Multiple Choice Questions for Physics 1 BA113

Chapter 23

Electric Fields

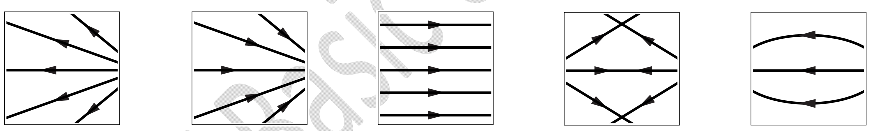
63. When a positive charge q is placed in the field created by two other charges Q_1 and Q_2, each a distance r away from q, the acceleration of q is

a. in the direction of the charge Q_1 or Q_2 of smaller magnitude.
b. in the direction of the charge Q_1 or Q_2 of greater magnitude.
c. in the direction of the negative charge if Q_1 and Q_2 are of opposite sign.
d. in the direction of the positive charge if Q_1 and Q_2 are of opposite sign.
e. in a direction determined by the vector sum of the electric fields of Q_1 and Q_2.

65. Rubber rods charged by rubbing with cat fur repel each other. Glass rods charged by rubbing with silk repel each other. A rubber rod and a glass rod charged respectively as above attract each other. A possible explanation is that

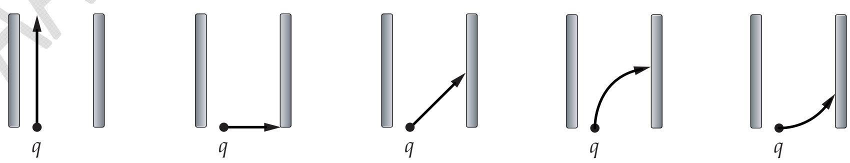
a. Any two rubber rods charged this way have opposite charges on them.
b. Any two glass rods charged this way have opposite charges on them.
c. A rubber rod and a glass rod charged this way have opposite charges on them.
d. All rubber rods always have an excess of positive charge on them.
e. All glass rods always have an excess of negative charge on them.

66. Which one of the diagrams below is *not* a possible electric field configuration for a region of space which does *not* contain any charges?



(a) **(b)** **(c)** **(d)** **(e)**

67. A positively charged particle is moving in the +y-direction when it enters a region with a uniform electric field pointing in the +x-direction. Which of the diagrams below shows its path while it is in the region where the electric field exists. The region with the field is the region between the plates bounding each figure. The field lines always point to the right. The x-direction is to the right; the y-direction is up.



(a) **(b)** **(c)** **(d)** **(e)**

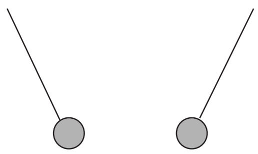
69. The symbol $k = \frac{1}{4\pi\varepsilon_0}$ appears in Coulomb's law because we use independently defined units for

a. force and distance.
b. charge and distance.
c. distance and force.
d. force, distance and electric charge.
e. charge.

71. Three pith balls supported by insulating threads hang from a support. We know that ball X is positively charged. When ball X is brought near balls Y and Z without touching them, it attracts Y and repels Z. We can conclude that

a. Y is neutral (has no net charge.)
b. Z has a negative charge.
c. Y has a positive charge.
d. Z is neutral (has no net charge.)
e. Y is negatively charged or neutral (has no net charge.)

72. Two identical pith balls supported by insulating threads hang side by side and close together, as shown below.



One is positively charged; the other is neutral. We can conclude that

a. all field lines leaving the positively charged pith ball end on the neutral pith ball.
b. some of the field lines leaving the positively charged pith ball end on the neutral pith ball.
c. none of the field lines leaving the positively charged pith ball end on the neutral pith ball.
d. positive charge is transferred along the field lines until both balls have equal charges.
e. positive charge is transferred along the field lines until both balls hang along vertical lines.

79. A uniform electric field $\vec{\mathbf{E}}_{\mathrm{I}}$ is present in the region between the infinite parallel planes of charge, A and B, and a uniform electric field $\vec{\mathbf{E}}_{\mathrm{II}}$ is present in the region between the infinite parallel planes of charge B and C. When the planes are vertical and the fields are both non-zero,

a. $\vec{\mathbf{E}}_{\mathrm{I}}$ and $\vec{\mathbf{E}}_{\mathrm{II}}$ are both directed to the right.
b. $\vec{\mathbf{E}}_{\mathrm{I}}$ and $\vec{\mathbf{E}}_{\mathrm{II}}$ are both directed to the left.
c. $\vec{\mathbf{E}}_{\mathrm{I}}$ points to the right and $\vec{\mathbf{E}}_{\mathrm{II}}$ to the left.
d. $\vec{\mathbf{E}}_{\mathrm{I}}$ points to the left and $\vec{\mathbf{E}}_{\mathrm{II}}$ to the right.
e. Any one of the above is possible.

Chapter 25

Electric Potential

65. Equipotentials are lines along which

- **a.** the electric field is constant in magnitude and direction.
- **b.** the electric charge is constant in magnitude and direction.
- **c.** maximum work against electrical forces is required to move a charge at constant speed.
- **d.** a charge may be moved at constant speed without work against electrical forces.
- **e.** charges move by themselves.

67. When a positive charge is released and moves along an electric field line, it moves to a position of

- **a.** lower potential and lower potential energy.
- **b.** lower potential and higher potential energy.
- **c.** higher potential and lower potential energy.
- **d.** higher potential and higher potential energy.
- **e.** greater magnitude of the electric field.

68. When a negative charge is released and moves along an electric field line, it moves to a position of

- **a.** lower potential and lower potential energy.
- **b.** lower potential and higher potential energy.
- **c.** higher potential and lower potential energy.
- **d.** higher potential and higher potential energy.
- **e.** decreasing magnitude of the electric field.

82. When introduced into a region where an electric field is present, an electron with initial velocity $\vec{\mathbf{v}}$ will always move

- **a.** along an electric field line, in the positive direction of the line.
- **b.** along an electric field line, in the negative direction of the line.
- **c.** from a point at a positive potential to a point at a negative potential.
- **d.** from a point at a negative potential to a point at a positive potential.
- **e.** as described in both (b) and (d).

83. When introduced into a region where an electric field is present, an proton with initial velocity $\vec{\mathbf{v}}$ will always move

- **a.** along an electric field line, in the positive direction of the line.
- **b.** along an electric field line, in the negative direction of the line.
- **c.** from a point at a positive potential to a point at a negative potential.
- **d.** from a point at a negative potential to a point at a positive potential.
- **e.** as described in both (a) and (c).

84. A system consisting of a positively-charged particle and an electric field

a. loses potential difference and kinetic energy when the charged particle moves in the direction of the field.
b. loses electric potential energy when the charged particle moves in the direction of the field.
c. loses kinetic energy when the charged particle moves in the direction of the field.
d. gains electric potential energy when the charged particle moves in the direction of the field.
e. gains potential difference and electric potential energy when the charged particle moves in the direction of the field.

85. A system consisting of a negatively-charged particle and an electric field

a. gains potential difference and kinetic energy when the charged particle moves in the direction of the field.
b. loses electric potential energy when the charged particle moves in the direction of the field.
c. gains kinetic energy when the charged particle moves in the direction of the field.
d. gains electric potential energy when the charged particle moves in the direction of the field.
e. gains potential difference and electric potential energy when the charged particle moves in the direction of the field.

89. An electron is released form rest in a region of space where a uniform electric field is present. Joanna claims that its kinetic and potential energies both increase as it moves from its initial position to its final position. Sonya claims that they both decrease. Which one, if either, is correct?

a. Joanna, because the electron moves opposite to the direction of the field.
b. Sonya, because the electron moves opposite to the direction of the field.
c. Joanna, because the electron moves in the direction of the field.
d. Sonya, because the electron moves in the direction of the field.
e. Neither, because the kinetic energy increases while the electron moves to a point at a higher potential.

Chapter 26

Capacitance and Dielectrics

36. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. It is then disconnected from the battery and the plates are pulled apart to a separation $2d$ without discharging them. After the plates are $2d$ apart, the magnitude of the charge on the plates and the potential difference between them are

a. $\frac{1}{2}Q_0, \frac{1}{2}V_0$

b. $Q_0, \frac{1}{2}V_0$

c. Q_0, V_0

d. $Q_0, 2V_0$

e. $2Q_0, 2V_0$

37. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. It is then disconnected from the battery and the plates are pulled apart to a separation $2d$ without discharging them. After the plates are $2d$ apart, the new capacitance and the potential difference between the plates are

a. $\frac{1}{2}C_0, \frac{1}{2}V_0$

b. $\frac{1}{2}C_0, V_0$

c. $\frac{1}{2}C_0, 2V_0$

d. $C_0, 2V_0$

e. $2C_0, 2V_0$

38. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. The plates are pulled apart to a separation $2d$ while the capacitor remains connected to the battery. After the plates are $2d$ apart, the magnitude of the charge on the plates and the potential difference between them are

a. $\frac{1}{2}Q_0, \frac{1}{2}V_0$

b. $\frac{1}{2}Q_0, V_0$

c. Q_0, V_0

d. $2Q_0, V_0$

e. $2Q_0, 2V_0$

39. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. The plates are pulled apart to a separation $2d$ while the capacitor remains connected to the battery. After the plates are $2d$ apart, the capacitance of the capacitor and the magnitude of the charge on the plates are

a. $\frac{1}{2}C_0, \frac{1}{2}Q_0$
b. $\frac{1}{2}C_0, Q_0$
c. C_0, Q_0
d. $2C_0, Q_0$
e. $2C_0, 2Q_0$

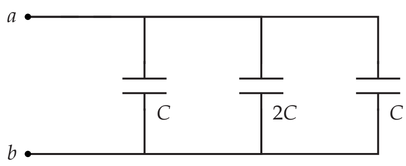
40. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. While it is connected to the battery the space between the plates is filled with a material of dielectric constant 3. After the dielectric is added, the magnitude of the charge on the plates and the potential difference between them are

a. $\frac{1}{3}Q_0, \frac{1}{3}V_0$
b. $Q_0, \frac{1}{3}V_0$
c. Q_0, V_0
d. $3Q_0, V_0$
e. $3Q_0, 3V_0$

41. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. While it is connected to the battery, the space between the plates is filled with a material of dielectric constant 3. After the dielectric is added, the magnitude of the charge on the plates and the new capacitance are

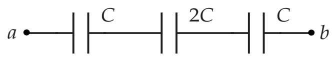
a. $\frac{1}{3}Q_0, \frac{1}{3}C_0$
b. $Q_0, \frac{1}{3}C_0$
c. Q_0, C_0
d. $3Q_0, C_0$
e. $3Q_0, 3C_0$

42. The equivalent capacitance of the circuit shown below is



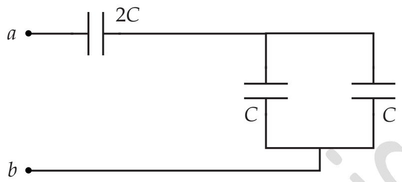
a. 0.2 C.
b. 0.4 C.
c. 1 C.
d. 4 C.
e. 5 C.

43. The equivalent capacitance of the circuit shown below is



a. 0.2 C.
b. 0.4 C.
c. 1 C.
d. 4 C.
e. 5 C.

44. The equivalent capacitance of the circuit shown below is



a. 0.50 C.
b. 1.0 C.
c. 1.5 C.
d. 2.0 C.
e. 2.5 C.

46. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. It is then disconnected from the battery and the space between the plates is filled with a material of dielectric constant 3. After the dielectric is added, the magnitudes of the charge on the plates and the potential difference between them are

a. $\frac{1}{3}Q_0, \frac{1}{3}V_0$.
b. $Q_0, \frac{1}{3}V_0$.
c. Q_0, V_0.
d. $Q_0, 3V_0$.
e. $3Q_0, 3V_0$.

47. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. It is then disconnected from the battery and the space between the plates is filled with a material of dielectric constant 3. After the dielectric is added, the magnitudes of the capacitance and the potential difference between the plates are

a. $\frac{1}{3}C_0, \frac{1}{3}V_0$.

b. $C_0, \frac{1}{3}V_0$.

c. C_0, V_0.

d. $3C_0, \frac{1}{3}V_0$.

e. $3C_0, 3V_0$.

48. An initially uncharged parallel plate capacitor of capacitance *C* is charged to potential *V* by a battery. The battery is then disconnected. Which statement is correct?

a. There is no charge on either plate of the capacitor.
b. The capacitor can be discharged by grounding any one of its two plates.
c. Charge is distributed evenly over both the inner and outer surfaces of the plates.
d. The magnitude of the electric field outside the space between the plates is approximately zero.
e. The capacitance increases when the distance between the plates increases.

52. A parallel plate capacitor is charged to voltage *V* and then disconnected from the battery. Leopold says that the voltage will decrease if the plates are pulled apart. Gerhardt says that the voltage will remain the same. Which one, if either, is correct, and why?

a. Gerhardt, because the maximum voltage is determined by the battery.
b. Gerhardt, because the charge per unit area on the plates does not change.
c. Leopold, because charge is transferred from one plate to the other when the plates are separated.
d. Leopold, because the force each plate exerts on the other decreases when the plates are pulled apart.
e. Neither, because the voltage increases when the plates are pulled apart.

54. A parallel plate capacitor is connected to a battery and charged to voltage *V*. Leah says that the charge on the plates will decrease if the distance between the plates is increased while they are still connected to the battery. Gertie says that the charge will remain the same. Which one, if either, is correct, and why?

a. Gertie, because the maximum voltage is determined by the battery.
b. Gertie, because the capacitance of the capacitor does not change.
c. Leah, because the capacitance decreases when the plate separation is increased.
d. Leah, because the capacitance increases when the plate separation is increased.
e. Neither, because the charge increases when the plate separation is increased.

Chapter 27

Current and Resistance

24. Light bulb A is rated at 60 W and light bulb B is rated at 100 W. Both are designed to operate at 110 V. Which statement is correct?

- **a.** The 60 W bulb has a greater resistance and greater current than the 100 W bulb.
- **b.** The 60 W bulb has a greater resistance and smaller current than the 100 W bulb.
- **c.** The 60 W bulb has a smaller resistance and smaller current than the 100 W bulb.
- **d.** The 60 W bulb has a smaller resistance and greater current than the 100 W bulb.
- **e.** We need to know the resistivities of the filaments to answer this question.

25. Jadeen says that you can increase the resistance of a copper wire by hammering the wire to make it narrower and longer. Arnell says that you can increase its resistance by heating the wire. Which one, if either, is correct, and why?

- **a.** Arnell, because the conductivity of the wire increases when it is heated.
- **b.** Arnell, because the conductivity of the wire decreases when it is heated.
- **c.** Jadeen, because the conductivity of a wire is directly proportional to its area and inversely proportional to its length.
- **d.** Jadeen, because the conductivity of a copper wire does not increase and might decrease when it is hammered.
- **e.** Both are correct because (b) and (d) are both correct.

27. A cook plugs a 500 W crockpot and a 1000 W kettle into a 240 V power supply, all operating on direct current. When we compare the two, we find that

- **a.** $I_{crockpot} < I_{kettle}$ and $R_{crockpot} < R_{kettle}$.
- **b.** $I_{crockpot} < I_{kettle}$ and $R_{crockpot} > R_{kettle}$.
- **c.** $I_{crockpot} = I_{kettle}$ and $R_{crockpot} = R_{kettle}$.
- **d.** $I_{crockpot} > I_{kettle}$ and $R_{crockpot} < R_{kettle}$.
- **e.** $I_{crockpot} > I_{kettle}$ and $R_{crockpot} > R_{kettle}$.

28. To increase the current density in a wire of length ℓ and diameter D, you can

- **a.** decrease the potential difference between the two ends of the wire.
- **b.** increase the potential difference between the two ends of the wire.
- **c.** decrease the magnitude of the electric field in the wire.
- **d.** heat the wire to a higher temperature.
- **e.** combine both (b) and (d).

Chapter 28

Direct Current Circuits

56. In a loop in a closed circuit, the sum of the currents entering a junction equals the sum of the currents leaving a junction because

a. the potential of the nearest battery is the potential at the junction.
b. there are no transformations of energy from one type to another in a circuit loop.
c. capacitors tend to maintain current through them at a constant value.
d. current is used up after it leaves a junction.
e. charge is neither created nor destroyed at a junction.

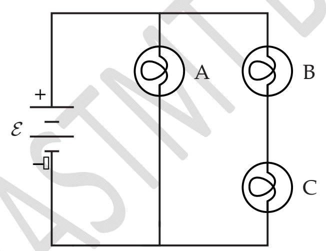
57. When a capacitor is fully charged, the current through the capacitor is

a. zero.
b. at its maximum value.
c. equal to the current in a resistive circuit in parallel with the capacitor circuit.
d. greater than the current in a resistor that is farther from the battery than the capacitor.
e. zero if it is the only capacitor, but maximum if there is another capacitor in series with it.

58. The algebraic sum of the changes of potential around any closed circuit loop is

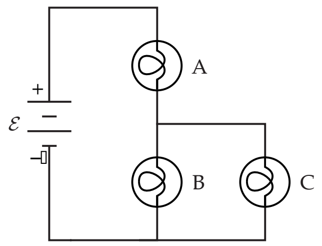
a. zero.
b. maximum.
c. zero only if there are no sources of emf in the loop.
d. maximum if there are no sources of emf in the loop.
e. equal to the sum of the currents in the branches of the loop.

59. The circuit below contains three 100W light bulbs. The emf $\mathcal{E}$ = 110 V. Which light bulb(s) is(are) brightest?



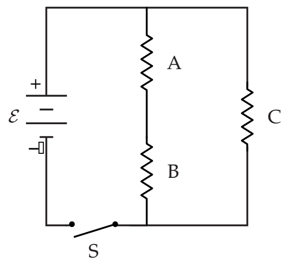
a. A
b. B
c. C
d. B and C
e. All three are equally bright.

60. The circuit below contains three 100 watt light bulbs. The emf $\mathcal{E}$ = 110 V. Which light bulb(s) is(are) the brightest?



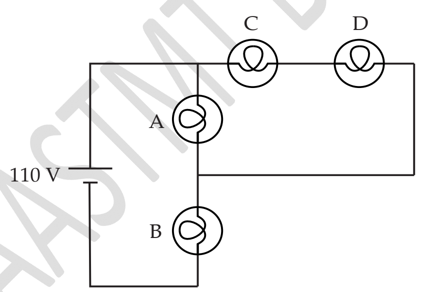
a. A
b. B
c. C
d. B and C
e. All three are equally bright.

63. The circuit below contains three resistors, A, B, and C, which all have equal resistances. The emf $\mathcal{E}$ = 110V. Which resistor generates the most thermal energy after the switch is closed?



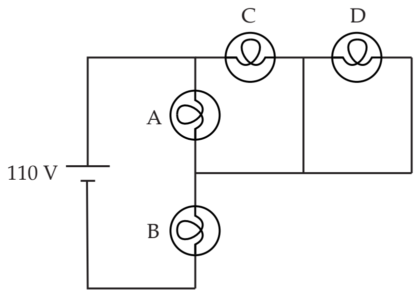
a. A
b. B
c. C
d. A and B
e. All three generate equal amounts of thermal energy.

66. The circuit below contains 4 light bulbs. The emf is 110 V. Which light bulb(s) is(are) brightest?



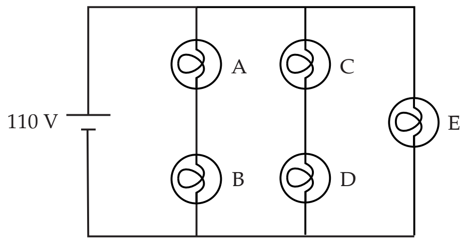
a. A
b. B
c. C
d. D
e. C and D

67. The circuit below contains 4 light bulbs. The emf is 110 V. Which light bulb(s) is(are) brightest?



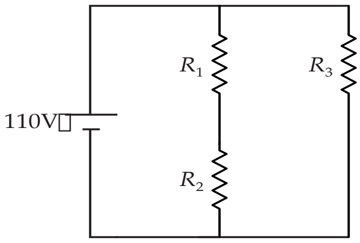
a. A
b. B
c. C
d. D
e. **C and D**

70. The circuit below contains 5 light bulbs. The emf is 110 V. Which light bulb(s) is(are) brightest?

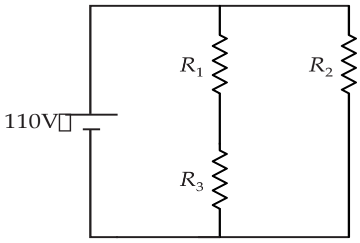


a. A: The one closest to the positive terminal of the battery.
b. A and C: The bulbs closest to the positive terminal of the battery.
c. A and B: Because they are closest to the terminals of the battery.
d. C and D: Because they receive current from A and B and from E.
e. E: Because the potential difference across E is that of the battery.

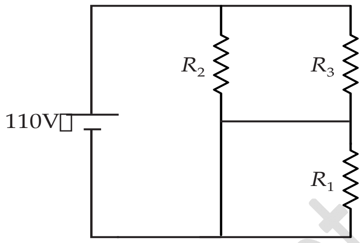
73. Which two circuits are exactly equivalent?



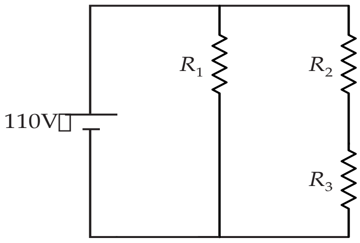
A



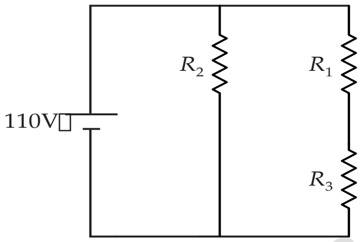
B



C



D



E

a. A and B
b. B and C
c. C and D
d. D and E
e. B and E

Chapter 29

Magnetic Fields

4. An electron moving in the positive x direction experiences a magnetic force in the positive z direction. If $B_x = 0$, what is the direction of the magnetic field?

a. negative y direction
b. positive y direction
c. negative z direction
d. positive z direction
e. negative x direction

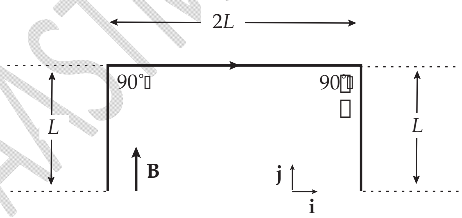
9. A positively charged particle has a velocity in the negative z direction at point P. The magnetic force on the particle at this point is in the negative y direction. Which one of the following statements about the magnetic field at point P can be determined from this data?

a. B_x is positive.
b. B_z is positive.
c. B_y is negative.
d. B_y is positive.
e. B_x is negative.

11. A charged particle (mass = M, charge = $Q > 0$) moves in a region of space where the magnetic field has a constant magnitude of B and a downward direction. What is the magnetic force on the particle at an instant when it is moving horizontally toward the north with speed V?

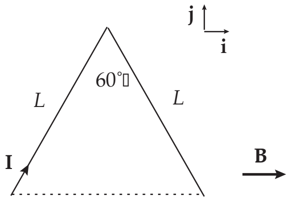
a. QVB toward the east
b. Zero
c. QVB toward the west
d. QVB upward
e. QVB toward the south

19. A straight wire is bent into the shape shown. Determine the net magnetic force on the wire when the current I travels in the direction shown in the magnetic field **B**.



a. $2IBL$ in the $-z$ direction
b. $2IBL$ in the $+z$ direction
c. $4IBL$ in the $+z$ direction
d. $4IBL$ in the $-z$ direction
e. zero

20. A straight wire is bent into the shape shown. Determine the net magnetic force on the wire.



a. Zero
b. *IBL* in the +*z* direction
c. *IBL* in the –*z* direction
d. 1.7 *IBL* in the +*z* direction
e. 1.4 *IBL* in the –*z* direction

54. Equal charges, one at rest, the other having a velocity of 10^4 m/s, are released in a uniform magnetic field. Which charge has the largest force exerted on it by the magnetic field?

a. The charge that is at rest.
b. The charge that is moving, if its velocity is parallel to the magnetic field direction when it is released.
c. The charge that is moving if its velocity makes an angle of 45° with the direction of the magnetic field when it is released.
d. The charge that is moving if its velocity is perpendicular to the magnetic field direction when it is released.
e. All the charges above experience equal forces when released in the same magnetic field.

55. Three particles of equal charge, X, Y, and Z, enter a uniform magnetic field **B**. X has velocity of magnitude *v* parallel to the field. Y has velocity of magnitude *v* perpendicular to the field. Z has equal velocity components *v* parallel and perpendicular to the field. Rank the radii of their orbits from least to greatest.

a. $R_x = R_y < R_z$.
b. $R_x < R_y < R_z$.
c. $R_x = R_y = R_z$.
d. $R_x > R_y > R_z$.
e. $R_x < R_y = \sqrt{2} \times R_z$.

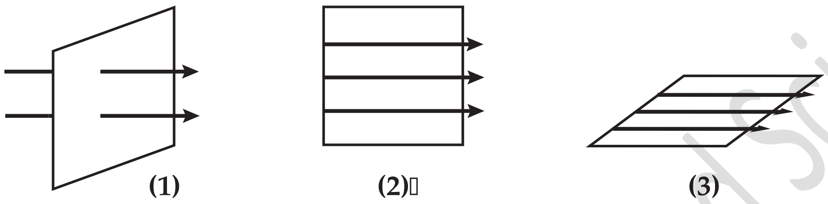
56. One reason why we know that magnetic fields are not the same as electric fields is because the force exerted on a charge +*q*

a. is in opposite directions in electric and magnetic fields.
b. is in the same direction in electric and magnetic fields.
c. is parallel to a magnetic field and perpendicular to an electric field.
d. is parallel to an electric field and perpendicular to a magnetic field.
e. is zero in both if the charge is not moving.

57. You stand near the earth's equator. A positively charged particle that starts moving parallel to the surface of the earth in a straight line directed east is initially deflected upwards. If you know there are no electric fields in the vicinity, a possible reason why the particle does not initially acquire a downward component of velocity is because near the equator the magnetic field lines of the earth are directed

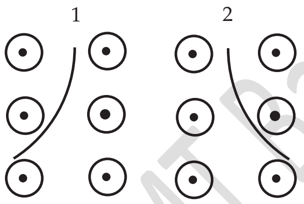
- **a.** upward.
- **b.** downward.
- **c.** from south to north.
- **d.** from north to south.
- **e.** from east to west.

58. A current loop is oriented in three different positions relative to a uniform magnetic field. In position 1 the plane of the loop is perpendicular to the field lines. In position 2 and 3 the plane of the loop is parallel to the field as shown. The torque on the loop is maximum in



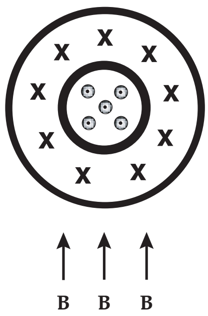
- **a.** position 1.
- **b.** position 2.
- **c.** position 3
- **d.** positions 2 and 3.
- **e.** all three positions.

59. A magnetic field is directed out of the page. Two charged particles enter from the top and take the paths shown in the figure. Which statement is correct?



- **a.** Particle 1 has a positive charge and particle 2 has a negative charge.
- **b.** Both particles are positively charged.
- **c.** Both particles are negatively charged.
- **d.** Particle one has a negative charge and particle 2 has a positive charge.
- **e.** The direction of the paths depends on the magnitude of the velocity, not on the sign of the charge.

60. A coaxial cable has an inner cylindrical conductor surrounded by cylindrical insulation and an outer cylindrical conducting shell. The outer shell carries the same current but in the opposite direction from that in the inner conductor as shown. If the coaxial cable sits in a uniform magnetic field directed upwards with respect to the cable, the effect of the field on the cable is



a. a net force to the left.
b. a net force to the right.
c. a net force upwards.
d. no net force but a slight shift of the inner conductor to the left and the outer conductor to the right.
e. no net force but a slight shift of the inner conductor to the right and the outer conductor to the left.

61. The diagram below shows the position of a long straight wire perpendicular to the page and a set of directions labeled A through H.

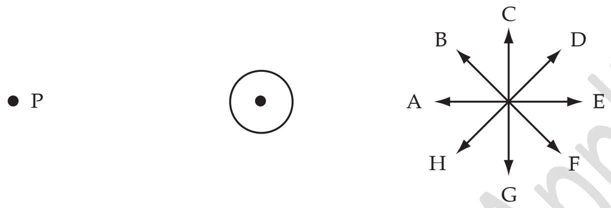
When the current in the wire is directed up out of the page, the direction of the magnetic field at point P is

a. A.
b. B.
c. C.
d. D.
e. E.

62. The diagram below shows the position of a long straight wire perpendicular to the page and a set of directions labeled A through H. When the current in the wire is directed up out of the page, the direction of the magnetic field at point P is

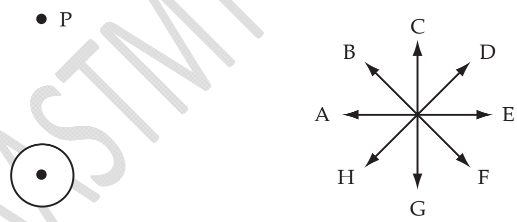
a. D.
b. E.
c. F.
d. G.
e. H.

63. The diagram below shows the position of a long straight wire perpendicular to the page and a set of directions labeled A through H. When the current in the wire is directed up out of the page, the direction of the magnetic field at point P is



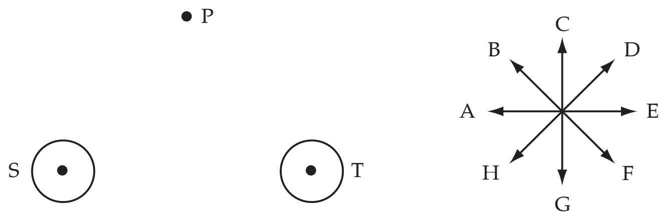
a. E.
b. F.
c. G.
d. H.
e. A.

64. The diagram below shows the position of a long straight wire perpendicular to the page and a set of directions labeled A through H. When the current in the wire is directed up out of the page, the direction of the magnetic field at point P is



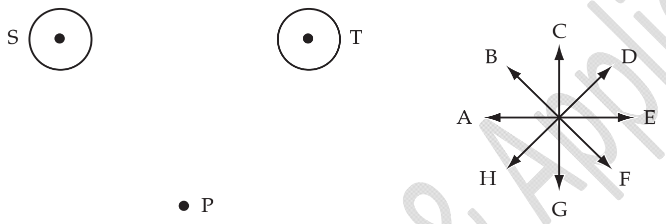
a. E.
b. F.
c. G.
d. H.
e. A.

65. The point P lies along the perpendicular bisector of the line connecting two long straight wires S and T that are perpendicular to the page. A set of directions A through H is shown next to the diagram. When the two equal currents in the wires are directed up out of the page, the direction of the magnetic field at P is closest to the direction of



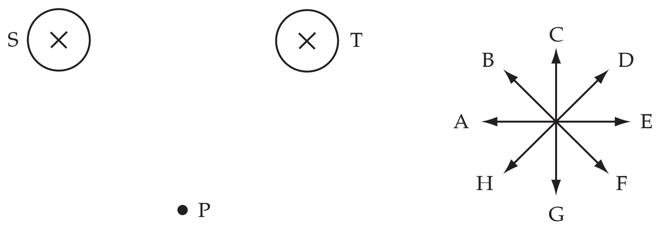
a. E.
b. F.
c. G.
d. H.
e. A

66. The point P lies along the perpendicular bisector of the line connecting two long straight wires S and T perpendicular to the page. A set of directions A through H is shown next to the diagram. When the two equal currents in the wires are directed up out of the page, the direction of the magnetic field at P is closest to the direction of



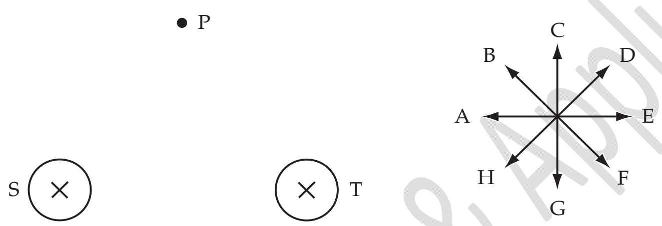
a. E.
b. F.
c. G.
d. H.
e. A.

67. The point P lies along the perpendicular bisector of the line connecting two long straight wires S and T perpendicular to the page. A set of directions A through H is shown next to the diagram. When the two equal currents in the wires are directed into the page, the direction of the magnetic field at P is closest to the direction of



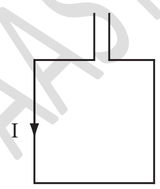
- **a.** E.
- **b.** F.
- **c.** G.
- **d.** H.
- **e.** A.

68. The point P lies along the perpendicular bisector of the line connecting two long straight wires S and T perpendicular to the page. A set of directions A through H is shown next to the diagram. When the two equal currents in the wires are directed into the page, the direction of the magnetic field at P is closest to the direction of



- **a.** A
- **b.** B.
- **c.** C.
- **d.** D.
- **e.** E.

69. The magnetic field in a region of space is parallel to the surface of a long flat table. Imagine that this page is lying flat on the table. When current is present in the coil, which is lying on the table, the coil tends to rotate so that the left side moves up and the right side moves down. The magnetic field is



- **a.** directed parallel to the page and downwards.
- **b.** directed parallel to the page and upwards.
- **c.** directed parallel to the page and to the right.
- **d.** directed parallel to the page and to the left.
- **e.** in a direction that cannot be determined in this experiment

70. A charged particle (mass = M, charge = $Q > 0$) moves in a region of space where the magnetic field has a constant magnitude of B and a downward direction. What is the magnetic force on the particle at an instant when it is moving horizontally toward the north with a speed V?

- **a.** QVB toward the east
- **b.** Zero
- **c.** QVB toward the west
- **d.** QVB upward
- **e.** QVB toward the south

71. An explorer walks into a lab in a science building. She has a compass in her hand and finds that the south pole of her compass points toward the room's East wall when she is nearer that wall and toward the west wall when she is nearer that wall. You could explain this if magnetized metal had been installed in the East and West walls with North poles pointing into the room. If no magnetic material was installed in the North or South walls of the room, she would expect that

- **a.** the south pole of the compass would tend to point toward those walls.
- **b.** the north pole of the compass would tend to point toward those walls.
- **c.** the compass needle would not point in any particular direction.
- **d.** the north pole of the compass needle would tend to point toward the centers of those walls, but the south pole would tend to point toward the sides of those walls.
- **e.** the south pole of the compass needle would tend to point toward the centers of those walls, but the north pole would tend to point toward the sides of those walls.

72. Charlotte says that you can use a voltmeter to find the current direction in a wire if you can't see the terminals it is connected to. Bonnie says that an ammeter will do. Finally, Rita says that you can bring the north pole of a magnet up to the wire and determine the current direction from the direction of the magnetic force on the wire. Which one(s), if any, is(are) correct?

- **a.** All three are correct.
- **b.** Charlotte and Rita are correct, but Bonnie is wrong.
- **c.** Bonnie and Rita are correct, but Charlotte is wrong.
- **d.** Charlotte and Bonnie are correct, but Rita is wrong.
- **e.** Only Rita is correct.

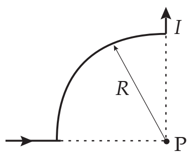
76. Bert says that a charged particle in a vacuum can travel in a helix only if a uniform electric field and a uniform magnetic field are both present and both parallel to the axis of the helix. Stuart says that only a magnetic field with a component parallel to the axis of the helix is needed. Which one, if either, is correct, and why?

- **a.** Bert, because the charged particle's velocity can have a vertical component only if an electric field in the vertical direction is present.
- **b.** Stuart, because a component of velocity in the vertical direction is not changed by a vertical component of a magnetic field.
- **c.** Bert, because a component of velocity in the vertical direction is changed by a vertical component of a magnetic field.
- **d.** Stuart, because an electric field in the vertical direction would cause the particle to come to a complete stop.
- **e.** Neither, because particles cannot move in helical paths in the presence of magnetic and electric fields.

Chapter 30

Sources of the Magnetic Field

22. The segment of wire (total length = $6R$) is formed into the shape shown and carries a current I. What is the magnitude of the resulting magnetic field at the point P?



a. $\frac{\mu_0 I}{8R}$

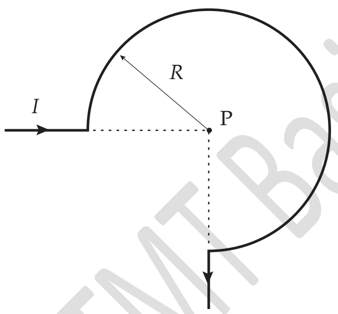
b. $\frac{\mu_0 I}{2R}$

c. $\frac{\mu_0 I}{4R}$

d. $\frac{\mu_0 I}{2\pi R}$

e. $\frac{\mu_0 \pi I}{8R}$

23. The segment of wire (total length = $6R$) is formed into the shape shown and carries a current I. What is the magnitude of the resulting magnetic field at the point P?



a. $\frac{3\mu_0 I}{8R}$

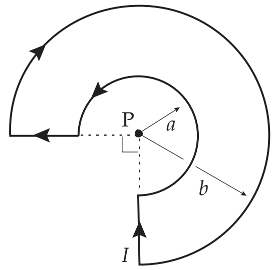
b. $\frac{3\mu_0 I}{2R}$

c. $\frac{3\mu_0 I}{4R}$

d. $\frac{3\mu_0 I}{2R}$

e. $\frac{3\mu_0 \pi I}{8R}$

24. What is the magnitude of the magnetic field at point P if $a = R$ and $b = 2R$?



a. $\frac{9\mu_0 I}{16R}$

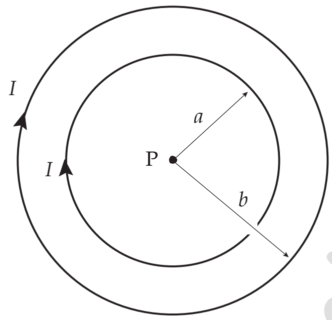
b. $\frac{3\mu_0 I}{16R}$

c. $\frac{\mu_0 I}{4R}$

d. $\frac{3\mu_0 I}{4R}$

e. $\frac{3\mu_0 I}{8R}$

25. What is the magnitude of the magnetic field at point P if $a = R$ and $b = 2R$?



a. $\frac{3\mu_0 I}{4R}$

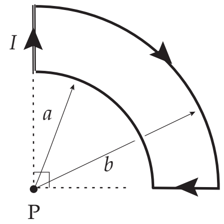
b. $\frac{\mu_0 I}{4R}$

c. $\frac{2\mu_0 I}{3R}$

d. $\frac{\mu_0 I}{3R}$

e. $\frac{3\mu_0 \pi I}{4R}$

26. What is the magnitude of the magnetic field at point P if $a = R$ and $b = 2R$?



a. $\frac{\mu_0 I}{6R}$
b. $\frac{3\mu_0 I}{16R}$
c. $\frac{\mu_0 I}{12R}$
d. $\frac{\mu_0 I}{16R}$
e. $\frac{\mu_0 I}{32R}$

62. By using a compass to measure the magnetic field direction at various points adjacent to a long straight wire, you can show that the wire's magnetic field lines are

a. straight lines in space that go from one magnetic charge to another.
b. straight lines in space that are parallel to the wire.
c. straight lines in space that are perpendicular to the wire.
d. circles that have their centers on the wire and lie in planes perpendicular to the wire.
e. circles that have the wire lying along a diameter of the circle.

63. The reason the north pole of a bar magnet free to rotate points north is because

a. the south geographic pole of the earth is the earth's magnetic north pole.
b. the south geographic pole of the earth is the earth's magnetic south pole.
c. there is a net accumulation of negative magnetic charge at the earth's south geographic pole.
d. there is a net accumulation of positive magnetic charge at the earth's north geographic pole.
e. the north geographic pole of the earth is the earth's magnetic north pole.

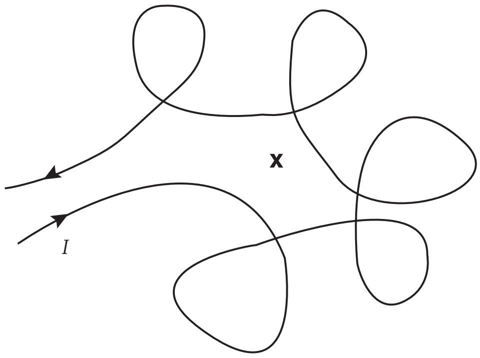
64. The following statements all refer to the human brain when mental activity is occurring. Which statement is correct?

a. In order to detect electric currents in the brain, you must open the skull and make direct electrical contact with the brain.
b. The electric currents in the brain can be detected outside the brain by detecting the magnetic fields they produce.
c. The electric currents in the brain can be mapped by shaving a person's head and dropping iron filings on the head.
d. The electric currents in the brain produce an aura that can be detected visually.
e. The electric currents in the brain cannot be detected by any means.

65. At a point in space where the magnetic field is measured, the magnetic field produced by a current element

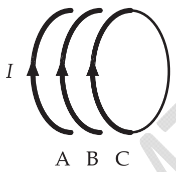
- **a.** points radially away in the direction from the current element to the point in space.
- **b.** points radially in the direction from the point in space towards the current element.
- **c.** points in a direction parallel to the current element.
- **d.** points in a direction parallel to but opposite in direction to the current element.
- **e.** points in a direction that is perpendicular to the current element and perpendicular to the radial direction.

66. A long wire lies in a tangle on the surface of a table, as shown below. When a current is run through the wire as shown, the largest component of the magnetic field at X points



- **a.** into the table.
- **b.** out of the table.
- **c.** parallel to the nearest segment of wire.
- **d.** antiparallel to the nearest segment of wire.
- **e.** along a circle which has its center at the center of the overall loop.

67. A solenoid consists of 100 circular turns of copper wire. Parts of three turns, A, B and C, are shown below.



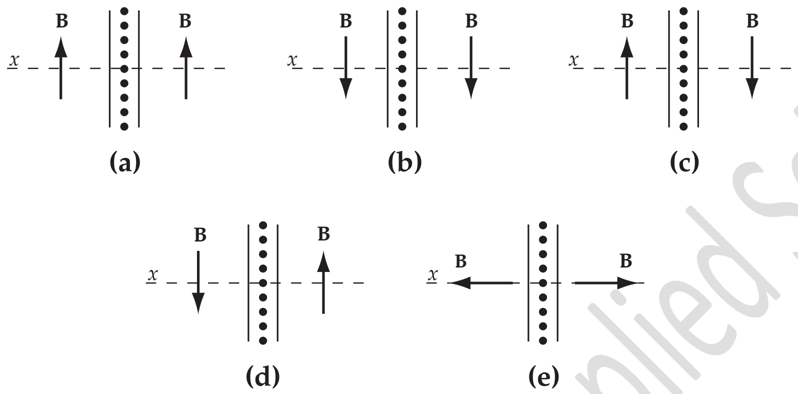
When a current flows through the coil,

- **a.** both A and C are repelled by B.
- **b.** A is attracted to B; C is repelled by B.
- **c.** neither A nor C is attracted to or repelled by B.
- **d.** A is repelled by B; C is attracted to B.
- **e.** both A and C are attracted to B.

68. When a microwave filter consisting of vertical parallel metal rods is in the absorbing position, oscillating currents are set up in the rods. At any one instant, the current in each rod has the same magnitude and direction. At that instant

- **a.** the rods will try to move apart horizontally.
- **b.** the rods will try to move together horizontally.
- **c.** the rods will try to shift vertically upwards.
- **d.** the rods will try to shift vertically downwards.
- **e.** the rods will not be affected because the source of current is not a battery.

73. A thin infinitely large current sheet lies in the *y*-*z* plane. Current of magnitude J_s per unit length along the *z* axis travels in the *y*-axis direction, which is up out of the page. Which diagram below correctly represents the direction of the magnetic field on either side of the sheet?



74. The magnetic moment of an electron (charge = $-e$; mass = m_e) moving in a circular orbit of radius r with speed v about a nucleus of mass m_N is proportional to

- **a.** r.
- **b.** v.
- **c.** vr.
- **d.** evr.
- **e.** $m_N vr$.

75. The magnetic field strength **H** within a solenoid with n turns per unit length (length = ℓ) and current I has magnitude H equal to

- **a.** nI.
- **b.** $\mu_0 nI$.
- **c.** $(1+\mu_0)nI$.
- **d.** $\frac{nI}{\ell}$.
- **e.** $\frac{\mu_0 nI}{\ell}$.

76. On the average, in a ferromagnetic domain permanent atomic magnetic moments are aligned _____ to one another.

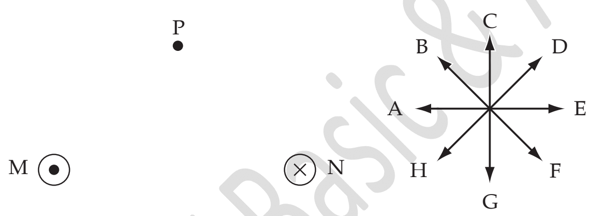
a. antiparallel
b. parallel
c. perpendicular
d. alternately parallel and antiparallel
e. randomly relative

77. Equal currents of magnitude *I* travel out of the page in wires M and N. Eight directions are indicated by letters A through H.

The direction of the magnetic field at point P is

a. E.
b. F.
c. G.
d. H.
e. A.

78. Equal currents of magnitude *I* travel out of the page in wire M and into the page in wire N. Eight directions are indicated by letters A through H.



The direction of the magnetic field at point P is

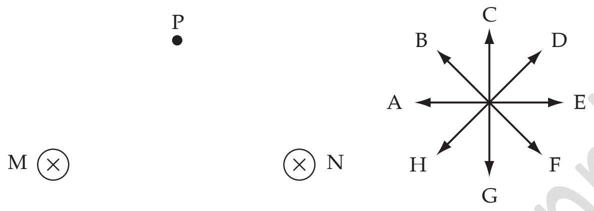
a. A.
b. B.
c. C.
d. D.
e. E.

79. Equal currents of magnitude *I* travel into the page in wire M and out of the page in wire N. Eight directions are indicated by letters A through H.

The direction of the magnetic field at point P is

- **a.** C.
- **b.** E.
- **c.** F.
- **d.** G.
- **e.** H.

80. Equal currents of magnitude *I* travel into the page in wires M and N. Eight directions are indicated by letters A through H.



The direction of the magnetic field at point P is

- **a.** B.
- **b.** C.
- **c.** D.
- **d.** E.
- **e.** F.

81. Lara says that the magnetic field outside an infinitely long solenoid would be no larger than the field caused by a single winding. Meara says that it is zero, because the magnetic field is confined to the inside of an infinite solenoid. Which one, if either, is correct, and why?

- **a.** Meara, because each loop in an adjacent pair of windings cancels out the magnetic field of the other.
- **b.** Lara, because each loop in an adjacent pair of windings cancels out the magnetic field of the other.
- **c.** Meara, because the magnetic fields from loops of wire at equal distances from a given loop cancel at the position of that loop.
- **d.** Lara, because the magnetic fields from loops of wire at equal distances from a given loop cancel at the position of that loop.
- **e.** Neither. They are both wrong because the field outside the solenoid is directly proportional to the distance between the windings.

82. If you were to travel parallel to an infinitely long straight wire with current I at the same velocity as the electrons in the wire at a distance a from the wire, the magnitude of the magnetic field (according to your measuring instruments) would be

a. 0.

b. $\frac{\mu_0 I}{2\pi a}$.

c. $\frac{\mu_0 I}{\pi a}$.

d. $\frac{2\mu_0 I}{\pi a}$.

e. $\frac{4\mu_0 I}{\pi a}$.

83. Two parallel and coaxial current loops of radius a are placed a distance L apart. The current in each ring circulates in the same direction. At a point on the axis half way between the loops the magnetic field in T has magnitude

a. 0.

b. $\frac{\mu_0 I a^2}{4(a^2+L^2)^{3/2}}$.

c. $\frac{\mu_0 I a^2}{2(a^2+L^2)^{3/2}}$.

d. $\frac{\mu_0 I a^2}{(a^2+L^2)^{3/2}}$.

e. $\frac{2\mu_0 I}{L}$.

84. Two parallel and coaxial current loops of radius a are placed a distance L apart. When you look along the axis at the loops, the current in one is clockwise, and counterclockwise in the other. At a point on the axis half way between the loops the magnetic field in T has magnitude

a. 0.

b. $\frac{\mu_0 I a^2}{4(a^2+L^2)^{3/2}}$.

c. $\frac{\mu_0 I a^2}{2(a^2+L^2)^{3/2}}$.

d. $\frac{\mu_0 I a^2}{(a^2+L^2)^{3/2}}$.

e. $\frac{2\mu_0 I}{L}$.

85. Two current loops are coaxial and coplanar. One has radius *a* and the other has radius *2a*. Current *2I* in the outer loop is parallel to current *I* in the inner loop. The magnitude of the magnetic field at the center of the two loops is

a. 0.

b. $\frac{\mu_0 I}{4a}$.

c. $\frac{\mu_0 I}{2a}$.

d. $\frac{\mu_0 I}{a}$.

e. $\frac{2\mu_0 I}{a}$.

86. Two current loops are coaxial and coplanar. One has radius *a* and the other has radius *2a*. Current *2I* in the outer loop is antiparallel to current *I* in the inner loop. The magnitude of the magnetic field at the center of the two loops is

a. 0.

b. $\frac{\mu_0 I}{4a}$.

c. $\frac{\mu_0 I}{2a}$.

d. $\frac{\mu_0 I}{a}$.

e. $\frac{2\mu_0 I}{a}$.

87. We find that *N* current loops are coplanar and coaxial. The first has radius *a* and current *I*. The second has radius *2a* and current *2I*, and the pattern is repeated up to the *N*th, which has radius *Na* and current *NI*. The current in each loop is counterclockwise as seen from above. The magnitude of the magnetic field at the center of the loops is

a. $\frac{\mu_0 I}{2Na}$.

b. $\frac{\mu_0 I}{Na}$.

c. $\frac{\mu_0 I}{2a}$.

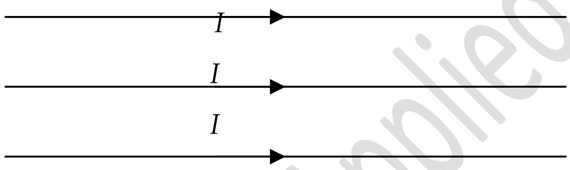
d. $\frac{\mu_0 NI}{2a}$.

e. $\frac{\mu_0 NI}{a}$.

88. We find that 2N current loops are coplanar and coaxial. The first has radius a and current I. The second has radius $2a$ and current $2I$, and the pattern is repeated up to the Nth, which has radius Na and current NI. The current in the loops alternates in direction from loop to loop as seen from above. Thus the current in the first loop is counterclockwise, in the next clockwise, up to the last loop where it is again clockwise. The magnitude of the magnetic field at the center of the loops is

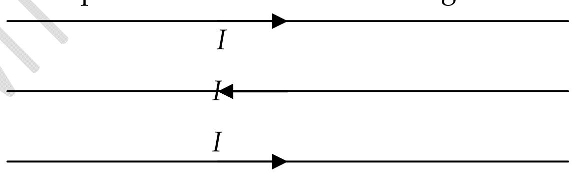
- **a.** 0.
- **b.** $\dfrac{\mu_0 I}{2Na}$.
- **c.** $\dfrac{\mu_0 I}{Na}$.
- **d.** $\dfrac{\mu_0 NI}{2a}$.
- **e.** $\dfrac{\mu_0 NI}{a}$.

89. Three coplanar parallel straight wires carry equal currents I to the right as shown below. Each pair of wires is a distance a apart. The direction of the magnetic force on the middle wire



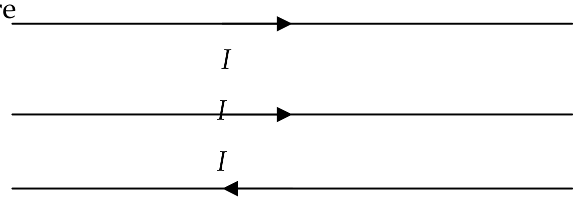
- **a.** is up out of the plane of the wires.
- **b.** is down into the plane of the wires.
- **c.** is in the plane of the wires, directed upwards.
- **d.** is in the plane of the wires, directed downwards
- **e.** cannot be defined, because there is no magnetic force on the middle wire.

90. Three coplanar parallel straight wires carry equal currents I as shown below. The current in the outer wires is directed to the right, and that in the middle wire is directed to the left. Each pair of wires is a distance a apart. The direction of the magnetic force on the middle wire



- **a.** is up out of the plane of the wires.
- **b.** is down into the plane of the wires.
- **c.** is in the plane of the wires, directed upwards.
- **d.** is in the plane of the wires, directed downwards
- **e.** cannot be defined, because there is no magnetic force on the middle wire.

91. Three coplanar parallel straight wires carry equal currents I to the right as shown below. The current in the upper two wires is directed to the right, but the current in the bottom wire is directed to the left. Each pair of wires is a distance a apart. The direction of the magnetic force on the middle wire

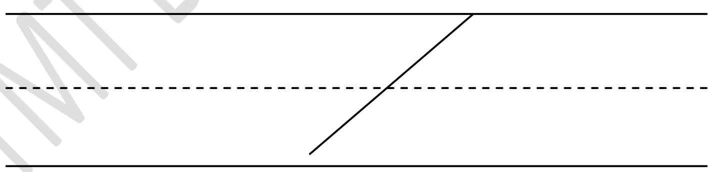


a. is up out of the plane of the wires.
b. is down into the plane of the wires.
c. is in the plane of the wires, directed upwards.
d. is in the plane of the wires, directed downwards
e. cannot be defined, because there is no magnetic force on the middle wire.

92. An ideal solenoid of radius a has n turns per unit unit length and current I. The magnetic flux Φ_B through any circular area of radius a inside the solenoid, centered on and perpendicular to the solenoid axis is

a. $\mu_0 \frac{\pi a^2}{4} nI$.
b. $\mu_0 \frac{\pi a^2}{2} nI$.
c. $\mu_0 \pi a^2 nI$.
d. $2\mu_0 \pi a^2 nI$.
e. 0.

93. An ideal solenoid of radius a has n turns per unit unit length and current I. The magnetic flux Φ_B through any area completely inside the solenoid, centered on the solenoid axis but at a $45°$ angle to the axis, so that it touches the inside of the solenoid, as shown below, is



a. $\mu_0 \frac{\pi a^2}{4} nI$.
b. $\mu_0 \frac{\pi a^2}{2} nI$.
c. $\mu_0 \pi a^2 nI$.
d. $2\mu_0 \pi a^2 nI$.
e. 0.

Chapter 31

Faraday's Law

41. The magnetic flux through a loop perpendicular to a uniform magnetic field will change

- **a.** if the loop is replaced by two loops, each of which has half of the area of the original loop.
- **b.** if the loop moves at constant velocity while remaining perpendicular to and within the uniform magnetic field.
- **c.** if the loop moves at constant velocity in a direction parallel to the axis of the loop while remaining in the uniform magnetic field.
- **d.** if the loop is rotated through 180 degrees about an axis through its center and in the plane of the loop.
- **e.** in none of the above cases.

42. A current may be induced in a coil by

- **a.** moving one end of a bar magnet through the coil.
- **b.** moving the coil toward one end of the bar magnet.
- **c.** holding the coil near a second coil while the electric current in the second coil is increasing.
- **d.** all of the above.
- **e.** none of the above.

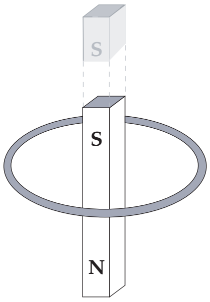
43. Coil 1, connected to a 100 Ω resistor, sits inside coil 2. Coil 1 is connected to a source of 60 cycle per second AC current. Which statement about coil 2 is correct?

- **a.** No current will be induced in coil 2.
- **b.** DC current (current flow in only one direction) will be induced in coil 2.
- **c.** AC current (current flow in alternating directions) will be induced in coil 2.
- **d.** DC current will be induced in coil 2, but its direction will depend on the initial direction of flow of current in coil 1.
- **e.** Both AC and DC current will be induced in coil 2.

44. An induced emf is produced in

- **a.** a closed loop of wire when it remains at rest in a nonuniform static magnetic field.
- **b.** a closed loop of wire when it remains at rest in a uniform static magnetic field.
- **c.** a closed loop of wire moving at constant velocity in a nonuniform static magnetic field.
- **d.** all of the above.
- **e.** only b and c above.

45. A bar magnet is dropped from above and falls through the loop of wire shown below. The north pole of the bar magnet points downward towards the page as it falls. Which statement is correct?



a. The current in the loop always flows in a clockwise direction.
b. The current in the loop always flows in a counterclockwise direction.
c. The current in the loop flows first in a clockwise, then in a counterclockwise direction.
d. The current in the loop flows first in a counterclockwise, then in a clockwise direction.
e. No current flows in the loop because both ends of the magnet move through the loop.

46. The difference between a DC and an AC generator is that

a. the DC generator has one unbroken slip ring.
b. the AC generator has one unbroken slip ring.
c. the DC generator has one slip ring split in two halves.
d. the AC generator has one slip ring split in two halves.
e. The DC generator has two unbroken slip rings.

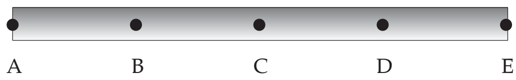
47. Alternating currents in power lines usually cannot produce significant electrical currents in human brains because power lines

a. carry high current at high voltage.
b. carry low current at high voltage.
c. carry low current at low voltage.
d. carry high current at low voltage.
e. have high I^2R (resistive) losses.

48. Human brain activity produces weak variable electric currents. The way these are detected without surgery is by

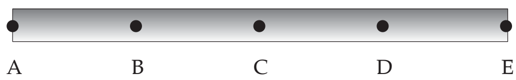
a. measuring the force on a wire carrying a large electric current that is placed near the brain.
b. measuring the force on a solenoid carrying a large electric current that is placed near the brain.
c. measuring the magnetic fields they produce by means of small loops of wire of very low resistance placed near the brain.
d. measuring the potential difference between the leaves of an electroscope that is placed near the brain.
e. attaching the leads of an ohmmeter to a person's ears.

51. A metal rod of length L in a region of space where a constant magnetic field points into the page rotates clockwise about an axis through its center at constant angular velocity ω. While it rotates, the point(s) at highest potential is(are)



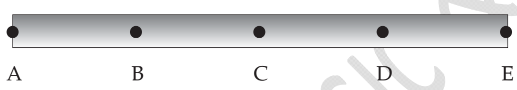
- **a.** A.
- **b.** B.
- **c.** C.
- **d.** D.
- **e.** A and E.

52. A metal rod of length L in a region of space where a constant magnetic field points into the page rotates clockwise about an axis through its center at constant angular velocity ω. While it rotates, the point(s) at lowest potential is(are)



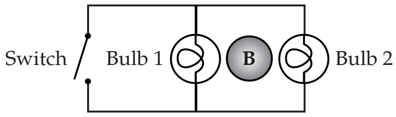
- **a.** A.
- **b.** B.
- **c.** C.
- **d.** D.
- **e.** A and E.

53. A metal rod of length L in a region of space where a constant magnetic field points into the page rotates about an axis through its center at constant angular velocity ω. The ends, A and E, make contact with a split ring that connects to an external circuit. The current in the external circuit of resistance R has magnitude



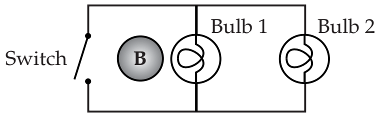
- **a.** 0.
- **b.** $\frac{1}{R}\frac{d\Phi_B}{dt}$.
- **c.** $\frac{\sqrt{2}}{R}\frac{d\Phi_B}{dt}$.
- **d.** $\frac{2}{R}\frac{d\Phi_B}{dt}$.
- **e.** $\frac{2\sqrt{2}}{R}\frac{d\Phi_B}{dt}$.

54. Two bulbs are shown in a circuit that surrounds a region of increasing magnetic field directed out of the page. When the switch is closed,



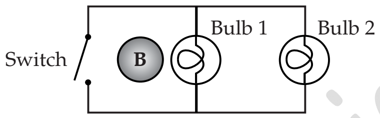
- **a.** bulb 1 glows more brightly.
- **b.** bulb 2 glows more brightly.
- **c.** both bulbs continue to glow with the same brightness.
- **d.** bulb 1 goes out.
- **e.** bulb 2 goes out.

55. Two bulbs are shown in a circuit that surrounds a region of increasing magnetic field directed out of the page. When the switch is closed,



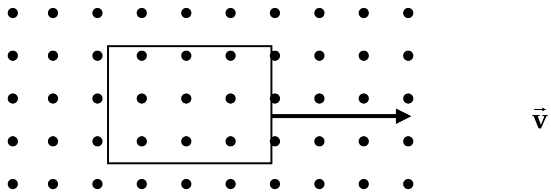
- **a.** bulb 1 glows more brightly.
- **b.** bulb 2 glows more brightly.
- **c.** both bulbs glow equally brightly.
- **d.** bulb 1 goes out.
- **e.** bulb 2 goes out.

56. Two bulbs are shown in a circuit that surrounds a region of increasing magnetic field directed out of the page. When the switch is open,



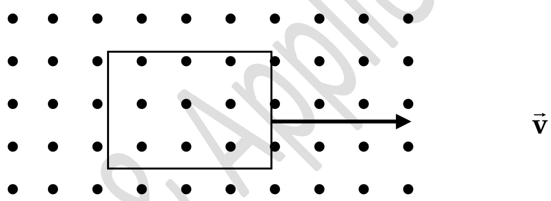
- **a.** bulb 1 is glowing; bulb 2 is dark.
- **b.** bulb 2 is glowing; bulb 1 is dark.
- **c.** both bulbs glow equally brightly.
- **d.** both bulbs glow one half as brightly as they do with the switch closed.
- **e.** both bulbs are dark.

57. As shown below, a square loop of wire of side *a* moves through a uniform magnetic field of magnitude *B* perpendicular to the page at constant velocity $\vec{\mathbf{v}}$ directed to the right. Judd says that the emf induced in the loop is zero. Roger claims that it has magnitude $B\ell v$. Which one, if either, is correct, and why?



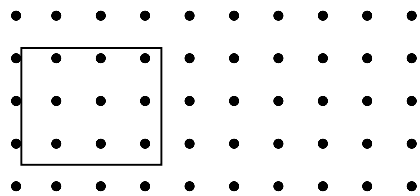
a. Judd, because the magnetic flux through the loop is constant.
b. Roger, because the magnetic flux through the loop is constant.
c. Judd, because the magnetic flux through the loop is not constant if $\vec{\mathbf{v}} \neq 0$.
d. Roger, because the magnetic flux through the loop is not constant if $\vec{\mathbf{v}} \neq 0$.
e. Roger, because the magnetic flux through the loop is $\Phi_B = 0$.

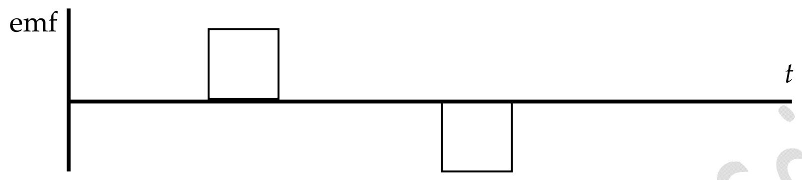
58. As shown below, a square loop of wire of side *a* moves through a uniform magnetic field of magnitude *B* perpendicular to the page at constant velocity $\vec{\mathbf{v}}$ directed to the right. Which statement regarding the electric field induced in the wires is correct for the wires at the left and right sides of the loop?



a. The electric field $\vec{\mathbf{E}}$ is directed upwards in both the right and left sides of the loop.
b. The electric field $\vec{\mathbf{E}}$ is directed upwards in the right side and downwards in the left side of the loop.
c. The electric field $\vec{\mathbf{E}}$ is directed upwards in the left side and downwards in the right side of the loop.
d. The electric field $\vec{\mathbf{E}}$ is directed downwards in both the right and left sides of the loop.
e. There is no electric field present in any side of the loop.

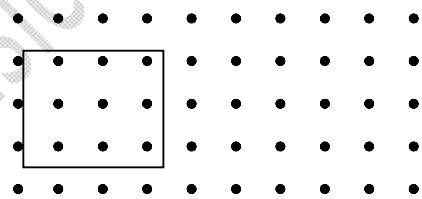
59. Starting outside the region with the magnetic field, a single square coil of wire moves across the region with a uniform magnetic field $\vec{\mathbf{B}}$ perpendicular to the page. The loop moves at constant velocity $\vec{\mathbf{v}}$. As seen from above, a counterclockwise emf is regarded as positive. Roger claims that the graph shown below represents the induced emf. Martin says he's wrong. In which direction did the loop move over the plane of the page, or is Martin correct?

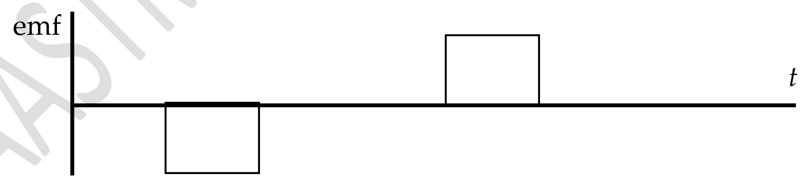




a. Roger is correct: the loop moved from bottom to top.
b. Roger is correct: the loop moved from top to bottom.
c. Roger is correct: the loop moved from left to right.
d. Roger is correct: the loop moved from right to left.
e. Martin is correct: none of these directions of motion will produce the graph of emf vs *t*.

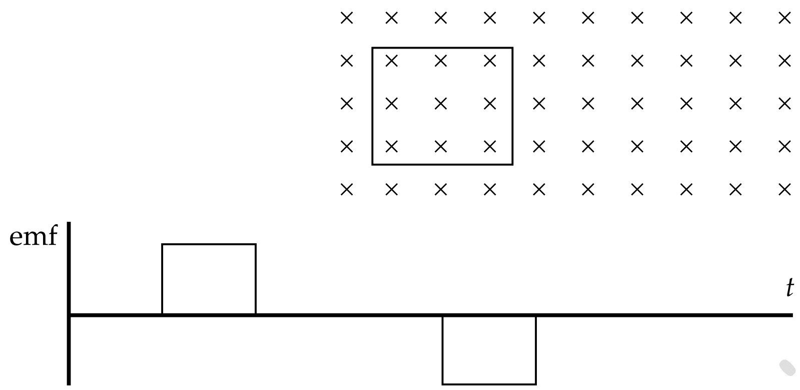
60. Starting outside the region with the magnetic field, a single square coil of wire enters, moves across, and then leaves the region with a uniform magnetic field $\vec{\mathbf{B}}$ perpendicular to the page so that the graph shown below represents the induced emf. The loop moves at constant velocity $\vec{\mathbf{v}}$. As seen from above, a counterclockwise emf is regarded as positive.. In which direction did the loop move over the plane of the page?





a. The loop moved from bottom to top.
b. The loop moved from top to bottom.
c. The loop moved from left to right.
d. The loop moved from right to left.
e. All of these directions of motion will produce the graph of emf vs *t*.

61. Starting outside the region with the magnetic field, a single square coil of wire enters, moves across, and then leaves the region with a uniform magnetic field $\vec{\mathbf{B}}$ perpendicular to the page so that the graph shown below represents the induced emf. The loop moves at constant velocity $\vec{\mathbf{v}}$. As seen from above, a counterclockwise emf is regarded as positive.. In which direction did the loop move over the plane of the page?

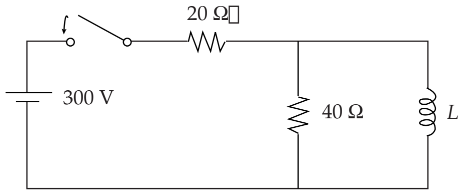


a. The loop moved from bottom to top.
b. The loop moved from top to bottom.
c. The loop moved from left to right.
d. The loop moved from right to left.
e. All of these directions of motion will produce the graph of emf vs *t*.

Chapter 32

Inductance

5. There is no current in the circuit shown in the figure below until the switch is closed. The current through the 20-Ω resistor the instant after the switch is closed is either [1] 15 A or [2] 5.0 A, and the current through the 20-Ω resistor after the switch has been closed a long time is either [3] 5.0 A or [4] 15 A. Which combination of the above choices is correct?



- **a.** [1] and [3]
- **b.** [1] and [4]
- **c.** [2] and [3]
- **d.** [2] and [4]
- **e.** None of these

6. Which of the following are the units of a henry and a farad respectively?

- **a.** $J \cdot s^2/C^2$ and C^2/J
- **b.** $V \cdot s/A$ and V/C
- **c.** $V/(A \cdot s)$ and C/V
- **d.** $N \cdot m/A^2$ and $1/J$
- **e.** None of the above

15. An inductor produces a back emf in a DC series RL circuit when a switch connecting the battery to the circuit is closed. We can explain this by

- **a.** Lenz's law.
- **b.** increasing magnetic flux within the coils of the inductor.
- **c.** increasing current in the coils of the inductor.
- **d.** all of the above.
- **e.** only (a) and (c) above.

16. When a switch is closed to complete a DC series RL circuit,

- **a.** the electric field in the wires increases to a maximum value.
- **b.** the magnetic field outside the wires increases to a maximum value.
- **c.** the rate of change of the electric and magnetic fields is greatest at the instant when the switch is closed.
- **d.** all of the above are true.
- **e.** only (a) and (c) above are true.

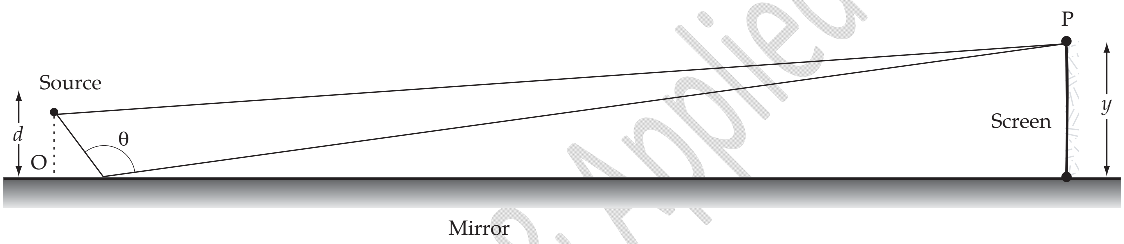
17. After a switch is thrown to remove the battery from a DC LR circuit, but the circuit is still left complete, the time constant represents

- **a.** the time rate of change of the current in the circuit.
- **b.** the time rate of change of the induced emf in the circuit.
- **c.** the magnitude of the ratio of the current to the time rate of change of the current.
- **d.** all of the above.
- **e.** only (a) and (b) above.

Chapter 37

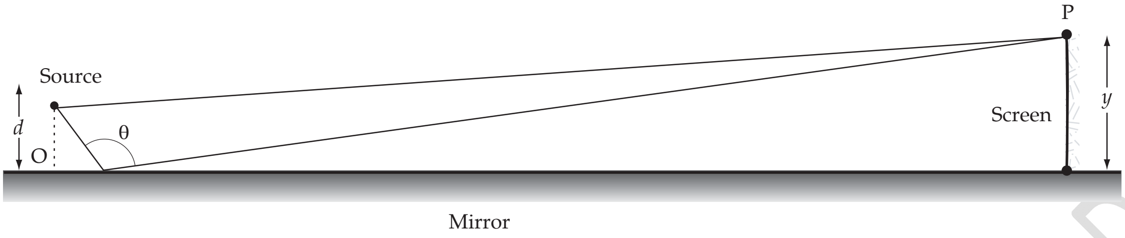
Interference of Light Waves

15. An interference pattern is produced at point P on a screen as a result of direct rays and rays reflected off a mirror as shown in the figure. If the source is 100 m to the left of the screen, 1.0 cm above the mirror, and the source is a distance d above the mirror, monochromatic (λ = 500 nm), find the condition for maximum intensity (constructive interference) on the screen in terms of θ, λ, and d.



- **a.** $2d \sin \theta = m\lambda$
- **b.** $2d \sin \theta = (m + 1/2)\lambda$
- **c.** $d \sin \theta = m\lambda$
- **d.** $d \sin \theta = (m + 1/2)\lambda$
- **e.** none of these

16. An interference pattern is produced at point P on a screen as a result of direct rays and rays reflected off a mirror as shown in the figure. If the source is 100 m to the left of the screen, 1 cm above the mirror, and the source is monochromatic (λ = 500 nm), find the conditions for minimum brightness on the screen in terms of θ, λ, and d.



- **a.** $2d \sin \theta = (m + 1/2)\lambda$
- **b.** $2d \sin \theta = m\lambda$
- **c.** $d \sin \theta = (m + 1/2)\lambda$
- **d.** $d \sin \theta = m\lambda$
- **e.** none of these

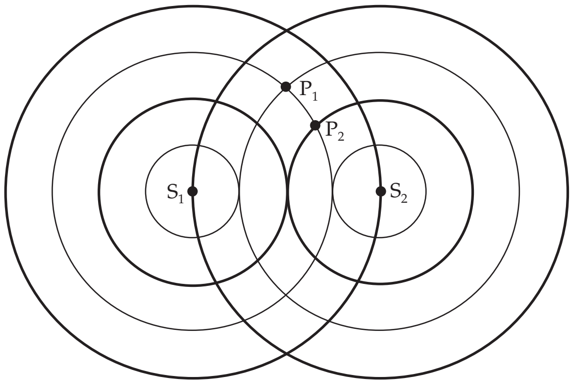
26. The bright and dark bands you see in a photograph of a double slit interference pattern represent

- **a.** the respective positions of the crests and the troughs of the light wave.
- **b.** an interference pattern that is not present unless it is produced by the camera lens.
- **c.** the respective positions of constructive and destructive interference of light from the two sources.
- **d.** the respective positions of destructive and constructive interference of light from the two sources.
- **e.** the respective positions of bright and dark particles of light.

27. In an interference pattern, the wavelength and frequency are

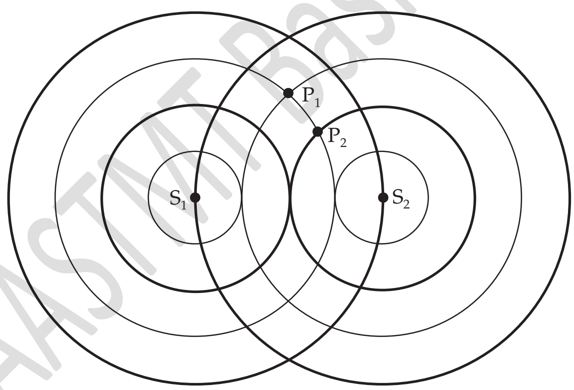
- **a.** the same in both the regions of constructive interference and the regions of destructive interference.
- **b.** greater in regions of constructive interference than in regions of destructive interference.
- **c.** smaller in regions of constructive interference than in regions of destructive interference.
- **d.** unchanged in regions of destructive interference but greater in regions of constructive interference.
- **e.** unchanged in regions of destructive interference but smaller in regions of constructive interference.

28. A planar cross section through two spherical waves emanating from the sources S_1 and S_2 in the plane is shown in the figure. S_1 and S_2 are in phase. The black circles are one and two wavelengths from their respective sources. The lighter circles are one half and one and a half wavelengths distant from their respective sources. If the waves shown arriving at P_1 both arrive with amplitude A, the resultant amplitude at point P_1 is



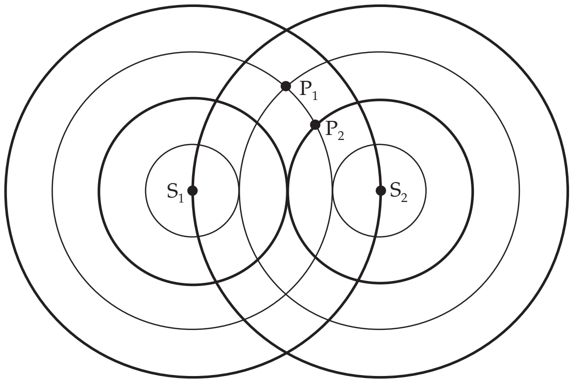
a. 0.
b. $\frac{1}{2}A$.
c. A.
d. $\frac{3}{2}A$.
e. $2A$.

29. A planar cross section through two spherical waves emanating from the sources S_1 and S_2 in the plane is shown in the figure. S_1 and S_2 are in phase. The black circles are one and two wavelengths from their respective sources. The lighter circles are one half and one and a half wavelengths distant from their respective sources. If the waves shown arriving at P_2 both arrive with amplitude A, the resultant amplitude at point P_2 is



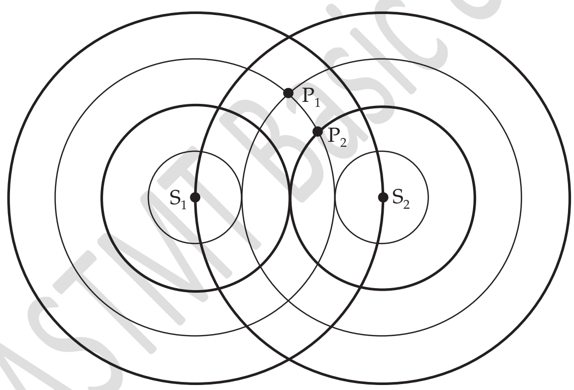
a. 0.
b. $\frac{1}{2}A$.
c. A.
d. $\frac{3}{2}A$.
e. $2A$.

30. A planar cross section through two spherical waves emanating from the sources S_1 and S_2 in the plane is shown in the figure. The black circles are one and two wavelengths from their respective sources. The lighter circles are one half and one and a half wavelengths distant from their respective sources. If the phase at S_1 and S_2 is zero at this instant, and the waves shown arriving at P_1 both arrive with amplitude A, the phase angle of each wave at point P_1 (in radians) is



a. 0.
b. π.
c. 2π.
d. 3π.
e. π/2.

31. A planar cross section through two spherical waves emanating from the sources S_1 and S_2 in the plane is shown in the figure. The black circles are one and two wavelengths from their respective sources. The lighter circles are one half and one and a half wavelengths distant from their respective sources. If the phase at S_1 and S_2 is zero at this instant, and the waves shown arriving at P_2 both arrive with amplitude A, the difference in phase angle at point P_2 (in radians) is



a. 0.
b. π/2.
c. π.
d. 3π/2.
e. 2π.

32. When a central dark fringe is observed in reflection in a circular interference pattern, waves reflected from the upper and lower surfaces of the medium must have a phase difference, in radians, of

a. 0.
b. $\pi/2$.
c. π.
d. $3\pi/2$.
e. 2π.

33. A film of index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 > n_2$, the condition for constructive interference for reflected monochromatic light of wavelength λ in air is

a. $t = m\frac{\lambda}{n_1}$.
b. $t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_1}$.
c. $2t = m\frac{\lambda}{n_1}$.
d. $2t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_1}$.
e. $4t = m\frac{\lambda}{n_1}$.

34. A film of index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 > n_2$, the condition for destructive interference for reflected monochromatic light of wavelength λ in air is

a. $t = m\frac{\lambda}{n_1}$.
b. $t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_1}$.
c. $2t = m\frac{\lambda}{n_1}$.
d. $2t = \left(m + \frac{1}{2}\right)\frac{\lambda}{n_1}$.
e. $4t = m\frac{\lambda}{n_1}$.

35. A film of index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 < n_2$, the condition for constructive interference for reflected monochromatic light of wavelength λ in air is

a. $t = m\dfrac{\lambda}{n_1}$.

b. $t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$.

c. $2t = m\dfrac{\lambda}{n_1}$.

d. $2t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$.

e. $4t = m\dfrac{\lambda}{n_1}$.

36. A film of index of refraction n_1 coats a surface with index of refraction n_2. When $n_1 < n_2$, the condition for destructive interference for reflected monochromatic light of wavelength λ in air is

a. $t = m\dfrac{\lambda}{n_1}$.

b. $t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$.

c. $2t = m\dfrac{\lambda}{n_1}$.

d. $2t = \left(m + \dfrac{1}{2}\right)\dfrac{\lambda}{n_1}$.

e. $4t = m\dfrac{\lambda}{n_1}$.

37. The superposition of two waves $E_1 = E_0 \sin(\omega t)$ and $E_2 = E_0 \sin(\omega t + \phi)$ arriving at the same point in space at the same time is $E =$

a. $2E_0 \sin(\omega t)\cos(\frac{\phi}{2})$.

b. $2E_0 \sin(\omega t)\cos(\phi)$.

c. $2E_0 \sin(\omega t + \frac{\phi}{2})\cos(\frac{\phi}{2})$.

d. $2E_0 \sin(\omega t + \frac{\phi}{2})\cos(\phi)$.

e. $2E_0 \cos(\omega t + \frac{\phi}{2})\cos(\frac{\phi}{2})$.

38. Ray says that interference effects cannot be observed with visible light because random phase changes occur in time intervals less than a nanosecond. Stacy says that doesn't matter if collimated light from a single source reaches multiple openings. (They are arguing about a light source 50.0 cm away from two 0.0100 mm-wide slits, 2.00 mm apart, with a screen 1.00 m away from the slits.) Which one, if either, is correct, and why?

- **a.** Ray, because the phases at the two slits will be random and different.
- **b.** Ray, because it takes light over 3 ns to travel 1.00 m to the screen.
- **c.** Stacy, because the difference in time of travel from the source to the slits is no more than about 7×10^{-12} s.
- **d.** Stacy, but only if a lens is placed in front of the slits.
- **e.** Both, because interference of light never occurs outside a physics lab.

39. Bright and dark fringes are seen on a screen when light from a single source reaches two narrow slits a short distance apart. The locations of bright and dark fringes can be interchanged if a thin film is placed in front of one of the slits. The minimum thickness of this film must be

- **a.** $d = \dfrac{\lambda_{air}}{2}$.
- **b.** $d = \dfrac{\lambda_{air}}{2n_{film}}$.
- **c.** $d = \dfrac{\lambda_{air}}{(n_{film} - 1)}$.
- **d.** $d = \dfrac{\lambda_{air}}{2(n_{film} - 1)}$.
- **e.** $d = \dfrac{\lambda_{air}}{n_{film}}$.

40. Bright and dark fringes are seen on a screen when light from a single source reaches two narrow slits a short distance apart. Each bright fringe will shift to the location of the adjacent bright fringe if a thin film is placed in front of one of the slits. The minimum thickness of this film must be

- **a.** $d = \dfrac{\lambda_{air}}{2}$.
- **b.** $d = \dfrac{\lambda_{air}}{2n_{film}}$.
- **c.** $d = \dfrac{\lambda_{air}}{(n_{film} - 1)}$.
- **d.** $d = \dfrac{\lambda_{air}}{2(n_{film} - 1)}$.
- **e.** $d = \dfrac{\lambda_{air}}{n_{film}}$.

41. Bright and dark fringes are seen on a screen when light from a single source reaches two narrow slits a short distance apart. The number of fringes per unit length on the screen can be doubled

a. if the distance between the slits is doubled.

b. if the wavelength is changed to $\lambda' = \frac{\lambda}{2}$.

c. if the distance between the slits is one quarter of the original distance and the wavelength is changed to $\lambda' = 2\lambda$.

d. if any of the above occurs.

e. only if the width of the slits is changed to $w' = \frac{w}{2}$.

42. Bright and dark fringes are seen on a screen when light from a single source reaches two narrow slits a short distance apart. The number of fringes per unit length on the screen can be halved

a. if the distance between the slits is changed to $d' = \frac{d}{2}$.

b. if the wavelength is changed to $\lambda' = 2\lambda$.

c. if the distance between the slits is $d' = \frac{d}{2}$ the wavelength is changed to $\lambda' = 4\lambda$.

d. if any of the above occurs.

e. only if the width of the slits is changed to $w' = 2w$.

43. When illuminated with monochromatic light of wavelength λ, a clear double slit interference pattern with approximately equal intensity for at least a dozen centrally located fringed can be seen only if

a. the distance between the slits is less than λ.

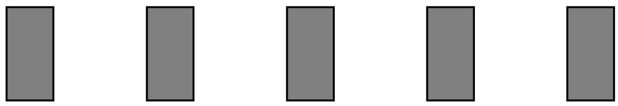
b. the width of the slits is equal to or less than λ.

c. the width of the slits is equal to or greater than 12λ.

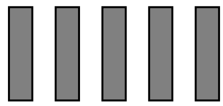
d. the distance between the slits is equal to or greater than 12λ.

e. laser light is used and the width of the slits is equal to or greater than 12λ.

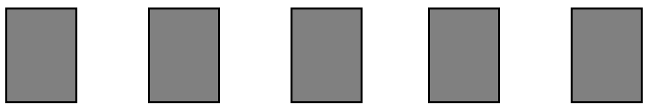
44. The figures below represent interference fringes. The distances from the screen to the slits is the same for each figure, and the planes of the screen and the slits are parallel. Which figure(s) represent(s) slits with the smallest spacing *d* between the slits? The white spaces represent the interference maxima.



I.



II.



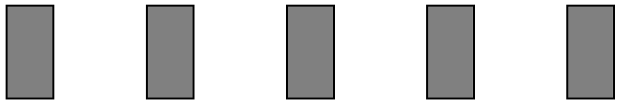
III.

IV.

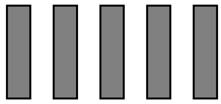
V.

- **a.** **I.**
- **b.** **II.**
- **c.** **III.**
- **d.** **IV.**
- **e.** **V.**

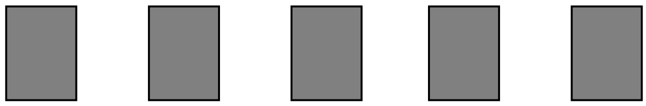
45. The figures below represent interference fringes. The distances from the screen to the slits is the same for each figure, and the planes of the screen and the slits are parallel. Which figure(s) represent(s) slits with the greatest spacing *d* between the slits? The white spaces represent the interference maxima.



I.



II.



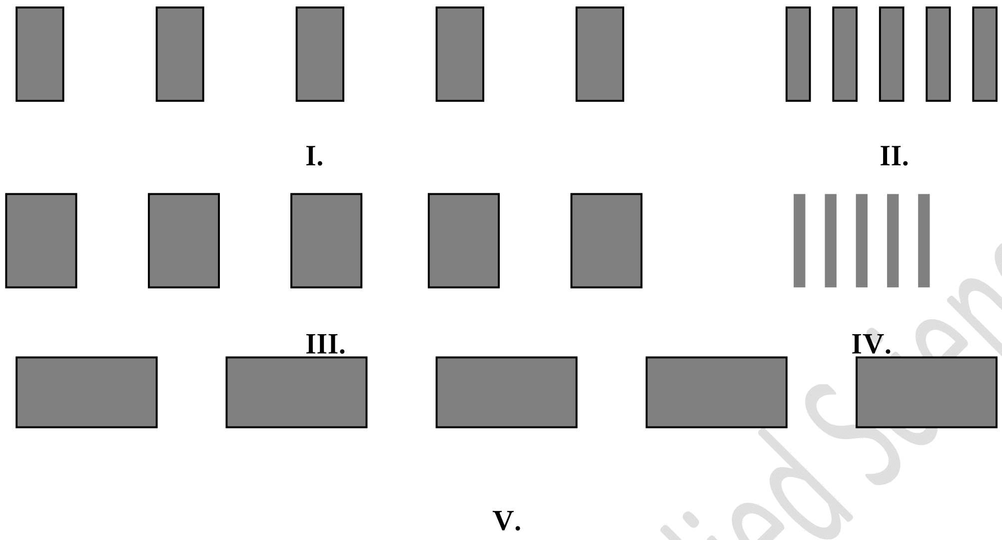
III.

IV.

V.

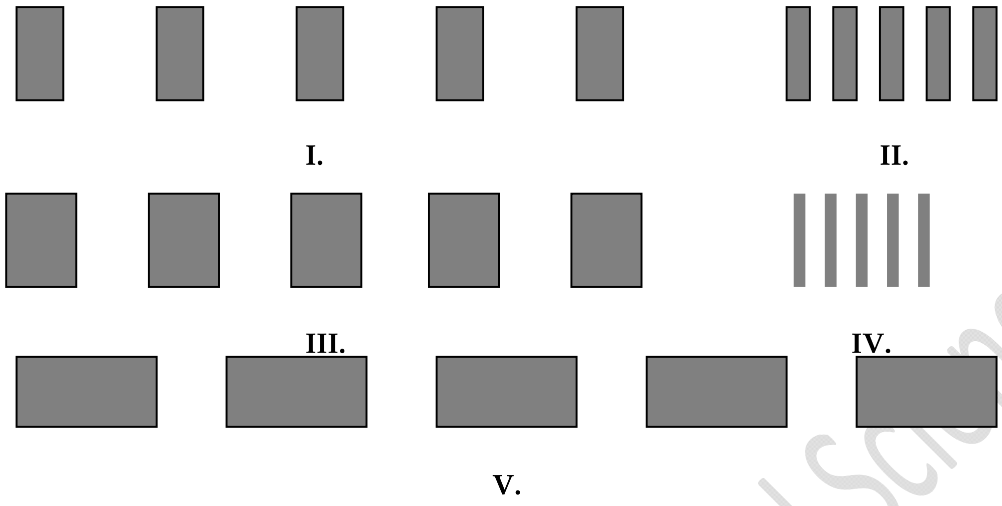
- **a.** **I.**
- **b.** **II.**
- **c.** **III.**
- **d.** **IV.**
- **e.** **V.**

46. The figures below represent interference fringes. The distances from the screen to the slits is the same for each figure, and the planes of the screen and the slits are parallel. In each figure the spacing d between the slits is the same. Which figure(s) represent(s) slits illuminated with light of the greatest wavelength λ? The white spaces represent the interference maxima.



a. I.
b. II.
c. III.
d. IV.
e. V.

47. The figures below represent interference fringes. The distances from the screen to the slits is the same for each figure, and the planes of the screen and the slits are parallel. In each figure the spacing d between the slits is the same. Which figure(s) represent(s) slits illuminated with light of the shortest wavelength λ? The white spaces represent the interference maxima.



a. I.
b. II.
c. III.
d. IV.
e. V.

Answers

Chapter 23

63. e
65. c
66. d
67. d
69. d
71. e
72. b
79. e

Chapter 25

65. d
67. a
68. c
82. d
83. c
84. b
85. d
86. d
87. c
89. e

Chapter 26

36. d
37. c
38. b
39. a
40. d
41. e
42. d
43. b
44. b
46. b
47. d
48. d
52. e
54. c

Chapter 27

24. b
25. e
27. b
28. b

Chapter 28

56. e
57. a
58. a
59. a
60. a
63. c
66. b
67. b
70. e
73. e

Chapter 29

4. a
9. a
11. c
19. b
20. a
54. d
55. d
56. d
57. c
58. d
59. a
60. d
61. c
62. b
63. c
64. e
65. e
66. a
67. e
68. e
69. c
70. c
71. b
72. b
76. b

Chapter 30

22. a
23. a
24. b
25. a
26. d

62. d
63. a
64. b
65. e
66. b
67. e
68. b
73. d
74. d
75. a
76. b
77. e
78. c
79. d
80. d
81. c
82. a
83. d
84. a
85. d
86. a
87. d
88. a
89. e
90. e
91. **c**
92. **c**
93. **c**

Chapter 31

41. d
42. d
43. c
44. c
45. d
46. c
47. b
48. c
51. e
52. c
53. a
54. d
55. c
56. e
57. a
58. d
59. e
60. e
61. e

Chapter 32

5. d
6. a
15. d
16. d
17. c

Chapter 37

15. b
16. b
26. c
27. a
28. e
29. a
30. d
31. c
32. c
33. d
34. c
35. c
36. d
37. c
38. c
39. d
40. c
41. d
42. d
43. b
44. e
45. d
46. e
47. d

Good Luck