1 Biot-Savart law

Theoretical Questions

1. **Biot-Savart Law is used to calculate:**
   (a) Electric field due to a point charge
   (b) Magnetic field due to a moving charge
   (c) Electric potential due to a dipole
   (d) Magnetic field due to a current element

2. **The direction of the magnetic field due to a current element is given by:**
   (a) Coulomb's law
   (b) Right-hand thumb rule
   (c) Faraday's law
   (d) Lenz's law

3. **The magnetic field at the center of a circular loop of radius R carrying current I is:**
   (a) $\frac{\mu_0 I}{2R}$
   (b) $\frac{\mu_0 I}{4\pi R}$
   (c) $\frac{\mu_0 I}{2\pi R}$
   (d) $\frac{\mu_0 I}{R}$

4. **The magnetic field due to a current-carrying circular loop is maximum at:**
   (a) The center of the loop
   (b) A point far away from the loop
   (c) A point on the axis of the loop
   (d) A point on the circumference of the loop

5. **The magnetic field on the axis of a circular loop of radius R at a distance x from the center is proportional to:**
   (a) $\frac{1}{x^2}$
   (b) $\frac{1}{x^3}$
   (c) $\frac{1}{x}$
   (d) $\frac{1}{\sqrt{x}}$

6. **The magnetic field due to a current-carrying circular loop resembles the magnetic field of a:**

(a) Bar magnet

(b) Straight wire

(c) Solenoid

(d) Toroid

7. The right-hand thumb rule is used to determine:

(a) The direction of the electric field

(b) The direction of the magnetic field

(c) The magnitude of the magnetic field

(d) The direction of the current

8. The Biot-Savart law is valid for:

(a) Only straight conductors

(b) Only circular loops

(c) Any current-carrying conductor

(d) Only solenoids

9. The magnetic field at a point on the axis of a circular loop is directed:

(a) Along the axis

(b) Perpendicular to the axis

(c) Tangential to the loop

(d) Radially outward

10. The magnetic field due to a current-carrying circular loop at a point far away from the loop varies as:

(a) $\frac{1}{r}$

(b) $\frac{1}{r^2}$

(c) $\frac{1}{r^3}$

(d) $\frac{1}{r^4}$

Numerical Questions

1. A circular loop of radius $0.1\,\mathrm{m}$ carries a current of $2\,\mathrm{A}$. The magnetic field at the center of the loop is:

(a) $4\pi \times 10^{-6}\,\mathrm{T}$

(b) $2\pi \times 10^{-6}\,\mathrm{T}$

(c) $8\pi \times 10^{-6}\,\mathrm{T}$

(d) $\pi \times 10^{-6}\,\mathrm{T}$

2. A circular loop of radius $0.2\,\mathrm{m}$ carries a current of $5\,\mathrm{A}$. The magnetic field at a point on the axis of the loop at a distance of $0.2\,\mathrm{m}$ from the center is:

(a) $1.25 \times 10^{-6}\,\mathrm{T}$

(b) $2.5 \times 10^{-6}\,\mathrm{T}$

(c) $5 \times 10^{-6}\,\mathrm{T}$

(d) $10 \times 10^{-6}\,\mathrm{T}$

3. A circular loop of radius $0.5\,\mathrm{m}$ carries a current of $10\,\mathrm{A}$. The magnetic field at the center of the loop is:

(a) $4\pi \times 10^{-6}\,\mathrm{T}$

(b) $8\pi \times 10^{-6}\,\mathrm{T}$

(c) $12\pi \times 10^{-6}\,\mathrm{T}$

(d) $16\pi \times 10^{-6}\,\mathrm{T}$

4. A circular loop of radius $0.3\,\mathrm{m}$ carries a current of $3\,\mathrm{A}$. The magnetic field at a point on the axis of the loop at a distance of $0.4\,\mathrm{m}$ from the center is:

(a) $1.08 \times 10^{-6}\,\mathrm{T}$

(b) $2.16 \times 10^{-6}\,\mathrm{T}$

(c) $3.24 \times 10^{-6}\,\mathrm{T}$

(d) $4.32 \times 10^{-6}\,\mathrm{T}$

5. A circular loop of radius $0.4\,\mathrm{m}$ carries a current of $8\,\mathrm{A}$. The magnetic field at the center of the loop is:

(a) $4\pi \times 10^{-6}\,\mathrm{T}$

(b) $8\pi \times 10^{-6}\,\mathrm{T}$

(c) $12\pi \times 10^{-6}\,\mathrm{T}$

(d) $16\pi \times 10^{-6}\,\mathrm{T}$

6. A circular loop of radius $0.1\,\mathrm{m}$ carries a current of $1\,\mathrm{A}$. The magnetic field at a point on the axis of the loop at a distance of $0.1\,\mathrm{m}$ from the center is:

(a) $0.5 \times 10^{-6}\,\mathrm{T}$

(b) $1 \times 10^{-6}\,\mathrm{T}$

(c) $2 \times 10^{-6}\,\mathrm{T}$

(d) $4 \times 10^{-6}\,\mathrm{T}$

7. **A circular loop of radius $0.2\,\mathrm{m}$ carries a current of $4\,\mathrm{A}$. The magnetic field at the center of the loop is:**

   (a) $4\pi \times 10^{-6}\,\mathrm{T}$

   (b) $8\pi \times 10^{-6}\,\mathrm{T}$

   (c) $12\pi \times 10^{-6}\,\mathrm{T}$

   (d) $16\pi \times 10^{-6}\,\mathrm{T}$

8. **A circular loop of radius $0.3\,\mathrm{m}$ carries a current of $6\,\mathrm{A}$. The magnetic field at a point on the axis of the loop at a distance of $0.3\,\mathrm{m}$ from the center is:**

   (a) $1.5 \times 10^{-6}\,\mathrm{T}$

   (b) $3 \times 10^{-6}\,\mathrm{T}$

   (c) $4.5 \times 10^{-6}\,\mathrm{T}$

   (d) $6 \times 10^{-6}\,\mathrm{T}$

9. **A circular loop of radius $0.4\,\mathrm{m}$ carries a current of $10\,\mathrm{A}$. The magnetic field at the center of the loop is:**

   (a) $5\pi \times 10^{-6}\,\mathrm{T}$

   (b) $10\pi \times 10^{-6}\,\mathrm{T}$

   (c) $15\pi \times 10^{-6}\,\mathrm{T}$

   (d) $20\pi \times 10^{-6}\,\mathrm{T}$

10. **A circular loop of radius $0.5\,\mathrm{m}$ carries a current of $12\,\mathrm{A}$. The magnetic field at a point on the axis of the loop at a distance of $0.5\,\mathrm{m}$ from the center is:**

    (a) $3 \times 10^{-6}\,\mathrm{T}$

    (b) $6 \times 10^{-6}\,\mathrm{T}$

    (c) $9 \times 10^{-6}\,\mathrm{T}$

    (d) $12 \times 10^{-6}\,\mathrm{T}$

Key with Explanations

1. **(d)** Biot-Savart Law calculates the magnetic field due to a current element.
2. **(b)** The right-hand thumb rule gives the direction of the magnetic field.
3. **(a)** The magnetic field at the center of a circular loop is $B = \frac{\mu_0 I}{2R}$.
4. **(a)** The magnetic field is maximum at the center of the loop.
5. **(b)** The magnetic field on the axis varies as $\frac{1}{x^3}$.

6. **(a)** The magnetic field resembles that of a bar magnet.

7. **(b)** The right-hand thumb rule determines the direction of the magnetic field.

8. **(c)** Biot-Savart Law is valid for any current-carrying conductor.

9. **(a)** The magnetic field on the axis is directed along the axis.

10. **(c)** The magnetic field far away varies as $\frac{1}{r^3}$.

11. **(a)** $B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 2}{2 \times 0.1} = 4\pi \times 10^{-6}\,\mathrm{T}$.

12. **(b)** Use the formula for the magnetic field on the axis of a loop.

13. **(a)** $B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 10}{2 \times 0.5} = 4\pi \times 10^{-6}\,\mathrm{T}$.

14. **(b)** Use the formula for the magnetic field on the axis of a loop.

15. **(b)** $B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 8}{2 \times 0.4} = 8\pi \times 10^{-6}\,\mathrm{T}$.

16. **(b)** Use the formula for the magnetic field on the axis of a loop.

17. **(a)** $B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 4}{2 \times 0.2} = 4\pi \times 10^{-6}\,\mathrm{T}$.

18. **(b)** Use the formula for the magnetic field on the axis of a loop.

19. **(b)** $B = \frac{\mu_0 I}{2R} = \frac{4\pi \times 10^{-7} \times 10}{2 \times 0.4} = 10\pi \times 10^{-6}\,\mathrm{T}$.

20. **(b)** Use the formula for the magnetic field on the axis of a loop.