

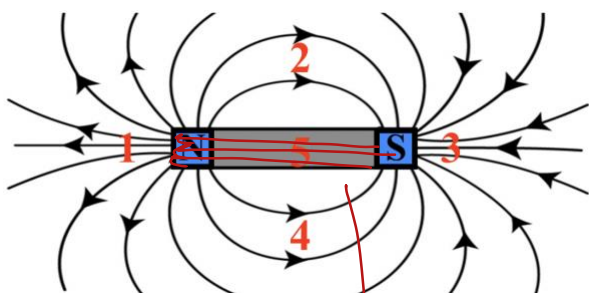
ID Resources: Topic 7– Magnetism

1. Which of the following is/are true regarding the magnetic field?

- I. The spacing between the field lines represent the strength of the magnetic field ✓ (more dense = stronger)
- II. The magnetic field vector is always tangent to the field lines ✓
- III. Magnetic field lines form closed loops ✓

- A. I only
- B. I and II
- C. II and III
- D. I, II and III

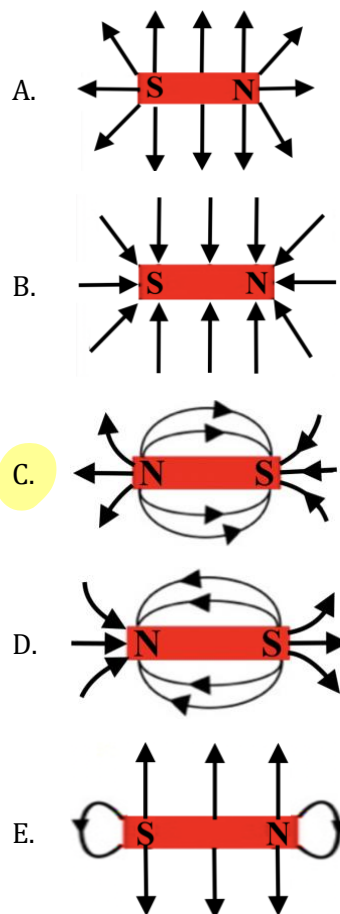
2. The figure below shows the magnetic field around a bar magnet. At which of the five labelled point(s) is the magnetic field the strongest?



- A. 2 only
- B. 4 only
- C. 5 only
- D. 1 and 3

Strongest field but they said "Around a bar magnet" if inside then 5
→ answer

3. Which of the following diagrams is the correct representation of the magnetic field around a bar magnet?



4. A uniform magnetic field does **NOT** exert a magnetic force on a charged particle if the particle_____.

- I. moves parallel to the field
- II. moves perpendicular to the field
- III. is at rest

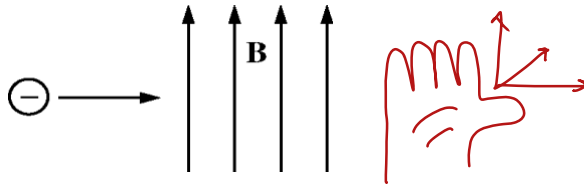
$$F = qvB \sin \theta$$

- A. I only
- B. II only
- C. III only
- D. I and II only
- E. I and III only

$$\sin(0) \text{ or } \sin(180) = 0$$

At rest means $V=0$

5. An electron moving to the right with constant velocity enters a region with a uniform magnetic field $\mathbf{B}$ directed toward the top of the page, as shown below. In what direction will the electron initially be deflected?



- A. Toward the top of the page
- B. Toward the bottom of the page
- C. Into the page
- D. Out of the page

6. A proton enters with a speed of $3.0 \times 10^5 \text{ m/s}$ into a uniform magnetic field of strength 2.5 T as shown below. What is the magnitude and direction of the magnetic force acting on the proton?

Given

$$V = 3 \times 10^5 \text{ m/s}$$

$$B = 2.5 \text{ T}$$

$$q = 1.6 \times 10^{-19} \text{ C}$$



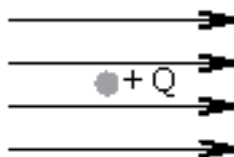
- A. $1.2 \times 10^{-13} \text{ N}$, upward
- B. $1.2 \times 10^{-13} \text{ N}$, downward
- C. $2.4 \times 10^{-13} \text{ N}$, upward
- D. $2.4 \times 10^{-13} \text{ N}$, downward

$$F = qVB$$

$$= (1.6 \times 10^{-19}) (3 \times 10^5) (2.5)$$

$$= 1.2 \times 10^{-13} \text{ N}$$

7. A stationary positive charge $+Q$ is located in a magnetic field $\mathbf{B}$, which is directed toward the right as indicated. Which of the following is true regarding the direction of the magnetic force on Q ?



- A. Toward the right
- B. downwards
- C. upwards
- D. There is no magnetic force

8. The force on a charged particle created by its motion in a magnetic field is maximum at what angle between the particle velocity and field?

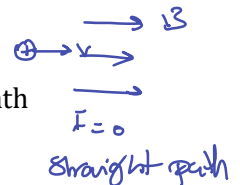
- A. 0
- B. 45°
- C. 90°
- D. 180°

9. An electron which moves with a speed of $3.0 \times 10^4 \text{ m/s}$ parallel to a uniform magnetic field of 0.40 T experiences a force of what magnitude?

- A. 0
- B. $2.2 \times 10^{-24} \text{ N}$
- C. $1.9 \times 10^{-15} \text{ N}$
- D. $4.8 \times 10^{-14} \text{ N}$

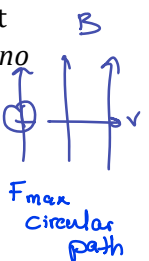
10. A charged particle is injected into a uniform magnetic field such that its velocity vector is perpendicular to the magnetic field vector. Ignoring the particle's weight, the particle will ____:

- A. move in a straight line
- B. follow a spiral path
- C. move along a parabolic path
- D. follow a circular path

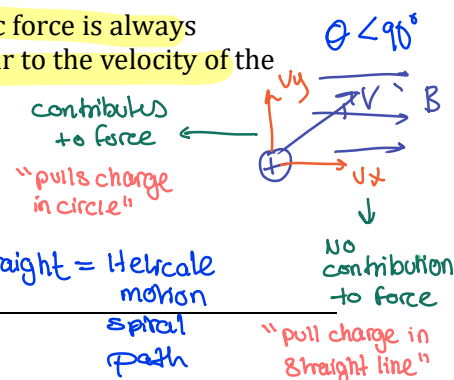


11. Which one of the following statements best explains why a constant magnetic field can do no work on a moving charged particle?

- A. The magnetic field is conservative
- B. The magnetic force is a velocity dependent force
- C. The magnetic field is a vector and work is a scalar quantity



- D. The magnetic force is always perpendicular to the velocity of the particle



12. An electron is moving in a circular orbit of radius 2 mm in a uniform 0.50 T magnetic field perpendicular to the velocity of the electron. What is the speed of the electron?

A. $1.76 \times 10^8 \text{ m/s}$

B. $1.92 \times 10^8 \text{ m/s}$

C. $2.15 \times 10^8 \text{ m/s}$

D. $2.25 \times 10^8 \text{ m/s}$

$r = 2 \times 10^{-3} \text{ m}$
 $B = 0.5 \text{ T}$
 $q = 1.6 \times 10^{-19} \text{ C}$
 $m = 9.1 \times 10^{-31} \text{ kg}$
 $r = \frac{mv}{qB} \rightarrow v = \frac{rqB}{m}$
 plug in values & solve

13. An electron moves in a circular trajectory with radius r in a constant magnetic field. What is the final radius of the trajectory when the magnetic field is doubled?

A. $r/4$

B. $r/2$

C. $2r$

D. $4r$

$r = \frac{mv}{qB}$
 $r \propto \frac{1}{B}$

14. A charged particle is observed traveling in a circular path in a uniform magnetic field. If the particle had been traveling twice as fast, the radius of the circular path would be ____.

A. twice the original radius

B. four times the original radius

C. the same as the original radius

D. one-half the original radius

15. A particle carrying a charge of $+e$ travels in a circular path in a uniform magnetic field. If instead the particle carried a charge of $+2e$, the radius of the circular path would have been ____.

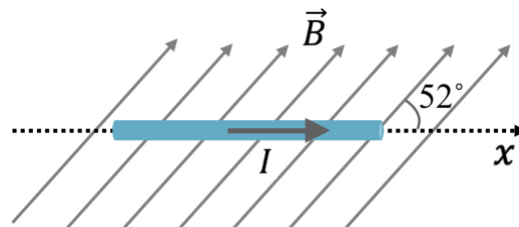
A. twice the original radius

B. four times the original radius

C. the same as the original radius

D. one-half the original radius

16. A 7.0 cm straight wire carrying a current of 4.2 A is placed in a uniform magnetic field of strength 4.25 T oriented at 52° to the x-axis as shown below.



Given
 $l = 0.07 \text{ m}$
 $I = 4.2 \text{ A}$
 $B = 4.25 \text{ T}$
 $\theta = 52^\circ$

What is the magnetic force on the wire?

A. 0.98 N

B. 1.75 N

C. 2.12 N

D. 2.16 N

$F = IlB \sin \theta$
 $= (4.2)(0.07)(4.25)(\sin 52^\circ)$
 $= 0.98 \text{ N}$

17. A 0.20 m long wire carries a current of 15 A and lies perpendicular to a magnetic field. The magnetic force on the wire is measured to be 0.060 N. What is the magnitude of the magnetic field?

A. 0.010 T

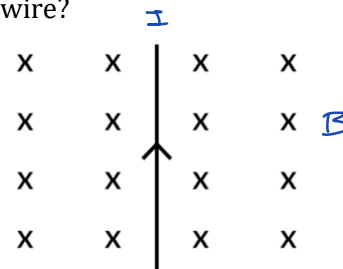
B. 0.020 T

C. 0.040 T

D. 0.060 T

Given
 $l = 0.20 \text{ m}$
 $I = 15 \text{ A}$
 $F = 0.06 \text{ N}$
 $B = ?$
 $F = IlB \sin \theta$
 $B = \frac{F}{Il}$
 $= \frac{0.06}{0.20 \times 15}$
 $= 0.02 \text{ T}$

18. A wire carrying current toward the top of the page is in a magnetic field directed into the page as shown below. What is the direction of the force on the wire?



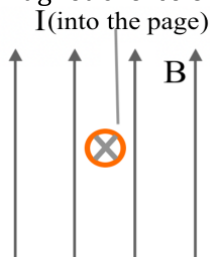
A. Into the page

B. Top of the page

C. Left of the page

D. Right of the page

19. A current-carrying wire is placed in a magnetic field B as shown below. What is the direction of the magnetic force on the wire?



- A. Downward
- B. To the left
- C. To the right
- D. Upward

20. The figure below shows a rectangular loop in a uniform magnetic field, free to rotate about the axle. The loop of width 3.0 cm and length 12.0 cm carries a current of 2.0 A. The uniform magnetic field has a magnitude of 1.5×10^{-3} T. What is the magnitude of the net torque and direction of rotation of the loop?

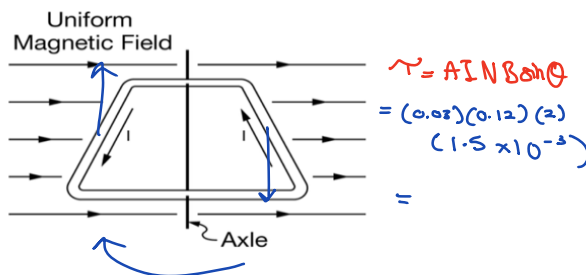
Given

$$w = 0.03 \text{ m}$$

$$l = 0.12 \text{ m}$$

$$I = 2 \text{ A}$$

$$B = 1.5 \times 10^{-3} \text{ T}$$



- A. 1.1×10^{-5} Nm, clockwise
- B. 1.1×10^{-5} Nm, counterclockwise
- C. 5.5×10^{-6} Nm, clockwise
- D. 5.5×10^{-6} Nm, counterclockwise

21. A coil is composed of circular loops of radius 5.13 cm and has 47 windings. A current, 1.27 A, flows through the coil, which is inside a uniform magnetic field of magnitude 0.911 T. What is the maximum torque on the coil due to the magnetic field?

$\theta = 90^\circ$

A. 0.148 Nm

B. 0.211 Nm

C. 0.350 Nm

D. 0.450 Nm

Given

$$r = 0.0513 \text{ m}$$

$$N = 47$$

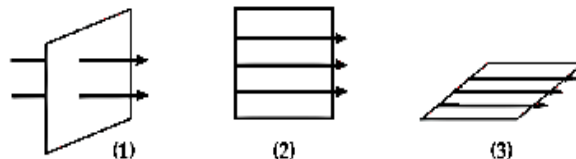
$$I = 1.27 \text{ A}$$

$$B = 0.911 \text{ T}$$

$$\tau = IAB \sin \theta$$

$$= (1.27)(\pi)(0.0513)^2 (47)(0.911)$$

22. A current loop is oriented in three different positions relative to a uniform magnetic field. In position 1 the plane of the loop is perpendicular to the field lines. In position 2 and 3 the plane of the loop is parallel to the field as shown.



The torque on the loop is maximum in ____.

- A. position 1
- B. position 2
- C. position 3
- D. positions 2 and 3

Free Response:

1. True or False

- Torque has the maximum value when the field is parallel to the plane of the loop and is zero when the field is perpendicular to the plane of the loop.
- The magnetic force acting on a straight-line segment of a current-carrying conductor in a uniform magnetic field is zero if the direction of the current is perpendicular to the direction of the magnetic field.

parallel

2. A laboratory electromagnet produces a magnetic field of magnitude 1.50 T . A proton moves through this field with a speed of $6.00 \times 10^6\text{ m/s}$.

- Find the magnitude of the maximum magnetic force that could be exerted on the proton.

Given

$$B = 1.5\text{ T}$$

$$q = 1.6 \times 10^{-19}\text{ C}$$

$$v = 6 \times 10^6\text{ m/s}$$

$$\theta = 90^\circ$$

$$F = qvB$$

$$= (1.6 \times 10^{-19})(6 \times 10^6)(1.5)$$

$$= 1.44 \times 10^{-12}\text{ N}$$

- What is the magnitude of the maximum acceleration of the proton?

$$F = m \times a$$

$$a = \frac{F}{m} = \frac{1.44 \times 10^{-12}}{1.67 \times 10^{-27}} = 8.62 \times 10^{14}\text{ m/s}^2$$

- The proton is now replaced by an electron.

- Would the field exert the same magnetic force on the electron moving through the field with the same speed?

yes

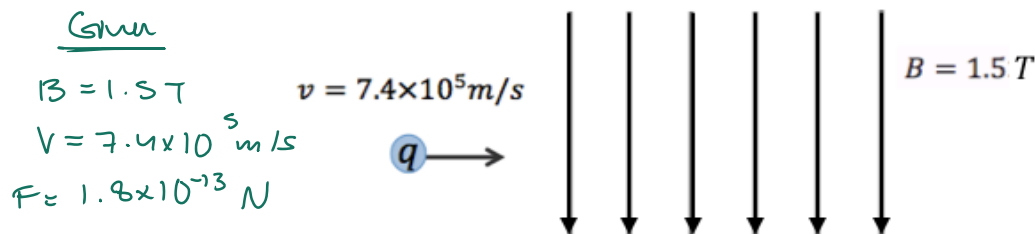
- Would the electron experience the same acceleration? Explain.

No, since the electron's mass is much lighter, it'll experience a much bigger acceleration.

②

$$\sin(90^\circ) = 1$$

2. A negatively charged particle enters perpendicularly into a region of uniform magnetic field of strength 1.5 T at a constant speed of $7.4 \times 10^5 \text{ m/s}$. It experiences a magnetic force of $1.8 \times 10^{-13} \text{ N}$.



a. What is the direction of the magnetic force on the charge as it enters the magnetic field?

Out of the Page

b. What is the magnitude of the charge on the particle?

$$F = qvB \rightarrow q = \frac{F}{vB} = \frac{1.8 \times 10^{-13}}{(7.4 \times 10^5)(1.5)} = 1.62 \times 10^{-19} \text{ C}$$

c. What is the work done on the charge by the magnetic force? Explain your answer.

$W = 0$ since $W = Fd \cos \theta$ & $\theta = 90$ & $\cos(90) = 0$
& Force & motion are perpendicular so work = 0.

3. A particle of net charge $3.2 \times 10^{-19} \text{ C}$ is moving in a circular orbit of radius 21 cm in a uniform 0.30 T magnetic field perpendicular to the velocity of the electron. If the speed of the particle is $2.0 \times 10^6 \text{ m/s}$, what is the mass of the particle?

Given

$q = 3.2 \times 10^{-19} \text{ C}$

$r = 21 \text{ cm} = 0.21 \text{ m}$

$B = 0.3 \text{ T}$

$v = 2 \times 10^6 \text{ m/s}$

They want the mass

$$F_m = F_c$$

$$qvB = \frac{mv^2}{r}$$

$$m = \frac{qBr}{v}$$

$$= \frac{(3.2 \times 10^{-19})(0.3)(0.21)}{2 \times 10^6} = 1.008 \times 10^{-26} \text{ kg}$$

4. A straight wire of length 2.00 m carries a current of 24.0 A . It is placed on a horizontal tabletop in a uniform horizontal magnetic field. The wire makes an angle of 30.0° with the magnetic field lines. If the magnitude of the force on the wire is 0.500 N , what is the magnitude of the magnetic field?

Given

$l = 2 \text{ m}$

$I = 24 \text{ A}$

$\theta = 30^\circ$

$F = 0.5 \text{ N}$

$$F = IlB \sin \theta \rightarrow B = \frac{F}{Il \sin \theta}$$

$$B = \frac{0.5}{2 \times 24 \times \sin 30^\circ}$$

$$= 0.2 \text{ T or } 20 \text{ mT}$$

+ To convert to milli, multiply by 1000

5. A horizontal power line of length 50.0 m carries a current of 5000 A northward as shown in the figure below. A magnetic field at this location has a magnitude of $10.0 \times 10^{-5}\text{ T}$ and directed at an angle of 65.0° below the power line.

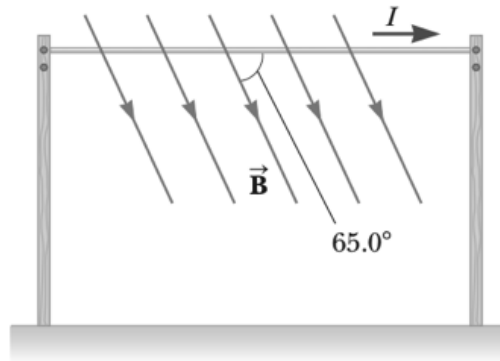
Given

$$l = 50\text{ m}$$

$$I = 5000\text{ A}$$

$$B = 10 \times 10^{-5}\text{ T}$$

$$\theta = 65^\circ$$



- a. Calculate the magnitude of the magnetic force on the power line.

$$\begin{aligned} F &= I l B \sin \theta \\ &= 5000(50)(10 \times 10^{-5}) \sin 65^\circ \\ &= 22.7\text{ N} \end{aligned}$$

- b. What is the direction of the magnetic force on the power line?

Into the page & moving in a spiral b/c we have an angle.

- c. Select **all** the actions below that will **increase** the magnetic force exerted on the wire.

- ☒ Increasing the current in the wire $F \propto I$
- ☐ Decreasing the angle between the wire and the magnetic field from 90° to 0° $\sin(0) = 0$
- ☒ Increasing the magnetic field strength $F \propto B$
- ☐ Decreasing the length of the wire in the magnetic field $F \propto l$, Force will decrease

6. A 12.0 V battery is connected to a $3.00\ \Omega$ resistor in a rigid rectangular loop of wire measuring 3.00 m by 1.00 m . As shown in the figure, a length $l = 1.00\text{ m}$ of wire at the end of the loop extends into a 2.00 m by 2.00 m region with a magnetic field of magnitude 5.00 T , directed into the page. What is the net force on the loop?

* Remember: $I = \frac{V}{R}$

$$F = \frac{V}{R} l B \sin \theta$$

$$= \frac{12}{3} (1)(5) \sin 90^\circ$$

$$= 20\text{ N}$$

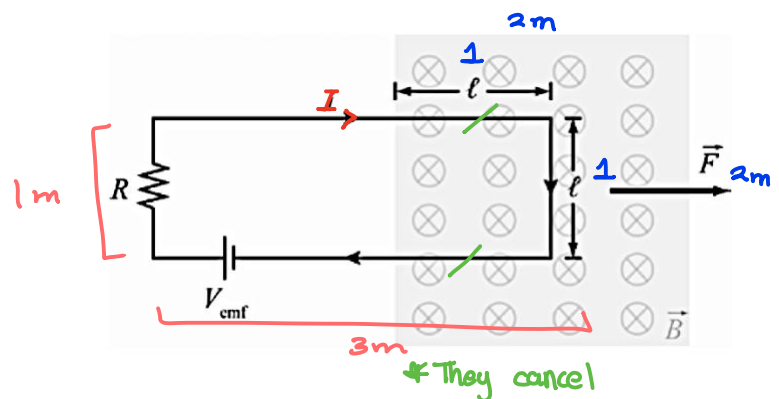
Given

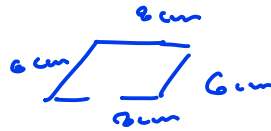
$$V = 12\text{ V}$$

$$R = 3\ \Omega$$

$$l = 2\text{ m}$$

$$B = 5\text{ T}$$





7. A rectangular coil with 20 windings carries a current of 2.00 mA flowing in the counterclockwise direction. It has two sides that are parallel to the y-axis and have length 8.00 cm and two sides that are parallel to the x-axis and have length 6.00 cm. A uniform magnetic field of 50.0 μT acts in the positive x-direction. What torque must be applied to the loop to hold it steady?

Given

$$N = 20$$

$$I = 2 \times 10^{-3} \text{ A}$$

$$A = (8 \times 10^{-2})(6 \times 10^{-2})$$

$$B = 50 \times 10^{-6} \text{ T}$$

$$\tau = N I A B \sin \theta$$

$$\tau = 20(2 \times 10^{-3})(6 \times 10^{-2})(8 \times 10^{-2})(50 \times 10^{-6}) \sin 90^\circ$$

$$\tau = 9.6 \times 10^{-9} \text{ Nm}$$

8. A circular coil with a radius of 10.0 cm has 100 turns of wire and carries a current, $I = 1.00 \text{ mA}$. It is free to rotate in a region with a constant horizontal magnetic field given by $B = (0.0100 \text{ T})\hat{x}$. If the unit normal vector to the plane of the coil makes an angle of 30.0° with the horizontal, what is the magnitude of the net torque acting on the coil?

Given

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

$$N = 100$$

$$I = 1 \times 10^{-3} \text{ A}$$

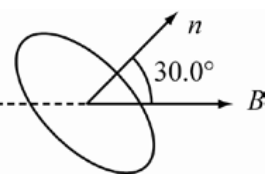
$$B_x = 0.01 \text{ T}$$

$$\theta = 30^\circ$$

$$\tau = N I A B \sin \theta$$

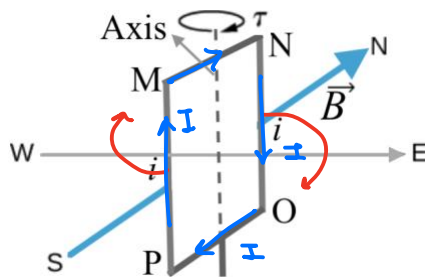
$$= 100(1 \times 10^{-3})(\pi)(10 \times 10^{-2})^2(0.01) \sin 30^\circ$$

$$= 1.57 \times 10^{-3} \text{ Nm}$$

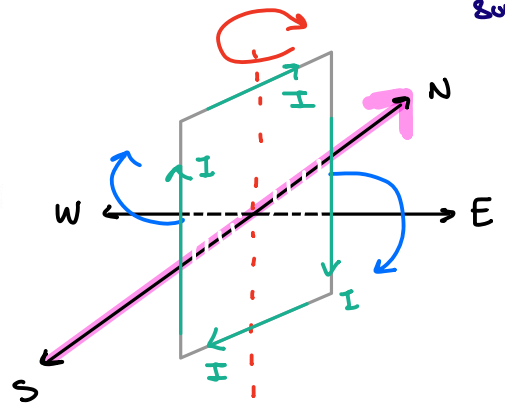


9. A current-carrying rectangular loop is vertical and rotates clockwise about its axis when a magnetic field is applied along the Earth's field, due north (blue line).

Field From South to North



$$MN, PO = 0$$



Answer the following questions in the space below.

- a. What is the direction of the magnetic force, if any, on each of the four sides (MN, NO, OP and PM) of the loop?

MN & $PO = 0$ since current is parallel to field.

PM : West, inwards

NO : East, outwards

- b. When viewed from the east, what is the direction of the current in the loop?

Clockwise