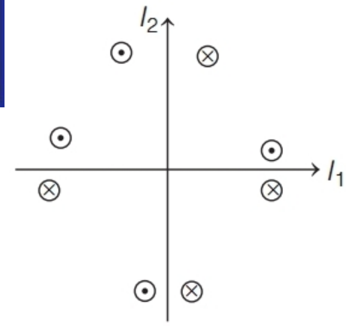
Explanations

1. (b) The region II has vertically upward strongest magnetic field produced by both the wires carrying currents. The direction of field in other region is as shown



2. (a) Magnetic field at the centre of a current carrying circular loop of radius R is given by

$$B_1 = \frac{\mu_0 I}{2R} \quad \ldots(i)$$

Magnetic field at point on its axis at a distance R from the centre loop is

$$B_2 = \frac{\mu_0 I R^2}{2(x^2 + R^2)^{3/2}}$$

Here, $x = R$

$$\Rightarrow \quad B_2 = \frac{\mu_0 I R^2}{2(R^2 + R^2)^{3/2}} = \frac{\mu_0 I}{2(2\sqrt{2}R)} \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$\frac{B_1}{B_2} = 2\sqrt{2}$$

3. (c) When iron rod is inserted in a current carrying solenoid along its axis, then the magnetic field, magnetic flux and self-inductance of the solenoid increases, but there is no increase in the rate of heating, as it depends on the current flowing in it.

4. (d) The radius of circular path traversed by a moving charged particle in a magnetic field is

$$r = \frac{mv}{Bq} \Rightarrow r \propto \frac{mv}{q}$$

$$\therefore \quad \frac{r_p}{r_\alpha} = \frac{m_p v_p}{q_p} \times \frac{q_\alpha}{m_\alpha v_\alpha}$$

$$= \frac{m_p}{q_p} \times \frac{2q_p}{4m_p} \times \frac{9}{4} \quad \left(\because \frac{v_p}{v_\alpha} = \frac{9}{4}\right)$$

$$= \frac{9}{8}$$

5. (d) Given, $I_1 = 4\text{A}$, $I_2 = 10\text{A}$, $r = 2.5\,\text{cm}$

$$= 2.5 \times 10^{-2}\ \text{m}$$

Force per unit length, $\dfrac{F}{l} = \dfrac{\mu_0}{2\pi}\dfrac{I_1 I_2}{r}$

$$= \frac{2 \times 10^{-7} \times 4 \times 10}{2.5 \times 10^{-2}}$$

$$= 3.2 \times 10^{-4}\ \text{N/m}$$

6. (a) If an ammeter is to be used in place of a voltmeter, then a low resistance must be connected in parallel to it. So, that the current flow through it and the voltage across it is measured accurately by ammeter that becomes a high resistance voltmeter.

7. (a) The force experienced by a current carrying wire in a uniform magnetic field is given by

$$F = IlB\sin\theta$$

So, it will be maximum, when $\sin\theta$ is maximum i.e. at $\theta = 90°$ or the wire is perpendicular to the magnetic field.

8. (c) The magnetic force due to field on a current carrying wire is

$$F_m = IlB$$

When rod is suspended, the gravitational force acting on it is

$$F_g = mg$$

To remove tension in strings, these two forces must be balanced i.e.

$$F_m = F_g$$
$$IlB = mg$$
$$\Rightarrow \quad I = \frac{mg}{lB}$$

9. (a) Given, current, $I = 10$ A (East to West)

Distance, $r = 10 \text{ cm} = 10 \times 10^{-2}$ m

Magnetic field, $|\mathbf{B}| = ?$

The magnitude of magnetic field $|\mathbf{B}|$ for infinite length of wire $= \frac{\mu_0 I}{2\pi r}$

$$\Rightarrow \quad |\mathbf{B}| = \frac{4\pi \times 10^{-7} \times 10}{2 \times \pi \times 10 \times 10^{-2}} = 2 \times 10^{-5} \text{T},$$

acting downward

10. (d) The magnetic field due to the long straight conductor at O is given by

$$B_1 = \frac{\mu_0 I}{2\pi R}$$

and that due to circular loop of radius R is

$$B_2 = \frac{\mu_0 I}{2R}$$

As, $\quad B_2 > B_1$

$\therefore$ The magnitude of net magnetic field at point O is

$$B_{\text{net}} = B_2 - B_1 = \frac{\mu_0 I}{2R} - \frac{\mu_0 I}{2\pi R}$$
$$= \frac{\mu_0 I}{2R}\left(1 - \frac{1}{\pi}\right)$$

11. (b) For the given charged particle, the radius of the circular path is

$$r = \frac{mv}{Bq} = \frac{\sqrt{2qVm}}{Bq} \quad \dots \text{(i)}$$

Keeping q, B and m fixed, if V is doubled, then

$$r' = \frac{\sqrt{2q(2V)m}}{Bq} = \frac{\sqrt{2}\sqrt{2qVm}}{Bq}$$
$$= \sqrt{2}r \quad [\because \text{from Eq. (i)}]$$

12. (a) The magnetic moment of a current carrying circular loop is

$$M = IA \Rightarrow M \propto A$$

or $\quad M \propto r^2 \quad (\because A = \pi r^2)$

When radius of loop is doubled, the magnetic moment becomes four times.

13. (c) The higher the range, lower is the resistance of an ammeter. This can be achieved by adding a shunt parallel to it.

14. (a) Magnetic field at the centre of current carrying circular loop is given as

$$B = \frac{\mu_0 I}{2r} \Rightarrow B \propto \frac{1}{r}$$

15. (a) A stationary charge produces electric field only. However, a moving charge which is equivalent to a current is produce a magnetic field in the surrounding space.

16. (b) The magnetic field due to solenoid having n number of turns/metre and carrying current I is $B = \mu_0 nI$.

It is obvious that, magnetic field is independent of length and cross-sectional area.

Also, magnetic field is uniform inside the solenoid.

17. (d) As, $r = \frac{\sqrt{2Km}}{Bq}$ or $r \propto \frac{\sqrt{m}}{q}$

$$\left(\frac{\sqrt{m}}{q}\right) = \frac{\sqrt{4}}{2} = 1 \Rightarrow \left(\frac{\sqrt{m}}{q}\right)_d = \frac{\sqrt{2}}{1} = \sqrt{2}$$

$$r_d > r_\alpha$$

Further, $\left(\frac{q}{m}\right)_\alpha = \frac{2}{4} = \frac{1}{2}$

and $\quad \left(\frac{q}{m}\right)_d = \frac{1}{2}$

$$\left(\frac{q}{m}\right)_\alpha = \left(\frac{q}{m}\right)_d$$

18. (c) Magnetic force of attraction on lower wire is upwards while its weight is downwards. At a certain distance x, these two forces are equal. If the lower wire is displaced upwards from this position, then magnetic force will increase but weight will remain same. Therefore, net force is upwards or equilibrium is unstable.

19. (b) Current sensitivity, $I_S = \frac{\phi}{I}$

i.e. $$I_S \propto \frac{1}{I}$$

Voltage sensitivity, $V_S = \frac{\phi}{V} \Rightarrow V_S \propto \frac{I}{V}$

20. (i) (a) As, $r_0 = \frac{mv}{Bq} \Rightarrow r' = \frac{m(4v_0)}{Bq}$

$$= 4\frac{mv_0}{Bq} = 4r_0$$

(ii) (c) As, time period, $T = \frac{2\pi m}{Bq}$

Hence, time period (T) does not depend upon velocity, hence it remains same.

(iii) (b) $\mathbf{B} = (2\hat{i} + 4\hat{j}) \times 10^2 \mathrm{T}$

$$\mathbf{a} = (x\hat{i} + 4\hat{j}) \text{ m/s}^2$$

Since, $F \perp B$

$\therefore \quad a \perp B \qquad [\because F = ma]$

$\therefore \quad \mathbf{a} \cdot \mathbf{B} = 0$

$$(x\hat{i} + 4\hat{j}) \cdot (2\hat{i} + 4\hat{j}) \times 10^2 = 0$$

$$(x\hat{i} + 4\hat{j}) \cdot (2\hat{i} + 4\hat{j}) = 0$$

$$2x + 16 = 0$$

$$x = -8 \text{ ms}^{-2}$$

(iv) (d) When electron enters into magnetic field not perpendicular to B, then for $\theta = 0^\circ$ or 180°, it move in a straight line and for other value of θ, it will move on helical path.

(v) (d) Here, $\theta = 0^\circ$

$\therefore \quad F = Bev \sin 0^\circ = 0$

21. (i) (d) A moving coil galvanometer is a sensitive instrument which is used to measure a deflection when a current flows through its coil.

(ii) (d) Uniform field is made radial by cutting pole pieces cylindrically.

(iii) (b) The deflection in a moving coil galvanometer,

$$\phi = \frac{NAB}{k} \cdot I \text{ or } \phi \propto N$$

where, N is number of turns in a coil, B is magnetic field and A is area of cross-section.

(iv) (d) The deflecting torque acting on the coil,

$$\tau_{\text{deflection}} = NIAB$$

(v) (b) Current sensitivity of galvanometer

$$\frac{\phi}{I} = S_i = \frac{NBA}{k}$$

Hence, to increase (current sensitivity) S_i, (torsional constant of spring) k must be decreased.