QB365

# Important Questions - Magnetic Effects of Current

12th Standard CBSE

**Physics**

Reg.No. :

Time : 01:00:00 Hrs

Total Marks : 50

## Section-A

1) The magnetic field at a perpendicular distance of 2 cm from an infinite straight current carrying conductor is $2X10^{-6}$ T. The current in the wire is 1

(a) 0.1 A (b) 0.2 A (c) 0.4 A (d) 0.8 A

2) A positive charge is moving towards an observer. The direction of magnetic induction lines is 1

(a) clockwise (b) anticlockwise (c) right (d) left

3) If a copper wire carries a direct current, the magnetic field associated with the current will be 1

(a) only outside the wire (b) only inside the wire (c) both inside and outside the wire

(d) neither inside nor outside the wire

4) Current carrying wire produces 1

(a) Only electric field (b) Only magnetic field (c) Both electric and magnetic field

(d) None of the above

5) A circular coil of n turns and radius r carries a current I. The magnetic field at the centre is 1

(a) $\frac{\mu_o nI}{r}$ (b) $\frac{\mu_o nI}{2r}$ (c) $\frac{2\mu_o nI}{r}$ (d) $\frac{\mu_o nI}{4r}$

6) A thin ring of radius R metre has charge q coulomb uniformly spread on it. The ring rotates about its axis with a constant frequency of f revolutions/s. The value of magnetic field induction in $Wb/m^2$ at the centre of the ring is 1

(a) $\frac{\mu_o qf}{2\pi R}$ (b) $\frac{\mu_o q}{2\pi fR}$ (c) $\frac{\mu_o q}{2fR}$ (d) $\frac{\mu_o qf}{2R}$

## Section-B

7) Write the relation for the force $\vec{F}$ acting on a charge carrier q moving with a velocity $\vec{v}$ through a magnetic field $\vec{B}$ in vector notation. Using this relation, deduce the conditions under which this force will be (i) maximum (ii) minimum. 2

8) What is magnetic flux density? Define its units and give its dimensions. 2

9) In what respect does a wire carrying a current differ from a wire, which carries no current? 2

10) A current of one ampere is passed through a straight wire of length 2.0 metre. Find the magnetic field at a point in air at a distance 3 metre from one end of wire but lying on the axis of the wire. 2

11) Write the relation for the magnetic field induction at a point due to a linear conductor carrying current and hence deduce the relation for the magnetic field induction at a point due to a very long linear conductor carrying current. 2

12) What is the magnetic effect of current ? Describe the nature of the magnetic field related with the current in circular coil. **2**

## Section-C

13) Find the force on a wire (of negligible mass) of length 4.0 cm placed inside a solenoid near its centre, making an angle of $60^o$ with its axis. The wire carries a current of 12 A and magnetic field due to solenoid has a magnitude of 0.25 T. Find also the direction of the force experienced by the wire. **3**

14) In a galvanometer there is a deflection of 10 divisions per mA. The internal resistance of the galvanometer is 78 Ω. If a shunt of 2 Ω is connected to the galvanometer and there are 75 divisions in all on the maximum current which the galvanometer can read. **3**

15) A galvanometer of resistance 80 Ω, shunted by a resistance of 20Ω is joined in series with a resistance of 200 Ω and a cell of e.m.f. 15 V. What is the sensitivity of the galvanometer if it shows a deflection of 30 division? **3**

16) An electron emitted by a heated cathode and accelerated through a potential difference of 2.0 kV, enters a region with uniform magnetic field of 0.15 T. Determine the trajectory of the electron if the field (a) is transverse to its initial velocity, (b) makes an angle of $30^o$ with the initial velocity. **3**

## Section-D

17) Assume the dipole model for earth's magnetic field B which by $B_v =$ vertical component of magnetic field= $\frac{\mu_0}{4\pi}\frac{2M\cos\theta}{r^3} B_H =$ Horizontal component of magnetic field=$\frac{\mu_0}{4\pi}\frac{2M\sin\theta M}{r^3}$, $\theta = 90^\circ =$ lattitude as measured from magnetic equator.Find loci of points for which (i) $|B|$ is minimum:(ii) dip angle is zero.and (iii) dip angle is$\pm 45^\circ$. **5**

18) How are materials classified according to their behaviour in magnetic field? **5**

19) Find the expression for maximum energy of a charged particle accelerated by a cyclotron. **5**

20) Two linear parallel conductors carrying currents in the same direction attract each other and two linear parallel conductors carrying in opposite directions repel each other. The force acting per unit length due to currents $I_1 and I_2$in two linear parallel conductors held distance r apart in vacuum in SI unit is $F = \frac{\mu_0}{2\pi}\frac{2I_1I_2}{r}$ **5**

Read the above passage and answer the following questions:

(i) What is the basic reason for the force between two linear parallel conductors currents?

(ii) Two straight wires A and B of lengths 2 cm and 20 cm, carrying currents 2.0 A and 5.0 A respectively in opposite directions are lying parallel to each other 4.0 cm apart. The wire A is held near the middle of wire B. What is the force on 20 cm long wire B?

(iii) What does this study imply in day to day life?

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## Section-A

1) (b) 0.2 A **1**

2) (b) anticlockwise **1**

3) (a) only outside the wire **1**

4) (b) Only magnetic field **1**

5) (b) $\frac{\mu_o nI}{2r}$ **1**

6) (d) $\frac{\mu_o qf}{2R}$ **1**

## Section-B

7) **2**

$\vec{F} = q\left(\vec{v} \times \vec{B}\right) or \quad \left|\vec{F}\right| = q\left|\vec{v} \times \vec{B}\right| = qvBsin\theta$

(i) F will be maximum, when $sin\theta = 1 \quad or \quad \theta = 90^o$ , i.e., the charged particle is moving perpendicular to the direction of magnetic field.

(ii) F will be minimum, when $sin\theta = 0 \quad or \quad \theta = 0^o \quad or \quad 180^o$ i.e., the charged particle is moving parallel to the direction of magnetic field.

8) **2**

Magnetic flux density at a point in a magnetic field means magnetic field induction at that point. It is defined as the force experienced by a unit charge while moving with a unit velocity, perpendicular to the direction of magnetic field at that point. Force experienced by the charged particle having charge q moving with velocity $\vec{v}$ through a magnetic field $\vec{B}$ is given by

$$\left|\vec{F}\right| = q\left|\vec{v} \times \vec{B}\right| = qvBsin\theta or \quad B = \frac{F}{qvsin\theta}$$

The SI unit of B is tesla, where 1 tesla is the magnetic flux density at a point if 1 coulomb charge while moving with a velocity of 1 $ms^{-1}$, perpendicular to a magnetic field experiences a force of 1 N at that point.

The dimensional formula of B

$$= \frac{\left[MLT^{-2}\right]}{[AT]\left[LT^{-1}\right]} = \left[ML^oT^{-2}A^{-1}\right]$$

9) **2**

A current carrying wire produces a magnetic field. When current is flowing through a wire, the electrons move inside it along a definite direction. On the other hand, if no current is flowing through a wire, the electrons inside this wire are in random motion, their average thermal velocity is zero. Such a wire does not produce any magnetic field.

10) **2**

When a point P lies on the axis of wire conductor in air, then $\overrightarrow{Idl} \quad and \quad \vec{r}$ for each element of the straight wire conductor are parallel. Therefore, $\overrightarrow{Idl} \times \vec{r} = 0,$ so the magnetic field induction at given point is zero.

11) **2**

Magnetic field induction at a point P in space at a perpendicular distance a from a linear conductor carrying current i is

$$B = \frac{\mu_o}{4\pi a}\left(sin\phi_1 + sin\phi_2\right)$$

Where $\phi_1$ and $\phi_2$ are the angles subtended by the lines joining the ends of linear conductor with point P and perpendicular drawn on the conductor from point P.

In case of infinitely long conductor,

$$\phi_1 = \frac{\pi}{2} = \phi_2 \therefore \qquad B = \frac{\mu_o}{4\pi}\frac{i}{a}\left(sin\frac{\pi}{2} + sin\frac{\pi}{2}\right) = \frac{\mu_o}{4\pi}\frac{2i}{a}$$

12) 2

When a current is passed through a conductor, magnetic field is produced around the conductor. It is called magnetic effect of current. The magnetic field is in the form of concentric circular magnetic lines of force for a linear conductor carrying current. The magnetic field is in the form of parallel straight lines at the centre and concentric magnetic lines near the circular coil carrying current.

## Section-C

13) F = 0.104 N 3

14) I = 0.3 A 3

15) 21600 div/amp. 3

16) (a) circular trajectory of r = 1.0 mm (b) helical trajectroy of r = 0.5 mm 3

## Section-D

17) 5

$$B_v = \frac{\mu_0}{4\pi}\frac{2M\cos\theta}{r^3}$$

$$B_H = \frac{\mu_0}{4\pi}\frac{M\sin\theta}{r^3}$$

$$B = \sqrt{{B_v}^2 + {B_H}^2} = \frac{\mu_0 M}{4\pi r^3}\left[4\cos^2\theta + \sin^2\theta\right]$$

$$B = \frac{\mu_0 M}{4\pi r^3}\left[3\cos^2\theta + 1\right]$$

Now B will be minimum if $\cos\theta = 0 \quad or \quad \theta = 90^\circ$

i.e. B will be minimum at magnetic equator.

(ii) Angle of dip is given by

$$\tan\delta = \frac{B_V}{B_H} = \frac{2\cos\theta}{\sin\theta} = 2\cot\theta$$

$$\delta = 0, if \quad \cot\theta = 0 \quad or \quad \theta = \frac{\pi}{2}$$

i.e. angle of dip is zero at magnetic equator(iii) $\delta = 45^\circ, \cot\theta = \frac{1}{2} or \quad \tan\theta = 2$

$$\theta = \tan^{-1} 2 is \quad the \quad locus.$$

18) 5

On the basis of their in a magnetic field, the various materials can be classified in three classes.

(i)Diamagnetic.Those materials, which when placed in a magnetic field, are feebly magnetised in a direction opposite to the magnetising field are called diamagnetic substances.A few examples of diamagnetic materials are copper, zinc, bismuth, water, sodium chloride, helium, argon etc. When a diamagnetic substance is suspended in a magnetic field, it arranges itself in the direction of the magnetic field. (ii) Paramagnetic. Those materials, which when placed in a magnetic field, are feebly magnetised in the direction of magnetic field, are called paramagnetic substances.A few examples of paramagnetic substances are aluminium, sodium, antimony, platinum, copper chloride, liquid oxygen etc. When a paramagnetic substance is suspended in a magnetic field it arranges itself to the direction of magnetic field. (iii) Ferromagnetic. Those materials which when placed in a magnetic field are strongly magnetised in the direction of the magnetising field, are ferromagnetic substances.A few examples of ferromagnetic substances are iron, nickel, cobalt, alnico, mercury etc.

19) **5**

Let $r_0$ = Maximum radius of circular path followed by charged particle (Equal to the radius of the Dees)

$v_0$ = Maximum velocity Since the necessary centripetal force is provided by the Lorentz magnetic force, therefore,

$$\frac{mv_0^2}{r_0} = Bqv_0 \qquad v_0 = \frac{Bqr_0}{m} \therefore \quad K.E_{maxi} = \frac{1}{2} \times m \times \left(\frac{Bqr_0}{m}\right)^2 \qquad = \frac{b^2q^2r_0^2}{2m}$$

This is the required result.

20) **5**

(i) The force is due to the interaction between magnetic fields due to currents in two linear parallel conductors.

(ii) Here, $l_1 = 2cm = 2 \times 10^{-2}m; l_2 = 20 \times 10^{-2}m; I_1 = 2.0A; I_2 = 5.0A; r = 4 \times 10^{-2}m$

Since action and reaction are equal and opposite so the magnitude of repulsive force on 20 cm long wire = the magnitude of repulsive force on 2 cm long wire= $\frac{\mu_0}{4\pi}\frac{2I_1I_2}{r}l_1 = 10^{-7} \times \frac{2 \times 2 \times 5 \times (2 \times 10^{-2})}{4 \times 10^{-2}} = 10^{-6}$

This study shows that when the current through two parallel conductors flow in the same direction, they attract each other and vice versa. It implies that when the thoughts and actions of two business partners are aligned in the same direction, their behavior is cohesive and they succeed. If there thoughts and actions are opposing, the partnership is likely to collapse. The same thing is true for husband and wife. For a successful family life, the coherence of thoughts and action is a must.