Principle of Electrical Engineering

UNIT 2: ELECTRIC CURRENT FUNDAMENTAL

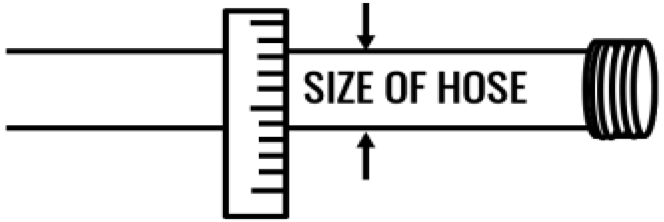
prepared by Er. Bibek Dahal

Electric current and voltage

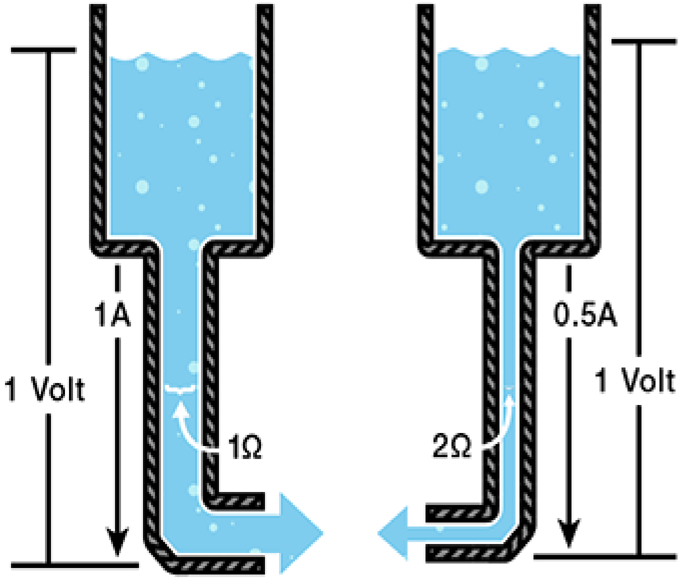
Electricity is like a water hose

Voltage Volts (V)

Current Amps (A or I)



Resistance Ohms (R or Ω)



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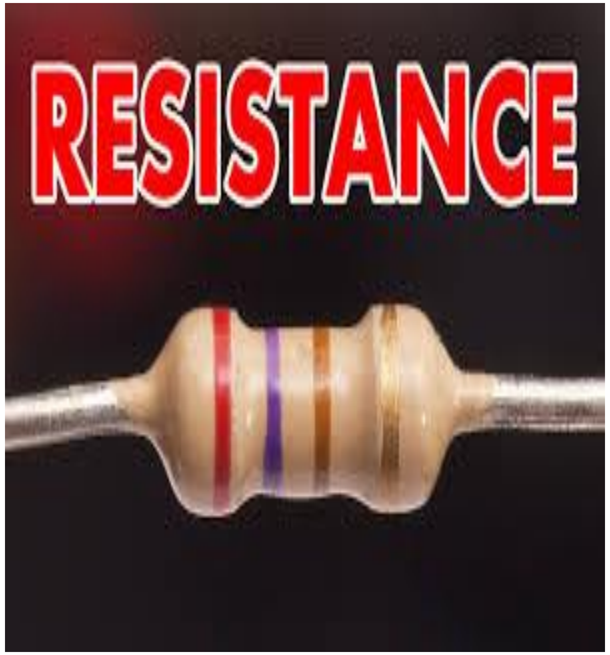
Resistor

- Definition from unit 1

Laws of resistance

- The resistance offered by a conductor depends on following factor:
  - It varies directly proportional as its length . **R** α **L**
  - It varies inversely proportional on its cross section Area (A). **R** α **A**
  - It depends upon the nature of materials
  - It also depends upon the temperature of conductor



Resistor

Laws Of Resistance

The resistance of a material depends upon the fallowing four factors, which are called laws of resistance.

1st law of resistance

The resistance of conductor is directly proportional to the length of the conductor. Greater is the length of conductor greater will be the resistance, similarly smaller is the length, and smaller will be the resistance of the conductor.

2nd law of resistance

The resistance of the conductor is inversely proportional to the cross sectional area of the conductor. Greater is the cross sectional area smaller will be the resistance and when smaller is cross sectional area greater will be the resistance

3rd law of resistance

The resistance of the conductor depends upon the nature of the conductor. Two wire having the same gauges, but different material will have different resistance.

4th law of resistance

The resistance of the conductor depends upon the temperature of it. Resistance of metallic conductor increase with increase in temperature of the conductor.

Resistor

Taking in to consideration 1st three laws and neglecting 4th law for movement, we have

R ∝ L ....(eq. 1)

R ∝ l / A ....(eq. 2)

From equation 1 and 2 we get

$$R \alpha \frac{L}{A}$$

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

No crt.	Material	Electrical characteristics	
		Electrical Resistivity (Ω x cm)	Electrical Conductivity (Ω^{-1} x cm^{-1})
1	Cu	0.034 x10^{-5}	29 x 10^{5}
2	Fe	32.54 x 10^{-5}	0.031 x 10^{5}
3	Ag	0.36 x 10^{-5}	2.8 x 10^{5}
4	Al	0.03 x 10^{-5}	33.3 x 10^{5}
5	Ni	0.046 x 10^{-5}	21.7 x 10^{5}
6	Cu-Fe	33.37 x 10^{-5}	0.030 x 10^{5}
7	Cu-Ag	2.71 x 10^{-5}	0.37 x 10^{5}
8	Al-Ni	0.564 x 10^{-5}	1.77 x 10^{5}

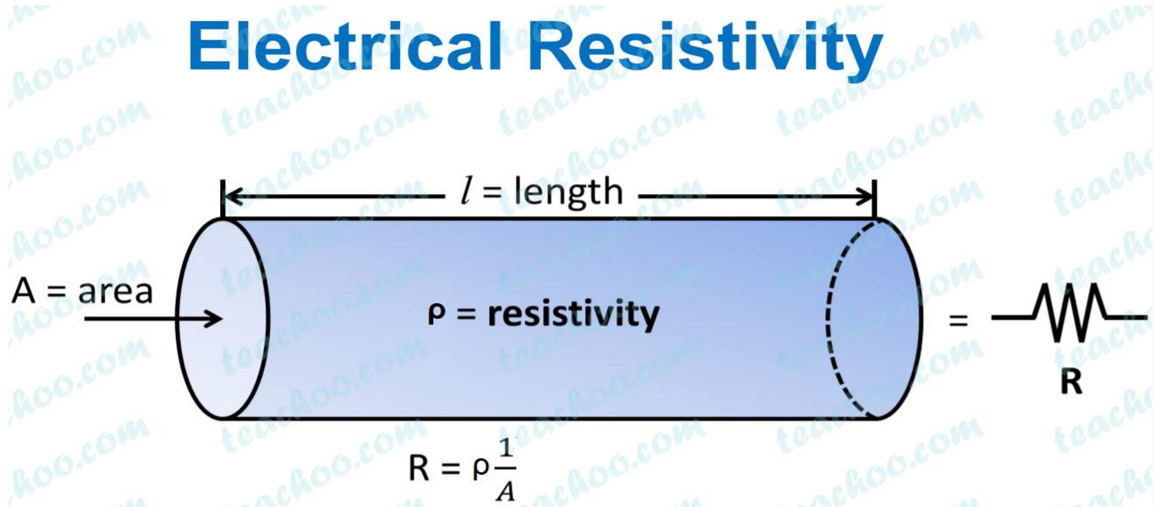
Where ρ is called rho .it is a constant and is known as resistivity or specific resistance of a material.

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

$$A \times R = \rho L$$

$$\rho = \frac{A \times R}{L}$$

$$\rho = \frac{m^2\Omega}{m} = m\Omega$$



Its unit is Ωm

Specific Resistance or Resistivity

Specific resistance can be derived from the following relations of the resistance dependence factors.

1. LENGTH

Resistacne is directly proportional to the length of conductor.

$R \propto L$ ---------1

2. AREA

Resistance is inversily proportional to the area of conductor.

$R \propto 1/A$ ----------2

by combining 1 and 2

$R \propto L/A$

$R = \varrho L/A$

Where ϱ (Rho) is constant for the material called its specific resistance or resistivity.

"The Specific resistance of a material is the resistance of a piece of unit length and uint cross-sectional area."

OR

"It is the resistance between opposite faces of uint cube of the material."

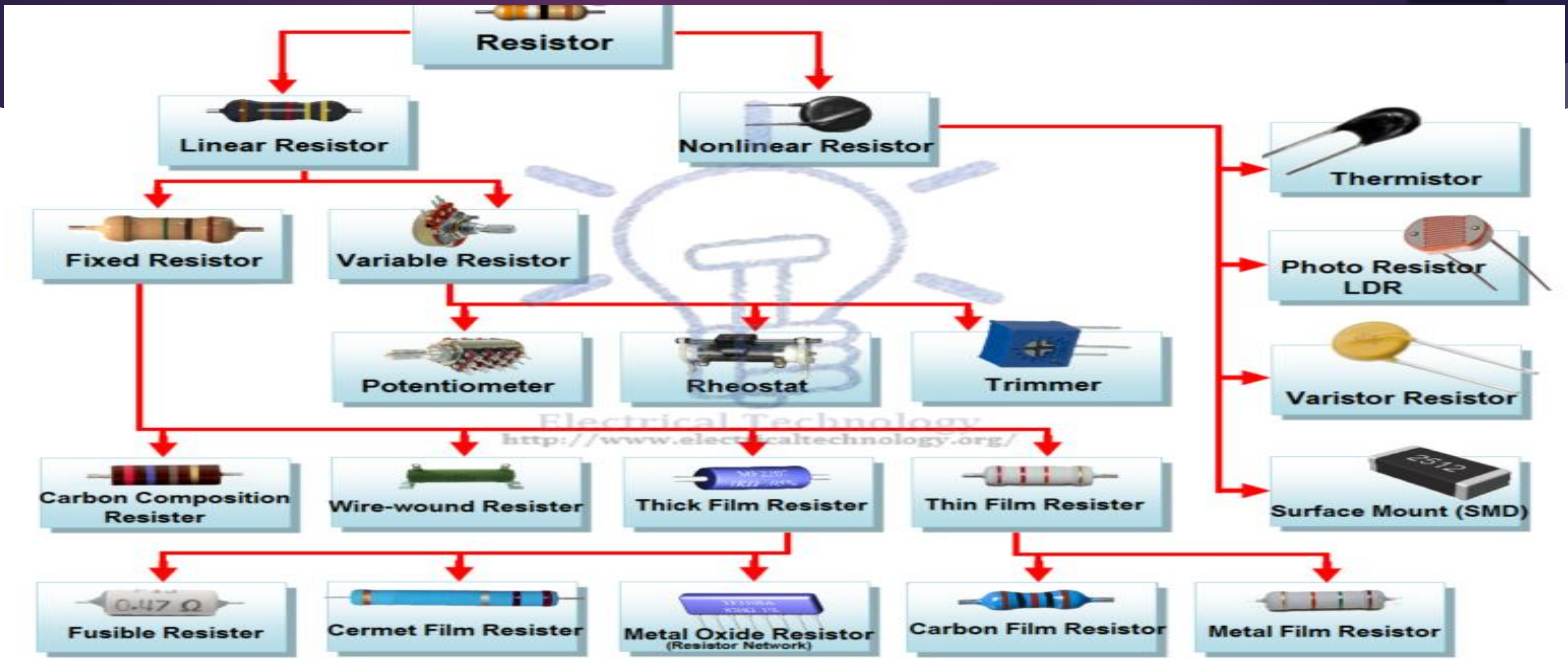
Conductance

- Electrical conductance, G, is the reciprocal of resistance (R)

$$\mathbf{G} = \frac{1}{R}$$

- Electrical conductance measures how easily electricity flows through electrical components for a given voltage difference. The SI unit of conductance is siemens (the older unit was the mho).
- Electrical conductance is closely related to electrical conductivity. Electrical conductance is a property of a particular electrical component (like a particular wire), while conductivity is a property of the material itself (like silver).

Types of Resistor



- Assignment :
- https://www.electricaltechnology.org/2015/01/resistor-types-resistors-fixed-variable-linear-non-linear.html

Color code of resistor

Standard Resistor Values and Color

Components and wires are coded with colors to identify their value and function.

Resistor Color Coding uses colored bands to quickly identify a resistors resistive value and its percentage of tolerance with the physical size of the resistor indicating its wattage rating.

Generally, the resistance value, tolerance, and wattage rating are printed on the body of a resistor as numbers or letters when the resistors body is big enough to read the print, such as large power resistors.

But when a resistor is smaller (example: 1/4 watt carbon or film type), the print is too small to read, so the specifications must be shown in another way.

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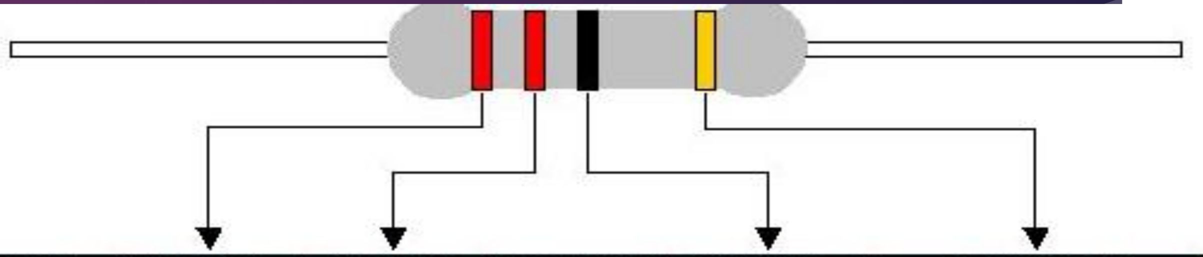
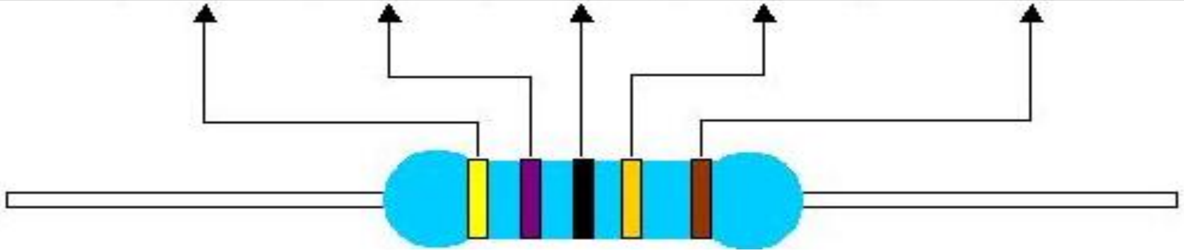
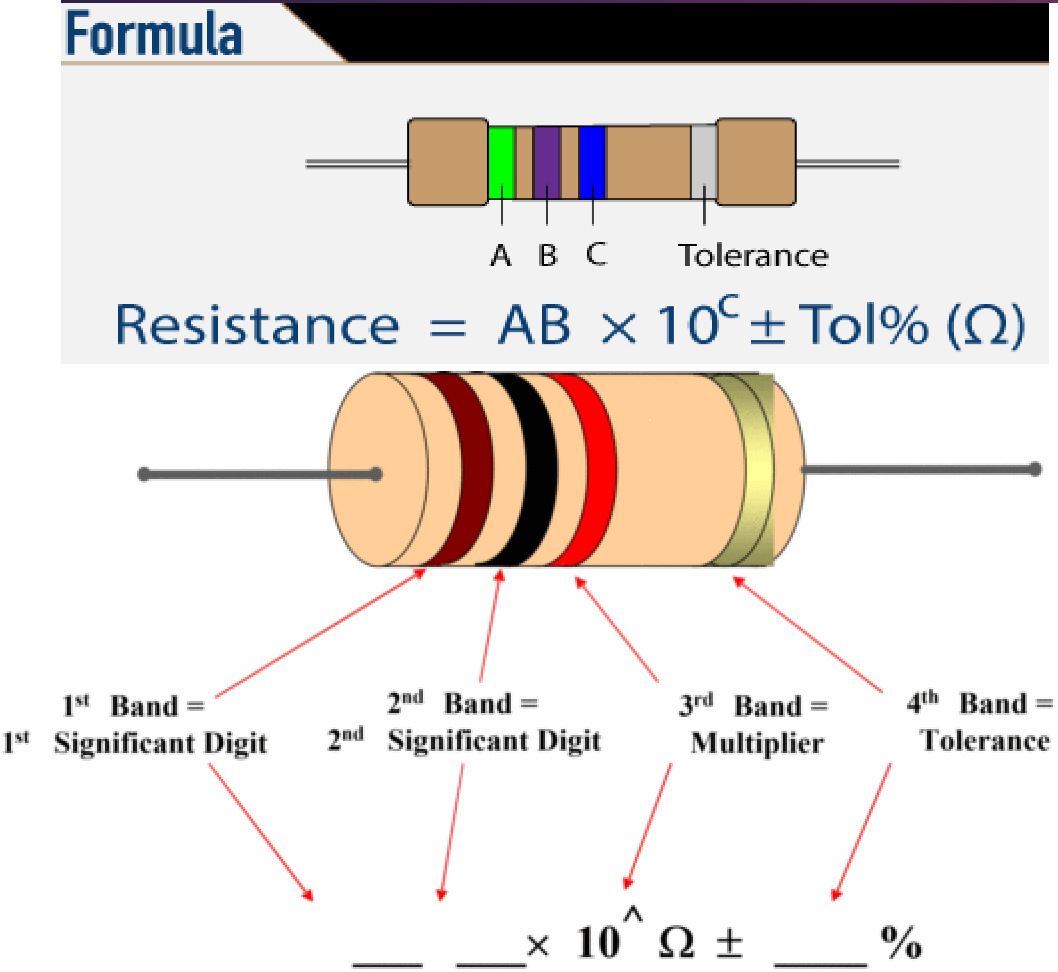
- **BBROY** of **G**reat **B**ritain has **V**ery **G**ood **W**ife

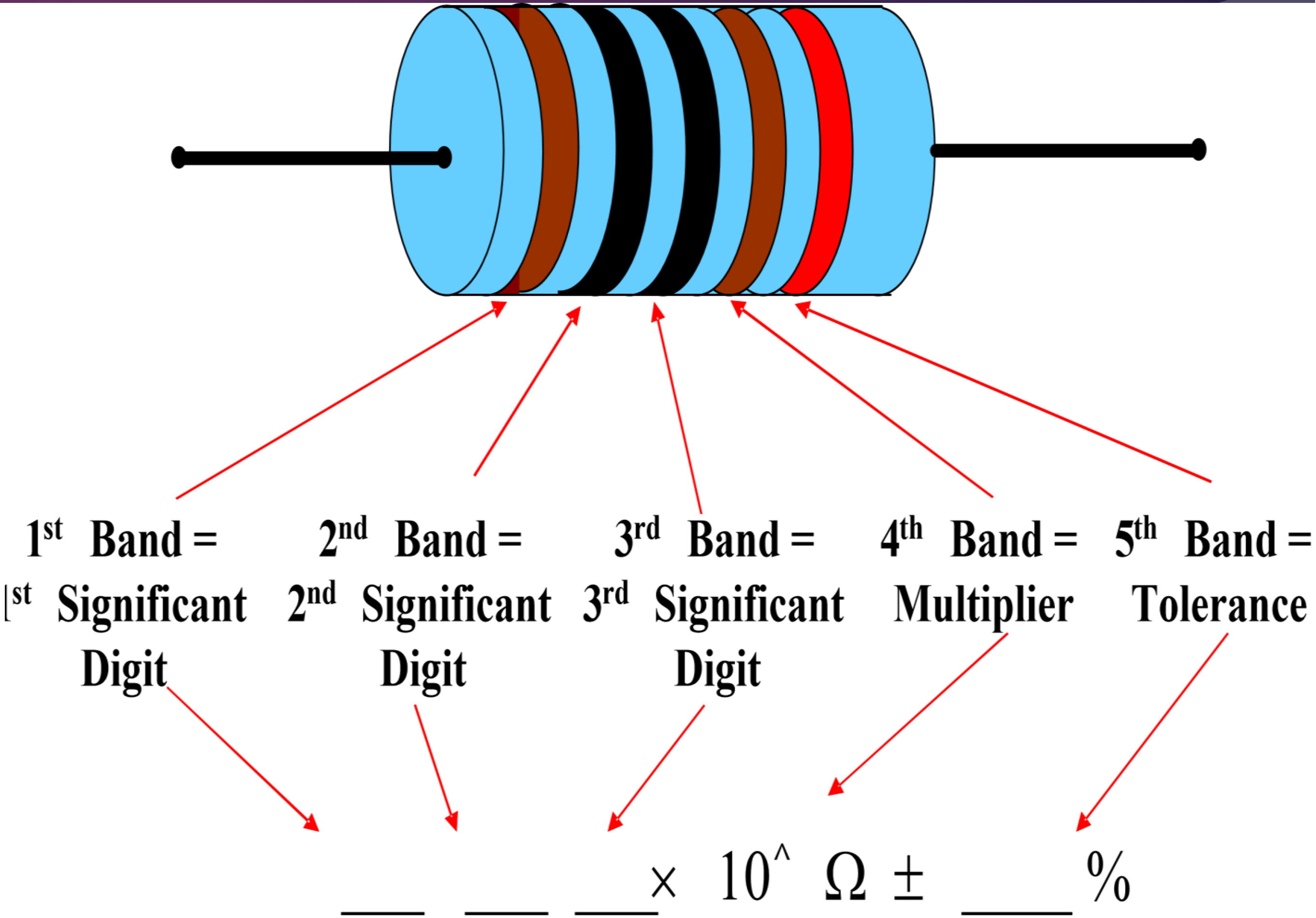


COLOR	1ST BAND	2ND BAND	3TH BAND	MULTIPLIER	TOLERANCE	
BLACK	0	0	0	1		
BROWN	1	1	1	10	± 1%	F
RED	2	2	2	100	± 2%	G
ORANGE	3	3	3	1K		
YELLOW	4	4	4	10K		
GREEN	5	5	5	100K	± 0.5%	D
BLUE	6	6	6	1M	± 0.25%	C
VIOLET	7	7	7	10M	± 0.10%	B
GREY	8	8	8		± 0.05%	A
WHITE	9	9	9			
GOLD				0.1	± 5%	J
SILVER				0.01	± 10%	K
PLAIN					± 20%	M



Color code of resistor





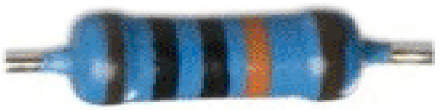
Color code of resistor

Parts per Million per degree Kelvin

4-band resistor

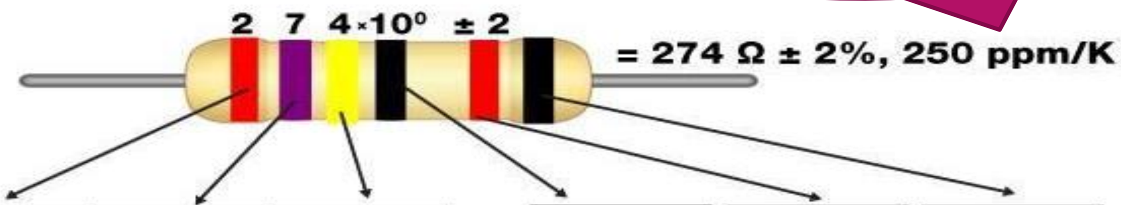
270 ohms ± 5%

5-band resistor



100k ohms ± 1%

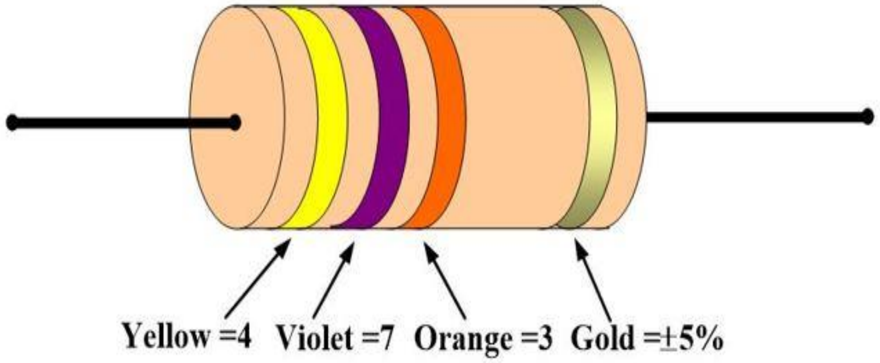
6-Band



Color	1st Digit	2nd Digit	3rd Digit		Multiplier	Tolerance	Temperature Coefficient
Black	0	0	0		1 Ω		250 ppm/K
Brown	1	1	1		10 Ω	± 1%	100 ppm/K
Red	2	2	2		100 Ω	± 2%	50 ppm/K
Orange	3	3	3	×	1k Ω		15 ppm/K
Yellow	4	4	4		10k Ω		25 ppm/K
Green	5	5	5		100k Ω	± 0.5%	20 ppm/K
Blue	6	6	6		1M Ω	± 0.25%	10 ppm/K
Violet	7	7	7			± 0.1%	5 ppm/K
Grey	8	8	8				1 ppm/K
White	9	9	9				
Gold					0.1 Ω	± 5%	
Silver					0.01 Ω	± 10%	

Numerical

Determine the ohmic value of the carbon resistor with color bands given in the following figure.



Solution

$$Resistor\ nominal\ value = 47 * 10^3 \Omega$$

$$= 47,000\ \Omega = 47\ \text{k}\Omega$$

If we consider the tolerance value then,

For minimum resistance value:

$$= 47k\Omega - 47k\Omega * 0.05$$
$$= 47k\Omega - 2.35k\Omega$$
$$= 44.65k\Omega$$

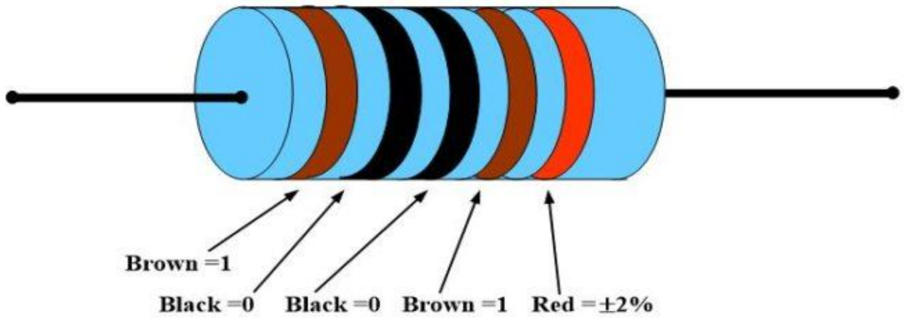
For maximum resistance value:

$$= 47k\Omega + 47k\Omega * 0.05$$
$$= 47k\Omega + 2.35k\Omega$$
$$= 49.35k\Omega$$

Consequently, any value between $44.65k\Omega$ and $49.35k\Omega$ is within the tolerance range and is satisfactory.

Numerical

1. Find the value of resistance if First band is Yellow, Second band is orange, Third band is violet, And fourth band is gold.
2. A.



3. 4 band color code of resistor with resistance of 270 ohm and tolerance of 5%
4. 5 band color code of resistor with resistance of 100 kilo ohm and tolerance of 1%

Thank you