Physics · Electric Current and Electromagnetism · Magnetic Effect of Electric Current and Measuring Instruments

Magnetic Effect of Electric Current

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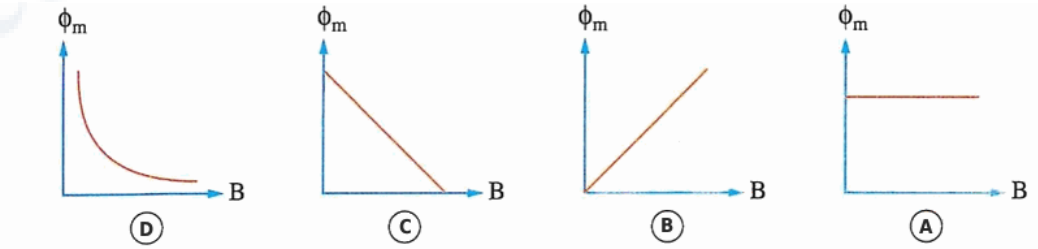
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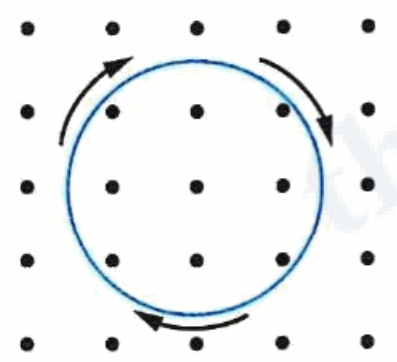
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Multiple choice questions — 102 questions

1 A rectangular coil is placed perpendicular to a magnetic flux whose density changes uniformly. Which of the following graphs represents the relation between the total flux (φ_m) through the coil and the magnetic flux density (B) in which the coil is placed?



2 The opposite figure shows a circular coil placed perpendicular to a uniform magnetic field. If the coil rotates clockwise through 90° about an axis perpendicular to its plane, the flux passing through the coil .....



(A) increases (B) equals zero (C) decreases (D) does not change

3 A ring of cross-sectional area 0.2 m² is placed perpendicular to the lines of a uniform magnetic flux of density 0.04 Wb/m². The magnetic flux passing through the ring equals .....

(A) 0.002 Wb (B) 0.004 Wb (C) 0.006 Wb (D) 0.008 Wb

4 A square frame of side length 20 cm is placed in a uniform magnetic field of flux density 3×10^{-2} Tesla. If the flux passing through the frame is 6×10^{-4} Weber, the angle between the plane of the frame and the flux lines equals .....

(A) 20° (B) 30° (C) 45° (D) 90°

5 A coil of area 2 m^2 is placed in a magnetic field of flux density 0.05 Wb/m^2 so that the flux through it is maximum. The magnetic flux through the coil when the coil rotates from this position through an angle of:

30° equals .....

(A) 0.01 Wb (B) -0.1 Wb (C) 0.7 Wb (D) 0.087 Wb

6 A coil of area 2 m^2 is placed in a magnetic field of flux density 0.05 Wb/m^2 so that the flux through it is maximum. The magnetic flux through the coil when the coil rotates from this position through an angle of:

45° equals .....

(A) -0.01 Wb (B) 0.03 Wb (C) 0.07 Wb (D) 0.09 Wb

7 A coil of area 2 m^2 is placed in a magnetic field of flux density 0.05 Wb/m^2 so that the flux through it is maximum. The magnetic flux through the coil when the coil rotates from this position through an angle of:

135° equals .....

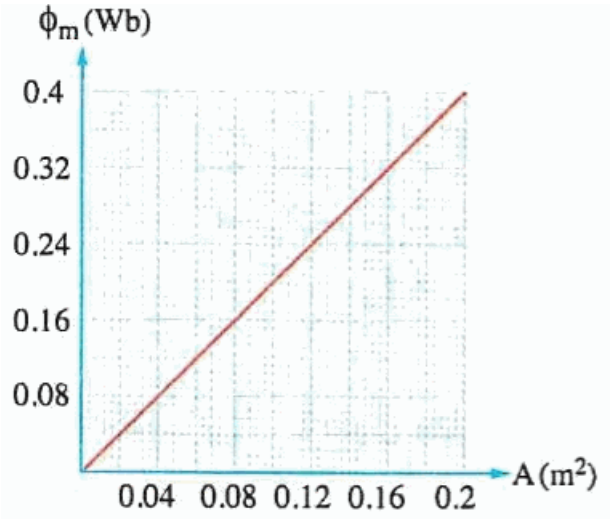
(A) 0.1 Wb (B) 0.005 Wb (C) -0.07 Wb (D) -0.09 Wb

8 A coil of area 2 m^2 is placed in a magnetic field of flux density 0.05 Wb/m^2 so that the flux through it is maximum. The magnetic flux through the coil when the coil rotates from this position through an angle of:

180° equals .....

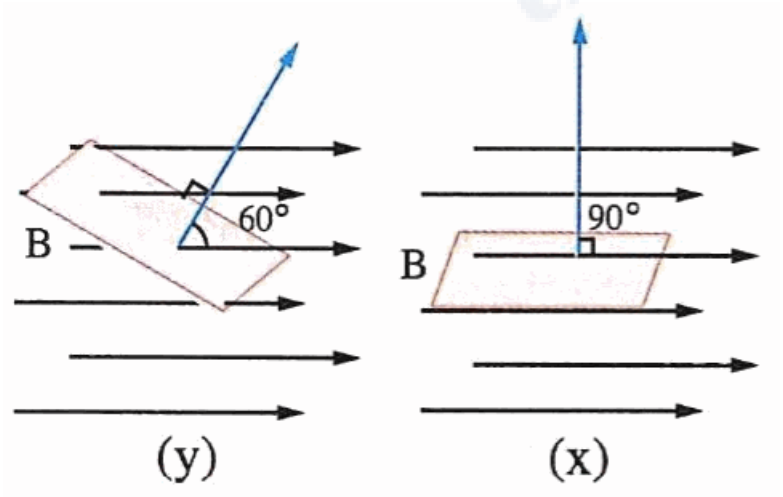
(A) -0.1 Wb (B) 0.2 Wb (C) -0.3 Wb (D) 0.4 Wb

9 Several rectangular coils of different areas are placed in a uniform magnetic field, inclined to it at 30°. The opposite graph shows the relation between the total flux through the coil (φ_m) and the area of the coil (A). The magnetic flux density acting on all the coils is .....



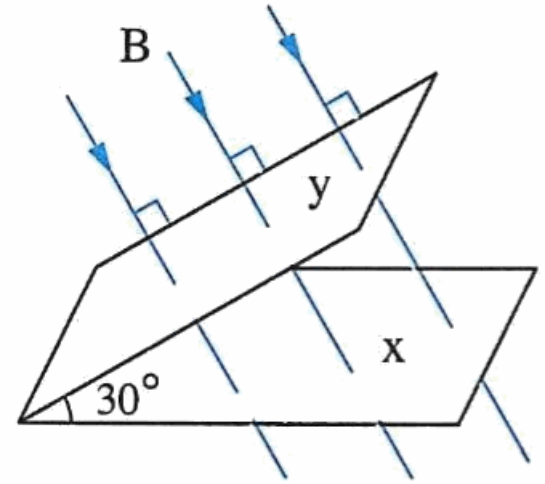
(A) 1 T (B) 4 T (C) 0.5 T (D) 0.8 T

10 The opposite figure shows two different positions (x) and (y) of a coil of area 0.2 m^2 placed in a uniform magnetic field of flux density 0.8 T. The change in magnetic flux $\Delta\varphi_m$ through the coil between the two positions equals .....



(A) 0 (B) 0.08 Wb (C) 0.4 Wb (D) 0.16 Wb

11 Two rectangular coils (x) and (y) of the same area are fixed together so that one is inclined to the other at 30°. If both coils are exposed to a magnetic flux of density B in the direction shown in the opposite figure, the ratio between the magnetic fluxes through the two coils $(((\varphi_m)_x)/((\varphi_m)_y))$ equals .....



(A) *1/2* (B) *2/1* (C) *(√(3))/2* (D) *2/(√(3))*

12 A coil of face area A is placed perpendicular to a uniform magnetic flux of density B. The change in the magnetic flux through the coil when it rotates from the perpendicular position about an axis in its own plane through:
a quarter of a turn equals .....

(A) zero (B) BA (C) *3/2* BA (D) 2 BA

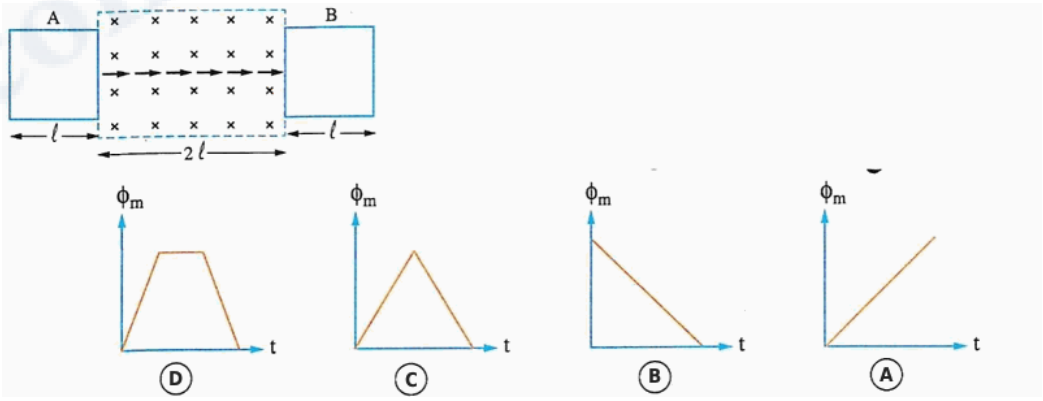
13 A coil of face area A is placed perpendicular to a uniform magnetic flux of density B. The change in the magnetic flux through the coil when it rotates from the perpendicular position about an axis in its own plane through:
half a turn equals .....

(A) zero (B) BA (C) *3/2* BA (D) 2 BA

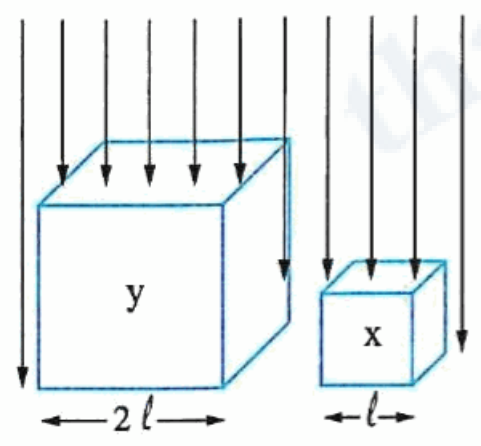
14 A coil of face area A is placed perpendicular to a uniform magnetic flux of density B. The change in the magnetic flux through the coil when it rotates from the perpendicular position about an axis in its own plane through:
a third of a turn equals .....

(A) zero (B) BA (C) *3/2* BA (D) 2 BA

15 The opposite figure shows a square coil moving at constant speed to the right of the page through a uniform magnetic field perpendicular to the page and into it. The relation between the magnetic flux (φ_m) through the coil while it moves from position A to B and the time (t) is .....

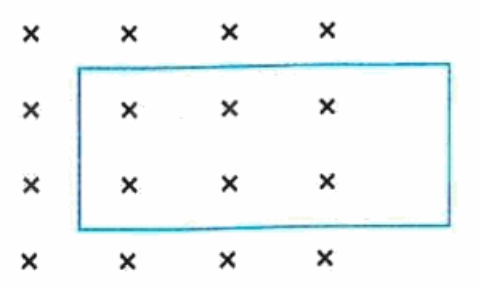


16 Two cubes x and y of side lengths ℓ and 2ℓ respectively each have a uniform magnetic field acting perpendicular to its upper face, as in the figure. Which of the following relations represents the relation between the magnetic fluxes through their upper faces?



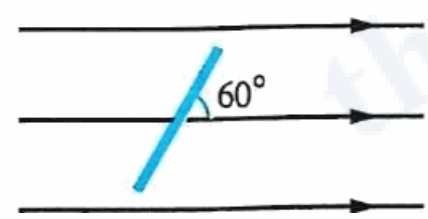
(A) $(\varphi_m)_y = 1/4(\varphi_m)_x$
(B) $(\varphi_m)_y = (\varphi_m)_x$
(C) $(\varphi_m)_y = 2(\varphi_m)_x$
(D) $(\varphi_m)_y = 4(\varphi_m)_x$

17 A coil of area A placed completely in a uniform magnetic field perpendicular to its plane has a magnetic flux of 10^{-3} Wb through its face. The coil was moved so that the area through which the flux passes decreased by 10 cm², as in the opposite figure, and the magnetic flux through the coil became 7.5×10^{-4} Wb. The area of the coil (A) equals .....



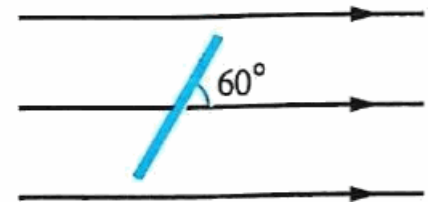
(A) 10 cm² (B) 20 cm² (C) 40 cm² (D) 80 cm²

18 A coil is placed in a uniform magnetic field so that its plane is inclined to the field lines at 60°, as in the figure, and the magnetic flux through it is 2×10^{-6} Wb. The flux through the coil when it rotates:
clockwise through 30° equals .....



(A) 3.854×10^{-8} Wb (B) 1.155×10^{-6} Wb
(C) 9.731×10^{-5} Wb (D) 8.514×10^{-7} Wb

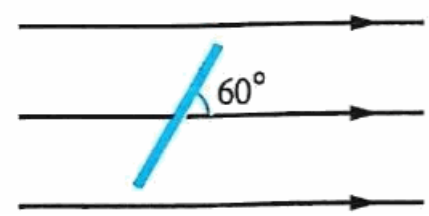
19 A coil is placed in a uniform magnetic field so that its plane is inclined to the field lines at 60°, as in the figure, and the magnetic flux through it is 2×10^{-6} Wb. The flux through the coil when it rotates:
clockwise through a quarter of a turn equals .....



(A) 6.25×10^{-6} Wb (B) 7.93×10^{-4} Wb
(C) 1.155×10^{-6} Wb (D) 9.11×10^{-4} Wb

20 A coil is placed in a uniform magnetic field so that its plane is inclined to the field lines at 60°, as in the figure, and the magnetic flux through it is 2×10^{-6} Wb. The flux through the coil when it rotates:

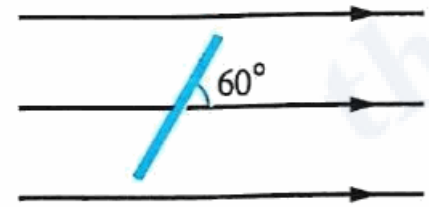
anticlockwise through 30° equals .....



(A) 1.155×10^{-6} Wb
(B) 2.31×10^{-6} Wb
(C) 4.692×10^{-7} Wb
(D) 3.854×10^{-8} Wb

21 A coil is placed in a uniform magnetic field so that its plane is inclined to the field lines at 60°, as in the figure, and the magnetic flux through it is 2×10^{-6} Wb. The flux through the coil when it rotates:

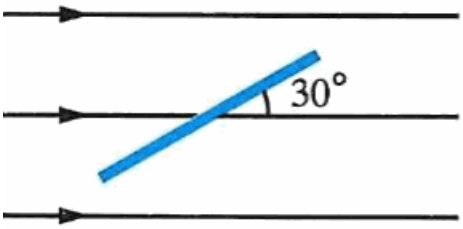
anticlockwise through a quarter of a turn equals .....



(A) 1.155×10^{-6} Wb
(B) 2.231×10^{-5} Wb
(C) 4.692×10^{-7} Wb
(D) 3.854×10^{-8} Wb

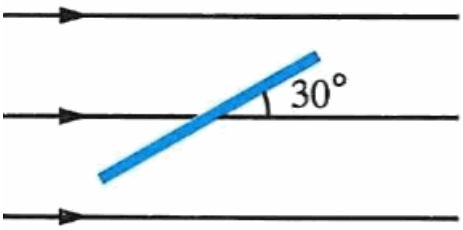
22 In the opposite figure, a coil of area A is placed in a magnetic field of density B so that it is inclined to the field at 30°, and the total flux through the coil is φ_m. The smallest angle the coil must rotate through so that the flux through it becomes:

$2\varphi_m$ is .....



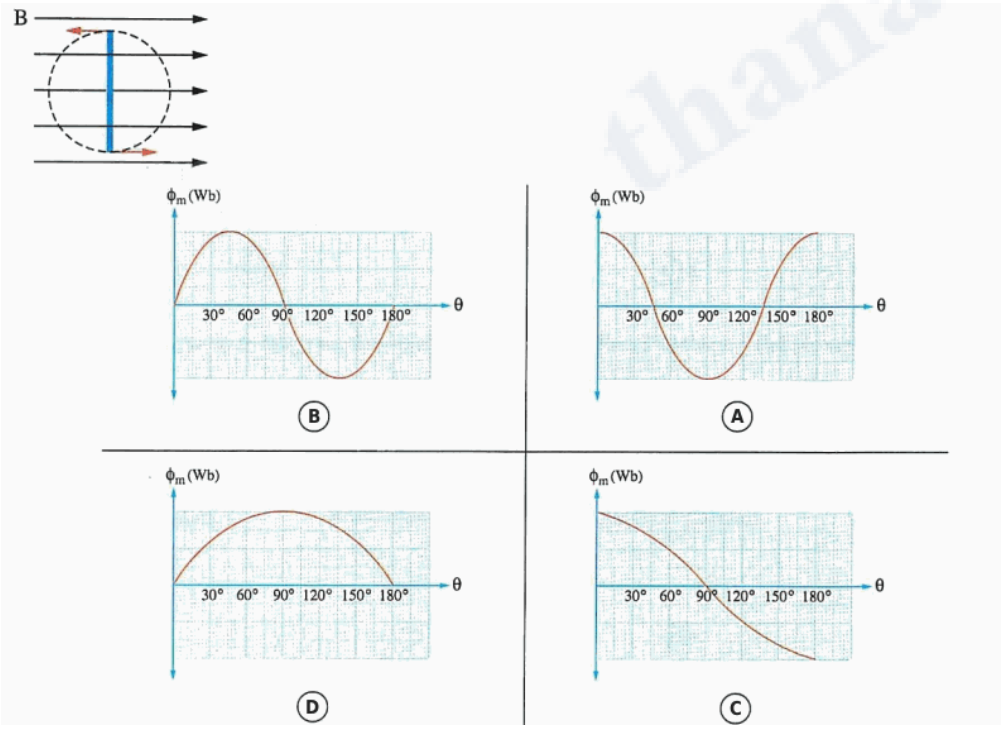
(A) 30°
(B) 45°
(C) 60°
(D) 90°

23 In the opposite figure, a coil of area A is placed in a magnetic field of density B so that it is inclined to the field at 30°, and the total flux through the coil is φ_m. The smallest angle the coil must rotate through so that the flux through it becomes: $2/3\varphi_m$ is .....



(A) 20.31° (B) 10.53° (C) 13.9° (D) 15.52°

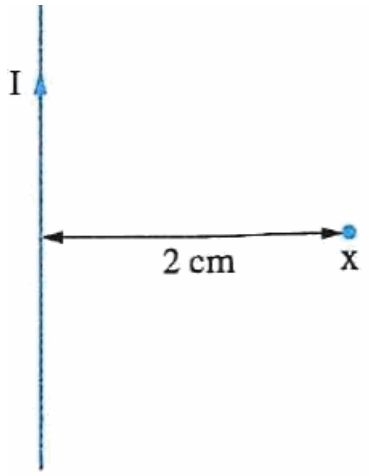
24 The opposite figure shows a rectangular coil rotating in a uniform magnetic field about an axis parallel to its long sides. The graph that represents the relation between the magnetic flux (φ_m) through the coil and the angle (θ) the coil rotates through during half a turn, starting from the position perpendicular to the magnetic field, is .....



25 The unit $Wb.A^{-1}.m^{-1}$ is the unit of .....

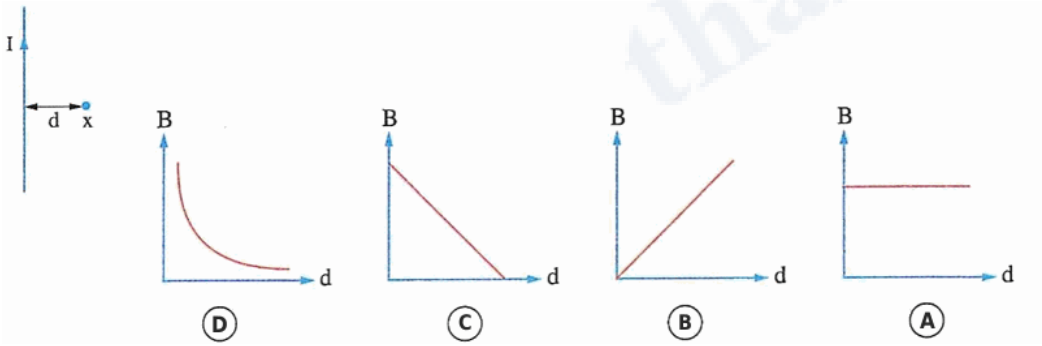
(A) magnetic flux (B) magnetic flux density
(C) magnetic permeability (D) electric power

26 In the figure shown, a long straight wire has a resistance of 0.2 Ω and the potential difference across it is 1 V. The magnetic flux density at point x is .....

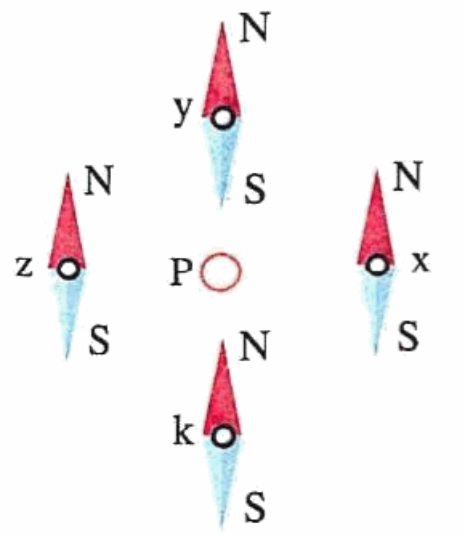


(A) 5×10^{-5} T, into the page
(B) 5×10^{-5} T, out of the page
(C) 2×10^{-5} T, into the page
(D) 2×10^{-5} T, out of the page

27 Which of the following graphs represents the relation between the magnetic flux density (B) at point x and the distance (d) of point x from the axis of the wire shown in the figure?

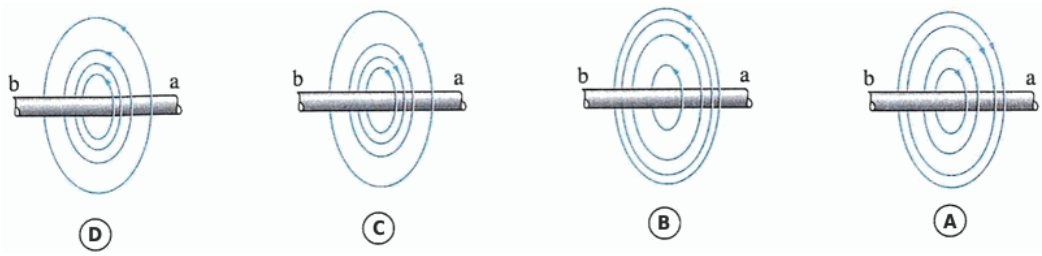


28 The opposite figure shows a vertical straight wire (P) surrounded by four compasses, the needle of each in the magnetic meridian plane. When an electric current passes through the wire downward (into the page), it produces a magnetic field stronger than the Earth's magnetic field. The compass whose needle's north pole does not change the direction it points to is .....

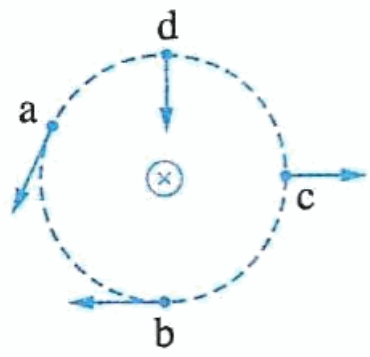


(A) x (B) y (C) z (D) k

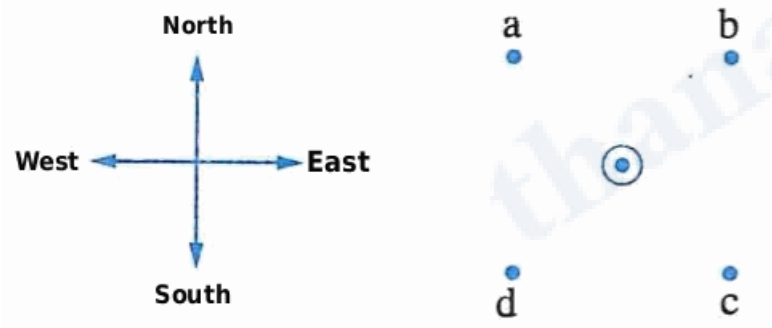
29 A wire ab carries a direct current, with the free electrons moving through it from end a to end b. Which of the following figures correctly represents the pattern of magnetic flux lines produced around the wire?



30 The opposite figure shows a straight wire perpendicular to the plane of the page carrying a current into the page. Points a, b, c and d lie in the plane of the page at equal distances from the wire. The point at which the arrow correctly shows the direction of the magnetic field of the wire's current is .....



31 In the opposite figure, a straight wire perpendicular to the plane of the page carries a current out of the page. The magnetic field points north-west at point .....



32 A straight wire carries a current of 4 A. If the magnetic flux density at a point at a certain distance from its axis is 2×10^{-5} T, the distance of the point from the axis of the wire equals .....

(A) 0.01 m (B) 0.02 m (C) 0.03 m (D) 0.04 m

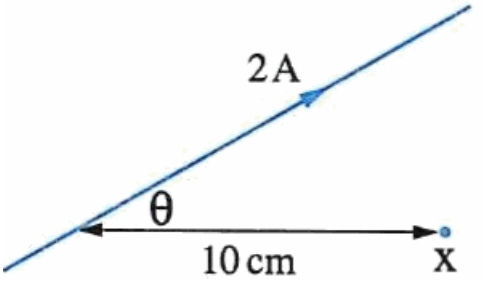
33 A current I passes through a straight wire, and the magnetic flux density it produces at a point 5 cm perpendicular distance from the wire is 5×10^{-5} T. The rate of flow of electrons through a cross-section of the wire equals .....

(A) 5.61×10^{21} electron/s (B) 7.81×10^{21} electron/s
(C) 5.61×10^{19} electron/s (D) 7.81×10^{19} electron/s

34 A battery of emf 8 V and internal resistance 2 Ω is connected to a straight wire of length 20 cm, cross-sectional area 3×10^{-8} m² and resistivity 4.5×10^{-6} Ω.m. The magnetic flux density at a point 10 cm perpendicular distance from the axis of the wire equals .....

(A) 4×10^{-6} T (B) 5×10^{-7} T (C) 6×10^{-8} T (D) 7×10^{-9} T

35 In the figure shown, the magnetic flux density produced by the current in the wire at point x .....



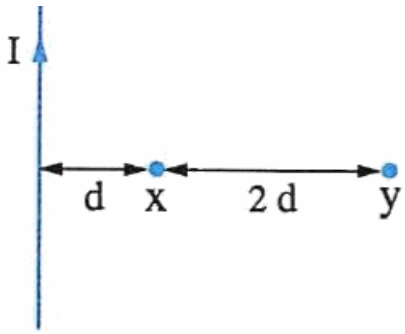
(A) equals 4×10^{-6} T (B) is greater than 4×10^{-6} T

(C) is less than 4×10^{-6} T (D) cannot be determined

36 If the ratio between the magnetic flux densities at two points (X, Y) near a straight wire carrying a current (B_X/B_Y) is $2/3$, the ratio between the perpendicular distances of the two points from the wire d_X/d_Y is .....

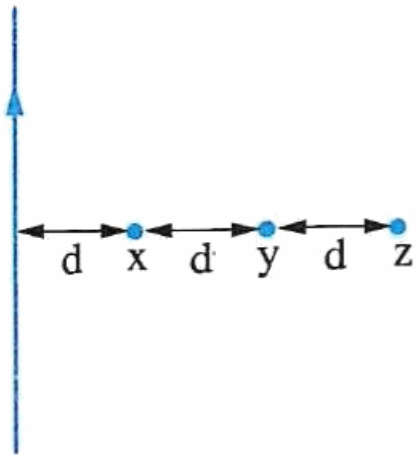
(A) $2/3$ (B) $1/3$ (C) $1/6$ (D) $3/2$

37 The opposite figure shows a straight wire carrying a direct current. The ratio between the magnetic flux densities produced by that current at points x and y (B_x/B_y) equals .....



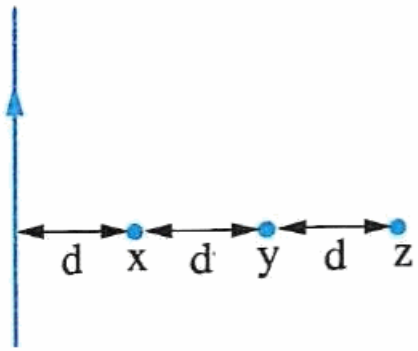
(A) $1/2$ (B) $3/1$ (C) $2/1$ (D) $1/3$

38 The opposite figure represents a long straight wire carrying a direct current. If the magnetic flux density at point (z) equals (B), the magnetic flux density:
at point (x) is ..... the magnetic flux density at point (z).



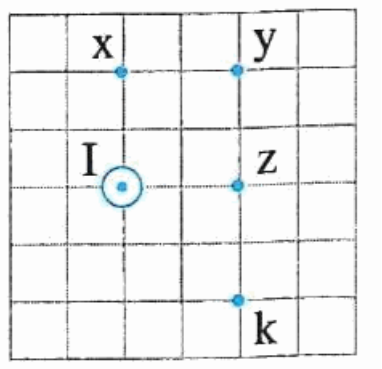
(A) greater by *2/3* B than
(B) less by *2/3* B than
(C) greater by 2 B than
(D) less by 2 B than

39 The opposite figure represents a long straight wire carrying a direct current. If the magnetic flux density at point (z) equals (B), the magnetic flux density:
at point (y) is ..... the magnetic flux density at point (z).



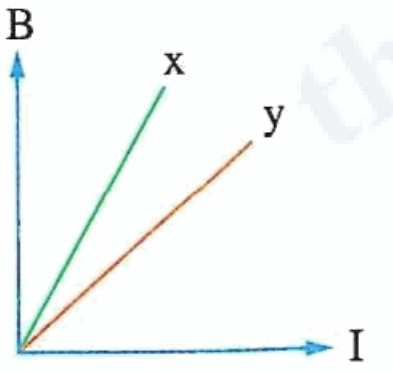
(A) greater by *1/3* B than
(B) less by *1/3* B than
(C) greater by *1/2* B than
(D) less by *1/2* B than

40 A straight wire is placed perpendicular to the page and carries a direct current out of the page, as in the opposite figure. The correct order of the magnetic flux density at the points shown is .....



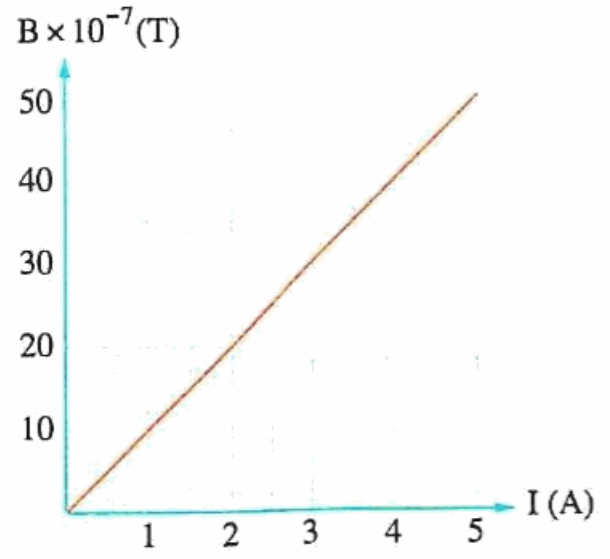
(A) $B_z > B_x = B_y > B_k$
(B) $B_y = B_z = B_k > B_x$
(C) $B_z > B_y = B_k > B_x$
(D) $B_z = B_x > B_y = B_k$

41 The opposite graph represents the change of the magnetic flux density (B) produced by a current in a straight wire with the current intensity (I) at two points x and y. So .....



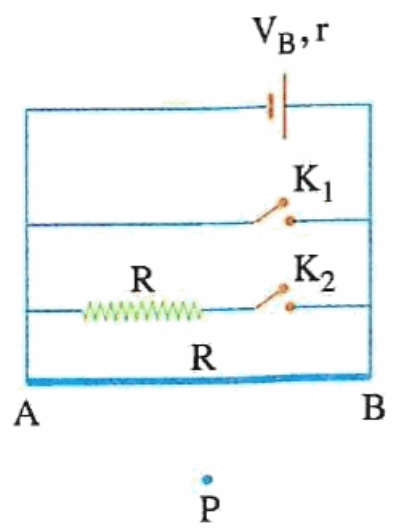
(A) the distance of point x from the axis of the wire is greater than that of point y
(B) the distance of point x from the axis of the wire is less than that of point y
(C) the distance of point x from the axis of the wire equals that of point y
(D) cannot be determined

42 The opposite graph represents the relation between the magnetic flux density (B) produced by a current in a straight wire at a certain point and the current intensity (I). The distance of that point from the axis of the wire is .....



(A) 10 cm (B) 20 cm (C) 40 cm (D) 100 cm

43 A straight wire AB of resistance R is connected in an electric circuit as in the opposite figure. The magnetic flux density at point P produced by the current through wire AB is greatest when .....



(A) switches K_1 and K_2 are both open

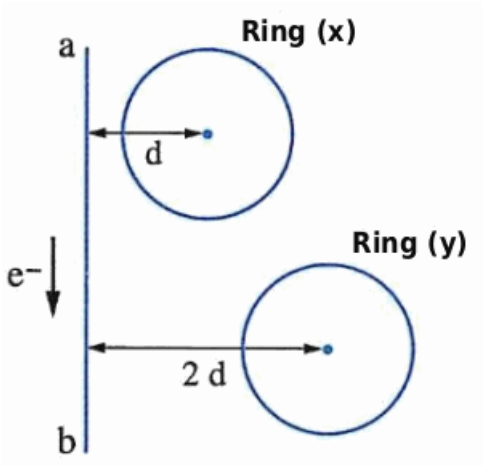
(B) switches K_1 and K_2 are both closed

(C) switch K_1 is closed and switch K_2 is open

(D) switch K_1 is open and switch K_2 is closed

44 Two identical metal rings x and y are placed in the same vertical plane, with a straight wire ab next to them in their plane, as in the opposite figure. If the free electrons move through the wire from end a to end b:

the direction of the magnetic flux lines through the two rings is .....



(A) perpendicular to the plane of the rings and inward

(B) perpendicular to the plane of the rings and outward

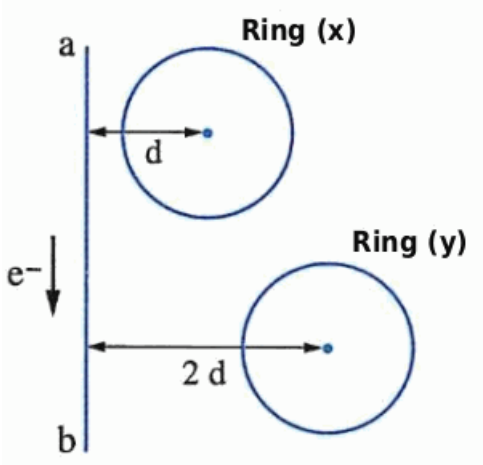
(C) in the plane of the rings toward the wire

(D) in the plane of the rings away from the wire

---

45 Two identical metal rings x and y are placed in the same vertical plane, with a straight wire ab next to them in their plane, as in the opposite figure. If the free electrons move through the wire from end a to end b:

the ratio between the magnetic fluxes through the two rings $(((\varphi_m)_x)/((\varphi_m)_y))$ is .....



(A) greater than one

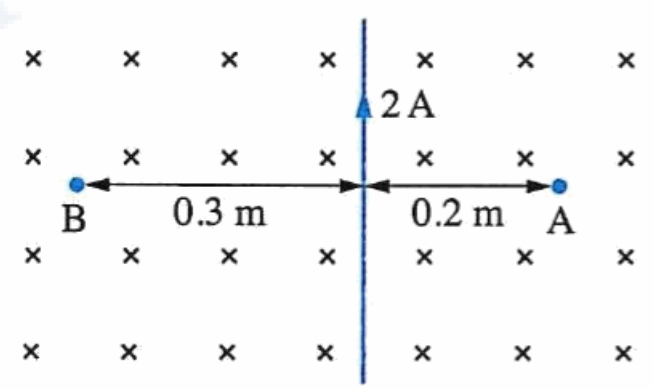
(B) less than one

(C) equal to one

(D) cannot be determined

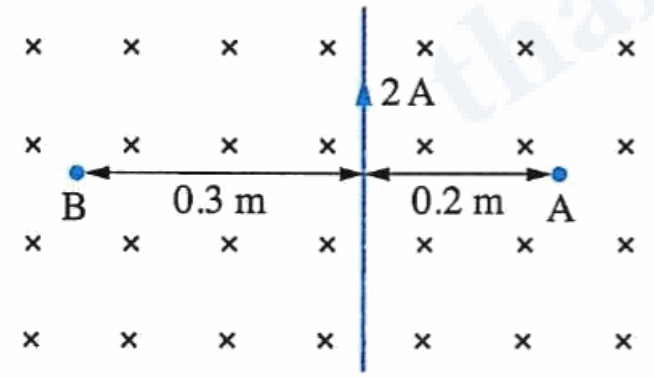
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46 In the figure shown, a long straight wire carries a current of 2 A and is placed perpendicular to a uniform magnetic field of flux density 4×10^{-6} T. The resultant magnetic flux density at: point A equals .....



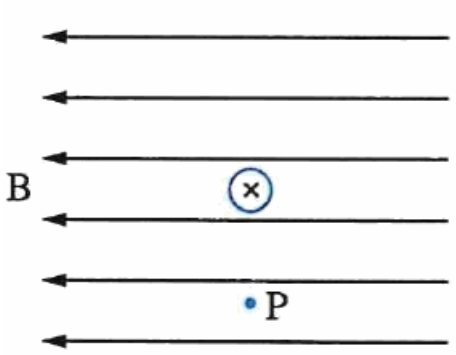
(A) 3.5×10^{-6} T (B) 6×10^{-6} T (C) 8×10^{-6} T (D) 9×10^{-6} T

47 In the figure shown, a long straight wire carries a current of 2 A and is placed perpendicular to a uniform magnetic field of flux density 4×10^{-6} T. The resultant magnetic flux density at: point B equals .....



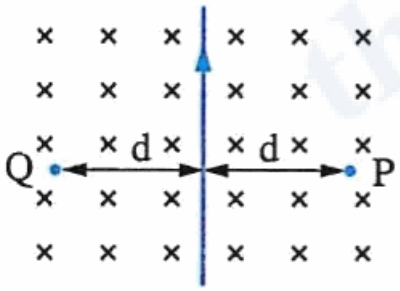
(A) 2.5×10^{-6} T (B) 5×10^{-6} T (C) 2.67×10^{-6} T (D) 9×10^{-6} T

48 In the opposite figure, a long straight wire perpendicular to the plane of the page carries a current of 40 A into the page. The wire is placed in a uniform magnetic field of flux density 6×10^{-5} T directed to the left of the page. The resultant magnetic flux density at point P, 10 cm from the axis of the wire, is .....



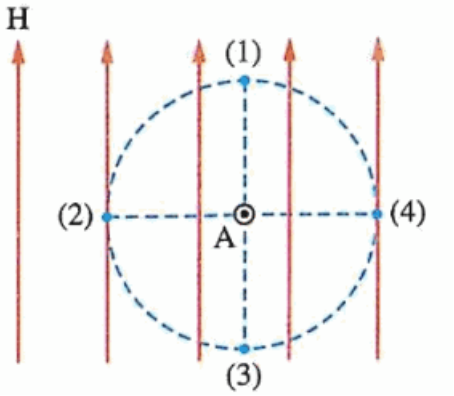
(A) 1.4×10^{-4} T (B) 1×10^{-4} T (C) 8×10^{-5} T (D) 2×10^{-5} T

49 In the opposite figure, a straight wire is placed perpendicular to a uniform magnetic field of density B directed into the page. If a current I passes through the wire, the total magnetic flux density at point P becomes 3B. The resultant magnetic flux density at point Q is .....



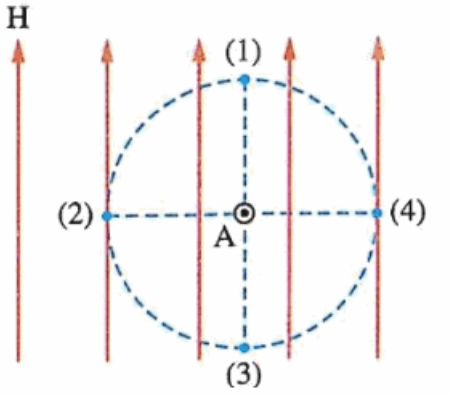
(A) zero (B) B (C) 2B (D) 3B

50 The opposite figure shows a wire A placed perpendicular to the plane of the page carrying a current out of the page, producing a magnetic flux of density H tesla at the points shown. If the flux density of the horizontal component of the Earth's field is H tesla in the direction shown, the resultant flux density of these two fields at:
point (1) equals ..... tesla.



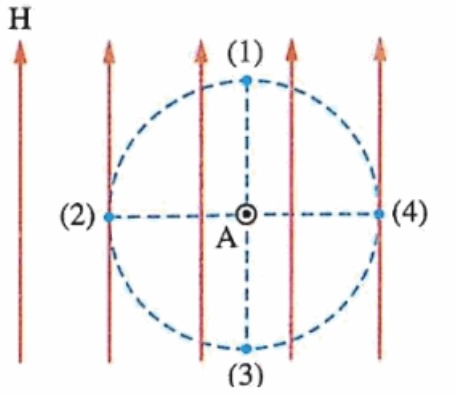
(A) $\sqrt{(2)}$ H (B) $\sqrt{(3)}$ H (C) H (D) 2 H

51 The opposite figure shows a wire A placed perpendicular to the plane of the page carrying a current out of the page, producing a magnetic flux of density H tesla at the points shown. If the flux density of the horizontal component of the Earth's field is H tesla in the direction shown, the resultant flux density of these two fields at:
point (2) equals ..... tesla.



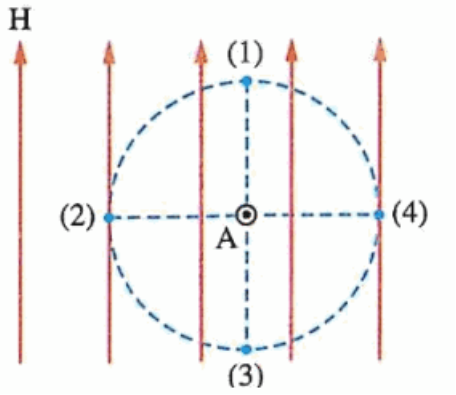
(A) 0 (B) H (C) 3 H (D) $\sqrt{(5)}$ H

52 The opposite figure shows a wire A placed perpendicular to the plane of the page carrying a current out of the page, producing a magnetic flux of density H tesla at the points shown. If the flux density of the horizontal component of the Earth's field is H tesla in the direction shown, the resultant flux density of these two fields at:
point (3) equals ..... tesla.



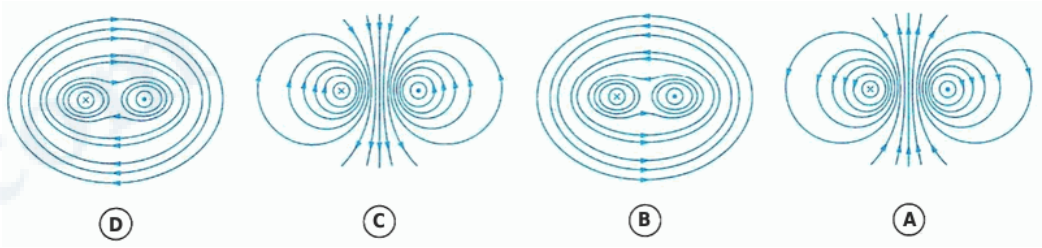
(A) 4 H (B) 2.5 H (C) $\sqrt{(2)}$ H (D) $\sqrt{(7)}$ H

53 The opposite figure shows a wire A placed perpendicular to the plane of the page carrying a current out of the page, producing a magnetic flux of density H tesla at the points shown. If the flux density of the horizontal component of the Earth's field is H tesla in the direction shown, the resultant flux density of these two fields at:
point (4) equals ..... tesla.

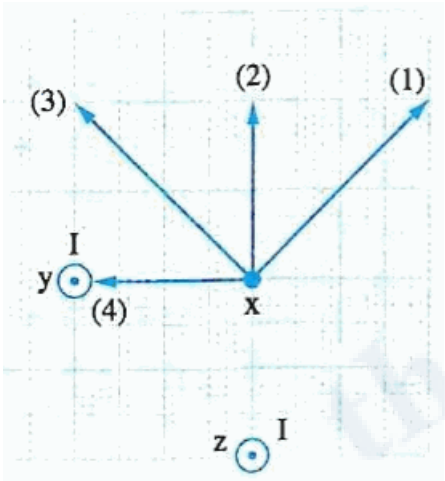


(A) H (B) 2 H (C) 3 H (D) 4 H

54 Which of the following figures correctly represents the pattern of magnetic flux lines produced by two equal currents flowing in opposite directions in two parallel wires?

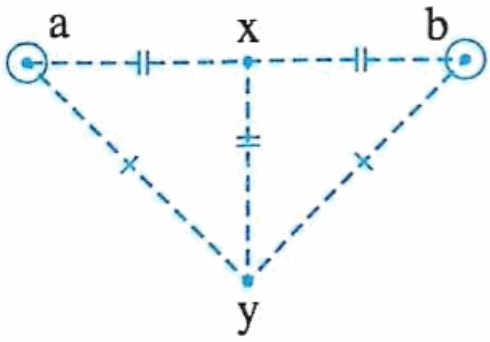


55 The opposite figure shows two long parallel wires y and z, each carrying a current of the same intensity (I). The direction of the resultant magnetic flux density at point x is direction .....



(A) (1) (B) (2) (C) (3) (D) (4)

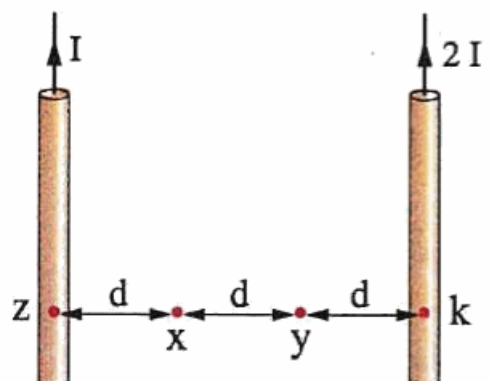
56 In the opposite figure, two parallel straight wires a and b perpendicular to the plane of the page carry currents I and 2I respectively. At point y, the resultant magnetic flux density (B) is calculated from the relation .....



(A) $B = B_a + B_b$ (B) $B = B_a - B_b$

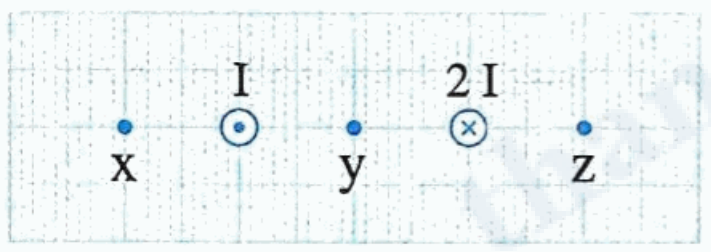
(C) $B = B_b - 2B_a$ (D) $B = \sqrt{(B_a^2 + B_b^2)}$

57 In the opposite figure, two long parallel wires each carry a current. The magnetic flux density is greatest at point .....



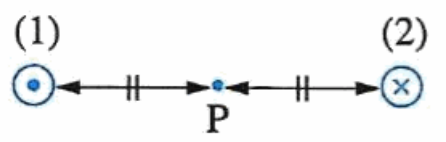
(A) x (B) y (C) z (D) k

58 Two long parallel straight wires carry currents (I, 2I) in opposite directions as in the opposite figure. The correct order of the magnetic flux density at points (x, y, z) is .....



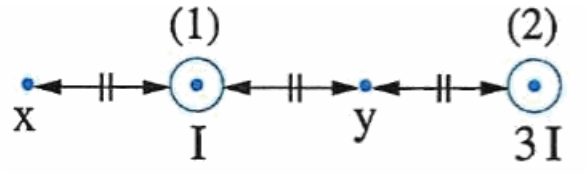
(A) $B_x > B_y > B_z$ (B) $B_z > B_y > B_x$ (C) $B_y > B_x > B_z$ (D) $B_y > B_z > B_x$

59 The opposite figure shows two very long parallel straight wires perpendicular to the plane of the page, each carrying a current. If the current in the first wire is greater than that in the second wire, the direction of the resultant magnetic flux density at point P is in the plane of the page and toward the .....



(A) right (B) left (C) top (D) bottom

60 In the opposite figure, two long parallel straight wires (1) and (2) carry currents I and 3I respectively. Comparing the resultant magnetic flux densities at points x and y, we find that the two resultants .....



(A) have the same magnitude and direction

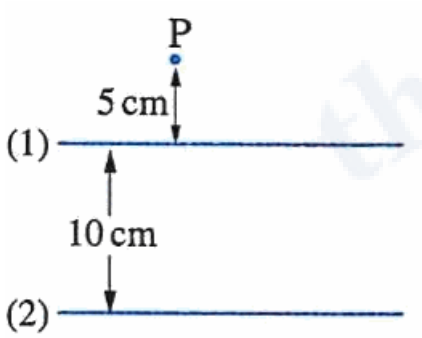
(B) differ in magnitude and direction

(C) have the same magnitude but different directions

(D) differ in magnitude but have the same direction

---

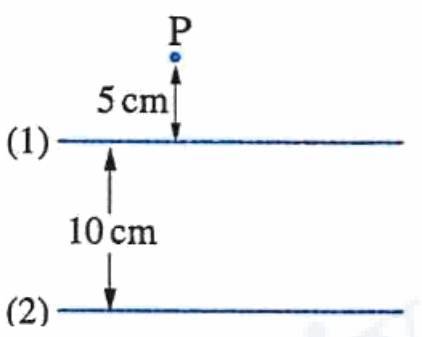
61 In the opposite figure, two parallel wires: wire (1) carries a current of 2 A and wire (2) a current of 4 A. The total magnetic flux density at point P if the two currents are: in the same direction equals .....



(A) 1.33×10^{-5} T (B) 2.66×10^{-5} T (C) 4.43×10^{-6} T (D) 6.65×10^{-6} T

---

62 In the opposite figure, two parallel wires: wire (1) carries a current of 2 A and wire (2) a current of 4 A. The total magnetic flux density at point P if the two currents are: in opposite directions equals .....



(A) 4.14×10^{-5} T (B) 3.06×10^{-7} T (C) 2.9×10^{-8} T (D) 2.67×10^{-6} T

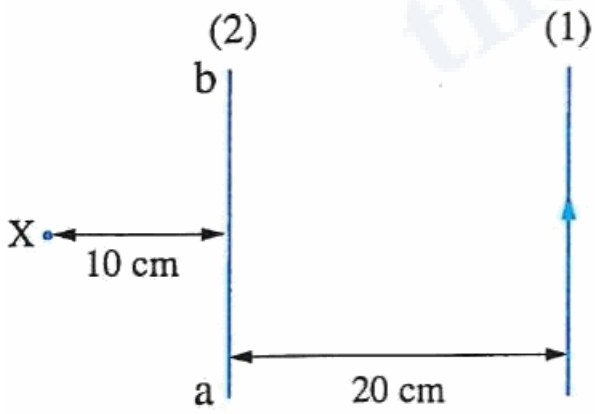
63 Two parallel straight wires x and y are 5 cm apart. Free electrons pass through a cross-section of wire x at a constant rate of 2.5×10^{20} electron/s, and wire y carries a current of 40 A. The flux density at a point midway between the two wires, if the direction of motion of the free electrons in wire x and the conventional current in wire y are:
in the same direction, equals .....

(A) 1.6×10^{-4} T (B) 0 (C) 2.56×10^{-4} T (D) 6.4×10^{-4} T

64 Two parallel straight wires x and y are 5 cm apart. Free electrons pass through a cross-section of wire x at a constant rate of 2.5×10^{20} electron/s, and wire y carries a current of 40 A. The flux density at a point midway between the two wires, if the direction of motion of the free electrons in wire x and the conventional current in wire y are:
in opposite directions, equals .....

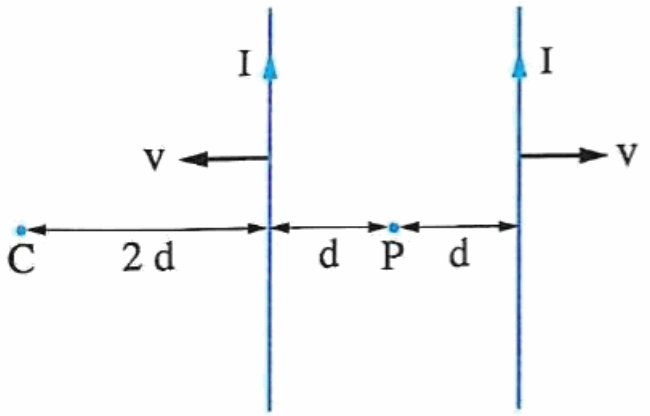
(A) 0 (B) 6.4×10^{-4} T (C) 3.2×10^{-4} T (D) 1.92×10^{-4} T

65 In the opposite figure, two long parallel wires (1) and (2) in the plane of the page are 20 cm apart. Wire (1) carries a current of 9 A. The magnitude and direction of the current in wire (2) that makes the resultant magnetic field of the two wires at point X zero are .....



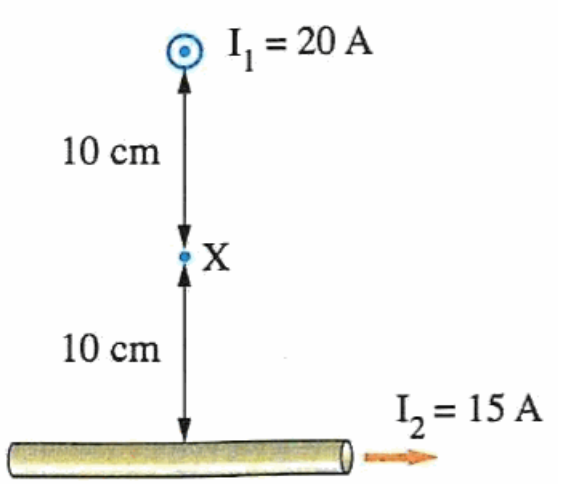
(A) 4.5 A, from a to b (B) 4.5 A, from b to a
(C) 3 A, from a to b (D) 3 A, from b to a

66 Two parallel straight wires each carry a current I in the same direction. While the two wires are moved a distance d in opposite directions at the same instant and with the same uniform speed (v), as in the opposite figure, the resultant magnetic flux density at points P and C respectively .....



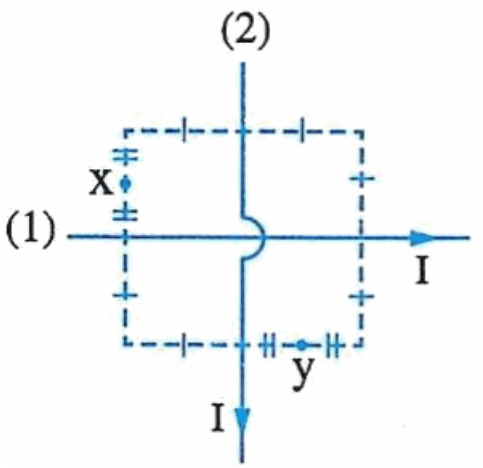
(A) at P: stays zero, at C: increases
(B) at P: stays zero, at C: decreases
(C) at P: increases, at C: increases
(D) at P: increases, at C: decreases

67 In the opposite figure, two long straight wires are perpendicular to each other with a shortest distance of 20 cm between them. The first wire is perpendicular to the page and carries a current of 20 A, and the second wire is in the plane of the page and carries a current of 15 A. The resultant magnetic flux density at point X equals .....



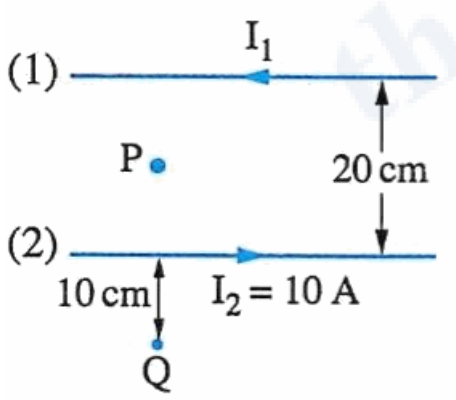
(A) 3×10^{-5} T
(B) 4×10^{-5} T
(C) 5×10^{-5} T
(D) 6×10^{-5} T

68 The opposite figure shows two perpendicular insulated straight wires, each carrying a current I. The ratio between the flux densities at points x and y respectively is .....



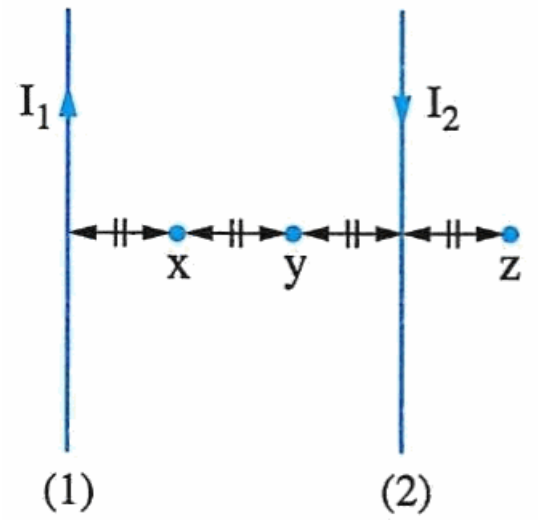
(A) 1 : 1 (B) 2 : 1 (C) 1 : 2 (D) 3 : 2

69 In the opposite figure, two parallel straight wires (1) and (2). If the total magnetic flux density B_t at point P (midway between the two wires) equals 6×10^{-5} T, the total magnetic flux density at point Q equals .....



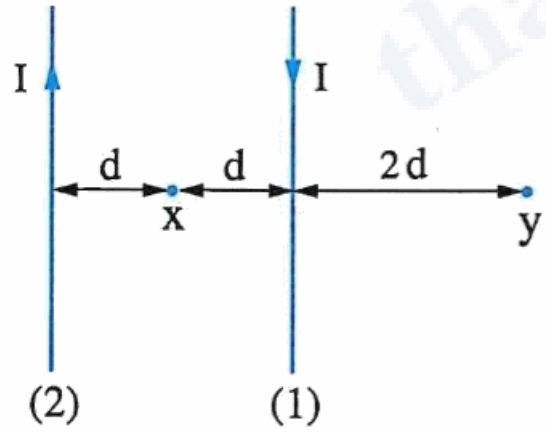
(A) 3.35×10^{-5} T (B) 2.68×10^{-6} T (C) 2.01×10^{-5} T (D) 6.7×10^{-6} T

70 In the opposite figure, two long parallel straight wires (1) and (2) each carry a current. If the resultant magnetic flux densities at points x and y are equal and the resultant magnetic flux density at point z is (B), the resultant magnetic flux density at point x is .....



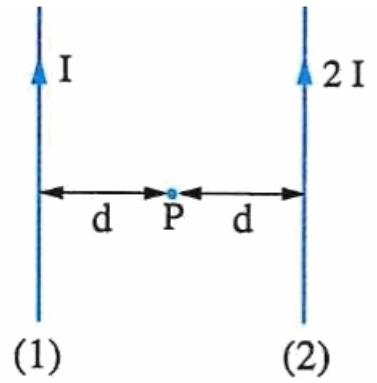
(A) 0.75 B (B) B (C) 1.5 B (D) 2 B

71 If the magnetic flux density at point x is B, the flux density at point y is .....



(A) *B/12* (B) 12 B (C) *B/2* (D) *B/8*

72 In the opposite figure, two very long parallel straight wires each carry a current. If the magnetic flux density produced by the current of wire (1) at point P equals B, the magnitude and direction of the resultant magnetic flux density at point P are .....



(A) B, perpendicular to the page and inward

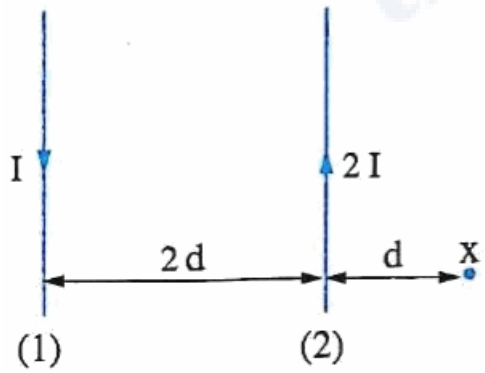
(B) 3 B, perpendicular to the page and inward

(C) B, perpendicular to the page and outward

(D) 3 B, perpendicular to the page and outward

---

73 In the opposite figure, when the current in wire (1) is increased to 6 I, the resultant magnetic flux density at point x .....



(A) increases to three times

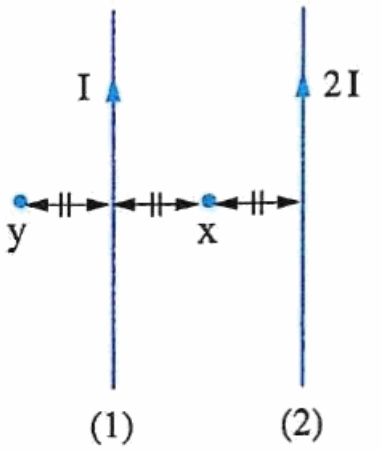
(B) increases to six times

(C) becomes zero

(D) decreases to one third

---

74 Two long parallel straight wires (1) and (2) carry currents in the same direction of I and 2I respectively, as in the opposite figure. Which of the following actions increases the magnetic flux density at both points (x) and (y)?



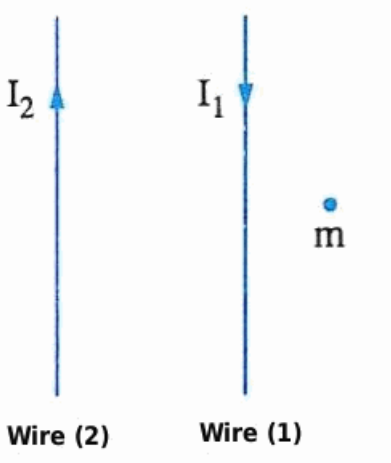
A Increasing the current in wire (1) to 2 I

B Increasing the current in wire (1) to 3 I

C Increasing the current in wire (2) to 4 I

D Passing no current in wire (2)

75 In the opposite figure, two long parallel straight wires (1) and (2) carry currents in opposite directions with $(I_1 > I_2)$. Which of the following actions increases the magnitude of the resultant magnetic flux density at point (m)?



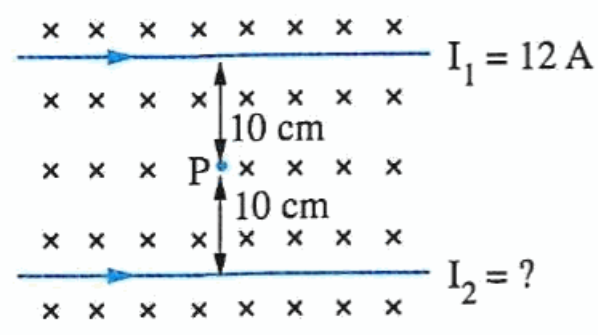
A Increasing the current (I_2) until it equals (I_1)

B Decreasing the current (I_1) until it equals (I_2)

C Reversing the direction of the current in one of the wires

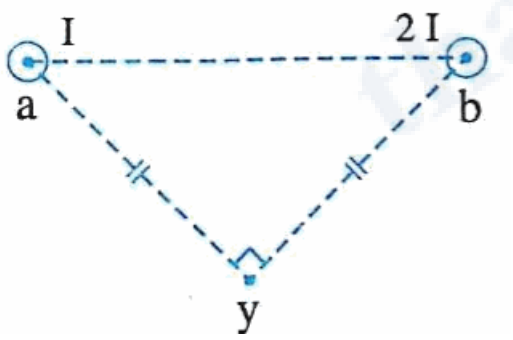
D Bringing one wire closer to the other

76 The opposite figure shows two very long parallel straight wires in the plane of the page, acted on by a uniform external magnetic field of flux density 2×10^{-5} T perpendicular to the plane of the page and inward. If the resultant magnetic flux density at point P equals 2×10^{-5} T into the page, the current in the second wire equals .....



(A) 24 A (B) 18 A (C) 12 A (D) 6 A

77 In the opposite figure, two parallel straight wires a and b carry currents I and 2I respectively as shown. If the flux density produced by wire a at point y is B, the resultant flux density at point y equals .....



(A) B (B) 2 B (C) $\sqrt{(3)}$ B (D) $\sqrt{(5)}$ B

78 Two long parallel straight wires (a) and (b) are placed perpendicular to the plane of the page and carry currents of the same intensity in opposite directions. The two wires are placed in different positions relative to each other as in the following figures.

At point (m), the magnitude of the resultant magnetic flux density is .....

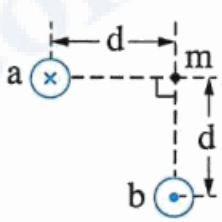


Figure (3)

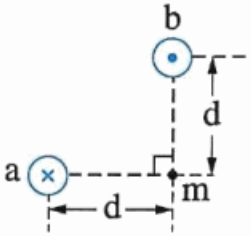


Figure (2)

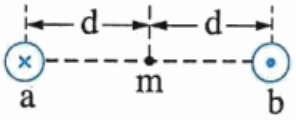


Figure (1)

(A) greatest in figure (1)

(B) greatest in figure (2)

(C) greatest in figure (3)

(D) equal in the three figures

---

79 Two long parallel straight wires (a) and (b) are placed perpendicular to the plane of the page and carry currents of the same intensity in opposite directions. The two wires are placed in different positions relative to each other as in the following figures.

The resultant magnetic flux densities at point (m) in figures (2) and (3) .....

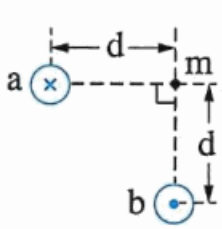


Figure (3)

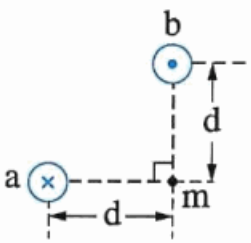


Figure (2)

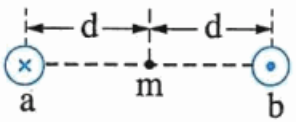


Figure (1)

(A) have the same magnitude and direction

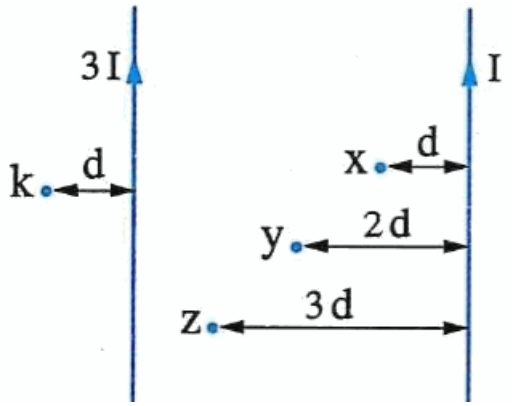
(B) have the same magnitude but different directions

(C) differ in magnitude but have the same direction

(D) differ in magnitude and direction

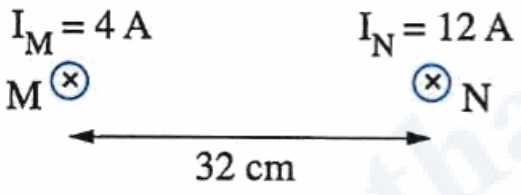
---

80 In the opposite figure, if the distance between the two wires is 4d, the neutral point is point .....



(A) x (B) y (C) z (D) k

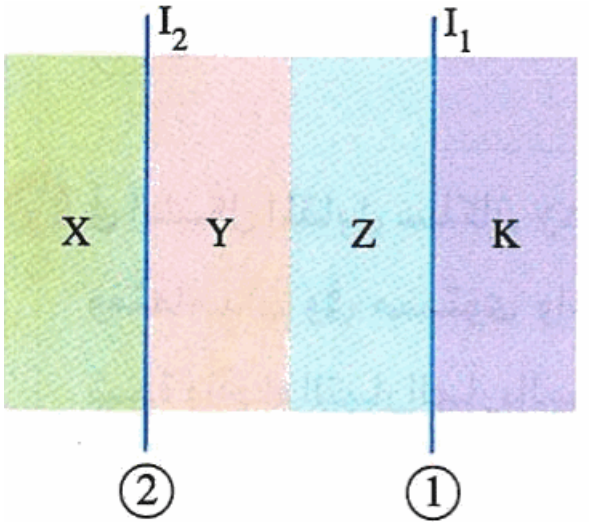
81 The opposite figure shows two long parallel wires M and N perpendicular to the plane of the page, carrying currents into the page. The neutral point is .....



(A) between them, 8 cm from wire M
(B) outside them, 8 cm from wire M
(C) between them, 24 cm from wire M
(D) outside them, 24 cm from wire M

82 In the opposite figure, two parallel straight wires in the same plane each carry a current. If $I_1 > I_2$, in which of the regions X, Y, Z, K is the neutral point located if the currents in the two wires are:

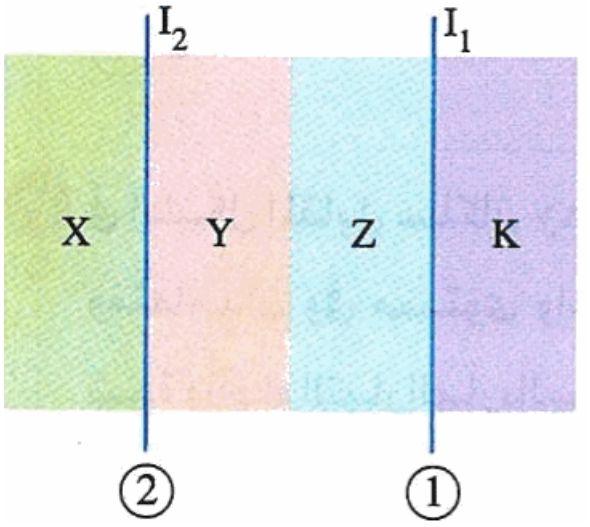
in the same direction?



(A) X (B) Y (C) Z (D) K

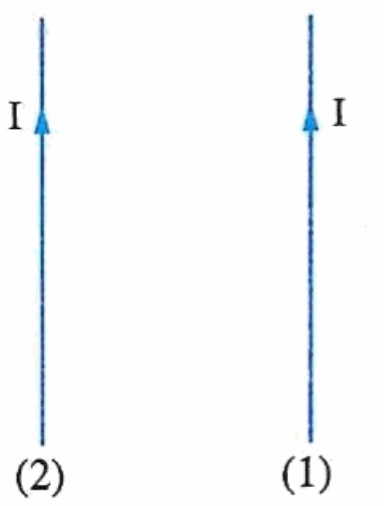
83 In the opposite figure, two parallel straight wires in the same plane each carry a current. If $I_1 > I_2$, in which of the regions X, Y, Z, K is the neutral point located if the currents in the two wires are:

in opposite directions?



(A) X (B) Y (C) Z (D) K

84 In the opposite figure, two parallel straight wires (1) and (2) each carry a current I in the same direction. Which of the following actions makes the neutral point disappear?



(A) Moving one wire away from the other

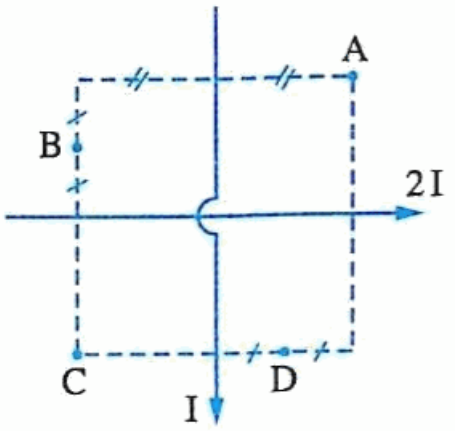
(B) Doubling the current in one of the wires

(C) Reversing the direction of the current in one of the wires

(D) Reversing the direction of the current in both wires

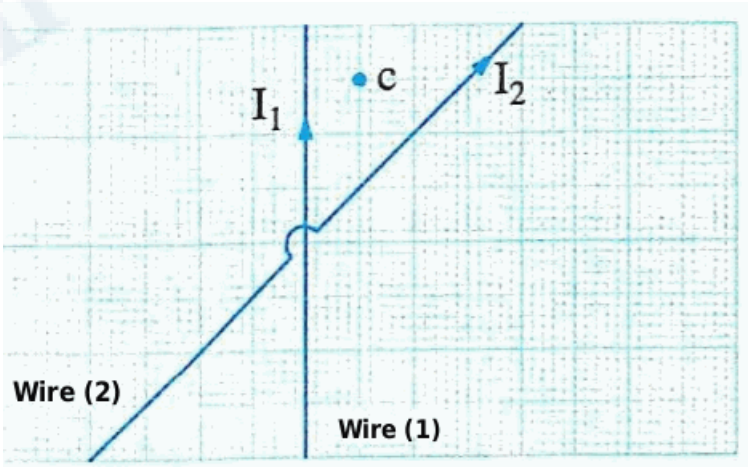
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85 In the figure, two perpendicular insulated wires each carry a current. Their resultant flux density is zero at point .....



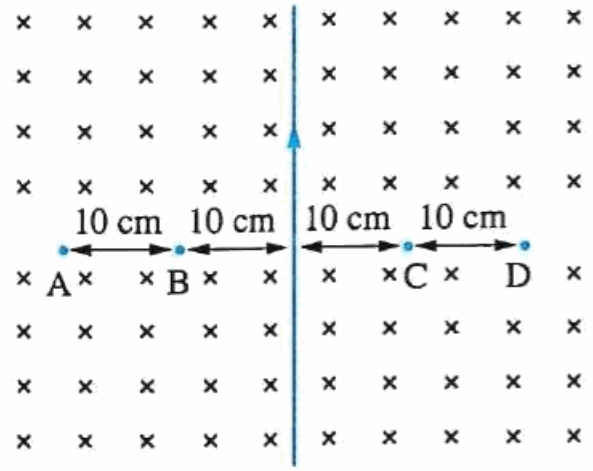
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86 Two long insulated straight wires (1) and (2) carry currents I_1 and I_2 in the directions shown in the opposite figure. If point (c) is a neutral point, which of the following relations is correct for the currents of the two wires?

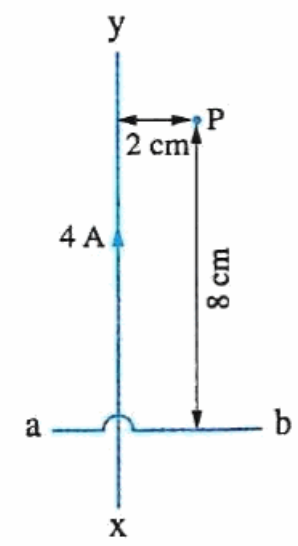


(A) $I_1 > I_2$
(B) $I_1 < I_2$
(C) $I_1 = I_2$
(D) cannot be determined

87 In the opposite figure, a long straight wire in the plane of the page carries a current of 10 A and is placed in a uniform magnetic field of flux density 2×10^{-5} T perpendicular to the page and inward. The point at which the resultant flux density is zero is .....



88 In the opposite figure, two long straight wires xy and ab, insulated from each other, are perpendicular and in the same plane. Wire (xy) carries a current of 4 A. The magnitude and direction of the current in wire (ab) so that the resultant flux density at point P is zero are .....

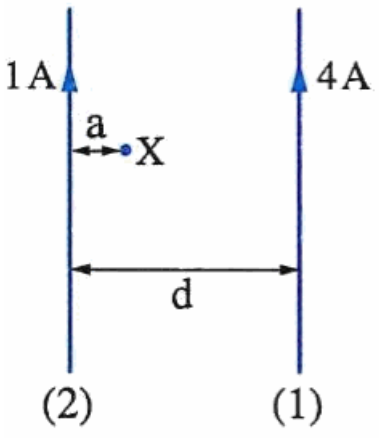


(A) 8 A, from a to b (B) 8 A, from b to a (C) 16 A, from a to b (D) 16 A, from b to a

89 A small compass is placed at a point between two parallel straight wires, 20 cm from the first wire, which carries a current of 2 A from south to north, and 40 cm from the second wire. The magnitude and direction of the current that, when passed through the second wire, causes no deflection of the compass needle are .....

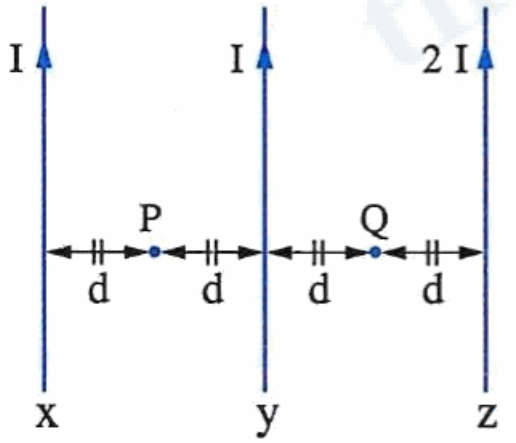
(A) 4 A, from north to south
(B) 2 A, from north to south
(C) 4 A, from south to north
(D) 2 A, from south to north

90 Two parallel straight wires (1) and (2) each carry a current as in the figure, so that point X is the neutral point, at a distance (a) from wire (2). If the current in wire (2) is increased to 4 A, the neutral point shifts by 10 cm. The distance d between the axes of the two wires equals .....



(A) 18.51 cm (B) 20.83 cm (C) 24.75 cm (D) 33.33 cm

91 In the figure shown, three long parallel straight wires each carry a current. The direction of the magnetic field at points P and Q is .....



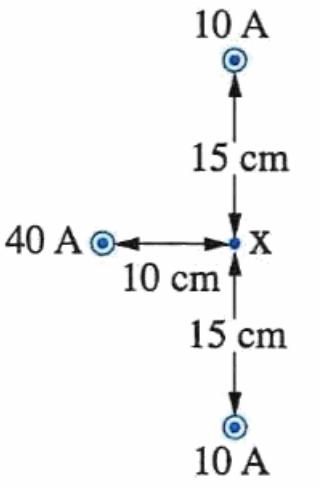
(A) at P: out of the page, at Q: out of the page

(B) at P: into the page, at Q: into the page

(C) at P: out of the page, at Q: into the page

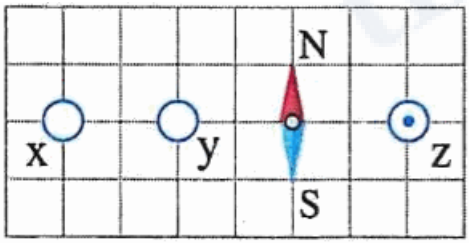
(D) at P: into the page, at Q: out of the page

92 The opposite figure shows three wires perpendicular to the plane of the page, each carrying a current. The resultant magnetic flux density at point x equals .....



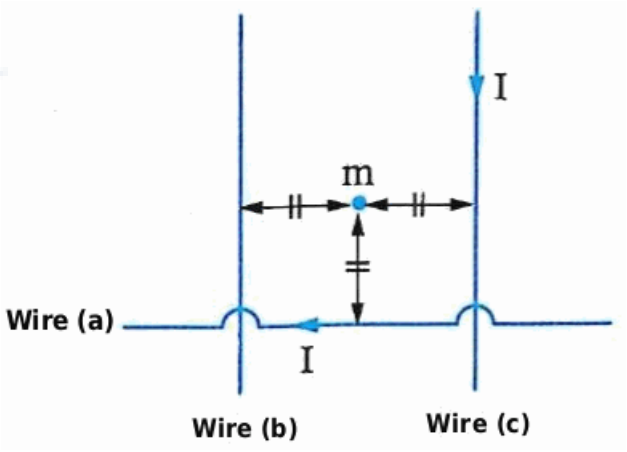
(A) 2×10^{-5} T (B) 8×10^{-5} T (C) 9×10^{-5} T (D) 4×10^{-4} T

93 Three vertical straight wires x, y and z in the same plane each carry a current I. A compass was placed between wires y and z, and its needle took the position shown in the opposite figure. Neglecting the Earth's magnetic field, the directions of the currents in wires x and y respectively are .....



(A) out of the page, out of the page
(B) out of the page, into the page
(C) into the page, out of the page
(D) into the page, into the page

94 In the opposite figure, three long straight wires (a), (b) and (c) lie in the same plane and each carries a current. If point (m) is a neutral point, then .....



(A) the current in wire (b) is upward, of intensity I

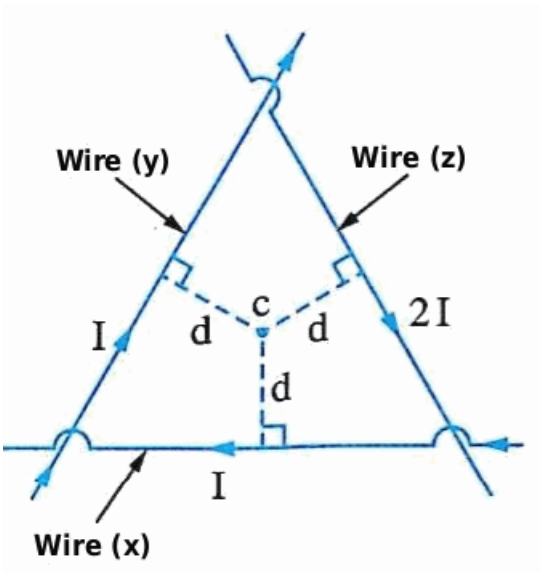
(B) the current in wire (b) is upward, of intensity 2I

(C) the current in wire (b) is downward, of intensity I

(D) the current in wire (b) is downward, of intensity 2I

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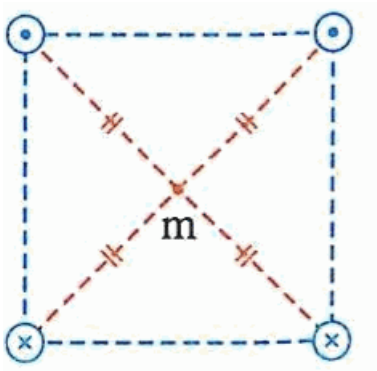
95 In the opposite figure, three wires x, y and z in the same plane each carry a current. If the magnetic flux density at point c produced by the current in wire z equals B_o, the magnitude of the resultant flux density at point c produced by the currents in the wires equals .....



(A) zero (B) $2B_o$ (C) $3B_o$ (D) $4B_o$

---

96 In the opposite figure, four very long parallel wires perpendicular to the plane of the page are placed at the corners of a square, each carrying a current of the same intensity in the direction shown. The direction of the resultant flux density at point (m) is .....



(A) perpendicular to the page and inward

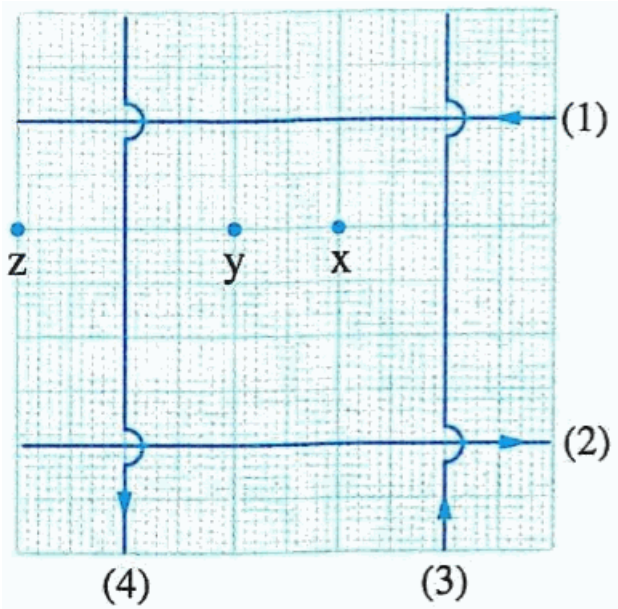
(B) perpendicular to the page and outward

(C) in the plane of the page, to the right of the page

(D) in the plane of the page, to the left of the page

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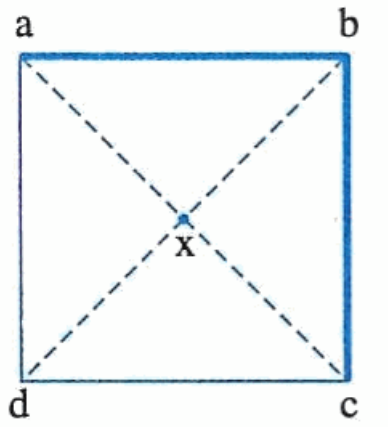
97 The opposite figure shows four long straight wires (1), (2), (3) and (4) in the same plane, each carrying a current I. The correct order of points x, y and z according to the resultant magnetic flux density at each is .....



(A) $z < y < x$ (B) $z > y > x$ (C) $z < y = x$ (D) $z > y = x$

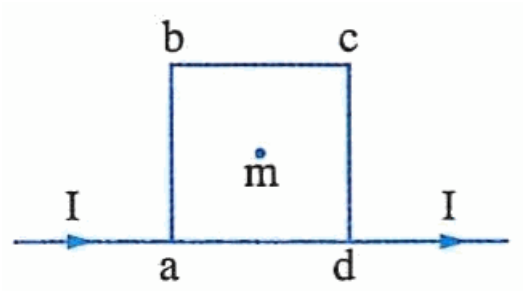
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98 Two wires abc and adc of the same metal have the same length but different cross-sectional areas. They are joined together in the shape of a square as in the opposite figure. The two points which, when connected to an electric source, make the resultant magnetic flux density at point x zero are .....



(A) a, d (B) a, c (C) a, b (D) b, d

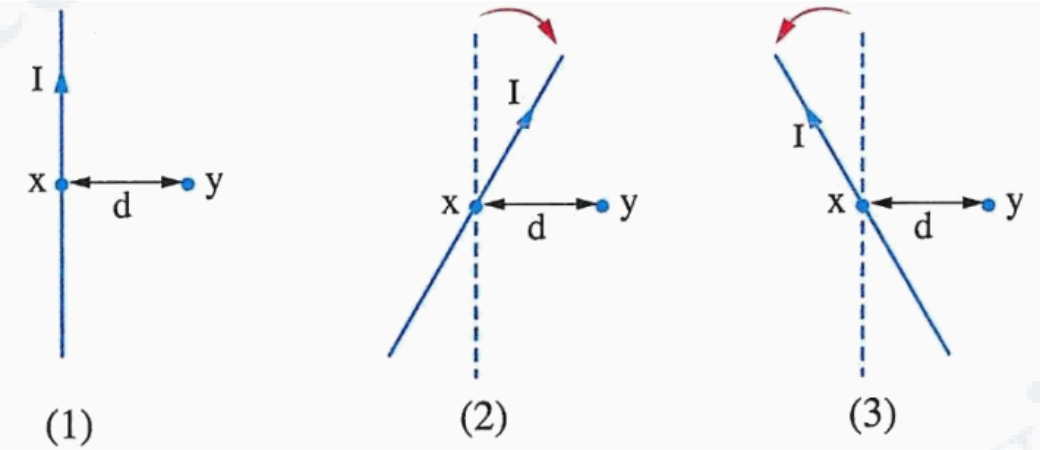
99 A wire of uniform cross-section is bent into a square abcd and a current is passed through it as in the opposite figure. If the magnetic flux density at point (m) produced by the current in part (ab) of the wire alone equals (B_o), the magnitude of the resultant magnetic flux density at point (m) equals .....



(A) zero (B) B_o (C) $2B_o$ (D) $4B_o$

100 In figure (1), a long straight wire in the plane of the page carries a current (I), and point (y) is at a distance (d) from it. The wire is rotated in the plane of the page about an axis through point (x) by 30° twice: first clockwise as in figure (2), and second anticlockwise as in figure (3).

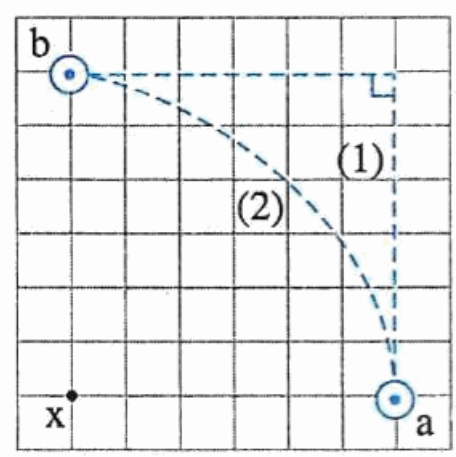
The correct order of the magnetic flux density at point (y) in the three figures is .....



(A) $B_1 = B_2 = B_3$ (B) $B_1 > B_2 = B_3$ (C) $B_2 > B_3 > B_1$ (D) $B_2 = B_3 > B_1$

101 A straight wire carrying a direct current is placed perpendicular to the plane of the page. It can be moved from position a to position b along one of two paths (1) or (2) (path (2) is a circle centred at point x), as in the opposite figure. What happens to the magnetic flux density at point x while the wire is moved along:

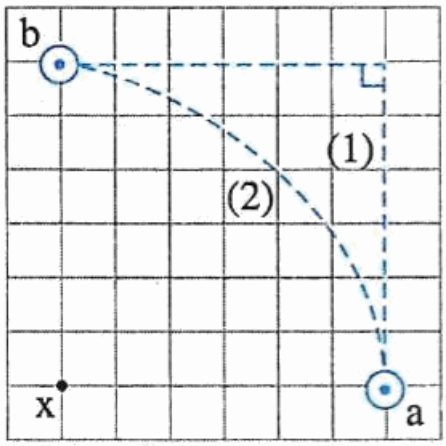
path (1)?



(A) it increases
(B) it does not change
(C) it increases then decreases
(D) it decreases then increases

102 A straight wire carrying a direct current is placed perpendicular to the plane of the page. It can be moved from position a to position b along one of two paths (1) or (2) (path (2) is a circle centred at point x), as in the opposite figure. What happens to the magnetic flux density at point x while the wire is moved along:

path (2)?



(A) it increases

(B) it does not change

(C) it increases then decreases

(D) it decreases then increases

Essay questions — 16 questions

1 A straight wire of length $1\ m$ is wound into a coil of one turn and placed perpendicular to a magnetic field of density $1\ T$. Find the magnetic flux through the turn if it is:

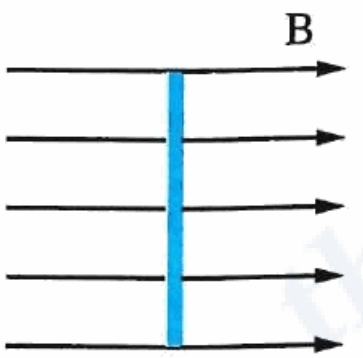
(1) circular.

(2) square.

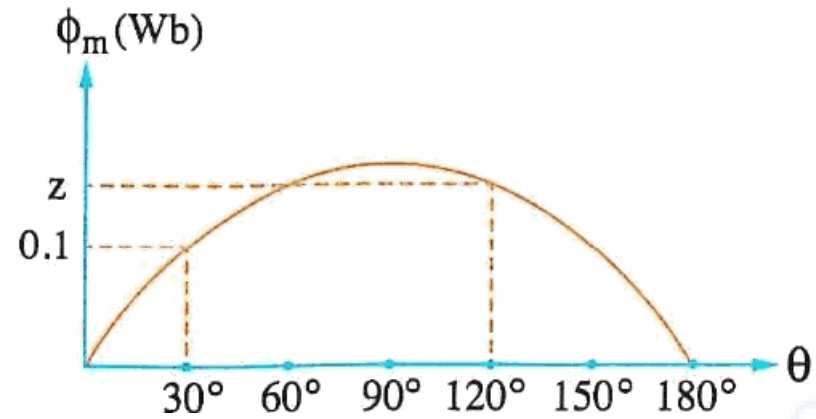
2 The opposite figure shows a side view of a coil placed in a uniform magnetic field, and the flux through the coil is $4\times10^{-2}\ Wb$. What is the smallest angle the coil must rotate clockwise from the position shown so that the flux through the coil becomes:

(1) $2\times10^{-2}\ Wb$?

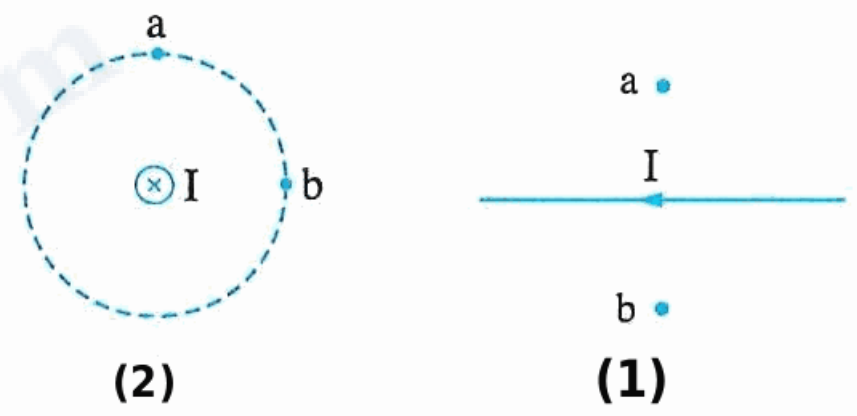
(2) $-2\times10^{-2}\ Wb$?



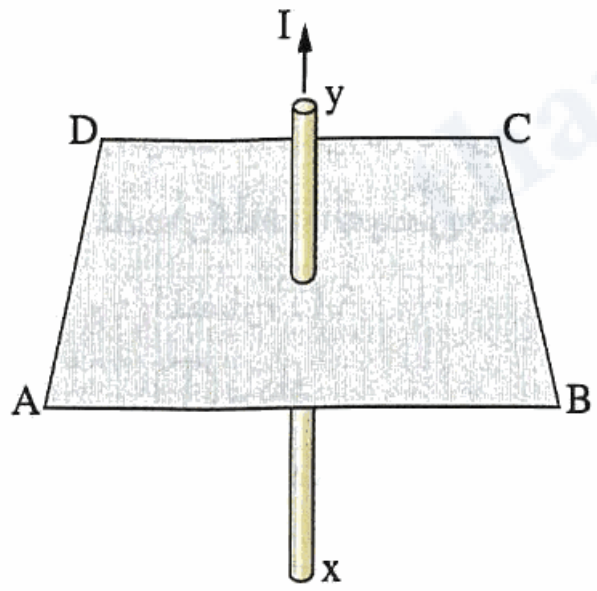
3 The opposite graph represents the relation between the magnetic flux (φ_m) through a coil rotating at a uniform rate in a magnetic field and the angle (θ) between the plane of the coil and the direction of the field. Find the value of z.



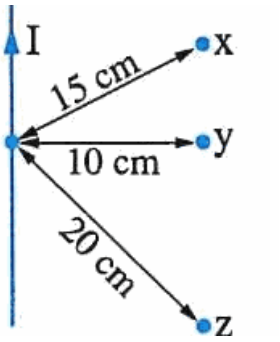
4 What is the direction of the magnetic field at each of points a and b produced by a current (I) in the straight wire shown in each of figures (1) and (2)?



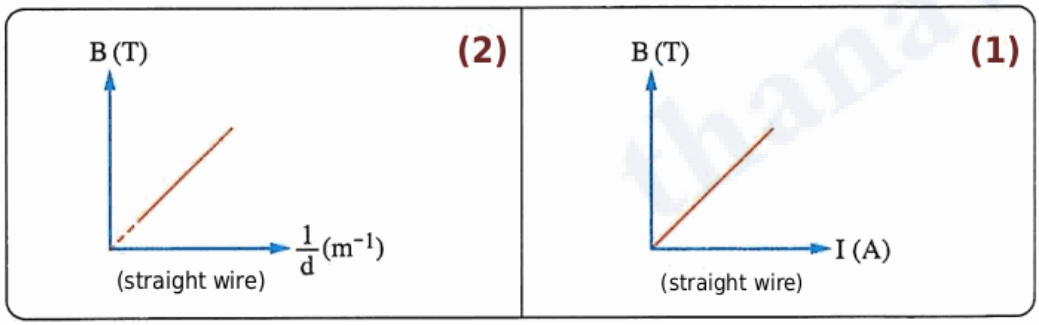
5 A vertical straight wire xy carries a current and passes through a horizontal sheet of cardboard as shown in the figure. Draw on the sheet ABCD four of the magnetic field lines produced by the current in wire xy.



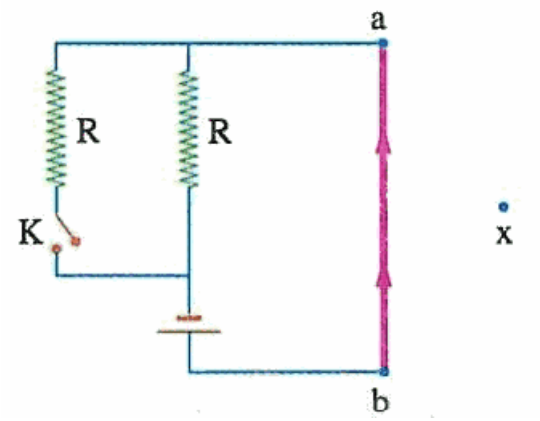
6 In the opposite figure, a very long straight wire carries a current, and three points x, y and z lie next to it on a line parallel to it. Compare the values of the magnetic flux density at these points, explaining your answer.



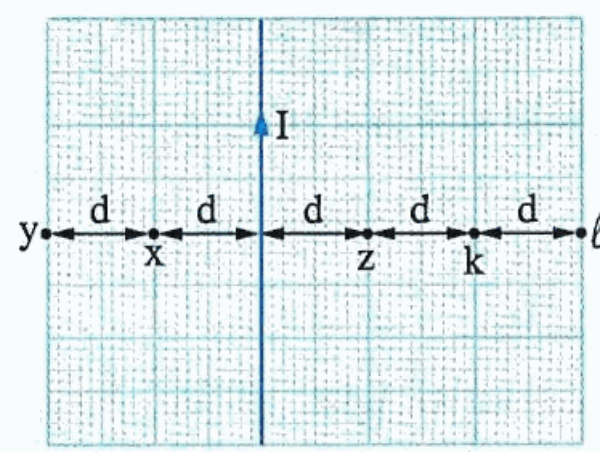
7 Write the mathematical relation represented by each of the following graphs and what the slope of the straight line represents:
(where: (B) is the magnetic flux density, (I) the current in the wire, (d) the distance of the point from the axis of the wire)



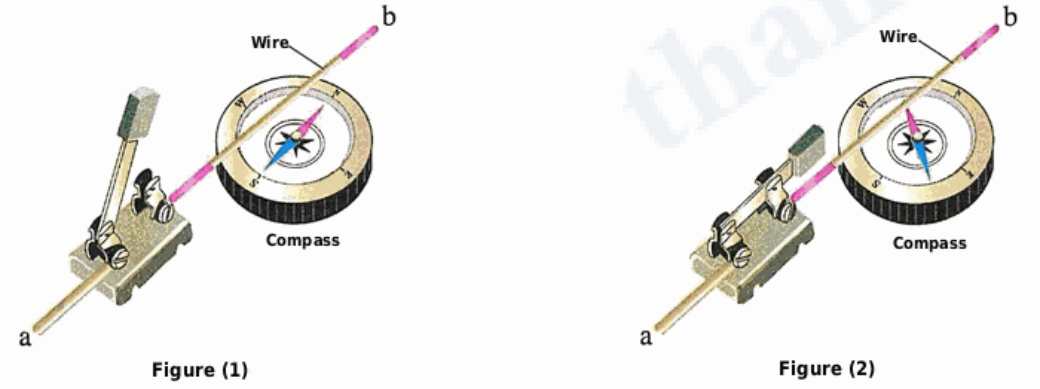
8 Explain: the magnetic flux density at point x produced by the current in wire ab increases when switch K in the opposite circuit is closed.



9 In the opposite figure, if the magnetic flux density produced by the current (I) in the wire at point x equals B in a certain direction, determine, with explanation, the point at which the flux density becomes $B/2$ in the opposite direction.



10 Figure (1) shows a compass placed in the magnetic meridian plane below a straight wire. When a current passes through the wire, the compass needle is deflected and settles as in figure (2). Determine the direction of the current in the wire.

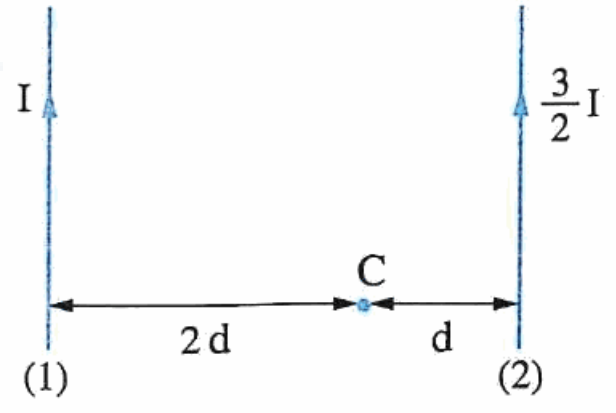


11 Two parallel straight wires (x, y) are $0.3\ m$ apart. Wire x carries a current of $2\ A$ and wire y a current of $3\ A$. Calculate the distance of the neutral point from wire y if the two currents flow:

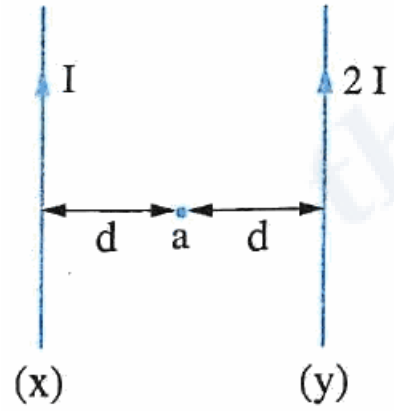
(1) in the same direction.

(2) in opposite directions.

12 Two parallel straight wires (1) and (2) each carry a current as in the figure. Find the resultant magnetic flux density at point C in terms of I, d and μ.



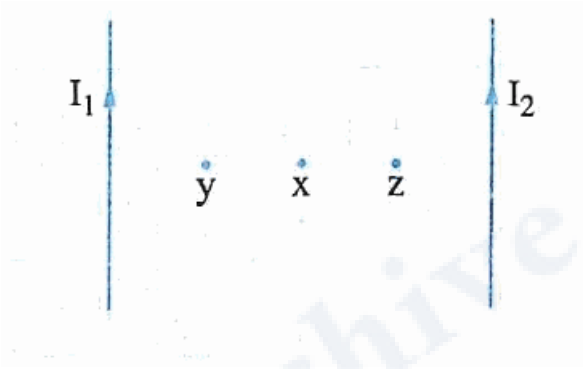
13 Two parallel straight wires x and y each carry a current as in the opposite figure. Explain what happens to the magnetic flux density at point a if wire x is moved a distance *1/2d* toward wire y.



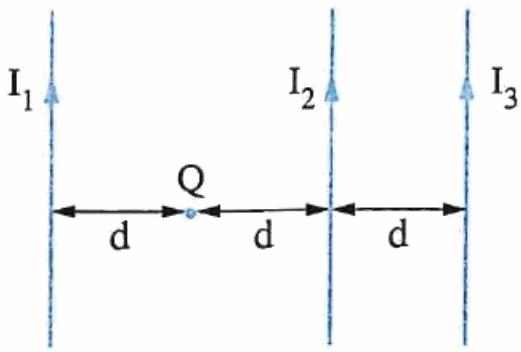
14 In the opposite figure, when currents I_1 and I_2 flow in the two parallel straight wires, point x is the neutral point. What change must be made to the current I_2 so that the neutral point becomes:

(1) at point y?

(2) at point z?



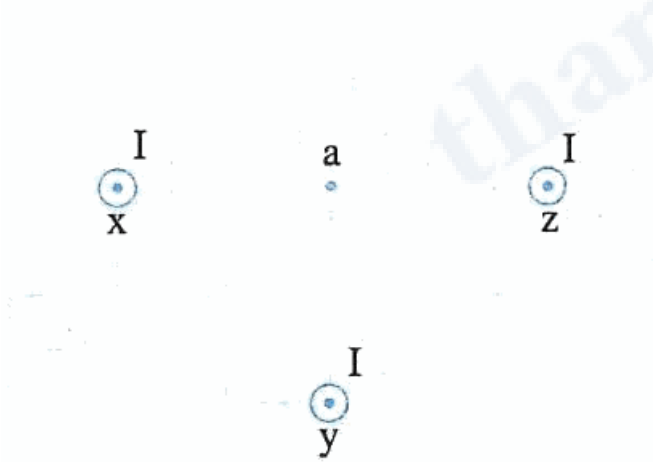
15 In the opposite figure, three long parallel straight wires carry currents. If the resultant magnetic flux density is zero at point Q, prove that: $I_1 < (I_2 + I_3)$



16 In the figure shown, three parallel straight wires x, y and z each carry a current I. If the magnetic flux density produced by wire x at point a equals B, calculate the resultant magnetic flux density at point a in terms of B when there is no current in:

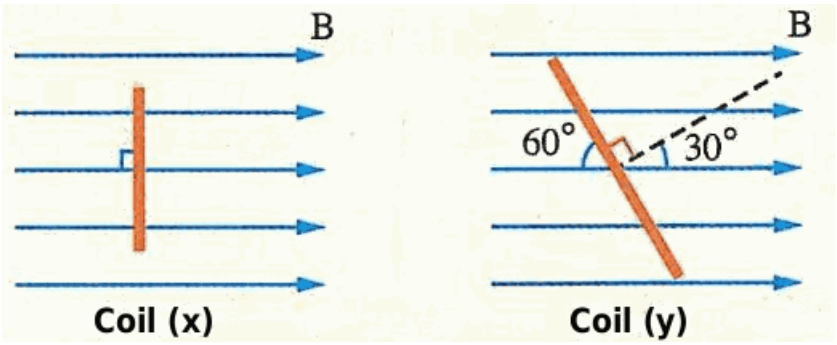
(1) wire y

(2) wire z



Past exam questions — 23 questions

1 In the opposite figure, two rectangular coils (x) and (y) of areas A and 3A respectively are placed in a uniform magnetic field. The ratio between the magnetic fluxes cutting them $((\varphi_m)_x)/((\varphi_m)_y)$ is ..... (Sample exam 2025)



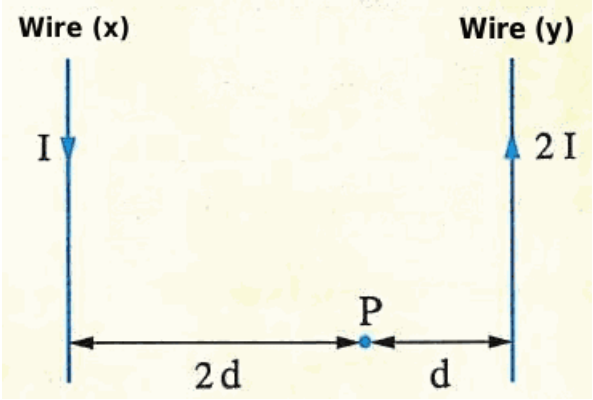
(A) $(\sqrt{(3)})/2$ (B) $(2\sqrt{(3)})/9$ (C) $1/(\sqrt{(3)})$ (D) $(2\sqrt{(3)})/5$

2 A long straight wire carries a current I as shown in the figure. Which of the following relations correctly expresses the magnetic flux density (B) produced by the wire's current at points x, y and z, which lie in the same plane as the wire? (Trial exam / June 2021)



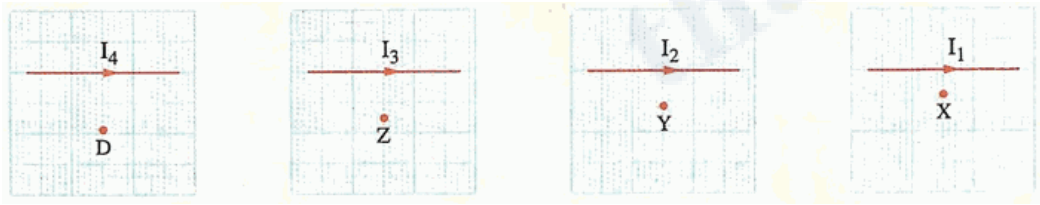
(A) $B_z > B_y$ (B) $B_y < B_x$ (C) $B_x < B_z$ (D) $B_y = B_z$

3 In the opposite figure, the magnetic flux density produced by the currents in wires (x) and (y) at point P equals B_t. If the direction of the current in wire (x) is reversed while the current in wire (y) stays as it is, the magnetic flux density at point P becomes ..... (Trial exam / June 2021)



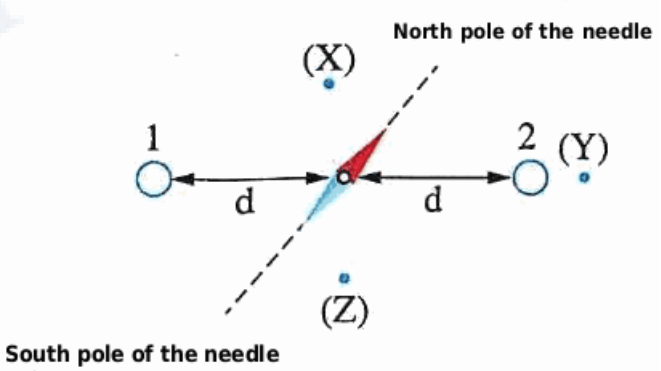
(A) $3/7B_t$ (B) $2/3B_t$ (C) $3/5B_t$ (D) $3/8B_t$

4 The following figure represents four wires carrying different currents I_1, I_2, I_3 and I_4, and the flux density at points X, Y, Z and D is the same. The greatest current is ..... (1st session 2021)



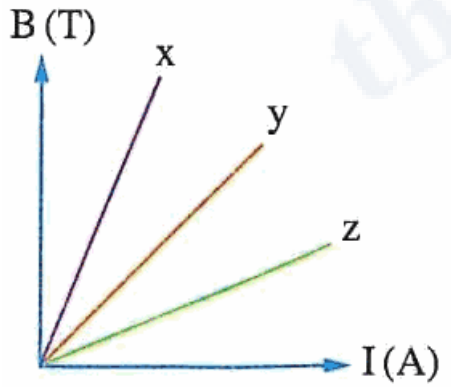
(A) I_1 (B) I_2 (C) I_3 (D) I_4

5 The opposite figure represents two straight wires 1 and 2 in a plane perpendicular to the page, with a magnetic needle placed midway between them. If each carries a current I out of the page, the north pole of the needle ..... (2nd session 2021)



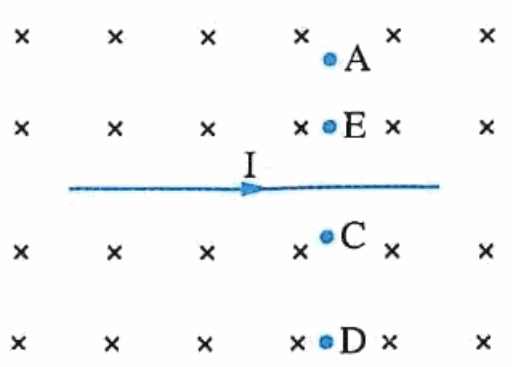
(A) is deflected toward point X
(B) is deflected toward point Y
(C) is deflected toward point Z
(D) stays in its position without deflection

6 The opposite graph represents the relation between the magnetic flux density (B) produced by a current at a point and the current (I) in three wires x, y and z, each separately. This point is ..... (2nd session 2021)



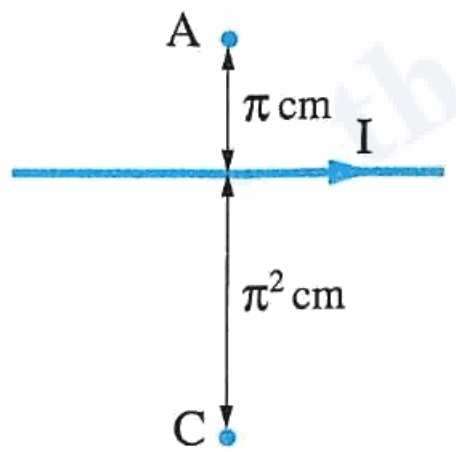
(A) closer to wire (z) than to wire (y)
(B) at equal distances from wires (x), (y) and (z)
(C) closer to wire (x) than to wire (y)
(D) closer to wire (y) than to wire (x)

7 In the figure shown, a straight wire carrying a current (I) is placed in a uniform magnetic field. The order of the resultant flux density (B) at points A, E, C and D is ..... (1st session 2022)



(A) $B_C > B_D > B_A > B_E$ (B) $B_D > B_C > B_E > B_A$ (C) $B_A > B_C > B_D > B_E$ (D) $B_E > B_C > B_D > B_A$

8 The opposite figure represents a straight wire carrying a current (I), with points A and C on either side of the wire. If the flux density at point A is B_A and the magnetic flux density at point C is B_C, the ratio B_A/B_C equals ..... (2nd session 2022)

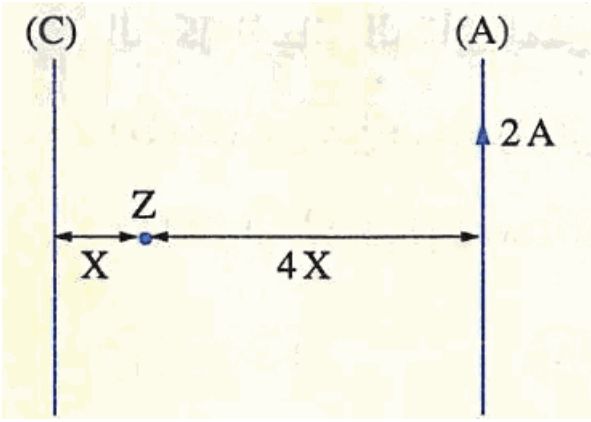


(A) $1/(\pi)$ (B) $1/(2\pi)$ (C) 2π (D) π

9 Two long parallel wires (X) and (Y) are separated by a perpendicular distance of $0.5\ m$ and carry currents in the same direction of I and 3I respectively. The neutral point is at a distance of ..... (Trial exam 2023)

(A) $0.125\ m$ from wire Y (B) $0.25\ m$ from wire Y
(C) $0.125\ m$ from wire X (D) $0.625\ m$ from wire X

10 The opposite figure shows two long parallel wires (A) and (C), each carrying a current. To get a neutral point at point (Z), which of the following choices is correct for the magnitude and direction of the current in wire (C)? (1st session 2023)



(A) *2 A*, in the same direction as the current in wire (A)

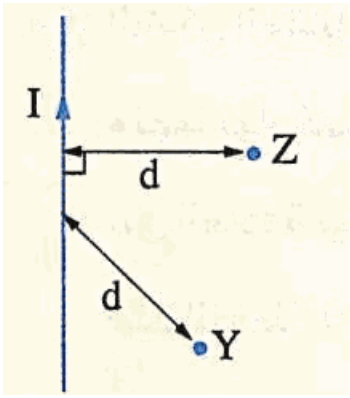
(B) *0.5 A*, in the same direction as the current in wire (A)

(C) *0.5 A*, opposite to the current in wire (A)

(D) *2 A*, opposite to the current in wire (A)

---

11 The figure represents a straight wire carrying a current (I). Which of the following choices correctly expresses the relation between the magnetic flux densities (B) produced by the wire's current at points (Z) and (Y), which lie in the same vertical plane as the wire? (2nd session 2023)



(A) $B_Y = B_Z$, in opposite directions

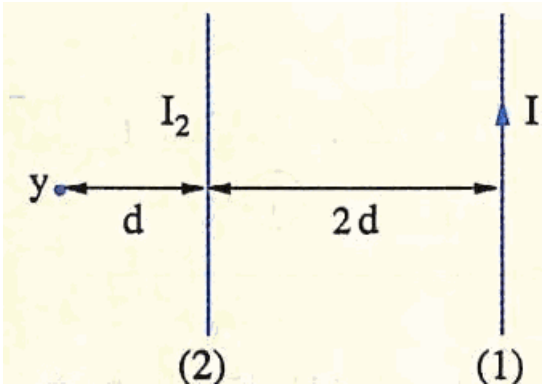
(B) $B_Y = B_Z$, in the same direction

(C) $B_Y < B_Z$, in opposite directions

(D) $B_Y > B_Z$, in the same direction

---

12 The figure shows two parallel wires (1) and (2) carrying currents I_1 and I_2 respectively. For point (y) to be a neutral point of the two magnetic fields, the magnitude and direction of the current I_2 must be ..... (2nd session 2023)



(A) $I_1/2$, upward (B) I_1, upward (C) $2I_1$, downward (D) $I_1/3$, downward

13 When a current passes through a straight wire of uniform cross-section and resistance (R), whose ends are connected to a DC source and which is placed in air, a magnetic field of flux density (B) is produced at a point near the wire. Which of the following changes decreases the flux density at the same point, other factors being constant? (1st session 2024)

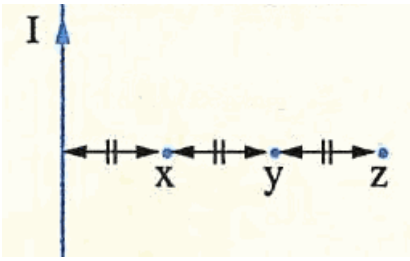
(A) Replacing the wire with a shorter one

(B) Replacing the wire with a longer one

(C) Replacing the wire with one of larger cross-sectional area

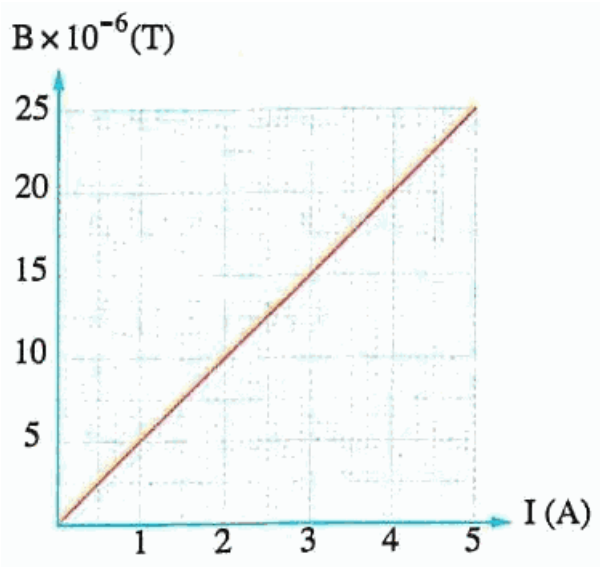
(D) Replacing the source with one of greater emf

14 In the opposite figure, a straight wire carries a current. The ratio between the magnetic flux densities produced by the wire's current at the three points shown B_z:B_y:B_x respectively equals ..... (2nd session 2024)



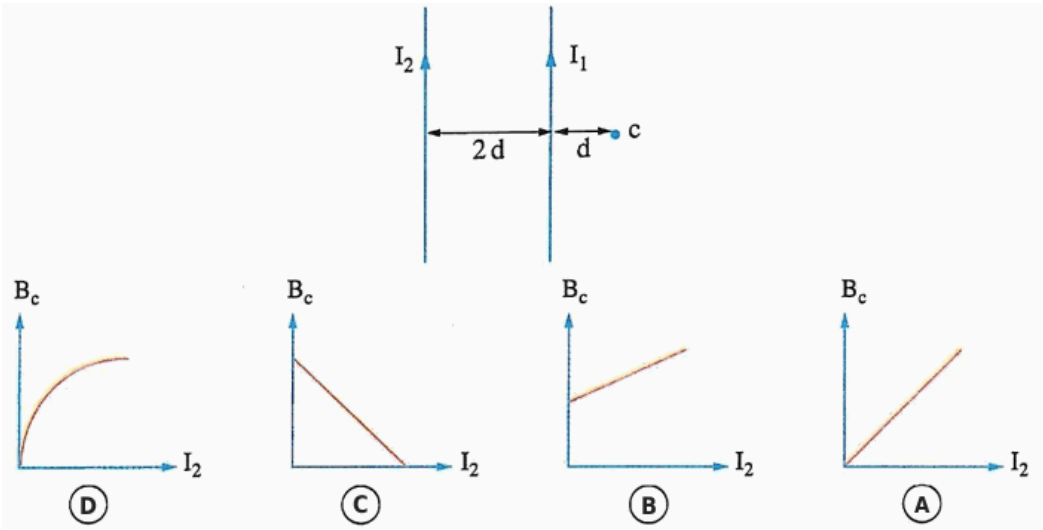
(A) 2:3:6 (B) 1:2:3 (C) 3:2:1 (D) 2:6:4

15 The opposite graph represents the relation between the magnetic flux density (B) produced by a current in a straight wire at a certain point and the current (I). The distance of that point from the axis of the wire is ..... (Sample exam 2025)

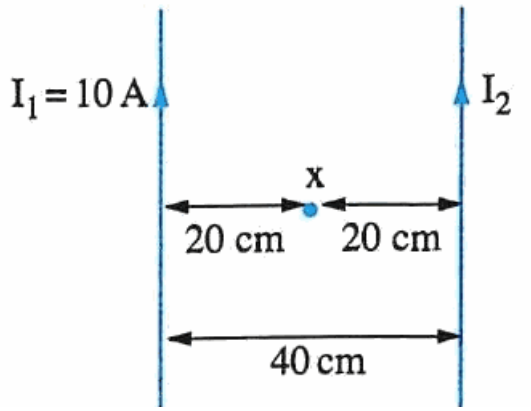


(A) *10 cm* (B) *8 cm* (C) *6 cm* (D) *4 cm*

16 The opposite figure shows two long parallel straight wires, each carrying a current in the same direction. Which of the following graphs expresses the relation between the resultant magnetic flux density (B_c) of the two wires at point (c) and the current (I_2)? (Sample exam 2025)

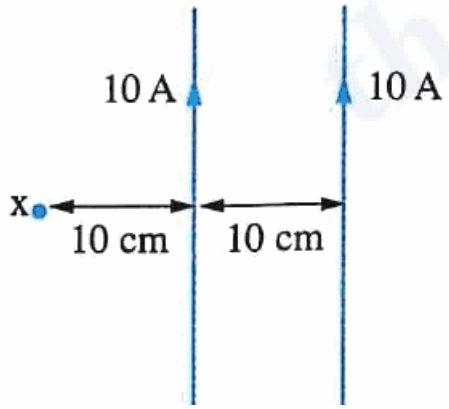


17 In the opposite figure, two very long parallel straight wires are in the plane of the page. If the resultant magnetic flux density at point (x) produced by the currents of the two wires is 2×10^{-5} *T*, the current in the second wire (I_2) equals ..... (Sample exam 2025)



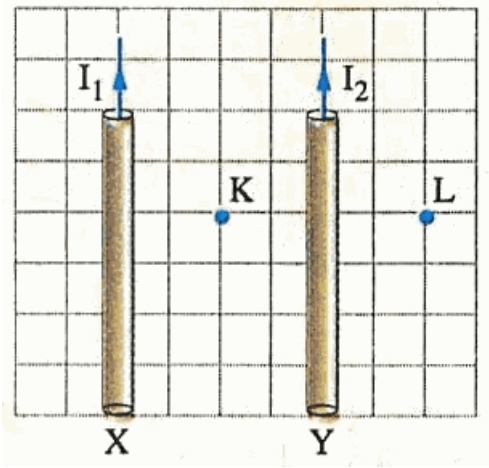
(A) *10 A* (B) *20 A* (C) *30 A* (D) *40 A*

18 In the opposite figure, two very long parallel straight wires carrying the same current are placed in the plane of the page. The resultant magnetic flux density at point (x) equals ..... (Sample exam 2025)



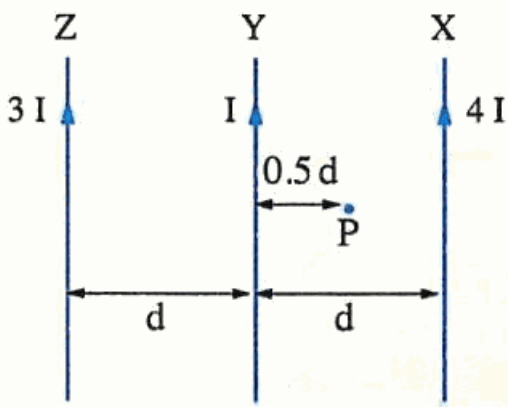
(A) 10^{-5} *T* (B) 2×10^{-5} *T* (C) 3×10^{-5} *T* (D) 5×10^{-5} *T*

19 Two long parallel straight wires each carry a current as in the opposite figure. If the direction of the current in wire (X) is reversed, the magnitudes of the resultant magnetic flux densities at points K and L respectively ..... (Sample exam 2025)



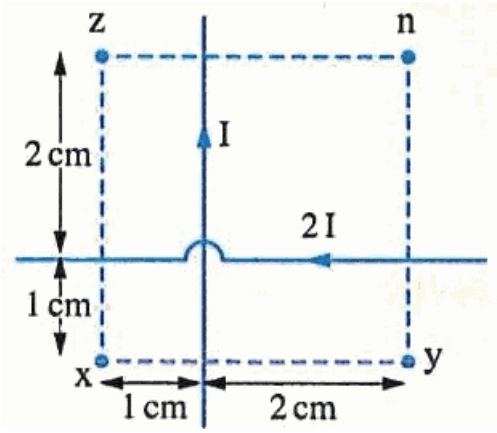
(A) decreases, increases
(B) increases, decreases
(C) does not change, does not change
(D) decreases, decreases

20 Three long parallel straight wires (X, Y, Z) each carry a current as shown in the opposite figure. If the magnetic flux density produced by the current in wire Y at point P equals B, the magnitude of the resultant magnetic flux density at point P equals ..... (Sample exam 2025)



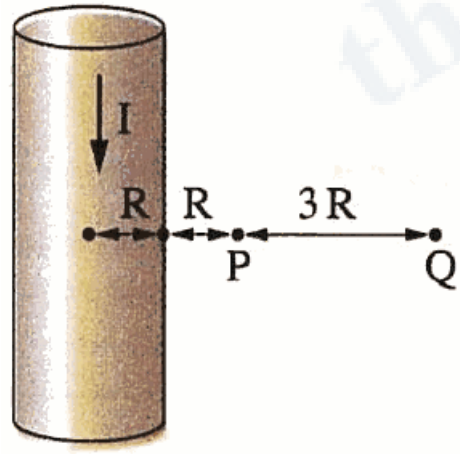
(A) B
(B) 2B
(C) 4B
(D) 8B

21 The figure shows two insulated perpendicular straight wires lying in the same plane, each carrying a current. If the four points (x, y, z, n) shown in the figure all lie in the plane of the wires, at which of these points is the resultant magnetic flux density zero? (2nd session 2025)



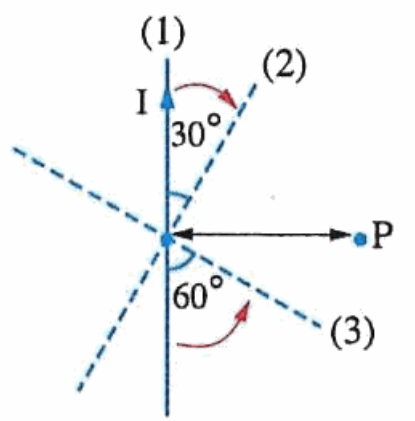
(A) Point (y) (B) Point (x) (C) Point (n) (D) Point (z)

22 The figure shows a long straight wire of uniform cross-section and radius (R) carrying a direct current (I) in the direction shown. The relation between the magnetic flux density at point P and the magnetic flux density at point Q is ..... (Sample exam 2026)



(A) $B_P = 2B_Q$ (B) $B_P = 3B_Q$ (C) $B_P = 4B_Q$ (D) $B_P = 2.5B_Q$

23 The figure represents a long straight wire carrying a current (I), placed in position (1), and the magnetic flux density produced at point (P) is (B_1). When the wire is rotated in the directions marked on the figure to position (2) and then position (3), the magnetic flux density produced at point (P) is (B_2) and (B_3) respectively. The correct order of the magnetic flux density at point (P) produced by the same current in the wire in the three positions is ..... (Sample exam 2026)



(A) $B_1 > B_2 > B_3$ (B) $B_3 > B_2 > B_1$ (C) $B_1 > B_3 > B_2$ (D) $B_2 > B_3 > B_1$

Answer key and solutions

Multiple choice questions

1 B	2 D	3 D	4 B	5 D	6 C	7 C	8 A	9 B	10 B
11 C	12 B	13 D	14 C	15 D	16 D	17 C	18 B	19 C	20 B
21 A	22 C	23 B	24 C	25 C	26 A	27 D	28 C	29 C	30 B
31 B	32 D	33 D	34 B	35 B	36 D	37 B	38 C	39 C	40 D
41 B	42 B	43 A	44 A	45 A	46 B	47 C	48 A	49 B	50 A
51 A	52 C	53 B	54 C	55 C	56 D	57 B	58 D	59 C	60 A
61 A	62 D	63 D	64 A	65 D	66 A	67 C	68 A	69 D	70 D
71 D	72 C	73 C	74 C	75 C	76 C	77 D	78 A	79 B	80 A
81 A	82 B	83 A	84 C	85 D	86 B	87 B	88 C	89 C	90 D
91 A	92 B	93 A	94 D	95 B	96 C	97 C	98 D	99 A	100 D
101 D	102 B								

1 **Answer (B)**

The coil is perpendicular to the lines, so the area facing the field is constant.

$\varphi_m = BA$

So the flux is directly proportional to B: a straight line through the origin.

2 **Answer (D)**

Rotating about an axis perpendicular to the plane of the coil is rotating about the direction of the field itself.

So the angle between the field and the normal to the coil does not change.

So the flux is constant.

3 **Answer (D)**

$\varphi_m = BA = 0.04 \times 0.2 = 0.008\ Wb$

4 **Answer (B)**

$A = (0.2)^2 = 0.04\ m^2$

$\varphi_m = BA\sin\theta \Rightarrow \sin\theta = (6\times10^{-4})/(3\times10^{-2}\times0.04) = 0.5$

$\theta = 30^\circ$ (the angle with the plane of the coil)

5 **Answer (D)**

The flux is maximum when the coil is perpendicular to the field.

$\varphi_{max} = BA = 0.05 \times 2 = 0.1\ Wb$

$\varphi = \varphi_{max}\cos 30^\circ = 0.087\ Wb$

6 **Answer (C)**

$\varphi_{max} = BA = 0.1\ Wb$

$\varphi = 0.1\cos 45^\circ = 0.07\ Wb$

7 **Answer (C)**

$\varphi_{max} = BA = 0.1\ Wb$

$\varphi = 0.1\cos 135^\circ = -0.07\ Wb$

8 **Answer (A)**

$\varphi_{max} = BA = 0.1\ Wb$

$\varphi = 0.1\cos 180^\circ = -0.1\ Wb$

9 **Answer (B)**

Slope of the line $= (\varphi_m)/A = 0.4/0.2 = 2\ Wb/m^2$

$\varphi_m = BA\sin 30^\circ \Rightarrow B\sin 30^\circ = 2$

$B = 4\ T$

10 **Answer (B)**

Position (x): the field is parallel to the plane of the coil, so the flux is zero.

Position (y): $\varphi_m = BA\cos 60^\circ = 0.8\times0.2\times0.5 = 0.08\ Wb$

$\Delta\varphi_m = 0.08 - 0 = 0.08\ Wb$

11 **Answer (C)**

The field is perpendicular to coil (y), so $\varphi_y = BA$

Coil (x) is inclined to (y) at 30°, so $\varphi_x = BA\cos 30^\circ$

$(\varphi_x)/(\varphi_y) = \cos 30^\circ = (\sqrt{3})/2$

12 **Answer (B)**

At first the flux is BA (coil perpendicular to the field); after a quarter turn the coil is parallel to the field, so the flux is zero.

$|\Delta\varphi_m| = BA - 0 = BA$

13 **Answer (D)**

At first $+BA$ and after half a turn $-BA$

$|\Delta\varphi_m| = 2BA$

14 **Answer (C)**

A third of a turn $= 120^\circ$, so the flux is $BA\cos 120^\circ = -0.5\,BA$

$|\Delta\varphi_m| = BA - (-0.5\,BA) = 1.5\,BA$

15 **Answer (D)**

Before entering the field the flux is zero; while entering (a distance l) it increases uniformly.

When the whole coil is inside the field the flux stays constant.

Then it decreases uniformly while leaving, so the graph is a trapezium.

16 **Answer (D)**

The field is perpendicular to the face, so $\varphi_m = BA$

$A_y/A_x = ((2l)^2)/(l^2) = 4$

$(\varphi_m)_y = 4(\varphi_m)_x$

17 **Answer (C)**

The area decreased by $10\ cm^2$, so the flux decreased by $10^{-3} - 7.5\times10^{-4} = 2.5\times10^{-4}\ Wb$

$B = (\Delta\varphi_m)/(\Delta A) = (2.5\times10^{-4})/(10\times10^{-4}) = 0.25\ T$

$A = (\varphi_m)/B = (10^{-3})/0.25 = 4\times10^{-3}\ m^2 = 40\ cm^2$

18 **Answer (B)**

$BA = frac\varphi_m \sin 60^\circ = (2\times10^{-6})/0.866 = 2.31\times10^{-6}$

Rotating 30° clockwise makes the angle between the coil and the field $60^\circ - 30^\circ = 30^\circ$

$\varphi_m = BA\sin 30^\circ = 1.155\times10^{-6}\ Wb$

19 **Answer (C)**

$BA = 2.31 \times 10^{-6}$

A quarter turn clockwise: the angle is $60^\circ - 90^\circ = -30^\circ$

$|\varphi_m| = BA\sin 30^\circ = 1.155 \times 10^{-6}\ Wb$

20 **Answer (B)**

$BA = 2.31 \times 10^{-6}$

Rotating 30° anticlockwise makes the angle $60^\circ + 30^\circ = 90^\circ$, so the coil is perpendicular to the field.

$\varphi_m = BA\sin 90^\circ = 2.31 \times 10^{-6}\ Wb$

21 **Answer (A)**

$BA = 2.31 \times 10^{-6}$

A quarter turn anticlockwise: the angle is $60^\circ + 90^\circ = 150^\circ$

$\varphi_m = BA\sin 150^\circ = 1.155 \times 10^{-6}\ Wb$

22 **Answer (C)**

$\varphi_m = BA\sin 30^\circ = 0.5\ BA$

The required $2\varphi_m = BA$ is the maximum value, so $\sin\theta = 1$ and the coil is perpendicular to the field $(\theta = 90^\circ)$

The required rotation is $90^\circ - 30^\circ = 60^\circ$

23 **Answer (B)**

$\varphi_m = 0.5\ BA$, and the required $2/3\varphi_m = BA/3$

$\sin\theta = 1/3 \Rightarrow \theta = 19.47^\circ$

Smallest rotation $30^\circ - 19.47^\circ = 10.53^\circ$

24 **Answer (C)**

At the start the coil is perpendicular to the field, so the flux is maximum: $\varphi_m = BA\cos\theta$

It decreases to zero at 90° and then becomes negative at 180° (a cosine curve over half a turn).

25 **Answer (C)**

$B = (\mu I)/(2\pi d) \Rightarrow \mu = (B\ 2\pi\ d)/I$

Its unit is $(T \cdot m)/A = Wb/(A \cdot m)$, i.e. $Wb \cdot A^{-1} \cdot m^{-1}$

So it is the unit of magnetic permeability.

26 **Answer (A)**

$I = V/R = 1/0.2 = 5\ A$

$B = (\mu_0 I)/(2\pi d) = (2\times10^{-7}\times5)/0.02 = 5\times10^{-5}\ T$

The current is upward and the point is to the right of the wire; by the right-hand rule the field is **into** the page.

27 **Answer (D)**

$B = (\mu I)/(2\pi d)$, so the density is inversely proportional to the distance.

So the relation is a hyperbola that decreases as d increases.

28 **Answer (C)**

The current is into the page, so the field lines around the wire are clockwise.

At the left point (z) the field of the wire points north, the same direction as the Earth's magnetic field.

So the direction of compass z does not change.

29 **Answer (C)**

The electrons move from a to b, so the conventional current is from b to a.

By the right-hand rule the lines are circles around the wire in the direction shown.

The lines get farther apart away from the wire because B decreases.

30 **Answer (B)**

The current is into the page, so the field is clockwise around the wire.

The field is tangent to the circle, so at the lower point b it points to the left.

31 **Answer (B)**

The current is out of the page, so the field is anticlockwise.

The field is tangent to the circle, so at point b (north-east of the wire) it points north-west.

32 **Answer (D)**

$B = (\mu_0 I)/(2\pi d) \Rightarrow d = (2\times10^{-7}\times4)/(2\times10^{-5}) = 0.04\ m$

33 **Answer (D)**

$I = (2\pi d B)/(\mu_0) = (B d)/(2\times10^{-7}) = (5\times10^{-5}\times0.05)/(2\times10^{-7}) = 12.5\ A$

$n/t = I/e = 12.5/(1.6\times10^{-19}) = 7.81\times10^{19}\ electron/s$

34 **Answer (B)**

$R_{wire} = (\rho L)/A = (4.5\times10^{-6}\times0.2)/(3\times10^{-8}) = 30\ \Omega$

$I = V_B/(R + r) = 8/(30 + 2) = 0.25\ A$

$B = (\mu_0 I)/(2\pi d) = (2\times10^{-7}\times0.25)/0.1 = 5\times10^{-7}\ T$

35 **Answer (B)**

The perpendicular distance from the wire is $d = 10\sin\theta\ cm \leq 10\ cm$

At $d = 10\ cm$: $B = (2\times10^{-7}\times2)/0.1 = 4\times10^{-6}\ T$

The smaller the distance, the greater the density, so it is greater than $4\times10^{-6}\ T$

36 **Answer (D)**

$B \propto 1/d$, so $B_x/B_y = d_y/d_x = 2/3$

$d_x/d_y = 3/2$

37 **Answer (B)**

$B \propto 1/d$; point x is at distance d and point y at distance $3d$

$B_x/B_y = 3d/d = 3/1$

38 **Answer (C)**

Point z is at distance $3d$ and point x at distance d

$B_x = 3B_z = 3B$

So the increase is $3B - B = 2B$

39 **Answer (C)**

Point z is at distance $3d$ and point y at distance $2d$

$B_y = 3/2B_z = 1.5\ B$

So the increase is $1/2B$

40 **Answer (D)**

$B \propto 1/d$; points x and z are 2 squares from the wire.

Points y and k are $2\sqrt{(2)}$ squares away (farther).

$B_z = B_x > B_y = B_k$

41 **Answer (B)**

$B = (\mu_0 I)/(2\pi d) \Rightarrow B/I = (\mu_0)/(2\pi d)$, which is the slope of the line.

The greater slope (x) means a smaller distance.

So x is closer to the wire than y.

42 **Answer (B)**

Slope $= B/I = (10\times10^{-7})/1 = 10^{-6}\ T/A$

$d = (\mu_0)/(2\pi\ slope) = (2\times10^{-7})/(10^{-6}) = 0.2\ m = 20\ cm$

43 **Answer (A)**

$B \propto I$ in wire AB, so the greater current gives the greatest flux density.

The battery has an internal resistance; closing any switch adds a branch in parallel, so the current drawn from the battery increases and its terminal voltage decreases.

So the greatest voltage across AB (and the greatest current in it) is when both switches are open.

44 **Answer (A)**

The electrons move from a to b, i.e. downward, so the conventional current is upward.

By the right-hand rule, the field to the right of the wire is into the page.

So the field lines are perpendicular to the plane of the rings and inward.

45 **Answer (A)**

The field is stronger closer to the wire.

The rings are identical and ring (x) is closer, so a greater flux passes through it.

$((\varphi_m)_x)/((\varphi_m)_y) > 1$

46 **Answer (B)**

Field of the wire at A: $B_w = (2\times10^{-7}\times2)/0.2 = 2\times10^{-6}\ T$

The current is upward and point A is to the right of the wire, so the wire's field is **into** the page, the same direction as the uniform field.

$B = 4\times10^{-6} + 2\times10^{-6} = 6\times10^{-6}\ T$

47 **Answer (C)**

Field of the wire at B: $B_w = (2\times10^{-7}\times2)/0.3 = 1.33\times10^{-6}\ T$

Point B is to the left of the wire, so its field is **out of** the page, opposite to the uniform field.

$B = 4\times10^{-6} - 1.33\times10^{-6} = 2.67\times10^{-6}\ T$

48 **Answer (A)**

Field of the wire at P: $B_w = (2\times10^{-7}\times40)/0.1 = 8\times10^{-5}\ T$

The current is into the page and point P is below the wire, so its field is to the left, the same direction as the uniform field.

$B = 6\times10^{-5} + 8\times10^{-5} = 1.4\times10^{-4}\ T$

49 **Answer (B)**

At P the wire's field adds to B to give $3B$, so the wire's field at P equals $2B$

Point Q is at the same distance on the other side, so the wire's field there is $2B$ in the opposite direction.

$B_Q = |B - 2B| = B$

50 **Answer (A)**

The current is out of the page, so its field lines are anticlockwise, with magnitude H at every point on the circle.

At point (1) the wire's field is horizontal to the left and the Earth's field H is vertical upward.

$B = \sqrt{(H^2 + H^2)} = \sqrt{(2)}\, H$

51 **Answer (A)**

At point (2) the wire's field is vertical downward, of magnitude H

It is opposite to the Earth's field H upward, so the resultant is 0

52 **Answer (C)**

At point (3) the wire's field is horizontal to the right, of magnitude H, and the Earth's field is vertical.

$B = \sqrt{(H^2 + H^2)} = \sqrt{(2)}\, H$

53 **Answer (B)**

At point (4) the wire's field is vertical upward, of magnitude H, in the direction of the Earth's field.

$B = H + H = 2H$

54 **Answer (C)**

The currents are opposite, so their fields between the wires are in the same direction and add up.

So the lines come out of the region between the wires and return around them in a pattern like that of a magnet.

Currents in the same direction make the lines wrap around both wires together.

55 **Answer (C)**

Wires y and z have the same current and are at the same distance from x, and the current is out of the page.

The field of y at x is upward, and the field of z at x is to the left, with the same magnitude.

So the resultant is between them, i.e. in direction (3).

56 **Answer (D)**

Point y is at the same distance from the two wires, and the field of each wire is perpendicular to the line joining it to y.

The angle at y is a right angle, so the two fields are perpendicular.

$B = \sqrt{(B_a^2 + B_b^2)}$

57 **Answer (B)**

The currents are in the same direction, so their fields between the wires are opposite.

At x they are equal, so the resultant is zero. At y: $2I/d - I/2d = 1.5\ I/d$ (in units of 2×10^{-7})

At z only the other wire's field $2I/3d$ and at k $I/3d$; both are less.

So the greatest flux density is at y.

58 **Answer (D)**

The distances between the points and the wires are equal (d), and the currents are opposite.

At y (between the wires) the two fields are in the same direction: $B_y \propto I/d + 2I/d = 3$

At z: $2I/d - I/3d = 1.67$, and at x: $I/d - 2I/3d = 0.33$

$B_y > B_z > B_x$

59 **Answer (C)**

The currents are opposite and point P is between the wires, so their fields there are in the same direction.

The first wire (current out) gives an upward field at P, and the second wire (current in) also gives an upward field.

So the resultant is upward.

60 **Answer (A)**

The currents are in the same direction. At x both fields are downward: $I/d + 3I/3d = 2\ I/d$

At y the fields are opposite: $3I/d - I/d = 2\ I/d$, also downward.

So the two resultants have the same magnitude and direction.

61 **Answer (A)**

The currents are in the same direction and point P is outside the wires, so the two fields are in the same direction.

$B_1 = (2 \times 10^{-7} \times 2)/0.05 = 8 \times 10^{-6}\ T$

$B_2 = (2 \times 10^{-7} \times 4)/0.15 = 5.33 \times 10^{-6}\ T$

$B = 8 \times 10^{-6} + 5.33 \times 10^{-6} = 1.33 \times 10^{-5}\ T$

62 **Answer (D)**

The currents are opposite and point P is outside the wires, so the two fields are opposite.

$B = 8\times10^{-6} - 5.33\times10^{-6} = 2.67\times10^{-6}\ T$

63 **Answer (D)**

$I = (n\,e)/t = 2.5\times10^{20}\times1.6\times10^{-19} = 40\ A$ in wire x

The electrons in x move in the direction of the current in y, so the two conventional currents are opposite.

Midway, the fields of the two wires are in the same direction, each $(2\times10^{-7}\times40)/0.025 = 3.2\times10^{-4}\ T$

$B = 6.4\times10^{-4}\ T$

64 **Answer (A)**

$I_x = 40\ A$, and the conventional current in x is opposite to the motion of the electrons.

The electrons in x move opposite to the current in y, so the two conventional currents are in the same direction.

Midway, the two fields are equal and opposite, so the resultant is zero.

65 **Answer (D)**

Point X is outside the wires, so for the field to vanish the two currents must be **opposite**.

Wire (1) is $0.3\ m$ from X and wire (2) is $0.1\ m$ away.

$9/0.3 = I_2/0.1 \Rightarrow I_2 = 3\ A$

The current in (1) is upward, so the current in (2) is from b to a (downward).

66 **Answer (A)**

At P (the midpoint) the fields of the two wires are equal and opposite, and this stays so because the wires move apart at the same speed, so the resultant stays **zero**.

At C the fields of the two wires are in the same direction. The nearer wire approaches C and the farther one moves away, and approaching increases the field more than moving away decreases it.

So the resultant at C increases.

67 **Answer (C)**

$B_1 = (2\times10^{-7}\times20)/0.1 = 4\times10^{-5}\ T$ and $B_2 = (2\times10^{-7}\times15)/0.1 = 3\times10^{-5}\ T$

The wires are perpendicular, so the two fields at X are perpendicular.

$B = \sqrt{((4\times10^{-5})^2 + (3\times10^{-5})^2)} = 5\times10^{-5}\ T$

68 **Answer (A)**

Points x and y are at the same distance from each of the two wires.

At each of them the fields of the two wires are in the same direction, so the density doubles: $(2\mu_0 I)/(2\pi d)$

So the ratio is $1:1$

69 **Answer (D)**

At P the fields of the two wires are in the same direction (the currents are opposite): $B_2 = (2\times10^{-7}\times10)/0.1 = 2\times10^{-5}\ T$

$B_1 = 6\times10^{-5} - 2\times10^{-5} = 4\times10^{-5}\ T \Rightarrow I_1 = 20\ A$

At Q (outside the wires) the fields are opposite: $B_2 = 2\times10^{-5}\ T$ and $B_1 = (2\times10^{-7}\times20)/0.3 = 1.33\times10^{-5}\ T$

$B_Q = 2\times10^{-5} - 1.33\times10^{-5} = 6.7\times10^{-6}\ T$

70 **Answer (D)**

Take the four distances between the wires and the points as equal (d).

$B_x = I/d + I/2d = 1.5\ I/d$ (the currents are opposite, so the fields agree between the wires)

$B_z = I/d - I/4d = 0.75\ I/d = B$

$B_x = 2B$

71 **Answer (D)**

At x the two fields are in the same direction: $B = I/d + I/d = 2I/d$ (in units of 2×10^{-7})

At y (outside the wires) the fields are opposite: $I/2d - I/4d = I/4d$

$B_y/B_x = (1/4)/2 = 1/8$

72 **Answer (C)**

The field of wire (1) at P equals B, into the page (the current is upward and the point is to its right).

The field of wire (2) at P is out of the page, of magnitude $2B$ because its current is $2I$ at the same distance.

The resultant is $2B - B = B$, outward.

73 **Answer (C)**

The currents are opposite and point x is outside the wires, so the two fields are opposite.

$B_x = 2I/d - I/3d$ (in units of 2×10^{-7})

At $I_1 = 6I$: $B_x = 2I/d - 6I/3d = 0$

74 **Answer (C)**

At y (outside the wires) the two fields are in the same direction, so the density increases when either current increases.

At x (between the wires) the two fields are opposite, and the larger field is that of wire (2) because it is nearer and stronger.

So increasing the current in wire (2) increases the resultant at x as well as at y, while increasing the current in (1) decreases it at x.

75 **Answer (C)**

At m the two fields are opposite, so the resultant is B_1 - B_2

Reversing the current in one wire makes the two fields in the same direction, so the resultant becomes $B_1 + B_2$, the greatest possible.

76 **Answer (C)**

The uniform field and the resultant are equal, so the field of the two wires at P is zero.

Point P is midway between the wires, so the field vanishes if the two currents are equal and in the same direction: $I_2 = I_1 = 12\ A$

77 **Answer (D)**

Wire b carries $2I$, so its field at y equals $2B$ (same distance).

The angle at y is a right angle, so the two fields are perpendicular.

$B_y = \sqrt{(B^2 + (2B)^2)} = \sqrt{(5)}\ B$

78 **Answer (A)**

Figure (1): m is at the midpoint and the currents are opposite, so the fields are in the same direction: $B = 2\ (\mu_0\ I)/(2\pi\ d)$

Figures (2) and (3): m is at distance d from each wire with a right angle between the fields: $B = \sqrt{(2)}\ (\mu_0\ I)/(2\pi\ d)$

So the greatest is in figure (1).

79 **Answer (B)**

In figures (2) and (3) the field of each wire at m has the same magnitude $(\mu_0\ I)/(2\pi\ d)$ and the two fields are perpendicular.

So the magnitude $\sqrt{(2)}\ (\mu_0\ I)/(2\pi\ d)$ is the same in both figures.

But the positions of the wires differ, so the direction of the resultant differs.

80 **Answer (A)**

The currents are in the same direction, so the neutral point is **between** the wires, where their fields are equal.

$3I/r_1 = I/r_2 \Rightarrow r_1 = 3r_2$ and $r_1 + r_2 = 4d$

$r_2 = d$ from the right wire, which is point x.

81 **Answer (A)**

The currents are in the same direction, so the neutral point is **between** the wires.

At the neutral point $I_M/r_M = I_N/r_N \Rightarrow 4/r_M = 12/r_N \Rightarrow r_N = 3r_M$

$r_M + r_N = 32 \Rightarrow r_M = 8\ cm$

82 **Answer (B)**

The currents are in the same direction, so the neutral point is **between** the wires, i.e. in Y or Z.

It is closer to the wire with the smaller current $(I_2$ on the left).

So it is in region Y.

83 **Answer (A)**

The currents are opposite, so the neutral point is **outside** the wires.

It is closer to the wire with the smaller current (I_2), i.e. to its left.

So it is in region X.

84 **Answer (C)**

The currents are equal and in the same direction, so the neutral point is midway between the wires.

Reversing one of the currents makes the two fields between the wires in the same direction, so there is no neutral point between them.

Outside the wires the two fields are never equal because the distances differ, so there is no neutral point at all.

85 **Answer (D)**

A neutral point needs equal fields: $I/d_1 = 2I/d_2 \Rightarrow d_2 = 2d_1$

Point D is one unit from the wire I and two units from the wire $2I$, so the two fields are equal.

And their fields are opposite (one out of the page and the other into it), so the resultant is zero.

86 **Answer (B)**

At point c the fields of the two wires are equal: $I_1/d_1 = I_2/d_2$

Point c is closer to wire (1) than to wire (2) $(d_1 < d_2)$.

So for the fields to be equal, $I_1 < I_2$

87 **Answer (B)**

The current is upward, so the wire's field to its left is **out of** the page, opposite to the uniform field (inward).

They cancel when $(\mu_0 I)/(2\pi d) = 2\times10^{-5}$

$d = (2\times10^{-7}\times10)/(2\times10^{-5}) = 0.1\ m = 10\ cm$ to the left of the wire, which is point B.

88 **Answer (C)**

Field of wire xy at P: $B = (2\times10^{-7}\times4)/0.02 = 4\times10^{-5}\ T$, into the page.

So wire ab must give at P (above it) a field out of the page of the same magnitude.

$I = (B\ d)/(2\times10^{-7}) = (4\times10^{-5}\times0.08)/(2\times10^{-7}) = 16\ A$

Its direction is from a to b (to the right) to give an outward field above the wire.

89 **Answer (C)**

The compass is between the wires and the current in the first is south to north; for no deflection the two fields must be equal and opposite.

With both currents in the same direction (south to north), the two fields between the wires are opposite.

$2/0.2 = I_2/0.4 \Rightarrow I_2 = 4\ A$

90 **Answer (D)**

At first: $1/a = 4/(d - a) \Rightarrow d = 5a$, so the neutral point is $d/5$ from wire (2).

After increasing the current to $4\ A$ the two currents are equal, so the neutral point is at the midpoint, $d/2$ away.

The shift is $d/2 - d/5 = 0.3\ d = 10\ cm \Rightarrow d = 33.33\ cm$

91 **Answer (A)**

All currents are upward. At P: the field of x is inward (I/d), the field of y is outward (I/d) and the field of z is outward $(2I/3d)$

The resultant is $2I/3d$ **outward**.

At Q: x inward $I/3d$, y inward I/d, z outward $2I/d$

The resultant is $2I/3d$ **outward**.

92 **Answer (B)**

The two $10\ A$ wires are at the same distance from x and their fields at x are equal and opposite, so they cancel.

The field of the $40\ A$ wire remains: $B = (2\times10^{-7}\times40)/0.1 = 8\times10^{-5}\ T$

93 **Answer (A)**

The resultant field at the compass is vertical upward (the direction of the N pole).

Wire z carries a current out of the page and the compass is to its left, so its field is downward.

For the resultant to be upward, wires y and x (to the left of the compass) must give an upward field, which happens if their currents are **out of** the page.

94 **Answer (D)**

At m: the field of wire (c) is into the page $(\mu_0 I)/(2\pi d)$ and the field of wire (a) is also inward $(\mu_0 I)/(2\pi d)$

For the resultant to vanish, wire (b) must give an outward field of $(2\mu_0 I)/(2\pi d)$

So its current is $2I$ downward.

95 **Answer (B)**

The wires are in the plane of the page and c is at distance d from each, so all their fields are perpendicular to the page and add algebraically.

$B_z = B_0$ from a current $2I$, so the field of each of x and y (current I) equals $B_0/2$

The currents circulate in the same sense around the triangle, so their fields agree: $B = B_0 + B_0/2 + B_0/2 = 2B_0$

96 **Answer (C)**

The field of each wire at m is tangent to the circle around it and has the same magnitude.

The vertical components cancel by symmetry (the top currents are opposite to the bottom ones).

The horizontal components add toward the **right**, so the resultant is in the plane of the page and to the right.

97 **Answer (C)**

The wires are in the plane of the page, so all their fields are perpendicular to the page and add algebraically.

The field of the two horizontal wires (1) and (2) has the same direction and value at the three points because they lie on one line between them.

Points x and y are at the same height and their distances from the vertical wires are swapped (the near one for one is the far one for the other), so their resultants are equal.

At z (outside the figure) the field of the vertical wires reverses, so it reduces the field of the horizontal wires instead of adding to it, and the resultant is smaller.

$z < y = x$

98 **Answer (D)**

When the source is connected between b and d, the current flows from b to d through two paths.

Each path consists of one side of the first wire and one side of the second wire in series, so the resistances of the two paths are equal and the two currents are equal.

Equal currents in two identical paths give opposite fields at the centre, so the resultant vanishes.

99 **Answer (A)**

The current I divides at a between side ad of resistance R and path abcd (three sides) of resistance $3R$

$I_{ad} = 3I/4$ and $I_{abcd} = I/4$

Each of the three sides gives B_0 inward at m: $3B_0$, and side ad gives $3B_0$ outward.

The resultant is zero.

100 **Answer (D)**

In figures (2) and (3) the wire is inclined 30° to the vertical and passes through point x.

The perpendicular distance from y is $d\cos 30^\circ < d$ in both figures, with the same value.

So the field is greater than in figure (1) and equal in (2) and (3): $B_2 = B_3 > B_1$

101 **Answer (D)**

Path (1) consists of two perpendicular sides: the wire moves away from x from distance R to $\sqrt{(2)}R$ at the corner, then returns to R

The field $B \propto 1/d$, so it decreases then increases.

102 **Answer (B)**

Path (2) is a circle centred at point x, so the distance between the wire and point x equals the radius throughout the motion.

So the flux density does not change.

Essay questions

1 **Model answer**

(1) For a circular turn:

$2\pi r = 1$, so $r = 1/(2\pi)\ m$

$A = \pi r^2 = 1/(4\pi)\ m^2$

$\varphi_m = BA\cos\theta = 1 \times 1/(4\pi) \times \cos 0 = 1/(4\pi)\ Wb$

(2) For a square turn:

Side length $= 1/4\ m$, $A = 1/16\ m^2$

$\varphi_m = 1 \times 1/16 \times \cos 0 = 1/16\ Wb$

2 **Model answer**

(1) $\varphi_m = (\varphi_m)_{max}\cos\theta$

$2 \times 10^{-2} = 4 \times 10^{-2}\cos\theta$

$\theta = 60^\circ$

(2) The negative sign means that the magnetic flux enters the other face of the coil:

$-2 \times 10^{-2} = 4 \times 10^{-2}\cos\theta$

$\cos\theta = -1/2$, so $\theta = 120^\circ$

3 **Model answer**

$\varphi_m = (\varphi_m)_{max}\cos(90-\theta)$

At $\theta = 30^\circ$: $0.1 = (\varphi_m)_{max}\cos 60$, so $(\varphi_m)_{max} = 0.2\ Wb$

At $\theta = 120^\circ$: $\varphi_m = 0.2\cos(90-120) = (\sqrt{3})/10\ Wb$

$z = (\sqrt{3})/10\ Wb$

4 **Model answer**

Applying Ampere's right-hand rule:

(1) At point a: perpendicular to the page and inward; at point b: perpendicular to the page and outward.

(2) At point a: in the plane of the page and to the right; at point b: in the plane of the page and downward.

5 **Model answer**

The field lines are concentric circles centred on wire xy in the plane of the sheet, anticlockwise (seen from above) according to Ampere's right-hand rule.

Note that the spacing between the circles increases as we move away from the wire.

6 **Model answer**

The values of the magnetic flux density (B) at the three points are equal, according to the relation $B = (\mu\ I)/(2\pi\ d)$

since the three points have the same perpendicular distance from the wire (d).

7 **Model answer**

(1) Mathematical relation: $B = (\mu\ I)/(2\pi\ d)$

Slope: $slope = (\Delta\ B)/(\Delta\ I) = (\mu)/(2\pi\ d)$

(2) Mathematical relation: $B = (\mu\ I)/(2\pi\ d)$

Slope: $slope = (\Delta\ B)/(\Delta(1/d)) = (\mu\ I)/(2\pi)$

8 **Model answer**

Because when switch K is closed, the total resistance of the circuit decreases, so the current in the circuit increases according to the relation $I = V/(R')$

So the magnetic flux density at point x increases according to the relation $B = (\mu\ I)/(2\pi\ d)$, where d and μ are constant.

9 **Model answer**

Point k, where the direction of the field is opposite to its direction at point x because it lies on the other side of the wire.

For the magnetic flux density to be $B/2$, the distance of the point from the wire must be twice the first distance, i.e. 2d

10 **Model answer**

The needle was deflected from north to north-west, which is the direction of the resultant of the Earth's field and the field of the current in the wire.

So the magnetic field of the current in the wire acting on the needle is toward the west.

The current in the wire is from a to b.

11 **Model answer**

(1) When the currents are in the same direction, the neutral point is in the region between the wires:

$I_x/d_x = I_y/d_y : 2/(0.3-d_y) = 3/d_y$

$d_y = 0.18\ m$ from wire y

(2) When the currents are opposite, the neutral point is outside the wires, on the side of the wire with the smaller current:

$2/d_x = 3/(0.3 + d_x)$, so $d_x = 0.6\ m$

$d_y = 0.9\ m$ from wire y

12 **Model answer**

$B_1 = (\mu\ I)/(2\pi \times 2d) = (\mu\ I)/(4\pi\ d)$, perpendicular to the page and inward.

$B_2 = (\mu \times 3/2I)/(2\pi\ d) = (3\mu\ I)/(4\pi\ d)$, perpendicular to the page and outward.

$B_C = B_2 - B_1 = (\mu\ I)/(2\pi\ d)$

13 **Model answer**

The fields of the two wires are opposite at point a:

$B_a = B_y - B_x = (\mu \times 2I)/(2\pi\ d) - (\mu\ I)/(2\pi\ d) = (\mu\ I)/(2\pi\ d)$

When wire x is moved a distance $1/2d$ toward wire y:

$B_a = (\mu \times 2I)/(2\pi\ d) - (\mu\ I)/(2pid/2) = 0$

The magnetic flux density at point a decreases gradually until it vanishes when wire x is at a distance $1/2d$ from point a

14 **Model answer**

The neutral point is midway between the wires, so $I_1 = I_2$

(1) For the neutral point to be at point y: $I_1/I_2 = d_1/d_2 = 1/3$

The current I_2 is increased to three times its first value.

(2) For the neutral point to be at point z: $I_1/I_2 = 3/1$

The current I_2 is decreased to one third of its first value.

15 **Model answer**

At point Q: the field of I_1 is perpendicular to the page and inward, and the fields of I_2 and I_3 are perpendicular to the page and outward.

$B_Q = 0$, so $B_1 = B_2 + B_3$

$(\mu\ I_1)/(2\pi\ d) = (\mu\ I_2)/(2\pi\ d) + (\mu\ I_3)/(2\pi \times 2d)$

$I_1 = I_2 + 1/2I_3$

So $I_1 < (I_2 + I_3)$

16 **Model answer**

At point a: $d_x = d_y = d_z$, so $B_x = B_y = B_z = B$

(1) With no current in wire y: $B_x = B_z$ in opposite directions, so $B_a = 0$

(2) With no current in wire z: the directions of B_x and B_y are perpendicular.

$B_a = \sqrt{(B_x^2 + B_y^2)} = \sqrt{(2)}B$

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	B	C	D	D	C	A	D	C	B
11	12	13	14	15	16	17	18	19	20
D	D	B	A	D	B	C	C	A	B
21	22	23							
D	D	B							

1 **Answer (B)**

$\varphi_m = BA\cos\theta$, where θ is the angle between the normal to the coil and the field.

$(\varphi_m)_x = BA$

$(\varphi_m)_y = B \times 3A\cos 30 = (3\sqrt{3})/2BA$

$((\varphi_m)_x)/((\varphi_m)_y) = 2/(3\sqrt{3}) = (2\sqrt{3})/9$

2 **Answer (B)**

$B = (\mu I)/(2\pi d)$ decreases as the distance from the wire increases.

Point x is closer to the wire, so $B_y < B_x$

3 **Answer (C)**

$B_x = (\mu I)/(2\pi \times 2d) = (\mu I)/(4\pi d)$, $B_y = (\mu \times 2I)/(2\pi d) = (4\mu I)/(4\pi d)$

The currents are opposite, so the fields between them are in the same direction: $B_t = (5\mu I)/(4\pi d)$

Reversing the current in x makes the fields opposite: $B = (3\mu I)/(4\pi d) = 3/5B_t$

4 **Answer (D)**

$B = (\mu I)/(2\pi d)$; with B the same, I is directly proportional to d

Point D is the farthest from its wire, so I_4 is the greatest.

5 **Answer (D)**

The two currents are equal and in the same direction, and the needle is midway between them.

The two fields are equal and opposite at the needle, so the resultant vanishes and the needle is not deflected.

6 **Answer (C)**

Slope of the line $= B/I = (\mu)/(2\pi d)$, inversely proportional to d

The slope of x is greater than that of y, so the point is closer to wire (x) than to wire (y).

7 **Answer (A)**

The external field is into the page; the wire's field below it is into the page (adds) and above it is out of the page (subtracts).

The wire's field increases the closer the point is: $B_C > B_D$ below the wire.

Above the wire the wire's field is subtracted: $B_A > B_E$ because E is closer.

$B_C > B_D > B_A > B_E$

8 **Answer (D)**

$B \propto 1/d$

$B_A/B_C = d_C/d_A = (\pi^2)/(\pi) = \pi$

9 **Answer (C)**

The currents are in the same direction, so the neutral point is between them and closer to the smaller current:

$I/d = 3I/(0.5-d)$

$d = 0.125\ m$ from wire X

10 **Answer (B)**

The neutral point is between the wires, so the two currents are in the same direction.

$I_C/x = 2/4x$

$I_C = 0.5\ A$, in the same direction as the current in wire (A)

11 **Answer (D)**

The two points are on the same side of the wire, so the fields are in the same direction.

The perpendicular distance of point Y from the wire is less than d, so $B_Y > B_Z$

12 **Answer (D)**

The neutral point is outside the wires, so the currents are opposite, and it lies next to the smaller current.

$I_2/d = I_1/3d$

$I_2 = I_1/3$, downward

13 **Answer (B)**

$B = (\mu\ I)/(2\pi\ d)$ and $I = V_B/R$ and $R = (\rho_e \ell)/A$

Increasing the length of the wire increases the resistance, so the current decreases and the flux density decreases.

14 **Answer (A)**

$B \propto 1/d$ and $d_x = d$, $d_y = 2d$, $d_z = 3d$

$B_x : B_y : B_z = 1 : 1/2 : 1/3 = 6 : 3 : 2$

$B_z : B_y : B_x = 2 : 3 : 6$

15 **Answer (D)**

Slope $= B/I = (25 \times 10^{-6})/5 = 5 \times 10^{-6}\ T/A$

$(\mu)/(2\pi\ d) = 5 \times 10^{-6}$

$d = (2 \times 10^{-7})/(5 \times 10^{-6}) = 0.04\ m = 4\ cm$

16 **Answer (B)**

Point c is outside the wires and the currents are in the same direction, so the two fields are in the same direction:

$B_c = B_1 + (\mu\ I_2)/(2\pi \times 3d)$

A linear relation with a positive slope and an intercept (B_1) at $I_2 = 0$

17 **Answer (C)**

The currents are in the same direction, so the two fields at x are opposite:

$B = (\mu)/(2\pi \times 0.2)(I_2 - 10) = 2 \times 10^{-5}$

$I_2 - 10 = 20$, so $I_2 = 30\ A$

18 **Answer (C)**

The currents are in the same direction and the point is outside them, so the two fields are in the same direction:

$B = (2 \times 10^{-7} \times 10)/0.1 + (2 \times 10^{-7} \times 10)/0.2$

$B = 2 \times 10^{-5} + 1 \times 10^{-5} = 3 \times 10^{-5}\ T$

19 **Answer (A)**

20 **Answer (B)**

$B_Y = (\mu\ I)/(2\pi \times 0.5d) = B$

$B_X = (\mu \times 4I)/(2\pi \times 0.5d) = 4B$, $B_Z = (\mu \times 3I)/(2\pi \times 1.5d) = B$

The fields of Y and Z at P are in one direction, and the field of X is in the opposite direction:

$B_P = 4B - B - B = 2B$

21 **Answer (D)**

By the right-hand rule: at point z the field of the vertical wire is out of the page and the field of the horizontal wire is into it.

$B_1 = (\mu\ I)/(2\pi \times 1)$, $B_2 = (\mu \times 2I)/(2\pi \times 2)$

The two fields are equal and opposite, so the resultant is zero at point (z).

22 **Answer (D)**

Distance from the axis of the wire: $d_P = 2R$, $d_Q = 5R$

$B_P/B_Q = 5R/2R = 2.5$

23 **Answer (B)**

As the wire rotates, the perpendicular distance between point P and the wire decreases, so the flux density increases.

$d_1 = r$, $d_2 = r\cos 30$, $d_3 = r\cos 60$

$B_3 > B_2 > B_1$