Chapter 34: IMAGES

1. A virtual image is one:
   A. toward which light rays converge but do not pass through
   B. from which light rays diverge but do not pass through
   C. from which light rays diverge as they pass through
   D. toward which light rays converge and pass through
   E. with a ray normal to a mirror passing through it

   ans: B

2. Which of the following is true of all virtual images?
   A. They can be seen but not photographed
   B. They are ephemeral
   C. They are smaller than the objects
   D. They are larger than the objects
   E. None of the above

   ans: E

3. When you stand in front of a plane mirror, your image is:
   A. real, erect, and smaller than you
   B. real, erect, and the same size as you
   C. virtual, erect, and smaller than you
   D. virtual, erect, and the same size as you
   E. real, inverted, and the same size as you

   ans: D

4. An object is 2 m in front of a plane mirror. Its image is:
   A. virtual, inverted, and 2 m behind the mirror
   B. virtual, inverted, and 2 m in front of the mirror
   C. virtual, erect, and 2 m in front of the mirror
   D. real, erect, and 2 m behind the mirror
   E. none of the above

   ans: E

5. A ball is held 50 cm in front of a plane mirror. The distance between the ball and its image is:
   A. 100 cm
   B. 150 cm
   C. 200 cm
   D. 0
   E. 50 cm

   ans: A

6. A card marked IAHIO8 is standing upright in front of a plane mirror. Which of the following is NOT true?
   A. The image is virtual
   B. The image shifts its position as the observer shifts his position
   C. The image appears as 8OIHAI to a person looking in the mirror
   D. The image is caused mostly by specular rather than diffuse reflection
   E. The image is the same size as the object

   ans: B

7. The angle between a horizontal ruler and a vertical plane mirror is 30°. The angle between the ruler and its image is:
   A. 15°
   B. 30°
   C. 60°
   D. 90°
   E. 180°

   ans: C

8. A 5.0-ft woman wishes to see a full length image of herself in a plane mirror. The minimum length mirror required is:
   A. 5 ft
   B. 10 ft
   C. 2.5 ft
   D. 3.54 ft
   E. variable: the farther away she stands the smaller the required mirror length

   ans: C

9. A man holds a rectangular card in front of and parallel to a plane mirror. In order for him to see the entire image of the card, the least mirror area needed is:
   A. that of the whole mirror, regardless of its size
   B. that of the pupil of his eye
   C. one-half that of the card
   D. one-fourth that of the card
   E. an amount which decreases with his distance from the mirror

   ans: D

10. A light bulb burns in front of the center of a 40-cm wide plane mirror that is hung vertically on a wall. A man walks in front of the mirror along a line that is parallel to the mirror and twice as far from it as the bulb. The greatest distance he can walk and still see the image of the bulb is:
   A. 20 cm
   B. 40 cm
   C. 60 cm
   D. 80 cm
   E. 120 cm

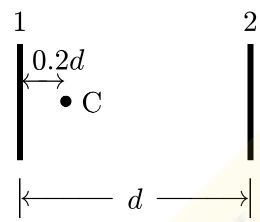
   ans: E

11. A plane mirror is in a vertical plane and is rotating about a vertical axis at 100 rpm. A horizontal beam of light is

A. 100 rpm
B. 141 rpm
C. 0 rpm
D. 200 rpm
E. 10, 000 rpm

ans: D

12. A candle C sits between two parallel mirrors, a distance $0.2d$ from mirror 1. Here d is the distance between the mirrors. Multiple images of the candle appear in both mirrors. How far behind mirror 1 are the nearest three images of the candle in that mirror?



A. $0.2d$, $1.8d$, $2.2d$
B. $0.2d$, $2.2d$, $4.2d$
C. $0.2d$, $1.8d$, $3.8d$
D. $0.2d$, $0.8d$, $1.4d$
E. $0.2d$, $1.8d$, $3.4d$

ans: A

13. Two plane mirrors make an angle of 120° with each other. The maximum number of images of an object placed between them is:

A. one
B. two
C. three
D. four
E. more than four

ans: B

14. A parallel beam of monochromatic light in air is incident on a plane glass surface. In the glass, the beam:

A. remains parallel
D. undergoes dispersion
B. becomes diverging
E. follows a parabolic path
C. becomes converging

ans: A

15. The focal length of a spherical mirror is N times its radius of curvature where N is:
  A. 1/4
  B. 1/2
  C. 1
  D. 2
  E. 4

  ans: B

16. Real images formed by a spherical mirror are always:
  A. on the side of the mirror opposite the source
  B. on the same side of the mirror as the source but closer to the mirror than the source
  C. on the same side of the mirror as the source but closer to the mirror than the focal point
  D. on the same side of the mirror as the source but further from the mirror than the focal point
  E. none of the above

  ans: E

17. The image produced by a convex mirror of an erect object in front of the mirror is always:
  A. virtual, erect, and larger than the object
  B. virtual, erect, and smaller than the object
  C. real, erect, and larger than the object
  D. real, erect, and smaller than the object
  E. none of the above

  ans: B

18. An erect object is located between a concave mirror and its focal point. Its image is:
  A. real, erect, and larger than the object
  B. real, inverted, and larger than the object
  C. virtual, erect, and larger than the object
  D. virtual, inverted, and larger than the object
  E. virtual, erect, and smaller than the object

  ans: C

19. An erect object is in front of a convex mirror a distance greater than the focal length. The image is:
  A. real, inverted, and smaller than the object
  B. virtual, inverted, and larger than the object
  C. real, inverted, and larger than the object
  D. virtual, erect, and smaller than the object
  E. real, erect, and larger than the object

  ans: D

20. As an object is moved from the center of curvature of a concave mirror toward its focal point its image:
    A. remains virtual and becomes larger
    B. remains virtual and becomes smaller
    C. remains real and becomes larger
    D. remains real and becomes smaller
    E. remains real and approaches the same size as the object

    ans: C

21. As an object is moved from a distant location toward the center of curvature of a concave mirror its image:
    A. remains virtual and becomes smaller
    B. remains virtual and becomes larger
    C. remains real and becomes smaller
    D. remains real and becomes larger
    E. changes from real to virtual

    ans: D

22. The image of an erect candle, formed using a convex mirror, is always:
    A. virtual, inverted, and smaller than the candle
    B. virtual, inverted, and larger than the candle
    C. virtual, erect, and larger than the candle
    D. virtual, erect, and smaller than the candle
    E. real, erect, and smaller than the candle

    ans: D

23. At what distance in front of a concave mirror must an object be placed so that the image and object are the same size?
    A. a focal length
    B. half a focal length
    C. twice a focal length
    D. less than half focal length
    E. more than twice a focal length

    ans: B

24. A point source is to be used with a concave mirror to produce a beam of parallel light. The source should be placed:
    A. as close to the mirror as possible
    B. at the center of curvature
    C. midway between the center of curvature and the focal point
    D. midway between the center of curvature and the mirror
    E. midway between the focal point and the mirror

    ans: D

25. A concave mirror forms a real image that is twice the size of the object. If the object is 20 cm from the mirror, the radiu

A. 13 cm
B. 20 cm
C. 27 cm
D. 40 cm
E. 80 cm

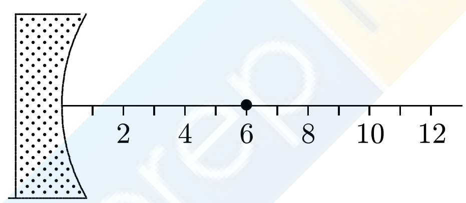
ans: C

26. A man stands with his nose 8 cm from a concave shaving mirror of radius 32 cm The distance from the mirror to the image of his nose is:

A. 8 cm
B. 12 cm
C. 16 cm
D. 24 cm
E. 32 cm

ans: C

27. The figure shows a concave mirror with a small object located at the point marked 6. If the image is also at this point, then the center of curvature of the mirror is at the point marked:



A. 3
B. 4
C. 6
D. 9
E. 12

ans: C

28. A concave spherical mirror has a focal length of 12 cm. If an object is placed 6 cm in front of it the image position is:

A. 4 cm behind the mirror
B. 4 cm in front of the mirror
C. 12 cm behind the mirror
D. 12 cm in front of the mirror
E. at infinity

ans: C

29. A concave spherical mirror has a focal length of 12 cm. If an object is placed 18 cm in front of it the image position is:

A. 7.2 cm behind the mirror
B. 7.2 cm in front of the mirror
C. 36 cm behind the mirror
D. 36 cm in front of the mirror
E. at infinity

ans: D

30. A convex spherical mirror has a focal length of 12 cm. If an object is placed 6 cm in front of it the image position is:

A. 4 cm behind the mirror
B. 4 cm in front of the mirror
C. 12 cm behind the mirror
D. 12 cm in front of the mirror
E. at infinity

ans: A

31. A concave spherical mirror has a focal length of 12 cm. If an erect object is placed 6 cm in front of it:

A. the magnification is 2 and the image is erect
B. the magnification is 2 and the image is inverted
C. the magnification is 0.67 and the image is erect
D. the magnification is 0.67 and the image is inverted
E. the magnification is 0.5 and the image is erect

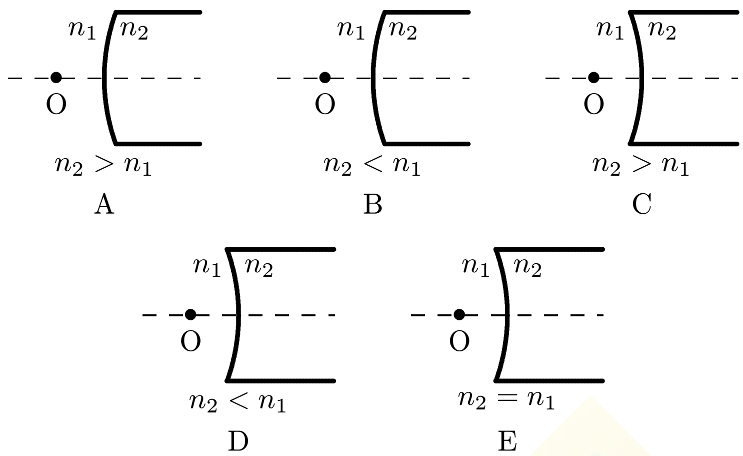
ans: A

32. An erect object is located on the central axis of a spherical mirror. The magnification is -3. This means:

A. its image is real, inverted, and on the same side of the mirror
B. its image is virtual, erect, and on the opposite side of the mirror
C. its image is real, erect, and on the same side of the mirror
D. its image is real, inverted, and on the opposite side of the mirror
E. its image is virtual, inverted, and on the opposite side of the mirror

ans: A

33. An object O, in air, is in front of the concave spherical refracting surface of a piece of glass. Which of the general situa



ans: C

34. A concave refracting surface is one with a center of curvature:

A. to the left of the surface
B. to the right of the surface
C. on the side of the incident light
D. on the side of the refracted light
E. on the side with the higher index of refraction

ans: C

35. A convex refracting surface has a radius of 12 cm. Light is incident in air ($n = 1$) and is refracted into a medium with an index of refraction of 2. Light incident parallel to the central axis is focused at a point:

A. 3 cm from the surface
B. 6 cm from the surface
C. 12 cm from the surface
D. 18 cm from the surface
E. 24 cm from the surface

ans: E

36. A convex refracting surface has a radius of 12 cm. Light is incident in air ($n = 1$) and refracted into a medium with an index of refraction of 2. To obtain light with rays parallel to the central axis after refraction a point source should be placed on the axis:

A. 3 cm from the surface
B. 6 cm from the surface
C. 12 cm from the surface
D. 18 cm from the surface
E. 24 cm from the surface

ans: C

37. A concave refracting surface of a medium with index of refraction n produces a real image no matter where an object is

A. always
B. only if the index of refraction of the surrounding medium is less than n
C. only if the index of refraction of the surrounding medium is greater than n
D. never
E. none of the above

ans: E

38. A convex spherical refracting surface separates a medium with index of refraction 2 from air. The image of an object outside the surface is real:

A. always
B. never
C. only if it is close to the surface
D. only if it is far from the surface
E. only if the radius of curvature is small

ans: D

39. A convex spherical surface with radius r separates a medium with index of refraction 2 from air. As an object is moved toward the surface from far away along the central axis, its image:

A. changes from virtual to real when it is $r/2$ from the surface
B. changes from virtual to real when it is r from the surface
C. changes from real to virtual when it is $r/2$ from the surface
D. changes from real to virtual when it is r from the surface
E. remains real

ans: D

40. A concave spherical surface with radius r separates a medium with index of refraction 2 from air. As an object is moved toward the surface from far away along the central axis, its image:

A. changes from virtual to real when it is $r/2$ from the surface
B. changes from virtual to real when it is $2r$ from the surface
C. changes from real to virtual when it is $r/2$ from the surface
D. changes from real to virtual when it is $2r$ from the surface
E. remains virtual

ans: E

41. An erect object is placed on the central axis of a thin lens, further from the lens than the magnitude of its focal length. The magnification is +0.4. This means:

A. the image is real and erect and the lens is a converging lens
B. the image is real and inverted and the lens is a converging lens
C. the image is virtual and erect, and the lens is a diverging lens
D. the image is virtual and erect, and the lens is a converging lens
E. the image is virtual and inverted and the lens is a diverging lens

ans: C

42. Where must an object be placed in front of a converging lens in order to obtain a virtual image?
   A. At the focal point
   B. At twice the focal length
   C. Greater than the focal length
   D. Between the focal point and the lens
   E. Between the focal length and twice the focal length

   ans: D

43. An erect object placed outside the focal point of a converging lens will produce an image that is:
   A. erect and virtual
   B. inverted and virtual
   C. erect and real
   D. inverted and real
   E. impossible to locate

   ans: D

44. An object is 30 cm in front of a converging lens of focal length 10 cm. The image is:
   A. real and larger than the object
   B. real and the same size than the object
   C. real and smaller than the object
   D. virtual and the same size than the object
   E. virtual and smaller than the object

   ans: C

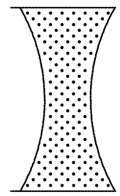
45. Let p denote the object-lens distance and i the image-lens distance. The image produced by a lens of focal length f has a height that can be obtained from the object height by multiplying it by:
   A. p/i
   B. i/p
   C. f/p
   D. f/i
   E. i/f

   ans: B

46. A camera with a lens of focal length 6.0 cm takes a picture of a 1.4-m tall man standing 11 m away. The height of the image is about:
   A. 0.39 cm
   B. 0.77 cm
   C. 1.5 cm
   D. 3.0 cm
   E. 6.0 cm

   ans: B

47. A hollow lens is made of thin glass, as shown. It can be filled with air, water ($n = 1.3$) or CS_2 ($n = 1.6$). The lens will di



A. air and immersed in air
B. air and immersed in water
C. water and immersed in CS2
D. CS_2 and immersed in water
E. CS_2 and immersed in CS_2

ans: D

48. The object-lens distance for a certain converging lens is 400 mm. The image is three times the size of the object. To make the image five times the size of the object-lens distance must be changed to:

A. 360 mm
B. 540 mm
C. 600 mm
D. 720 mm
E. 960 mm

ans: A

49. An erect object is $2f$ in front of a converging lens of focal length f. The image is:

A. real, inverted, magnified
B. real, erect, same size
C. real, inverted, same size
D. virtual, inverted, reduced
E. real, inverted, reduced

ans: C

50. An ordinary magnifying glass in front of an erect object produces an image that is:

A. real and erect
B. real and inverted
C. virtual and inverted
D. virtual and erect
E. none of these

ans: D

51. The Sun subtends 0.5° as seen from Earth. The diameter of its image, using a 1.0-m focal length lens, is about:

A. 10 cm
B. 2 cm
C. 1 cm
D. 5 mm
E. 1 mm

ans: C

52. An object is in front of a converging lens, at a distance less than the focal length from the lens. Its image is:

A. virtual and larger than the object
B. real and smaller than the object
C. virtual and smaller than the object
D. real and larger than the object
E. virtual and the same size as the object

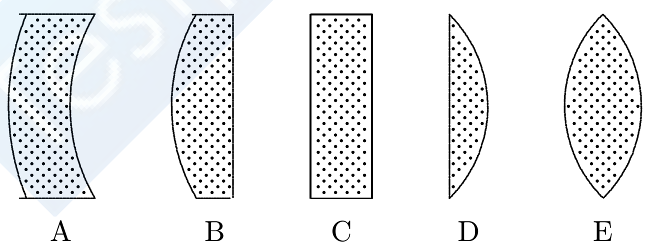
ans: A

53. A plano-convex glass ($n = 1.5$) lens has a curved side whose radius is 50 cm. If the image size is to be the same as the object size, the object should be placed at a distance from the lens of:

A. 50 cm
B. 100 cm
C. 200 cm
D. 400 cm
E. 340 cm

ans: C

54. Which of the following five glass lenses is a diverging lens?



ans: A

55. The bellows of an adjustable camera can be extended so that the largest film to lens distance is one and one-half times the focal length. If the focal length is 12 cm, the nearest object that can be sharply focused on the film must be what distance from the lens?

A. 12 cm
B. 24 cm
C. 36 cm
D. 48 cm
E. 72 cm

ans: C

56. A 3-cm high object is in front of a thin lens. The object distance is 4 cm and the image distance is −8 cm. The image heigh

A. 0.5 cm
B. 1 cm
C. 1.5 cm
D. 6 cm
E. 24 cm

ans: D

57. When a single-lens camera is focused on a distant object, the lens-to-film distance is found to be 40.0 mm. To focus on an object 0.54 m in front of the lens, the film-to-lens distance should be:

A. 40.0 mm
B. 37.3 mm
C. 36.8 mm
D. 42.7 mm
E. 43.2 mm

ans: E

58. In a cinema, a picture 2.5 cm wide on the film is projected to an image 3.0 m wide on a screen that is 18 m away. The focal length of the lens is about:

A. 7.5 cm
B. 10 cm
C. 12.5 cm
D. 15 cm
E. 20 cm

ans: D

59. The term "virtual" as applied to an image made by a mirror means that the image:

A. is on the mirror surface
B. cannot be photographed by a camera
C. is in front of the mirror
D. is the same size as the object
E. cannot be shown directly on a screen

ans: E

60. Which instrument uses a single converging lens with the object placed just inside the focal point?

A. Camera
B. Compound microscope
C. Magnifying glass
D. Overhead projector
E. Telescope

ans: C

61. Let f_o and f_e be the focal lengths of the objective and eyepiece of a compound microscope. In ordinary use, the object:

A. is less than f_o from the objective lens
B. is more that f_o from the objective
C. produces an intermediate image that is slightly more than f_e from the eyepiece
D. produces an intermediate image that is $2f_e$ away from the eyepiece
E. produces an intermediate image that is less than f_o from the objective lens

ans: B

62. Consider the following four statements concerning a compound microscope:

1. Each lens produces an image that is virtual and inverted.
2. The objective lens has a very short focal length.
3. The eyepiece is used as a simple magnifying glass.
4. The objective lens is convex and the eyepiece is concave.

Which two of the four statements are correct?

A. 1, 2
B. 1, 3
C. 1, 4
D. 2, 3
E. 2, 4

ans: D

63. What type of eyeglasses should a nearsighted person wear?

A. diverging lenses
D. bifocal lenses
B. converging lenses
E. plano-convex lenses
C. double convex lenses

ans: A

64. Which of the following is NOT correct for a simple magnifying glass?

A. The image is virtual
B. The image is erect
C. The image is larger than the object
D. The object is inside the focal point
E. The lens is diverging

ans: E

65. A nearsighted person can see clearly only objects within 1.4 m of her eye. To see distant objects, she should wear eyeglasses of what type and focal length?

A. diverging, 2.8 m
B. diverging, 1.4 m
C. converging, 2.8 m
D. converging, 1.4 m
E. diverging, 0.72 m

ans: B

66. A magnifying glass has a focal length of 15 cm. If the near point of the eye is 25 cm from the eye the angular magnificat

A. 0.067
B. 0.33
C. 0.67
D. 1.7
E. 15

ans: D

67. An object is 20 cm to the left of a lens of focal length +10 cm. A second lens, of focal length +12.5 cm, is 30 cm to the right of the first lens. The distance between the original object and the final image is:

A. 28 cm
B. 50 cm
C. 100 cm
D. 0
E. infinity

ans: D

68. A converging lens of focal length 20 cm is placed in contact with a converging lens of focal length 30 cm. The focal length of this combination is:

A. +10 cm
B. −10 cm
C. +60 cm
D. −60 cm
E. +25 cm

ans: A

69. A student sets the cross-hairs of an eyepiece in line with an image that he is measuring. He then notes that when he moves his head slightly to the right, the image moves slightly to the left (with respect to the cross-hairs). Therefore the image is:

A. infinitely far away
B. farther away from him that the cross-hairs
C. nearer to him than the cross-hairs
D. in the focal plane of the eyepiece
E. in the plane of the cross-hairs

ans: C

70. In a two lens microscope, the intermediate image is:

A. virtual, erect, and magnified
B. real, erect, and magnified
C. real, inverted, and magnified
D. virtual, inverted, and reduced
E. virtual, inverted, and magnified

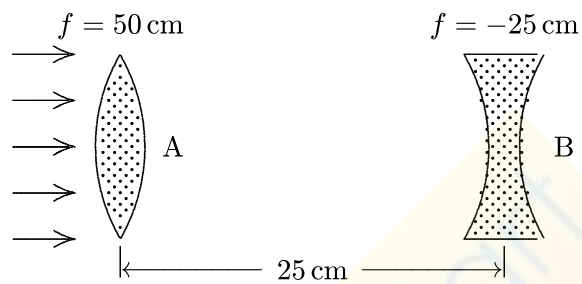
ans: C

71. Two thin lenses (focal lengths f_1 and f_2) are in contact. Their equivalent focal length is:

A. $f_1 + f_2$
B. $f_1 f_2/(f_1 + f_2)$
C. $1/f_1 + 1/f_2$
D. $f_1 - f_2$
E. $f_1(f_1 - f_2)/f_2$

ans: B

72. The two lenses shown are illuminated by a beam of parallel light from the left. Lens B is then moved slowly toward lens A. The beam emerging from lens B is:



A. initially parallel and then diverging
B. always diverging
C. initially converging and finally parallel
D. always parallel
E. initially converging and finally diverging

ans: A

Chapter 35: INTERFERENCE

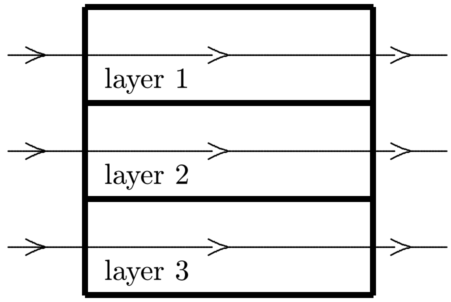
1. A “wave front” is a surface of constant:
   A. phase
   B. frequency
   C. wavelength
   D. amplitude
   E. speed
   ans: A

2. Huygens’ construction can be used only:
   A. for light
   B. for an electromagnetic wave
   C. if one of the media is vacuum (or air)
   D. for transverse waves
   E. for all of the above and other situations
   ans: E

3. Consider (I) the law of reflection and (II) the law of refraction. Huygens’ principle can be used to derive:
   A. only I
   B. only II
   C. both I and II
   D. neither I nor II
   E. the question is meaningless because Huygens’ principle is for wave fronts whereas both I and II concern rays
   ans: C

4. Units of “optical path length” are:
   A. m^{-1}
   B. m
   C. m/s
   D. Hz/m
   E. m/Hz
   ans: B

5. The light waves represented by the three rays shown in the diagram all have the same frequency. 4.7 wavelengths fit into la[illegible] into layer 3. Rank the layers according to the speeds of the waves, least to greatest.



A. 1, 2, 3
B. 2, 1, 3
C. 3, 1, 2
D. 3, 1, 2
E. 1, 3, 2

ans: D

6. Interference of light is evidence that:

A. the speed of light is very large
B. light is a transverse wave
C. light is electromagnetic in character
D. light is a wave phenomenon
E. light does not obey conservation of energy

ans: D

7. The reason there are two slits, rather than one, in a Young's experiment is:

A. to increase the intensity
B. one slit is for frequency, the other for wavelength
C. to create a path length difference
D. one slit is for $\vec{E}$ fields, the other is for $\vec{B}$ fields
E. two slits in parallel offer less resistance

ans: C

8. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:

A. a fourth of a wavelength
B. a half a wavelength
C. a wavelength
D. three-fourths of a wavelength
E. none of the above

ans: E

9. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by

A. $\pi/4$
B. $\pi/2$
C. π
D. $3\pi/4$
E. 2π

ans: E

10. Waves from two slits are in phase at the slits and travel to a distant screen to produce the third side maximum of the interference pattern. The difference in the distance traveled by the waves is:

A. half a wavelength
B. a wavelength
C. three halves of a wavelength
D. two wavelengths
E. three wavelengths

ans: E

11. Waves from two slits are in phase at the slits and travel to a distant screen to produce the second minimum of the interference pattern. The difference in the distance traveled by the waves is:

A. half a wavelength
B. a wavelength
C. three halves of a wavelength
D. two wavelengths
E. five halves of a wavelength

ans: C

12. A monochromatic light source illuminates a double slit and the resulting interference pattern is observed on a distant screen. Let d = center-to-center slit spacing, a = individual slit width, D = screen-to-slit distance, and ℓ = adjacent dark line spacing in the interference pattern. The wavelength of the light is then:

A. $d\ell/D$
B. Ld/a
C. da/D
D. $\ell D/a$
E. Dd/ℓ

ans: A

13. Light from a small region of an ordinary incandescent bulb is passed through a yellow filter and then serves as the source f [illegible] nges would cause the interference pattern to be more closely spaced?

A. Use slits that are closer together
B. Use a light source of lower intensity
C. Use a light source of higher intensity
D. Use a blue filter instead of a yellow filter
E. Move the light source further away from the slits.

ans: D

14. In a Young's double-slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to:

A. $D/2$
B. $D/\sqrt{2}$
C. $D\sqrt{2}$
D. $2D$
E. $4D$

ans: D

15. In a Young's double-slit experiment, light of wavelength 500 nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5 m from the slits is:

A. 0.10 cm
B. 0.25 cm
C. 0.50 cm
D. 1.0 cm
E. none of the above

ans: B

16. In a Young's double-slit experiment, the separation between slits is d and the screen is a distance D from the slits. D is much greater than d and λ is the wavelength of the light. The number of bright fringes per unit width on the screen is:

A. Dd/λ
B. $D\lambda/d$
C. $D/d\lambda$
D. λ/Dd
E. $d/D\lambda$

ans: E

17. In a Young's double-slit experiment, the slit separation is doubled. This results in:

A. an increase in fringe intensity
B. a decrease in fringe intensity
C. a halving of the wavelength
D. a halving of the fringe spacing
E. a doubling of the fringe spacing

ans: D

18. In an experiment to measure the wavelength of light using a double slit, it is found that the fringes are too close togeth uld:
   A. decrease the slit separation
   B. increase the slit separation
   C. increase the width of each slit
   D. decrease the width of each slit
   E. none of these

   ans: A

19. The phase difference between the two waves that give rise to a dark spot in a Young's double-slit experiment is (where $m =$ integer):
   A. zero
   B. $2\pi m + \pi/8$
   C. $2\pi m + \pi/4$
   D. $2\pi m + \pi/2$
   E. $2\pi m + \pi$

   ans: E

20. In a Young's experiment, it is essential that the two beams:
   A. have exactly equal intensity
   B. be exactly parallel
   C. travel equal distances
   D. come originally from the same source
   E. be composed of a broad band of frequencies

   ans: D

21. A light wave with an electric field amplitude of E_0 and a phase constant of zero is to be combined with one of the following waves:

   wave A has an amplitude of E_0 and a phase constant of zero
   wave B has an amplitude of E_0 and a phase constant of π
   wave C has an amplitude of $2E_0$ and a phase constant of zero
   wave D has an amplitude of $2E_0$ and a phase constant of π
   wave E has an amplitude of $3E_0$ and a phase constant of π

   Which of these combinations produces the greatest intensity?

   ans: C

22. A light wave with an electric field amplitude of $2E_0$ and a phase constant of zero is to be combined with one of the following waves:

   wave A has an amplitude of E_0 and a phase constant of zero
   wave B has an amplitude of E_0 and a phase constant of π
   wave C has an amplitude of $2E_0$ and a phase constant of zero
   wave D has an amplitude of $2E_0$ and a phase constant of π
   wave E has an amplitude of $3E_0$ and a phase constant of π

   Which of these combinations produces the least intensity?

   ans: D

23. One of the two slits in a Young's experiment is painted over so that it transmits only one-half the intensity of the other s

A. the fringe system disappears
B. the bright fringes get brighter and the dark ones get darker
C. the fringes just get dimmer
D. the dark fringes just get brighter
E. the dark fringes get brighter and the bright ones get darker

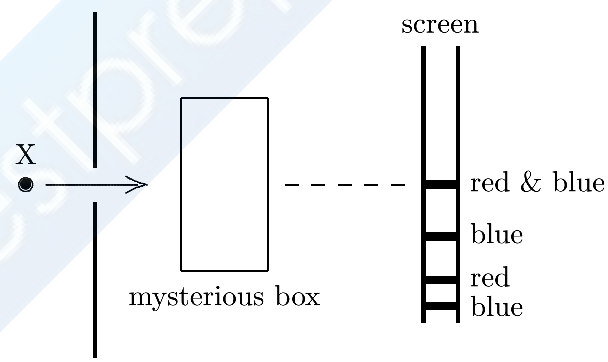
ans: E

24. In a Young's double-slit experiment, a thin sheet of mica is placed over one of the two slits. As a result, the center of the fringe pattern (on the screen) shifts by an amount corresponding to 30 dark bands. The wavelength of the light in this experiment is 480 nm and the index of the mica is 1.60. The mica thickness is:

A. 0.090 mm
B. 0.012 mm
C. 0.014 mm
D. 0.024 mm
E. 0.062 mm

ans: D

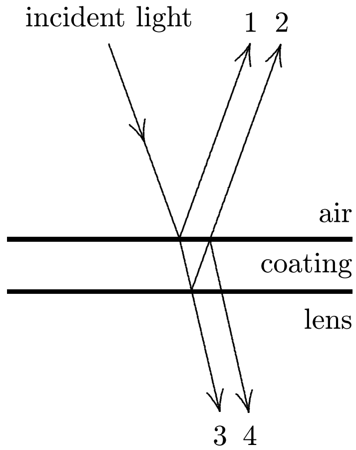
25. Light from a point source X contains only blue and red components. After passing through a mysterious box, the light falls on a screen. Bright red and blue hands are observed as shown. The box must contain:



A. a lens
B. a mirror
C. a prism
D. a double slit
E. a blue and red filter

ans: D

26. Binoculars and microscopes are frequently made with coated optics by adding a thin layer of transparent material to th



A. constructive interference between waves 1 and 2
B. destructive interference between waves 3 and 4
C. constructive interference between 3 and 4
D. the coating to be more transparent than the lens
E. the speed of light in the coating to be less than that in the lens

ans: C

27. Monochromatic light, at normal incidence, strikes a thin film in air. If λ denotes the wavelength in the film, what is the thinnest film in which the reflected light will be a maximum?

A. Much less than λ
B. $\lambda/4$
C. $\lambda/2$
D. $3\lambda/4$
E. λ

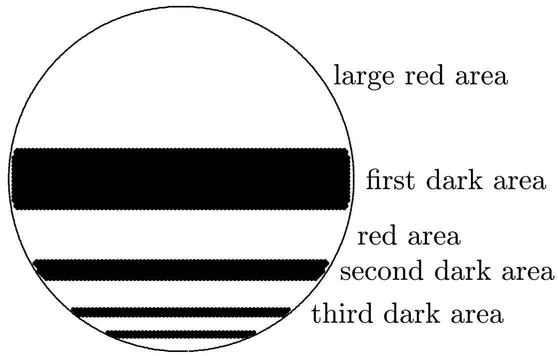
ans: B

28. A soap film is illuminated by white light normal to its surface. The index of refraction of the film is 1.50. Wavelengths of 480 nm and 800 nm and no wavelengths between are be intensified in the reflected beam. The thickness of the film is:

A. 1.5×10^{-5} cm
B. 2.4×10^{-5} cm
C. 3.6×10^{-5} cm
D. 4.0×10^{-5} cm
E. 6.0×10^{-5} cm

ans: D

29. Red light is viewed through a thin vertical soap film. At the third dark area shown, the thickness of the film, in te



A. λ
B. $3\lambda/4$
C. $\lambda/2$
D. $\lambda/4$
E. $5\lambda/4$

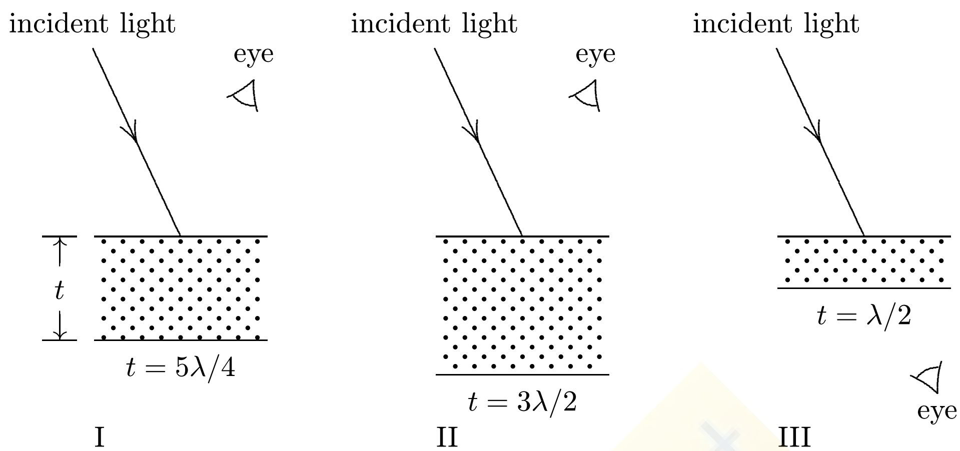
ans: E

30. Yellow light is viewed by reflection from a thin vertical soap film. Let λ be the wavelength of the light within the film. Why is there a large dark space at the top of the film?

A. no light is transmitted through this part of the film
B. the film thickness there is $\lambda/4$
C. the film thickness there is much less than λ
D. the film is too thick in this region for thin film formulas to apply
E. the reflected light is in the infrared

ans: C

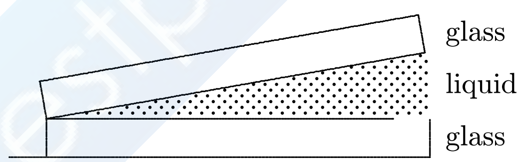
31. Three experiments involving a thin film (in air) are shown. If t denotes the film thickness and λ denotes the wavelength ([illegible] tive interference as seen by the observer? The incident light is nearly normal to the surface.



A. I only
B. II only
C. III only
D. I and III only
E. II and III only

ans: D

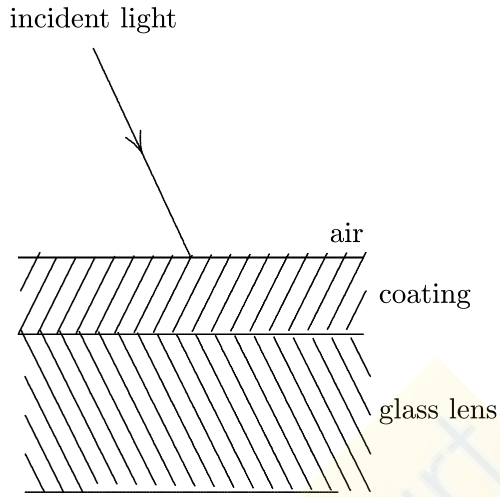
32. A liquid of refractive index $n = 4/3$ replaces the air between a fixed wedge formed from two glass plates as shown. As a result, the spacing between adjacent dark bands in the interference pattern:



A. increases by a factor of 4/3
B. increases by a factor of 3
C. remains the same
D. decreases to 3/4 of its original value
E. decreases to 1/3 of its original value

ans: D

33. A lens with a refractive index of 1.5 is coated with a material of refractive index 1.2 in order to minimize reflection. If the thinnest possible such coating?



A. 0.5λ
B. 0.416λ
C. 0.3λ
D. 0.208λ
E. 0.25λ

ans: D

34. In a thin film experiment, a wedge of air is used between two glass plates. If the wavelength of the incident light in air is 480 nm, how much thicker is the air wedge at the 16^{th} dark fringe than it is at the 6^{th}?

A. 2400 nm
B. 4800 nm
C. 240 nm
D. 480 nm
E. None of these

ans: A

35. An air wedge is formed from two glass plates that are in contact at their left edges. There are ten dark bands when viewed by reflection using monochromatic light. The left edge of the top plate is now slowly lifted until the plates are parallel. During this process:

A. the dark bands crowd toward the right edge
B. the dark bands remain stationary
C. the dark bands crowd toward the left edge
D. the dark bands spread out, disappearing off the right edge
E. the dark bands spread out, disappearing off the left edge

ans: E

36. An air wedge is formed using two glass plates that are in contact along their left edge. When viewed by highly monochr[illegible]ght. The air is now evacuated (with the glass plates remaining rigidly fixed) and the number of dark bands decreases to exactly 4000. The index of refraction of the air is:

A. 0.00025
B. 0.00050
C. 1.00025
D. 1.00050
E. 1.00000, by definition

ans: C

37. A glass ($n = 1.6$) lens is coated with a thin film ($n = 1.3$) to reduce reflection of certain incident light. If λ is the wavelength of the light in the film, the least film thickness is:

A. less than $\lambda/4$
B. $\lambda/4$
C. $\lambda/2$
D. λ
E. more than λ

ans: B

38. Two point sources, vibrating in phase, produce an interference pattern in a ripple tank. If the frequency is increased by 20%, the number of nodal lines:

A. is increased by 20%
B. is increased by 40%
C. remains the same
D. is decreased by 20%
E. is decreased by 40%

ans: A

39. If two light waves are coherent:

A. their amplitudes are the same
B. their frequencies are the same
C. their wavelengths are the same
D. their phase difference is constant
E. the difference in their frequencies is constant

ans: D

40. To obtain an observable double-slit interference pattern:

A. the light must be incident normally on the slits
B. the light must be monochromatic
C. the light must consist of plane waves
D. the light must be coherent
E. the screen must be far away from the slits

ans: D

Chapter 36: DIFFRACTION

1. Sound differs from light in that sound:
   A. is not subject to diffraction
   B. is a torsional wave rather than a longitudinal wave
   C. does not require energy for its origin
   D. is a longitudinal wave rather than a transverse wave
   E. is always monochromatic

   ans: D

2. Radio waves are readily diffracted around buildings whereas light waves are negligibly diffracted around buildings. This is because radio waves:
   A. are plane polarized
   B. have much longer wavelengths than light waves
   C. have much shorter wavelengths than light waves
   D. are nearly monochromatic (single frequency)
   E. are amplitude modulated (AM).

   ans: B

3. Diffraction plays an important role in which of the following phenomena?
   A. The sun appears as a disk rather than a point to the naked eye
   B. Light is bent as it passes through a glass prism
   C. A cheerleader yells through a megaphone
   D. A farsighted person uses eyeglasses of positive focal length
   E. A thin soap film exhibits colors when illuminated with white light

   ans: C

4. The rainbow seen after a rain shower is caused by:
   A. diffraction
   B. interference
   C. refraction
   D. polarization
   E. absorption

   ans: C

5. When a highly coherent beam of light is directed against a very fine wire, the shadow formed behind it is not just that of a single wire but rather looks like the shadow of several parallel wires. The explanation of this involves:
   A. refraction
   B. diffraction
   C. reflection
   D. the Doppler effect
   E. an optical illusion

   ans: B

6. When the atmosphere is not quite clear, one may sometimes see colored circles concentric with the Sun or the Moon. The [illegible] oon and invariably the innermost ring is blue. The explanation for this phenomena involves:
   - A. reflection
   - B. refraction
   - C. interference
   - D. diffraction
   - E. the Doppler effect

   ans: D

7. The shimmering or wavy lines that can often be seen near the ground on a hot day are due to:
   - A. Brownian movement
   - B. reflection
   - C. refraction
   - D. diffraction
   - E. dispersion

   ans: C

8. A point source of monochromatic light is placed in front of a soccer ball and a screen is placed behind the ball. The light intensity pattern on the screen is best described as:
   - A. a dark disk on a bright background
   - B. a dark disk with bright rings outside
   - C. a dark disk with a bright spot at its center
   - D. a dark disk with a bright spot at its center and bright rings outside
   - E. a bright disk with bright rings outside

   ans: D

9. In the equation $\sin\theta = \lambda/a$ for single-slit diffraction, θ is:
   - A. the angle to the first minimum
   - B. the angle to the second maximum
   - C. the phase angle between the extreme rays
   - D. $N\pi$ where N is an integer
   - E. $(N + 1/2)\pi$ where N is an integer

   ans: A

10. In the equation $\phi = (2\pi a/\lambda)\sin\theta$ for single-slit diffraction, ϕ is:
   - A. the angle to the first minimum
   - B. the angle to the second maximum
   - C. the phase angle between the extreme rays
   - D. $N\pi$ where N is an integer
   - E. $(N + 1/2)\pi$ where N is an integer

   ans: C

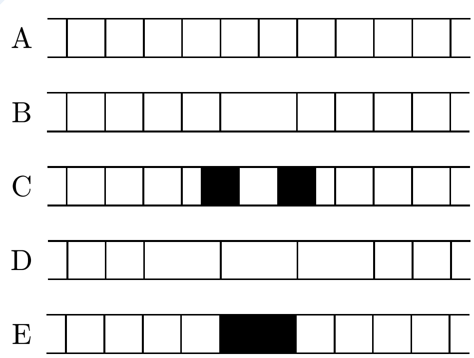
11. No fringes are seen in a single-slit diffraction pattern if:
    A. the screen is far away
    B. the wavelength is less than the slit width
    C. the wavelength is greater than the slit width
    D. the wavelength is less than the distance to the screen
    E. the distance to the screen is greater than the slit width
    ans: C

12. A student wishes to produce a single-slit diffraction pattern in a ripple tank experiment. He considers the following parameters:
    1. frequency
    2. wavelength
    3. water depth
    4. slit width

    Which two of the above should be decreased to produce more bending?
    A. 1, 3
    B. 1, 4
    C. 2, 3
    D. 2, 4
    E. 3, 4
    ans: B

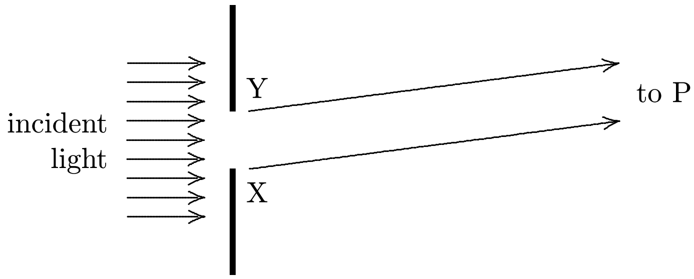
13. A parallel beam of monochromatic light is incident on a slit of width 2 cm. The light passing through the slit falls on a screen 2 m away. As the slit width is decreased:
    A. the width of the pattern on the screen continuously decreases
    B. the width of the pattern on the screen at first decreases but then increases
    C. the width of the pattern on the screen increases and then decreases
    D. the width of the pattern on the screen remains the same
    E. the pattern on the screen changes color going from red to blue
    ans: B

14. Monochromatic plane waves of light are incident normally on a single slit. Which one of the five figures below correctly shows the diffraction pattern observed on a distant screen?



    ans: B

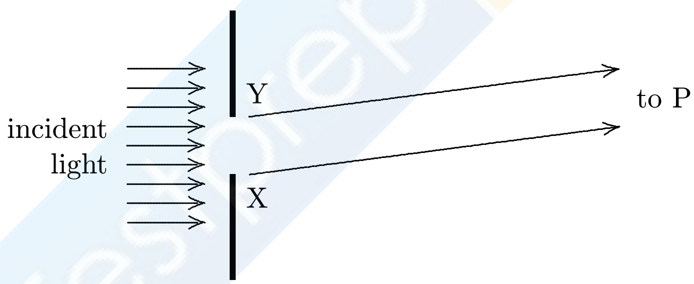
15. The diagram shows a single slit with the direction to a point P on a distant screen shown. At P, the pattern has its seco[illegible]ges of the slit, what is the path length difference (PX) - (PY)?



A. $\lambda/2$
B. λ
C. $3\lambda/2$
D. 2λ
E. $5\lambda/2$

ans: D

16. The diagram shows a single slit with the direction to a point P on a distant screen shown. At P, the pattern has its maximum nearest the central maximum. If X and Y are the edges of the slit, what is the path length difference (PX) - (PY)?



A. $\lambda/2$
B. λ
C. $3\lambda/2$
D. 2λ
E. $5\lambda/2$

ans: C

17. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern the phase difference between the Huygens wavelet from the top of the slit and the wavelet from the midpoint of the slit is:

A. $\pi/8$ rad
B. $\pi/4$ rad
C. $\pi/2$ rad
D. π rad
E. $3\pi/2$ rad

ans: D

18. At the second minimum adjacent to the central maximum of a single-slit diffraction pattern the Huygens wavelet from

A. a point one-fourth of the slit width from the top
B. the midpoint of the slit
C. a point one-fourth of the slit width from the bottom of the slit
D. the bottom of the slit
E. none of these

ans: A

19. A plane wave with a wavelength of 500 nm is incident normally on a single slit with a width of 5.0×10^{-6} m. Consider waves that reach a point on a far-away screen such that rays from the slit make an angle of 1.0° with the normal. The difference in phase for waves from the top and bottom of the slit is:

A. 0
B. 0.55 rad
C. 1.1 rad
D. 1.6 rad
E. 2.2 rad

ans: C

20. A diffraction pattern is produced on a viewing screen by illuminating a long narrow slit with light of wavelength λ. If λ is increased and no other changes are made:

A. the intensity at the center of the pattern decreases and the pattern expands away from the bright center
B. the intensity at the center of the pattern increases and the pattern contracts toward the bright center
C. the intensity at the center of the pattern does not change and the pattern expands away from the bright center
D. the intensity at the center of the pattern does not change and the pattern contracts toward the bright center
E. neither the intensity at the center of the pattern nor the pattern itself change

ans: C

21. A diffraction pattern is produced on a viewing screen by illuminating a long narrow slit with light of wavelength λ. If the slit width is decreased and no other changes are made:

A. the intensity at the center of the pattern decreases and the pattern expands away from the bright center
B. the intensity at the center of the pattern increases and the pattern contracts toward the bright center
C. the intensity at the center of the pattern does not change and the pattern expands away from the bright center
D. the intensity at the center of the pattern does not change and the pattern contracts toward the bright center
E. neither the intensity at the center of the pattern nor the pattern itself change

ans: A

22. In order to obtain a good single-slit diffraction pattern, the slit width could be:
   A. λ
   B. $\lambda/10$
   C. 10λ
   D. $10^4\lambda$
   E. $\lambda/10^4$
   ans: C

23. Consider a single-slit diffraction pattern caused by a slit of width a. There is a maximum if $\sin\theta$ is equal to:
   A. slightly more than $3\lambda/2a$
   B. slightly less than $3\lambda/2a$
   C. exactly $3\lambda/2a$
   D. exactly $\lambda/2a$
   E. very nearly $\lambda/2a$
   ans: B

24. Consider a single-slit diffraction pattern caused by a slit of width a. There is a minimum if $\sin\theta$ is equal to:
   A. exactly λ/a
   B. slightly more than λ/a
   C. slightly less than λ/a
   D. exactly $\lambda/2a$
   E. very nearly $\lambda/2a$
   ans: A

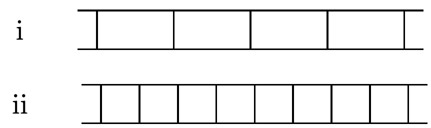
25. In a single-slit diffraction pattern, the central maximum is about twice as wide as the other maxima. This is because:
   A. half the light is diffracted up and half is diffracted down
   B. the central maximum has both electric and magnetic fields present
   C. the small angle approximation applies only near the central maximum
   D. the screen is flat instead of spherical
   E. none of the above
   ans: E

26. The intensity at a secondary maximum of a single-slit diffraction pattern is less than the intensity at the central maximum chiefly because:
   A. some Huygens wavelets sum to zero at the secondary maximum but not at the central maximum
   B. the secondary maximum is further from the slits than the central maximum and intensity decreases as the square of the distance
   C. the Huygens construction is not valid for a secondary maximum
   D. the amplitude of every Huygens wavelet is smaller when it travels to a secondary maximum than when it travels to the central maximum
   E. none of the above
   ans: A

27. Figure (i) shows a double-slit pattern obtained using monochromatic light. Consider the following five possible change

1. decrease the frequency
2. increase the frequency
3. increase the width of each slit
4. increase the separation between the slits
5. decrease the separation between the slits

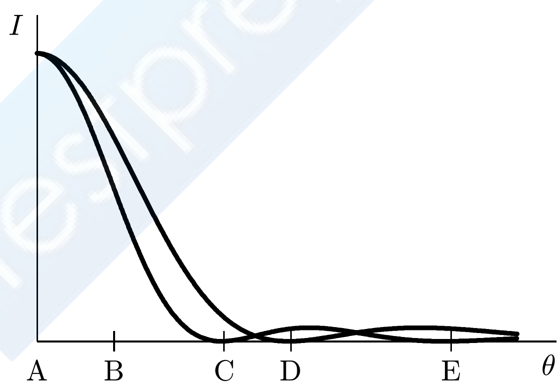
Which of the above would change Figure (i) into Figure (ii)?



A. 3 only
B. 5 only
C. 1 and 3 only
D. 1 and 5 only
E. 2 and 4 only

ans: E

28. Two wavelengths, 800 nm and 600 nm, are used separately in single-slit diffraction experiments. The diagram shows the intensities on a far-away viewing screen as function of the angle made by the rays with the straight-ahead direction. If both wavelengths are then used simultaneously, at which angle is the light on the screen purely 800-nm light?



ans: C

29. If we increase the wavelength of the light used to form a double-slit diffraction pattern:

A. the width of the centr[illegible]hin the peak increases

B. the width of the central diffraction peak increases and the number of bright fringes within the peak decreases

C. the width of the central diffraction peak decreases and the number of bright fringes within the peak increases

D. the width of the central diffraction peak decreases and the number of bright fringes within the peak decreases

E. the width of the central diffraction peak increases and the number of bright fringes within the peak stays the same

ans: E

30. Two slits of width a and separation d are illuminated by a beam of light of wavelength λ. The separation of the interference fringes on a screen a distance D away is:

A. $\lambda a/D$

B. $\lambda d/D$

C. $\lambda D/d$

D. dD/λ

E. $\lambda D/a$

ans: C

31. Two slits in an opaque barrier each have a width of 0.020 mm and are separated by 0.050 mm. When coherent monochromatic light passes through the slits the number of interference maxima within the central diffraction maximum:

A. is 1

B. is 2

C. is 4

D. is 5

E. cannot be determined unless the wavelength is given

ans: D

32. When 450-nm light is incident normally on a certain double-slit system the number of interference maxima within the central diffraction maximum is 5. When 900-nm light is incident on the same slit system the number is:

A. 2

B. 3

C. 5

D. 9

E. 10

ans: C

33. In a double-slit diffraction experiment the number of interference fringes within the central diffraction maximum can l

A. increasing the wavelength
B. decreasing the wavelength
C. decreasing the slit separation
D. increasing the slit width
E. decreasing the slit width

ans: E

34. A diffraction-limited laser of length ℓ and aperture diameter d generates light of wavelength λ. If the beam is directed at the surface of the Moon a distance D away, the radius of the illuminated area on the Moon is approximately:

A. dD/ℓ
B. dD/λ
C. $D\lambda/\ell$
D. $D\lambda/d$
E. $\ell\lambda/d$

ans: D

35. Two stars that are close together are photographed through a telescope. The black and white film is equally sensitive to all colors. Which situation would result in the most clearly separated images of the stars?

A. Small lens, red stars
B. Small lens, blue stars
C. Large lens, red stars
D. Large lens, blue stars
E. Large lens, one star red and the other blue

ans: D

36. The resolving power of a telescope can be increased by:

A. increasing the objective focal length and decreasing the eyepiece focal length
B. increasing the lens diameters
C. decreasing the lens diameters
D. inserting a correction lens between objective and eyepiece
E. none of the above

ans: B

37. In the equation $d \sin\theta = m\lambda$ for the lines of a diffraction grating m is:

A. the number of slits
B. the slit width
C. the slit separation
D. the order of the line
E. the index of refraction

ans: D

38. In the equation $d \sin\theta = m\lambda$ for the lines of a diffraction grating d is:

A. the number of slits
B. the slit width
C. the slit separation
D. the order of the line
E. the index of refraction

ans: C

39. As more slits with the same spacing are added to a diffraction grating the lines:

A. spread farther apart
B. move closer together
C. become wider
D. becomes narrower
E. do not change in position or width

ans: D

40. An N-slit system has slit separation d and slit width a. Plane waves with intensity I and wavelength λ are incident normally on it. The angular separation of the lines depends only on:

A. a and N
B. a and λ
C. N and λ
D. d and λ
E. I and N

ans: D

41. 600-nm light is incident on a diffraction grating with a ruling separation of 1.7×10^{-6} m. The second order line occurs at a diffraction angle of:

A. 0
B. 10°
C. 21°
D. 42°
E. 45°

ans: E

42. The widths of the lines produced by monochromatic light falling on a diffraction grating can be reduced by:

A. increasing the wavelength of the light
B. increasing the number of rulings without changing their spacing
C. decreasing the spacing between adjacent rulings without changing the number of rulings
D. decreasing both the wavelength and the spacing between rulings by the same factor
E. increasing the number of rulings and decreasing their spacing so the length of the grating remains the same

ans: B

43. Monochromatic light is normally incident on a diffraction grating that is 1 cm wide and has 10,000 slits. The first orde ..., of the incident light?

A. 300
B. 400
C. 500
D. 600
E. 1000

ans: C

44. A light spectrum is formed on a screen using a diffraction grating. The entire apparatus (source, grating and screen) is now immersed in a liquid of refractive index 1.33. As a result, the pattern on the screen:

A. remains the same
B. spreads out
C. crowds together
D. becomes reversed, with the previously blue end becoming red
E. disappears because the refractive index isn't an integer

ans: C

45. The spacing between adjacent slits on a diffraction grating is 3λ. The deviation θ of the first order diffracted beam is given by:

A. $\sin(\theta/2) = 1/3$
B. $\sin(\theta/3) = 2/3$
C. $\sin(\theta) = 1/3$
D. $\tan(\theta/2) = 1/3$
E. $\tan(\theta) = 2/3$

ans: C

46. When light of a certain wavelength is incident normally on a certain diffraction grating the line of order 1 is at a diffraction angle of 25°. The diffraction angle for the second order line is:

A. 25°
B. 42°
C. 50°
D. 58°
E. 75°

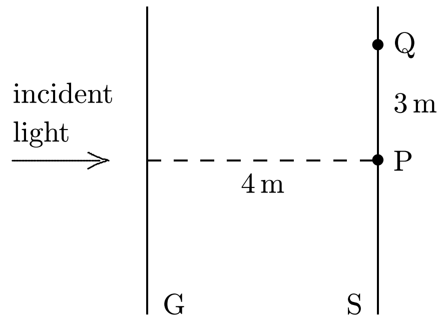
ans D

47. A diffraction grating of width W produces a deviation θ in second order for light of wavelength λ. The total number N of slits in the grating is given by:

A. $2W\lambda/\sin\theta$
B. $(W/\lambda)\sin\theta$
C. $\lambda W/2\sin\theta$
D. $(W/2\lambda)\sin\theta$
E. $2\lambda/\sin\theta$

ans: D

48. Light of wavelength λ is normally incident on a diffraction grating G. On the screen S, the central line is at P and th ent slits in the grating is:



A. $3\lambda/5$
B. $3\lambda/4$
C. $4\lambda/5$
D. $5\lambda/4$
E. $5\lambda/3$

ans: E

49. 550-nm light is incident normally on a diffraction grating and exactly 6 lines are produced. The ruling separation must be:

A. between 2.75×10^{-7} m and 5.50×10^{-7} m
B. between 5.50×10^{-7} m and 1.10×10^{-6} m
C. between 3.30×10^{-6} m and 3.85×10^{-6} m
D. between 3.85×10^{-6} m and 4.40×10^{-6} m
E. greater than 4.40×10^{-6} m

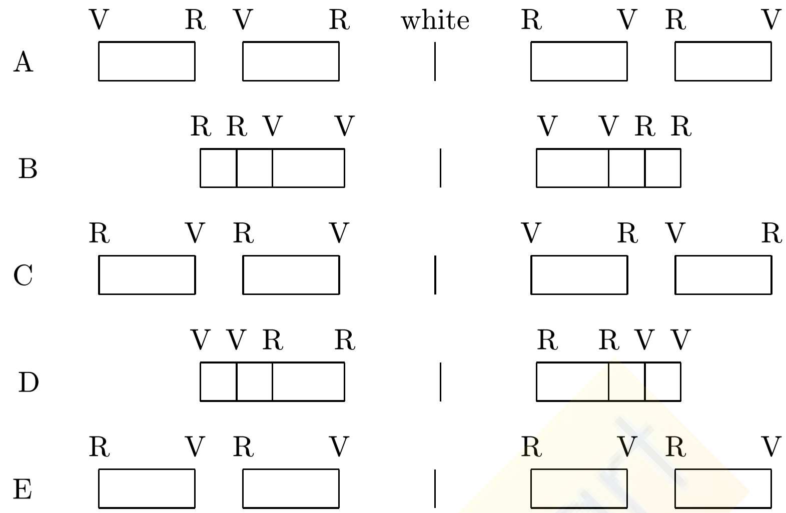
ans: E

50. A mixture of 450-nm and 900-nm light is incident on a diffraction grating. Which of the following is true?

A. all lines of the 900-nm light coincide with even order lines of the 450-nm light
B. all lines of the 450-nm light coincide with even order lines of the 900-nm light
C. all lines of the 900-nm light coincide with odd order lines of the 450-nm light
D. None of the lines of the 450-nm light coincide with lines of the 900-nm light
E. All of the lines of the 450-nm light coincide with lines of the 900-nm light

ans: A

51. A beam of white light (from 400 nm for violet to 700 nm for red) is normally incident on a diffraction grating. It pro R = red, V = violet) correctly shows the pattern on the screen?



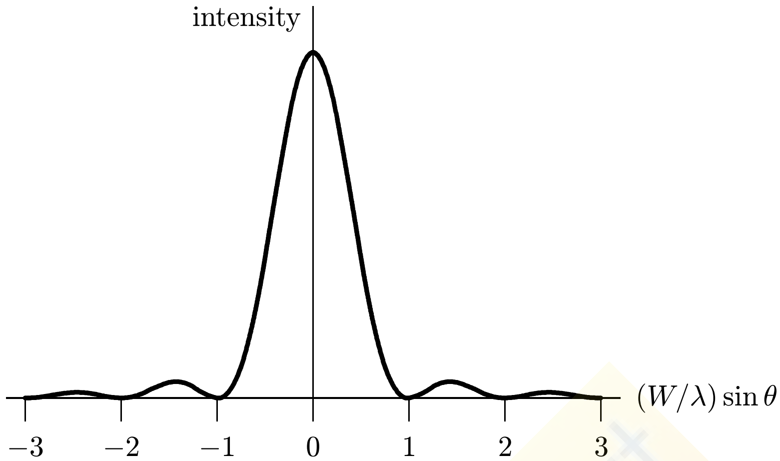
ans: C

52. If white light is incident on a diffraction grating:

A. the first order lines for all visible wavelengths occur at smaller diffraction angles than any of the second order lines
B. some first order lines overlap the second order lines if the ruling separation is small but do not if it is large
C. some first order lines overlap second order lines if the ruling separation is large but do not if it is small
D. some first order lines overlap second order lines no matter what the ruling separation
E. first and second order lines have the same range of diffraction angles

ans: A

53. Light of wavelength is normally incident on some plane optical device. The intensity pattern shown is observed on a dis ce).
The device could be:



A. a single slit of width W
B. a single slit of width $2W$
C. two narrow slits with separation W
D. two narrow slits with separation $2W$
E. a diffraction grating with slit separation W

ans: A

54. A person with her eye relaxed looks through a diffraction grating at a distant monochromatic point source of light. The slits of the grating are vertical. She sees:

A. one point of light
B. a hazy horizontal strip of light of the same color as the source
C. a hazy strip of light varying from violet to red
D. a sequence of horizontal points of light
E. a sequence of closely spaced vertical lines

ans: D

55. Monochromatic light is normally incident on a diffraction grating. The m^{th} order line is at a diffraction angle θ and has width w. A wide single slit is now placed in front of the grating and its width is then slowly reduced. As a result:

A. both θ and w increase
B. both θ and w decrease
C. θ remains the same and w increases
D. θ remains the same and w decreases
E. θ decreases and w increases

ans: C

56. At a diffraction line phasors associated with waves from the slits of a multiple-slit barrier:

A. are aligned
B. form a closed polygon
C. form a polygon with several sides missing
D. are parallel but adjacent phasors point in opposite directions
E. form the arc of a circle

ans: A

57. For a certain multiple-slit barrier the slit separation is 4 times the slit width. For this system:

A. the orders of the lines that appear are all multiples of 4
B. the orders of lines that appear are all multiples of 2
C. the orders of the missing lines are all multiples of 4
D. the orders of the missing lines are all multiples of 2
E. none of the above are true

ans: C

58. The dispersion D of a grating can have units:

A. cm
B. 1/nm
C. nm/cm
D. radian
E. none of these

ans: B

59. The resolving power R of a grating can have units:

A. cm
B. degree/nm
C. watt
D. nm/cm
E. watt/nm

ans: D

60. The dispersion of a diffraction grating indicates:

A. the resolution of the grating
B. the separation of lines of the same order
C. the number of rulings in the grating
D. the width of the lines
E. the separation of lines of different order for the same wavelength

ans: B

61. The resolving power of a diffraction grating is defined by $R = \lambda/\Delta\lambda$. Here λ and $\lambda + \Delta\lambda$ are:

A. any two wavelengths
B. any two wavelengths that are nearly the same
C. two wavelengths for which lines of the same order are separated by π radians
D. two wavelengths for which lines of the same order are separated by 2π radians
E. two wavelengths for which lines of the same order are separated by half the width of a maximum

ans: E

62. A light beam incident on a diffraction grating consists of waves with two different wavelengths. The separation of the two first order lines is great if:

A. the dispersion is great
B. the resolution is great
C. the dispersion is small
D. the resolution is small
E. none of the above (line separation does not depend on either dispersion or resolution)

ans: A

63. To obtain greater dispersion by a diffraction grating:

A. the slit width should be increased
B. the slit width should be decreased
C. the slit separation should be increased
D. the slit separation should be decreased
E. more slits with the same width and separation should be added to the system

ans: D

64. Two nearly equal wavelengths of light are incident on an N-slit grating. The two wavelengths are not resolvable. When N is increased they become resolvable. This is because:

A. more light gets through the grating
B. the lines get more intense
C. the entire pattern spreads out
D. there are more orders present
E. the lines become more narrow

ans: E

65. A diffraction grating just resolves the wavelengths 400.0 nm and 400.1 nm in first order. The number of slits in the grating is:

A. 400
B. 1000
C. 2500
D. 4000
E. not enough information is given

ans: D

66. What is the minimum number of slits required in a diffraction grating to just resolve light with wavelengths of 471.0 nm a

A. 99
B. 197
C. 393
D. 786
E. 1179

ans: C

67. X rays are:

A. electromagnetic waves
B. negatively charged ions
C. rapidly moving electrons
D. rapidly moving protons
E. rapidly moving neutrons

ans: A

68. Bragg's law for x-ray diffraction is $2d \sin\theta = m\lambda$, where θ is the angle between the incident beam and:

A. a reflecting plane of atoms
B. the normal to a reflecting plane of atoms
C. the scattered beam
D. the normal to the scattered beam
E. the refracted beam

ans: A

69. Bragg's law for x-ray diffraction is $2d \sin\theta = m\lambda$, where the quantity d is:

A. the height of a unit cell
B. the smallest interatomic distance
C. the distance from detector to sample
D. the distance between planes of atoms
E. the usual calculus symbol for a differential

ans: D

70. Which of the following is true for Bragg diffraction but not for diffraction from a grating?

A. Two different wavelengths may be used
B. For a given wavelength, a maximum may exist in several directions
C. Long waves are deviated more than short ones
D. There is only one grating spacing
E. Maxima occur only for particular angles of incidence

ans: E

71. The longest x-ray wavelength that can be diffracted by crystal planes with a separation of 0.316 nm is:

A. 0.158 nm
B. 0.316 nm
C. 0.474 nm
D. 0.632 nm
E. 1.26 nm

ans: D

72. A beam of x rays of wavelength 0.20 nm is diffracted by a set of planes in a crystal whose separation is 3.1×10^{-8} cm. The smallest angle between the beam and the crystal planes for which a reflection occurs is:

A. 0.70 rad
B. 0.33 rad
C. 0.033 rad
D. 0.066 rad
E. no such angle exists

ans: C

73. An x-ray beam of wavelength 3×10^{-11} m is incident on a calcite crystal of lattice spacing 0.3 nm. The smallest angle between crystal planes and the x-ray beam that will result in constructive interference is:

A. 2.87°
B. 5.73°
C. 11.63°
D. 23.27°
E. none of these

ans: A

74. A beam of x rays of wavelength 0.10 nm is found to diffract in second order from the face of a LiF crystal at a Bragg angle of 30°. The distance between adjacent crystal planes, in nm, is about:

A. 0.15
B. 0.20
C. 0.25
D. 0.30
E. 0.40

ans: B