Electronics

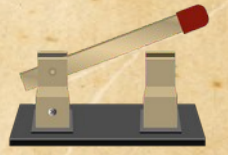
Resistance and Resistor Color Codes

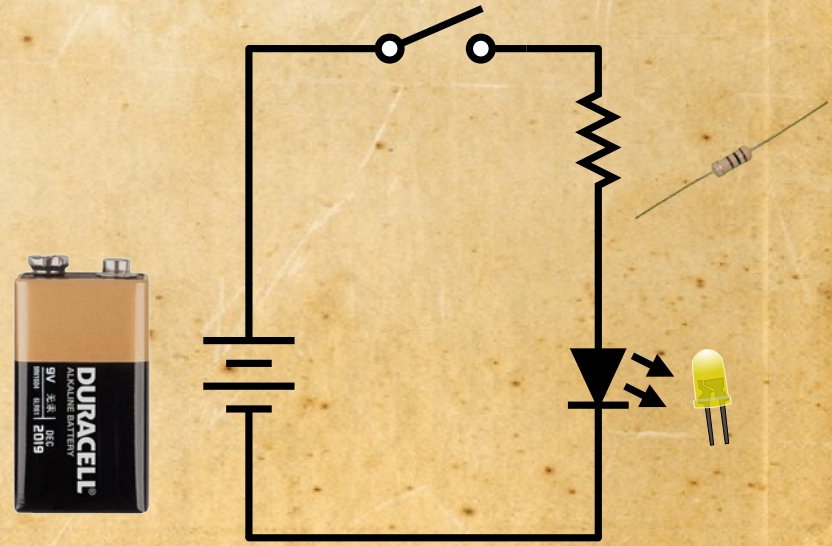
Lecture Contents

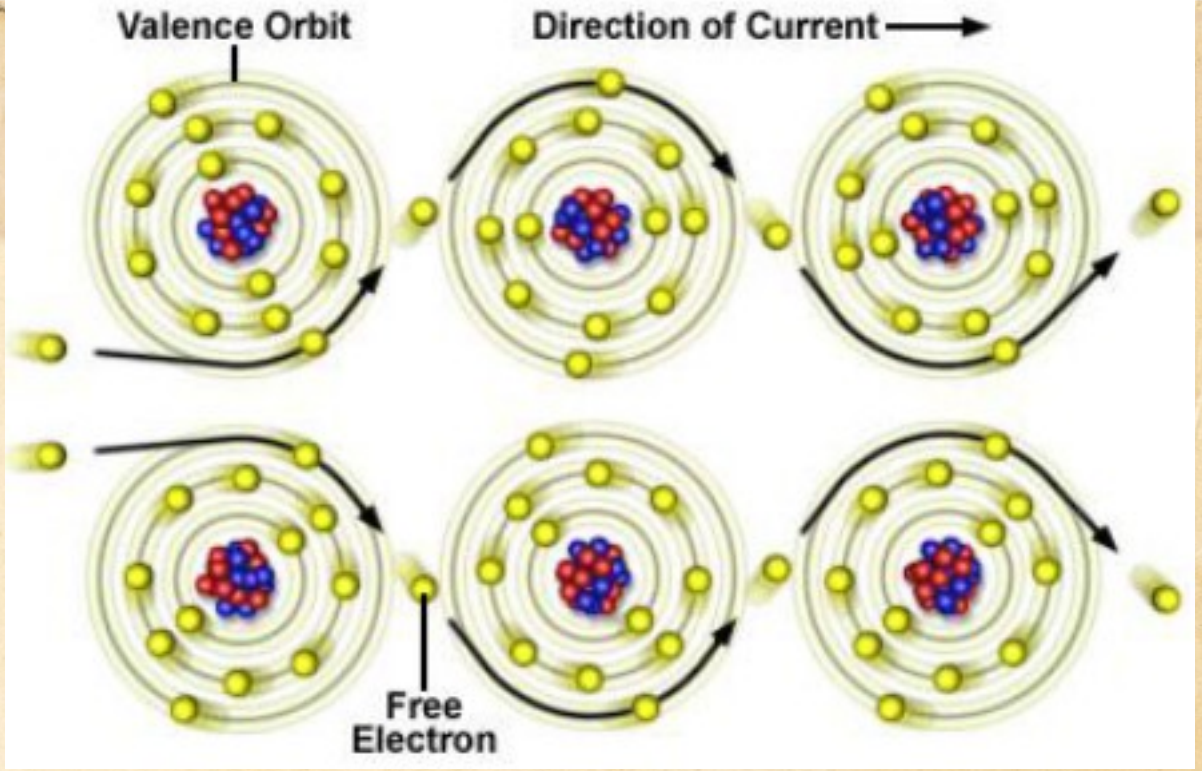
- Review of Current
- Ohm’s Law
- Resistor Color Codes
- Measuring Resistance

Electronics – Coulomb

- **Charge:** 1 Coulomb of charge per 6.24150975^{18} electrons
  - 1 electron has a charge of **$1.60217646 \times 10^{-19}$ Coulombs**
- **Current:** 1 Ampere = 1 Coulomb per second





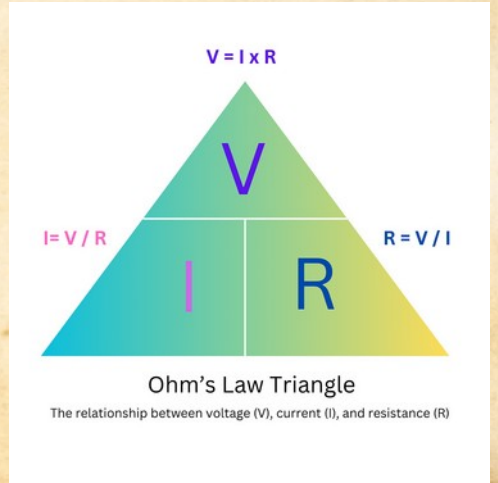


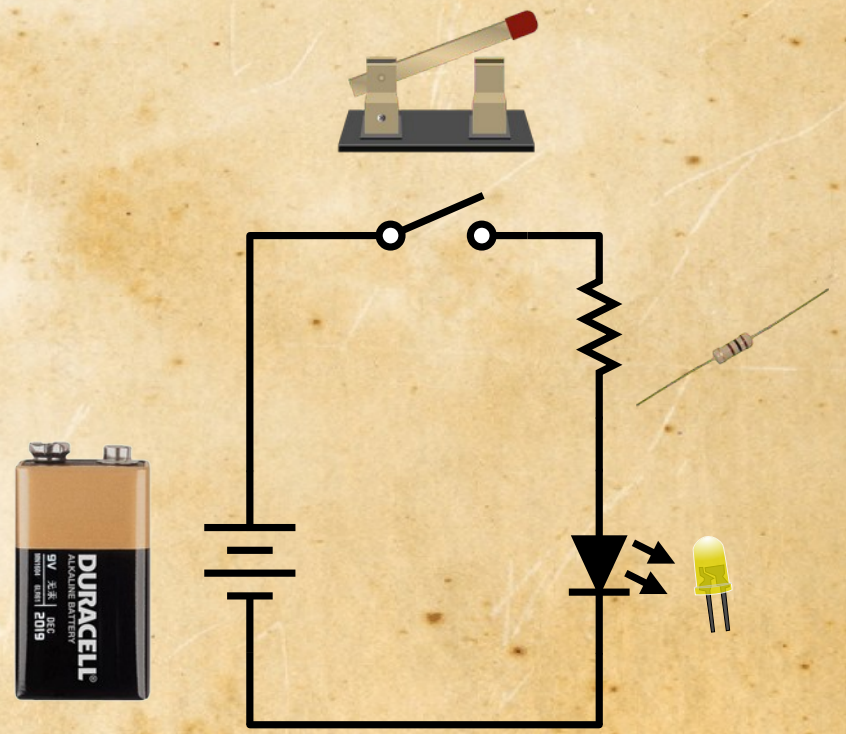
- ***Conductance*** **–** how easily current flows through an object.
  - Depends on the chemical properties
- ***Resistance*** **–** inverse of conductance
  - We will be using *resistance* in our calculations

$$resistance = \frac{1}{conductance}$$

Current and Voltage

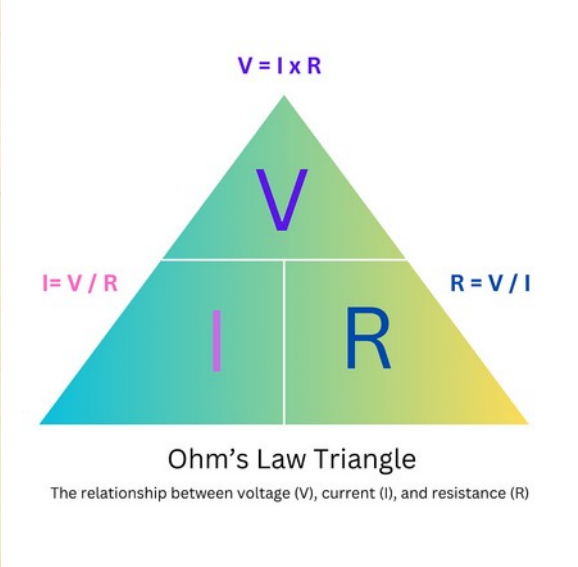
- ***Current*** is the amount of charge (the number of electrons) flowing through the circuit per unit time
- ***Voltage*** is the strength with which those electrons are pushed.

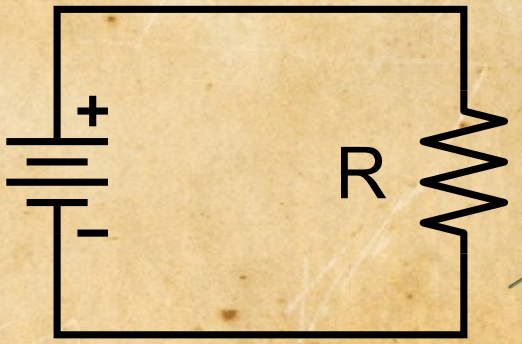




Voltage Resistance and Current

- We usually connect our circuitry to a power supply designed to output a specific ***voltage***.
  - Wall socket, battery, USB, DC Supply, …
- We find the current, I, through the circuit using Ohm's Law:

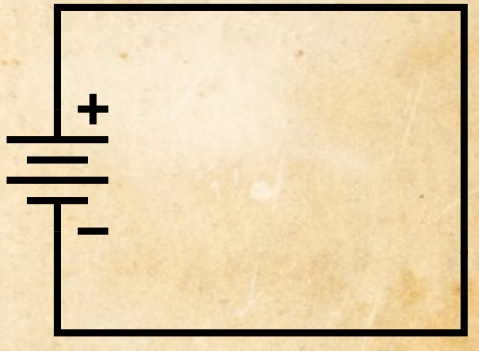




$$I = \frac{V}{R}$$

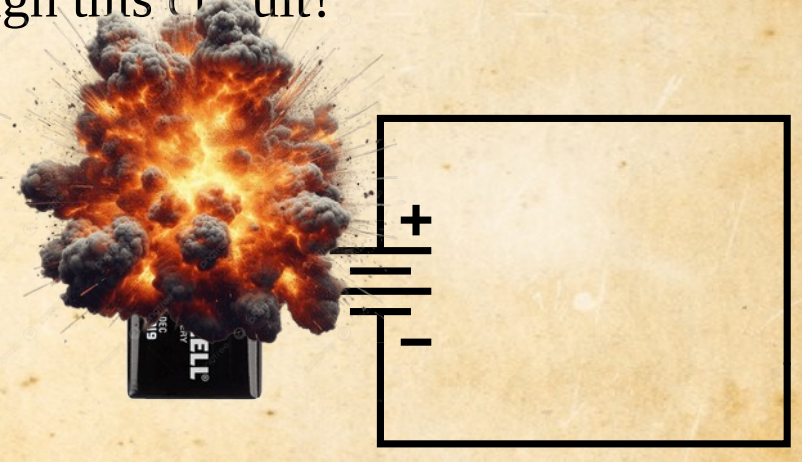
Voltage Resistance and Current

- We find the current through the circuit using Ohm's Law: $I = \frac{V}{R}$
- Copper wires have low resistance
  - Many cases, we can assume zero resistance
  - If we assume the wires have zero resistance, what is the current flow through this circuit?



Voltage Resistance and Current

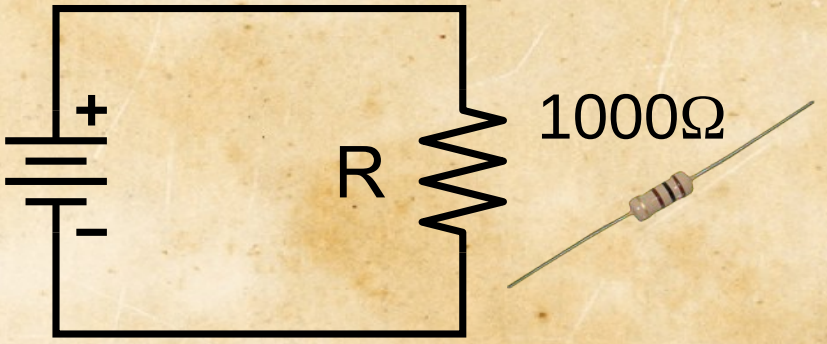
- We find the current through the circuit using Ohm's Law: $I = \frac{V}{R}$
- Copper wires have low resistance
  - Many cases, we can assume zero resistance
  - If we assume the wires have zero resistance, what is the current flow through this circuit?



Voltage Resistance and Current

- Calculate the current

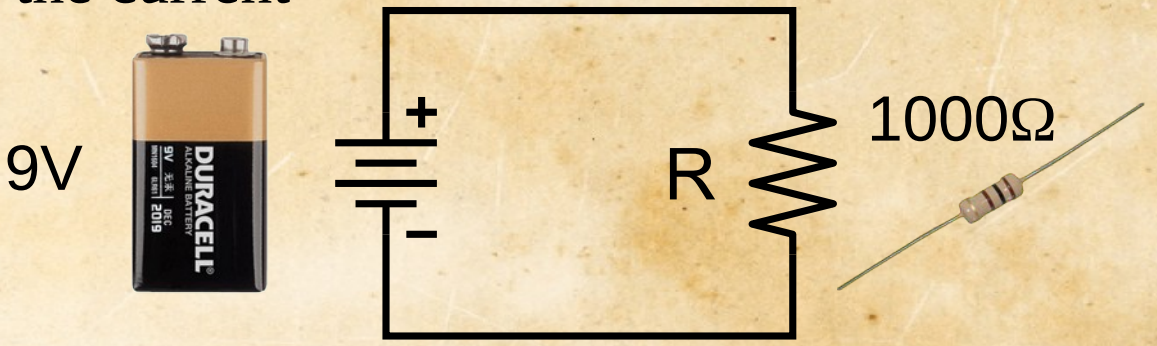
9V



$$I = \frac{V}{R}$$

Voltage Resistance and Current

- Calculate the current

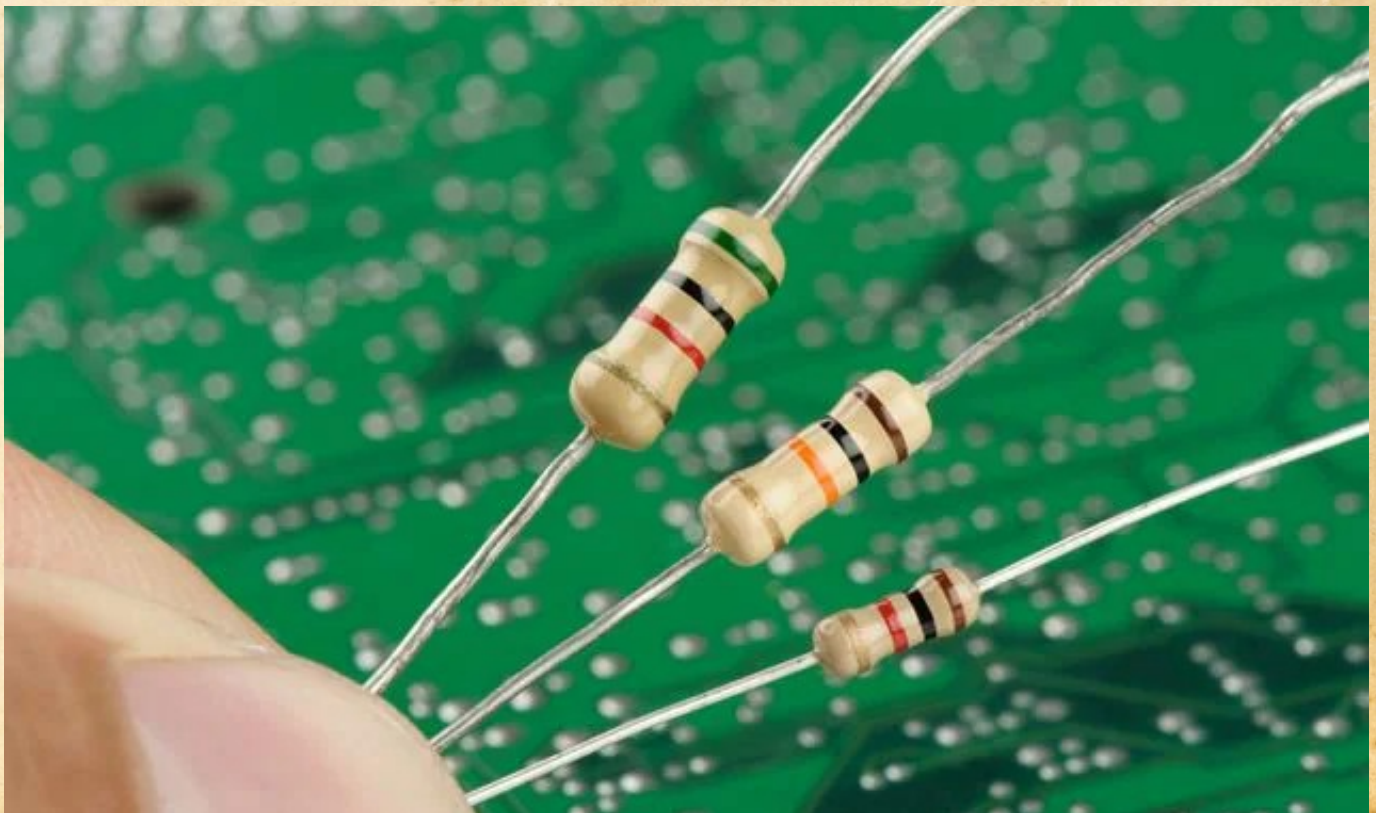


$$I = \frac{V}{R}$$

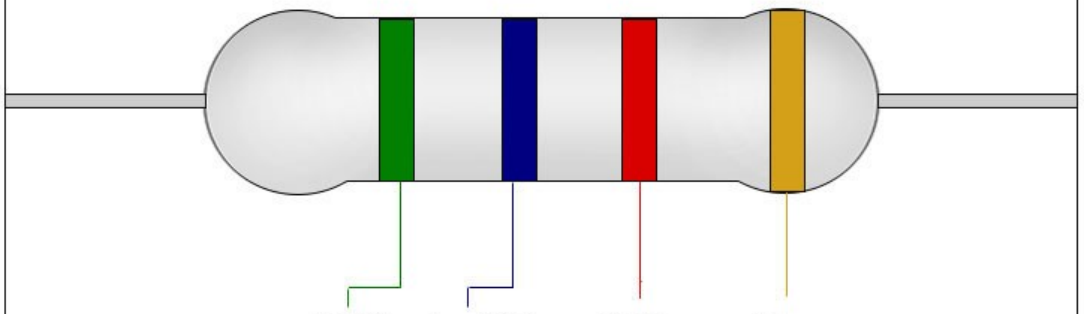
$$I = \frac{V}{R} = \frac{9\ V}{1000\ \Omega} = 0.009\ A = 9\ mA$$

Voltage Resistance and Current

- What are these colored stripes?



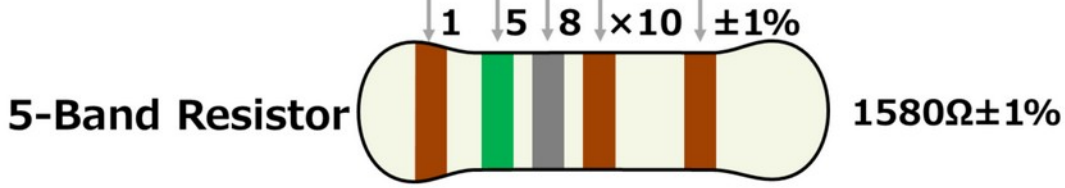
Reading Resistor Color Codes



	First Digit	Second Digit	Multiplier	Tolerance
Black	Nil	0	1	Nil
Brown	1	1	10	±1%
Red	2	2	100	±2%
Orange	3	3	1000	±3%
Yellow	4	4	10000	±4%
Green	5	5	100000	±0.5%
Blue	6	6	1M	±0.25%
Violet	7	7	10M	±0.10%
Grey	8	8	100M	±0.05%
White	9	9	1G	Nil
Gold	Nil	Nil	÷10	±5%
Silver	Nil	Nil	÷100	±10%

Resistor Color Code

Color	1st Band	2nd Band	3rd Band	Multiplier		Tolerance	Temperature Coefficient (ppm/K)
Black	0	0	0	×1	(=10^0)		250
Brown	1	1	1	×10	(=10^1)	±1%	100
Red	2	2	2	×100	(=10^2)	±2%	50
Orange	3	3	3	×1k	(=10^3)	±0.05%	15
Yellow	4	4	4	×10k	(=10^4)	±0.02%	25
Green	5	5	5	×100k	(=10^5)	±0.5%	20
Blue	6	6	6	×1M	(=10^6)	±0.25%	10
Violet	7	7	7	×10M	(=10^7)	±0.1%	5
Gray	8	8	8	×100M	(=10^8)	±0.01%	1
White	9	9	9	×1G	(=10^9)		
Gold				×0.1	(=10^{-1})	±5%	
Silver				×0.01	(=10^{-2})	±10%	
None						±20%	



RESISTOR COLOR CODE

5-Band-Resistor

234*100kΩ = 23.4MΩ @ 0.25%

Color	Band 1	Band 2	Band 3	Multiplic.	Tolerance
Black	0	0	0	10^0 (1Ω)	
Brown	1	1	1	10^1 (10Ω)	± 1%
Red	2	2	2	10^2 (100Ω)	± 2%
Orange	3	3	3	10^3 (1kΩ)	
Yellow	4	4	4	10^4 (10kΩ)	
Green	5	5	5	10^5(100kΩ)	± 0.5%
Blue	6	6	6	10^6 (1MΩ)	± 0.25%
Purple	7	7	7	10^7 (10MΩ)	± 0.1%
Gray	8	8	8	10^8(100MΩ)	± 0.05%
White	9	9	9	10^9 (1GΩ)	
Gold				10^{-1}(100mΩ)	± 5%
Silver				10^{-2} (10mΩ)	± 10%

4-Band-Resistor

23*10kΩ = 230kΩ @ 0.5%

EIA Standard Resistor Values by ± Tolerance%

Move the decimal point to achieve the actual value desired.

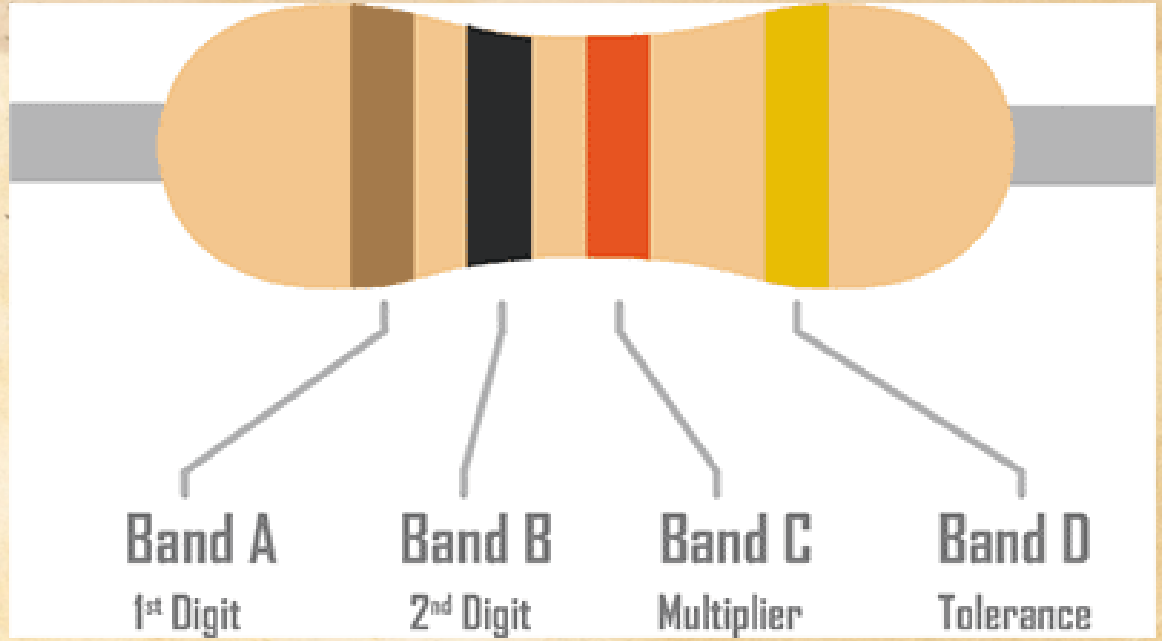
E6	E12	E24	E48	E96
± 20%	± 10%	± 5%	± 2%	± 1%
100	100	100	100	100
				102
			105	105
				107
		110	110	110
				113
			115	115
				118
	120	120	121	121
				124
			127	127
				130
		130	133	133
				137
			140	140
				143
150	150	150	147	147
				150
			154	154
				158
		160	162	162
				165
			169	169
				174
	180	180	178	178
				182
			187	187
				191
		200	196	196
				200
			205	205
				210

E6	E12	E24	E48	E96
± 20%	± 10%	± 5%	± 2%	± 1%
220	220	220	215	215
				221
			226	226
				232
		240	237	237
				243
			249	249
				255
	270	270	261	261
				267
			274	274
				280
		300	287	287
				294
			301	301
				309
330	330	330	316	316
				324
			332	332
				340
		360	348	348
				357
			365	365
				374
	390	390	383	383
				392
			402	402
				412
		430	422	422
				432
			442	442
				453

E6	E12	E24	E48	E96
± 20%	± 10%	± 5%	± 2%	± 1%
470	470	470	464	464
				475
			487	487
				499
		510	511	511
				523
			536	536
				549
	560	560	562	562
				576
			590	590
				604
		620	619	619
				634
			649	649
				665
680	680	680	681	681
				698
			715	715
				732
		750	750	750
				768
			787	787
				806
	820	820	825	825
				845
			866	866
				887
		910	909	909
				931
			953	953
				976

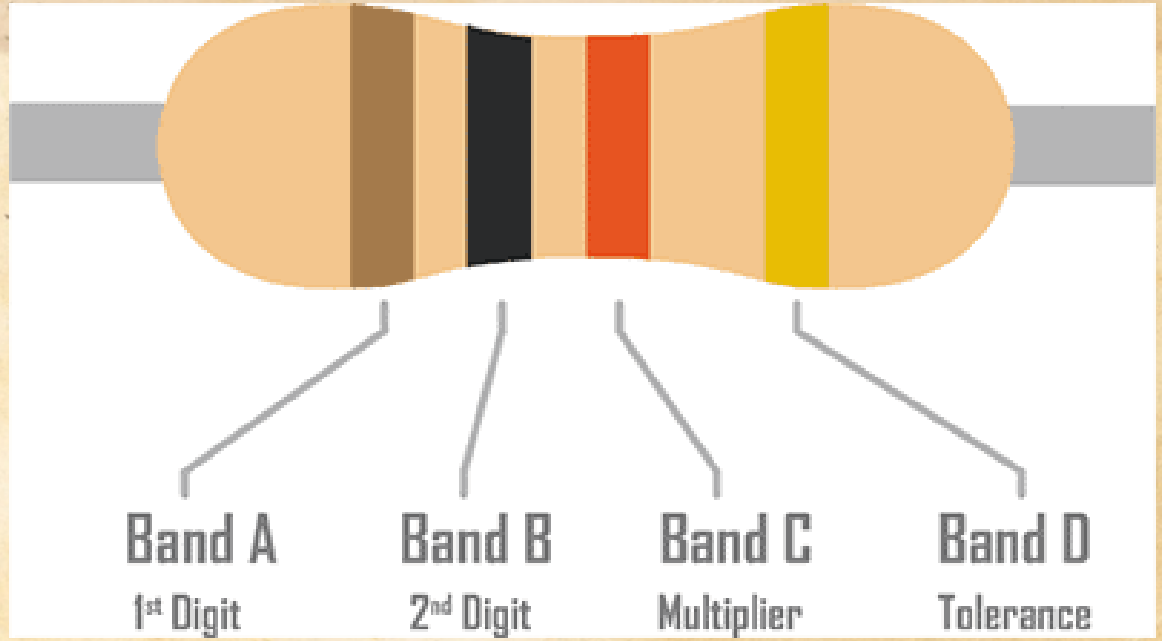
20%	100, 150,
10%	120, 180
5%	110, 130, 160, 200
20%	220, 330
10%	270, 390
5%	240, 300, 360, 430
20%	470, 680
10%	560, 820
5%	510, 620, 750, 910

Reading Resistor Color Codes



Brown Black Red Gold

Reading Resistor Color Codes

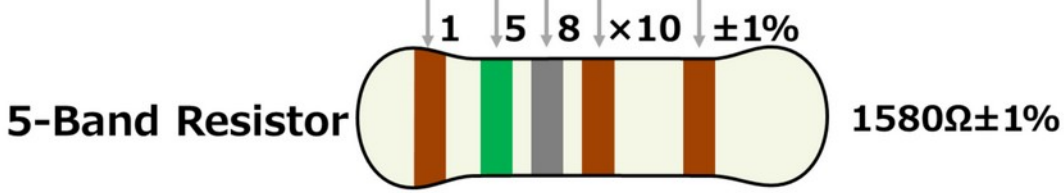


Brown	Black	Red	Gold
1	0	x 10^2	± 5%

1000Ω±5% → 950Ω to 1050Ω

Resistor Color Code

Color	1st Band	2nd Band	3rd Band	Multiplier		Tolerance	Temperature Coefficient (ppm/K)
Black	0	0	0	×1	(=10^0)		250
Brown	1	1	1	×10	(=10^1)	±1%	100
Red	2	2	2	×100	(=10^2)	±2%	50
Orange	3	3	3	×1k	(=10^3)	±0.05%	15
Yellow	4	4	4	×10k	(=10^4)	±0.02%	25
Green	5	5	5	×100k	(=10^5)	±0.5%	20
Blue	6	6	6	×1M	(=10^6)	±0.25%	10
Violet	7	7	7	×10M	(=10^7)	±0.1%	5
Gray	8	8	8	×100M	(=10^8)	±0.01%	1
White	9	9	9	×1G	(=10^9)		
Gold				×0.1	(=10^{-1})	±5%	
Silver				×0.01	(=10^{-2})	±10%	
None						±20%	



20%	100, 150,
10%	120, 180
5%	110, 130, 160, 200
20%	220, 330
10%	270, 390
5%	240, 300, 360, 430
20%	470, 680
10%	560, 820
5%	510, 620, 750, 910

Next :

How to measure resistance

Electronics

Resistance and Resistor Color Codes