Name\_

- 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) sideways from the CCD sensors

B) towards the CCD sensorsD) It does not make any difference.

- C) away from the CCD sensors
- 2) If a camera lens aperture is set to f/4, then
  - A) the radius of the lens aperture is 4 times its focal length.
  - B) the radius of the lens aperture is <sup>1</sup>/<sub>4</sub> the focal length.
  - C) the diameter of the lens aperture is  $\frac{1}{4}$  the focal length.
  - D) the diameter of the lens aperture is 4 times its focal length.
  - E) the focal length of the lens is 4 mm.
- 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) 2*I* B) *I*/2 C) *I*/4 D) 16*I* E) 4*I*
- 4) If the eye lens in a person's eye is too highly curved, this person is suffering from
  - A) spherical aberration.
  - B) astigmatism.
  - C) nearsightedness.
  - D) chromatic aberration.
  - E) farsightedness.

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

- A) chromatic aberration.
- B) spherical aberration.
- C) astigmatism.
- D) nearsightedness.
- E) farsightedness.
- 6) Nearsightedness is usually corrected with
  - A) concave mirrors.
  - B) diverging lenses.
  - C) cylindrical lenses.
  - D) convex mirrors.
  - E) converging lenses.
- 7) 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.

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

- A) the near point of the eye.
- B) the far point of the eye.
- C) infinity.
- D) the focal point of the lens.
- E) The magnification depends on the magnifying glass lens, not where the person puts his eye.
- 9) In a compound microscope
  - A) 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.
  - B) magnification is provided by the objective lens and not by the eyepiece. The eyepiece merely increases the resolution of the image viewed.
  - C) the image of the objective serves as the object for the eyepiece.
  - D) magnification is provided by the objective and not by the eyepiece. The eyepiece merely increases the brightness of the image viewed.
  - E) both the objective and the eyepiece form real images.
- 10) A simple compound microscope normally uses
  - A) a long focal length objective and a shorter focal length eyepiece.
  - B) a short focal length objective and a shorter focal length eyepiece.
  - C) a short focal length objective and a longer focal length eyepiece.
  - D) a very long focal length objective and a longer focal length eyepiece.
- 11) For relaxed viewing with a microscope or a telescope, the eyepiece is adjusted to place the image at
  - A) the focal point of the objective lens.
  - B) the near point of the eye.
  - C) the focal point of the eyepiece.
  - D) the pupil of the eye.
  - E) infinity.
- 12) Jack and Mary view the same microorganism through the same compound microscope. Mary's near point distance,  $N_{\rm M}$ , is twice as large as Jack's near point distance,  $N_{\rm J}$ . If Mary sees the microorganism with magnification  $M_{\rm M}$ , with what magnification does Jack see it?
  - A)  $M_{\rm M}/2$  B) 8  $M_{\rm M}$  C) 2  $M_{\rm M}$  D) 4  $M_{\rm M}$  E)  $M_{\rm M}/4$
- 13) Which one of the following is a characteristic of a compound microscope?
  - A) The objective is a diverging lens.
  - B) The image formed by the objective is virtual.
  - C) The final image is real.
  - D) The eyepiece is a diverging lens.
  - E) The image formed by the objective is real.

14) 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, but it doesn't matter what the focal length of the eyepiece is.
- E) The objective lens should have a large focal length and the eyepiece should have a small focal length.

- 15) 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) There is less diffraction with a larger lens than with a smaller lens.
  - B) A larger lens has a longer focal length than a smaller lens.
  - C) A larger lens can gather more light than a smaller lens.
  - D) A larger lens can focus more wavelengths of light than a smaller lens.
  - E) A larger lens can focus more accurately than a smaller lens.
- 16) 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 away from the centerline.
  - B) It moves toward the centerline.
  - C) It doesn't change.
- 17) 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?
- 18) 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?
- 19) 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?
- 20) 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?
- 21) 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?
- 22) 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?
- 23) 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.
- 24) 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?
- 25) 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?
- 26) 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?

- 27) 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"?
- 28) 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?
- 29) 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?
- 30) 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.

- 31) 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)
- 32) 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?

## Answer Key Testname: CH25\_OPTICAL\_INSTRUMENTSWIP

1) C 2) C 3) C 4) C 5) E 6) B 7) A 8) A 9) C 10) C 11) E 12) A 13) E 14) E 15) A 16) B 17) (a) 2.79 mm, away from the film (b) 10.7 mm 18) 0.3 mm 19) 4.0 20) 2.2 cm  $\leq f \leq$  2.4 cm 21) -0.59 diopters 22) 31 cm 23) 12 cm 24) +2.8 diopters 25) 2.5 26) 110 mrad 27) 5.8 cm 28) 41 mm 29) 4.9 × 10-2 m 30) (a) 3.7  $\mu$ rad (b) 330 km 31) 19 mi 32) 0.59 mm