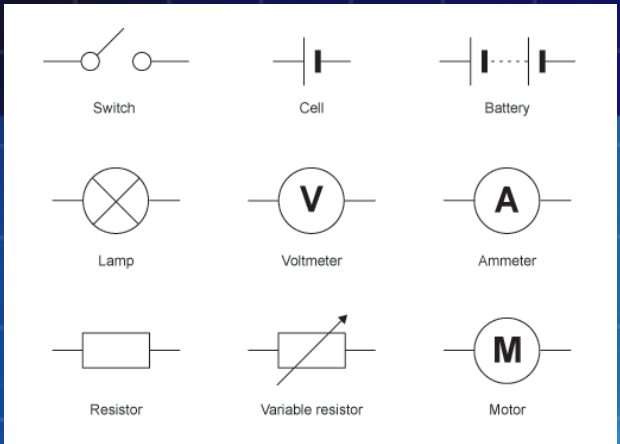
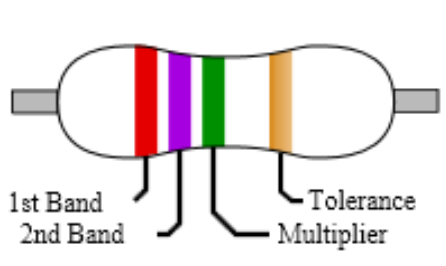




Circuit Lab

Practice #9—Multiple sources, special notation, resistor marking

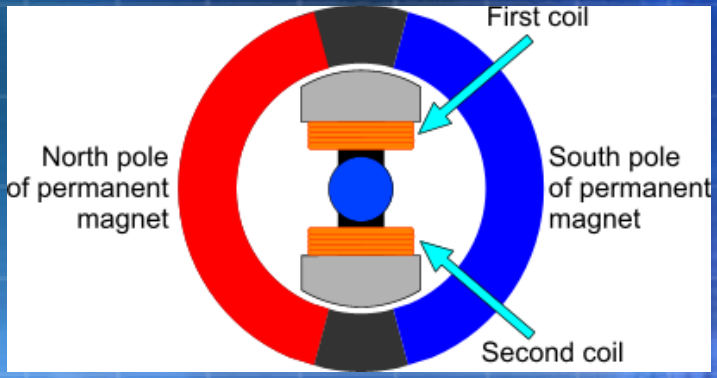
Mr. Burleson
geaux15@hotmail.com

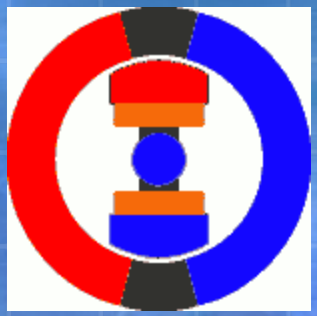
Agenda

- 15 minutes—Grading homework.
- 20 minutes—Learning Lesson of the Day
- 40 minutes—In Practice Sample Competition
- 10 minutes—Notebook Review
- 5 minutes—Sending out homework

How does a motor work?

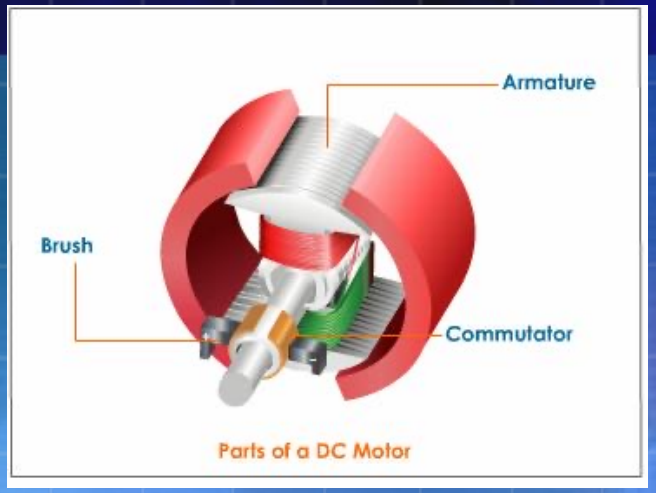
- DC motor has two windings and two permanent magnets
- Coils are powered from the Commutator and the Brushes
- The current that runs through each windings changes direction at the halfway point (caused by the connection of the commutator)
- Magnets are wound such that when one is North, the other is South
  - Please note this is colored differently than we normally used

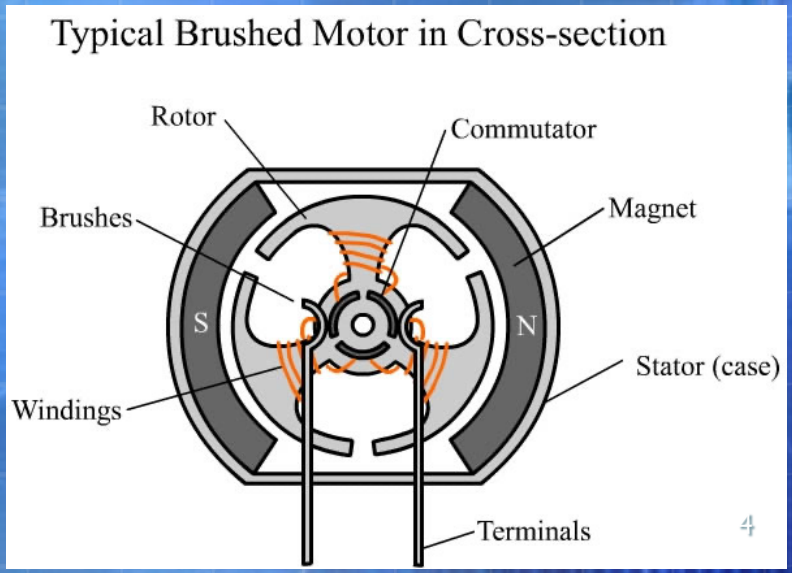




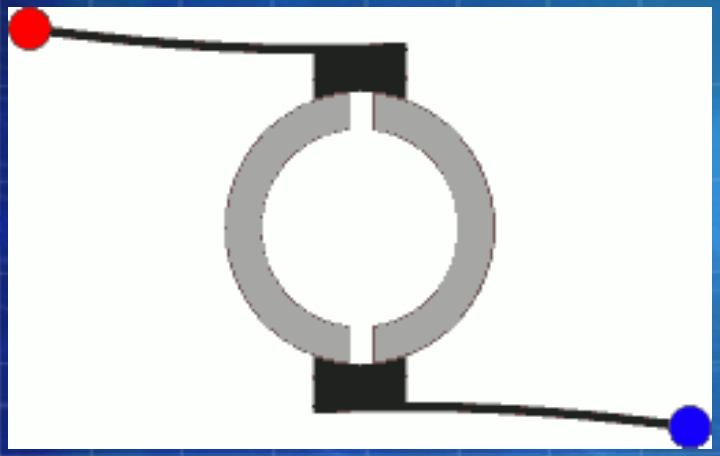
Parts of Motor

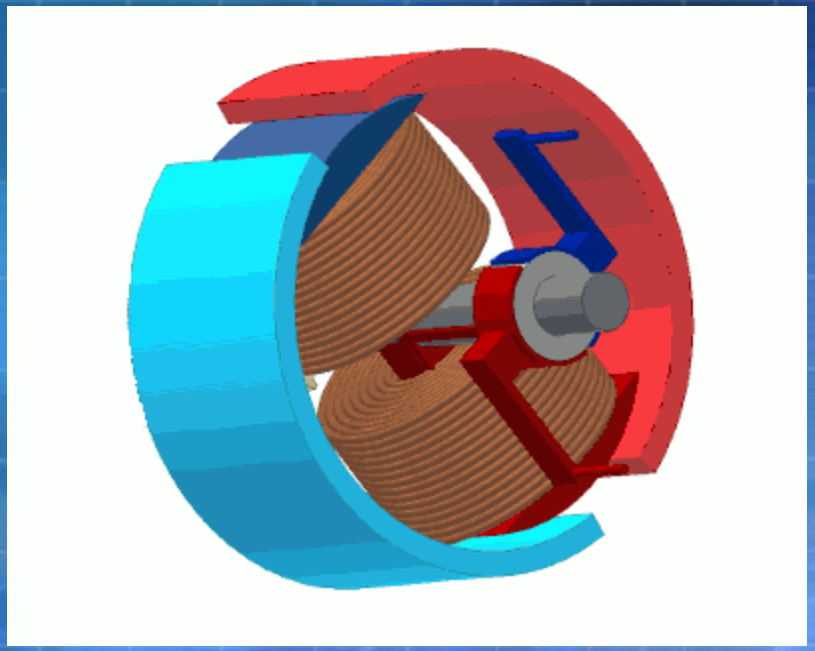
- The part that rotates in the middle is called the Rotor
  - In a Brushed DC motor, this has the windings
  - Armature is the part that contains the main current-carrying winding. The armature usually consists of a coil of copper wire wound around an iron or steel core.
- The part that doesn't move on the outside is called the Stator
  - In a Brushed DC motor, this is where the permanent magnets are located





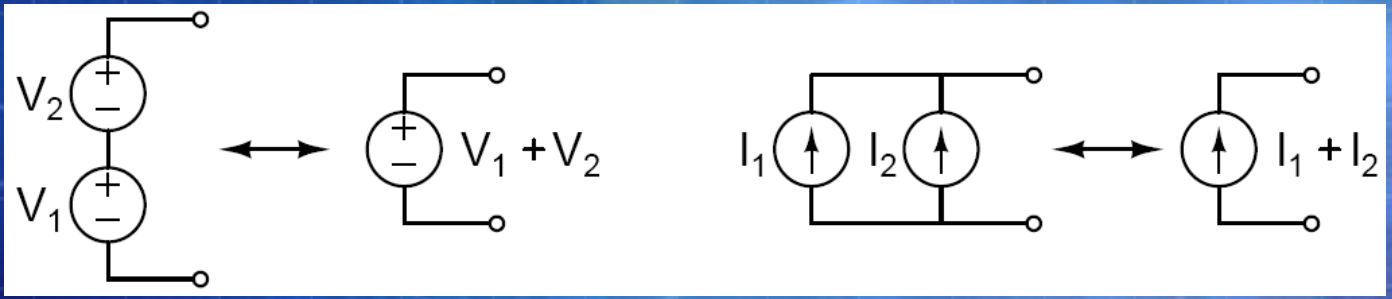
DC Motors in Motion





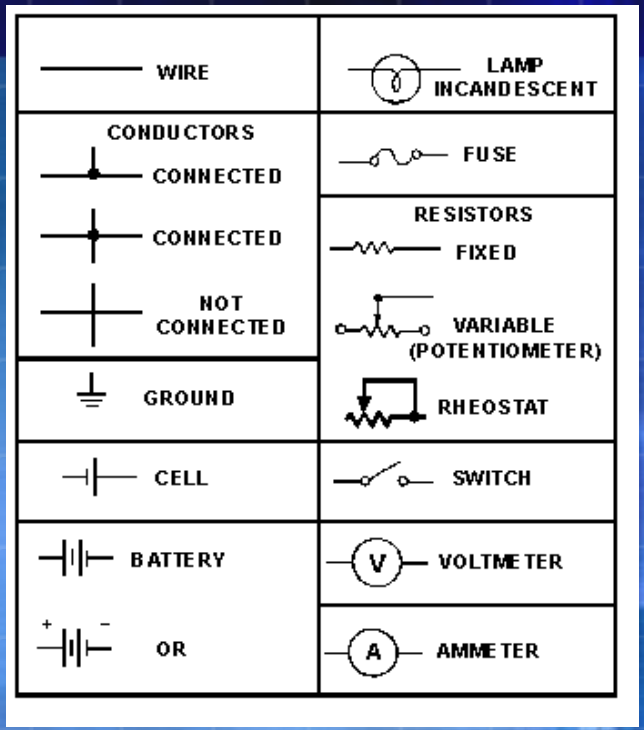
Multiple Sources

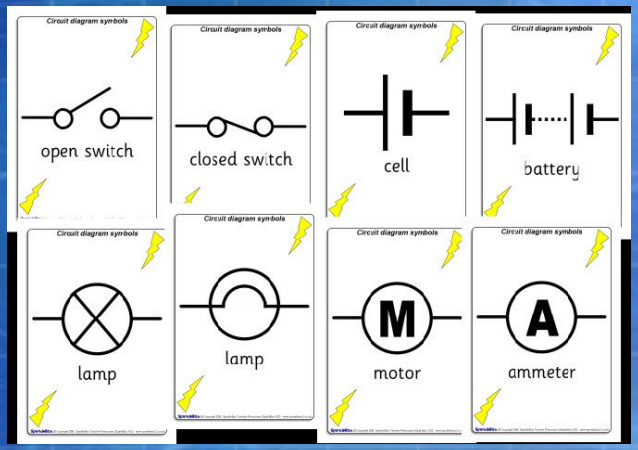
- Sometimes a circuit has more than one source
- Voltage Sources should be added in series
- Current Sources should be added in parallel
- You SHOULD NOT put voltage sources in parallel or current sources in series, as it can create a situation that violates circuit rules.

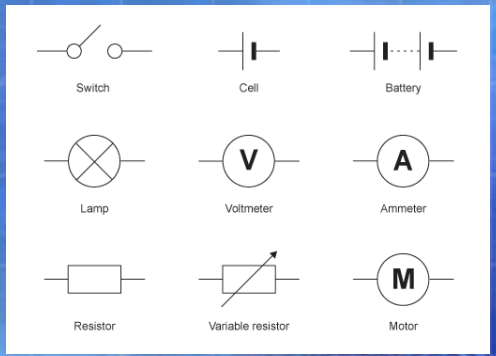


Circuit Symbols

- Sometimes they also use just a picture of a light bulb or other object,
- especially for a load.
- Please note the different ways to see resistors and batteries
- Not a full list





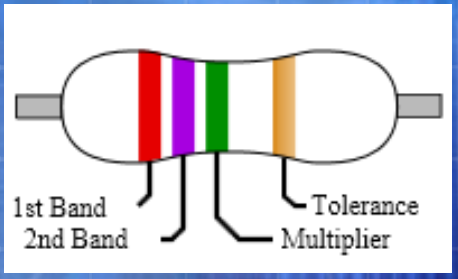


Resistor Marking

- **Electronic Color Code Developed in early 1920's.**
  - **Sometimes the resistance is printed directly on the resistor to avoid confusion, esp. for colorblind people.**
  - **If you are colorblind, let your event supervisor know at start of test.**

A is the first significant digit of the component
B is the second significant digit
C is the decimal multiplier
D (if present) indicates the tolerance—no D means 20%

This example is the following:
A=Red=2; B=Violet=7; C=Green=10^5; D=Gold=5%
Or 2.7MΩ +/- 5%



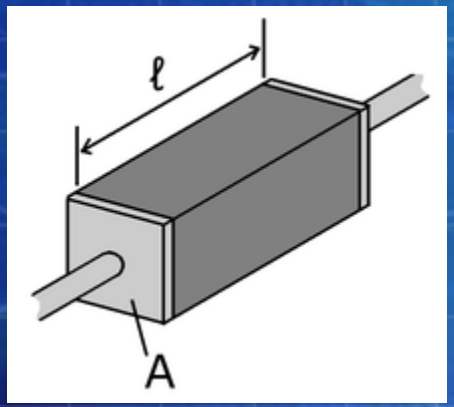
Standard Color Code

Color	Significant figures	Multiplier	Tolerance		Temp. Coefficient (ppm/K)	
Black	0	$\times 10^0$	–		250	U
Brown	1	$\times 10^1$	±1%	F	100	S
Red	2	$\times 10^2$	±2%	G	50	R
Orange	3	$\times 10^3$	–		15	P
Yellow	4	$\times 10^4$	(±5%)	–	25	Q
Green	5	$\times 10^5$	±0.5%	D	20	Z
Blue	6	$\times 10^6$	±0.25%	C	10	Z
Violet	7	$\times 10^7$	±0.1%	B	5	M
Gray	8	$\times 10^8$	±0.05% (±10%)	A	1	K
White	9	$\times 10^9$	–		–	
Gold	–	$\times 10^{-1}$	±5%	J	–	
Silver	–	$\times 10^{-2}$	±10%	K	–	
None	–	–	±20%	M	–	

Big boys race our young girls but Violet generally wins.

Resistance (Ω)

- Many resistors and conductors have a uniform cross section with a uniform flow of electric current, and are made of one material. In this case, the electrical resistivity ρ (Greek: rho) is defined as:



$$\rho = R\frac{A}{\ell}$$

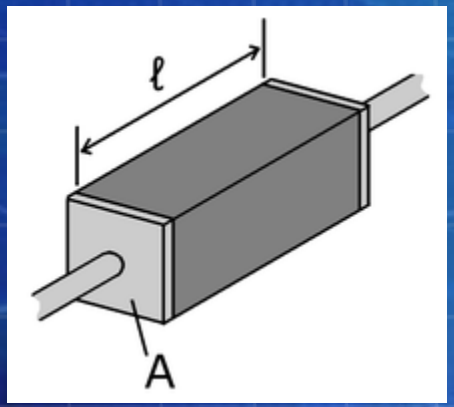
$$R = \rho\frac{\ell}{A}$$

- Resistance increases
  - Longer lengths
  - Less area/smaller cross section
  - Higher temperature
  - Less conductive material
- Resistance decreases
  - Shorter lengths
  - Larger area/cross section
  - Lower temperature
  - More conductive material

https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity

Resistance of Common Materials

- Always have tables of resistivity, ρ units are Ω•m
- Superconductors = 0 Ω•m
- Metals/Conductors ~10^{-8} Ω•m
- Semiconductors (variable upon doping)
- Insulators ~10^{16} Ω•m
- Superinsulators ~∞ Ω•m



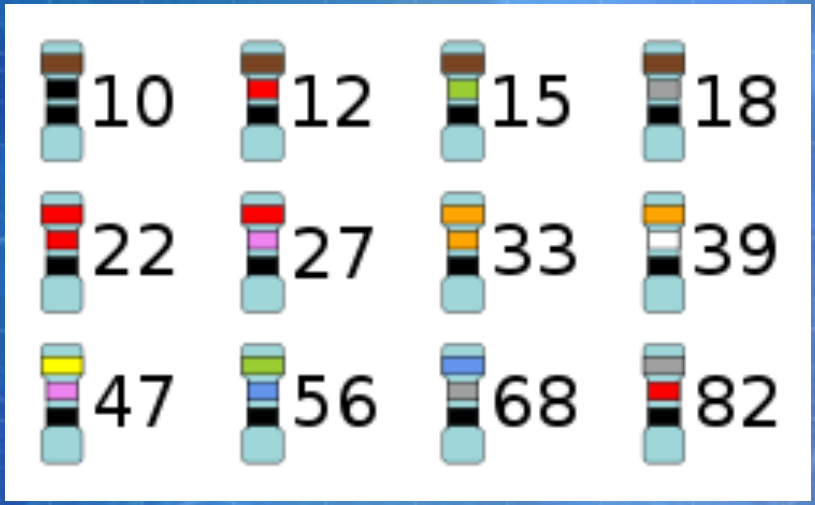
$$\rho = R\frac{A}{\ell}$$

$$R = \rho\frac{\ell}{A}$$

- Top Common Conductors
  - Silver ρ = 1.59x10^{-8} Ω•m
  - Copper ρ = 1.68x10^{-8} Ω•m
  - Gold ρ = 2.44x10^{-8} Ω•m
  - Aluminum ρ = 2.65x10^{-8} Ω•m
- Top Common Semiconductors
  - GaAs ρ = 1x10^{-3} to 1x10^{8}Ω•m
  - Germanium ρ = 4.6x10^{-1}Ω•m
  - Silicon ρ = 6.4x10^{2} Ω•m
- Top Common Insulators
  - Deionized water, Glass, Diamond, Hard Rubber, Air, and Dry Wood
  - Fused Quartz ρ = 7.5x10^{17}Ω•m
  - PET ρ = 1x10^{21}Ω•m
  - Teflon ρ = 1x10^{23} to 1x10^{25}Ω•m

Standard Resistor Types

- They usually only pick a few resistor sizes and repeat them for every decade of magnitude (i.e. 6.8Ω, 68Ω, 680Ω, 6.8kΩ, etc.)
  - They are picked based upon the tolerance and geometric progression.
  - The 12 most common are in the table below with markings (for 10% resistors).



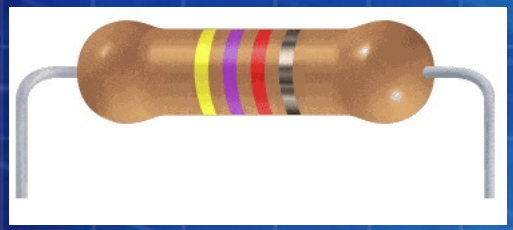
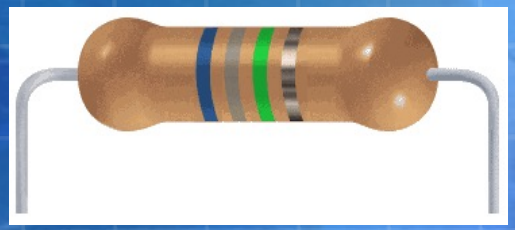
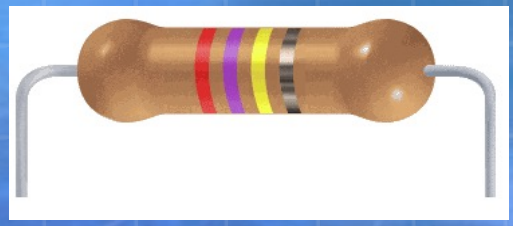
Resistor Marking

- Here is a 100 kΩ resistor
- A great site to learn the resistors is the following:
- http://www.okaphone.nl/calc/resistor.shtml

In Class Quiz

- Give the resistor values for the following:



In Practice Sample Competition

- 100 points
- Timed—40 minutes
- Do the following written quiz individually
- You may use any and all notes in your binder
- You may use your calculator
- Make sure you fill out your name and team at the top of each page
- Tackle the easy problems first, then the tough ones you know how to tackle, then finally the ones you have to guess on.
- If you have time, check your answers

Your Binder is Your Lifeline

- A good binder is like having an open book test
- Use your binder in all studying, practices, and at tournaments
- Always build your own binder in case something happens to your partner's
- First page should be the rules, so you can find them quickly
- Always have easy to read tables for constants, materials, and equations
- Organize into sections that work for you and your teammate with tabs for easy finding
- Focus on the things you have to look up or don't understand
- Include other tests with keys and work shown
- When you have two or more pictures of the same thing, include ALL of them (often Event Supervisors will get diagrams and samples from the internet)
- When you solve a difficult problem, show all your work and put that in the binder to help remind you how you solved that difficult problem
- Keep the binder small enough to be useful, but big enough to be comprehensive
- Test you skills at finding things in the binder each practice so that it takes no more than 10 seconds to find anything
- Make sure you can read it (good fonts)
- Use sheet protectors when possible

Homework

- Update your binder to get it competition ready
- Complete the circuit problems from the Homework Generator
  - Level 6 Combination
  - Level 7 Multi-Source
  - Level 10 Resistors
- Correct the problems you missed on the practice competition on separate paper.