ELECTROMAGNETISM

PREVIOUS EAMCET BITS

Engineering paper

1. An ammeter and a voltmeter of resistance R are connected in series to an electric cell of negligible internal resistance. Their readings are A and V respectively. If another resistance R is connected in parallel with the voltmeter , then **(2000 E)**

   1) Both A and V increases 2) Both A and V decreases

   3) A decreases but V increases 4) A increases but V decreases.

   Ans: 4

Sol. When a resistance R is connected in parallel to the voltmeter, the effective resistance decreases. Thereby ammeter reading increases and voltmeter reading decreases.

2. Two long parallel copper wires carry currents of 5A each in the opposite direction . If the wires are seperated by a distance of 0.5 m, then the force between the two wires is **(2000 E)**

   1) 10^{-5} N attractive 2) 10^{-5} N repulsive 3) $2x10^{-6}$ N attractive 4) $2x10^{-5}$ N repulsive

   Ans: 2

Sol. Force between two parallel straight current carrying conductors will be

$$F = \frac{\mu_0}{2\pi}.\frac{i_1 i_2 \ell}{d}$$

$$\Rightarrow \frac{F}{\ell} = \frac{\left(2\times10^{-7}\right)(5)(5)}{0.5} = 10^{-5}\,N/m$$

As the directions of currents are opposite to each other force of repulsion between them is 10^{-5} N

3 An electron moves with a speed 2 x 10^5 m/s along the positive x-direction in the presence of a magnetic induction $\overline{B} = (\overline{i} + 4\overline{j} - 3\overline{k})\ \ T$. The magnitude of the force experienced by the electron in newton is (charge on the electron = $1.6x10^{-19}$C) **(2001 E)**

   1) $1.18x10^{-13}$ 2) $1.28x10^{-13}$ 3) $1.6x10^{-13}$ 4) $1.72x10^{-13}$

   Ans: 3

Sol. F = qV × B

$$= qV\hat{i}\times\left(\hat{i} + 4\hat{j} - 3\hat{k}\right)$$

$$= qV\left(4\hat{k} + 3\hat{j}\right)$$

$$F = qV\sqrt{4^2 + 3^2} = 5qV$$

$$= 5\times1.6\times10^{-19}\times2\times10^5$$

$$= 1.6\times10^{-13}\,N$$

4. A particle of mass 0.6 g and having charge of 25 nC is moving horizontally with a uniform velocity $1.2x10^4$ m/s in a uniform magnetic field, then the value of the magnetic induction is **(2001 E)**

   1) zero 2) 10T 3) 20T 4) 200T

   Ans: 3

Sol. As the particle is moving horizontally, Magnetic force = gravitational force

$\Rightarrow qVB = mg$

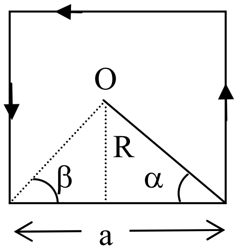
$\Rightarrow B = \frac{mg}{qv} = \frac{0.6\times10^{-3}\times10}{25\times10^{-9}\times1.2\times10^{4}} = 20\ T$

5. A wire in the form of a square of side 'a' carries a current i. Then the magnetic induction at the centre of the square wire is (magnetic permeability of free space = μ_0) **(2001 E)**

1) $\frac{\mu_0 i}{2\pi a}$ 2) $\frac{\mu_0 i\sqrt{2}}{\pi a}$ 3) $\frac{2\sqrt{2}\mu_0 i}{\pi a}$ 4) $\frac{\mu_0 i}{\sqrt{2\pi a}}$

Ans: 3

Sol.



For the current in one side, B at the centre O is given by $B_1 = \frac{\mu_0 i}{4\pi R}(\cos\alpha + \cos\beta)$

$\alpha = \beta = 45°$

$R = \frac{a}{2}$

Contribution from all the four sides is equal. $B = 4B_1 = 4\frac{\mu_0 i}{4\pi\left(\frac{a}{2}\right)}\times 2\cos 45^0$

$= = 2\sqrt{2}\frac{\mu_0 i}{\pi a}$

6. An electron revolves in a circle of radius 0.4A° with a speed of 10^6 m/s in Hydrogen atom. The magnetic field produced at the centre of the orbit due to the motion of the electron in tesla is

$\left(\mu_0 = 4\pi\times10^{-7} H/m;\ \text{charge on the electron}=1.6\times10^{-19} C\right)$ **[EAMCET 2002 E]**

1) 0.1 2) 1.0 3) 10 4)100

Ans: 3

Sol. $B = \frac{\mu_0 i}{2r} = \frac{\mu_0}{2r}.\frac{q}{T}$

$\Rightarrow \frac{\mu_0 q}{2r\times\frac{2\pi r}{V}} = \frac{\mu_0 qv}{4\pi r^2}$ $\left[as\ T = \frac{2\pi r}{v}\right]$

$= \frac{10^{-7}\times1.6\times10^{-19}\times10^{6}}{\left(0.4\times10^{-10}\right)} = 10$ Tesla

7 A galvanometer having a resistance of 50Ω gives a full scale deflection for a current of 0.005 A. The length in meter of a resistance wire of area of cross section $2.97\times10^{-3}cm^{-2}$ that can be used

to convert the galvanometer into an ammeter which can be read a maximum of 5A current is [specific resistance of the wire = $5\times10^{-7}\Omega - m$] **(2003 E)**

1) 9 2) 6 3) 3 4) 1.5

Ans: 3

Sol. Let 's' is the shunt resistance and G is the resistance of galvanometer

$$s = \frac{G}{n-1} = \frac{50}{\frac{5}{0.5}-1} = \frac{50}{99}\Omega$$

$$R = \frac{\rho\ell}{A}$$

$$\Rightarrow \ell = \frac{AR}{\rho} = \frac{2.97\times10^{-6}}{5\times10^{-7}}\times\frac{50}{99} = 3m$$

8 A long straight wire carrying a current of 30A is placed in an external uniform magnetic field of induction $4\times10^{-4}T$. The magnetic field is acting parallel. to the direction of current. The magnitude of the resultant magnetic induction in tesla at a point 2.0 cm away from the wire is [$\mu_0 = 4\pi\times10^{-7}Hm^{-1}$] **(EAMCET-2003 E)**

1) 10^{-4} 2) 3×10^{-4} 3) 5×10^{-4} 4) 6×10^{-4}

Ans: 3

Sol. Given $B_1 = 4\times10^{-4}T$

Magnetic induction at a point from the straight conductor carrying current.

$$B_2 = \frac{\mu_0}{2\pi}.\frac{i}{r} = \frac{(2\times10^{-7})(30)}{2\times10^{-2}} = 3\times10^{-3}T$$

As the fields are perpendicular to each other. $B_{res} = \sqrt{B_1^2 + B_2^2} = 5\times10^{-4}T$

9. The scale of a galvanometer of resistance 100 ohms contains 25 divisions. It gives a deflection of one division on passing a current of 4×10^{-4} amperes. The resistance in ohms to be added to it, so that it may become a voltmeter of range 2.5 volts is **(EAMCET-2003 E)**

1)100 2)150 3)250 4)300

Ans: 2

Sol. For full deflection, $i = 25\times4\times10^{-4} = 10^{-2}A$

$V = iG = 10^{-2}\times100 = 1$ volt

$R = G(N-1) = 100(2.5-1) = 150\Omega$ to be added in series

10. Magnetic induction at the centre of a circular loop of area square meter is 0.1 tesla. The magnetic moment of the loop is (μ_0 is permeability of air) **(EAMCET-2004 E)**

1) $\frac{0.1\pi}{\mu_0}$ 2) $\frac{0.2\pi}{\mu_0}$ 3) $\frac{0.3\pi}{\mu_0}$ 4) $\frac{0.4\pi}{\mu_0}$

Ans: 2

Sol. Magnetic induction at the centre of circular loop

$$B = \frac{\mu_0}{2} \cdot \frac{ni}{r}$$

$\therefore$ Magnetic moment of the loop = niA where n is the number of loops i is the current and A is the area of cross-section

$$\therefore\ M = niA = \frac{2BrA}{\mu_0} = \frac{(0.2)\pi}{\mu_0} [\because r = 1]$$

11. A wire of length 'l' is bent into a circular coil of one turn of radius R_1 . Another wire of the same materi al and same area of cross section and same length is bent into a circular coil of two turns of radius R_2 . When the same current flows through the two coils, the ratio of magnetic induction at the centres of the two coils is **(EAMCET-2004 E)**

1) 1:2 2)1:1 3) 1:4 4) 3:1

Ans: 3

Sol. B = Magnetic induction at the centre of a circular coil = $\frac{\mu_0 ni}{2r}$

$$2\pi R_1 = \ell \Rightarrow R_i = \frac{\ell}{2\pi}$$

$$B_1 = \frac{\mu_0 in}{2R_1} = \frac{\mu_0 i}{2\ell} \times 2\pi = \frac{\pi\mu_0 i}{\ell}$$

$$(2\pi R_2) \times 2 = \ell \Rightarrow R_2 = \frac{\ell}{4\pi}$$

$$B_2 = \frac{\mu_0 i}{2\ell} \times 4\pi \times 2 = \frac{4\pi\mu_0 i}{\ell} = 4B_1$$

$$\Rightarrow \frac{B_1}{B_2} = \frac{1}{4}$$

12. A circular coil of radius 2R is carrying current i. The ratio of magnetic fields at the centre of the coil and at a point at a distance 6R from the centre of the coil on the axis of the coil is **(EAMCET-2004 E)**

1) 10 2) $10\sqrt{10}$ 3) $20\sqrt{10}$ 4) $20\sqrt{5}$

Ans: 2

Sol. At the centre of the coil, $B_1 = \frac{\mu_0 i}{2 \times 2R} = \frac{\mu_0 i}{4R}$

On the axis of the coil, $B_2 = \frac{\mu_0 i (2R)^2}{2(4R^2 + x^2)^{3/2}}$

Put x = 6R

$$\Rightarrow B_2 = \frac{\mu_0 i}{2R} \times \frac{4}{40^{3/2}} = \frac{\mu_0 i}{40\sqrt{10}R}$$

$$\Rightarrow \frac{B_1}{B_2} = 10\sqrt{10}$$

13. An electrical meter of internal resistance 20Ω 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 each, in milliamperes is **(EAMCET-2004 E)**

1) 10 2) 8 3) 6 4) 4

Ans: 3

Sol. We know $E = ir = 1 \times 20 = 20$ volt

Maximum current is obtained when all the three resistors are used in parallel with the internal resistance of the electrical meter.

$$\frac{1}{R} = \frac{1}{20} + \frac{1}{12} + \frac{1}{12} + \frac{1}{12} \Rightarrow R = \frac{20}{6}\ \Omega$$

$$E = i'R = \frac{20}{6} i' = 20$$

$$\Rightarrow i' = 6\text{mA}$$

14. Magnetic field induction at the center of a circular coil of radius 5cm and carrying a current 0.9 A is (in S.I. units) ($\in_0$ = absolute permittivity of air in S.I. units: velocity of light $= 3 \times 10^8 ms^{-1}$) **(2005 E)**

1) $\frac{1}{\in_0 10^{16}}$ 2) $\frac{10^{16}}{\in_0}$ 3) $\frac{\in_0}{10^{16}}$ 4) $10^{16} \in_0$

Ans: 1

Sol. $B = \frac{\mu_0 i}{2r}$ = Magnetic field induction at the centre of circular coil

We know $C = \frac{1}{\sqrt{\mu_0 \in_0}} \Rightarrow \mu_0 = \frac{1}{\in_0 \times 9 \times 10^{16}}$

$$B = \frac{0.9}{\in_0 9 \times 10^{16} \times 2 \times 5 \times 10^{-2}}$$

$$\Rightarrow B = \frac{1}{\in_0 \times 10^{16}}$$

15 A particle of mass 1×10^{-26} kg and charge 1.6×10^{-19} C travelling with a velocity $1.28 \times 10^6 ms^{-1}$ along the positive X-axis enters a region in which a uniform electric field $\vec{E} = -102.4 \times 10^3 k\ NC^{-1}$ and magnetic field $B = 8 \times 10^{-2} jWbm^{-2}$, the direction of motion of the particles is: **(EAMCET-2005E)**

1)along the positive X-axis 2) along the negative X-axis

3) at 45^0 to the positive X-axis 4) at 135^0 to the positive X-axis

Ans: 1

Sol. $\vec{E}, \vec{B}$ are acting in Z, Y direction .

So Null deflection is observed

16. When a positively charged particle enters a uniform magnetic field with uniform velocity, its trajectory can be : **[EAMCET 2006 E]**

a) a straight line (b) a circle c) a helix

1) a only 2) a or b 3) a or c 4) any one of a, b and c

Ans:4

Sol. If it enters parallel to the field it moves along a straight line

If it enters at right angles, it moves along a circular path

If it enters at an angle between 0° and 90°, its path is helical

17. Two wires A and B are of lengths 40cm and 30cm. A is bent into a circle of radius r and B into an arc of radius r. A current i_1 is passed through A and i_2 through B. To have the same magnetic inductions at the centre, the ratio of $i_1 : i_2$ is **(EAMCET 2007 E)**

1) 3 : 4 2) 3 : 5 3) 2 : 3 4) 4 : 3

Ans: 1

Sol. $B = \frac{\mu_0 i}{2r} \Rightarrow \frac{B_1}{B_2} = \frac{r_2}{r_1}$ but $\ell_1 = 2\pi r_1 \Rightarrow r_1 = \frac{2\pi}{\ell_1}$

$\ell_2 = 2\pi r_2 \Rightarrow r_2 = \frac{2\pi}{\ell_2}$

$\therefore \frac{B_1}{B_2} = \frac{\ell_1}{\ell_2}$

18. In a galvanometer 5% of the total current in the circuit passes through it. If the resistance of the galvanometer is G, the shunt resistance 'S' connected to the galvanometer is **(EAMCET 2008 E)**

1) 19G 2) $\frac{G}{19}$ 3) 20G 4) $\frac{19G}{19}$

Ans: 2

Sol. If the range of the galvanometer is increased to n times, then $\frac{1}{n}$th of main current passes through galvanometer

$S = \frac{G}{n-1}$

5% is $\frac{1}{20}$th of main current

Here n = 20

$\therefore S = \frac{G}{20-1} = \frac{G}{19}$

19. The following, series L – C – R circuit, when driven by an e.m.f. source of angular frequency 70 kilo-radians per second, the circuit effectively behaves like **[EAMCET 2009 E]**

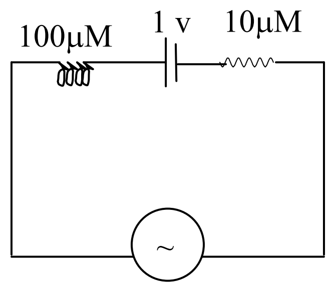
1) purely resistive circuit

2) series R – L circuit

3) series R-C circuit

4) series L-C circuit with R = 0

Ans: 3



Sol. The effective circuit behaves as a R- C circuit

20. A wire of length '*l*' is bent into a circular loop of radius R and carries a current I. The magnetic field at the centre of the loop is 'B'. The same wire is now bent into a double loop of equal radii If both loops carry the same current I and it is in the same direction, the magnetic field at the centre of the double loop will be **[EAMCET 2009 E]**

1) Zero 2) 2B 3) 4B 4) 8B

Ans: 3

Sol. We know $B = \frac{\mu_0}{2}.\frac{ni}{r}$ = magnetic induction at the centre of circular loop.

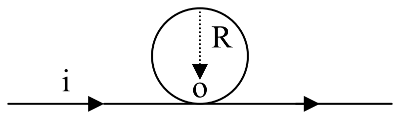
$\Rightarrow \frac{B_1}{B_2} = \frac{n_1}{n_2} \times \frac{r_2}{r_1} = \frac{1}{2} \times \frac{r/2}{r} = \frac{1}{4}$

$\Rightarrow B_2 = 4B_1 = 4B$

21. An infinitely long straight conductor is bent into the shape as shown below. It carries a current of i amps and the radius of the circular loop is R metres. Then the magnitude of magnetic induction at the centre of the circular loop is **[EAMCET 2009 E]**

1) $\frac{\mu_0 i}{2\pi R}$ 2) $\frac{\mu_0 ni}{2R}$

3) $\frac{\mu_0 i}{2\pi R}(\pi + 1)$ $\frac{\mu_0 i}{2\pi R}(\pi - 1)$



Ans: 3

Sol. $B = \frac{\mu_0}{2\pi}\frac{i}{R} + \frac{\mu_0}{2}.\frac{i}{R} = \frac{\mu_0 i}{2\pi R}[1 + \pi]$

MEDICAL

22. A galvanometer of $25\,\Omega$ resistance can read a maximum current of 6 mA. It can be used as a voltmeter to measure maximum 6V by connecting a resistance to galvanometer. Identify the correct choice in the given answers **(2000 M)**

1) $1025\,\Omega$ in series 2) 1025 Ω in parallel 3) 975 Ω in series 4) 975 Ω in parallel.

Ans: 3

Sol. Resistance $R = \frac{v}{\ell} - G = \frac{6}{6 \times 10^{-3}} - 25$

$\therefore$ $975\,\Omega$ resistance is connected in series

23. A long straight wire carries an electric current of 2A. The magnetic induction at a perpendicular distance of 5 m from the wire is ($\mu_0 = 4\ \pi \times 10^{-7}$ Hm^{-1}) **(2000 M)**

1) 4×10^{-8} T 2) 8×10^{-8} T 3) 12×10^{-8} T 4) 16×10^{-8}T

Ans: 2

Sol. $B = \frac{\mu_0}{2\pi}, \frac{i}{d} = \frac{\left(2\times10^{-7}\right)(2)}{5}$

$= 8\times10^{-8}$T

24. The range of a voltmeter of resistance $300\,\Omega$ is 5V. The resistance to be connected to convert it as an ammeter of range 5A is **(2001 M)**

1) $1\,\Omega$ in series 2) $1\,\Omega$ in parallel 3) $0.1\,\Omega$ in series 4) 0.1 Ω in parallel.

Ans: 2

Sol. $V = iR \Rightarrow i = \frac{V}{R} = \frac{5}{300} = \frac{1}{60}$

$N = \frac{i_i}{i} = \frac{5}{1/60} = 300$

$S = \frac{R}{N-1} = \frac{300}{300-1} = 1\Omega$ in parallel

25. The magnetic induction at the centre of a current carrying circular coil of radius 10 cm is $5\sqrt{5}$ times the magnetic induction at a point on its axis. The distance of the point from the centre of the coil in cm is **(2002 M)**

1) 5 2) 10 3) 20 4) 25

Ans: 3

Sol. $B = \frac{\mu_0 i R^2}{2\left(R^2 + x^2\right)^{3/2}}$

$B_0 = \frac{\mu_0 i}{2R}$

$\Rightarrow \frac{B_0}{B} = 5\sqrt{5} = \frac{\left(R^2 + x^2\right)^{3/2}}{R^3}$

Squaring on both sides and solving, we find x = 2R= 2 x 10 = 20 cm

26. 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 is rewound into a circular coil of four turns. The magnetic induction at the centre of the coil now is, in tesla (if same current flows in the coil) **(EAMCET-2003 M)**

1)0.2 2) 0.4 3) 0.6 4) 0.8

Ans: 4

Sol. $\frac{B_1}{B_2} = \frac{n_1}{n_2} \times \frac{r_2}{r_1}$

$$\frac{0.2}{B_2} = \frac{2}{4} \times \frac{r/2}{r} = \frac{1}{4}$$

27. A current carrying circular coil, suspended freely in a uniform external magnetic field orients to a position of stable equilibrium. In this state: **(EAMCET-2005M)**

1)The plane of the coil is normal to the external magnetic field

2)The plane of the coil is parallel to the external magnetic field

3)Flux through the coil is minimum

4) Torque on the coil is maximum

Ans: 1

Sol. In this case the plane of the coil is normal o the external magnetic field

28. A proton is projected with a velocity $10^7 ms^{-1}$, at right angles to a uniform magnetic field of induction 100 mT. The time (in seconds) taken by the proton to traverse 90^0 arc is :

(Mass of proton $= 1.65 \times 10^{-27}$ kg and charge of proton $= 1.6 \times 10^{-19} C$) **(EAMCET-2005M)**

1) 0.81×10^{-7} 2) 1.62×10^{-7} 3) 2.43×10^{-7} 4) 3.24×10^{-7}

Ans: 2

Sol. Cyclotron time period $T = \frac{2\pi m}{qB}$

Time required to complete a sector of angle 90° is

$$\frac{T}{4} = \frac{\pi m}{2qB} = \frac{\pi \times 1.6 \times 10^{-27}}{2 \times 1.6 \times 10^{-19} \times 100 \times 10^{-3}} = 1.6 \times 10^{-7}$$

29. A long horizontal rigidly supported wire carries a current $i_a = 96A$. Directly above it and parallel to it at a distance, another wire of 0.144N weight per metre carrying a current $i_b = 24A$, in a direction opposite to that air due to magnetic repulsion, then its distance (in mm) from the lower wire is : **(EAMCET 2006 M)**

1) 9.6 2) 4.8 3) 3.2 4) 1.6

Ans: 3

Sol. $mg = \frac{\mu_0 i_1 i_2 l}{2\pi d}$ $F = \frac{\mu_0 i_1 i_2 \ell}{2T_1 r}$

$$\Rightarrow \frac{mg}{l} = \frac{\mu_0 i_1 i_2}{2\pi d}$$

$$144 \times 10^{-3} \times 10 = \frac{2 \times 10^{-7} \times 96 \times 24}{d}$$

$$d = \frac{2 \times 96 \times 24 \times 10^{-7}}{144 \times 10^{-2}} = 3.2mm$$

Hence (3) is the correct choice.

30. Two coils are wound on the same iron rod so that the flux generated by one passes through the other. The primary coil has N_p turns in it and when a current 2A flows through it the flux in it is

2.5×10^{-4} Wb. If the secondary coil has 12 turns the mutual inductance of the coils is (assume the secondary coil is in open circuit) **(EAMCET 2007 M)**

1) $10\times10^{-4}H$ 2) $15\times10^{-4}H$ 3) $20\times10^{-4}H$ 4) $25\times10^{-4}H$

Ans: 2

Sol. $|N_s\phi_s| = |Mi_p|$

$$M = \frac{N_s\phi_s}{i_p} = \frac{12\times2.5\times10^{-4}}{2} = 15\times10^{-4}H$$

Hence (2) is the correct choice

31. A circular coil of wire of radius ‘r’ has ‘n’ turns and carries a current ‘l’. The magnetic induction (B) at a point on the axis of the coil at a distance $\sqrt{3}$ r from its centre is **[EAMCET 2008 M]**

1) $\frac{\mu_0 In}{4r}$ 2) $\frac{\mu_0 In}{8r}$ 3) $\frac{\mu_0 nI}{16r}$ 4) $\frac{\mu_0 In}{32r}$

Ans: 3

Sol.

32. The following, series L – C – R circuit, when driven by an e.m.f. source of angular frequency 70 kilo-radians per second, the circuit effectively behaves like **[EAMCET 2009 M]**

1) purely resistive circuit

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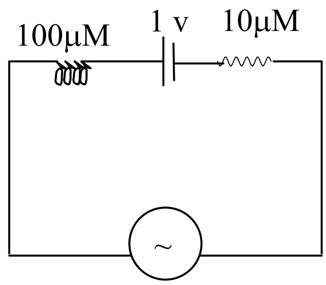

Ans: 3

Sol. The effective circuit behaves as a R- C circuit

33. A 8μF capacitor is charged by a 400 supply through 0.1 MΩ resistance. The time taken by the capacitor to develop a potential difference of 300 V I s(Given $\log_{10} 4 = 0.602$)

(EAMCET 2009 M)

1) 2. 2 sec 2) 1.1 sec 3) 0.55 sec 4) 0.48 sec

Ans: 2

Sol. $q = q_0\left[1-e^{\frac{-t}{CR}}\right] \Rightarrow V = V_0\left[1-e^{\frac{-t}{CR}}\right]$

$$300 = 400\left[1-e^{\frac{-t}{CR}}\right]$$

$1-e^{\frac{-t}{CR}}=\frac{3}{4}$

$\Rightarrow e^{\frac{-t}{0.8}}=\frac{1}{4}\Rightarrow\frac{1}{e^{t/0.8}}=\frac{1}{4}$

$\Rightarrow\frac{t}{0.8}=\log_e^4\Rightarrow t=1.1\text{ sec}.$

34. A charged particle with velocity $\overline{v}=x\overline{i}+y\overline{j}$ moves in a magnetic field $\overline{B}=x\overline{i}+y\overline{j}$. Magnetite of the force acting on the particle is F. The correct option for F is : **[EAMCET 2009 M]**

a) No force will act on particle if x = y

b) Force will act along y axis if y < x

c) Force is proportional to $\left(x^2-y^2\right)$ if $x>y$

d) Force is proportional to $\left(x^2+y^2\right)$ if $y>x$

1) a and b are true 2) a and c are true 3) b and d are true 4) c and d are true

Ans: 2

Sol. The force acting on a charged particle is $F=q\left(\vec{V}\times\vec{B}\right)$

$$\therefore\ F=q\left(\vec{V}\times\vec{B}\right)=q\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\x&y&0\\y&x&0\end{vmatrix}$$

$\left|\vec{F}\right|=q\left[x^2-y^2\right]$

(i) If x = y then F = 0

(ii) $F\alpha\left(x^2-y^2\right)$ if $x>y$