

**Physics: Principle and Applications, 7e (Giancoli)**  
**Chapter 25 Optical Instruments**

**25.1 Conceptual Questions**

1) The focal length of the lens of a simple digital camera is 40 mm, and it is originally focused on a person 25 m away. In what direction must the lens be moved to change the focus of the camera to a person 4.0 m away?

- A) It does not make any difference.
- B) sideways from the CCD sensors
- C) away from the CCD sensors
- D) towards the CCD sensors

Answer: C

Var: 1

2) If a camera lens aperture is set to  $f/4$ , then

- A) the radius of the lens aperture is  $\frac{1}{4}$  the focal length.
- B) the focal length of the lens is 4 mm.
- C) the diameter of the lens aperture is  $\frac{1}{4}$  the focal length.
- D) the radius of the lens aperture is 4 times its focal length.
- E) the diameter of the lens aperture is 4 times its focal length.

Answer: C

Var: 1

3) If a camera lens lets in an amount of light  $I$  when it is set to  $f/4$ , then how much light will it let in when it is set to  $f/8$ ?

- A)  $I/4$
- B)  $I/2$
- C)  $2I$
- D)  $4I$
- E)  $16I$

Answer: A

Var: 1

4) The closest object that a typical young person with normal vision can focus on clearly is closest to

- A) 1 cm.
- B) 10 cm.
- C) 25 cm.
- D) 50 cm.
- E) 75 cm.

Answer: C

Var: 1

5) If the lens in a person's eye is too highly curved, this person is suffering from

- A) farsightedness.
- B) spherical aberration.
- C) astigmatism.
- D) chromatic aberration.
- E) nearsightedness.

Answer: E

Var: 1

6) If the back of a person's eye is too close to the lens, this person is suffering from

- A) nearsightedness.
- B) spherical aberration.
- C) astigmatism.
- D) chromatic aberration.
- E) farsightedness.

Answer: E

Var: 1

7) Nearsightedness is usually corrected with

- A) converging lenses.
- B) diverging lenses.
- C) convex mirrors.
- D) cylindrical lenses.
- E) concave mirrors.

Answer: B

Var: 1

8) Farsightedness can usually be corrected with

- A) converging lenses.
- B) diverging lenses.
- C) convex mirrors.
- D) cylindrical lenses.
- E) concave mirrors.

Answer: A

Var: 1

9) A little known fact is that both Robinson Crusoe and Friday wore eyeglasses. As it so happens, Robinson Crusoe was farsighted while Friday was nearsighted. Whose eyeglasses did they use whenever they wanted to start a fire by focusing the sun's rays?

- A) Robinson Crusoe's
- B) Friday's
- C) Both would work equally well.
- D) Both actually worked, but Friday's was a little bit better.
- E) Neither's worked, but fortunately they were in possession of matches.

Answer: A

Var: 1

10) What type of lens is used to make a magnifying glass?

- A) converging
- B) diverging
- C) Either type would work equally well.

Answer: A

Var: 1

11) The angular magnification of a magnifying glass is largest when the image is at

- A) the far point of the eye.
- B) the focal point of the lens.
- C) the near point of the eye.
- D) infinity.
- E) The magnification depends on the magnifying glass lens, not where the person puts his eye.

Answer: C

Var: 1

12) In a compound microscope

- A) both the objective and the eyepiece form real images.
- B) magnification is provided by the objective lens and not by the eyepiece. The eyepiece merely increases the resolution of the image viewed.
- C) magnification is provided by the objective and not by the eyepiece. The eyepiece merely increases the brightness of the image viewed.
- D) the magnification is  $m_1 + M_2$ , where  $m_1$  is the lateral magnification of the objective and  $M_2$  is the angular magnification of the eyepiece.
- E) the image of the objective serves as the object for the eyepiece.

Answer: E

Var: 1

13) A simple compound microscope normally uses

- A) a short focal length objective and a shorter focal length eyepiece.
- B) a short focal length objective and a longer focal length eyepiece.
- C) a long focal length objective and a shorter focal length eyepiece.
- D) a very long focal length objective and a longer focal length eyepiece.

Answer: B

Var: 1

14) For relaxed viewing with a microscope or a telescope, the eyepiece is adjusted to place the image at

- A) the near point of the eye.
- B) the pupil of the eye.
- C) the focal point of the eyepiece.
- D) infinity.
- E) the focal point of the objective lens.

Answer: D

Var: 1

15) Jack and Mary view the same microorganism through the same compound microscope. Mary's near point distance,  $N_M$ , is twice as large as Jack's near point distance,  $N_J$ . If Mary sees the microorganism with magnification  $M_M$ , with what magnification does Jack see it?

- A)  $2 M_M$
- B)  $M_M/2$
- C)  $4 M_M$
- D)  $M_M/4$
- E)  $8 M_M$

Answer: B

Var: 1

16) You have a choice between two lenses of focal lengths  $f_a$  and  $f_b$ , where  $f_b = 2f_a$ , to use as the objective lens in building a compound microscope. If the magnification you obtain using lens  $a$  is  $M_a$ , what will be the magnification when using lens  $b$ ?

- A)  $M_b = 2 M_a$
- B)  $M_b = 4 M_a$
- C)  $M_b = 8 M_a$
- D)  $M_b = M_a/4$
- E)  $M_b = M_a/2$

Answer: E

Var: 1

17) Which one of the following is a characteristic of a compound microscope?

- A) The objective is a diverging lens.
- B) The eyepiece is a diverging lens.
- C) The final image is real.
- D) The image formed by the objective is virtual.
- E) The image formed by the objective is real.

Answer: E

Var: 1

18) Which one of the following statements is correct?

- A) The image formed by the objective of a microscope is smaller than the object.
- B) The image formed by the objective lens of a telescope is larger than the object.
- C) The image formed by the eyepiece is real for both a microscope and a telescope.
- D) The image formed by the objective lens of a microscope is larger than the object.

Answer: D

Var: 1

19) You are given two converging lenses to build a compound microscope. Lens A has focal length 0.50 cm and lens B has focal length of 3.0 cm. Which one of the two lenses would you use for the objective?

- A) Lens A, because it has the shorter focal length.
- B) Lens B, because it has the longer focal length.
- C) It makes no difference which lens I use for the objective.
- D) None, because the objective should be a diverging lens.

Answer: A

Var: 1

20) To maximize the magnification of a refracting telescope, what lenses should you choose?

- A) The objective lens and eyepiece should both have small focal lengths.
- B) The objective lens and eyepiece should both have large focal lengths.
- C) The objective lens should have a small focal length and the eyepiece should have a large focal length.
- D) The objective lens should have a large focal length and the eyepiece should have a small focal length.
- E) The objective lens should have a large focal length, but it doesn't matter what the focal length of the eyepiece is.

Answer: D

Var: 1

21) Which one of the following is normally *not* a characteristic of a simple two-lens refracting astronomical telescope?

- A) The angular size of the final image is larger than that of the object.
- B) The final image is virtual.
- C) The objective forms a virtual image.
- D) The final image is inverted.

Answer: C

Var: 1

22) A simple refracting telescope provides large magnification by employing

- A) a short focal length objective and a short focal length eyepiece.
- B) a short focal length objective and a long focal length eyepiece.
- C) a long focal length objective and a short focal length eyepiece.
- D) a long focal length objective and a long focal length eyepiece.

Answer: C

Var: 1

23) You have a choice between two lenses of focal lengths  $f_a$  and  $f_b$ , where  $f_b = 2f_a$ , to use as the objective lens in building a refracting telescope. If the magnification you obtain using lens  $a$  is  $M_a$ , what will be the magnification when using lens  $b$ ?

- A)  $M_b = 2 M_a$
- B)  $M_b = 4 M_a$
- C)  $M_b = 8 M_a$
- D)  $M_b = M_a/4$
- E)  $M_b = M_a/2$

Answer: A

Var: 1

24) A refracting telescope has a magnification  $M$ . If the focal length of the objective lens is doubled and the eyepiece focal length is halved, what is the new magnification?

- A)  $4M$
- B)  $2M$
- C)  $M/2$
- D)  $M/4$
- E)  $M$

Answer: A

Var: 1

25) Given perfect lenses, what is the main reason that a telescope with a large-diameter objective lens can produce a sharper image than one with a small-diameter lens?

- A) A larger lens can gather more light than a smaller lens.
- B) A larger lens can focus more accurately than a smaller lens.
- C) There is less diffraction with a larger lens than with a smaller lens.
- D) A larger lens can focus more wavelengths of light than a smaller lens.
- E) A larger lens has a longer focal length than a smaller lens.

Answer: C

Var: 1

26) If a metal sheet containing a tiny hole is heated (without damaging it) and therefore expands, what happens to the angular location of the first-order diffraction maximum?

- A) It moves toward the centerline.
- B) It moves away from the centerline.
- C) It doesn't change.

Answer: A

Var: 1

27) Light of wavelength 500 nm illuminates a round 0.50-mm-diameter hole. A screen is placed 6.0 m past the slit. What is the width of the central bright circle on the screen?

- A) 15 mm
- B) 260  $\mu\text{m}$
- C) 7.3 mm
- D) 3700  $\mu\text{m}$

Answer: A

Var: 50+

28) Light from a He-Ne laser of wavelength 633 nm passes through a circular aperture. The resulting pattern is observed on a screen 4.0 m behind the aperture, where the width of the central bright circle is 1.1 cm. What is the diameter of the hole?

- A) 560  $\mu\text{m}$
- B) 9.8  $\mu\text{m}$
- C) 32,000  $\mu\text{m}$
- D) 4700  $\mu\text{m}$

Answer: A

Var: 50+

29) A round 0.85-mm-diameter hole is illuminated by infrared light of wavelength 2.5  $\mu\text{m}$ . What is the angle of the first dark fringe in the resulting pattern?

- A) 0.21 degrees
- B)  $3.6 \times 10^{-3}$  degrees
- C)  $1.2 \times 10^{-2}$  degrees
- D)  $4.8 \times 10^{-2}$  degrees

Answer: A

Var: 50+

## 25.2 Problems

1) A 35-mm digital camera using a standard 50.0 mm lens is focused on a 1.80 m tall person who is standing 3.25 m from the lens. You now refocus the camera on a 15.0 cm tall flower that is 75.0 cm from the lens.

(a) In refocusing, by how much did you move the lens? Did you move it toward the film or away from it?

(b) What is the height of the flower's image on the CCD sensor?

Answer: (a) 2.79 mm, away from the film (b) 10.7 mm

Var: 1

2) A slide projector needs to focus the image of a 24.0-mm  $\times$  36.0-mm slide onto a square screen 1.50 m on each side. You want to fill the screen as completely as possible without any of the image falling beyond the screen. Due to space constraints in the projector, the slide must be placed 10.5 cm from the lens.

(a) What magnification does the projector produce?

(b) How far from the lens should the screen be placed?

(c) What focal length projector lens is needed?

Answer: (a) 41.7, (b) 4.38 m, (c) 10.3 cm

Var: 1

3) A 35-mm camera equipped with a 40-mm focal length lens is used to photograph a tree 17 m tall. If a 32-mm high image of the tree on the CCD sensor is required, how far should the camera lens be from the tree?

A) 21 m

B) 22 m

C) 23 m

D) 24 m

E) 26 m

Answer: A

Var: 50+

4) The focal length of the lens of a simple film camera is 40.0 mm. By what amount should the distance between the lens and the film be increased or decreased to change the focus from a person who is 25 m from the lens to one who is 4.0 m from the lens?

A) 0.2 mm

B) 0.3 mm

C) 0.4 mm

D) 0.5 mm

E) 0.7 mm

Answer: B

Var: 1



5) A simple digital camera lens with focal length  $f_o = 3.00$  cm perfectly focuses the image of an object on a CCD sensor located a distance 14.00 cm away from the lens. The object now moves away from the lens and the new distance between the lens and sensor is 13.00 cm.

(a) By what amount did the object change its distance from the lens?

(b) What is the new magnification?

A) (a) 0.08 cm

(b) 3.33

B) (a) 0.03 cm

(b) 0.30

C) (a) 990.00 cm

(b) 0.23

D) (a) 12.22 cm

(b) 4.33

Answer: A

Var: 50+

6) A 35-mm single lens reflex (SLR) digital camera is using a lens of focal length 35.0 mm to photograph a person who is 1.80 m tall and located 3.60 m from the lens.

(a) How far is the CCD sensor from the lens when the person is in focus?

(b) How tall is the person's image on the CCD sensor?

Answer: (a) 3.53 cm (b) 1.77 cm

Var: 1

7) A zoom lens for a camera is adjusted to change its focal length from 38 mm to 304 mm. If the same amount of light is to be admitted to the lens in both cases, what is the final  $f$ -number if the original  $f$ -number was  $f/2.0$ ?

Answer:  $f/16$

Var: 50+

8) A 35-mm camera equipped with a 45-mm focal length lens is used to photograph a tree 15 m tall. If the aperture of the lens is set at  $f/2$ , what is the aperture diameter?

A) 23 mm

B) 14 mm

C) 18 mm

D) 27 mm

E) 32 mm

Answer: A

Var: 50+

9) A lens of focal length 45 mm is mounted on a 35-mm camera. The lens aperture is set at  $f/2.0$  and the shutter speed set at  $1/2000$  s. The photographer wants to keep the same exposure (amount of light), but wants to change the  $f$ -number to  $f/8.0$  for greater depth of field. What should be the new shutter speed to maintain the same exposure?

- A)  $1/1000$  s
- B)  $1/500$  s
- C)  $1/4000$  s
- D)  $1/8000$  s
- E)  $1/125$  s

Answer: E

Var: 1

10) A camera lens has a focal length of 50.0 mm and an aperture setting of  $f/4.00$ . What is the diameter of the aperture of this lens?

- A) 12.5 mm
- B) 10.1 mm
- C) 25.0 mm
- D) 35.4 mm
- E) 200 mm

Answer: A

Var: 1

11) The focal length of a camera lens is 40 mm and its aperture diameter is 10 mm. What is the  $f$ -number of this lens?

- A) 4.0
- B) 2.0
- C) 5.6
- D) 0.25
- E) 0.40

Answer: A

Var: 1

12) For an eye that is 2.4 cm in diameter, what must be the range of focal lengths of the lens to focus objects from the near point (25 cm) to infinity on the retina?

Answer:  $2.2 \text{ cm} \leq f \leq 2.4 \text{ cm}$

Var: 1

13) A person's near point is 25 cm, and her eye lens is 2.7 cm away from the retina. What must be the focal length of this lens for an object at the near point of the eye to focus on the retina?

- A) -3.4 cm
- B) -2.4 cm
- C) 2.4 cm
- D) 3.4 cm
- E) 2.6 cm

Answer: C

Var: 5

14) A person's eye lens is 2.8 cm from the retina, and his near point is at 25 cm. What must be the focal length of his eye lens so that an object at the far point of the eye will focus on the retina?

- A) -2.8 cm
- B) 2.8 cm
- C) -2.4 cm
- D) 2.4 cm
- E) 2.2 cm

Answer: B

Var: 5

15) What power (in diopters) of corrective contact lens is required to correct the vision of a myopic eye whose far point is at 170 cm?

Answer: -0.59 diopters

Var: 29

16) A person is nearsighted with a far point of 75.0 cm.

- (a) What focal length contact lens is needed to give him normal vision?
- (b) What is the power of the corrective lens?

Answer: (a) -75.0 cm (b) -1.33 diopters

Var: 1

17) A nearsighted person has a near point of 12 cm and a far point of 17 cm. If the corrective lens is 2.0 cm from his eye, (a) what lens power will enable this person to see distant objects clearly, and (b) what then will be the new near point of his eye?

Answer: (a) -6.7 diopters (b) 30 cm in front of the lens

Var: 1

18) A person uses corrective glasses of power -8.5 D that are worn 2.0 cm from her eye.

- (a) Is she nearsighted or farsighted?
- (b) What is her far point without glasses?

Answer: (a) nearsighted (b) 14 cm

Var: 1

19) A nearsighted man wears contact lenses of -3.00 diopters. With these lenses, his corrected near point is 25.0 cm. What is his uncorrected near point?

Answer: 14.3 cm

Var: 1

20) A person's hyperopic (farsighted) eye can focus on objects that are 75 cm away and farther. What power and what focal length contact lenses should be prescribed so this person can see objects 25 cm and farther from the eye?

Answer: 2.7 diopters, 38 cm

Var: 1

21) A nearsighted person has a far point of 50 cm for his right eye and 150 cm for his left eye. For each eye, what power contact lens will allow the person to see gorgeous sunsets?

Answer: -2.0 diopters (right eye), -0.67 diopters (left eye)

Var: 1

22) What is the power of the lens that has a focal length of 40 cm and a diameter of 5.0 cm?

- A) -2.5 diopters
- B) +20 diopters
- C) +0.20 diopters
- D) +2.5 diopters
- E) +2.7 diopters

Answer: D

Var: 1

23) What is the power of a lens that has a focal length of -40 cm and a width of 2.0 cm?

- A) -2.5 diopters
- B) -0.50 diopters
- C) +4.0 diopters
- D) +2.5 diopters
- E) -50 diopters

Answer: A

Var: 1

24) The power of a lens is 4.0 diopters and its diameter is 5.0 cm. What is the focal length of this lens?

- A) 25 cm
- B) 55 cm
- C) 10 cm
- D) 0.25 cm
- E) 2.5 cm

Answer: A

Var: 1

25) A farsighted boy has a near point at 2.3 m and requires contact lenses to correct his vision to the normal near point. What is the correct choice of lens power for the contact lenses?

- A) -0.28 diopters
- B) +0.28 diopters
- C) -3.6 diopters
- D) +3.6 diopters
- E) +1.8 diopters

Answer: D

Var: 1

26) A farsighted girl has a near point at 2.0 m but has forgotten her glasses at home. The girl borrows eyeglasses that have a power of +2.75 diopters. With these eyeglasses, what is the near point of the girl, assuming that she wears them extremely close to her eyes?

- A) 28 cm
- B) 31 cm
- C) 33 cm
- D) 37 cm
- E) 40 cm

Answer: B

Var: 1

27) A myopic (nearsighted) child wears contact lenses that allow her to have clear distant vision. The power of the lenses of her eyeglasses is -3.00 diopters. Without the corrective lenses, what is the far point of the girl?

- A) 0.33 m
- B) 0.25 m
- C) 0.17 m
- D) 0.42 m
- E) 0.50 m

Answer: A

Var: 12

28) A machinist with normal vision has a near point at 25 cm. This machinist wears +4.25-diopter eyeglasses in order to do very close work. With these eyeglasses, what is the near point of the machinist? Assume that he wears the glasses extremely close to his eyes.

- A) 12 cm
- B) 10 cm
- C) 7 cm
- D) 15 cm
- E) 17 cm

Answer: A

Var: 14

29) As a treatment for cataracts (a cloudiness of the lens of the eye), the natural lens is removed and a plastic lens is implanted. After this is done a person can see distant objects clearly, but he cannot accommodate to focus on nearby objects. If such a person wanted to read a book at a distance of 25 cm, he would have to wear contact lenses having a diopter power of

- A) +2.78 diopters
- B) +3.33 diopters
- C) -1.78 diopters
- D) +4.00 diopters
- E) -4.00 diopters

Answer: D

Var: 1

30) What is the focal length of the corrective contact lens needed by a nearsighted person whose far point is at 60 cm?

- A) -60 cm
- B) -30 cm
- C) +30 cm
- D) +60 cm
- E) +130 cm

Answer: A

Var: 5

31) The near point of a farsighted person is 65 cm. What power contact lens must he use to correct this problem and be able to read a book at a normal near point of 25 cm?

- A) -4.2 diopters
- B) -2.5 diopters
- C) -2.4 diopters
- D) +4.2 diopters
- E) +2.5 diopters

Answer: E

Var: 5

32) A nearsighted person has a far point that is 4.2 m from his eyes. What focal length lenses must he use in his contact lenses to allow him to focus on very distant mountains?

- A) -4.2 m
- B) 4.2 m
- C) -5.2 m
- D) 5.2 m
- E) -4.8 m

Answer: A

Var: 1

33) A nearsighted person has a far point that is 4.2 m from his eyes. What power contact lenses must he wear to allow him to focus on distant mountains?

- A) 0.48 diopters
- B) -0.48 diopters
- C) -0.36 diopters
- D) -0.24 diopters
- E) 0.24 diopters

Answer: D

Var: 1

34) What is the focal length of a contact lens that will allow a person with a near point of 125 cm to read a physics book held 25.0 cm from his eyes?

- A) -100 cm
- B) -31.3 cm
- C) 10.2 cm
- D) 20.8 cm
- E) 31.3 cm

Answer: E

Var: 1

35) What power contact lens should be used to correct the vision of a farsighted person whose near point is 80 cm so she can see things clearly that are 25 cm in front of her?

- A) +2.8 diopters
- B) -2.8 diopters
- C) -4.0 diopters
- D) -4.2 diopters
- E) +4.2 diopters

Answer: A

Var: 1

36) What power contact lens must be used to correct the vision of a nearsighted person whose far point is 40 cm?

- A) +2.5 diopters
- B) -2.5 diopters
- C) -3.6 diopters
- D) -4.0 diopters
- E) +4.0 diopters

Answer: B

Var: 1

37) What is the *uncorrected* near point of a farsighted person who can comfortably read a newspaper held 25 cm from his eyes when he wears +3.33-diopter contact lenses?

- A) 1.5 m
- B) 0.50 m
- C) 1.9 m
- D) 0.75 m
- E) 0.60 m

Answer: A

Var: 1

38) Without glasses, a person can comfortably read a magazine when it is held at 60 cm from his eyes. What should be the focal length of his contact lenses to allow him to read the magazine comfortably at a distance of 30 cm?

- A) -30 cm
- B) +30 cm
- C) -60 cm
- D) +60 cm
- E) +90 cm

Answer: D

Var: 1

39) Diego is nearsighted and cannot see things beyond 110 cm from his eyes. What is the focal length of the contact lenses that will enable him to comfortably see distant hills clearly?

- A) +50 cm
- B) -50 cm
- C) -110 cm
- D) +110 cm
- E) -30 cm

Answer: C

Var: 5

40) Olga is nearsighted and cannot see things beyond 90 cm from her eyes. What is the refractive power of the contact lenses that will enable her to comfortably see distant buildings clearly?

- A) +1.1 diopters
- B) -1.1 diopters
- C) -1.7 diopters
- D) -2.2 diopters
- E) +2.2 diopters

Answer: B

Var: 5

41) Mahmood is farsighted and cannot see objects clearly that are closer to his eye than 80.0 cm. What is the focal length of the contact lenses that will enable him to comfortably see objects at a distance of 25.0 cm from his eyes?

- A) +36.4 cm
- B) -36.4 cm
- C) -21.2 cm
- D) +21.2 cm
- E) +32.5 cm

Answer: A

Var: 5



42) Alice is farsighted and cannot see objects clearly that are closer to her eye than 80.0 cm. What is the refractive power of the contact lenses that will enable her to comfortably see objects at a distance of 25.0 cm from her eyes?

- A) +2.75 diopters
- B) -2.75 diopters
- C) -4.72 diopters
- D) +4.72 diopters
- E) +7.00 diopters

Answer: A

Var: 5

43) A nearsighted person cannot see objects beyond 80 cm from his eyes. Which one of the following combinations represents the correct focal length and the refractive power of the contact lenses that will enable him to comfortably see the distant objects clearly?

- A) +80 cm, +1.3 diopters
- B) -80 cm, +1.3 diopters
- C) +80 cm, -1.3 diopters
- D) -80 cm, -1.3 diopters
- E) -1.3 cm, +1.3 diopters

Answer: D

Var: 5

44) A farsighted person cannot see clearly objects that are closer to her eyes than 60.0 cm. Which one of the following combinations represents the correct focal length and the refractive power of the contact lenses that will enable her to comfortably see the objects at a distance of 25.0 cm from her eyes?

- A) -42.9 cm, +2.33 diopters
- B) -42.9 cm, -2.33 diopters
- C) +42.9 cm, +2.33 diopters
- D) +42.9 cm, -2.33 diopters
- E) +60 cm, +42.9 diopters

Answer: C

Var: 5

45) A nearsighted person has a far point of 18 cm. What power contact lenses will allow this person to comfortably see distant objects clearly?

- A) +5.6 diopters
- B) -5.6 diopters
- C) +0.056 diopters
- D) -0.056 diopters

Answer: B

Var: 3

46) A person cannot see clearly objects more than 70.0 cm away. What power of corrective lens should be prescribed if the glass is to be worn 1.00 cm in front of the eye?

- A) 1.45 diopters
- B) -1.45 diopters
- C) 0.0145 diopters
- D) -0.0145 diopters

Answer: B

Var: 1

47) A nearsighted person wears contact lenses having a power of -0.15 diopters. What is the person's uncorrected far point?

- A) 1.5 m
- B) 3.3 m
- C) 6.0 m
- D) 6.7 m

Answer: D

Var: 1

48) What power contact lens is needed to correct for farsightedness where the uncorrected near point is 75 cm?

- A) +2.7 D
- B) -2.7 D
- C) +5.3 D
- D) -5.3 D

Answer: A

Var: 2

49) The near point of a farsighted person is 100 cm. She places reading glasses very close to her eyes, and with them she can comfortably read a book at a distance of 25 cm. What is the power of the lenses in her reading glasses?

- A) +2.5 diopters
- B) +3.0 diopters
- C) +3.2 diopters
- D) -2.0 diopters

Answer: B

Var: 1

50) When a person with a near point at 28 cm uses a certain magnifying glass, it produces an angular magnification of 7.0 with the image very distant. What is the focal length of the lens of this magnifying glass?

- A) 2.0 cm
- B) 3.0 cm
- C) 4.0 cm
- D) 5.0 cm
- E) 6.0 cm

Answer: C

Var: 1

51) The focal length of a magnifying glass is 15 cm. If the near point of a person is 25 cm, what is the angular magnification of the glass for this person when his eyes are focused at infinity?

- A) 1.7
- B) 2.7
- C) 3.7
- D) 4.7
- E) 5.7

Answer: A

Var: 1

52) The focal length of a converging lens is 10 cm. What is the angular magnification of this lens if the image is viewed by a relaxed eye with a near point of 25 cm?

- A) 0.50
- B) 1.5
- C) 2.5
- D) 3.5
- E) 4.5

Answer: C

Var: 1

53) What is the angular magnification of a magnifying glass of focal length 4.0 cm if the image is to be viewed by a relaxed eye having a near point of 25 cm?

- A) 2.0
- B) 3.0
- C) 3.6
- D) 4.0
- E) 6.3

Answer: E

Var: 1

54) A lens of focal length 90 mm is used as a magnifier by a person with a near point of 25 cm. The object being viewed is 9.9 mm long, and is positioned at the focal point of the lens. What is the angle subtended by the image at infinity, in milliradians?

- A) 110 mrad
- B) 73 mrad
- C) 37 mrad
- D) 147 mrad
- E) 183 mrad

Answer: A

Var: 50+

55) A lens of focal length 40 mm is used as a magnifier. The object being viewed is 5.3 mm long, and is positioned at the focal point of the lens. The user of the magnifier has a near point at 25 cm. What is the angular magnification of the magnifier?

- A) 6.3
- B) 5.6
- C) 6.9
- D) 7.5
- E) 8.1

Answer: A

Var: 50+

56) A person having a near point of 25 cm uses a magnifying glass with a focal length of 10 cm. What is the angular magnification of the glass for that person when her eyes are focused at infinity?

- A) 1.5
- B) 2.5
- C) 3.5
- D) 4.5

Answer: B

Var: 1

57) A magnifying glass has a focal length of 7.0 cm. What is the angular magnification if the image is viewed by a person having a relaxed eye with the near point of 25 cm?

- A) 1.6
- B) 2.6
- C) 3.6
- D) 4.6

Answer: C

Var: 3

58) A person uses a converging lens of focal length 5.0 cm as a magnifying glass. What is the angular magnification if the person's eye is relaxed and has a near point of 25 cm?

- A) 4.0
- B) 5.0
- C) 6.0
- D) 7.0

Answer: B

Var: 1

59) A magnifying glass uses a converging lens with a refractive power of 20 diopters. What is the angular magnification if the image is to be viewed by a relaxed eye with a near point of 25 cm?

- A) 5.0
- B) 3.0
- C) 4.0
- D) 1.0
- E) 2.0

Answer: A

Var: 1

60) A person with a near point at 25 cm uses a magnifying glass of focal length 10 cm. What is the maximum angular magnification possible with this glass?

Answer: 3.5

Var: 1

61) A magnifying glass of focal length 150 mm is used to examine an old manuscript very closely by a person with a near point at 25 cm.

(a) What is the maximum angular magnification given by the lens?

(b) What is the angular magnification for relaxed eye-viewing, with the image at infinity?

Answer: (a) 2.7 (b) 1.7

Var: 1

62) Consider a magnifying glass with a power of 3.0 diopters.

(a) What is the maximum angular magnification for a person with a near point at 25 cm?

(b) What is the angular magnification when viewing with a relaxed eye?

Answer: (a) 1.75 (b) 0.75

Var: 9

63) A person with normal eyesight uses a converging lens of focal length 10 cm as a magnifying glass to finish an engraving job. To see detail, he holds the lens very close to his eyes. What is the maximum angular magnification of the lens under these circumstances?

- A) 3.5
- B) 4.5
- C) 6.5
- D) 7.5
- E) 8.5

Answer: A

Var: 1

64) A person with normal eyesight uses a converging lens of focal length 10 cm as a magnifying glass to finish an engraving job. To see detail, he holds the lens very close to his eyes. At what minimum distance from the job must he hold the lens?

- A) 14 cm
- B) 7.1 cm
- C) 9.4 cm
- D) 30 cm
- E) 20 cm

Answer: B

Var: 1

65) What is the maximum possible angular magnification of the converging lens of focal length 5 cm for a person with normal vision?

- A) 2
- B) 3
- C) 4
- D) 5
- E) 6

Answer: E

Var: 1

66) A person with a near point of 25 cm uses a magnifying lens having a focal length of 10 cm. What is the angular magnification of this lens if the person's eyes are focused at his near point?

- A) 1.5
- B) 2.5
- C) 3.5
- D) 4.5

Answer: C

Var: 1

67) Vicki very closely examines her new ruby ring with the jeweler's "loop." The ruby appears 7.0 times larger through this lens than when she views it close-up without the "loop." If her near point is 35 cm, what is the focal length of the lens of the "loop"?

- A) 4.2 cm
- B) 6.7 cm
- C) 7.0 cm
- D) 3.6 cm
- E) 5.8 cm

Answer: E

Var: 1

68) A compound microscope consists of an objective lens of focal length  $f_0$  and an eyepiece that by itself produces an angular magnification 25.0. The microscope is designed so that the object to be viewed is on the left side of the objective lens and is focused in a plane that is 28.00 cm away from the right-hand (or inside) focal point of the objective lens. When properly adjusted, the eyepiece and the objective lens are 29.90 cm apart. The eyepiece magnification is based on an image at infinity and a near point at 25.0 cm. What is  $f_0$ ?

Answer: 0.90 cm

Var: 50+

69) The objective lens of a microscope has a focal length of 2.4 mm and the eyepiece has an angular magnification of 15. The object is positioned 0.060 mm beyond the focal point of the objective. The focal point of the eyepiece is positioned at the real image formed by the objective. The near point of the microscope user is at 25 cm. The magnitude of the overall magnification of the microscope is closest to

A) 400.

B) 450.

C) 500.

D) 550.

E) 600.

Answer: E

Var: 1

70) A very delicate sample is placed 0.150 cm from the objective lens of a microscope. The focal length of the objective is 0.140 cm, and that of the eyepiece is 1.0 cm. The near-point distance of the person using the microscope is 25.0 cm. The magnitude of the final magnification of the microscope is closest to

A) 375.

B) 300.

C) 250.

D) 125.

E) 100.

Answer: A

Var: 1

71) The objective lens of a microscope has a focal length of 2.4 mm and the eyepiece has an angular magnification of 15. The object is positioned 0.060 mm beyond the focal point of the objective. The focal point of the eyepiece is positioned at the real image formed by the objective. The near point of the microscope user is at 25 cm. What is the distance between the objective lens and the eyepiece?

A) 98 mm

B) 102 mm

C) 107 mm

D) 111 mm

E) 115 mm

Answer: E

Var: 1

72) A microscope has an objective lens of focal length 1.40 mm and an eyepiece of focal length 20.00 mm. It is adjusted for minimum eyestrain for persons with a near point of 25.0 cm. A blood sample is placed 1.50 mm from the objective. How far apart are the lenses?

- A) 20 mm
- B) 21 mm
- C) 23 mm
- D) 41 mm

Answer: D

Var: 1

73) A microscope has an objective lens of focal length 1.40 mm and an eyepiece of focal length 20.00 mm. It is adjusted for minimum eyestrain for persons with a near point of 25.0 cm. A blood sample is placed 1.50 mm from the objective. The magnitude of the overall magnification is closest to

- A) 18.
- B) 37.
- C) 180.
- D) 370.

Answer: C

Var: 1

74) A compound microscope has an objective with a focal length of 3.00 mm and an eyepiece of focal length 6.00 cm. It is adjusted for minimum eyestrain for persons with a near point of 25 cm. If the two lenses are separated by 40.0 cm, what is the total overall magnification?

- A) 28
- B) 56
- C) 470
- D) 550
- E) 2200

Answer: C

Var: 1

75) A compound microscope has a 18-cm-long barrel and an objective lens with a focal length of 8.0 mm. What is the focal length of the eyepiece to give a total magnification of 240? It is adjusted for minimum eyestrain for persons with a near point of 25 cm.

- A) 1.3 m
- B) 1.5 cm
- C) 1.9 cm
- D) 2.1 cm
- E) 2.3 cm

Answer: D

Var: 1



76) The focal lengths of the objective lens and the eyepiece in a microscope are 2.90 mm and 2.50 cm, respectively. An object is placed 3.00 mm from the objective. The image of this object is viewed with the eyepiece adjusted for minimum eyestrain for persons with a near point of 25 cm. What is the distance between the objective and the eyepiece?

- A) 9.9 cm
- B) 9.0 cm
- C) 15 cm
- D) 11 cm
- E) 13 cm

Answer: D

Var: 1

77) The focal lengths of the objective lens and the eyepiece in a microscope are 0.29 cm and 2.50 cm, respectively. An object is placed at 0.30 cm from the objective lens and the image of this object is viewed with the eyepiece adjusted for minimum eyestrain for persons with a near point of 25 cm. The magnitude of the final overall magnification of the microscope is closest to

- A) 100
- B) 200
- C) 300
- D) 410
- E) 500

Answer: C

Var: 1

78) The focal lengths of the objective lens and the eyepiece of a microscope are 0.50 cm and 2.0 cm, respectively, and their separation adjusted for minimum eyestrain is 6.0 cm. If the microscope is focused on a small object, what is the distance between the object and the objective lens?

- A) 0.31 cm
- B) 0.42 cm
- C) 0.49 cm
- D) 0.57 cm
- E) 0.73 cm

Answer: D

Var: 1

79) The focal lengths of the objective lens and the eyepiece of a microscope are 0.50 cm and 2.0 cm, respectively, and their separation is 6.0 cm when adjusted for minimum eyestrain for a person with a near point of 25.0 cm. If the microscope is focused on a small object, the magnitude of its final overall magnification is closest to

- A) 50.
- B) 100.
- C) 150.
- D) 200.
- E) 250.

Answer: B

Var: 1

80) The distance between the object to be viewed and the eyepiece of a compound microscope is 18.0 cm. The focal length of its objective lens is 0.80 cm and the eyepiece has a focal length of 2.3 cm. The near-point distance of the person using the microscope is 25.0 cm. What is the magnitude of the total magnification of the microscope if it is designed for minimum eyestrain?

- A) 120
- B) 184
- C) 200
- D) 360
- E) 480

Answer: C

Var: 1

81) The distance between the object to be viewed and the eyepiece of a compound microscope is 25.0 cm. The focal length of its objective lens is 0.200 cm and the eyepiece has a focal length of 2.60 cm. What is the magnitude of the total magnification of the microscope when used by the person of normal eyesight if it is designed for minimum eyestrain?

- A) 1070
- B) 204
- C) 520
- D) 477
- E) 772

Answer: A

Var: 1

82) The objective lens and the eyepiece of a microscope have focal lengths of 4.0 mm and 25 mm, respectively. The objective produces a real image 30 times the size of the object, with the final image viewed at infinity. The near point of the microscope user is at 25 cm. What is the distance between the object and the focal point of the objective lens?

- A) 0.13 mm
- B) 0.18 mm
- C) 0.23 mm
- D) 0.28 mm
- E) 0.33 mm

Answer: A

Var: 1

83) The objective lens and the eyepiece of a microscope have focal lengths of 4.0 mm and 25 mm, respectively. The objective produces a real image 30 times the size of the object, with the final image viewed at infinity. The near point of the microscope user is at 25 cm. What is the distance between the objective lens and the real image that it produces?

- A) 116 mm
- B) 120 mm
- C) 124 mm
- D) 128 mm
- E) 132 mm

Answer: C

Var: 1

84) The objective lens and the eyepiece of a microscope have focal lengths of 4.0 mm and 25 mm, respectively. The objective produces a real image 30 times the size of the object, with the final image viewed at infinity. The near point of the microscope user is at 25 cm. What is the magnitude of the overall magnification of the microscope?

- A) 250
- B) 300
- C) 350
- D) 400
- E) 450

Answer: B

Var: 1

85) The eyepiece of a compound microscope has a focal length of 2.50 cm, and the objective has a focal length of 1.60 cm. The two lenses are separated by 14.0 cm. The microscope is used by a person with normal eyes, having a near point at 25 cm. What is the magnitude of the magnification of the microscope?

- A) 72
- B) 88
- C) 180
- D) 219
- E) 115

Answer: A

Var: 50+

86) A refracting telescope has an eyepiece of focal length -80 mm and an objective of focal length 36 cm. What is the magnification of this instrument?

Answer: 4.5

Var: 1

87) A student wishing to build a telescope has available an eyepiece of focal length -5.0 cm. What focal length objective is needed to obtain a magnification of 10?

Answer: 50 cm

Var: 1

88) The objective lens of a telescope has a focal length of 1.90 m. When viewed through this telescope, the Moon appears 5.25 times larger than normal. How far apart are the objective lens and the eyepiece when this instrument is focused on the Moon?

Answer: 2.26 m

Var: 1

89) Mary builds a simple refracting telescope using two lenses of focal length 80 cm and 5.0 cm. The respective diameters are 60 mm and 10 mm. How many degrees wide does the moon appear through the telescope if it appears only  $1/2$  degree wide with the "naked eye"?

Answer:  $8^\circ$  (16 times larger)

Var: 1

90) You have available lenses of focal lengths 2.0 cm, 4.0 cm, 8.0 cm, and 16.0 cm. If you could use any two of these lenses to build a telescope, what is the maximum magnification you could achieve for comfortable viewing of a planet?

A) 2.0

B) 4.0

C) 6.0

D) 8.0

Answer: D

Var: 1

91) You have available lenses of focal lengths 2.0 cm, 4.0 cm, 8.0 cm, and 16 cm. If you could use any two of these lenses to build a telescope, what is the lens separation for the telescope to provide the maximum magnification for comfortable viewing of a planet?

A) 10.0 cm

B) 12.0 cm

C) 18.0 cm

D) 24.0 cm

Answer: C

Var: 1

92) The objective lens of a telescope has a focal length of 2.0 m and its eyepiece has a focal length of 1.0 cm. What is the magnification of this telescope when viewing Jupiter?

A) 0.0050

B) 0.50

C) 2.0

D) 20

E) 200

Answer: E

Var: 1

93) A student constructs an astronomical telescope and wishes it to have a magnification of 10. If the telescope has an objective lens of focal length 0.50 m, what must be the focal length of the eyepiece?

- A) 2.5 cm
- B) 5.0 cm
- C) 10 cm
- D) 25 cm

Answer: B

Var: 1

94) A student constructs an astronomical telescope with a magnification of 10. If the telescope has an objective lens of focal length 0.50 m, what is the resulting length of the telescope?

- A) 53 cm
- B) 55 cm
- C) 60 cm
- D) 75 cm

Answer: B

Var: 1

95) A person is designing a telescope with a magnification of 10. If the telescope is limited to a length of 0.20 m, what is the approximate focal length of the objective?

- A) 16 cm
- B) 17 cm
- C) 18 cm
- D) 19 cm

Answer: C

Var: 1

96) A telescope has an angular magnification of 250 when used with a 20 mm eyepiece. What is the focal length of the objective lens?

- A) 5.0 cm
- B) 25 m
- C) 5000 cm
- D) 5.0 m
- E) 2.5 m

Answer: D

Var: 1

97) Cal is viewing the Moon with his new telescope, using a 10-mm focal length eyepiece. For greater detail, he wishes to double the magnification of his telescope. An eyepiece having which one of the following characteristics will accomplish this for him?

- A) 40 diopters
- B) 8 mm
- C) 12 mm
- D) 200 diopters
- E) 5 diopters

Answer: D

Var: 1

98) The focal length of the objective lens of a telescope is 75.0 cm, and the eyepiece has a focal length of 6.00 cm. What is the magnification of this telescope?

- A) 0.0800
- B) 0.645
- C) 450
- D) 12.5
- E) 200

Answer: D

Var: 1

99) The length of a telescope is 2.00 m and the focal length of the objective lens is 2.0 cm. What is the focal length of the eyepiece?

- A) 200 cm
- B) 202 cm
- C) 101 cm
- D) 2.0 cm
- E) 198 cm

Answer: E

Var: 1

100) The length of a telescope is 2.20 m and the focal length of the eyepiece is 1.9 cm. What is the focal length of the objective lens?

- A) 41 cm
- B) 45 cm
- C) 111 cm
- D) 218 cm
- E) 16 cm

Answer: D

Var: 1

101) The focal length of the objective lens of a telescope is 0.20 m and the eyepiece has a focal length of 1.6 m. What is the length of this telescope?

- A) 8.0 m
- B) 1.4 m
- C) 0.90 m
- D) 1.6 m
- E) 1.8 m

Answer: E

Var: 1

102) The length of the telescope is 1.60 m, and it has a magnification of 60.0. What is the focal length of the objective lens?

- A) 60.0 cm
- B) 157 cm
- C) 100 cm
- D) 128 cm
- E) 96.0 cm

Answer: B

Var: 1

103) The length of a telescope is 1.60 m and it has a magnification of 60.0. What is the focal length of the eyepiece?

- A) 2.62 cm
- B) 60.0 cm
- C) 100 cm
- D) 1.16 cm
- E) 96.0 cm

Answer: A

Var: 1

104) The objective lens of a refracting astronomical telescope has a focal length of 60 cm, and the eyepiece has a focal length of 2.0 cm. How far apart should the lenses be placed in order to form a final image at infinity?

- A) 44 cm
- B) 58 cm
- C) 76 cm
- D) 60 cm
- E) 62 cm

Answer: E

Var: 1

105) An astronomical refracting telescope is made from two lenses. The objective lens has a focal length of 114 cm, and the eyepiece lens has a focal length of 17.0 cm.

(a) What is the total length of the telescope?

(b) What is the angular magnification of the telescope?

(c) What is the magnification by turning the telescope around and looking through the objective lens first?

A) (a) 131 cm

(b) 6.71

(c) 0.15

B) (a) 97 cm

(b) 0.15

(c) 6.71

C) (a) 262 cm

(b) 0.87

(c) 1.15

D) (a) 194 cm

(b) 1.18

(c) 0.85

Answer: A

Var: 50+

106) The angular magnification of a refracting telescope is 40. When the object and final image are both at infinity, the distance between the eyepiece and the objective is 143.5 cm. The telescope is used to view a distant radio tower. The real image of the tower, formed by the objective, is 6.0 mm in height. The focal point of the eyepiece is positioned at the real image. What is the focal length of the objective lens?

A) 138 cm

B) 139 cm

C) 140 cm

D) 141 cm

Answer: C

Var: 1

107) The angular magnification of a refracting telescope is 40. When the object and final image are both at infinity, the distance between the eyepiece and the objective is 143.5 cm. The telescope is used to view a distant radio tower. The real image of the tower, formed by the objective, is 6.0 mm in height. The focal point of the eyepiece is positioned at the real image. What is the angle subtended by the final image of the tower?

A) 0.15 rad

B) 0.17 rad

C) 0.19 rad

D) 0.21 rad

E) 0.23 rad

Answer: B

Var: 1



108) The objective and the eyepiece of a refracting astronomical telescope have focal lengths of 320 cm and 4.0 cm, respectively. The telescope is used to view Neptune and the final image is set at infinity. The diameter of Neptune is  $4.96 \times 10^7$  m, and its distance from Earth at the time of observation is  $4.4 \times 10^{12}$  m. What is the angle (in milliradians) subtended by the final telescopic image of Neptune?

- A) 0.90 mrad
- B) 1.1 mrad
- C) 1.3 mrad
- D) 1.5 mrad
- E) 1.7 mrad

Answer: A

Var: 1

109) Treat the pupil of your eye as a circular aperture of diameter 3.5 mm. Light of wavelength 500 nm is used to view two point sources that are 283 m distant from you. How far apart must these two point sources be if they are to be just barely resolved by your eye, assuming that the resolution is limited by diffraction?

Answer:  $4.9 \times 10^{-2}$  m

Var: 50+

110) Even with perfect optics, what is the resolution limit (in radians) of the Hubble Space Telescope when it is focusing light of wavelength 400 nm? The mirror diameter is 2.4 m.

Answer:  $2.0 \times 10^{-7}$  rad

Var: 1

111) The world's largest refracting telescope is operated at the Yerkes Observatory in Wisconsin. It has an objective lens of diameter of 1.02 m. Suppose such an instrument were mounted on a satellite at an elevation of 300 km above the ground and used to map surface details. If the telescope is forming images with light of wavelength 550 nm, what is the minimum separation of two objects on the ground whose separation could be clearly resolved by this lens?

Answer: 19.7 cm

Var: 1

112) What is the minimum distance between two points on the Moon that could be just resolved by the Keck telescope in Hawaii using a wavelength of 600 nm and having perfect optics? The diameter of this telescope mirror system is 10 m, and the distance to the Moon is 380,000 km.

Answer: 28 m

Var: 1

113) A camera with a 20-cm diameter lens is recording images using a filter that allows only light of wavelength 600 nm to pass through.

(a) What is the limit on the angular resolution (in microradians) in this case?

(b) What is the diameter of the minimum-sized features that could be resolved on Mars with this camera? The distance to Mars at the time is  $9.0 \times 10^7$  km.

Answer: (a)  $3.7 \mu\text{rad}$  (b) 330 km

Var: 1

114) In one particular case, the limiting angle of resolution for an eye is  $1.4 \times 10^{-4}$  rad. What is the minimum separation between two point sources of light that the eye can distinguish if they are at a distance of 40 m from the observer?

- A) 2.8 mm
- B) 5.6 mm
- C) 1.4 mm
- D) 8.4 mm
- E) 4.7 mm

Answer: B

Var: 1

115) A camera used for aerial mapping has a lens with a 30-cm diameter maximum aperture and a 42-cm focal length. Light of 550 nm wavelength is used to form the image. Assuming that the resolution of the camera is limited only by diffraction, what is the smallest angle (in milliradians) subtended by an object on the ground that can be resolved by this camera at maximum aperture?

- A) 1.6 mrad
- B) 2.2 mrad
- C) 3.2 mrad
- D) 4.5 mrad
- E) 6.3 mrad

Answer: B

Var: 1

116) Assuming a pupil diameter of 3 mm, what is the angular resolution of the human eye for light at the middle of the visible spectrum (550 nm)?

- A)  $0.8^\circ$
- B)  $0.2^\circ$
- C) 2 mrad
- D)  $0.01^\circ$
- E)  $2^\circ$

Answer: D

Var: 1

117) Suppose your telescope has perfect mirrors and is limited only by diffraction. If you are viewing with light of 400 nm wavelength, what diameter mirror in a space telescope would have 1.0-km resolution of objects on Mars when viewed from above the earth at a time when the Earth-Mars distance of 80 million kilometers?

- A) 39 km
- B) 3.9 m
- C) 3.9 km
- D) 39 m
- E) 390 m

Answer: D

Var: 1

118) Astronomers are proud of their telescopes and often say they can "resolve a dime at so many miles." How many miles from a 102-cm-diameter telescope mirror can you place a coin of diameter 3.0 cm and just resolve the coin using light of wavelength 389 nm? (1 mi = 1.609 km)

- A) 19 mi
- B) 9.7 mi
- C) 40 mi
- D) 190,000,000 mi

Answer: A

Var: 50+

119) A certain astronomical telescope has a diameter of 5.60 m. What is the minimum angle of resolution for this telescope when it is forming images using light of wavelength 620 nm?

- A)  $1.11 \times 10^{-7}$  rad
- B)  $3.11 \times 10^{-7}$  rad
- C)  $2.70 \times 10^{-7}$  rad
- D)  $1.35 \times 10^{-7}$  rad
- E)  $4.05 \times 10^{-7}$  rad

Answer: D

Var: 1

120) The two stars in a binary star system have an angular separation of  $1.0 \times 10^{-5}$  rad. If the wavelength of the light from the system is 500 nm, what is the smallest diameter aperture telescope that could just resolve this system to show that it contains two stars?

- A) 0.50 cm
- B) 0.61 cm
- C) 5.0 cm
- D) 6.1 cm

Answer: D

Var: 1

121) The pupil of a person's eye changes from a diameter of 3.5 mm to 1.5 mm as the illumination is increased. By what factor does the minimum angle of resolution change?

- A) 0.43
- B) 0.65
- C) 2.0
- D) 2.3

Answer: D

Var: 1

122) What is the limiting angle of resolution for a lens of radius 2.0 mm when viewing with light having a wavelength of 600 nm?

- A)  $1.3 \times 10^{-4}$  rad
- B)  $1.5 \times 10^{-4}$  rad
- C)  $1.8 \times 10^{-4}$  rad
- D)  $1.5 \times 10^{-7}$  rad
- E)  $1.8 \times 10^{-7}$  rad

Answer: C

Var: 1

123) A camera lens having a 50-mm focal length is set to  $f/4.0$ . What is the minimum spacing of two objects located 12 m from the lens if the objects are just barely resolved in the image using light of wavelength 500 nm?

- A) 1.66 mm
- B) 4.72 mm
- C) 0.024 mm
- D)  $4.9 \times 10^{-5}$  m
- E) 0.59 mm

Answer: E

Var: 1

124) A researcher is using x-rays to investigating a cubic crystal. He is looking at Bragg reflection from the planes parallel to the cube faces. He finds that when using x-rays with a wavelength of 0.165 nm, a strong first maximum occurs when the beam makes an angle of  $23.5^\circ$  with the planes. What is the spacing of adjacent atoms in this crystal?

Answer: 0.207 nm

Var: 1

125) Certain planes of a crystal of halite have a spacing of 0.399 nm. The crystal is irradiated by a beam of x-rays. First order constructive interference occurs when the beam makes an angle of  $20^\circ$  with the planes of the crystal surface. What is the wavelength of the x-rays?

- A) 0.14 nm
- B) 0.17 nm
- C) 0.21 nm
- D) 0.24 nm
- E) 0.27 nm

Answer: E

Var: 1

126) Certain planes of a crystal of halite have a spacing of 0.399 nm. The crystal is irradiated by a beam of x-rays. First order constructive interference occurs when the beam makes an angle of  $20^\circ$  with the planes of the crystal surface. What angle does the beam make with the crystal planes for second order constructive?

- A)  $37^\circ$
- B)  $40^\circ$
- C)  $43^\circ$
- D)  $46^\circ$
- E)  $49^\circ$

Answer: C

Var: 1

127) A crystal is irradiated with x-rays with a wavelength of 0.120 nm. The atomic planes in the crystal are separated by 0.21 nm. At what angles of incidence with respect to the normal will the x-rays reflect from the crystal?

- A)  $73^\circ$ ,  $55^\circ$ ,  $31^\circ$
- B) only  $55^\circ$
- C) only  $73^\circ$  and  $31^\circ$
- D) only  $73^\circ$

Answer: A

Var: 1

128) The lattice spacing of the principal Bragg planes in sodium chloride is 0.282 nm. For what wavelength of x-rays will the first order reflected beam diffract at  $55^\circ$  with respect to the normal to the crystal planes?

- A) 0.323 nm
- B) 0.530 nm
- C) 0.662 nm
- D) 0.150 nm
- E) 0.462 nm

Answer: A

Var: 1