

# Giant Magnetoresistance (GMR)

UW Internships in Public Science Education  
(IPSE)



## Outline

- Introduction
- Electricity & Magnetism
- Giant Magnetoresistance
- Hard drive dissection
- Wrap-up
- Re-build the hard drive



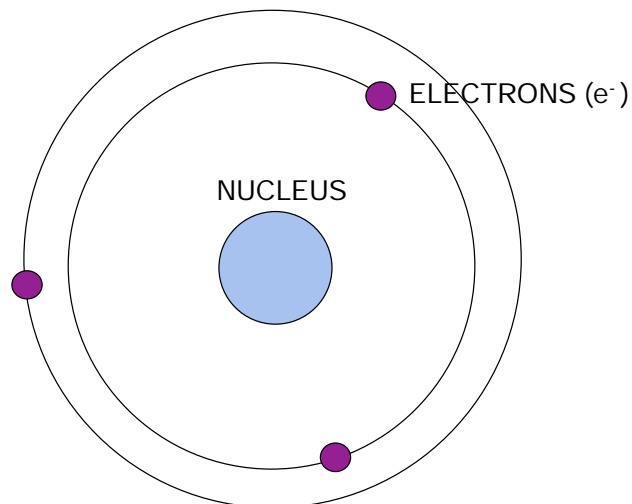
# Giant Magneto Resistance (GMR)

- Layers on "nano" level
- Store info on computer hard drive



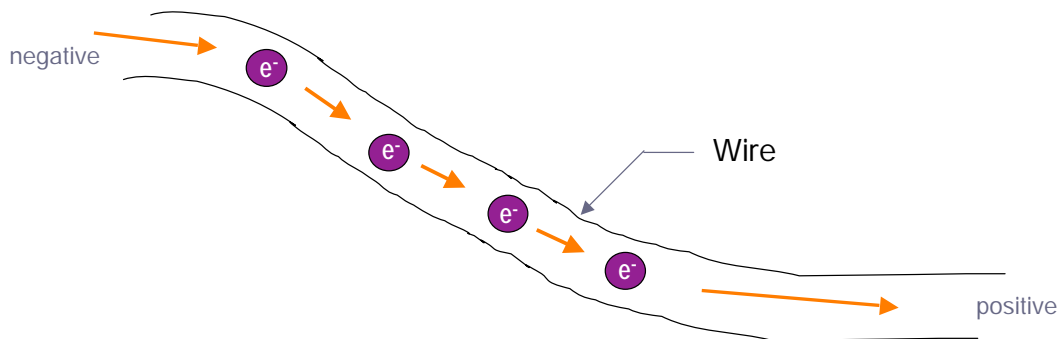
## Electricity

Diagram of an atom



# Electricity (cont'd)

Electric Current → Moving free electrons



Note: Electrons are actually much smaller in relation to the wire than shown in the picture.



# Electricity (cont'd)

## Conductor

- Low resistance
- Allows movement of large amounts of free electrons

## Insulator

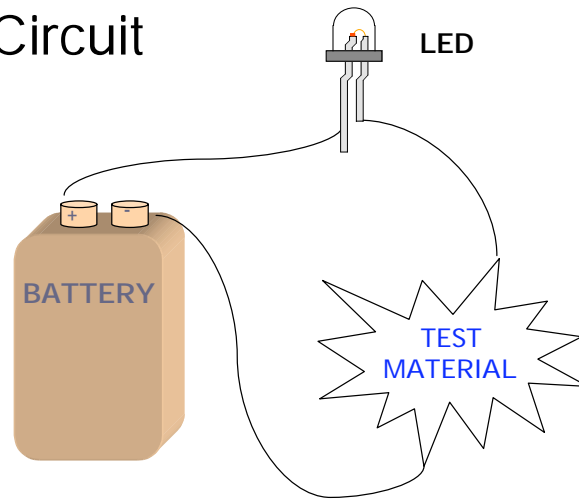
- High resistance
- Allows very little free electrons to move



# Electricity (cont'd)

## Diagram of Simple Circuit

1. Insert test material to complete the circuit.
2. Determine if test material is a **conductor** or an **insulator**.



*HINT: Look at how the LED reacts with the test material.*



## Question Time!

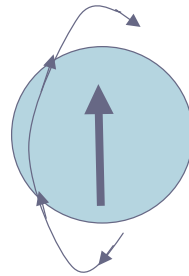
- ☞ Which materials are good conductors of electricity? Why?
- ☞ Are there any that don't conduct electricity at all? Why?
- ☞ Which type of materials (conductors or insulators) have a high resistance to electricity?



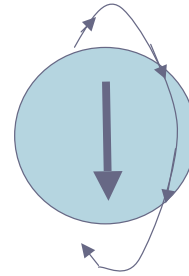
# Magnetism

One more thing about electrons.....

**They Spin!!!**



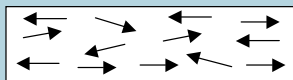
upspin



downspin

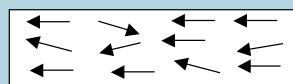


## Magnetism (cont'd)



Non-magnetic material

Electron spins are opposite and balance each other out.



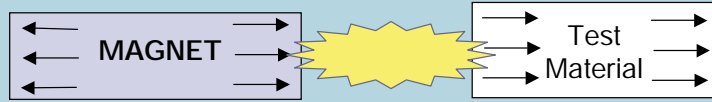
Magnetic material

Electron spins are unequal, with the majority spinning in one direction.



# Magnetism (cont'd)

Magnetic material attracts to magnet.



Non-magnetic material is not affected by magnet.



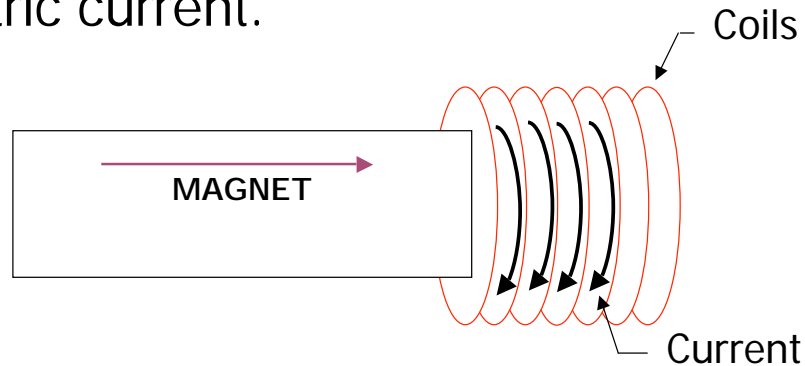
## Question Time!

☞ Which materials are magnetic? Why?



# Electricity/Magnetism Relationship

A changing magnetic field creates an electric current.



## Question Time!

- ☞ Can you create an electric current with the copper coil and cow magnet?
- ☞ How do you know that you created an electric current?



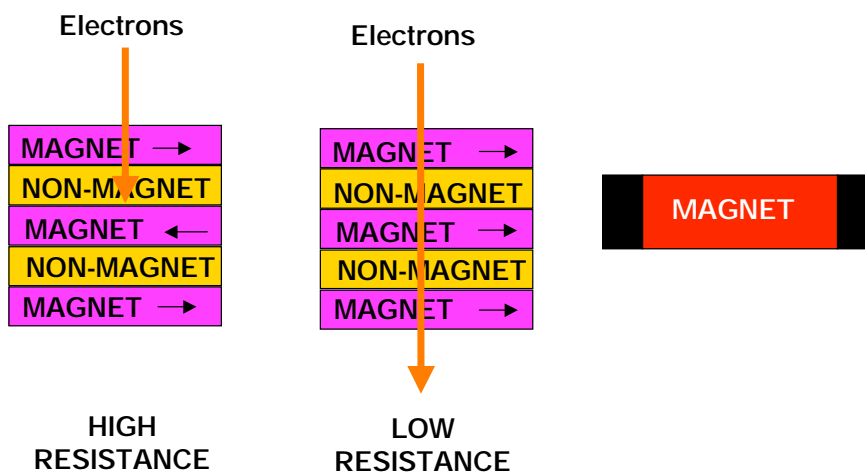
## What does electricity and magnetism have to do with GMR?!?!

1. Magnetoresistance is used to store information onto a computer's hard disk drive (like the last demonstration!) but not very sensitive.
2. GMR is more sensitive and allows more data to be stored.
3. GMR materials are found on Read/Write Heads and detect small changes in electrical resistance.



## Giant Magnetoresistance

### GMR materials





# Read/Write Head



<http://www.pcguides.com/ref/hdd/op/heads/op.htm>

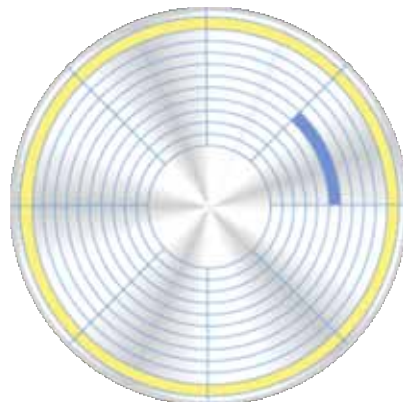


<http://www.howstuffworks.com/hard-disk2.htm>



## GMR (cont'd)

How data is stored on a hard disk



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Note: Domains are actually much smaller than this picture indicates.



## Question Time!

- ☛ Explain two ways in which electricity and/or magnetism are related to GMR.



## Find GMR Materials!

- ☛ Obtain a hard drive and a screwdriver
- ☛ Remove screws and place into cup
- ☛ Locate the read/write head in the hard drive (*HINT: This is where you can find GMR materials!*)



# Read/Write Head



<http://www.pcguide.com/ref/hdd/op/heads/op.htm>



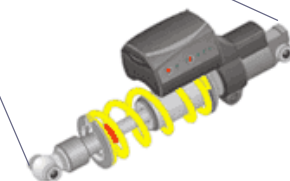
<http://www.howstuffworks.com/hard-disk2.htm>



## Applications of GMR Sensors



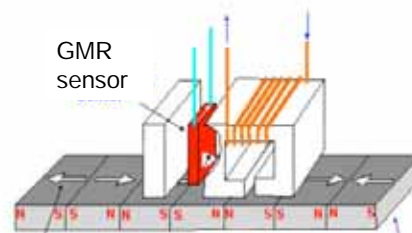
Mountain bike  
"Smart  
Shocks"



Portable Traffic  
Counters



<http://www.mega-technical.com/html/prod-histar.html>



Magnetization

Recording medium



\*Image from IBM Almaden

Questions?

