1) The electric field shown in Figure 15-3

![Figure 15-3](image)

A) decreases to the right.
B) is uniform.
C) increases down.
D) decreases down.
E) increases to the right.

Page Ref: Sec. 15.4

2) A point charge of +Q is placed at the center of a square, and a second point charge of -Q is placed at the upper-left corner. It is observed that an electrostatic force of 2 N acts on the positive charge at the center.

![Figure 15-7](image)

What is the magnitude of the force that acts on the center charge if a third charge of -Q is placed at the lower-left corner?
A) 4 N  B) $2\sqrt{2}$ N  C) zero  D) $2/\sqrt{3}$ N

Page Ref: Sec. 15.3

3) Two point charges of + 6.00 μC and + 9.00 μC are placed inside a cube of edge length 0.100 m. The net electric flux due to these charges is given by

A) $0.340 \times 10^6$ Nm$^2$/C
B) $3.80 \times 10^6$ Nm$^2$/C
C) $1.69 \times 10^6$ Nm$^2$/C
D) $4.20 \times 10^6$ Nm$^2$/C
E) $0.450 \times 10^6$ Nm$^2$/C

Page Ref: Sec. 15.6
4) \( Q_1 = 6.0 \text{ nC} \) is at \((0.30 \text{ m}, 0)\); \( Q_2 = -1.0 \text{ nC} \) is at \((0, 0.10 \text{ m})\); \( Q_3 = 5.0 \text{ nC} \) is at \((0, 0)\).
What is the magnitude of the net force on the 5.0 nC charge?
   A) \( 5.4 \times 10^{-6} \text{ N} \)
   B) \( 7.2 \times 10^{-6} \text{ N} \)
   C) \( 4.5 \times 10^{-6} \text{ N} \)
   D) \( 3.0 \times 10^{-6} \text{ N} \)
   E) \( 9.0 \times 10^{-6} \text{ N} \)
Page Ref: Sec. 15.2

5) Two point charges, initially 2.0 cm apart, experience a 1.0-N force. If they are moved to a new separation of 8.0 cm, what is the electric force between them?
   A) 2.0 N     B) 1/4 N     C) 16 N     D) 4.0 N     E) 1/16 N
Page Ref: Sec. 15.2

6) Two charged objects attract each other with a certain force. If the charges on both objects are doubled with no change in separation, the force between them
   A) increases, but we can’t say how much without knowing the distance between them.
   B) becomes zero.
   C) doubles.
   D) quadruples.
   E) halves.
Page Ref: Sec. 15.3

7) Gaussian surfaces A and B enclose the same positive charge \(+Q\). The area of Gaussian surface A is three times larger than that of Gaussian surface B. The flux of electric field through Gaussian surface A is
   A) nine times larger than the flux of electric field through Gaussian surface B.
   B) unrelated to the flux of electric field through Gaussian surface B.
   C) equal to the flux of electric field through Gaussian surface B.
   D) three times smaller than the flux of electric field through Gaussian surface B.
   E) three times larger than the flux of electric field through Gaussian surface B.
Page Ref: Sec. 15.6

8) A charge of 2.0 \( \mu \text{C} \) flows onto the plates of a capacitor when it is connected to a 12. V battery. How much work was done in charging this capacitor?
   A) 21. \( \mu \text{J} \)     B) 48. \( \mu \text{J} \)     C) 12. \( \mu \text{J} \)     D) 0.14 mJ     E) 24. \( \mu \text{J} \)
Page Ref: Sec. 16.3

9) The plates of a parallel-plate capacitor are maintained with constant voltage by a battery as they are pulled apart. What happens to the strength of the electric field during this process?
   A) It increases.
   B) There is no way to tell from the information given.
   C) It decreases.
   D) It remains constant.
Page Ref: Sec. 16.3
10) Which of the following will increase the capacitance of a parallel plate capacitor?
   A) a decrease in the plate area and an increase in the plate separation
   B) none of the above
   C) an increase in the plate area and a decrease in the plate separation
   D) a decrease in the potential difference between the plates
   E) an increase in the potential difference between the plates
   Page Ref: Sec. 16.3

11) Consider a uniform electric field of 50. N/C directed toward the East. If the voltage measured relative to ground at a given point in the field is 80. V, what is the voltage at a point 1.0 m directly South of that point?
   A) zero       B) 30 V       C) 80 V       D) 50. kV      E) 50 V
   Page Ref: Sec. 16.2

12) A battery charges a parallel-plate capacitor fully and then is removed. The plates are immediately pulled apart. (With the battery disconnected, the amount of charge on the plates remains constant.) What happens to the potential difference between the plates as they are being separated?
   A) There is no way to tell from the information given.
   B) It decreases.
   C) It remains constant.
   D) It increases.
   Page Ref: Sec. 16.3

13) The absolute potential at the center of a square is 3. V when a charge of +Q is located at one of the square’s corners. What is the absolute potential at the square’s center when a second charge of −Q is placed at one of the remaining corners?
   A) 6 V       B) −12 V      C) zero       D) −6 V       E) 12 V
   Page Ref: Sec. 16.1

14) If a Cu^{2+} ion drops through a potential difference of 12. V, it will acquire a kinetic energy (in the absence of friction) of
   A) 24. eV.   B) 6.0 J.     C) 6.0 eV.     D) 12. eV.     E) 12. J.
   Page Ref: Sec. 16.1

15) A 120–m long copper wire (resistivity 1.68 × 10^{-8} Ω · m) has resistance 6.0 Ω. What is the diameter of the wire?
   A) 0.065 mm   B) 0.65 mm  C) 0.65 m      D) 0.65 cm
   Page Ref: Sec. 17.3

16) If the resistance in a constant voltage circuit is doubled, the power dissipated by that circuit will
   A) decrease to one-half its original value.
   B) be unchanged.
   C) decrease to one-fourth its original value.
   D) increase by a factor of two.
   E) increase by a factor of four.
   Page Ref: Sec. 17.4
17) A 4000-Ω resistor is connected across 220 V. What current will flow?
   A) 1.8 A  B) 0.055 A  C) 5.5 A  D) 18 A
   Page Ref: Sec. 17.3

18) If you connect two identical storage batteries together in series ("+" to "+"), and place them in a circuit, the combination will provide
   A) the same voltage and the same current will flow through each.
   B) twice the voltage, and different currents will flow through each.
   C) zero volts.
   D) the same voltage, and different currents will flow through each.
   E) twice the voltage, and the same current will flow through each.
   Page Ref: Sec. 17.1

19) Consider a current moving from left to right through a resistor. Which end of the resistor is at higher potential?
   A) right
   B) left
   C) indeterminate, depends if current is charging a battery or discharging a battery
   Page Ref: Sec. 17.3

20) Consider two copper wires. One has twice the length and twice the cross-sectional area of the other. How do the resistances of these two wires compare?
   A) The shorter wire has four times the resistance of the longer wire.
   B) Both wires have the same resistance.
   C) The shorter wire has twice the resistance of the longer wire.
   D) The longer wire has twice the resistance of the shorter wire.
   E) The longer wire has four times the resistance of the shorter wire.
   Page Ref: Sec. 17.3

21) The lamps in a string of Christmas tree lights are connected in parallel. What happens if one lamp burns out? (Assume negligible resistance in the wires leading to the lamps.)
   A) The other lamps get brighter, but some get brighter than others.
   B) The brightness of the lamps will not change appreciably.
   C) The other lamps get dimmer equally.
   D) The other lamps get brighter equally.
   E) The other lamps get dimmer, but some get dimmer than others.
   Page Ref: Sec. 18.1

22) A 6.0 Ω and a 12. Ω resistor are connected in series to a 36. V battery. What power is dissipated by the 12.0 Ω resistor?
   Page Ref: Sec. 18.1

23) As more resistors are added in parallel to a constant voltage source, the power supplied by the source
   A) increases for a time and then starts to decrease.
   B) increases.
   C) does not change.
   D) decreases.
   Page Ref: Sec. 18.1
24) Two 4. Ω resistors are connected in parallel, and this combination is connected in series with 3 Ω. What is the effective resistance of this combination?
   A) 1.2 Ω   B) 5. Ω   C) 4. Ω   D) 7. Ω   E) 11. Ω
   Page Ref: Sec. 18.1

25) Consider three identical resistors, each of resistance R. The maximum power each can dissipate is P. Two of the resistors are connected in series, and a third is connected in parallel with these two. What is the maximum power this network can dissipate?
   A) P   B) 3P   C) 2P   D) 3P/2   E) 2P/3
   Page Ref: Sec. 18.1

26) When two or more resistors are connected in series to a battery
   A) the total voltage across the combination is the algebraic sum of the voltages across the individual resistors.
   B) the same current flows through each resistor.
   C) the equivalent resistance of the combination is equal to the sum of the resistances of each resistor.
   D) all of the other choices are true.
   Page Ref: Sec. 18.1

27) A charged particle moves with its velocity perpendicular to a magnetic field. The field acts to change the particle's
   A) energy.
   B) mass.
   C) charge.
   D) velocity.
   E) magnitude of momentum.
   Page Ref: Sec. 19.3

28) A cyclotron operates at 10. MHz. What magnetic field is needed to accelerate protons?
   A) 0.66 T
   B) 0.12 T
   C) 0.25 Gauss
   D) 1.1 T
   E) 0.25 T
   Page Ref: Sec. 19.3

29) A vertical wire carries a current straight up in a region where the magnetic field vector points due North. What is the direction of the resulting force on this current?
   A) North
   B) downward
   C) South
   D) East
   E) West
   Page Ref: Sec. 19.4
30) A charged particle is injected into a uniform magnetic field such that its velocity vector is perpendicular to the magnetic field vector. Ignoring the particle's weight, the particle will
   A) follow a circular path.
   B) move in a straight line.
   C) immediately stop.
   D) move along a parabolic path.
   E) follow a spiral path.

Page Ref: Sec. 19.3

31) Consider a magnetic field pointing out of this page, as shown in Figure 19-1.

   Figure 19-1

   ![Figure 19-1](image)

   An electron moving on the page toward the right will
   A) curve upward (path a).
   B) speed up.
   C) continue straight ahead (path b).
   D) curve downward (path c).
   E) slow down.

Page Ref: Sec. 19.2

32) At a particular instant, a proton moves Eastward in a uniform magnetic field that is directed straight downward. The magnetic force that acts on it is
   A) directed upward.
   B) Westward.
   C) Northward.
   D) zero.
   E) to the South.

Page Ref: Sec. 19.2

33) Electric dipoles always consist of two charges that are
   A) unequal in magnitude; opposite in sign.
   B) equal in magnitude; opposite in sign.
   C) equal in magnitude; both are negative.
   D) equal in magnitude; both are positive.

Page Ref: Sec. 15.4
34) Figure 15–5 shows four Gaussian surfaces surrounding a distribution of charges. Which Gaussian surfaces have no electric flux through them?
   A) a.
   B) b.
   C) b and c.
   D) b and d.
   E) c.
   Page Ref: Sec. 15.6

35) A parallel-plate capacitor has plates of area 0.20 m\(^2\) separated by a distance of 1.0 mm. What is this capacitor’s capacitance?
   A) 0.35 nF
   B) 40. F
   C) 22. \(\mu F\)
   D) 2.0 \(\times 10^2\) F
   E) 1.8 nF
   Page Ref: Sec. 16.3

36) An equipotential surface must be
   A) perpendicular to the electric field at any point.
   B) equal to the electric field at any point.
   C) randomly oriented with respect to the electric field.
   D) parallel to the electric field at any point.
   Page Ref: Sec. 16.2

37) It takes 10. J of energy to move 2.0 C of charge from point A to point B. What is the potential difference between points A and B?
   A) 0.20 V
   B) zero
   C) 5.0 V
   D) 20. V
   E) 0.50 V
   Page Ref: Sec. 16.1
38) A 500-W device is connected to a 100-V power source. What current flows through this source?
   A) 5.00 A  
   B) 20.0 A  
   C) 200 mA  
   D) 1.60 \times 10^{18} \text{ electrons/s}  
   E) 50,000 A
Page Ref: Sec. 17.4

39) A light bulb operating at 110 V draws 1.40 A of current. What is its resistance?
   A) 154 \Omega  
   B) 78.6 \Omega  
   C) 12.7 \Omega  
   D) 109 \Omega
Page Ref: Sec. 17.3

40) A copper wire of 1.0 \text{ cm}^2 cross-sectional area would have to be how long to have a resistance of 1.0 ohm?
   A) 5.9 \text{ km}  
   B) 5.9 \text{ Mm}  
   C) 5.9 \text{ m}  
   D) 5.9 \times 10^4 \text{ m}  
   E) 5.9 \times 10^2 \text{ m}
Page Ref: Sec. 17.3

41) A 3. \Omega resistor is connected in parallel with a 6. \Omega resistor. This pair is then connected in series with a 4. \Omega resistor. These resistors are connected to a battery. What will happen if the 3. \Omega resistor burns out, i.e., becomes an infinite resistance?
   A) The power dissipated in the circuit will increase.  
   B) The current provided by the battery will not change.  
   C) The current in the 4. \Omega resistor will drop to zero.  
   D) The current in the 6. \Omega resistor will increase.
Page Ref: Sec. 18.1

42) A proton is projected with a velocity of 7.0 \times 10^3 \text{ m/s} into a magnetic field of 0.60 T perpendicular to the motion of the proton. What is the force that acts on the proton?
   A) 0 \text{ N}  
   B) 13 \times 10^{-16} \text{ N}  
   C) 3.4 \times 10^{-16} \text{ N}  
   D) 4.2 \times 10^{-16} \text{ N}  
   E) 6.7 \times 10^{-16} \text{ N}
Page Ref: Sec. 19.2
43) A wire lying in the plane of the page carries a current toward the bottom of the page, as shown.

What is the direction of the magnetic force it produces on an electron that is moving perpendicularly toward the wire, also in the plane of the page, from your right?

A) perpendicular to the page and towards you  
B) toward the bottom of the page  
C) toward the top of the page  
D) zero  
E) perpendicular to the page and away from you

Page Ref: Sec. 19.6

44) A solid block of metal is placed in a uniform electric field. Which statement is correct concerning the electric field in the block’s interior?

A) The interior field points in a direction that is at right angles to the exterior field.
B) There is no electric field in the block’s interior.
C) The interior field points in a direction opposite to the exterior field.
D) The interior field points in a direction that is parallel to the exterior field.

Page Ref: Sec. 15.5

45) A voltage has been applied across a capacitor. If the dielectric is replaced with another dielectric constant eight times as great and the voltage is reduced to half of what it was, the ENERGY STORED in the capacitor is how many times the original stored energy?

A) 1/2  
B) 1/4  
C) 8  
D) 2  
E) 4

Page Ref: Sec. 16.3

46) Capacitors connected in series always have _______ total capacitance than any of the individual capacities.

A) more  
B) Not enough information given.  
C) the same  
D) less

Page Ref: Sec. 16.5

47) When resistors are connected in series

A) the total effective resistance is reduced.  
B) the same power is dissipated in each one.  
C) the current flowing in each is the same.  
D) the potential difference across each is the same.

Page Ref: Sec. 18.1
48) An ideal ammeter should
   A) introduce a very small series resistance into the circuit whose current is to be measured.
   B) introduce a very large series resistance into the circuit whose current is to be measured.
   C) have a high coil resistance.
   D) consist of a galvanometer in series with a large resistor.
Page Ref: Sec. 18.4

49) The magnetic field due to the current in a long, straight wire is 8.0 μT at a distance of 4.0 cm from the center of the wire. What is the current in the wire?
   A) 0.20 A   B) 0.80 A   C) 0.40 A   D) 1.6 A   E) 3.2 A
Page Ref: Sec. 19.6

50) Lenz’s Law is a consequence of the law of conservation of
   A) momentum.
   B) charge.
   C) mass.
   D) electric field.
   E) energy
Page Ref: Sec. 20.1

51) Faraday’s law of induction states that the emf induced in a loop of wire is proportional to
   A) current divided by time.
   B) the magnetic flux density times the loop’s area.
   C) the time variation of the magnetic flux.
   D) the magnetic flux.
Page Ref: Sec. 20.1

52) Doubling the number of loops of wire in a coil produces what kind of change on the induced emf, assuming all other factors remain constant?
   A) The induced emf is 4 times as much.
   B) There is no change in the induced emf.
   C) The induced emf is √2 times as much.
   D) The induced emf is 3 times as much.
   E) The induced emf is twice as much.
Page Ref: Sec. 20.1

53) A bar magnet is dropped, N pole down, so it falls through a horizontal loop of wire. As it approaches the loop, the induced current (viewed from above) is:
   A) clockwise   B) counterclockwise   C) zero
Page Ref: Sec. 20.1
54) Suppose that the maximum rate of change of current in a "high power" transmission line is $10^4$ A/s. How large a coil (area) placed 10. meters from the line would have 120. volts (max) induced in it?

A) $2. \times 10^3 \text{m}^2$
B) $6. \times 10^4 \text{m}^2$
C) $2. \times 10^5 \text{m}^2$
D) $6. \times 10^3 \text{m}^2$
E) $6. \times 10^5 \text{m}^2$

Page Ref: Sec. 20.1

55) A circular loop of wire is rotated at constant angular speed about an axis whose direction can be varied. In a region where a uniform magnetic field points straight down, what must be the orientation of the loop's axis of rotation if the induced emf is to be zero?

A) It must make an angle of 90° to the direction North.
B) Any horizontal orientation will do.
C) It must be vertical.
D) It must make an angle of 45° to the vertical.
E) It must make an angle of 45° to the direction North.

Page Ref: Sec. 20.1

56) The cross-sectional area of an adjustable single loop is reduced from 1.0 m² to 0.25 m² in 0.10 s. What is the average emf that is induced in this coil if it is in a region where $B = 2.0 \text{T}$ upward, and the coil's plane is perpendicular to B?

A) 18 V  
B) 21 V  
C) 12 V  
D) 0 V  
E) 15 V

Page Ref: Sec. 20.1

57) The output of a generator is 440. V at 20. A. It is to be transmitted on a line with resistance of 0.60 Ω. To what voltage must the generator output be stepped up with a transformer if the power loss in transmission is not to exceed 0.01% of the original power?

A) 72.7 kV  
B) 22. kV  
C) $4.4 \times 10^5 \text{ V}$  
D) 44.5 kV  
E) 4.4 kV

Page Ref: Sec. 20.3

58) A very long solenoid has $1.0 \times 10^6$ turns per meter and a cross-sectional area of $2.0 \times 10^6 \text{ m}^2$. A short, secondary coil with $1.0 \times 10^3$ turns is wound over the solenoid's midpoint. What emf is induced in the secondary coil if the current in the solenoid is changing at a rate of 4.0 A/s?

A) 2.7 V  
B) 4.4 V  
C) 1.6 V  
D) 0.52 V  
E) 1.0 V

Page Ref: Sec. 20.1
59) The secondary coil of a neon sign transformer provides 7500 V at 0.010 A. The primary coil operates on 120 V. What current does the primary draw?
   A) 0.625 A
   B) 1.66 A
   C) 0.16 A
   D) 333 mA
   E) 6.25 \times 10^{-4} A
   
   Page Ref: Sec. 20.3

60) An AC circuit has a 100. ohm resistor in series with a 4.9 \mu F capacitor and a 700. mH inductor. At what frequency does the circuit act like a pure resistance?
   A) 1.9 mHz
   B) 86. Hz
   C) 0.29 MHz
   D) 0.54 kHz
   E) 12. mHz
   
   Page Ref: Sec. 21.4

61) A capacitor is connected to an AC power supply. In this circuit, the current
   A) lags the voltage by 90°.
   B) is in phase with the voltage.
   C) leads the voltage by 45°.
   D) lags the voltage by 45°.
   E) leads the voltage by 90°.
   
   Page Ref: Sec. 21.2

62) A series RLC circuit has R = 20. \Omega, L = 200. mH, C = 10. \mu F. At what frequency should the circuit be driven in order to have maximum power transferred from the driving source?
   A) 0.96 kHz
   B) 0.45 kHz
   C) 0.28 kHz
   D) 0.11 kHz
   E) 0.17 kHz
   
   Page Ref: Sec. 21.4

63) Consider a 4500. ohm resistor in series with a 133. mH inductor. What capacitance should be added in series so that the impedance is a minimum at 500. KHz?
   A) 0.762 pF
   B) 0.627 pF
   C) 2.67 \mu F
   D) 7.26 \mu F
   E) 0.267 pF
   
   Page Ref: Sec. 21.4

64) Consider a series circuit in which the capacitive reactance equals the inductive reactance. What is the phase angle between current and voltage?
   A) +90°
   B) 0°
   C) -90°
   D) +180°
   E) -180°
   
   Page Ref: Sec. 21.4
65) A resistor is connected to an AC power supply. On this circuit, the current
A) leads the voltage by 45°.
B) leads the voltage by 90°.
C) is in phase with the voltage.
D) lags the voltage by 90°.
E) lags the voltage by 45°.
Page Ref: Sec. 21.1

66) In an RLC circuit, the resistance is 10. ohms, the capacitive reactance is 30. ohms, and the inductive reactance is 50. ohms. What is the circuit impedance?
A) 63. Ω    B) 81. Ω    C) 22. Ω    D) 10. Ω    E) 90. Ω
Page Ref: Sec. 21.4

67) If the frequency of the AC voltage across a capacitor is doubled, the capacitive reactance of that capacitor
A) increases to 4 times its original value.
B) increases to twice its original value.
C) decreases to one-half its original value.
D) becomes zero.
E) decreases to one-fourth its original value.
Page Ref: Sec. 21.2

68) A resistor and a capacitor are connected in series to an ideal battery of constant terminal voltage. At the moment contact is made with the battery, the voltage across the resistor is
A) less than the battery’s terminal voltage, but greater than zero.
B) greater than the battery’s terminal voltage.
C) zero.
D) equal to the battery’s terminal voltage.
Page Ref: Sec. 21.2

69) Which of the following colors undergoes the greatest REFRACTION when passing from air into glass?
A) yellow    B) green    C) orange    D) blue    E) red
Page Ref: Sec. 22.5

70) You can only see a rainbow if
A) the sun is 180° to the side.  B) the sun is in front of you.
C) the sun is behind you.      D) the sun is 90° to the side.
Page Ref: Sec. 22.5

71) The angle of incidence
A) is always greater than the angle of refraction.
B) must equal the angle of refraction.
C) may be greater than, less than, or equal to the angle of refraction.
D) is always less than the angle of refraction.
Page Ref: Sec. 22.3

72) What is the critical angle for light traveling from crown glass (n = 1.52) into water (n = 1.33)?
A) 48°    B) 42°    C) 66°    D) 57°    E) 61°
Page Ref: Sec. 22.4
73) The index of refraction of a certain medium is 1.5. What is the speed of light in that medium?
   A) $5.0 \times 10^8 \text{ m/s}$  
   B) $4.0 \times 10^8 \text{ m/s}$  
   C) $3.0 \times 10^8 \text{ m/s}$  
   D) $1.0 \times 10^8 \text{ m/s}$  
   E) $2.0 \times 10^8 \text{ m/s}$
   
   Page Ref: Sec. 22.3

74) Light travels fastest
   A) through glass.  
   B) through diamond.  
   C) through water.  
   D) in a vacuum.
   
   Page Ref: Sec. 22.3

75) In common transparent media, as the frequency of light increases, the index of refraction
   A) decreases.  
   B) varies as the sine of the incident angle.  
   C) stays constant.  
   D) increases.
   
   Page Ref: Sec. 22.5

76) Which of the following materials has the slowest speed of light?
   A) oil  
   B) air  
   C) diamond  
   D) flint glass  
   E) water
   
   Page Ref: Sec. 22.3

77) The critical angle for a beam of light passing from water into air is $48.8^\circ$. This means that all light rays with an angle of incidence greater than this angle will be
   A) totally reflected.  
   B) absorbed.  
   C) totally transmitted.  
   D) partially reflected and partially transmitted.
   
   Page Ref: Sec. 22.4

78) Fiber optics depends upon the phenomenon of
   A) dispersion.  
   B) diffuse reflection.  
   C) total internal reflection.  
   D) polarization.
   
   Page Ref: Sec. 22.4
79) Sometimes when you look into a curved mirror you see a magnified image (a great big you!) and sometimes you see a diminished image (a little you). If you look at the bottom (convex) side of a shiny spoon, what will you see?
   A) You won’t see an image of yourself because no image will be formed.
   B) You will see a little you, upside down.
   C) You will see a little you, right side up.
   D) You will see a little you, but whether you are right side up or upside down depends on how near you are to the spoon.
   E) You will either see a little you or a great big you, depending on how near you are to the spoon.
   
80) A person approaches a plane mirror at a speed of 2 m/s. How fast does he approach his image?
   A) 1 m/s  B) 1 m/s  C) 2 m/s  D) 3 m/s  E) 4 m/s

81) Consider a converging lens. If the object is inside the focal point, then the image will always be
   A) at the focal point.  B) real.
   C) virtual.  D) at infinity.

82) If you stand in front of a concave mirror, exactly at its focal point,
   A) you won’t see your image because there is none.
   B) you will see your image at your same height.
   C) you will see your image, and you will appear smaller.
   D) you won’t see your image because it’s focused at a different distance.
   E) you will see your image and you will appear larger.

83) The radius of curvature for a plane (flat) mirror is
   A) negative.  B) imaginary.  C) infinite.  D) zero.

84) The focal length of a concave mirror is 20 cm. What is its radius of curvature?
   A) ~20 cm  B) ~40 cm  C) 40 cm  D) 20 cm  E) 10 cm

85) Two very thin lenses, each with focal length 20. cm, are placed in contact. What is the focal length of this compound lens?
   A) 10. cm  B) 30. cm  C) 40. cm  D) 15. cm  E) 20. cm

86) How many orders are in the spectra formed by a grating with 3000. lines/cm illuminated by red light of wavelength 600. nm?
   A) 1  B) 0  C) 5  D) 3  E) 4
87) The condition \( 2d \sin(\theta) = n\lambda \) for X-ray diffraction maxima is attributed to
A) Land.
B) Young.
C) Bragg.
D) Brewster.
E) Rayleigh.
Page Ref: Sec. 24.3

88) An ideal polarizer is placed in a beam of unpolarized light and the intensity of the transmitted light is 1.000. A second ideal polarizer is placed in the beam with its referred direction rotated 40° to that of the first polarizer. What is the intensity of the beam after it has passed through both polarizers?
A) 0.7661 B) 0.4131 C) 0.5868 D) 0.5000 E) 0.6431
Page Ref: Sec. 24.4

89) What is the Brewster's angle for light traveling in vacuum and reflecting off a piece of glass of index of refraction 1.52?
A) 33.3° B) 48.1° C) 56.7° D) 41.1° E) 48.9°
Page Ref: Sec. 24.4

90) The separation between adjacent maxima in a double-slit interference pattern using monochromatic light is
A) greatest for blue light. B) greatest for green light.
C) the same for all colors of light. D) greatest for red light.
Page Ref: Sec. 24.1

91) A very fine thread is placed between two glass plates on one side and the other side is touching to form a wedge. A beam of monochromatic light of wavelength 600 nm illuminates the wedge and 178 bright fringes are observed. What is the thickness of the thread?
A) 76.3 \( \mu \)m B) 22.3 \( \mu \)m C) 26.7 \( \mu \)m D) 32.3 \( \mu \)m E) 53.3 \( \mu \)m
Page Ref: Sec. 24.2

92) A bar magnet is dropped, N pole down, so it falls through a horizontal loop of wire. As it leaves the loop, the induced current (viewed from above) is:
A) clockwise B) counterclockwise C) zero
Page Ref: Sec. 20.1

93) A coil lies flat on a table top in a region where the magnetic field vector points straight up. The magnetic field vanishes suddenly. When viewed from above, what is the sense of the induced current in this coil as the field fades?
A) The current flows clockwise initially, and then it flows counterclockwise before stopping.
B) The induced current flows counterclockwise.
C) The induced current flows clockwise.
D) There is no induced current in this coil.
Page Ref: Sec. 20.1
94) A horizontal metal bar that is 2.0 m long rotates at a constant angular velocity of 2.0 rad/s about a vertical axis through one of its ends while in a constant magnetic field of $5 \times 10^{-5}$ T. If the magnetic field vector points straight down, what emf is induced between the two ends of the bar?

A) $5.6 \times 10^{-3}$ V
B) $7.0 \times 10^{-4}$ V
C) $1.6 \times 10^{-4}$ V
D) $3.6 \times 10^{-3}$ V
E) $2.0 \times 10^{-4}$ V

Page Ref: Sec. 20.2

95) The flux through a coil changes from $4 \times 10^{-5}$ Wb to $5 \times 10^{-5}$ Wb in 0.1 s. What emf is induced in this coil?

A) $7 \times 10^{-4}$ V
B) $1 \times 10^{-4}$ V
C) $5 \times 10^{-4}$ V
D) $4 \times 10^{-4}$ V
E) $3 \times 10^{-4}$ V

Page Ref: Sec. 20.1

96) A pure inductor is connected to an AC power supply. In this circuit, the current

A) lags the voltage by 90°.
B) is in phase with the voltage.
C) leads the voltage by 90°.
D) leads the voltage by 45°.
E) lags the voltage by 45°.

Page Ref: Sec. 21.3

97) If the frequency of the AC voltage across an inductor is doubled, the inductive reactance of that inductor

A) decreases to one-half its original value.
B) increases to 4 times its original value.
C) decreases to one-fourth its original value.
D) increases to twice its original value.

Page Ref: Sec. 21.3

98) If the inductance and the capacitance both double in an LRC series circuit, the resonant frequency of that circuit will

A) decrease to one-eighth its original value.
B) increase to four times its original value.
C) decrease to one-half its original value.
D) decrease to one-fourth its original value.
E) increase to twice its original value.

Page Ref: Sec. 21.5
99) What size capacitor must be placed in series with a 30. Ω resistor and a 40. mH coil if the resonant frequency of the circuit is to be 1000. Hz?
   A) 6.0 μF       B) 0.63 μF       C) 2.0 μF       D) 3.3 μF       E) 4.5 μF

   Page Ref: Sec. 21.5

100) The speed of light in a certain medium is 2.2 x 10^8 m/s. What is the index of refraction of this medium?
   A) 1.4       B) 1.0       C) 1.2       D) 1.8       E) 1.6

   Page Ref: Sec. 22.3

101) The image of the rare stamp you see through a magnifying glass is
   A) either the same orientation or upside-down, depending on the thickness of the glass used.
   B) always upside-down compared to the stamp.
   C) always the same orientation as the stamp.
   D) either the same orientation or upside-down, depending on how close the stamp is to the glass.

   Page Ref: Sec. 23.3

102) A ray of light traveling in water (n = 1.33) hits a glass surface (n = 1.50). At what angle, with the surface, must the incident ray be in order that the polarization of the reflected ray is the greatest?
   A) 33.7°       B) 41.6°       C) 48.4°       D) 36.9°       E) 53.1°

   Page Ref: Sec. 24.4

103) An AC generator has 80. rectangular loops on its armature. Each loop is 12. cm long and 8.0 cm wide. The armature rotates at 1200. rpm about an axis parallel to the long side. If the loop rotates in a uniform magnetic field of 0.30 T, which is perpendicular to the axis of rotation, what will be the maximum output voltage of this generator?
   A) 220 V       B) 124 V       C) 120√2 V       D) 182 V       E) 167 V

   Page Ref: Sec. 20.2

104) The coil of a generator has 50 loops and a cross-sectional area of 0.25 m^2. What is the maximum emf generated by this generator if it is spinning with an angular velocity of 4.0 rad/s in a 2.0 T magnetic field?
   A) 100. V       B) 400. V       C) 75. V       D) 50. V       E) 0. V

   Page Ref: Sec. 20.2

105) Consider a capacitor connected across the AC supply. The current through the capacitor will _______ as the capacitance is increased.
   A) increase       B) decrease       C) remain constant

   Page Ref: Sec. 21.2

106) A beam of light, traveling in air, strikes a plate of transparent material at an angle of incidence of 56°. It is observed that the reflected and refracted beams form an angle of 90°. What is the index of refraction of this material?
   A) n = 1.40       B) n = 1.53       C) n = 1.48       D) n = 1.44       E) n = 1.43

   Page Ref: Sec. 22.3
107) How far from a lens of focal length 50.0 mm must the object be placed if it is to form a virtual image magnified in size by a factor of three?
   A) 38.3 mm  
   B) 33.3 mm  
   C) 42.2 mm  
   D) 54.4 mm  
   E) 48.0 mm  
   Page Ref: Sec. 23.3

108) What is the slit spacing of a diffraction necessary for a 600 nm light to have a first order principal maximum at 25.0°?
   A) 4.12 μm  
   B) 5.44 μm  
   C) 2.01 μm  
   D) 3.12 μm  
   E) 1.42 μm  
   Page Ref: Sec. 24.3

109) Inductive Reactance is actually a consequence of
   A) Coulomb’s Law.  
   B) Newton’s Law.  
   C) Faraday’s Law.  
   D) Gauss’s Law.  
   Page Ref: Sec. 21.3

110) The focal length of a convex mirror is -20 cm. What is its radius of curvature?
   A) 40 cm  
   B) -10 cm  
   C) -20 cm  
   D) 20 cm  
   E) -40 cm  
   Page Ref: Sec. 23.2

111) A flux of $4 \times 10^{-5}$ Wb is maintained through a coil for 0.5 s. What emf is induced in this coil by this flux?
   A) No emf is induced in this coil.  
   B) $2 \times 10^{-5}$ V  
   C) $6 \times 10^{-5}$ V  
   D) $4 \times 10^{-5}$ V  
   E) $8 \times 10^{-5}$ V  
   Page Ref: Sec. 20.1
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E</td>
<td>51</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>52</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>54</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
<td>55</td>
</tr>
<tr>
<td>6</td>
<td>D</td>
<td>56</td>
</tr>
<tr>
<td>7</td>
<td>C</td>
<td>57</td>
</tr>
<tr>
<td>8</td>
<td>C</td>
<td>58</td>
</tr>
<tr>
<td>9</td>
<td>C</td>
<td>59</td>
</tr>
<tr>
<td>10</td>
<td>C</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>C</td>
<td>61</td>
</tr>
<tr>
<td>12</td>
<td>D</td>
<td>62</td>
</tr>
<tr>
<td>13</td>
<td>C</td>
<td>63</td>
</tr>
<tr>
<td>14</td>
<td>A</td>
<td>64</td>
</tr>
<tr>
<td>15</td>
<td>B</td>
<td>65</td>
</tr>
<tr>
<td>16</td>
<td>A</td>
<td>66</td>
</tr>
<tr>
<td>17</td>
<td>B</td>
<td>67</td>
</tr>
<tr>
<td>18</td>
<td>E</td>
<td>68</td>
</tr>
<tr>
<td>19</td>
<td>B</td>
<td>69</td>
</tr>
<tr>
<td>20</td>
<td>B</td>
<td>70</td>
</tr>
<tr>
<td>21</td>
<td>B</td>
<td>71</td>
</tr>
<tr>
<td>22</td>
<td>A</td>
<td>72</td>
</tr>
<tr>
<td>23</td>
<td>B</td>
<td>73</td>
</tr>
<tr>
<td>24</td>
<td>B</td>
<td>74</td>
</tr>
<tr>
<td>25</td>
<td>D</td>
<td>75</td>
</tr>
<tr>
<td>26</td>
<td>D</td>
<td>76</td>
</tr>
<tr>
<td>27</td>
<td>D</td>
<td>77</td>
</tr>
<tr>
<td>28</td>
<td>A</td>
<td>78</td>
</tr>
<tr>
<td>29</td>
<td>E</td>
<td>79</td>
</tr>
<tr>
<td>30</td>
<td>A</td>
<td>80</td>
</tr>
<tr>
<td>31</td>
<td>A</td>
<td>81</td>
</tr>
<tr>
<td>32</td>
<td>C</td>
<td>82</td>
</tr>
<tr>
<td>33</td>
<td>B</td>
<td>83</td>
</tr>
<tr>
<td>34</td>
<td>E</td>
<td>84</td>
</tr>
<tr>
<td>35</td>
<td>E</td>
<td>85</td>
</tr>
<tr>
<td>36</td>
<td>A</td>
<td>86</td>
</tr>
<tr>
<td>37</td>
<td>C</td>
<td>87</td>
</tr>
<tr>
<td>38</td>
<td>A</td>
<td>88</td>
</tr>
<tr>
<td>39</td>
<td>B</td>
<td>89</td>
</tr>
<tr>
<td>40</td>
<td>A</td>
<td>90</td>
</tr>
<tr>
<td>41</td>
<td>D</td>
<td>91</td>
</tr>
<tr>
<td>42</td>
<td>E</td>
<td>92</td>
</tr>
<tr>
<td>43</td>
<td>B</td>
<td>93</td>
</tr>
<tr>
<td>44</td>
<td>B</td>
<td>94</td>
</tr>
<tr>
<td>45</td>
<td>D</td>
<td>95</td>
</tr>
<tr>
<td>46</td>
<td>D</td>
<td>96</td>
</tr>
<tr>
<td>47</td>
<td>C</td>
<td>97</td>
</tr>
<tr>
<td>48</td>
<td>A</td>
<td>98</td>
</tr>
<tr>
<td>49</td>
<td>D</td>
<td>99</td>
</tr>
<tr>
<td>50</td>
<td>E</td>
<td>100</td>
</tr>
</tbody>
</table>