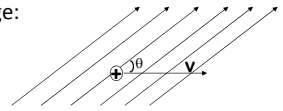
Physics 1161: Lecture 11

Currents and Magnetism

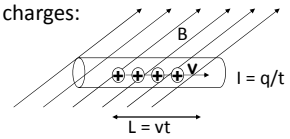
- **Textbook Sections 22-4 – 22-7**

Force of B-field on Current

- Force on 1 moving charge:

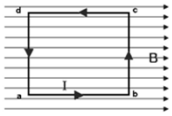


- Force on many moving charges:



Checkpoint
Current Loop in Magnetic Field 1 & 2

A rectangular loop of wire is carrying current as shown. There is a uniform magnetic field parallel to the sides A-B and C-D.



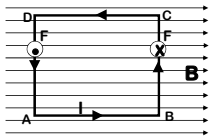
What is the direction of the force on section A-B of the wire?

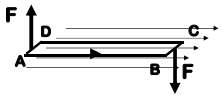
force is zero **out of the page** **into the page**

What is the direction of the force on section B-C of the wire?

force is zero **out of the page** **into the page**

Torque on Current Loop in B field



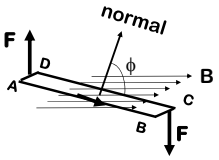


Look from here

Checkpoint
Current Loop in Magnetic Field 3 & 4

Torque on Current Loop

Magnitude:

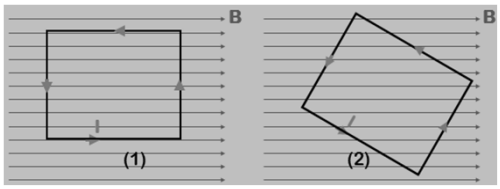


Direction:

Torque tries to line up the normal with B!

Even if the loop is not rectangular, as long as it is flat:

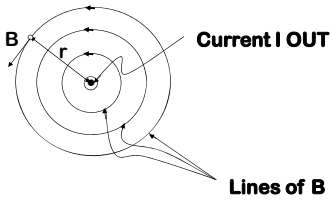
Compare the torque on loop 1 and 2 which have identical area, and current.



1. $\tau_1 > \tau_2$
2. $\tau_1 = \tau_2$
3. $\tau_1 < \tau_2$

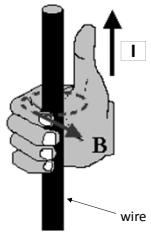
Currents *Create* B Fields

Magnitude:



Right-Hand Rule-2
Thumb:
Fingers:

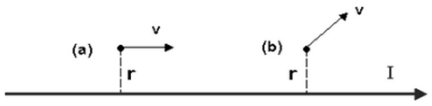
Right Hand Rule 2!



Fingers give B!

Checkpoint
Charge Moving Near Current

A long straight wire is carrying current from left to right. Near the wire is a charge q with velocity v



Compare magnetic force on q in (a) vs. (b)

a) has the larger force
b) has the larger force
c) force is the same for (a) and (b)

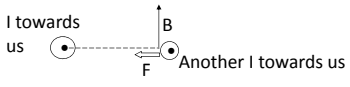
Two long wires carry opposite current. What is the direction of the magnetic field above, and midway between the two wires carrying current – at the point marked "X"?

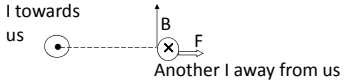
X

⊙ ⊗

1. **Left**
2. **Right**
3. **Up**
4. **Down**
5. **Zero**

Force between current-carrying wires



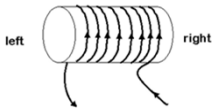


Comparison:
Electric Field vs. *Magnetic* Field

	Electric	Magnetic
Source		
Acts on		
Force		
Direction		
Field Lines		
Opposites		

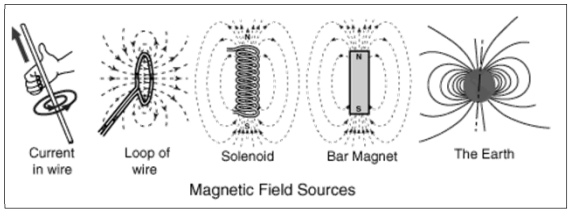
Checkpoint
Solenoid

A solenoid is wrapped with wire carrying a current, as shown in the figure.



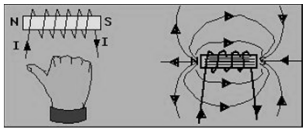
What is the direction of the magnetic field produced by the solenoid?
a. into the right end of the solenoid and out of the left end
b. out of the right end of the solenoid and into the left end

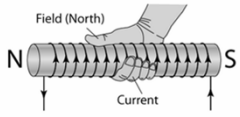
Magnetic Fields of Currents

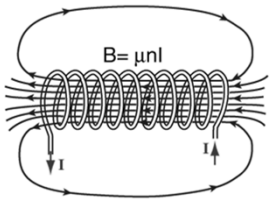


- http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/magfie.html#c1

Right Hand Rule 3
Magnetic Field of Solenoid



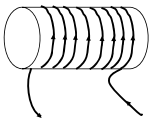




The magnetic field is concentrated into a nearly uniform field in the center of a long solenoid. The field outside is weak and divergent.

B Field Inside Solenoids

Magnitude of Field anywhere inside of solenoid :



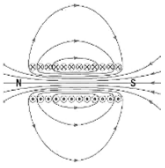
Right-Hand Rule for loop/solenoid

Fingers – curl around coil in direction of conventional (+) current

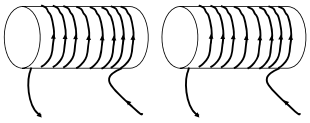
Thumb - points in direction of B along axis

Magnetic field lines look like bar magnet!

Solenoid has N and S poles!



What is the force between the two solenoids?



(1) Attractive

(2) Zero

(3) Repulsive