## Electro Magnetism

## Biot - Savart's Law and Ampere's Circuital Law

1. A current is flowing due north along a power line. The direction of the magnetic field above it, neglecting the earth's field is:
(1) North
(2) East
(3) South
(4) West
2. A vertical straight conductor carries a current vertically upwards. A point $P$ lies to the east of it at a small distance and another point $Q$ lies to the west at the same distance. The magnetic field at $P$ neglecting earth's field is:
(1) Greater than at Q
(2) Same as at Q
(3) Less than at Q
(4) Greater or lesser than that at Q , depending upon the strength of current.
3. A square conducting loop of length $L$ on a side has a current ' $i$ ' in it. The magnetic induction at the centre of the loop is
(1) Independent of $L$
(2) Directly proportional L
(3) Inversely proportional toL
(4) Inversely proportional to $L^{2}$
4. Field at the centre of circular coil of radius $r$, through which a current $I$ flows is
(1) Directly proportional to r
(2) Inversely proportional to I
(3) Directly proportional to I
(4) Directly proportional to $\mathrm{I}^{2}$
5. Lines of magnetic field around a current carrying straight conductor will be
1) Straight lines parallel to conductor
2) Circular in a plane parallel to conductor
3) Circular in a plane perpendicular to conductor
4) Straight perpendicular to conductor

6 Magnetic induction at a point due to a small element of current carrying conductor is

1) Inversely proportional to the square of the distance of the point from the conductor
2) Inversely proportional to the distance of the point form the conductor
3) Directly proportional to the square of the length of conductor
4) Directly proportional to the square of the current
7. Imagine a man swimming along a current carrying conductor in a direction opposite to that of current and facing the conductor. A magnetic needle free to rotate in a horizontal plane is mounted on a stand under the wire. Then
1) The north pole of the needle will deflect towards his left hand
2) The south pole of the needle will deflect towards his left hand
3) The needle will not deflect
4) The needle will oscillate
8. Statement A: current is scalar.

Statement B: current element is vector.

1) $A$ and $B$ are ture
2) $A$ and $B$ are false
3) Only A is ture
4) Only B is true
9. Statement (A): Ampere's law states that the line integral of $\vec{B} \cdot \overrightarrow{d \ell}$ along a closed path round the current carrying conductor is equal to $\mu_{0} i$ ( is the net current through the surface bounded by the closed path).

Statement (B): Ampere's law can be derived from Biot savart's law.

1) $A$ is true $B$ is false
2) $A$ is false $B$ is true
3) A and B are true
4) $A$ and $B$ is false
10. A vertical straight conductor carries a current vertically upwards. A point $P$ lies to the east of it as a small distance and another point $Q$ lies to the west at the same distance. The magnetic field at $P$ is
1) Greater than at $Q$
2) Same as at $Q$
3) Less than at $Q$
4) Greater or less than at Q depending upon the magnetic field of the current.
11. A current I flows along an infinitely long straight thin walled tube. The magnetic induction at a point inside the tube at a distance $r$ from its wall is
1) Infinite
2) Zero
3) $\frac{\mu_{0}}{4 \pi} \cdot \frac{2 I}{r}$
4) $\frac{2 I}{r}$
12. The magnetic field $\overrightarrow{d B}$ due to a small current element $\overrightarrow{d \ell}$ at a distance $\vec{r}$ and element carrying current $i$ is (or) Vector form of Biot - savart's law is
1) $\overrightarrow{d B}=\frac{\mu_{0}}{4 \pi} i\left(\frac{\overrightarrow{d \ell} \times \vec{r}}{r}\right)$
2) $\overrightarrow{d B}=\frac{\mu_{0}}{4 \pi} i^{2}\left(\frac{\overrightarrow{d \ell} \times \vec{r}}{r}\right)$
3) $\overrightarrow{d B}=\frac{\mu_{0}}{4 \pi} i^{2}\left(\frac{\overrightarrow{d \ell} \times \vec{r}}{r^{2}}\right)$
4) $\overrightarrow{d B}=\frac{\mu_{0}}{4 \pi} i\left(\frac{\overrightarrow{d \ell} \times \vec{r}}{r^{3}}\right)$
13. The current through a circular coil appears to be flowing in clock-wise direction for an observer. The magnetic induction at the centre of the coil is:
1) Perpendicular to the plane of the coil and towards the observer
2) Perpendicular to the plane of the coil and away from the observer
3) Parallel to plane of the coil
4) Inclined at $45^{0}$ at the plane of coil
14. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil $B$. It is then bent into a circular loop of $n$ turns. The magnetic field at the centre of the coil will be:
1) $n B$
2) $n^{2} B$
3) 2 nB
4) $2 n^{2} B$
15. The magnetic field at the centre of the current carrying coil is
1) Directed normal to plane of the coil
2) Directed parallel to plane of the coil
3) Zero
4) Radial from centre of the coil
16. A wire loop PQRSP is constructed by joining two semi circular coils of radii $r_{1}$ and $r_{2}$ respectively as shown in the fig. current is flowing in the loop. The magnetic induction at point ' $O$ ' will be

1) $\frac{\mu_{0} i}{4}\left[\frac{1}{r_{1}}-\frac{1}{r_{2}}\right]$
2) $\frac{\mu_{0} i}{4}\left[\frac{1}{r_{1}}+\frac{1}{r_{2}}\right]$
3) $\frac{\mu_{0} i}{2}\left[\frac{1}{r_{1}}-\frac{1}{r_{2}}\right]$
4) $\frac{\mu_{0} i}{2}\left[\frac{1}{r_{1}}+\frac{1}{r_{2}}\right]$
17. If the resistance of upper half of a rigid loop is twice that of the lower half the magnitude of magnetic induction at the centre is equal to

1) Zero
2) $\frac{\mu_{0} I}{4 a}$
3) $\frac{\mu_{0} I}{8 a}$
4) $\frac{\mu_{0} I}{12 a}$
18. Wires 1 and 2 carrying currents $i_{1}$ and $i_{2}$ respectively are inclined at an angle $\theta$ to each other. What is the force on a small element $d \boldsymbol{l}$ of wire 2 at a distance $r$ from wire 1 due to magnetic filed of wire 1 ?

1) $\frac{\mu_{0}}{2 \pi r} i_{1} i_{2} d l \tan \theta$
2) $\frac{\mu_{0}}{2 \pi r} i_{1} i_{2} d l \sin \theta$
3) $\frac{\mu_{0}}{2 \pi r} i_{1} i_{2} d l \cos \theta$
4) $\frac{\mu_{0}}{4 \pi r} i_{1} i_{2} d l \sin \theta$
19. What is the magnetic field at the center of the circular part in the figure below?

1) $B=\frac{\mu_{o} i}{8 r}\left[1+\frac{2}{r}\right]$
2) $B=\frac{\mu_{o} i}{8 r}\left[\pi+\frac{2}{\pi}\right]$
3) $B=\frac{\mu_{o} i}{8 r}\left[1-\frac{2}{\pi}\right]$
4) $B=\frac{\mu_{o} i}{8 r}\left[1+\frac{2}{\pi}\right]$
20. Four wires each of length $\mathbf{2 m}$ are bent into four loops $\mathbf{P}, \mathbf{Q}, \mathbf{R}$, and $S$ and then suspended into a uniform magnetic field same current is passed in each loop.The

correct statement is
1) Couple on loop $P$ will be highest.
2) Couple on loop $Q$ will be highest.
3) Couple on loop $R$ will be highest.
4) Couple on loop $S$ will be highest.
21. A current of $1 / 4 \pi \mathrm{amp}$ is flowing in a long straight conductor. The fine integral of magnetic induction around a closed path enclosing the current carrying conductor is
1) $10^{-7}$ weber per metre
2) $4 \pi \times 10^{-7}$ weber per metre
3) $16 \pi^{2} \times 10^{-7}$ weber per metre
4) Zero
22. The magnetic induction field at the centroid of an equilateral triangle of side ' $l$ ' and carrying a current ' $i$ ' is
1) $\frac{2 \sqrt{2} \mu_{0} i}{\pi \ell}$
2) $\frac{9 \mu_{0} i}{2 \pi \ell}$
3) $\frac{4 \mu_{0} i}{\pi \ell}$
4) $\frac{3 \sqrt{3} \mu_{0} i}{\pi \ell}$
23. The electric current in a circular coil of two turns produced a magnetic induction of 0.2 T at its centre. The coil is unwound and rewound in to a coil of four turns. The magnetic induction at the centre of the coil now is, in tesla (if the same current flows in the coil)
1) 0.2
2) 0.4
3) 0.6
4) 0.8
24. In an atom the electron has a time period of $0.16 \times 10^{-15} \mathrm{~s}$ in a circular orbit of radius $0.5 \mathrm{~A}^{0}$. The magnetic induction at the centre of the orbit will be (in tesla)
1) 12.56
2) 125.6
3) 1.256
4) 25.12
25. A circular arc of wire subtends an angle $\pi / 2$ at the centre. If it carries a current $i$ and its radius of curvature is $\mathbf{R}$ then the magnetic field at the centre of the arc is
1) $\frac{\mu_{0} i}{R}$
2) $\frac{\mu_{0} i}{2 R}$
3) $\frac{\mu_{0} i}{4 R}$
4) $\frac{\mu_{\rho} i}{8 R}$
26. A circular coil ' $A$ ' has a radius $R$ and the current flowing through it is $I$. Another circular coil ' $B$ ' has a radius $2 R$ and if $2 I$ is the current flowing through it, then the magnetic fields at the centre of the circular coil are in the ratio of
1) 4: 1
2) $2: 1$
3) $3: 1$
4) $1: 1$
27. Two circular coils of radii 20 cm and 30 cm having number of turns 50 and 100 made of same material are connected in series. The ratio of the magnetic field of induction at their centre is
1) $3: 4$
2) $2: 3$
3) $1: 2$
4) $3: 5$
28. An electron revolves in a circle of radius $0.4 A^{0}$ with a speed of $10^{6} \mathrm{~ms}^{\mathbf{- 1}}$ in a hydrogen atom. The magnetic field produced at the centre of the orbit due to motion of the electron, in tesla, is $\left[\mu_{0}=4 \pi \times 10^{-7} \mathrm{H} / \mathrm{m}\right]$
1) 0.1
2) 1.0
3) 10
4) 100
29. A wire of length ' $L$ ' meters carrying a current ' $i$ ' amperes is bent in the form of a circle. The magnitude of its magnetic moment is
1) $\frac{i L}{4 \pi}$
2) $\frac{i L^{2}}{4 \pi}$
3) $\frac{i^{2} L}{4 \pi}$
4) $\frac{i^{2} L^{2}}{4 \pi}$
30. Two identical coils have a common centre and their planes are at right angles to each other and carry equal currents. If the magnitude of the induction field at the centre due to one of the coil is ' $B$ ', then the resultant magnetic induction field due to combination at their common centre is
1) $B$
2) $\sqrt{2} B$
3) $B / \sqrt{2}$
4) $2 B$
31. A ring of radius ' $r$ ' is uniformly charged with a charge ' $q$ '. If the ring is rotated about its own axis with an angular frequency ' $\omega$ ' then the magnetic induction field at the centre is
1) $\frac{\mu_{0}}{4 \pi}\left(\frac{q \omega}{r}\right)$
2) $\frac{\mu_{0}}{4 \pi}\left(\frac{r}{q \omega}\right)$
3) $\frac{\mu_{0}}{4 \pi}\left(\frac{q}{r \omega}\right)$
4) $\frac{\mu_{0}}{4 \pi}\left(\frac{\omega}{q r}\right)$
32. A long straight wire of radius ' $a$ ' carries a steady current $i$. The current is uniformly distributed across its cross section. The ratio of the magnetic fields at $\mathbf{a} / \mathbf{2}$ and 2 a is
1) 1
2) $1 / 2$
3) $1 / 4$
4) 4
33. A straight wire of length $\left(\pi^{2}\right)$ meter is carrying a current of 2 A and the magnetic field due to it is measured at a point distance 1 cm from it. If the wire is to be bent into a circle and is to carry the same current as before, the ratio of the magnetic field as its centre to that obtained in the first case would be
1) $50: 1$
2) $1: 50$
3) $100: 1$
4) 1: 100
34. Equal current ' $i$ ' flows in the two segments of a circular loop in the direction shown in fig. radius fo the loop is ' $a$ '. Magnetic field at the centre of the loop is

1) Zero
2) $\left(\frac{\pi-\theta}{\pi}\right) \frac{\mu_{0} i}{2 a}$
3) $\left(\frac{2 \pi-\theta}{\pi}\right) \frac{\mu_{0} i}{2 a}$
4) $\left(\frac{\theta}{2 \pi}\right) \frac{\mu_{0} i}{2 a}$
35. The field normal to the plane of a coil of ' $n$ ' turns and radius ' $r$ ' which carries a current ' $i$ ' is measured on the axis of the coil at a small distance ' $h$ ' from the centre of the coil . This is smaller than the field at the centre by the fraction.
1) $\frac{3}{2} \frac{h^{2}}{r^{2}}$
2) $\frac{2}{3} \frac{h^{2}}{r^{2}}$
3) $\frac{3}{2} \frac{r^{2}}{h^{2}}$
4) $\frac{2}{3} \frac{r^{2}}{h^{3}}$
36. The total magnetic induction at point 0 due to curved portion and straight portion in the following figure, will be

1) $\frac{\mu_{0} i}{2 \pi r}[\pi-\phi+\tan \phi]$
2) $\frac{\mu_{0} i}{2 \pi r}$
3) 0
4) $\frac{\mu_{0} i}{\pi r}[\pi-\phi+\tan \phi]$
37. An infinitely long wire is bent in the form of a semicircle at the end as shown in the figure. It carries current $I$ along abcdo. If radius of the semicircle be $R$, then the magnetic field at ' $O$ ' which is the centre of the circular part is

1) $\frac{\mu_{0}}{4 \pi} \frac{2 I}{R}(\pi+1)$
2) $\frac{\mu_{0}}{4 \pi} \frac{2 I}{R}(\pi-1)$
3) $\frac{\mu_{0}}{4 \pi} \frac{I}{R}(\pi+1)$
4) $\frac{\mu_{0}}{4 \pi} \frac{I}{R}(\pi-1)$
38. The magnetic induction at point ' $O$ ' in the following fig. will be

1) $\frac{\mu_{0} I}{4 r}\left[\frac{3}{2}-\frac{1}{\pi}\right] \otimes$
2) $\frac{\mu_{0} I}{4 r}\left[\frac{3}{2}-\frac{1}{\pi}\right] \odot$
3) $\frac{\mu_{0} I}{4 r}\left[\frac{3}{2}+\frac{1}{\pi}\right] \odot$
4) $\frac{\mu_{0} I}{4 r}\left[\frac{3}{2}+\frac{1}{\pi}\right] \otimes$

Kеу

1) 2
2) 2
3) 3
4) 3
5) 3
6) 1
7) 2
8) 1
9) $3 \quad 1 0 \longdiv { 1 }$
10) 2 12) 4
11) 2
12) $2 \quad 15) 1$
13) 1
14) 1
15) 3 19)4
16) 4
$\begin{array}{lll}\text { 21) } 1 & \text { 22) } 2 & \text { 23) } 4\end{array}$
17) 1
18) $4 \quad 26) 4$
19) 1
20) 3
21) 2
22) 2
31)1 32) 1
33)2
23) $2 \quad 35) 1$ 36) 1
24) 3
25) 2

## Hints

21. $\int B \cdot d l=\mu_{0} i$

$$
=4 \pi \times 10^{-7} \times \frac{1}{4 \pi}=10^{-7} \mathrm{wblm}
$$

22. At the centroid of an equilateral triangle

$$
B=18 \frac{\mu_{0}}{4 \pi} \frac{i}{a} B=\frac{9 \mu_{o} i}{\pi a}
$$

23. $\frac{B_{1}}{B_{2}}=\frac{n_{1}^{2}}{n_{2}^{2}} \Rightarrow \frac{0.2}{B_{2}}=\frac{4}{16} \Rightarrow B_{2}=0.8 \mathrm{~T}$
24. $B=\frac{\mu_{0} i}{2 r}=\frac{\mu_{0}}{2 r} \frac{e}{T}=\frac{4 \times \pi \times 10^{-7} \times 1.6 \times 10^{-19}}{2 \times 0.5 \times 10^{-10} \times 0.16 \times 10^{-15}}=4 \pi$

$$
\mathrm{B}=4 \times 3.14=12.56 \mathrm{~T}
$$

25. $B=\frac{\mu_{0} i}{4 \pi r}(\theta) \Rightarrow B=\frac{\mu_{0} i}{4 \pi r} \frac{\pi}{2} \Rightarrow B=\frac{\mu_{0} i}{8 r}$
26. $B=\frac{\mu_{0} i}{2 r} \Rightarrow B_{1}: B_{2}=\frac{i_{1}}{r_{1}}: \frac{i_{2}}{r_{2}} \mathrm{~B}_{1}: \mathrm{B}_{2}=1$ :
27. In series $B_{1}: B_{2}=\frac{n_{1}}{r_{1}}: \frac{n_{2}}{r_{2}}=\frac{50}{20}: \frac{100}{30}$

$$
\mathrm{B}_{1}: \mathrm{B}_{2}=3: 4
$$

28. $B=\frac{\mu_{0}}{4 \pi} \frac{e v}{r^{2}}=\frac{10^{-7} \times 1.6 \times 10^{-19} \times 10^{6}}{\left(0.4 \times 10^{-10}\right)^{2}}=10$
29. $L=2 \pi r \Rightarrow r=\frac{L}{2 \pi}$

$$
M=n i A=1 \times i \times \pi r^{2}=\frac{i L^{2}}{4 \pi}
$$

30. $B_{\text {net }}=\sqrt{B_{1}^{2}+B_{2}^{2}}$, but $\mathrm{B}_{1}=\mathrm{B}_{2}$

$$
B_{n e t}=\sqrt{2} B
$$

31. $B=\frac{\mu_{o} i}{2 r}=\frac{\mu_{o}}{2 r} \frac{q}{T}=\frac{\mu_{o}}{2 r} \frac{q v}{2 \pi r}=\frac{\mu_{o}}{4 \pi}\left(\frac{q \omega}{r}\right)$
32. $B_{1}=\frac{\mu_{o} i r}{2 g p R^{2}}=\frac{\mu_{o} i \frac{a}{2}}{2 \pi a^{2}}=\frac{\mu_{o} i}{4 \pi a}$

$$
B_{2}=\frac{\mu_{o} i r}{2 \pi x}=\frac{\mu_{o} i}{2 \pi(2 a)}=\frac{\mu_{o} i}{4 \pi a}
$$

33. $B_{1}=\frac{\mu_{o} i}{2 \pi r}=\frac{2 \times 10^{-7} \times 2}{1 \times 10^{-2}}=4 \times 10^{-5} \mathrm{~T}$

$$
\begin{aligned}
& L=2 \pi r \Rightarrow \pi^{2}=2 \pi r \Rightarrow r=\pi / 2 \\
& B_{2}=\frac{\mu_{o} i}{2 r}=\frac{4 \pi \times 10^{-7} \times 2}{2 \times \pi / 2}=8 \times 10^{-7} T
\end{aligned}
$$

$$
\frac{B_{2}}{B_{1}}=\frac{8 \times 10^{-7}}{4 \times 10^{-5}}=\frac{2}{100}=1 / 50
$$

34. $B=B_{1}-B_{2}=\frac{\mu_{o} i}{4 \pi a}(2 \pi-\theta)-\frac{\mu_{o} i}{4 \pi a}(\theta)$

$$
B=\frac{\mu_{o} i}{4 \pi a}(2 \pi-2 \theta)=\frac{\mu_{o} i}{2 a}\left(\frac{\pi-\theta}{\pi}\right)
$$

35. $\frac{B_{c}}{B_{a}}=\left(1+\frac{x^{2}}{r^{2}}\right)^{3 / 2}=\left[1+\frac{h^{2}}{r^{2}}\right]^{3 / 2}=1+\frac{3}{2} \frac{h^{2}}{r^{2}}$
$\frac{B_{c}}{B_{a}}-1=1+\frac{3}{2} \frac{h^{2}}{r^{2}}-1$
$\frac{B_{c}-B_{a}}{B_{a}}=\frac{3}{2} \frac{h^{2}}{r^{2}}$
36. $x=r \cos \phi$
$B=B_{1}+B_{2}$
$B=\frac{\mu_{0} i}{4 \pi r}(2 \pi-2 \phi)+\frac{\mu_{0} i}{4 \pi x} 2 \sin \phi$
$B=\frac{\mu_{0} i}{2 \pi r}(\pi-\phi)+\frac{\mu_{0} i}{2 \pi r} \operatorname{Tan} \phi$
$B=\frac{\mu_{0} i}{2 \pi r}(\pi-\phi+\operatorname{Tan} \phi)$
37. $B=\frac{\mu_{o} I}{4 R}+\frac{\mu_{o} I}{4 \pi R}$

$$
B=\frac{\mu_{o} I}{4 \pi R}(\pi+1)
$$

38. 

$B=B_{1}+B_{2}-B_{3}=0+\frac{\mu_{0} i}{4 \pi r}\left(\frac{3 \pi}{2}\right)-\frac{\mu_{0} i}{4 \pi r}$
$\mu_{0} i[3-1$
$B=\frac{\mu_{0} i}{4 r}\left[\frac{3}{2}-\frac{1}{\pi}\right]$

1. A charged particle with charge $q$ is moving in a uniform magnetic field. If this particle makes any angle with the magnetic field, then its path will be
(1) Circular
(2) Straight Line
(3) Helical
(4) Parabolic
2. An electron is moving vertically downwards at any place. The direction of magnetic force acting on it due to horizontal component of the earth's magnetic field will be
(1) Towards East
(2) Towards West
(3) Towards North
(4) Towards South
3. Proton and $\alpha$-particle enter with same velocity at $90^{\circ}$ in aniform magnetic field. Ratio of radius of their paths will be
(1) $1: 2$
(2) $2: 1$
(3) $4: 1$
(4) $1: 4$
4. The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to:
(1) The charge on the particle
(2) The momentum of the particle
(3) The intensity of the field
(4) The energy of the particle
5. A proton enters in a magnetic field of strength $B$ (Tesla) with speed $v$, parallel to the direction of magnetic lines of force. The force on the proton is:
(1) evB
(2) Zero
(3) evB/4
(4) $e v B / 2$
6. A uniform electric field and a uniform magnetic field are produced, pointed in the same direction. An electron is projected with its velocity pointed in the same direction:
(1) The electron will turn to its left
(2) The electron will turn to its right
(3) The electron velocity will decrease in magnitude
(4) The electron velocity will increase in magnitude
7. Statement (A): Moving charges produce not only an electric field but also magnetic field in space.

Statement (B): The force is exerted by a magnetic field on moving charges or on a current carrying conductor only but not on stationary charges.

1) $A$ is true $B$ is false
2) A is false $B$ is true
3) $A$ and $B$ are true
4) A and B is false
8. In the given figure, the electron enters into the magnetic field. It deflects in

direction.
1)     + ve $X$ direction
2)     - ve $X$ direction
3)     + ve $Y$ direction
4)     - ve Y direction
9. An electron of mass $m$ and charge $e$ is accelerated by a potential difference $V$. It then enters a uniform magnetic field $B$ applied perpendicular to its path. The radius of the circular path of the electron is
1) $r=\left(\frac{2 m V}{e B^{2}}\right)^{1 / 2}$
2) $r=\left(\frac{2 m e V}{B^{2}}\right)^{1 / 2}$
3) $r=\left(\frac{2 m B}{e V^{2}}\right)^{1 / 2}$
4) $r=\left(\frac{2 B^{2} V}{e m}\right)^{1 / 2}$
10. A circular coil of radius $r$ having number of turn's $n$ and carrying a current $A$ produces magnetic induction at its centre of magnitude $B$. $B$ can be doubled by
1) Keeping the number of turns $n$ and changing the current to $A / 2$
2) Changing the number of turns to $n / 2$ and keeping the current at $A$
3) Simultaneously changing the number of turns and current to 2 n and 2 A
4) Keeping the current at A and changing the number of turns to $2 n$.
11. A charged particle of mass $m$ and charge $q$ travels on a circular path of radius $r$ that is perpendicular to a magnetic field $B$. The time taken by the particle to complete one revolution is
1) $\frac{2 \pi q B}{m}$
2) $\frac{2 \pi m}{q B}$
3) $\frac{2 \pi m q}{B}$
4) $\frac{2 \pi q^{2} B}{m}$
12. Statement (A): When a charged particle of charge ' $q$ ' moving with a velocity $V$ in the magnetic field of induction $B$ then the force acting on it is $\vec{F}=q(\vec{V} \times \vec{B})$

Statement (B): An electron is projected in a magnetic field along the lines of force then there will be no effect on the motion of the electron

1) $A$ is a true $B$ is false
2) A is false B is true
3) A and B are true
4) A and B is false
13. A charged particle with charge $q$ enters region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$, then
1) $\vec{v}=\vec{E} \times \vec{B} / E^{2}$
2) $\vec{v}=\vec{B} \times \vec{E} / E^{2}$
3) $\vec{v}=\vec{E} \times \vec{B} / B^{2}$
4) $\vec{v}=\vec{B} \times \vec{E} / B^{2}$
14. A uniform electric field and a uniform magnetic field are acting along the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity then
1) It will turn towards right of direction of motion
2) It will turn towards left of direction of motion
3) Its velocity will decrease
4) Its velocity will increase
15. An electron and a proton having same momenta enter perpendicularly to a magnetic field, then
1) Curved path of electron and proton will be same (ignoring the sense of revolution)
2) They will move undeflected
3) Curved path of electron is more curved than that of proton
4) Path of proton is more curved
16. Two long parallel wires are separated by a distance of $8 \mathbf{~ c m}$ carry electric currents of 3 A and 5 A . The distance of null point from the conductor carrying larger current when currents are flowing in the same direction is
1) 3 cm
2) 5 cm
3) 12 cm
4) 20 cm
17. Two particles $A$ and $B$ of mass $m_{A}$ and $m_{B}$ respectively and having the same charge are moving in a plane. A uniform magnetic field exist perpendicular to this plane. The speeds of the particles are $v_{A}$ and $v_{B}$ respectively, and the trajectories are as shown in the figure. Then

1) $m_{A} v_{A}<m_{B} v_{B}$
2) $m_{A} v_{A}>m_{B} v_{B}$
3) $m_{A}<m_{B}$ and $v_{A}<v_{B}$
4) $m_{A}=m_{B}$ and $v_{A}=v_{B}$
18. An electron moves with speed $2 \times 10^{5} \mathrm{~ms}^{-1}$ along the positive $x$-direction in the presence of a magnetic induction $\bar{B}=\hat{i}+4 \hat{j}-3 \hat{k}$ tesla. The magnitude of the force experienced by the electron in Newton is (charge on the electron $=1.6 \times 10^{-19} \mathrm{C}$ )
1) $1.18 \times 10^{-13}$
2) $1.28 \times 10^{-13}$
3) $1.6 \times 10^{-13}$
4) $1.72 \times 10^{-13}$
19. Two ions having masses in the ratio $1: 2$ and charges $1: 2$ are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2 : 3 . The ratio of the radii of circular paths along which the two particles move is
1) $4: 3$
2) $2: 3$
3) $3: 1$
4) $1: 2$
20. A proton, a deuteron and an $\alpha$-particle whose kinetic energies are same enter at right angles to a uniform magnetic field. Then the ratio of the radii of their circular paths is
1) $1: \sqrt{2}: 1$
2) $\sqrt{2}: 1: 1$
3) $1: 2: 1$
4) $2: 2: 1$
21. A horizontal wire carries 200A current below which another wire of linear density $20 \times 10^{-3} \mathrm{Kg} / \mathrm{m}$ carrying a current is kept at 2 cm distance. If the wire kept below hangs in air, then the current in the wire is
1) 9.8 A
2) 98 A
3) 980 A
4) 9800 A
22. Two long conductors, separated by a distance'd' carry current $I_{1}$ and $I_{2}$ in the same direction. They exert a force $F$ on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3d. The value of the force between them is
1) -2 F
2) $\frac{F}{3}$
3) $-\frac{2 F}{3}$
4) $-\frac{F}{3}$
23. A proton of velocity $[3 \hat{i}+2 \hat{j}] \mathbf{m} / \mathbf{s}$ enters a field a magnetic induction $[3 \hat{i}+2 \hat{j}]$ tesla, the acceleration produced in the proton $\mathrm{i} \mathbf{n}\left(\mathrm{m} / \mathbf{s}^{2}\right)$ is (specific charge of proton $=0.96 \mathrm{x}$ $10^{8} \mathrm{C} / \mathrm{Kg}$ )
1) $2.8 \times 10^{8}(2 \hat{\mathrm{i}}-3 \hat{\mathrm{j}})$
2) $2.88 \times 10^{8}(2 \hat{i}-3 \hat{j}+2 \hat{k})$
3) $2.8 \times 10^{8}(2 \hat{i}+3 \hat{k})$
4) $2.88 \times 10^{8}(\hat{\mathrm{i}}-3 \hat{\mathrm{j}}+2 \hat{\mathrm{k}})$
24. Two ions having equal masses, but charges in the ratio $1: 2$ are projected perpendicular to a uniform magnetic field with speeds in the ratio $2: 3$. The ratio of the radii of curvature along which the ions move, is
1) $4: 3$
2) $2: 3$
3) $3: 2$
4) $1: 4$
25. A proton moving in a perpendicular magnetic field ' $B$ ' possesses kinetic energy ' $K$ '. If the magnetic field increases to ' $4 B$ ' and the particle is constrained to move in the path of same radius, the kinetic energy will be
1) $K$
2) 4 K
3) 8 K
4) 16 K

Key

1) 3
2) 2
3) 2
4) 2
5) 2
6) 4
7) 3
8) 4
9) $1 \quad 10) 4$
10) 2
11) 3
12) 3
13) 3
14) 116$) 2$
15) 2
16) 2
17) 220$) 1$
$\begin{array}{lllll}\text { 21) } 2 & \text { 22) } 3 & \text { 23) } 2 & \text { 24) } 1 & \text { 25) } 4\end{array}$

## www.sakshieducation.com <br> Hints

16. $\frac{i_{1}}{r-x}=\frac{i_{2}}{x} \Rightarrow \frac{3}{8-x}=\frac{5}{x}$
$3 x=40-5 x \Rightarrow x=5 \mathrm{~cm}$
17. $r=\frac{m v}{q B} \Rightarrow r \alpha m v$
$\sin c e r_{A}>r_{B} \Rightarrow m_{A} v_{A}>m_{B} v_{B}$
18. Since electron is travelling along positive x - direction the magnetic field perpendicular to it $\vec{B}=4 \vec{j}-3 \vec{k} \Rightarrow|\vec{B}|=5 T$
$F=q \vee B \Rightarrow 1.6 \times 10^{-19} \times 2 \times 10^{5} \times 5$
$=1.6 \times 10^{-13} \mathrm{~T}$
19. $r=\frac{m v}{q B} \quad \mathrm{~B}$ is constant
$r_{1}: r_{2}=\frac{m_{1} v_{1}}{q_{1}}: \frac{m_{2} v_{2}}{q_{2}} \Rightarrow \frac{1}{1} \times 2: \frac{2}{2} \times 3=2: 3$
20. $r=\frac{p}{q B}=\frac{\sqrt{2 m k \cdot E}}{q B} \Rightarrow r \alpha \frac{\sqrt{m}}{q}$
$r_{1}: r_{2}: r_{3}=\frac{\sqrt{1}}{1}: \frac{\sqrt{2}}{1}: \frac{\sqrt{4}}{2}=1: \sqrt{2}: 1$
21. $F=m g \Rightarrow \frac{\mu_{0} i_{1} i_{2} l}{2 \pi r}=m g \Rightarrow \frac{\mu_{0} i_{1} i_{2}}{2 \pi r}=\frac{m}{l} g$

$$
\frac{2 \times 10^{-7} \times 200 \times i_{2}}{2 \times 10^{-2}}=20 \times 10^{-3} \times 9.8 \Rightarrow i_{2}=98 \mathrm{~A}
$$

22. $\frac{F_{1}}{F_{2}}=-\frac{i_{1} i_{2} / r_{1}}{i_{1}^{1} i_{2}^{1} / r_{2}^{1}}=\frac{i_{1} i_{2}}{i_{1} 2 i_{2}} \times \frac{3 d}{d} \Rightarrow F_{2}=\frac{-2 F}{3}$
23. $m a=e(V \times B) \Rightarrow a=\frac{e}{m}(\bar{V} \times \bar{B})$

$$
a=0.96 \times 10^{8}\left|\begin{array}{lll}
i & j & k \\
3 & 2 & 0 \\
0 & 2 & 3
\end{array}\right|=0.96 \times 10^{8}[6 i-9 j+6 k]
$$

24. $r=\frac{m v}{q B} \Rightarrow r_{1}: r_{2}=\frac{V_{1}}{q_{1}}: \frac{V_{2}}{q_{2}}=\frac{2}{1}: \frac{3}{2}=4: 3$
25. $r=\frac{m v}{q B}=\frac{\sqrt{2 m k \cdot E}}{q B} \Rightarrow \frac{K \cdot E_{1}}{B_{1}^{2}}=\frac{K \cdot E_{2}}{B_{2}^{2}} \Rightarrow \frac{K}{B^{2}}=\frac{K_{2}}{16 B^{2}}$
$K_{2}=16 K$

## Force and Torque on a current carrying conductor

1. Three infinite straight wires $A, B$ and $C$ carry currents as shown in Fig. The resultant force on wire $B$ is directed:

(1) Towards A
(2) Towards C
(3) Zero
(4) Perpendicular to the plane of the page
2. A current carrying straight wire is placed along east-west and current is passed through it eastward. The direction of the force act on it due to horizontal component of earth's magnetic field is
1) Due west
2) Due south
3) Vertically upwards
4) Vertically downwards
3. Two thin long, parallel wires, separated by a distance'd' carry a current of ' $i$ ' in the same direction. They will
1) Attract each other with a force of $\frac{\mu_{0} i^{2}}{\left(2 \pi d^{2}\right)}$ 2) Repel each other with a force of $\frac{\mu_{0} i^{2}}{\left(2 \pi d^{2}\right)}$
2) Attract each other with a force of $\left.\frac{\mu_{0} i^{2}}{(2 \pi d)} 4\right)$ Repel each other with a force of $\frac{\mu_{0} \mathrm{i}^{2}}{(2 \pi \mathrm{~d})}$
4. Two very long straight parallel wires carry steady currents I and -I. The distance between the wires is $d$. At a certain instant of time, a point charge ' $q$ ' is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity ' $v$ ' is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is
1) $\frac{\mu_{0} \mathrm{Iqv}}{2 \pi \mathrm{~d}}$
2) $\frac{\mu_{0} I q v}{\pi d}$
3) $\frac{2 \mu_{0} \text { Iqv }}{\pi \mathrm{d}}$
4) Zero
5. A current carrying circular coil, suspended freely in a uniform external magnetic field orients to a position of stable equilibrium. In this state:
1) The plane of coil is normal to external magnetic field
2) The plane of coil is parallel to external magnetic field
3) Flux through coil is minimum
4) Torque on coil is maximum
6. The plane of the coil of tangent galvanometer is kept parallel to magnetic meridian to
1) Avoid the influence of earth's magnetic field
2) Increase the magnetic field due to current in the coil
3) Make earth's magnetic field perpendicular to that due to current in the coil
4) Make readings more accurate
7. In a moving coil galvanometer a radial magnetic field is obtained with concave magnetic poles, to have
1) Uniform magnetic field
2) The plane of coil is parallel to the field in any orientation of coil
3) A non-linear scale for galvanometer
4) Both 1 and 2
8. A) Tangent galvanometer is a moving magnet type galvanometer
B) Tangent galvanometer works on tangent law
1) $A$ is true, $B$ is false
2) A is false, B is true
3) $A \& B$ are true
4) A \& B are false
9. The restoring couple for the coil of galvanometer [suspension coil type] is provided by
1) The magnetic field
2) Material of the coil
3) Twist produced in the suspension
4) Current in the coil
10. A) In Tangent galvanomter the circular frame is rotated until the plane of the coil is parallel to magnetic meridian
B) In Tangent galvanometer current through it is related to deflection of needle as
1) $A$ is true, B is false
2) A is false, B is true
3) A \& B are true
4) A \& B are false
11. In case of Tangent galvanometer
A) The galvanometer reduction factor depends on earth's magnetic field
B) External fields have effect on T.G and therefore T.G cannot be used in mines (ATB)
1) $A$ is true, $B$ is false
2) $A$ is false, $B$ is true
3) $A \& B$ are true
4) A \& B are false
12. The current that must flow through a galvanometer to have a deflection of $\mathbf{1}$ division on its scale is called
1) Meter sensitivity
2) Micro sensitivity
3) Figure of merit
4) Voltage sensitivity
13. A moving coil galvanometer can be converted into
1) An ammeter by connecting a high resistance in series with it
2) An ammeter by connecting a high resistance in parallel to it
3) A voltmeter by shunting a low resistance to it
4) A voltmeter by connecting a high resistance in series
14. The correct statement among the following is-
1) Ammeter is connected in series in a circuit because its resistance is generally high
2) Voltmeter is connected in parallel in a circuit because its resistance is generally low
3) Voltmeter is connected in parallel because its resistance is generally high
4) Ammeter is connected in parallel because its resistance is generally low
15. Statement $A$ : The resistance of ideal ammeter is zero. Statement B: The resistance of ideal voltmeter is infinity. Choose the correct option among the following.
1) Only A is correct
2) Only ' B ' is correct
3) Both A and B are correct
4) Both A and B are false
16. a) M.C.G is a highly sensitive instrument used to measure the small current of the order $10^{-9} \mathrm{~A}$
b) The suspension wire in M.C.G is phosphor - bronze because it has high young's modulus and very low rigidity modulus.
c) A soft iron cylinder is placed inside the coil in M.C.G to increase the intensity of the magnetic induction in between the poles.
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1) Only a is true
2) Only b is true
3) Only c is true
4) a, b, c all are true
17. Statement A: Ammeter is a low resistance galvanometer

Statement B: Voltmeter is a high resistance galvanometer
Read the above statements and chose the correct option given below

1) Only A is correct
2) only $B$ is correct
3) A and B are correct
4) A and B are false
18. Which of the following statement (s) are true
i) Moving coil galvanometer can be used in mines
ii) The coil of tangent galvanometer need not be arranged in magnetic meridian.
iii) The reduction factor of a tangent galvanometer varies from place to place
Iv) In tangent galvanometer, current is proportional to tangent of defleciton
1) i, ii and iii are correct
2) i, ii and iv are correct
3) i, ii and iv are correct
4) i, iii and iv are correct
19. A: For a point on the axis of a circular coil carrying current, magnetic field is maximum at the centre of the coil.

R: Magnetic field is inversely proportional to the distance of point from the circular coil.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'.
3) 'A' is true and 'R' is false.
4) 'A' is false and 'R' is true.
20. (A): In case of M.C.G the torque on the coil is maximum in any position of the coil.
$(R)$ : In case of M.C.G the concave shaped magnetic poles render the field to be radial between them so that the plane of the coil is always perpendicular to the lines of induction even after deflection.
1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'.
2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'.
3) 'A' is true and 'R' is false.
4) 'A' is false and 'R' is true.
21. Match the following.

## List - I

$\begin{array}{ll}\text { a) Moving coil galvanometer } & \text { d) } \mathrm{i} \propto \tan \theta \\ \begin{array}{lll}\text { b) Tangent galvanometer } & \text { e) } \mathrm{i} \propto \theta \\ \text { c) Duddle's galvanometer } & \text { f) } \mathrm{i} \propto \theta^{2} \\ & \text { g) } \mathrm{i} \propto \sqrt{\theta} \\ \text { 1) } \mathrm{a}-\mathrm{e}, \mathrm{b}-\mathrm{f}, \mathrm{c}-\mathrm{g} & \text { 2) } \mathrm{a}-\mathrm{e}, \mathrm{b}-\mathrm{d}, \mathrm{c}-\mathrm{g} & \text { 3) } \mathrm{a}-\mathrm{d}, \mathrm{b}-\mathrm{e}, \mathrm{c}-\mathrm{f}\end{array} & 4) \mathrm{a}-\mathrm{e}, \mathrm{b}-\mathrm{d}, \mathrm{c}-\mathrm{f}\end{array}$
22. A rectangular loop carrying a current ' $\mathbf{i}$ ' is placed in a uniform magnetic field $B$. The area enclosed by the loop is $A$. If there are $\mathbf{n}$ turns in the loop, the torque acting on the loop is given by
(PMT MP 1994)

1) $n i(\bar{A} \times \bar{B})$
2) $n i(\bar{A} \cdot \bar{B})$
3) $\left(\frac{i \bar{A} \times \bar{B}}{n}\right)$
4) $\left(\frac{i \bar{A} \cdot \bar{B}}{n}\right)$
23. An infinitely long conductor $P Q R$ is bent to form a right angle as shown. A current $I$ flows through PQR. The magnetic field due to this current at the point $M$ is $B_{1}$. Now another infinitely long straight conductor $Q S$ is connected to $\mathbf{Q}$ so that the current is $I / 2$ in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at $M$ is now $B_{2}$. The ratio $B_{1} / B_{2}$ is given by

1) $1 / 2$
2) 1
3) $2 / 3$
4) 2
24. Figure shows three long straight and parallel conductors $A, B$ and $C$ carrying currents $3 \mathrm{~A}, 1 \mathrm{~A}$ and 2 A respectively. A length of 0.5 m of the wire $B$ experiences a force of

1) $10^{-5}$ from left to right
2) $10^{-5}$ from right to left
3) $5 \times 10^{-6} \mathrm{~N}$ from L to R
4) $5 \times 10^{-6} \mathrm{~N}$ from R to L
25. A rectangular coil of wire of 100 turns and $10 \times 15 \mathrm{~cm}^{2}$ size carrying a current of 2 Amp . is in a magnetic field of induction $2 \times 10^{-3} \mathrm{wb} / \mathrm{m}^{2}$. If the normal drawn to the plane of the coil makes an angle $30^{0}$ with the field, then the torque on the coil is
1) $3 \times 10^{-5} \mathrm{~N}-\mathrm{m}$
2) $3 \times 10^{-3} \mathrm{~N}-\mathrm{m}$
3) $3 \sqrt{3} \times 10^{-5} \mathrm{~N}-\mathrm{m}$
4) $3 \sqrt{3} \times 10^{-3} \mathrm{~N}-\mathrm{m}$
26. A galvanometer of resistance 150 ohm is shunted such that only $1 / 11$ of the main current flows through the galvanometer. The resistance of the shunt is,
1) 5 W
2) 10 W
3) 15 W
4) 25 W
27. A galvanometer has coil of resistance $50 \Omega$ and shows full deflection at ${ }_{100 \mu A}$. The resistance to be added for the galvanometer to work as an ammeter of range 10 mA is nearly
1) $0.5 \Omega$ in series
2) $0.5 \Omega$ in parallel
3) $5.0 \Omega$ in series
4) $5.0 \Omega$ in parallel
28. When 0.005 A current flows through a moving coil galvanometer, it gives fullscale deflection. It is converted into a voltmeter to read 5 Volt, using an external resistance of $975 \Omega$. The resistance of galvanometer in ohms is
1) 5
2) 10
3) 15
4) 25
29. A galvanometer of resistance $40 \Omega$ and current passing through it is $100 \mu \mathrm{~A}$ per divison. The full scale has 50 divisions. If it is converted into an ammeter of range 2 A by using a shunt, then the resistance of ammeter is
1) $\frac{40}{399} \Omega$
2) $\frac{4}{399} \Omega$
3) $0.01 \Omega$
4) $0.4 \Omega$
30. An electrical meter of internal resistance $20 \Omega$ gives a full scale deflection when one milliampere current flows through it. The maximum current that can be measured by using three resistors of resistance $12 \Omega$ each, in milli ampere is
[2004 M]
1) 10
2) 8
3) 6
4) 4
31. In a galvanometer, a current of $1 \mu \mathrm{~A}$ produces a deflection of $\mathbf{2 0}$ divisions. It has a resistance of $10 \Omega$. If the galvanometer has 50 divisions on its scale and a shunt of $2.5 \Omega$ is connected across the galvanometer, the maximum current that the Galvanometer can measure now is
1) $10 \mu \mathrm{~A}$
2) $12.5 \mu \mathrm{~A}$
3) $9.5 \mu \mathrm{~A}$
4) $2.5 \mu \mathrm{~A}$
32. Two parallel horizontal conductors are suspended by light vertical threads each of length $\mathbf{7 5 c m}$. Each conductor has a mass of $\mathbf{0 . 4} \mathbf{g m}$ per $\mathbf{m}$. When no current flows through them, they are 0.5 cm apart. When same current flows through each conductor the separation is 1.5 cm . The value and direction of current is
1) 1.4 A in same direction
2) 1.4 A in opposite direction
3) 196 A in same direction
4) 196 A in opposite direction
33. A horizontal rod of mass 10 g and length 10 cm is placed on a smooth inclined plane of an angle of $60^{\circ}$ with the horizontal with the length of the rod parallel to the edge of the inclined plane. A uniform magnetic field of induction B is applied vertically downwards. If the current through the rod is $\sqrt{3} \mathrm{~A}$, the value of $\mathbf{B}$ for which the rod remains stationary on the inclined plane is
1) $B=\pi$
2) $B=2 \pi$
3) $B=3 \pi$
4) $B=4 \pi$
34. Two long parallel wires carrying currents 2.5 A and I amp in the same direction (directed into plane) are held at $\mathbf{P}$ and $\mathbf{Q}$ respectively as shown. The points $\mathbf{P}$ and $\mathbf{Q}$ are located at 5 m and 2 m respectively from a collinear point $R$. An electron moving with a velocity of $4 \times 10^{5} \mathrm{~m} / \mathrm{s}$ along positive $x$ axis experiences a force of $3.2 \times 10^{-20} \mathrm{~N}$ at the point ' $R$ '. The value of $I$ is

1) 4 A
2) 6 A
3) 8 A
4) 1 A
35. A galvanometer has resistance $G$ and Current $I_{g}$ produces full scale deflection. $S_{\mathbf{1}}$ is the value of the shunt which converts it into an ammeter of range $\mathbf{0}-\mathrm{I}$ and $\mathrm{S}_{\mathbf{2}}$ is the value of shunt for the range $0-2$. The ratio of $S_{1}$ and $S_{\mathbf{2}}$ is
1) $\frac{1}{2}\left(\frac{I-I_{g}}{2 I-I_{g}}\right)$
2) $\frac{2 I-I_{g}}{I-I_{g}}$
3) $1 / 2$
4) 2
36. A galvanometer having a resistance of $50 \Omega$, gives a full scale deflection for a current of 0.05 A . The length in meter of a resistance wire of area of cross section $2.97 \times \mathbf{1 0}^{\mathbf{- 2}}$ $\mathrm{cm}^{2}$ that can be used to convert the galvanometer into an ammeter which can read a maximum of 5 A current is ( specific resistance of the wire $=5 \times 10^{-7} \Omega-m$
1) 9
2) 6
3) 3
4) 1.5
37. A particle of mass ' $m$ ' and charge ' $q$ ' moves with a constant velocity ' $v$ ' along the positive $\mathbf{x}$ - direction. It enters a region containing a uniform magnetic field $\vec{B}$ directed along the negative $Z$-direction, extending from $x=a$ to $x=b$. The minimum value of ' $\mathbf{v}$ ' required, so that the particle can just enter the region $x>b$ is
1) $\frac{q b B}{m}$
2) $\frac{q(b-a) B}{m}$
3) $\frac{q a B}{m}$
4) $\frac{q(b+a) B}{2 m}$

Key

1) 1
2) 3
3) 3
4) 4
5) 1
6) 3
7) 2
8) 3
$\begin{array}{ll}\text { 9) } 3 & \text { 10) } 3\end{array}$
9) 3
10) 3
11) 4
12) $3 \quad$ 15) 3
13) 4
$\begin{array}{ll}\text { 19) } 3 & \text { 20) } 3\end{array}$
14) 4
15) 3
16) 3
-24) $4 \quad 25)$
2
17) 2
18) 1
$\begin{array}{ll}\text { 29) } 1 & \text { 30) } 3\end{array}$
19) 3
20) 2
21) 4
22) 1
23) 2
24) 2
25) 2
26) 1
27) 3
28) 2

## Hints

23. $B_{1}=\frac{\mu_{o} i}{4 \pi r} B_{2}=\frac{\mu_{o} i}{4 \pi r}+\frac{\mu_{o} i / 2}{4 \pi r}=\frac{3 \mu_{o} i}{8 \pi r}$

$$
\frac{B_{1}}{B_{2}}=\frac{\mu_{o} i}{4 \pi r} \times \frac{8 \pi r}{3 \mu_{o} i}=2 / 3
$$

24. 

$F_{n e t}=F_{A B}-F_{B C}=\frac{\mu_{o} l}{2 \pi}\left[\frac{i_{1} i_{2}}{r_{1}}-\frac{i_{2} i_{3}}{r_{2}}\right]$
$=2 \times 10^{-7} \times 0.5\left[\frac{3}{3 \times 10^{-2}}-\frac{2}{4 \times 10^{-2}}\right]$
$F_{\text {net }}=10^{-5}\left(1-\frac{1}{2}\right)=5 \times 10^{-6}$ from left to right

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25. $\widetilde{T}=B i A N \sin \theta=2 \times 10^{-3} \times 2 \times 10 \times 15 \times 10^{-4} \times 100 \times \frac{1}{2}$

$$
=3 \times 10^{-3} \mathrm{~N}-\mathrm{m}
$$

26. $S=\frac{G}{\frac{i}{i g}-1}=\frac{150}{\frac{11}{1}-1}=15 \Omega$
27. $S=\frac{G}{\frac{i}{i g}-1}=\frac{50}{\frac{10 \times 10^{-3}}{100 \times 10^{-6}}-1}=\frac{50}{100-1}=0.5 \Omega$ Parallel.
28. $\mathrm{V}=\mathrm{i}_{\mathrm{g}}(\mathrm{G}+\mathrm{R}) \Rightarrow 5=5 \times 10^{-3}(\mathrm{G}+975) \Rightarrow \mathrm{G}=25 \Omega$
29. $\mathrm{i}_{\mathrm{g}}=50 \times 100 \times 10^{-6}=5 \times 10^{-3} \mathrm{~A}$

$$
S=\frac{G}{\frac{i}{i g}-1}=\frac{40}{\frac{2}{5 \times 10^{-3}}-1}=\frac{40}{399} \Omega
$$

30. $G=20 \Omega \quad S=\frac{12}{3}=4 \Omega \quad \mathrm{i}_{\mathrm{g}}=1 \mathrm{~mA}$

$$
i=i_{g} \frac{(G+S)}{S}=\frac{1 \times 24}{4}=6 \mathrm{~mA}
$$

31. $i_{g}=\frac{50}{20} \times 1 \mu A=\frac{5}{2} \mu A$

$$
i_{g}=\frac{i S}{G+S} \Rightarrow i=i_{g} \frac{(G+S)}{S}=\frac{5}{2} \frac{12.5}{2.5}=12.5 \mu \mathrm{~A}
$$

32. $F=m g \operatorname{Tan} \theta$

$$
\begin{aligned}
& \frac{\mu_{o} i^{2} l}{2 \pi r}=m g \operatorname{Tan} \theta \\
& \frac{2 \times 10^{-7} i^{2} 75}{1.5}=\frac{m g}{} 0.5 \times 10^{-2} \\
& l
\end{aligned}
$$

$$
\frac{150 \times 10^{-7} i^{2}}{1.5}=4 \times 10^{-4} \times 9.8 \times 0.5 \times 10^{-2}
$$

$$
i^{2}=\frac{2 \times 9.8}{10}=1.96 \Rightarrow i=1.4 \mathrm{~A} \text { in opposite direction }
$$

33. Bil $\sin \alpha=m g \sin \theta \quad \theta=60^{\circ} ; \alpha=90-60=30^{\circ}$

$$
B \sqrt{3} \times 10 \times 10^{-2} \times \frac{1}{2}=10 \times 10^{-3} \times 10 \times \frac{\sqrt{3}}{2} \quad \alpha=90-60^{0}=30
$$

$$
B=\pi
$$

34. 

$$
\begin{aligned}
& q v\left(B_{1}+B_{2}\right)=F \\
& 1.6 \times 10^{-19} \times 4 \times 10^{5}\left(\frac{\mu_{0} \times 2.5}{2 \pi \times 5}+\frac{\mu_{0} I}{2 \pi \times 2}\right)=3.2 \times 10^{-20} \\
& 2 \times 10^{-14} \times 2 \times 10 \mathrm{~h}-7\left[\frac{1}{2}+\frac{I}{2}\right]=10^{-20} \\
& \frac{1}{2}+\frac{I}{2}=\frac{5}{2} \Rightarrow I=4 \mathrm{~A}
\end{aligned}
$$

35. $S_{1}=\frac{G}{\frac{I}{I_{g}}-1} \quad S_{2}=\frac{G}{\frac{2 I}{I_{g}}-1}$
$\frac{S_{1}}{S_{2}}=\frac{2 I-I_{g}}{I-I_{g}}$
36. $S=\frac{G}{\frac{i}{i g}-1}=\frac{50}{\frac{5}{0.05}-1}=\frac{50}{99}$
$S=\frac{P l}{A} \Rightarrow l=\frac{S A}{P}$
$l=\frac{50}{99} \times \frac{2.97 \times 10^{-2} \times 10^{-4}}{5 \times 10^{-7}}=3 \mathrm{~m}$
37. $F=m a=q v_{\text {avg }} B \Longleftrightarrow \frac{m v^{2}}{2 d}=q \frac{V}{2} B$

$$
\begin{aligned}
& V=\frac{q d B}{m} \text { but } d=x_{2}-x_{1}=b-a \\
& V=q \frac{(b-a) B}{m}
\end{aligned}
$$

