Phys.G12-Q3W8- Quarter 3-Revision and Exam-Revision sheet

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Which portion of the electromagnetic spectrum is used to identify fluorescent minerals?
a. ultraviolet light
b. X rays
c. infrared waves
d. gamma rays

____ 2. What is the wavelength of microwaves of 3.0×10^{9} Hz frequency?
a. 0.050 m
b. 0.060 m
c. 0.10 m
d. 0.20 m

____ 3. What is the wavelength of an infrared wave with a frequency of 4.2×10^{14} Hz?
a. 7.1×10^{5} m
b. 1.4×10^{6} m
c. 7.1×10^{-7} m
d. 1.4×10^{-6} m

____ 4. If you know the wavelength of any form of electromagnetic radiation, you can determine its frequency because
a. all wavelengths travel at the same speed.
b. the speed of light varies for each form.
c. wavelength and frequency are equal.
d. the speed of light increases as wavelength increases.

____ 5. The relationship between frequency, wavelength, and speed holds for light waves because
a. light travels slower in a vacuum than in air.
b. all forms of electromagnetic radiation travel at a single speed in a vacuum.
c. light travels in straight lines.
d. different forms of electromagnetic radiation travel at different speeds.

____ 6. The farther light is from a source,
a. the more spread out light becomes.
b. the more condensed light becomes.
c. the more bright light becomes.
d. the more light is available per unit area.

____ 7. Snow reflects almost all of the light incident upon it. However, a single beam of light is not reflected in the form of parallel rays. This is an example of ____ reflection off a ____ surface.
a. regular, rough
b. regular, specular
c. diffuse, specular
d. diffuse, rough

____ 8. When incoming rays of light strike a flat mirror at an angle close to the surface of the mirror, the reflected rays are
a. inclined high above the mirror's surface.
b. parallel to the mirror's surface.
c. perpendicular to the mirror's surface.
d. close to the mirror's surface.

____ 9. When a straight line is drawn perpendicular to a flat mirror at the point where an incoming ray strikes the mirror's surface, the angles of incidence and reflection are measured from the normal and
a. the angles of incidence and reflection are equal.
b. the angle of incidence is greater than the angle of reflection.
c. the angle of incidence is less than the angle of reflection.
d. the angle of incidence can be greater than or less than the angle of reflection.

____ 10. If a light ray strikes a flat mirror at an angle of 30° from the normal, the ray will be reflected at an angle of
a. 30° from the mirror's surface.
b. 60° from the mirror's surface.
c. 60° from the normal.
d. 90° from the normal.

____ 11. The image of an object in a flat mirror is always
a. larger than the object.
b. smaller than the object.
c. independent of the size of the object.
d. the same size as the object.

____ 12. When two parallel mirrors are placed so that their reflective sides face each other, ____ images form. This is because the image in one mirror becomes the ____ for the other mirror.
a. multiple, object
b. reduced, virtual image
c. inverted, center of curvature
d. enlarged, focal point

____ 13. If you stand 3.0 m in front of a flat mirror, how far away from you would your image be in the mirror?
a. 1.5 m
b. 3.0 m
c. 6.0 m
d. 12.0 m

____ 14. Which of the following best describes the image produced by a flat mirror?
a. virtual, inverted, and magnification greater than one
b. real, inverted, and magnification less than one
c. virtual, upright, and magnification equal to one
d. real, upright, and magnification equal to one

____ 15. What type of mirror is used whenever a magnified image of an object is needed?
a. flat mirror
b. concave mirror
c. convex mirror
d. two-way mirror

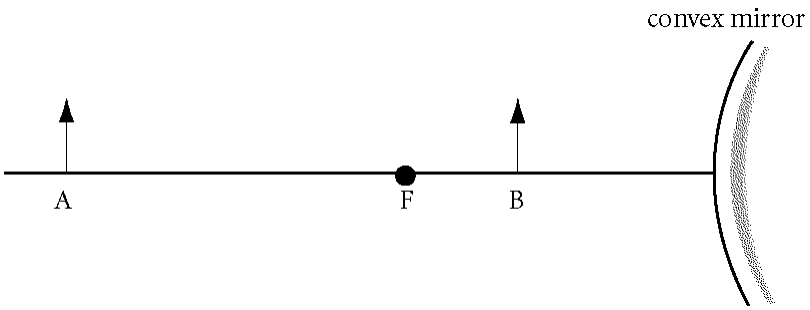
____ 16. Object distance, image distance, and radius of curvature are ____ for curved mirrors.
a. interdependent
b. independent
c. directly related
d. unrelated

____ 17. An object is 29 cm away from a concave mirror's surface along the principal axis. If the mirror's focal length is 9.50 cm, how far away is the corresponding image?
a. 12 cm
b. 14 cm
c. 29 cm
d. 36 cm

____ 18. If a virtual image is formed 10.0 cm along the principal axis from a convex mirror with a focal length of –15.0 cm, what is the object's distance from the mirror?
a. 30 cm
b. 12 cm
c. 6.0 cm
d. 3.0 cm

____ 19. A convex mirror with a focal length of –20.0 cm has an object 30.0 cm in front of the mirror. What is the value of *q* for the corresponding image?
a. −60 cm
b. −12 cm
c. 12 cm
d. 60 cm

____ 20. A mirror has an object located on its principal axis 40.0 cm from the mirror's surface. A virtual image is formed 15.0 cm behind the mirror. What is the mirror's focal length?
a. −24.0 cm
b. −10.9 cm
c. 2.38 cm
d. 13 cm



____ 21. In the diagram shown above, the image of object *B* would be
a. real, reduced, and upright.
b. virtual, enlarged, and upright.
c. virtual, reduced, and inverted.
d. virtual, reduced, and upright.

____ 22. A parabolic mirror, instead of a spherical mirror, can be used to reduce the occurrence of which effect?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

____ 23. As the angle between the electric-field waves and the transmission axis increases,
a. the component of light that passes through the polarizer decreases and the brightness of the light decreases.
b. the component of light that passes through the polarizer decreases and the brightness of the light increases.
c. the component of light that passes through the polarizer increases and the brightness of the light decreases.
d. the component of light that passes through the polarizer increases and the brightness of the light increases.

____ 24. If you looked at a light through the lenses from two polarizing sunglasses that were overlapped at right angles to each other,
a. all of the light would pass through.
b. most of the light would pass through.
c. little of the light would pass through.
d. none of the light would pass through.

____ 25. Part of a pencil that is placed in a glass of water appears bent in relation to the part of the pencil that extends out of the water. What is this phenomenon called?
a. interference
b. refraction
c. diffraction
d. reflection

____ 26. Refraction is the bending of a wave disturbance as it passes at an angle from one ____ into another.
a. glass
b. medium
c. area
d. boundary

____ 27. The ____ of light can change when light is refracted because the velocity changes.
a. frequency
b. medium
c. wavelength
d. transparency

____ 28. When light passes at an angle to the normal from one material into another material in which its speed is higher,
a. it is bent toward the normal to the surface.
b. it always lies along the normal to the surface.
c. it is unaffected.
d. it is bent away from the normal to the surface.

____ 29. A beam of light in air is incident at an angle of 35° to the surface of a rectangular block of clear plastic (n = 1.49). What is the angle of refraction?
a. 12°
b. 23°
c. 42°
d. 57°

____ 30. Carbon tetrachloride ($n = 1.46$) is poured into a container made of crown glass ($n = 1.52$). If a light ray in the glass is incident on the glass-to-liquid boundary and makes an angle of 30.0° with the normal, what is the angle of the corresponding refracted ray with respect to the normal?

a. 25.6°
b. 28.7°
c. 31.4°
d. 64.4°

____ 31. In what direction does a focal ray from an object proceed after passing through a converging lens?

a. The ray passes through the focal point, *F*.
b. The ray passes through the center of the lens.
c. The ray exits the lens parallel to the principal axis.
d. The ray intersects with the center of curvature, *C*.

____ 32. In what direction does a parallel ray from an object proceed after passing through a converging lens?

a. The ray passes through the focal point, *F*.
b. The ray continues parallel to the principal axis.
c. The ray passes through the center of the lens.
d. The ray is directed away from the focal point, *F*.

____ 33. All of the following images can be formed by a converging lens *except* which one?

a. image at infinity
b. virtual, inverted, and same size
c. real, inverted, and same size
d. real, inverted, and reduced

____ 34. A virtual image has a ____ image distance (q) and is located in ____ of the lens.

a. positive, front
b. positive, back
c. negative, front
d. negative, back

____ 35. The focal length for a diverging lens is

a. always positive.
b. always negative.
c. dependent on the location of the object.
d. dependent on the location of the image.

____ 36. An object is placed 20.0 cm from a thin converging lens along the axis of the lens. If a real image forms behind the lens at a distance of 8.00 cm from the lens, what is the focal length of the lens?

a. 5.71 cm
b. 12.0 cm
c. –13.3 cm
d. 13.3 cm

____ 37. A film projector produces a 1.51 m image of a horse on a screen. If the projector lens is 4.00 m from the screen and the size of the horse on the film is 1.07 cm, what is the magnitude of the magnification of the image?

a. 141
b. 14.1
c. 0.708
d. 7.08×10^{-3}

____ 38. An object that is 18 cm from a converging lens forms a real image 22.5 cm from the lens. What is the magnification of the image?

a. –1.25
b. –0.80
c. 0.80
d. 1.25

____ 39. Which of the following describes what will happen to a light ray incident on a glass-to-air boundary at greater than the critical angle?

a. total internal reflection
b. total external transmission
c. partial reflection, partial transmission
d. partial reflection, total transmission

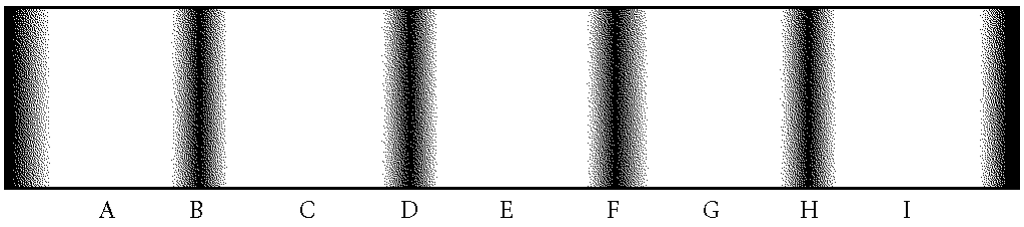
____ 40. Atmospheric refraction of light rays is responsible for which of the following effects?

a. spherical aberration
b. mirages
c. chromatic aberration
d. total internal reflection in a gemstone

____ 41. In a double-slit interference experiment, a wave from one slit arrives at a point on a screen one wavelength behind the wave from the other slit. What is observed at that point?
a. dark fringe
b. bright fringe
c. multicolored fringe
d. gray fringe, neither dark nor bright

____ 42. In a double-slit interference experiment, a wave from one slit arrives at a point on a screen one-half wavelength behind the wave from the other slit. What is observed at that point?
a. dark fringe
b. bright fringe
c. multicolored fringe
d. gray fringe, neither dark nor bright

____ 43. Coherence is the property by which two waves with identical wavelengths maintain a constant
a. amplitude.
b. frequency.
c. phase relationship.
d. speed.



The figure above shows the pattern of a double-slit interference experiment. The center of the pattern is located at E.

____ 44. In the double-slit interference experiment that produced the figure above, the two slits are moved closer. Which of the following would occur to the pattern shown in the figure?
a. E would shift to the right.
b. E would shift to the left.
c. F would shift to the right.
d. F would shift to the left.

____ 45. To produce a sustained interference pattern by light waves from multiple sources, which condition or conditions must be met?
a. Sources must be coherent.
b. Sources must be monochromatic.
c. Sources must be coherent and monochromatic.
d. Sources must be neither coherent nor monochromatic.

____ 46. Two beams of coherent light are shining on the same sheet of white paper. When referring to the crests and troughs of such waves, where will darkness appear on the paper?
a. where the crest from one wave overlaps the crest from the other
b. where the crest from one wave overlaps the trough from the other
c. where the troughs from both waves overlap
d. Darkness cannot occur because the two waves are coherent.

____ 47. The distance between two slits in a double-slit interference experiment is 2.9×10^{-6} m. The first-order bright fringe is measured on a screen at an angle of 12° from the central maximum. What is the wavelength of the light?
a. 1.2×10^{2} nm
b. 3.0×10^{2} nm
c. 4.6×10^{2} nm
d. 6.0×10^{2} nm

____ 48. The distance between two slits in a double-slit interference experiment is 0.0050 mm. What is the angle of the third-order bright fringe (m = 3) produced with light of 550 nm?
a. 5.0°
b. 9.9°
c. 12°
d. 19°

____ 49. At the first dark band in a single-slit diffraction pattern, the path lengths of selected pairs of wavelets differ by
a. one wavelength.
b. more than one wavelength.
c. one-half wavelength.
d. less than half of one wavelength.

____ 50. Monochromatic light shines on the surface of a diffraction grating with 5.3×10^3 lines/cm. The first-order maximum is observed at an angle of 17°. Find the wavelength.
a. 420 nm
b. 520 nm
c. 530 nm
d. 550 nm

____ 51. The angle between the first-order maximum and the central maximum for monochromatic light of 2300 nm is 27°. Calculate the number of lines per centimeter on this grating.
a. 1600 lines/cm
b. 2000 lines/cm
c. 2500 lines/cm
d. 4500 lines/cm

____ 52. Monochromatic light (λ = 632.8 nm) from a helium-neon laser shines at a right angle onto the surface of a diffraction grating that contains 531 001 lines/m. Find the angles at which one would observe the first-order and second-order maxima.
a. θ_1 = 19.63°; θ_2 = 39.26°
b. θ_1 = 19.63°; θ_2 = 42.20°
c. θ_1 = 21.10°; θ_2 = 42.20°
d. θ_1 = 33.60°; θ_2 = 67.20°

____ 53. A diffraction grating that contains 650 472 lines/m is illuminated by monochromatic light (λ = 632.8 nm) from a helium-neon laser directed perpendicular to the surface of the grating. At what angles would one observe the first-order and second-order maxima?
a. θ_1 = 2.358°; θ_2 = 4.719°
b. θ_1 = 24.30°; θ_2 = 55.38°
c. θ_1 = 29.37°; θ_2 = 55.38°
d. θ_1 = 55.38°; θ_2 = 83.078°

____ 54. For high resolution in optical instruments, the angle between resolved objects should be
a. as small as possible.
b. as large as possible.
c. 1.22°.
d. 45°.

____ 55. If light waves are coherent,
a. they shift over time.
b. their intensity is less than that of incoherent light.
c. they remain in phase.
d. they have less than three different wavelengths.

____ 56. In a laser, energy is added to a(n)
a. mirror.
b. active medium.
c. partially transparent mirror.
d. light wave.

____ 57. Which of the following is a device that produces an intense, nearly parallel beam of coherent light?
a. spectroscope
b. telescope
c. laser
d. diffraction grating

____ 58. The acronym *laser* stands for light amplification by ____ emission of radiation.
a. similar
b. simultaneous
c. spontaneous
d. stimulated

____ 59. In a laser, all of the following forms of energy can be converted into coherent light *except*
a. chemical energy.
b. electrical energy.
c. light.
d. nuclear energy.

____ 60. An attracting force occurs between two charged objects when the charges are of
a. unlike signs.
b. like signs.
c. equal magnitude.
d. unequal magnitude.

____ 61. When a glass rod is rubbed with silk and becomes positively charged,
a. electrons are removed from the rod.
b. protons are removed from the silk.
c. protons are added to the silk.
d. the silk remains neutral.

____ 62. Which sentence best describes electrical conductors?
a. Electrical conductors have low mass density.
b. Electrical conductors have high tensile strength.
c. Electrical conductors have electric charges that move freely.
d. Electrical conductors are poor heat conductors.

____ 63. The process of charging a conductor by bringing it near another charged object and then grounding the conductor is called
a. contact charging.
b. induction.
c. polarization
d. neutralization.

____ 64. Both insulators and conductors can be charged by
a. grounding.
b. induction.
c. polarization.
d. contact.

____ 65. Which is the *most* correct statement regarding the drawing of electric field lines?
a. Electric field lines always connect from one charge to another.
b. Electric field lines always form closed loops.
c. Electric field lines can start on a charge of either polarity.
d. Electric field lines never cross each other.

____ 66. The electric field just outside a charged conductor in electrostatic equilibrium is
a. zero.
b. at its minimum level.
c. the same as it is in the center of the conductor.
d. perpendicular to the conductor's surface.

____ 67. Electric field strength depends on
a. charge and distance.
b. charge and mass.
c. Coulomb constant and mass.
d. elementary charge and radius.

____ 68. Which of the following is *not* a characteristic of electrical potential energy?
a. It is a form of mechanical energy.
b. It results from a single charge.
c. It results from the interaction between charges.
d. It is associated with a charge in an electric field.

____ 69. Charge buildup between the plates of a capacitor stops when
a. there is no net charge on the plates.
b. unequal amounts of charge accumulate on the plates.
c. the potential difference between the plates is equal to the applied potential difference.
d. the charge on both plates is the same.

____ 70. What effect will be produced on a capacitor if the separation between the plates is increased?
a. It will increase the charge.
b. It will decrease the charge.
c. It will increase the capacitance.
d. It will decrease the capacitance.

____ 71. A 0.50 μF capacitor is connected to a 12 V battery. Use the expression $PE = \frac{1}{2}C(\Delta V)^2$ to determine how much electrical potential energy is stored in the capacitor.
a. 3.0×10^{-6} J
b. 6.0×10^{-6} J
c. 1.0×10^{-5} J
d. 3.6×10^{-5} J

____ 72. How is current affected if the number of charge carriers decreases?
a. The current increases.
b. The current decreases.
c. The current initially decreases and then is gradually restored.
d. The current is not affected.

____ 73. Which of the following wires would have the *least* resistance, assuming that all of the wires have the same cross-sectional area?

a. an iron wire 10 cm in length
b. an iron wire 5 cm in length
c. a copper wire 10 cm in length
d. a copper wire 5 cm in length

____ 74. Which of the following wires would have the *least* resistance?

a. an aluminum wire 20 cm in diameter at 40°C
b. an aluminum wire 20 cm in diameter at 60°C
c. an aluminum wire 40 cm in diameter at 40°C
d. an aluminum wire 40 cm in diameter at 60°C

____ 75. When compared in a given time interval with other lightbulbs connected to a 120 V circuit, a 60 W lightbulb

a. converts the same electrical energy to heat and light as a 40 W lightbulb.
b. converts more electrical energy to heat and light than a 100 W lightbulb.
c. converts less electrical energy to heat and light than a 40 W lightbulb.
d. converts less electrical energy to heat and light than a 100 W lightbulb.

____ 76. Which set of information will allow you to calculate the kilowatt•hr usage?

a. the voltage and current in the circuit
b. the resistance, the current, and the time the circuit operates
c. the voltage and the resistance of the circuit
d. the current and the time the circuit operates

____ 77. Tripling the current in a circuit with constant resistance has the effect of changing the power by what factor?

a. $\frac{1}{9}$
b. $\frac{1}{3}$
c. 3
d. 9

____ 78. If a 325 W heater has a current of 6.0 A, what is the resistance of the heating element?

a. 88 Ω
b. 54 Ω
c. 9.0 Ω
d. 4.5 Ω

____ 79. Which process will double the power dissipated by a resistor?

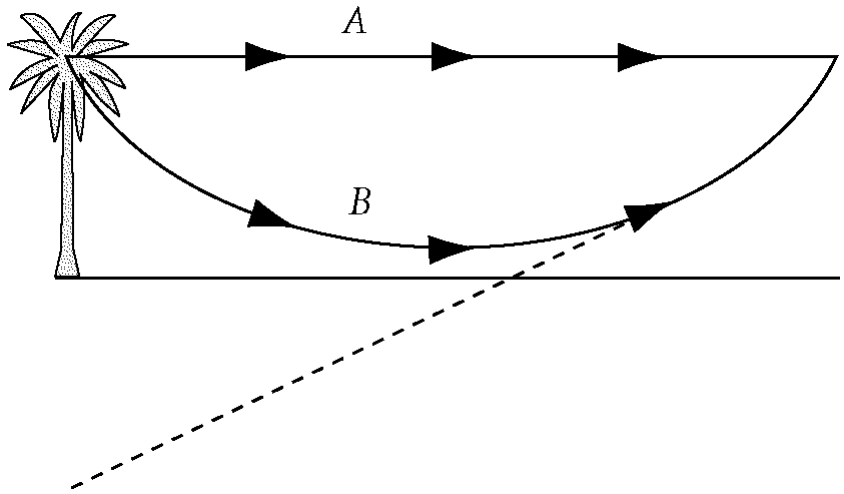
a. doubling the current while doubling the resistance
b. doubling the current and making the resistance half as big
c. doubling the current and doubling the potential difference
d. doubling the current while making the potential difference half as big

____ 80. A high-voltage transmission line carries 1000 A at 700 000 V. What is the maximum power carried in the line?

a. 700 MW
b. 400 MW
c. 100 MW
d. 70 MW

Short Answer

1. The focal point and center of curvature of a spherical mirror all lie along the _____.
2. An object's distance is 15.0 cm, and its image distance is 25.0 cm behind the mirror. If the height of the object is 10.0 cm, what is the height of the image? Is the image upright or inverted? Is the image real or inverted?
3. Why do motorists sometimes see what appear to be wet spots on the road on a dry summer day?



4. Use the figure shown above to describe how a mirage is produced.
5. The bright lines in a double-slit interference pattern are due to what type of interference?
6. How does an increase in the wavelength of light reaching an optical instrument with a set aperture affect the resolving power of the instrument?
7. How is a laser used in a CD player?
8. How does the electric force between two charged objects change when the charge on one of the objects is doubled? Explain.
9. Draw the lines of force representing the electric field surrounding two objects that have equal magnitude charges of opposite polarity.
10. What is potential difference?
11. How does the electrical potential energy of charges change when the energy produced by a battery moves those charges from one terminal to the other?
12. The current in a horizontal wire is the result of electrons moving through the wire from right to left. What is the direction of conventional current in the wire? Explain.
13. An operating (turned on) lightbulb has a resistance that is about 10 to 20 times greater than when it is not operating (turned off). How does this explain why lightbulbs often burn out at the moment they are turned on?
14. How do charges move in alternating current?
15. What is electric power?

Problem

1. A pencil is located 17.6 cm in front of a convex mirror whose focal length is 14.7 cm. In relation to the mirror's surface, where and how far away is the corresponding image located?
2. An object is 15.0 cm from the surface of a spherical glass tree ornament that is 5.00 cm in diameter. Find the magnification and location of the corresponding image in relation to the mirror's surface. Draw a ray diagram to confirm the position and magnification of the image.
3. The objective lens of a compound microscope has a focal length of 1.08 cm. A specimen is 1.21 cm from the objective lens. The image formed by the objective lens is 0.154 cm inside the focal point of the eyepiece whose focal length is 1.57 cm. What is the distance from the eyepiece to the image formed by the eyepiece lens?
4. A converging lens has a focal length of 12.6 cm. If a virtual image of an object is formed 26.8 cm in front of the lens, what is the magnification of the image? Describe the image.
5. A fiber-optic cable (n = 1.57) is submerged in water (n = 1.33). Predict whether light will be refracted or whether it will undergo total internal reflection if the angle of incidence is between 65° and 70°.
6. The distance between the two slits in a double-slit experiment is 0.0034 mm. The third-order bright fringe (m = 3) is measured on a screen at an angle of 22° from the central maximum. What is the wavelength of the light?
7. The distance between two slits in a double-slit experiment is 0.0016 mm. What is the angle between the central maximum and the second dark fringe in the interference pattern produced with light having a wavelength of 520 nm?
8. Monochromatic light shines on the surface of a diffraction grating with 6.7×10^{3} lines/cm. The angle between the central maximum and the first dark fringe is 11.5°. Find the wavelength of the light.
9. Monochromatic light shines on the surface of a diffraction grating with 7.9×10^{3} lines/cm. The angle between the central maximum and the third dark fringe is measured as 64.6°. Find the wavelength of the light.
10. What is the electric force between an electron and a proton that are separated by a distance of 3.4×10^{-10} m? Is the force attractive or repulsive? (e = 1.60×10^{-19} C, k_C = 8.99×10^{9} N•m^2/C^2)
11. Two point charges are 4.8 cm apart and have values of 56.5 μC and –56.5 μC, respectively. What is the electric field at the midpoint between the two charges? (k_C = 8.99×10^{9} N•m^2/C^2)
12. Two equal but oppositely charged points are 1.2 m apart in a vacuum. The electric field intensity at the midpoint between the charges is 4.8×10^{5} N/C. What is the magnitude of each charge? (k_C = 8.99×10^{9} N•m^2/C^2)
13. What is the capacitance of a parallel-plate capacitor made of two square aluminum plates that are 5.8 cm in length on each side and are separated by 7.7 mm? (ε_0 = 8.85×10^{-12} C^2/N•m^2)
14. A capacitor stores 8.1×10^{-6} J of energy when it is connected to a 9.8 V battery. What is the capacitance of the capacitor in μF?
15. A 17.9 Ω resistor has 0.051 A of current in it. What is the potential difference across the resistor?

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Answer Section

MULTIPLE CHOICE

1. ANS: A PTS: 1 DIF: I OBJ: 13-1.1
2. ANS: C

Given

$f = 3.0 \times 10^9 \text{ Hz} = 3.0 \times 10^9 \text{ s}^{-1}$

$c = 3.00 \times 10^8 \text{ m/s}$

Solution

Rearrange the wave speed equation, $c = f\lambda$, to isolate λ, and calculate.

$$\lambda = \frac{c}{f} = \frac{\left(3.00 \times 10^8 \text{ m/s}\right)}{\left(3.0 \times 10^9 \text{ s}^{-1}\right)} = 0.10 \text{ m}$$

PTS: 1 DIF: IIIA OBJ: 13-1.2

3. ANS: C

Given

$f = 4.2 \times 10^{14} \text{ Hz} = 4.2 \times 10^{14} \text{ s}^{-1}$

$c = 3.00 \times 10^8 \text{ m/s}$

Solution

Rearrange the wave speed equation, $c = f\lambda$, to isolate λ, and calculate.

$$\lambda = \frac{c}{f} = \frac{\left(3.00 \times 10^8 \text{ m/s}\right)}{\left(4.2 \times 10^{14} \text{ s}^{-1}\right)} = 7.1 \times 10^{-7} \text{ m}$$

PTS: 1 DIF: IIIA OBJ: 13-1.2

4. ANS: A PTS: 1 DIF: I OBJ: 13-1.3
5. ANS: B PTS: 1 DIF: II OBJ: 13-1.3
6. ANS: A PTS: 1 DIF: I OBJ: 13-1.4
7. ANS: D PTS: 1 DIF: II OBJ: 13-2.1
8. ANS: D PTS: 1 DIF: II OBJ: 13-2.2
9. ANS: A PTS: 1 DIF: I OBJ: 13-2.2
10. ANS: B

Given

$\theta = 30°$

Solution

According to the law of reflection, $\theta = \theta'$, therefore $\theta' = 30°$. The angle between the reflected ray and the surface is $90° - \theta'$, which equals $60°$. Therefore, the correct response is "B," since the reflected ray forms an angle of $60°$ with the mirror's surface.

PTS: 1 DIF: IIIA OBJ: 13-2.2

11. ANS: D PTS: 1 DIF: I OBJ: 13-2.3
12. ANS: A PTS: 1 DIF: II OBJ: 13-2.3
13. ANS: C

Given

$p = 3.0\text{ m}$

Solution

For a flat mirror, a virtual image forms behind the mirror and thus $p = q$.

Therefore, the total distance from the observer is $p + q = (3.0\text{ m}) + (3.0\text{ m}) = 6.0\text{ m}$.

PTS: 1 DIF: IIIA OBJ: 13-2.3

14. ANS: C PTS: 1 DIF: I OBJ: 13-2.3
15. ANS: C PTS: 1 DIF: I OBJ: 13-3.1
16. ANS: A PTS: 1 DIF: I OBJ: 13-3.1
17. ANS: B

Given

$p = 29\text{ cm}$

$f = 9.50\text{ cm}$

Solution

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{9.50\text{ cm}} - \frac{1}{29\text{ cm}} = \frac{3.05}{29\text{ cm}} - \frac{1}{29\text{ cm}} = \frac{2.05}{29\text{ cm}}$$

$p = 14\text{ cm}$

PTS: 1 DIF: IIIB OBJ: 13-3.1

18. ANS: A

Given

$f = -15.0\text{ cm}$

$q = -10.0\text{ cm}$

Solution

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for p.

$$\frac{1}{p} = \frac{1}{f} - \frac{1}{q} = \frac{1}{-15.0\text{ cm}} - \frac{1}{-10.0\text{ cm}} = -\frac{1}{15.0\text{ cm}} + \frac{1.5}{15.0\text{ cm}} = \frac{0.5}{15.0\text{ cm}}$$

$p = 30\text{ cm}$

PTS: 1 DIF: IIIB OBJ: 13-3.1

19. ANS: B

Given

$f = -20.0 \text{ cm}$

$p = 30.0 \text{ cm}$

Solution

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{-20.0 \text{ cm}} - \frac{1}{30.0 \text{ cm}} = -\frac{1.5}{30.0 \text{ cm}} - \frac{1}{30.0 \text{ cm}} = -\frac{2.5}{30.0 \text{ cm}}$$

$q = -12 \text{ cm}$

PTS: 1 DIF: IIIB OBJ: 13-3.1

20. ANS: A

Given

$p = 40.0 \text{ cm}$

$q = -15.0 \text{ cm}$

Solution

Use the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for f.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{40.0 \text{ cm}} + \frac{1}{-15.0 \text{ cm}} = \frac{3.00}{120. \text{ cm}} - \frac{8.00}{120. \text{ cm}} = -\frac{5.00}{120. \text{ cm}}$$

$f = -24.0 \text{ cm}$

PTS: 1 DIF: IIIB OBJ: 13-3.1

21. ANS: D PTS: 1 DIF: II OBJ: 13-3.3
22. ANS: A PTS: 1 DIF: I OBJ: 13-3.4
23. ANS: A PTS: 1 DIF: II OBJ: 13-4.3
24. ANS: D PTS: 1 DIF: II OBJ: 13-4.3
25. ANS: B PTS: 1 DIF: I OBJ: 14-1.1
26. ANS: B PTS: 1 DIF: I OBJ: 14-1.1
27. ANS: C PTS: 1 DIF: II OBJ: 14-1.1
28. ANS: D PTS: 1 DIF: I OBJ: 14-1.2
29. ANS: B

Given

$\theta_i = 35°$

$n_i = 1.00$

$n_r = 1.49$

Solution

Rearrange Snell's law, $n_i \sin\theta_i = n_r \sin\theta_r$, and solve for θ_r.

$$\theta_r = \sin^{-1}\left[\frac{n_i}{n_r}\left(\sin\theta_i\right)\right] = \sin^{-1}\left[\frac{1.00}{1.49}\left(\sin 35°\right)\right] = 23°$$

PTS: 1 DIF: IIIA OBJ: 14-1.3

30. ANS: C

Given

$\theta_i = 30.0°$

$n_i = 1.52$

$n_r = 1.46$

Solution

Rearrange Snell's law, $n_i \sin\theta_i = n_r \sin\theta_r$, and solve for θ_r.

$$\theta_r = \sin^{-1}\left[\frac{n_i}{n_r}\left(\sin\theta_i\right)\right] = \sin^{-1}\left[\frac{1.52}{1.46}\left(\sin 30.0°\right)\right] = 31.4°$$

PTS: 1 DIF: IIIB OBJ: 14-1.3

31. ANS: C PTS: 1 DIF: I OBJ: 14-2.1
32. ANS: A PTS: 1 DIF: I OBJ: 14-2.1
33. ANS: B PTS: 1 DIF: II OBJ: 14-2.1
34. ANS: C PTS: 1 DIF: I OBJ: 14-2.2
35. ANS: B PTS: 1 DIF: I OBJ: 14-2.2
36. ANS: A

Given

$p = 20.0$ cm

$q = 8.00$ cm (q is positive, since the image is real and behind the lens)

Solution

Use the thin-lens equation to find f.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{20.0\text{ cm}} + \frac{1}{8.00\text{ cm}} = \frac{0.0500}{1\text{ cm}} + \frac{0.125}{1\text{ cm}} = \frac{0.175}{1\text{ cm}}$$

$f = 5.71$ cm

PTS: 1 DIF: IIIA OBJ: 14-2.2

37. ANS: A

Given

$h' = 1.51\text{ m} = 151\text{ cm}$

$p = 4.00$ m

$h = 1.07$ cm

Solution

Use the magnification of a lens equation, $M = \frac{h'}{h}$, to find M.

$$M = \frac{h'}{h} = \frac{(151\text{ cm})}{(1.07\text{ cm})} = 141$$

PTS: 1 DIF: IIIA OBJ: 14-2.3

38. ANS: A

Given

$p = 18.0$ cm

$q = 22.5$ cm $\left(q \text{ is positive, since the image is real}\right)$

Solution

Use the magnification of a lens equation, $M = -\frac{q}{p}$, to find M.

$$M = -\frac{q}{p} = -\frac{(22.5\text{ cm})}{(18.0\text{ cm})} = -1.25 \left(\text{since } M \text{ is negative, a real, inverted image is formed}\right)$$

PTS: 1 DIF: IIIA OBJ: 14-2.3

39. ANS: A PTS: 1 DIF: I OBJ: 14-3.1
40. ANS: B PTS: 1 DIF: I OBJ: 14-3.2
41. ANS: B PTS: 1 DIF: I OBJ: 15-1.1
42. ANS: A PTS: 1 DIF: I OBJ: 15-1.1
43. ANS: C PTS: 1 DIF: I OBJ: 15-1.1
44. ANS: C PTS: 1 DIF: II OBJ: 15-1.3
45. ANS: C PTS: 1 DIF: I OBJ: 15-1.2
46. ANS: B PTS: 1 DIF: I OBJ: 15-1.2

47. ANS: B

Given

$d = 2.9 \times 10^{-6}$ m

$m = 1$

$\theta = 12°$

Solution

$d \sin\theta = m\lambda$

$$\lambda = \frac{d\sin\theta}{m} = \frac{(2.9 \times 10^{-6}\text{ m})(\sin 12°)}{2} = 3.0 \times 10^{-7}\text{ m} = 3.0 \times 10^{2}\text{ nm}$$

PTS: 1 DIF: IIIA OBJ: 15-1.3

48. ANS: D

Given

$d = 0.0050$ mm $= 5.0 \times 10^{-6}$ m

$m = 3$

$\lambda = 550$ nm $= 5.5 \times 10^{-6}$ m

Solution

$d \sin \theta = m\lambda$

$$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{(3)(5.5 \times 10^{-7}\ \text{m})}{(5.0 \times 10^{-6}\ \text{m})}\right) = 19°$$

PTS: 1 DIF: IIIB OBJ: 15-1.3

49. ANS: C PTS: 1 DIF: II OBJ: 15-2.1

50. ANS: D

Given

$$d = \frac{1}{5.3 \times 10^3\ \frac{\text{lines}}{\text{cm}}} = \frac{1}{5.3 \times 10^3}\ \text{cm}$$

$m = 1$

$\theta = 17°$

Solution

$d \sin \theta = m\lambda$

$$\lambda = \frac{d \sin \theta}{m} = \frac{\left(\frac{1}{5.3 \times 10^3}\ \text{cm}\right)(\sin 17°)}{1} = 5.5 \times 10^{-5}\ \text{cm} = 5.5 \times 10^2\ \text{nm}$$

PTS: 1 DIF: IIIA OBJ: 15-2.2

51. ANS: B

Given

$\lambda = 2300\ \text{nm} = 2.3 \times 10^{-6}\ \text{m}$

$m = 1$

$\theta = 27°$

Solution

$d \sin \theta = m\lambda$

$$d = \frac{m\lambda}{\sin \theta} = \frac{2.3 \times 10^{-6}\ \text{m}}{\sin 27°} = 5.1 \times 10^{-6}\ \text{m} = 5.1 \times 10^{-4}\ \text{cm}$$

$d = 5.1 \times 10^{-4}$ cm/line

$$\frac{1}{d} = \frac{1}{5.1 \times 10^{-4}\ \frac{\text{cm}}{\text{line}}} = 2.0 \times 10^3\ \text{lines/cm}$$

PTS: 1 DIF: IIIB OBJ: 15-2.2

52. ANS: B

Given

$\lambda = 632.8\ \text{nm} = 6.328 \times 10^{-7}\ \text{m}$

$$d = \frac{1}{5.310\,01 \times 10^5\ \frac{\text{lines}}{\text{m}}} = \frac{1}{5.310\,01 \times 10^5}\ \text{m}$$

$m = 1, 2$

Solution

$d \sin \theta = m\lambda$

$$\theta_1 = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{(6.328 \times 10^{-7}\ \text{m})}{\left(\frac{1}{5.310\,01 \times 10^{5}}\ \text{m}\right)}\right) = 19.63°$$

$$\theta_2 = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{(2)(6.328 \times 10^{-7}\ \text{m})}{\left(\frac{1}{5.310\,01 \times 10^{5}}\ \text{m}\right)}\right) = 42.20°$$

PTS: 1 DIF: IIIC OBJ: 15-2.2

53. ANS: B

Given

$$d = \frac{1}{6.504\,72 \times 10^{5}\ \frac{\text{lines}}{\text{m}}} = \frac{1}{6.504\,72 \times 10^{5}}\ \text{m}$$

λ = 632.8 nm = 6.328×10^{-7} m

m = 1, 2

Solution

$d \sin \theta = m\lambda$

$$\theta_1 = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{(6.328 \times 10^{-7}\ \text{m})}{\left(\frac{1}{6.504\,72 \times 10^{5}}\ \text{m}\right)}\right) = 24.30°$$

$$\theta_2 = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{(2)(6.328 \times 10^{-7}\ \text{m})}{\left(\frac{1}{6.504\,72 \times 10^{5}}\ \text{m}\right)}\right) = 55.38°$$

PTS: 1 DIF: IIIC OBJ: 15-2.2

54. ANS: A PTS: 1 DIF: I OBJ: 15-2.3
55. ANS: C PTS: 1 DIF: I OBJ: 15-3.1
56. ANS: B PTS: 1 DIF: I OBJ: 15-3.1
57. ANS: C PTS: 1 DIF: I OBJ: 15-3.1
58. ANS: D PTS: 1 DIF: I OBJ: 15-3.1
59. ANS: D PTS: 1 DIF: I OBJ: 15-3.1
60. ANS: A PTS: 1 DIF: I OBJ: 16-1.1
61. ANS: A PTS: 1 DIF: I OBJ: 16-1.1
62. ANS: C PTS: 1 DIF: I OBJ: 16-1.2

63. ANS: B PTS: 1 DIF: I OBJ: 16-1.3
64. ANS: D PTS: 1 DIF: I OBJ: 16-1.3
65. ANS: D PTS: 1 DIF: II OBJ: 16-3.2
66. ANS: D PTS: 1 DIF: I OBJ: 16-3.3
67. ANS: A PTS: 1 DIF: I OBJ: 16-3.1
68. ANS: B PTS: 1 DIF: I OBJ: 17-1.1
69. ANS: C PTS: 1 DIF: II OBJ: 17-2.1
70. ANS: D PTS: 1 DIF: I OBJ: 17-2.1
71. ANS: D

Given

$C = 0.50\ \mu\text{F} = 0.50 \times 10^{-6}\ \text{F}$

$\Delta V = 12\ \text{V}$

Solution

$$PE_{electric} = \frac{1}{2} C(\Delta V)^2 = \frac{1}{2}(0.50 \times 10^{-6}\ \text{F})(12\ \text{V})^2 = 3.6 \times 10^{-5}\ \text{J}$$

PTS: 1 DIF: IIIA OBJ: 17-2.3

72. ANS: B PTS: 1 DIF: II OBJ: 17-3.1
73. ANS: D PTS: 1 DIF: I OBJ: 17-3.4
74. ANS: C PTS: 1 DIF: I OBJ: 17-3.4
75. ANS: D PTS: 1 DIF: I OBJ: 17-4.2
76. ANS: B PTS: 1 DIF: II OBJ: 17-4.2
77. ANS: D PTS: 1 DIF: II OBJ: 17-4.3
78. ANS: C

Given

$P = 325\ \text{W}$

$I = 6.0\ \text{A}$

Solution

$P = I\Delta V = I(IR) = I^2R$

Rearrange to solve for R.

$$R = \frac{P}{I^2} = \frac{325\ \text{W}}{(6.0\ \text{A})^2} = 9.0\ \Omega$$

PTS: 1 DIF: IIIA OBJ: 17-4.3

79. ANS: B PTS: 1 DIF: II OBJ: 17-4.3
80. ANS: A

Given

$I = 1000\ \text{A}$

$\Delta V = 700\ 000\ \text{V}$

Solution

$P = I\Delta V = (1000\ \text{A})(700\ 000\ \text{V}) = 7 \times 10^8\ \text{W}$

$$P = (7 \times 10^8\ \text{W})\left(\frac{1\ \text{MW}}{1 \times 10^6\ \text{W}}\right) = 700\ \text{MW}$$

PTS: 1 DIF: IIIA OBJ: 17-4.3

SHORT ANSWER

1. ANS:
principal axis

PTS: 1 DIF: I OBJ: 13-3.1

2. ANS:
Given

$p = 15.0 \text{ cm}$

$q = -25.0 \text{ cm}$

$h = 10.0 \text{ cm}$

Solution

Use the equation for magnification, $M = \frac{h'}{h} = -\frac{q}{p}$, and solve for h'.

$$h' = -\frac{qh}{p} = -\frac{(-25.0 \text{ cm})(10.0 \text{ cm})}{(15.0 \text{ cm})} = 16.7 \text{ cm}$$

Since M is positive, the image is upright and virtual.

PTS: 1 DIF: IIIA OBJ: 13-3.1

3. ANS:
Light rays from the blue sky above are refracted by the warm air next to the dark, hot road and end up traveling upward into the motorists' eyes.

PTS: 1 DIF: II OBJ: 14-3.2

4. ANS:
In this situation, the observer sees the palm tree in two different ways. One group of light rays reaches the observer by the straight-line path *A*. In addition, a second group of rays travels along the curved path *B* because of refraction. Consequently, the observer also sees an inverted image of the palm tree.

PTS: 1 DIF: I OBJ: 14-3.2

5. ANS:
constructive

PTS: 1 DIF: I OBJ: 15-1.1

6. ANS:
The resolving power of the instrument will decrease.

PTS: 1 DIF: II OBJ: 15-2.3

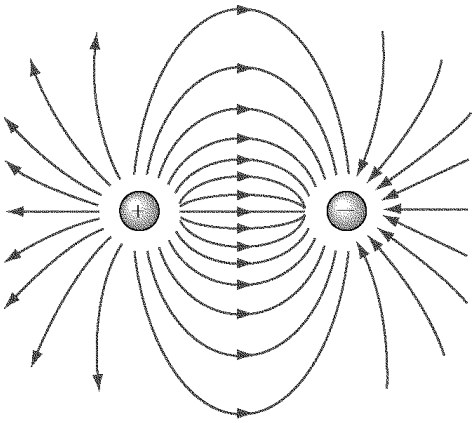
7. ANS:
Light from a laser passes through a glass plate and then a lens that directs it onto the CD. The reflection or lack of a reflection of the laser light is then read by a detector, and the signal is sent through electrical circuits.

PTS: 1 DIF: II OBJ: 15-3.2

8. ANS:
The force increases to twice its previous value because the force is directly proportional to the charge on each of the objects.

PTS: 1 DIF: IIIA OBJ: 16-2.1

9. ANS:



PTS: 1 DIF: I OBJ: 16-3.2

10. ANS:
The potential difference is the change in the electrical potential energy associated with a charged particle divided by the charge of the particle.

PTS: 1 DIF: I OBJ: 17-1.1

11. ANS:
The electrical potential energy of the charges increases.

PTS: 1 DIF: II OBJ: 17-1.3

12. ANS:
The conventional current through the wire is from left to right, because conventional current is defined as the flow of positive charge. Electrons are negative charges, so the conventional current is in a direction opposite to their motion.

PTS: 1 DIF: II OBJ: 17-3.1

13. ANS:
At the instant the bulb is turned on, the lower resistance results in a current through the bulb that is 10 to 20 times greater than the operating current. This high current may cause physical damage to the filament in the lightbulb.

PTS: 1 DIF: II OBJ: 17-3.3

14. ANS:
The motion of the charges continuously changes between moving in the forward direction and moving in the reverse direction.

PTS: 1 DIF: II OBJ: 17-4.1

15. ANS:
Electric power is the rate at which charge carriers convert electric potential energy to other forms of energy.

PTS: 1 DIF: I OBJ: 17-4.2

PROBLEM

1. ANS:
   -8.013 cm

   Given

   $f = -14.7$ cm

   $p = 17.6$ cm

   Solution

   Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

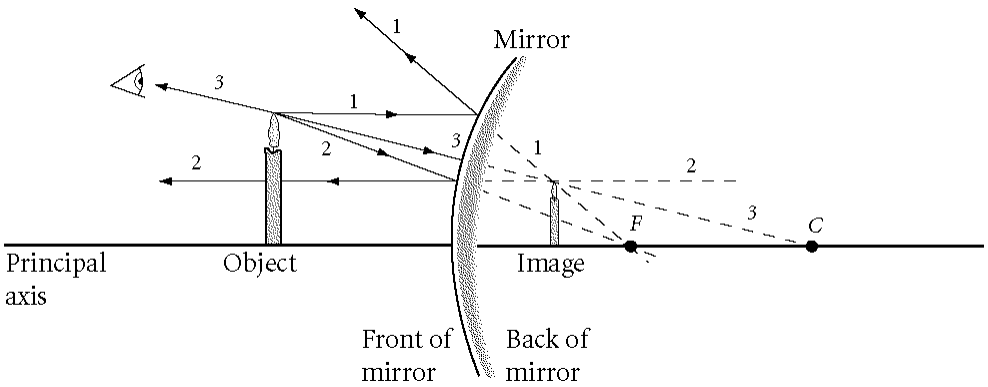
   $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{-14.7\text{ cm}} - \frac{1}{17.6\text{ cm}} = -\frac{0.0680}{1\text{ cm}} - \frac{0.0568}{1\text{ cm}} = -\frac{0.1248}{1\text{ cm}}$$

   $q = -8.013$ cm

   Since q is negative, the image is located 8.013 cm behind the mirror.

   PTS: 1 DIF: IIIB OBJ: 13-3.1
2. ANS:
   $q = -1.15$ cm

   $M = +7.69 \times 10^{-2}$



Given

$d = 5.00$ cm

$p = 15.0$ cm

Solution

Since $d = 5.00$ cm, $R = 2.50$ cm.

Since the ornament acts like a convex mirror, $f = -1.25$ cm.

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{-1.25\text{ cm}} - \frac{1}{15.0\text{ cm}} = -\frac{12}{15.0\text{ cm}} - \frac{1}{15.0\text{ cm}} = -\frac{13}{15.0\text{ cm}}$$

$q = -1.15$ cm

Since q is negative, the image is located 1.15 cm behind the mirror (or inside the ornament).

$$M = -\frac{q}{p} = -\frac{(-1.15\text{ cm})}{15.0\text{ cm}} = +7.69 \times 10^{-2}$$

PTS: 1 DIF: IIIC OBJ: 13-3.1

3. ANS:
−15 cm

Given
$f_o = 1.08$ cm ($f > 0$ for a converging lens)

$p_o = 1.21$ cm ($p > 0$ for an object in front of the lens)

$f_e = 1.57$ cm ($f > 0$ for a converging lens)

$p_e = 1.57\text{ cm} - 0.154\text{ cm} = 1.42$ cm ($p > 0$ for an object in front of the lens)

Solution
The focal length and object distance of the objective lens do not enter into the calculation.

The image of the objective lens is the object of the eyepiece lens.

Rearrange the thin-lens equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q_e} = \frac{1}{f_e} - \frac{1}{p_e} = \frac{1}{1.57\text{ cm}} - \frac{1}{1.42\text{ cm}} = \frac{0.637}{1\text{ cm}} - \frac{0.704}{1\text{ cm}} = -\frac{0.067}{1\text{ cm}}$$

$q_e = -15$ cm ($q < 0$, so the image is virtual and in front of the lens)

PTS: 1 DIF: IIIC OBJ: 14-2.2

4. ANS:

3.13; The image is three and a half times larger than the object. $M > 0$, so the image is virtual and upright.

Given

$f = 12.6$ cm ($f > 0$ for a converging lens)

$q = -26.8$ cm ($q < 0$ for an image in front of the lens)

Solution

First, rearrange the thin-lens equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, to find p.

$$\frac{1}{p} = \frac{1}{f} - \frac{1}{q} = \frac{1}{12.6\text{ cm}} - \frac{1}{-26.8\text{ cm}} = \frac{0.0794}{1\text{ cm}} + \frac{0.0373}{1\text{ cm}} = \frac{0.1167}{1\text{ cm}}$$

$$p = 8.569\text{ cm}$$

Use the magnification of a lens equation, $M = -\frac{q}{p}$, to find M.

$$M = -\frac{q}{p} = -\frac{(-26.8\text{ cm})}{(8.569\text{ cm})} = 3.13$$

The image is three and a half times larger than the object. $M > 0$, so the image is virtual and upright.

PTS: 1 DIF: IIIC OBJ: 14-2.3

5. ANS:
The angle of incidence is greater than the critical angle, $57.9°$, so the light ray will undergo total internal reflection.

Given

$n_{optic\ cable} = 1.57$

$n_{water} = 1.33$

$\theta_i = 65°$ through $70°$

Solution

Rearrange the critical angle equation, $\sin\theta_c = \frac{n_r}{n_i}$, to find θ_c.

$$\theta_c = \sin^{-1}\left(\frac{n_r}{n_i}\right) = \sin^{-1}\left(\frac{n_{water}}{n_{optic\ cable}}\right) = \sin^{-1}\left(\frac{1.33}{1.57}\right) = \sin^{-1}(0.847) = 57.9°$$

The angle of incidence is greater than the critical angle, so the light ray will undergo total internal reflection.

PTS: 1 DIF: IIIB OBJ: 14-3.1

6. ANS:
420 nm

Given

$d = 0.0034\text{ mm} = 3.4 \times 10^{-6}\text{ m}$

$m = 3$
$\theta = 22°$

Solution
$d \sin \theta = m\lambda$

$$\lambda = \frac{d \sin \theta}{m} = \frac{(3.4 \times 10^{-6}\ \text{m})(\sin 22°)}{3}$$

$$\lambda = \frac{(3.4 \times 10^{-6}\ \text{m})(0.37)}{3}$$

$$\lambda = 4.2 \times 10^{-7}\ \text{m} = 4.2 \times 10^{2}\ \text{nm} = 420\ \text{nm}$$

PTS: 1 DIF: IIIA OBJ: 15-1.3

7. ANS:
29°

Given
$d = 0.0016\ \text{mm} = 1.6 \times 10^{-6}\ \text{m}$
$m = 1\frac{1}{2} = \frac{3}{2}$
$\lambda = 520\ \text{nm} = 5.2 \times 10^{-7}\ \text{m}$

Solution
$d \sin \theta = m\lambda$

$$\theta = \sin^{-1}\left(\frac{m\lambda}{d}\right) = \sin^{-1}\left(\frac{\left(\frac{3}{2}\right)(5.2 \times 10^{-7}\ \text{m})}{(1.6 \times 10^{-6}\ \text{m})}\right)$$

$\theta = \sin^{-1}(0.49)$

$\theta = 29°$

PTS: 1 DIF: IIIB OBJ: 15-1.3

8. ANS:
5.9×10^{2} nm

Given
$$d = \frac{1}{6.7 \times 10^{3}\ \frac{\text{lines}}{\text{cm}}} = \frac{1}{6.7 \times 10^{3}}\ \text{cm}$$

$m = \frac{1}{2}$
$\theta = 11.5°$

Solution
$d \sin \theta = m\lambda$

$$\lambda = \frac{d \sin\theta}{m} = \frac{\left(\frac{1}{6.7 \times 10^3} \text{ cm}\right)(\sin 11.5°)}{\frac{1}{2}} = \frac{(2)(\sin 11.5°)}{\left(6.7 \times 10^3\right)} \text{ cm}$$

$$\lambda = \frac{(2)(0.199)}{\left(6.7 \times 10^3\right)} \text{ cm} = 5.9 \times 10^{-5} \text{ cm} = 5.9 \times 10^2 \text{ nm}$$

PTS: 1 DIF: IIIA OBJ: 15-2.2

9. ANS:
4.6×10^2 nm

Given

$$d = \frac{1}{7.9 \times 10^3 \frac{\text{lines}}{\text{cm}}} = \frac{1}{7.9 \times 10^3} \text{ cm}$$

$m = 2\frac{1}{2} = \frac{5}{2}$

$\theta = 64.6°$

Solution

$d \sin\theta = m\lambda$

$$\lambda = \frac{d \sin\theta}{m} = \frac{\left(\frac{1}{7.9 \times 10^3} \text{ cm}\right)(\sin 64.6°)}{\left(\frac{5}{2}\right)} = \frac{(2)(\sin 64.6°)}{(5)\left(7.9 \times 10^3\right)} \text{ cm}$$

$$\lambda = \frac{(2)(0.903)}{(5)(7.9 \times 10^3)} \text{ cm} = 4.6 \times 10^{-5} \text{ cm} = 4.6 \times 10^2 \text{ nm}$$

PTS: 1 DIF: IIIA OBJ: 15-2.2

10. ANS:
-2.0×10^{-9} N; attractive

Given

$q_e = -e = -1.60 \times 10^{-19}$ C

$q_p = +e = +1.60 \times 10^{-19}$ C

$r = 3.4 \times 10^{-10}$ m

$k_C = 8.99 \times 10^9$ N•m^2/C^2

Solution

$$F_{electric} = k_C \frac{q_e q_p}{r^2} = \left(8.99 \times 10^9 \text{ N} \bullet \text{m}^2/\text{C}^2\right)\left(\frac{\left(-1.60 \times 10^{-19} \text{ C}\right)\left(+1.60 \times 10^{-19} \text{ C}\right)}{\left(3.4 \times 10^{-10} \text{ m}\right)^2}\right)$$

$F_{electric} = -2.0 \times 10^{-9}$ N

The force is negative, and therefore attractive.

PTS: 1 DIF: IIIA OBJ: 16-2.1

11. ANS:
1.76×10^{9} N/C

Given

$r_1 = r_2 = \dfrac{4.8 \text{ cm}}{2} = 2.4 \text{ cm} = 2.4 \times 10^{-2} \text{ m}$

$\theta_1 = 0.0°$

$\theta_2 = 180°$

$q_1 = 56.5 \ \mu\text{C} = 5.65 \times 10^{-5} \text{ C}$

$q_2 = -56.5 \ \mu\text{C} = -5.65 \times 10^{-5} \text{ C}$

$k_C = 8.99 \times 10^9 \text{ N} \bullet \text{m}^2/\text{C}^2$

Solution

$$E_1 = k_C \frac{q_1}{r_1^2} = \left(8.99 \times 10^9 \text{ N} \bullet \text{m}^2/\text{C}^2\right) \frac{\left(5.65 \times 10^{-5} \text{ C}\right)}{\left(2.4 \times 10^{-2} \text{ m}\right)^2} = 8.8 \times 10^8 \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^2} = \left(8.99 \times 10^9 \text{ N} \bullet \text{m}^2/\text{C}^2\right) \frac{\left(-5.65 \times 10^{-5} \text{ C}\right)}{\left(2.4 \times 10^{-2} \text{ m}\right)^2} = -8.8 \times 10^8 \text{ N/C}$$

For E_1 : $E_{x,1} = (E_1)(\cos 0.0°) = (8.8 \times 10^8 \text{ N/C})(\cos 0.0°) = 8.8 \times 10^8 \text{ N/C}$

$E_{y,1} = 0$ N/C

For E_2 : $E_{x,2} = (E_2)(\cos 180°) = (-8.8 \times 10^8 \text{ N/C})(\cos 180°) = 8.8 \times 10^8 \text{ N/C}$

$E_{y,2} = 0$ N/C

$E_{x,tot} = E_{x,1} + E_{x,2} = 8.8 \times 10^8 \text{ N/C} + 8.8 \times 10^8 \text{ N/C} = 1.76 \times 10^9 \text{ N/C}$

$E_{y,tot} = E_{y,1} + E_{y,2} = 0 \text{ N/C} + 0 \text{ N/C} = 0 \text{ N/C}$

$$E_{tot} = \sqrt{\left(E_{x,tot}\right)^2 + \left(E_{y,tot}\right)^2} = \sqrt{\left(1.76 \times 10^9 \text{ N/C}\right)^2 + 0} = 1.76 \times 10^9 \text{ N/C}$$

$E_{tot} = 1.76 \times 10^9$ N/C

PTS: 1 DIF: IIIB OBJ: 16-3.1

12. ANS:
9.6×10^{-6} C = 9.6 μC

Given

$q_1 = q_2$

$r_{total} = 1.2$ m

$r_1 = r_2 = \frac{r_{total}}{2} = 0.60$ m

$E_{total} = 4.8 \times 10^5$ N/C

$k_C = 8.99 \times 10^9$ N • m^2/C^2

Solution

$$E_1 = E_2 = \frac{E_{total}}{2} = \frac{4.8 \times 10^5 \text{ N/C}}{2} = 2.4 \times 10^5 \text{ N/C}$$

$$E_1 = k_C \frac{q_1}{r_1^2}$$

Rearrange to solve for q_1.

$$q_1 = \frac{E_1 r_1^2}{k_C} = \frac{\left(2.4 \times 10^5 \text{ N/C}\right)(0.60 \text{ m})^2}{8.99 \times 10^9 \text{ N} \bullet \text{m}^2/\text{C}^2} = 9.6 \times 10^{-6} \text{ C}$$

$q_1 = q_2 = 9.6 \times 10^{-6}$ C $= 9.6 \mu$C

PTS: 1 DIF: IIIB OBJ: 16-3.2

13. ANS:
3.9×10^{-12} F

Given

$l = 5.8$ cm $= 5.8 \times 10^{-2}$m

$d = 7.7$ mm $= 7.7 \times 10^{-3}$m

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N•m^2

Solution

$A = l^2$

$$C = \varepsilon_0 \frac{A}{d} = \varepsilon_0 \frac{l^2}{d} = (8.85 \times 10^{-12} \text{ C}^2/\text{N} \bullet \text{m}^2) \frac{\left(5.8 \times 10^{-2} \text{ m}\right)^2}{\left(7.7 \times 10^{-3} \text{ m}\right)}$$

$C = 3.9 \times 10^{-12}$ F

PTS: 1 DIF: IIIB OBJ: 17-2.2

14. ANS:
0.17 μF

Given

$PE_{electric} = 8.1 \times 10^{-6}$ J

$\Delta V = 9.8$ V

Solution

$$PE_{electric} = \frac{1}{2} C(\Delta V)^2$$

$$C = \frac{2PE_{electric}}{(\Delta V)^2} = \frac{(2)\left(8.1 \times 10^{-6}\ \text{J}\right)}{(9.8\ \text{V})^2} = 1.7 \times 10^{-7}\ \text{F}$$

$$C = \left(1.7 \times 10^{-7}\ \text{F}\right) \times \frac{10^6\ \mu\text{F}}{1\ \text{F}} = 1.7 \times 10^{-1}\ \mu\text{F} = 0.17\ \mu\text{F}$$

PTS: 1 DIF: IIIB OBJ: 17-2.3

15. ANS:
0.91 V

Given
$R = 17.9\ \Omega$
$I = 0.051$ A

Solution

$$R = \frac{\Delta V}{I}$$

$$\Delta V = IR = (0.051\ \text{A})(17.9\ \Omega) = 0.91\ \text{V}$$

PTS: 1 DIF: IIIA OBJ: 17-3.3