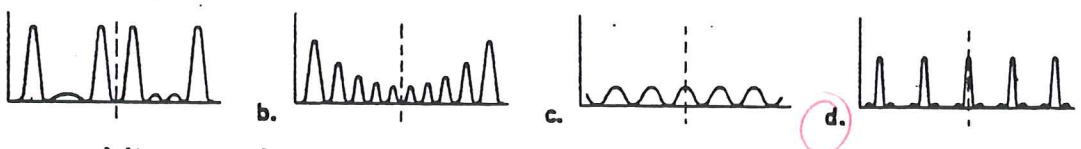
9. The Michelson interferometer provided experimental evidence that the speed of light is
   a. greater than the speed of sound
   b. independent of the observer's motion
   c. impossible to measure
   d. dependent upon the medium in which it travels

10. An experimenter working with a Michelson interferometer sees 200 fringes moving past a reference point as the mirror on the device is moved 5.0×10^{-5} m. The wavelength of the light being observed is
   a. 2500 Å
   b. 4000 Å
   c. 5000 Å
   d. 8000 Å

11. The maximum of the interference pattern formed by a diffraction grating compared with those of a double slit are
   a. fuzzier and dimmer
   b. fuzzier and brighter
   c. sharper and dimmer
   d. sharper and brighter

12. The prism in a spectroscope separates light into its component colors by
   a. refraction
   b. reflection
   c. diffraction
   d. interference

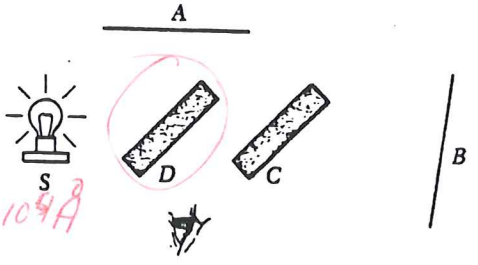
13. The relation between the intensity of light I and the distance from the center line C of an interference pattern formed by a diffraction grating is best shown by graph



14. A spectral line must be light
   a. of a single wavelength
   b. from two sources
   c. from a low-intensity source
   d. from a star

15. The greater the ability of a spectroscope to separate two colors of almost the same wavelength, the greater its
   a. grating space
   b. slit width
   c. eyepiece magnification
   d. resolving power

16. In the diagram of the Michelson interferometer, the half-silvered mirror used to split the light from source S is at
   a. A
   b. B
   c. C
   d. D



17. A diffraction grating has 2000 lines/cm. The space between the centers of the slits of the grating is
   a. 2000 Å
   b. 5000 Å
   c. 10,000 Å
   d. 50,000 Å

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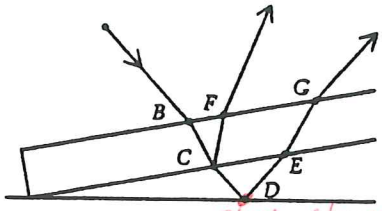
CHAPTER 23: Applications of Wave Optics

Select the term that best completes each of the following statements. Place the letter of the term you choose in the space provided for the answer.

1. Monochromatic light consists of
   a. only one wavelength
   b. a band of 10 wavelengths
   c. a band of 100 wavelengths
   d. a band of 1,000,000 wavelengths

   ✓ A 1.....

2. As shown in the diagram, ray *A* is reflected at points
   a. *C* and *D*
   b. *C* and *E*
   c. *D* and *G*
   d. *E* and *G*



phase change

✓ A 2.....

3. A series of bright and dark bands are seen when looking at an air wedge. A bright band *A* is followed by a dark band and then another bright band *B*. The total path difference between bright band *A* and *B* is
   a. $\lambda/4$
   b. $\lambda/2$
   c. λ
   d. 2λ

one λ farther

✓ C 3.....

4. Light of wavelength 5000 Å illuminates an air wedge 100 cm long with the top layer of glass 0.05 cm above the lower layer of glass at the open end. The distance between successive dark bands is
   a. 1.25×10^{-12} cm
   b. 5.0×10^{-2} cm
   c. 5.0×10^{2} cm
   d. 2.0×10^{5} cm

At end extra dist $2(\text{thickness}) = m\lambda$

$\frac{2 \times (.05 \times 10^{-2})}{5000 \times 10^{-10}} = 2000 = m \leftarrow$ # of minima over 1 meter

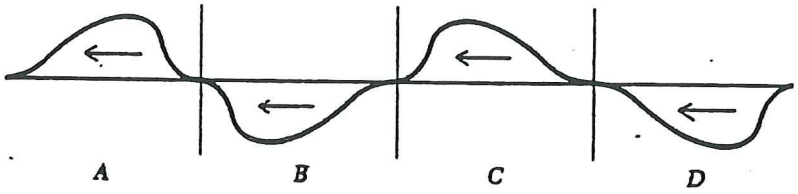
$= 5 \times 10^{-4}$ m between minima

$= 5 \times 10^{-2}$ cm

✓ B 4.....

Study carefully the information below; then complete statements 5-7.

The diagram at the right shows a pulse sent along a rope. The diagram below shows four sections, each a possible reflected pulse, labeled *A*, *B*, *C*, and *D*.



5. If the end of the rope is attached to a rigid wall, the reflected pulse will look like that in section
   a. *A*
   b. *B*
   c. *C*
   d. *D*

✓ B 5.....

6. If the end of the rope is unattached, the reflected pulse will look like that in section
   a. *A*
   b. *B*
   c. *C*
   d. *D*

✓ C 6.....

7. If the speed of the original pulse is 2 m/sec, the speed of the reflected pulse will be
   a. 0.5 m/sec
   b. 1 m/sec
   c. 2 m/sec
   d. 4 m/sec

✓ C 7.....

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Study the paragraph below; then complete statements 18-20.

A beam of light of a single wavelength ($\lambda = 4.5 \times 10^{-7}$ m) is directed at two parallel slits, S_1 and S_2, which are 3.0×10^{-4} m apart. An interference pattern appears on a screen 9.0×10^{-1} m from the slits.

18. The difference in the lengths of the paths from S_1 and S_2 to the second maximum is
    a. $\lambda/2$
    b. λ
    c. $3\lambda/2$
    d. 2λ

    18. D

19. The distance from the midpoint of the second maximum to the center line is
    a. 3.0×10^{-10} m
    b. 2.7×10^{-3} m
    c. 6.0×10^{2} m
    d. 6.1×10^{-12} m

    19. B

20. The frequency of the light is
    a. 1.5×10^{-15} Hz
    b. 1.4×10^{1} Hz
    c. 6.7×10^{14} Hz
    d. 3.0×10^{8} Hz

    20. C

$d \sin\theta_2 = 2\lambda$

$\theta_2 = \sin^{-1}\left(\frac{2\lambda}{d}\right) =$

$\theta_2 = .172^\circ$

$(.9)(\tan\theta_2) = 2.7 \times 10^{-3}$