Shahid Durwasa Nishad Govt. College Arjunda

Study materials

On

“Basics of Electricals & Electronic Components”

Offered

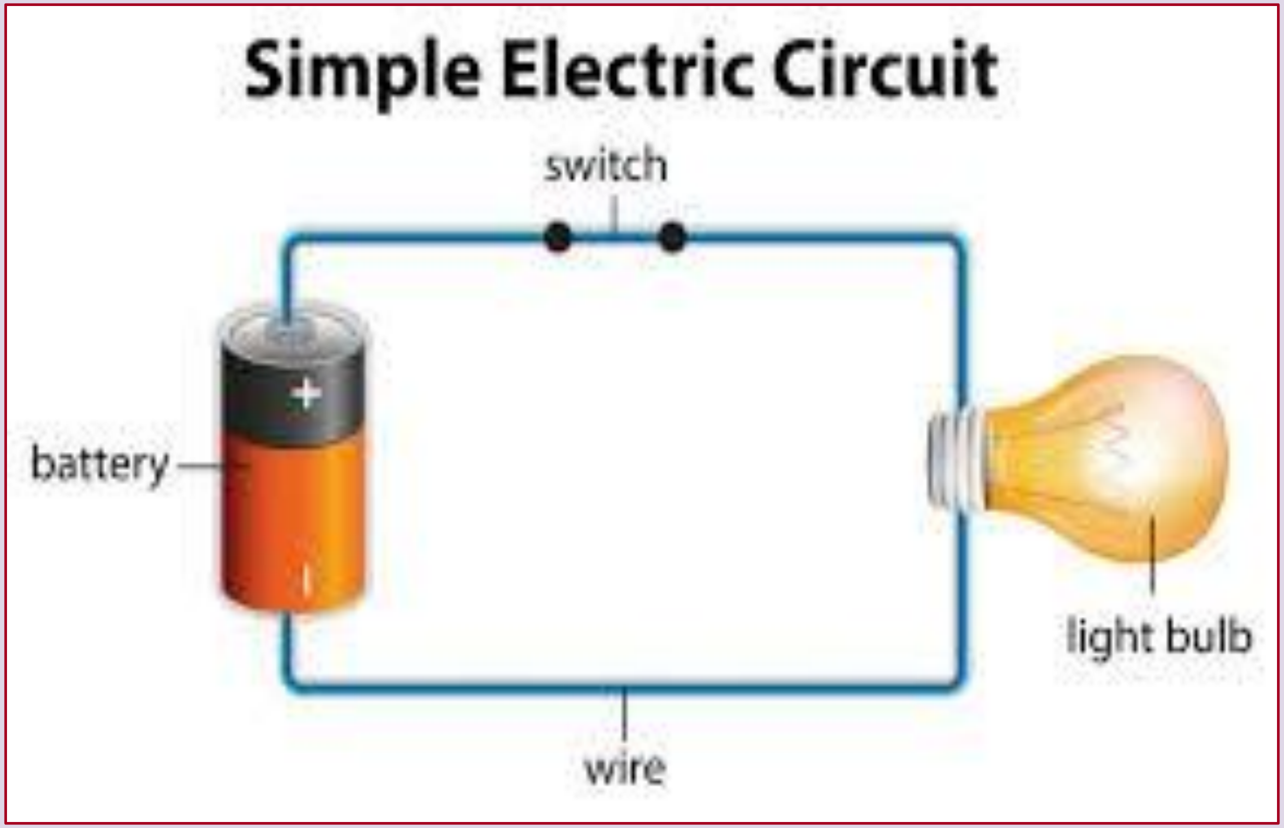
by

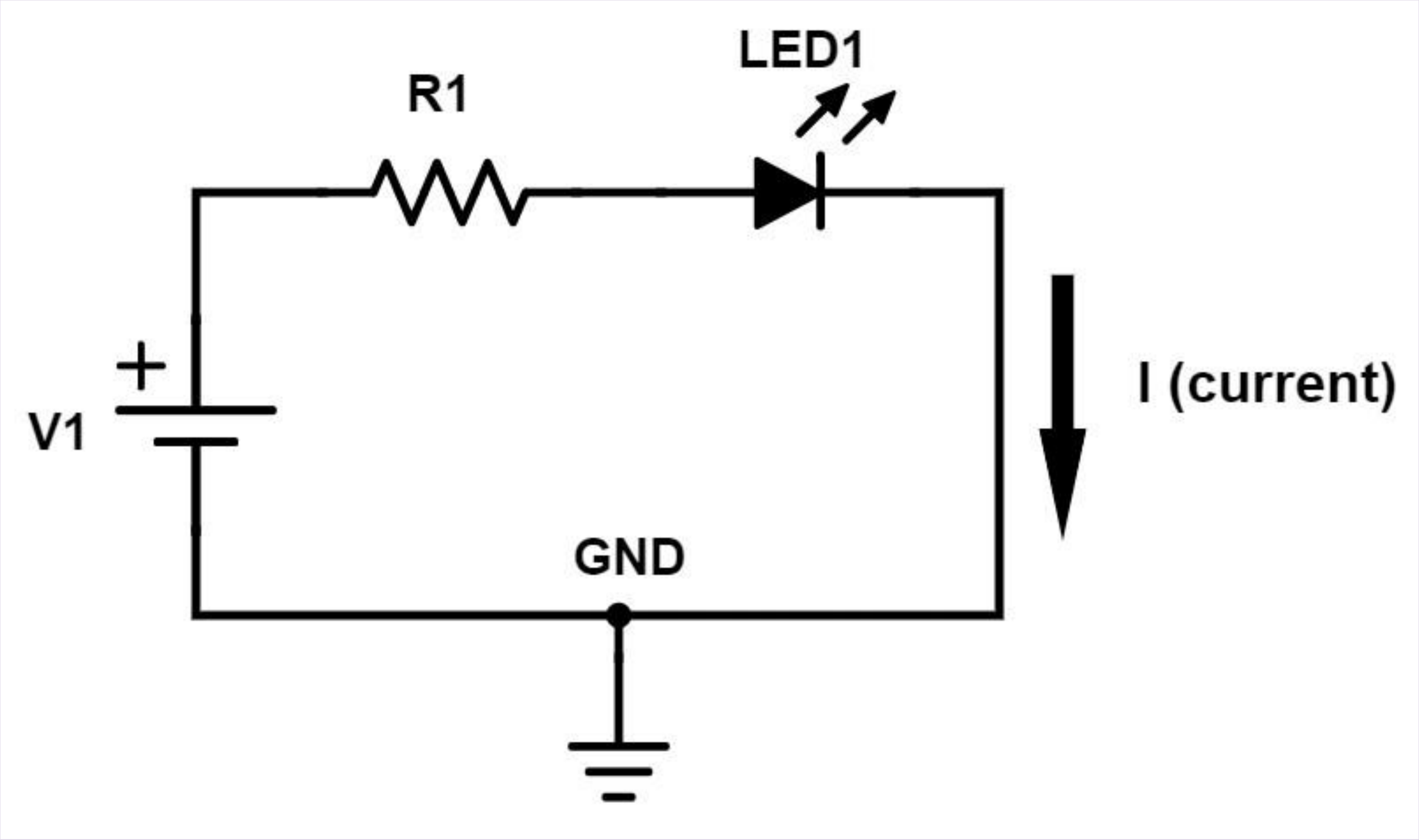
Department of

PHYSICS

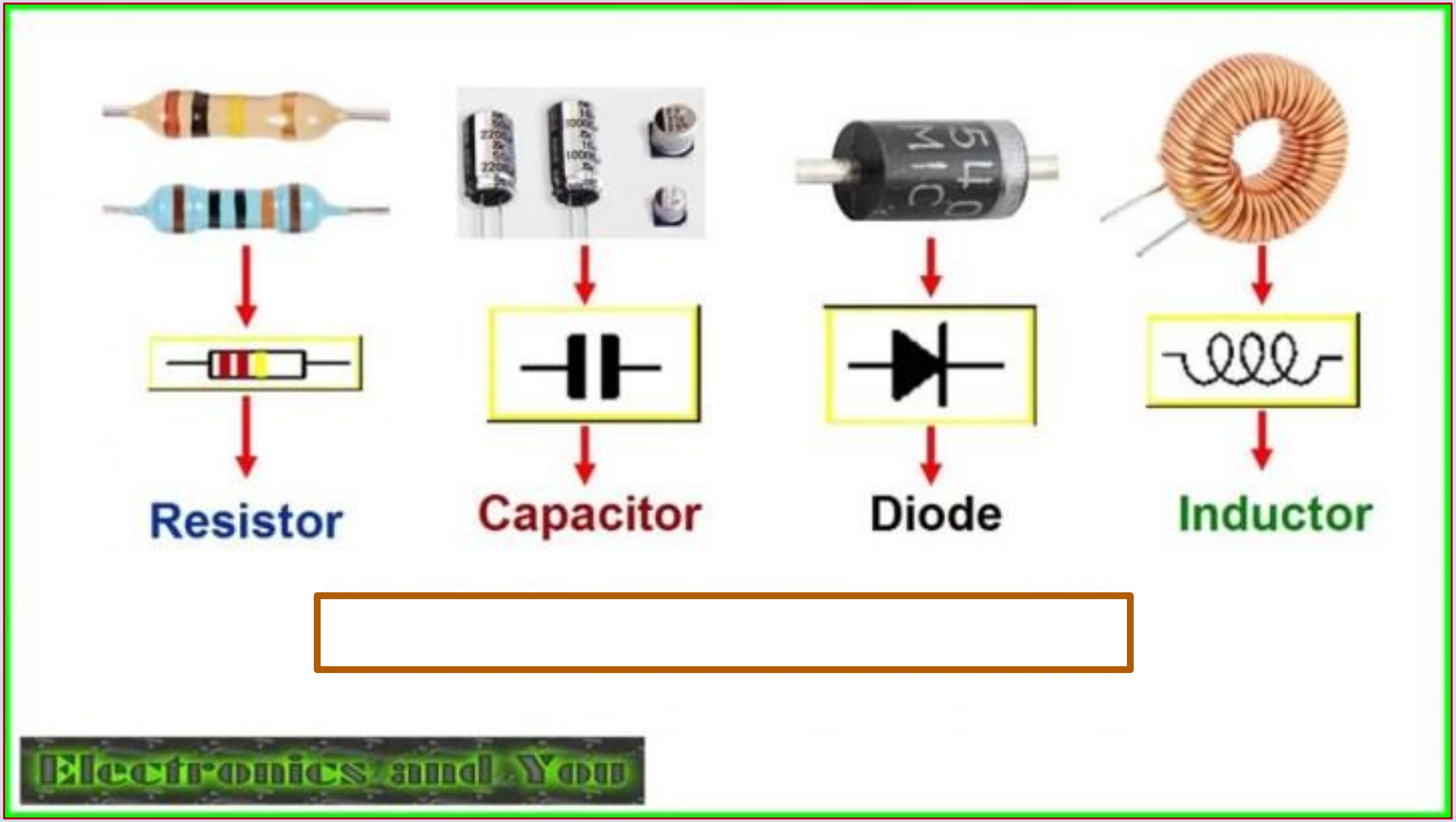
Electronic Circuit

An **electronic circuit** is composed of individual electronic components, such as resistors, transistors, capacitors, inductors and diodes, connected by.




LED1
R1
V1
+
I (current)
GND

Electronic Components



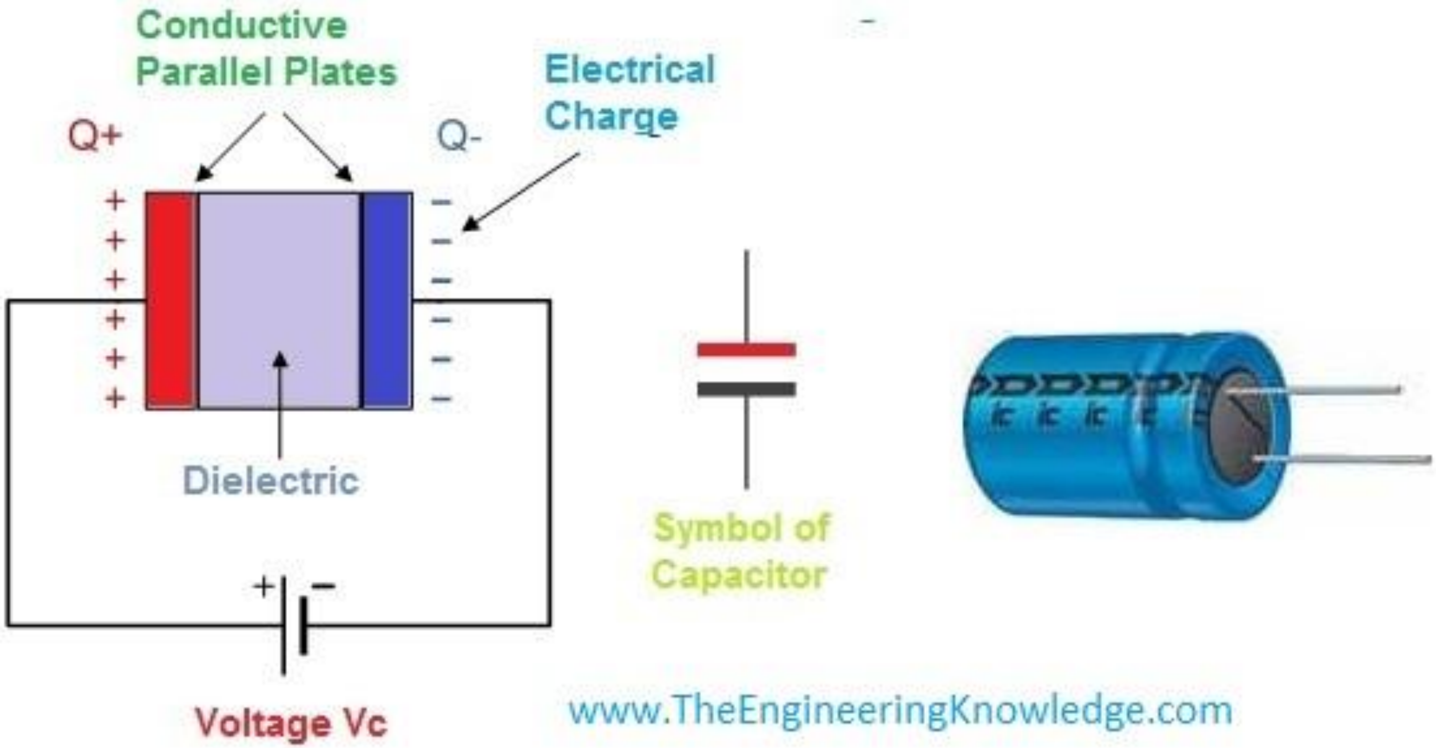
Capacitor/Condenser

A capacitor **can store electric energy when it is connected to its charging circuit** and when it is disconnected from its charging circuit, it can dissipate that energy.

Capacitance : Capacity or ability of a capacitor to store electrical energy. It is denoted by C and $C = Q/V$ Farad

Where Q = Charge stored in capacitor, V = potential difference

Introduction to Capacitors



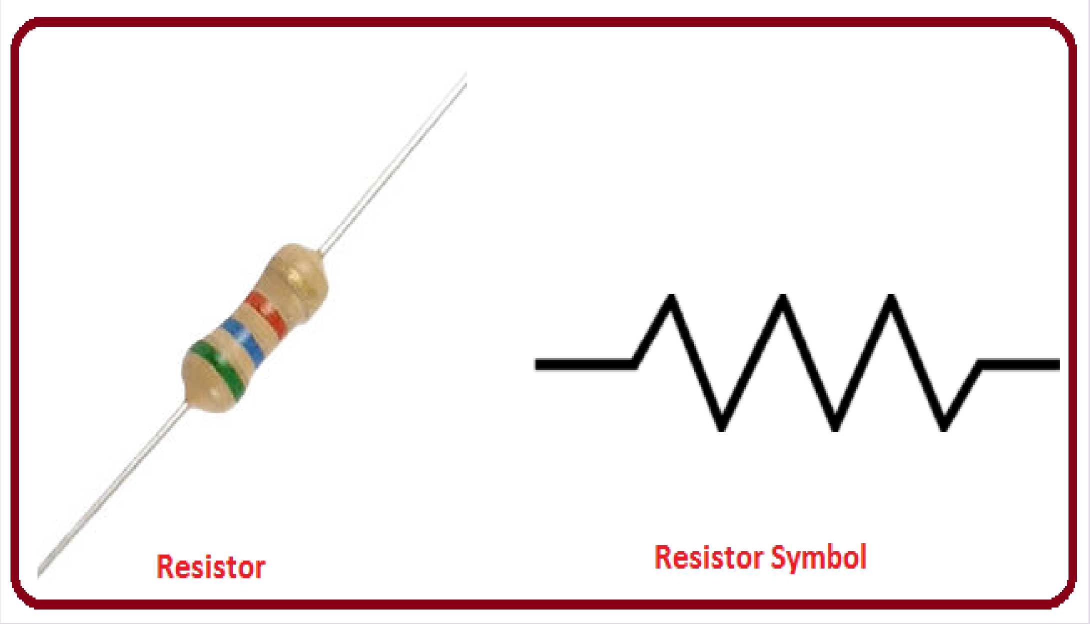
Resistor

Resistance: Resistance is a measure of the opposition to current flow in an electrical circuit. The higher the resistance, the lower the current flow.

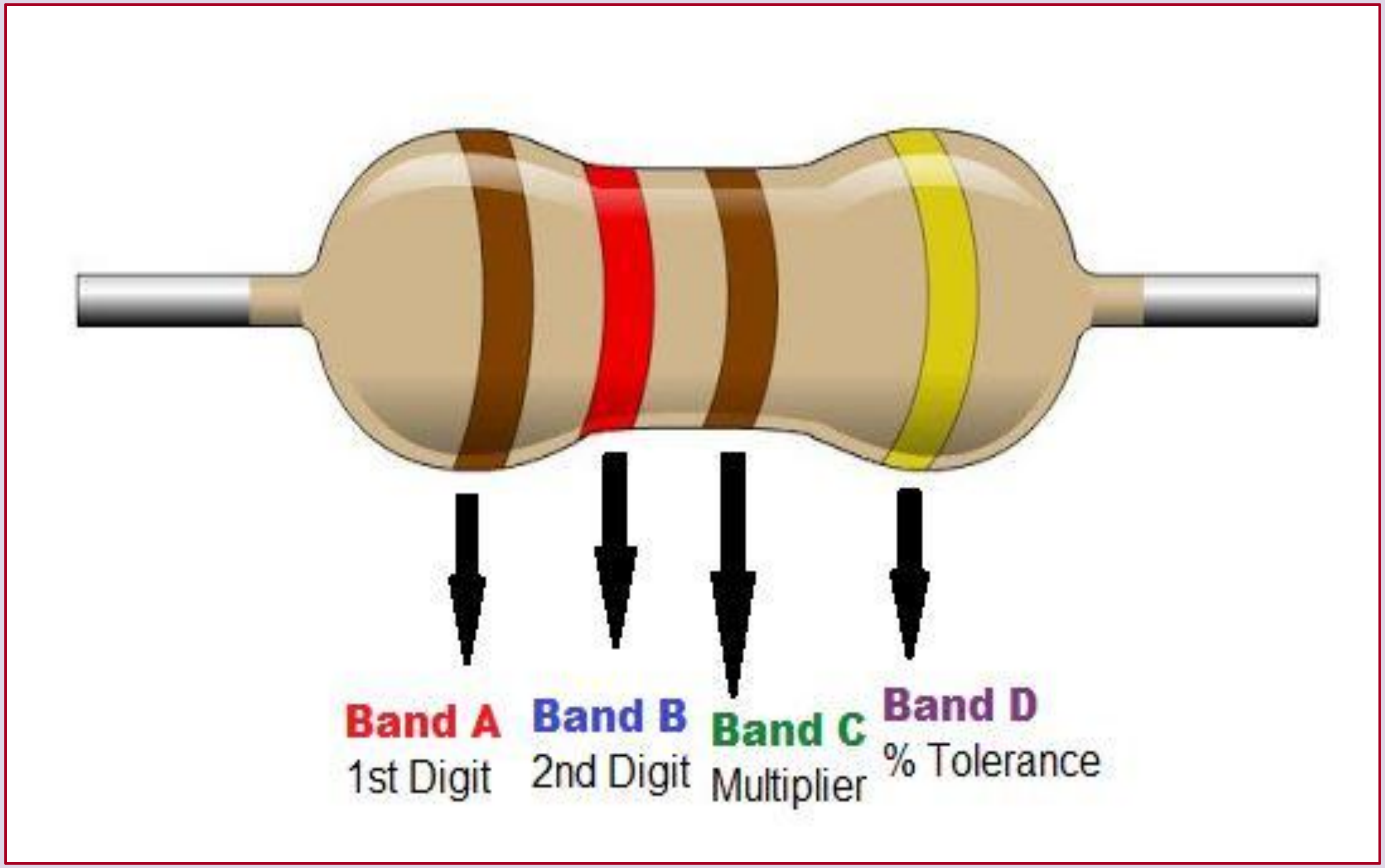
Resistance cannot be measured in an operating circuit. Technicians often determine resistance by taking voltage and current measurements and applying Ohm's Law:

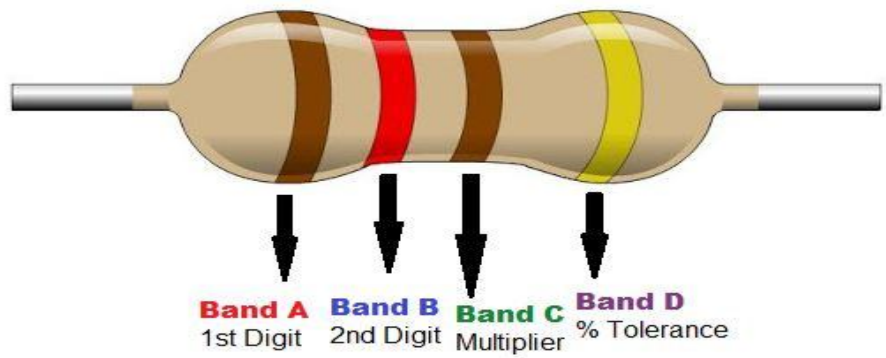
$V = IR$

$R = V/I$ Ohm or Ω



Calculate Resistance = ?



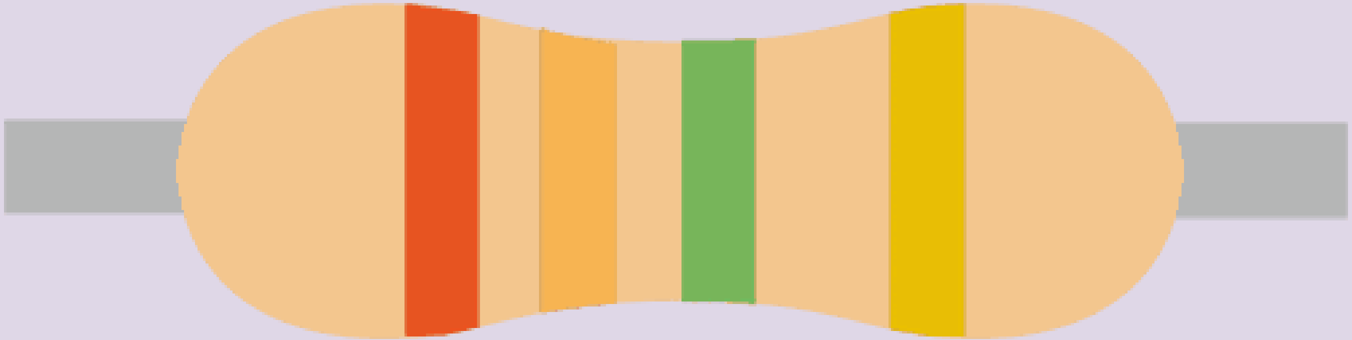


Resistor color code table

Color	Color	1st Band	2nd Band	3rd Band Multiplier	4th Band Tolerance
Black		0	0	x1Ω	
Brown		1	1	x10Ω	±1%
Red		2	2	x100Ω	±2%
Orange		3	3	x1kΩ	
Yellow		4	4	x10kΩ	
Green		5	5	x100kΩ	±0.5%
Blue		6	6	x1MΩ	±0.25%
Violet		7	7	x10MΩ	±0.10%
Grey		8	8	x100MΩ	±0.05%
White		9	9	x1GΩ	
Gold				x0.1Ω	±5%
Silver				x0.01Ω	±10%

Resistor color code table

Exercise



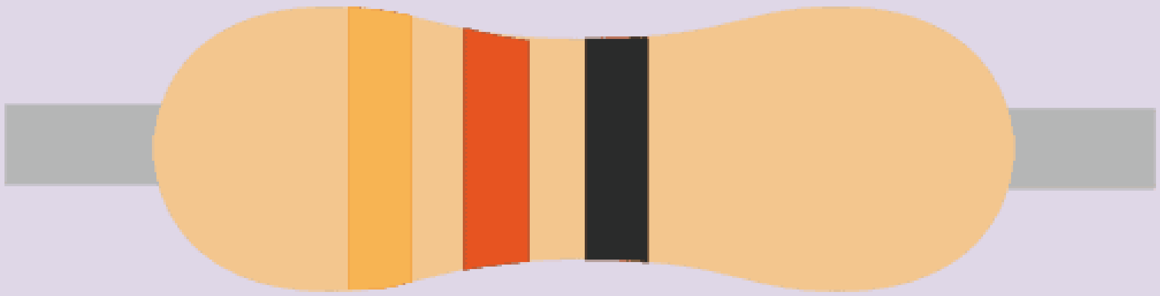
1st Band – Red ()

2nd Band – Orange ()

3rd Band – Green () multiplier

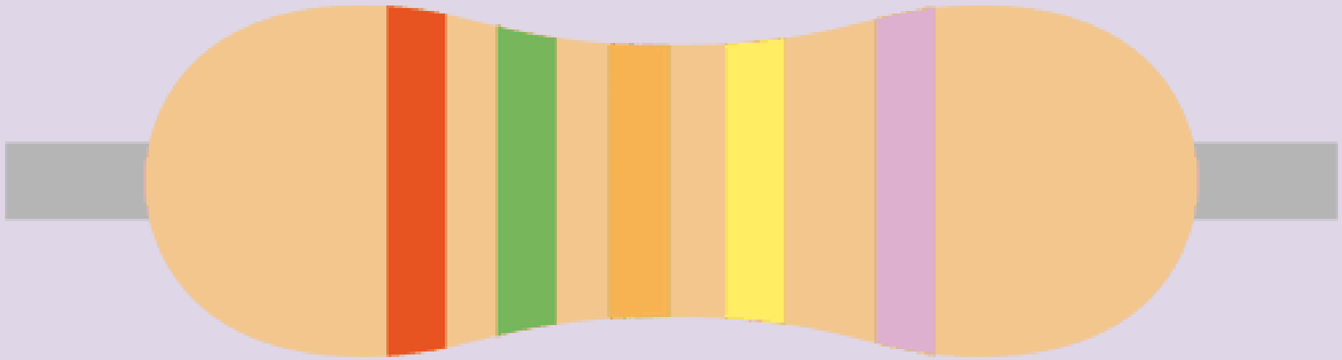
4th Band – Gold () tolerance

Ans. = So, the resistance is 23 multiplied by 100000 which is equal to 2.3 MΩ ±5%.



1st Band – Orange ()
2nd Band – Red ()
3rd Band – Black () multiplier

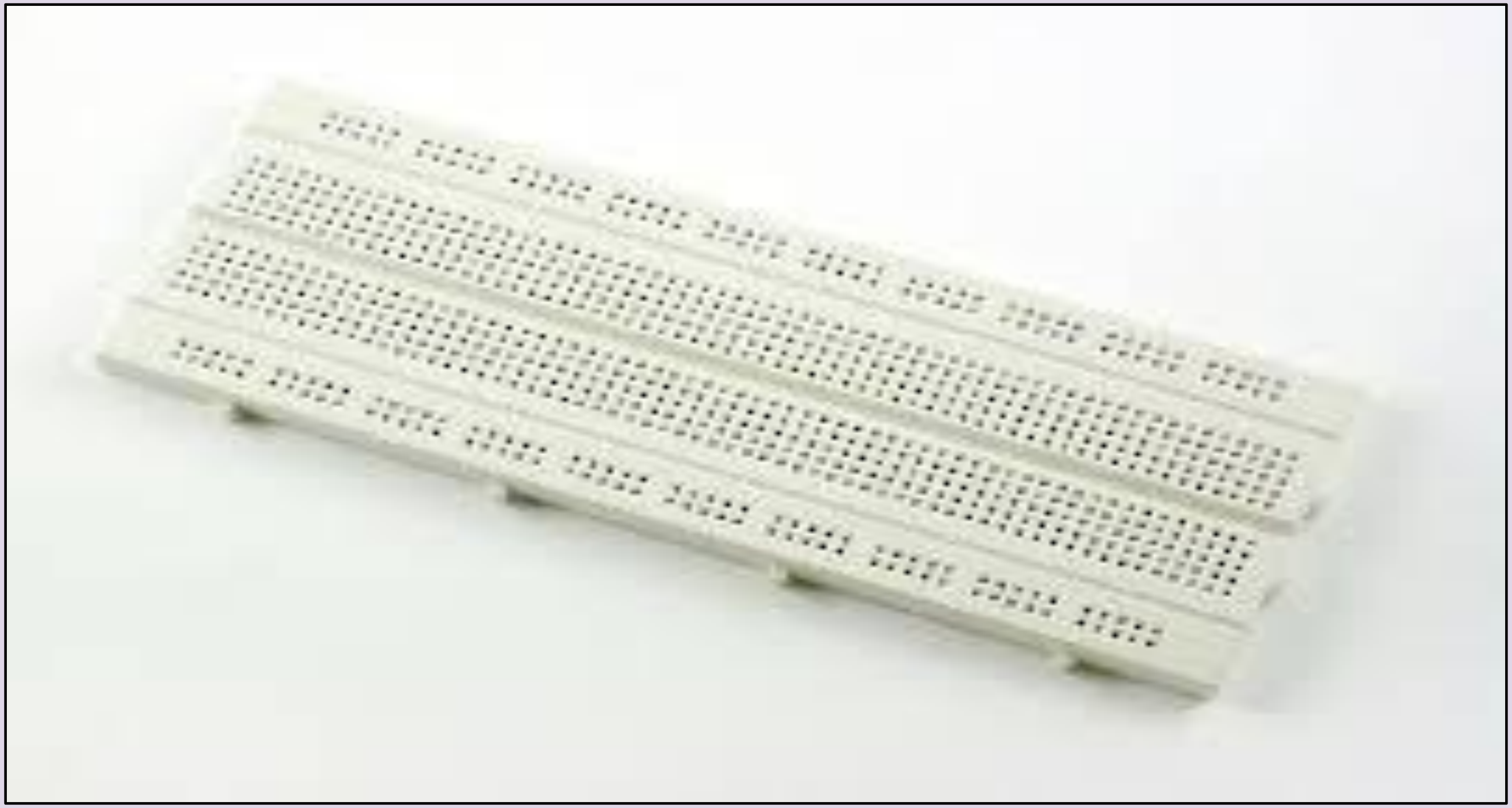
Ans. = So, the three band resistor value is 32 multiplied with one which is equal to 32Ω ±20%.

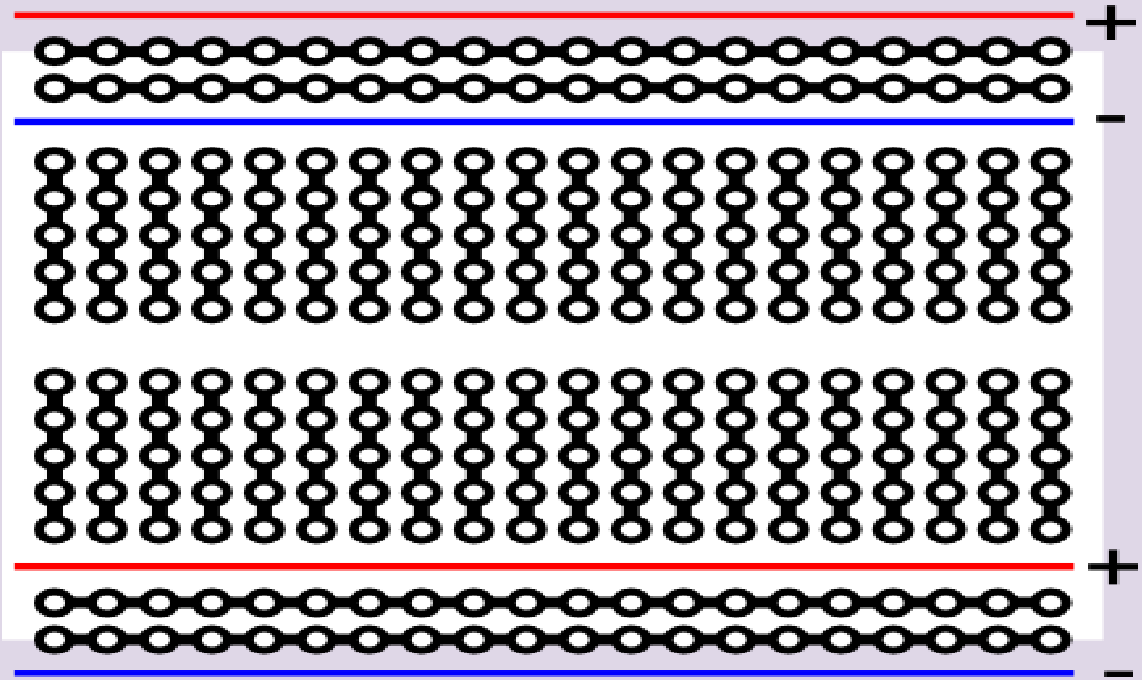


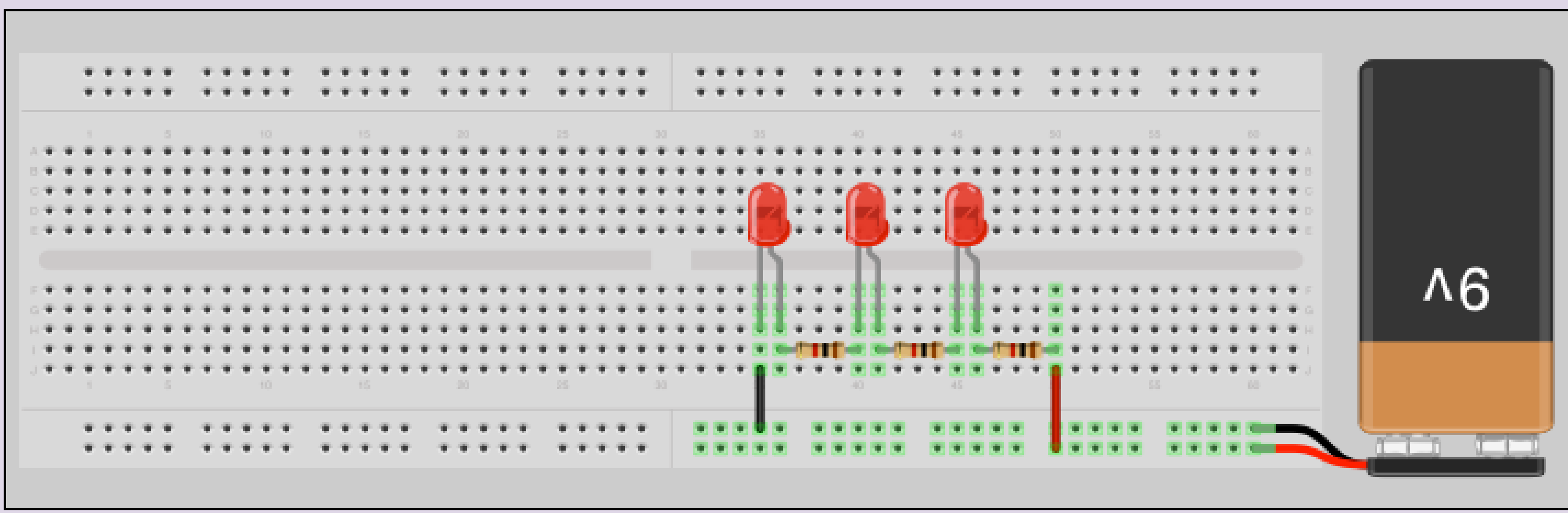
1st Band – Red ()
2nd Band – Green ()
3rd Band – Orange ()
4th Band – Yellow ()
5th Band – Violet ()

Ans. = So, the resistance is 253 multiplied with 10,000 which is equal to 2.53 MΩ ±0.1%. This means for a value of 2.53 MΩ, the resistance value varies from 2529999.9 ohms to 2530000.1 ohms.

Breadboard

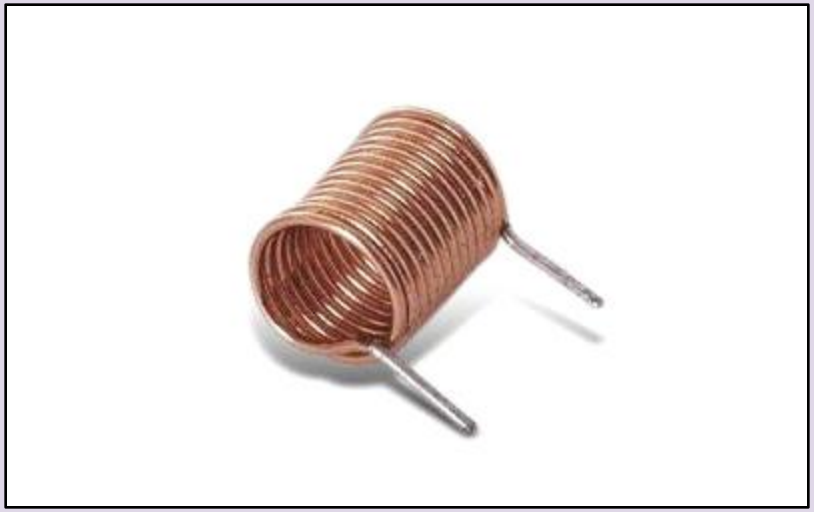


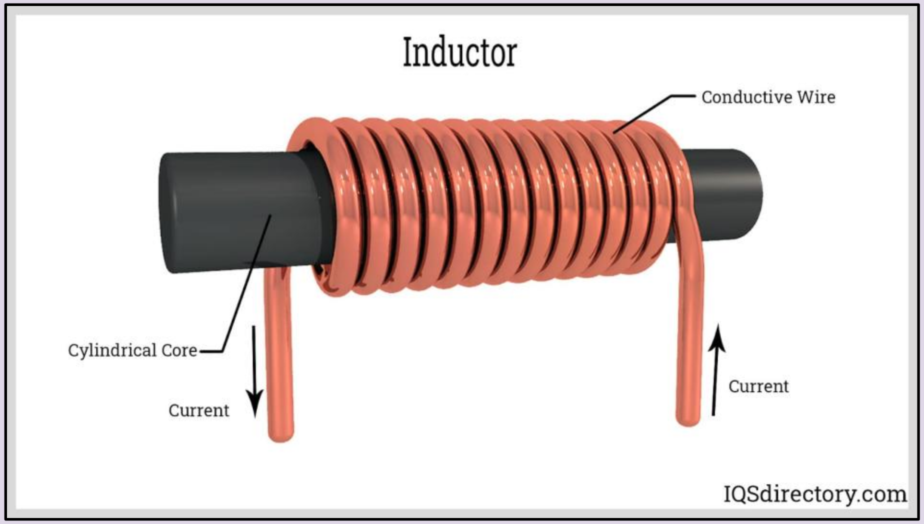

+
−
+
−


9V

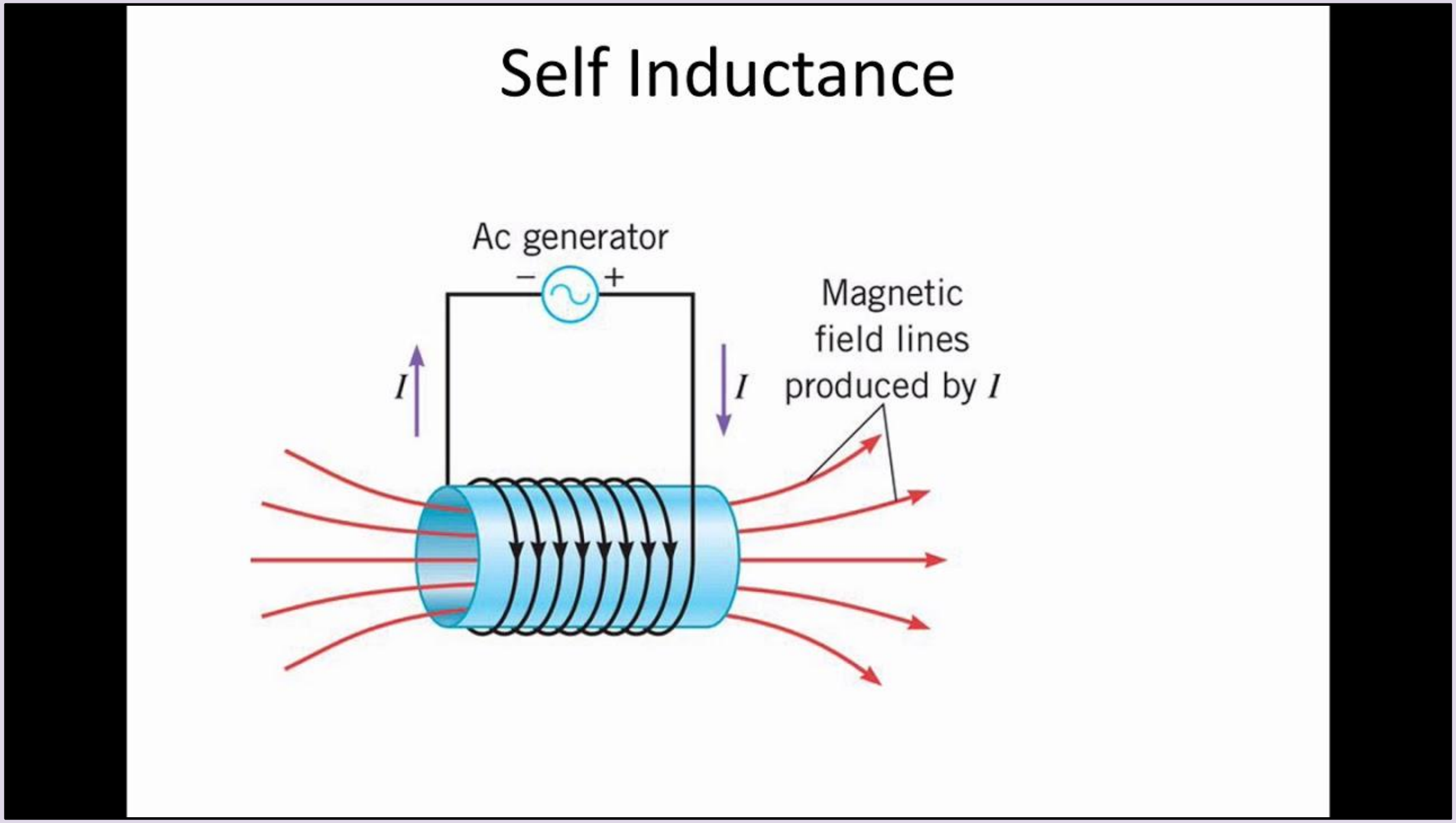
Inductor

An inductor, also called a coil, choke that stores energy in a magnetic field when electric current flows through it.
The SI unit -------- Henry (H),
and when we measure magnetic circuits,----------- Weber/ampere.



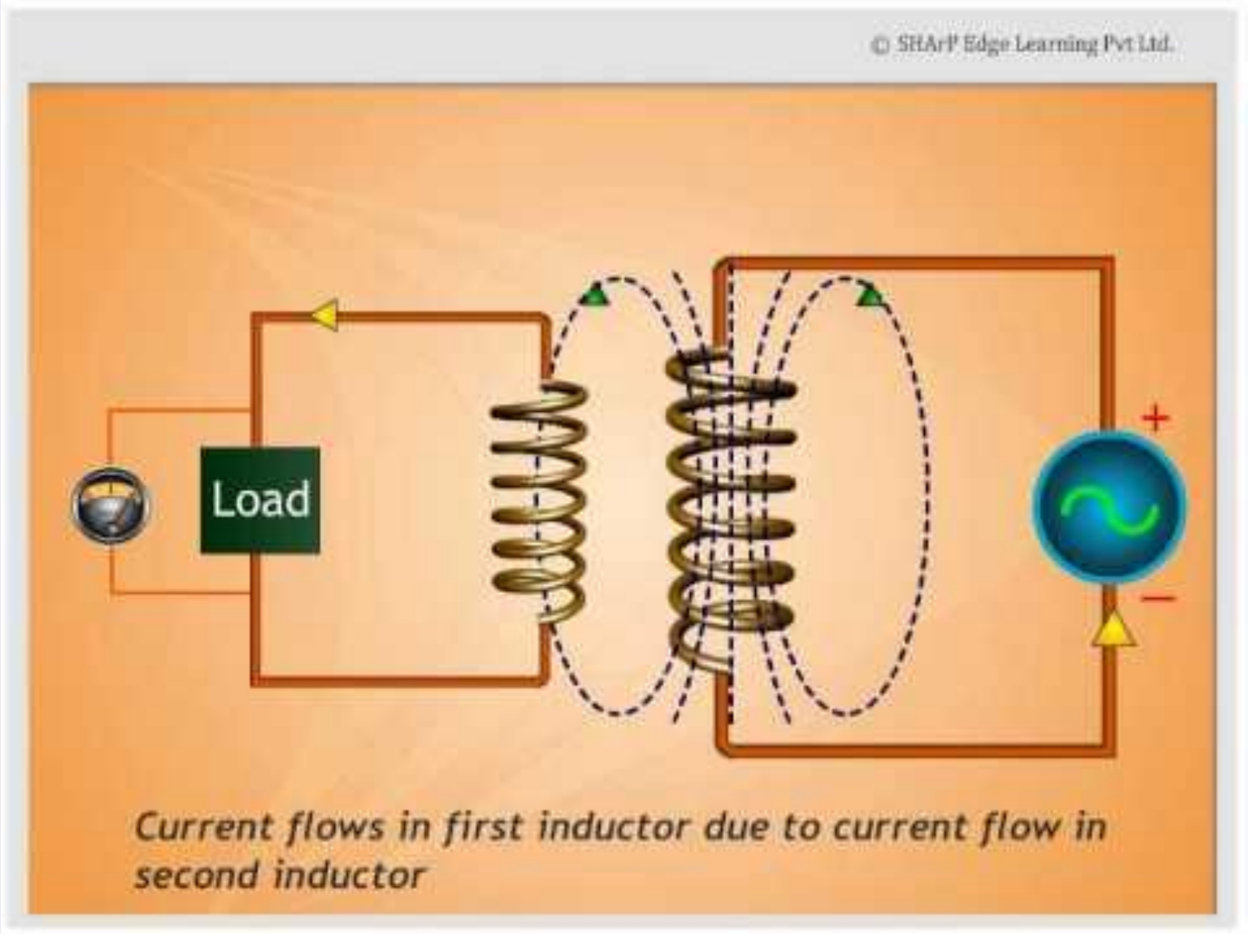


By Orsted

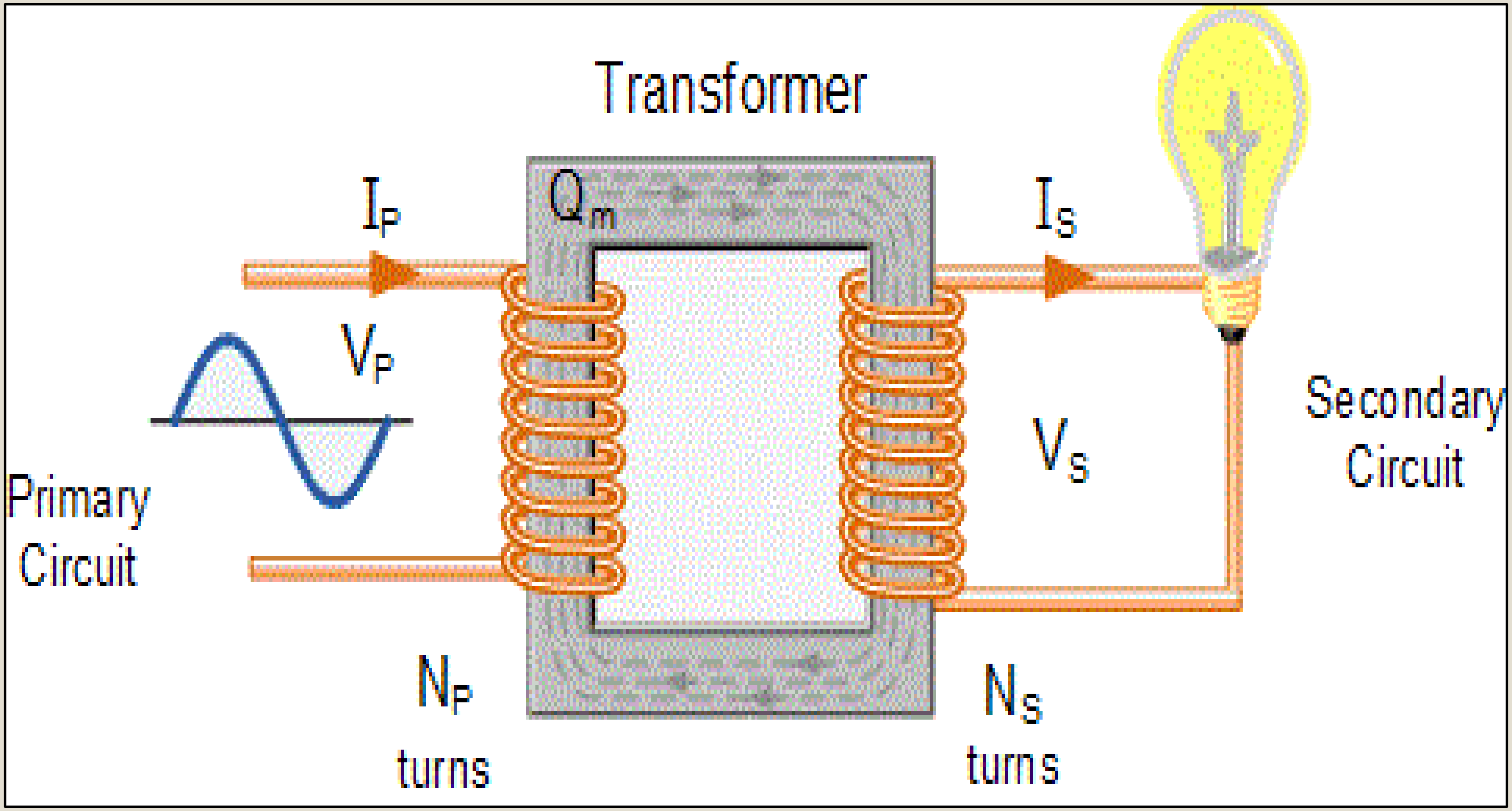


Induced e.m.f. $V_L = e = -L\,dI/dt$

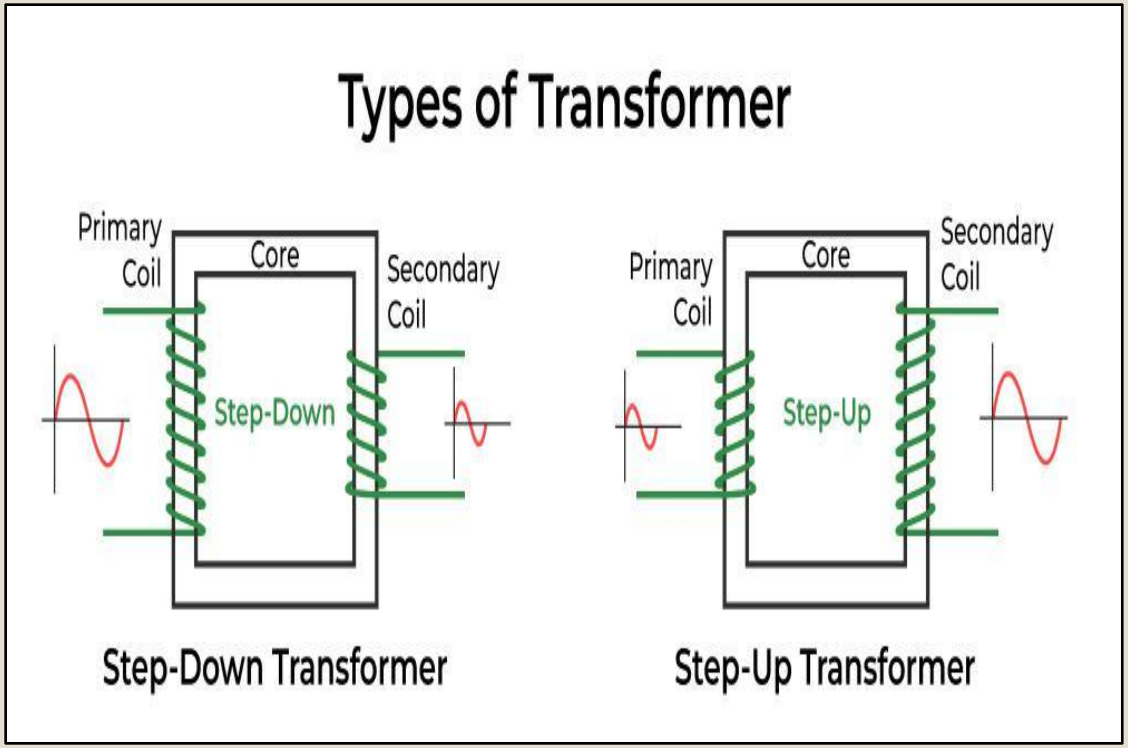
Mutual Induction



Induced e.m.f. $V_L = e = -M\, dI/dt$



A transformer is a static electrical device that transmits AC power from one circuit to another at a constant frequency, but the voltage level may be changed, implying the voltage can be increased or decreased depending on the requirement.



$$a = \frac{n_1}{n_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

where: a = turns ratio of transformer
n_1 = number of turns on primary
n_2 = number of turns on secondary
V_1 = primary voltage
V_2 = secondary voltage
I_1 = primary current
I_2 = secondary current

There are primarily two types of Transformer based on the operating voltage.

1. **Step-down Transformer:** The primary voltage is converted to a lower voltage across the secondary output using a step-down transformer.
2. **Step-up Transformer:** The secondary voltage of a step-up transformer is raised from the low primary voltage.

QUESTION : We have a transformer. No. of turns in primary coil is 20 and that of in secondary coil is 100. Primary voltage is 250 Volt. We have to find out :

1. Type of transformer
2. output voltage

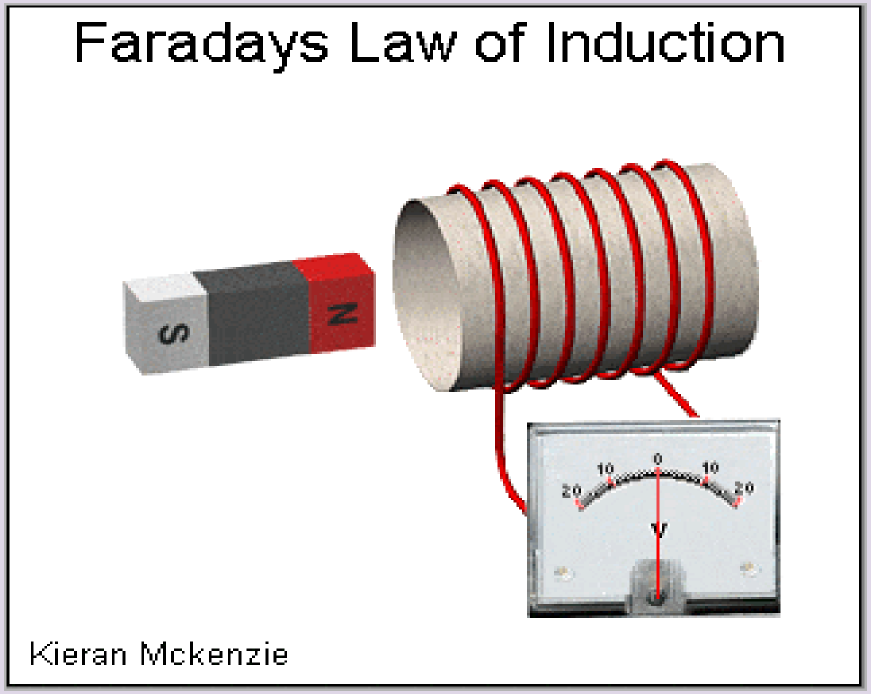
$$V_s = \frac{V_p N_s}{N_p}$$

$$V_s = \frac{(250\ V)(100)}{20}$$

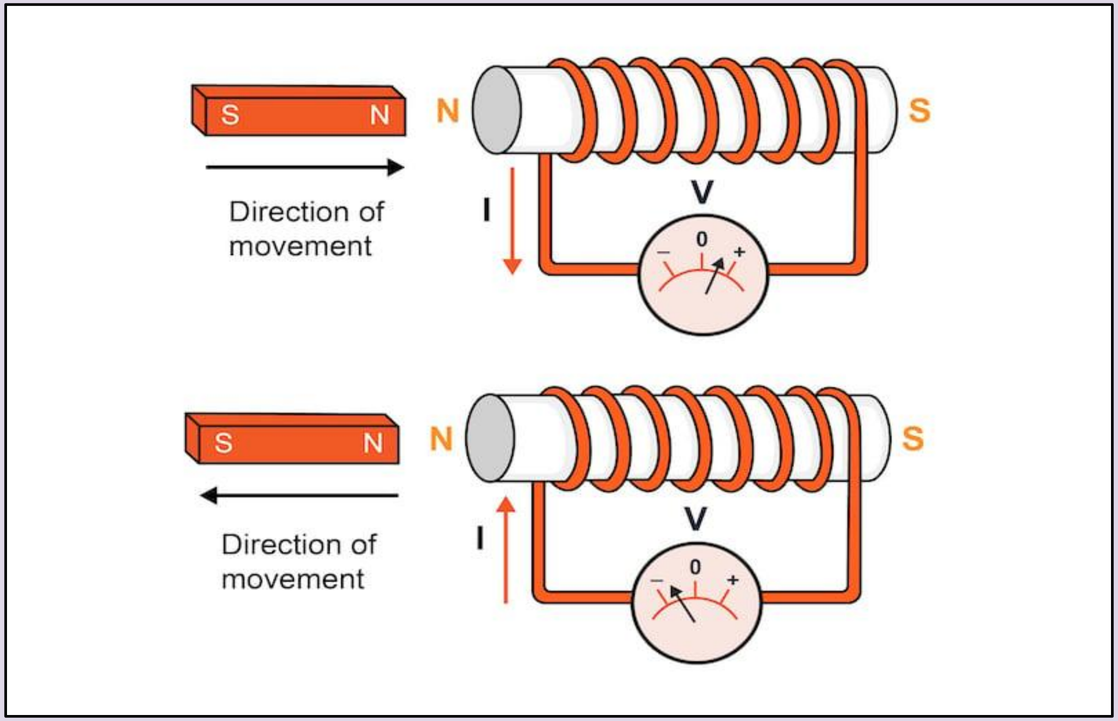
$$V_s = 1250\ volts$$

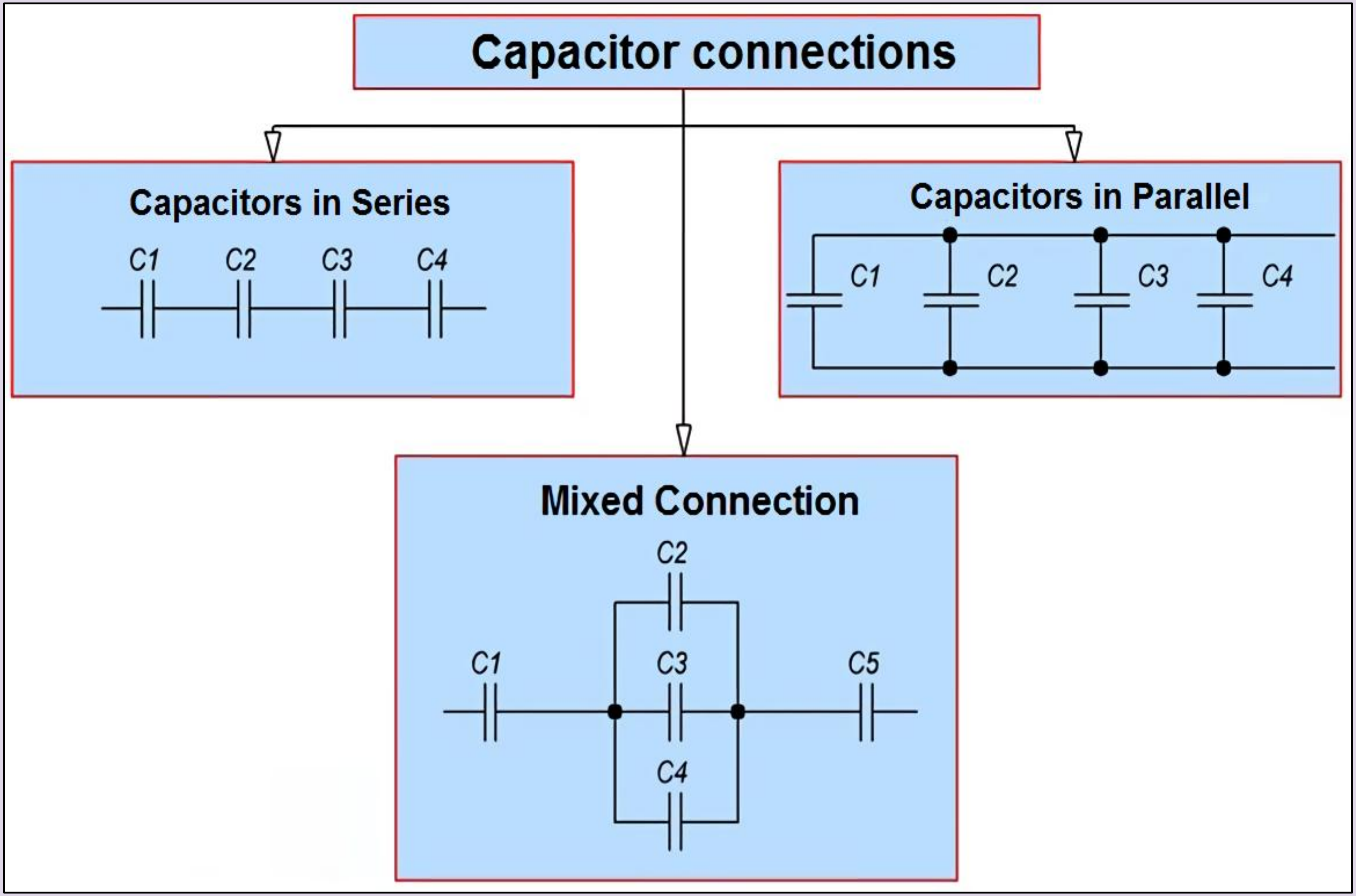
QUESTION : A transformer enhances the 220 volt A.C. mains voltage to 2200 volt. If there are 2000 turns in secondary coil of transformer then calculate the number of turns in primary coil.

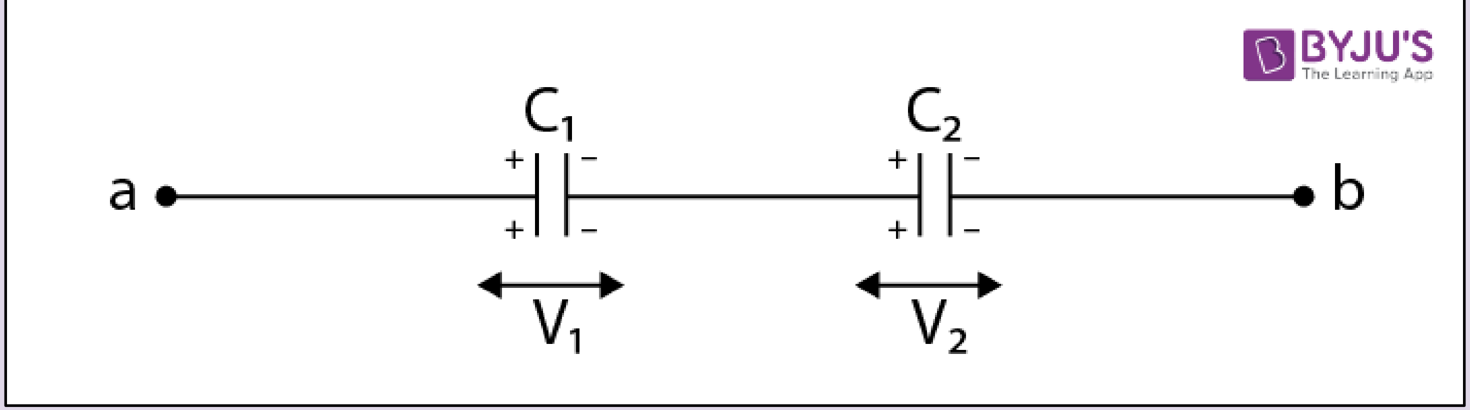
Answer = 200



Practical Work




Capacitor connections
Capacitors in Series
C1
C2
C3
C4
Capacitors in Parallel
C1
C2
C3
C4
Mixed Connection
C2
C1
C3
C5
C4

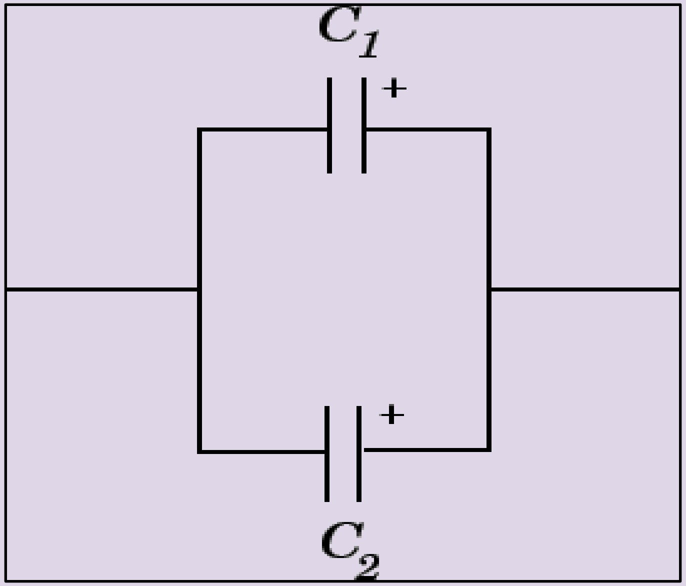


$Q = C_1 V_1 = C_2 V_2$

$V = V_1 + V_2$

The equivalent capacitance C is given by:

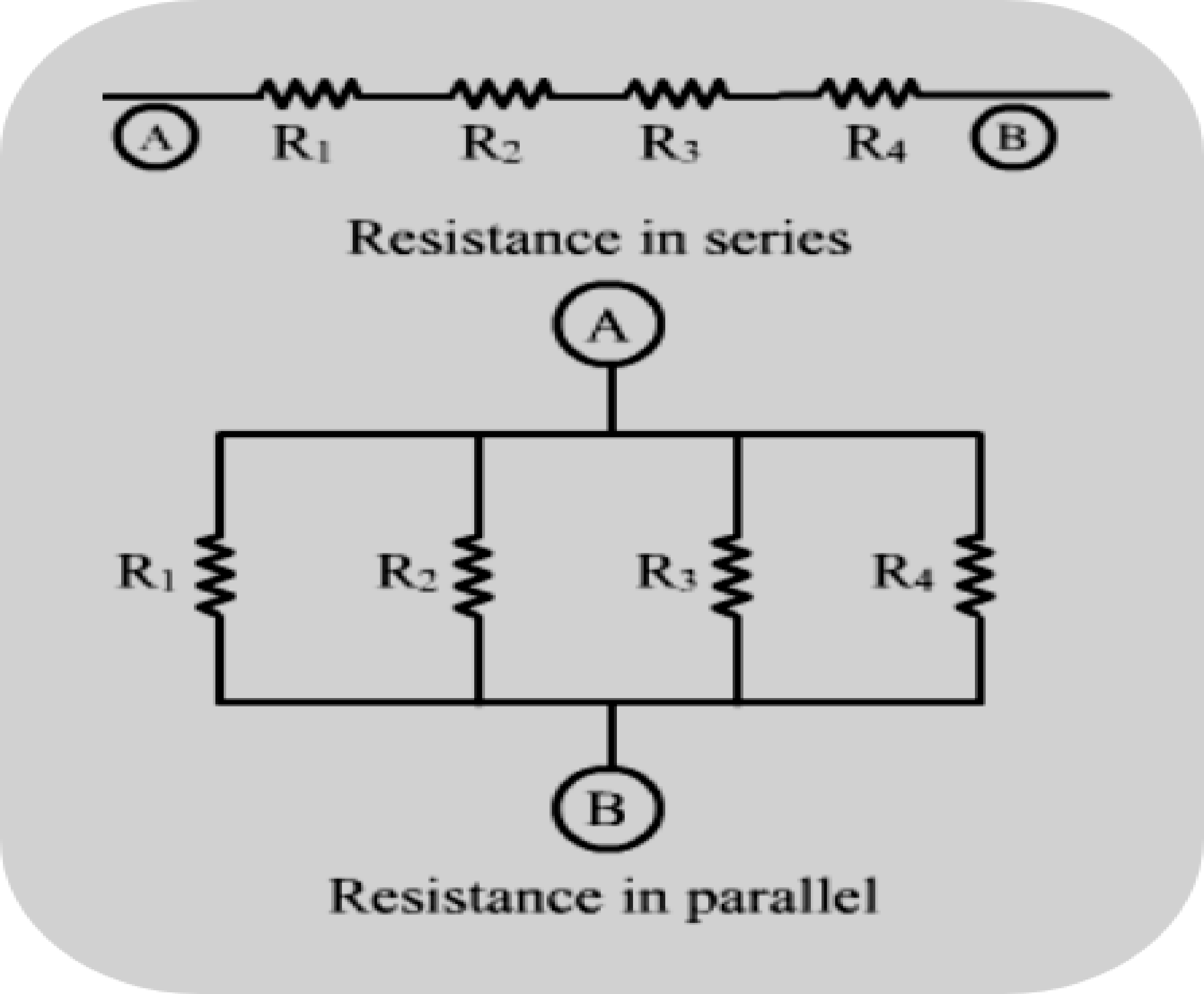
1/C = 1/C1 + 1/C2



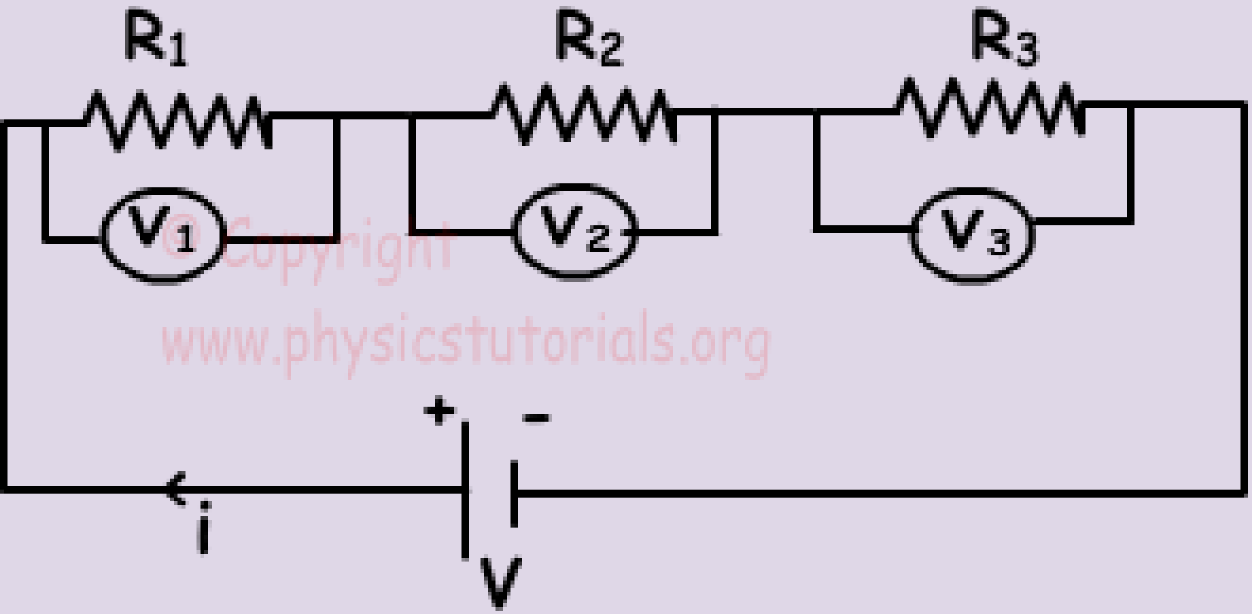
The equivalent capacitance C is given by:

C = C1 + C2

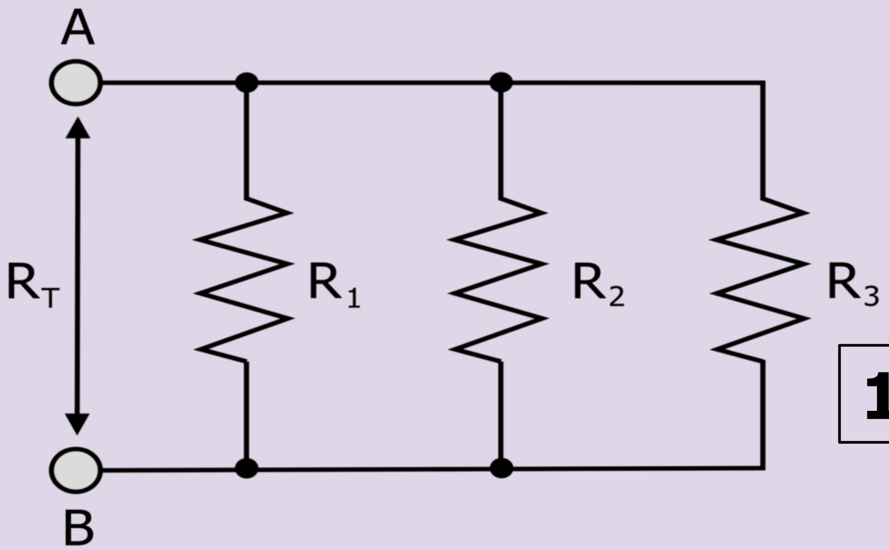
Resistance Combination



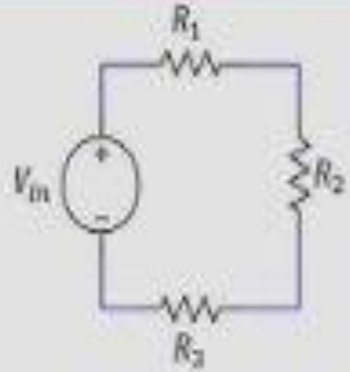
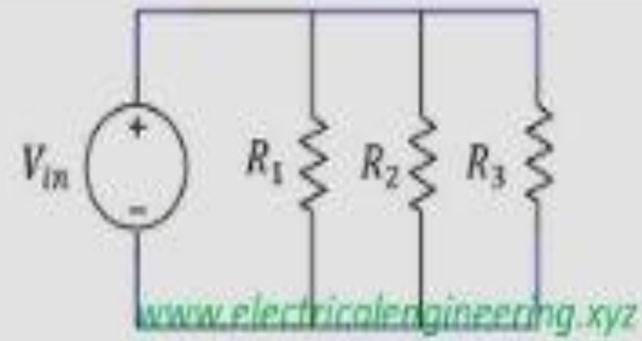
Resistance series combination

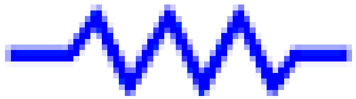
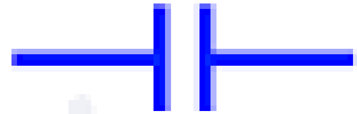
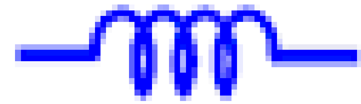


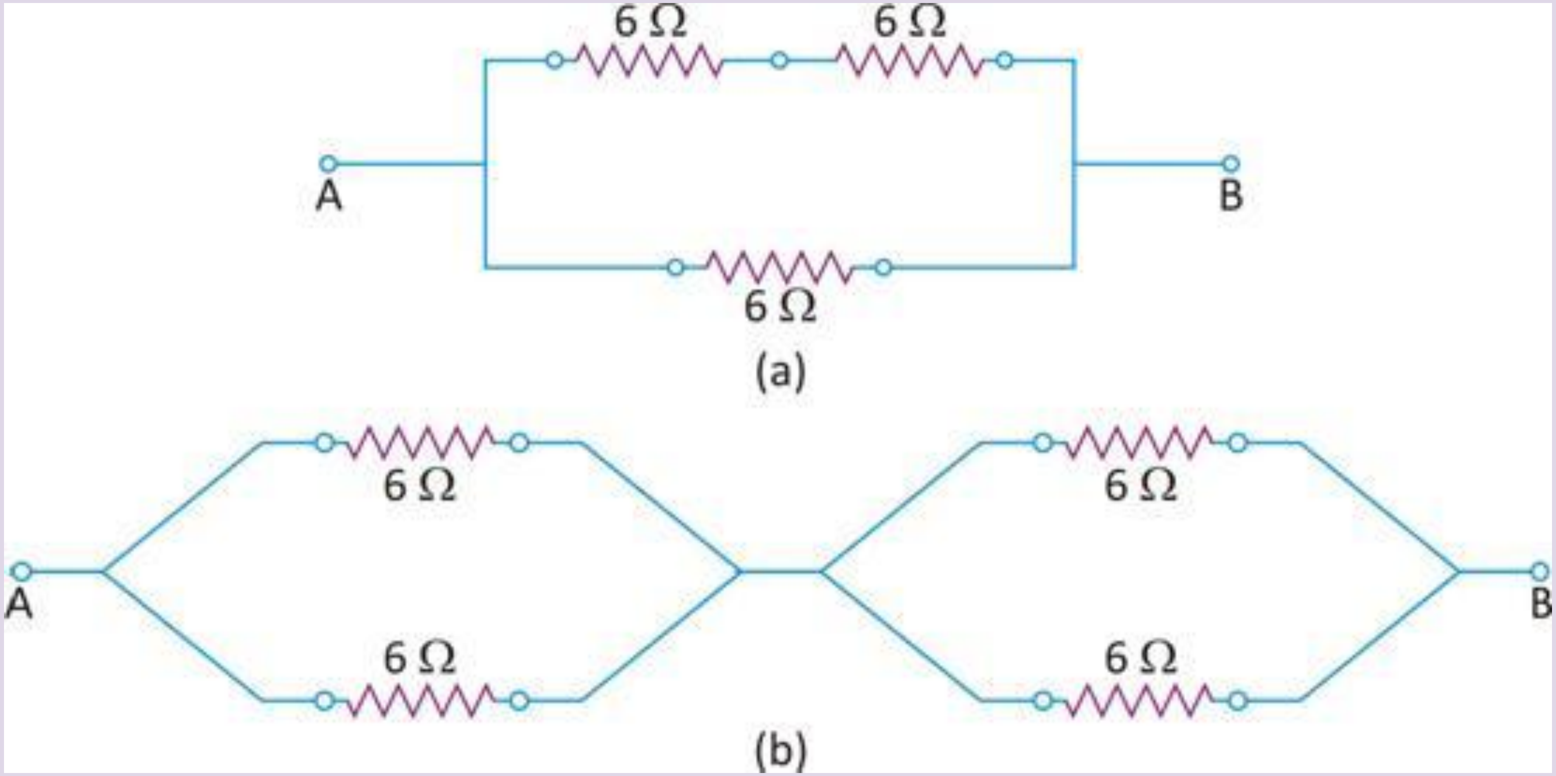
R = R1+R2+R3



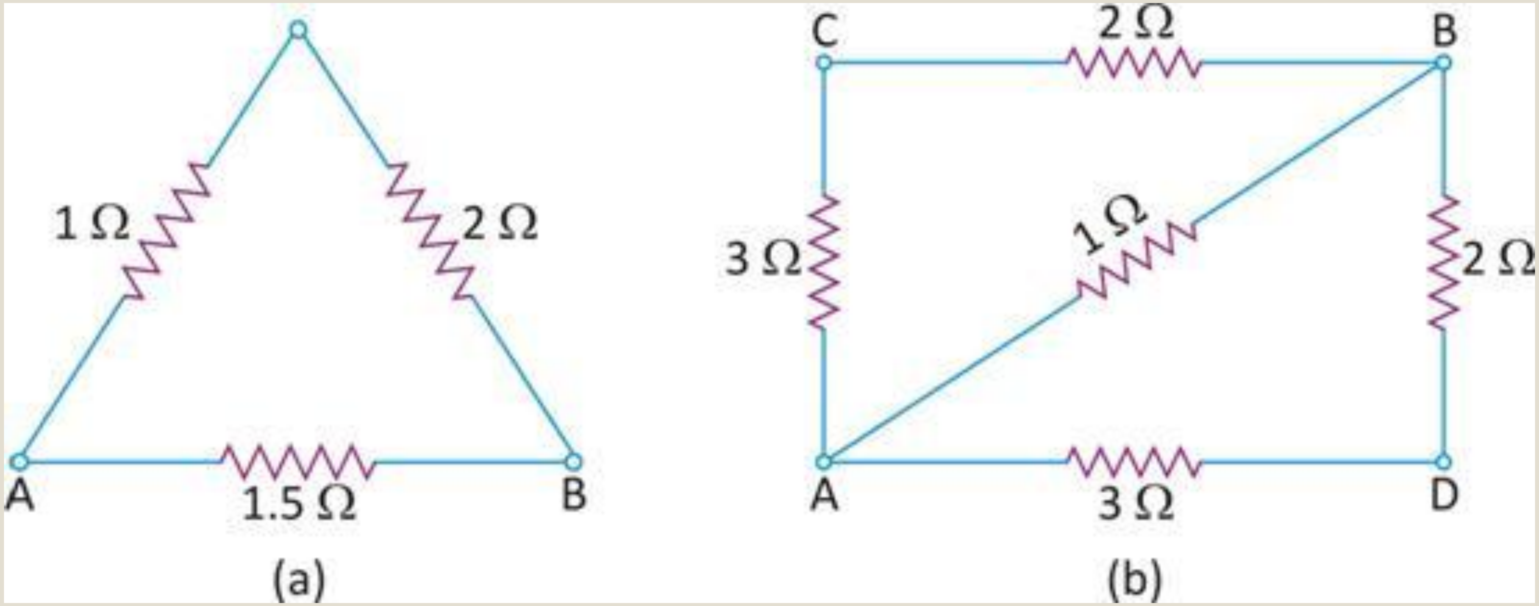
1/R = 1/R1+1/R2+1/R3

	Series	Parallel
How it looks		
Voltage	$V_{in} = V_1 + V_2 + V_3$	$V_{in} = V_1 = V_2 = V_3$
Current	$I_{series} = I_1 = I_2 = I_3$	$I_{in} = I_1 + I_2 + I_3$
Resistance	$R_{eq} = R_1 + R_2 + R_3$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
Features	If one components burns current becomes inactive	If one component burns current stops only through that branch rest part works fine

Elements	RESISTOR	CAPACITOR	INDUCTOR
Symbol			
Denoted by	R	C	L
Equation	$R = \frac{V}{I}$	$C = \frac{Q}{V}$	$L = \frac{V_L}{(di/dt)}$
Series	$R_T = R_1 + R_2$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$	$L_T = L_1 + L_2$
Parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$	$C_T = C_1 + C_2$	$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2}$



a. 4 ohm
b. 6 ohm



a. 1 ohm
b. 5/7 or 0.71 ohm

Semiconductors

- Intrinsic
  Ge, Si
- Extrinsic

P-type = 1. Intrinsic semiconductor + trivalent impurity

2. majority charge carrier electron

3. Doner energy level near bottom of CB

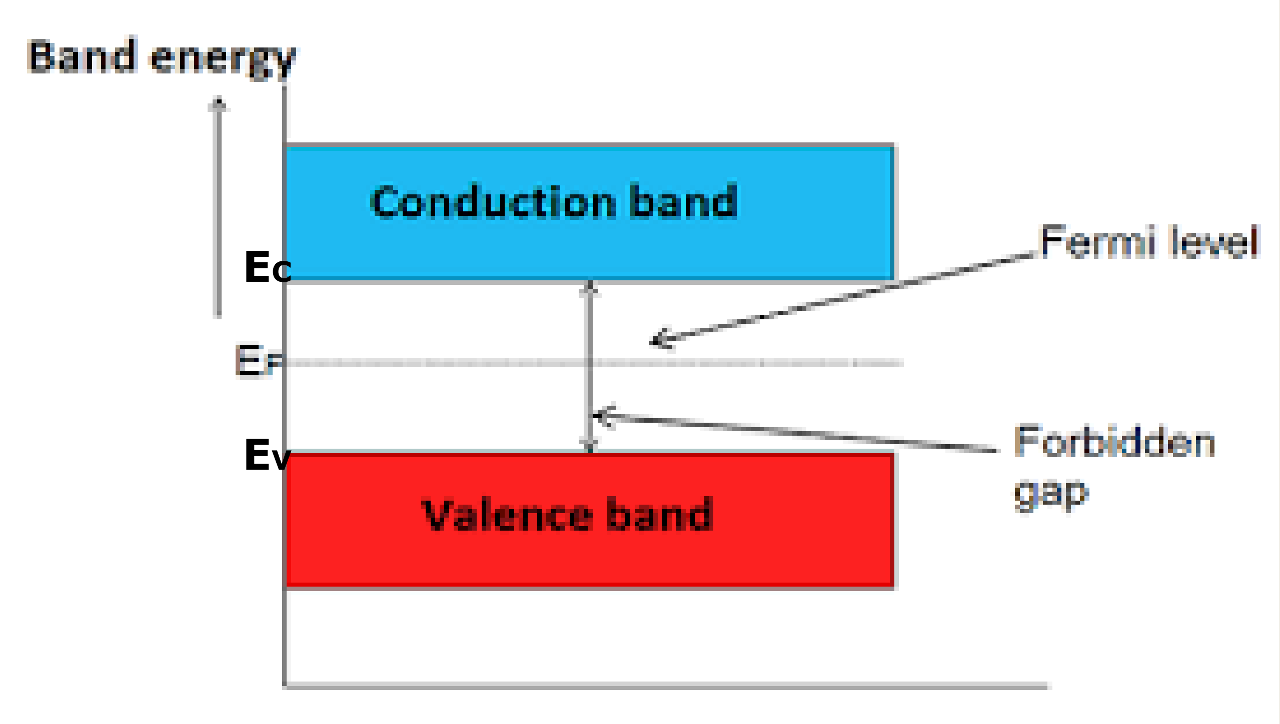
N-type = 1. Intrinsic semiconductor + Penta-valent impurity

2. majority charge carrier hole

3. acceptor energy level near top of VB

N-type semiconductor	P-type semiconductor
It is type extrinsic semiconductor.	It also type of extrinsic semiconductor.
In N-type semiconductor, electrons are majority carriers and holes are minority carriers.	In P-type semiconductor, holes are majority carriers and electrons are minority carriers.
It has Larger electron concentration and less hole concentration.	It has Larger hole concentration and less electron concentration.
Pentavalent impurities are added.	Trivalent impurities are added.
It has donor energy levels very close to conduction band.	It has acceptor energy levels very close to valance band.

Fermi Level In Intrinsic Semiconductor

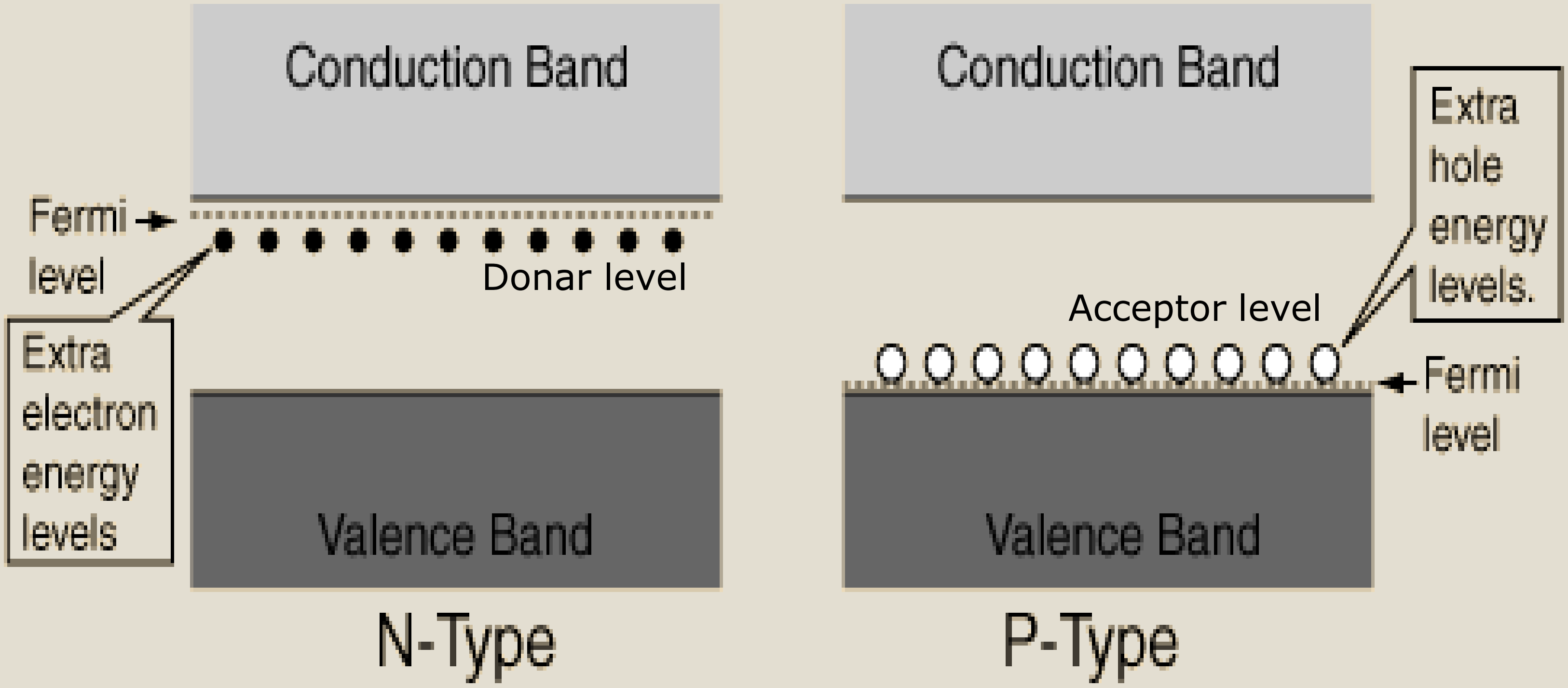


यदि संयोजी बैंड की अधिकतम ऊर्जा E_v तथा चालन बैंड की न्यूनतम ऊर्जा E_c हो, तो फर्मी स्तर की ऊर्जा

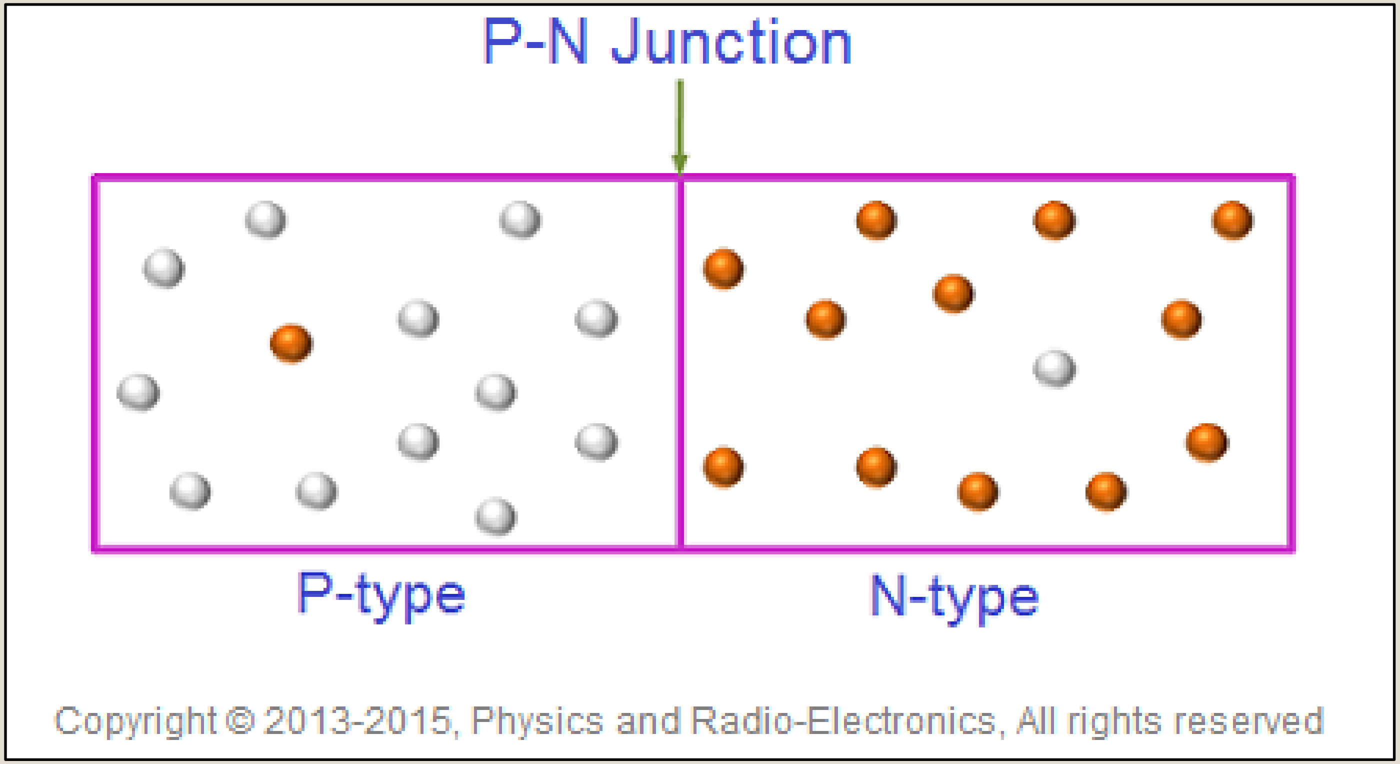
$$E_F = \frac{E_c + E_v}{2}.$$

Fermi Level In Extrinsic Semiconductor

In n-type material there are electron energy levels near the top of the band gap so that they can be easily excited into the conduction band. In p-type material, extra holes in the band gap allow excitation of valence band electrons, leaving mobile holes in the valence band.

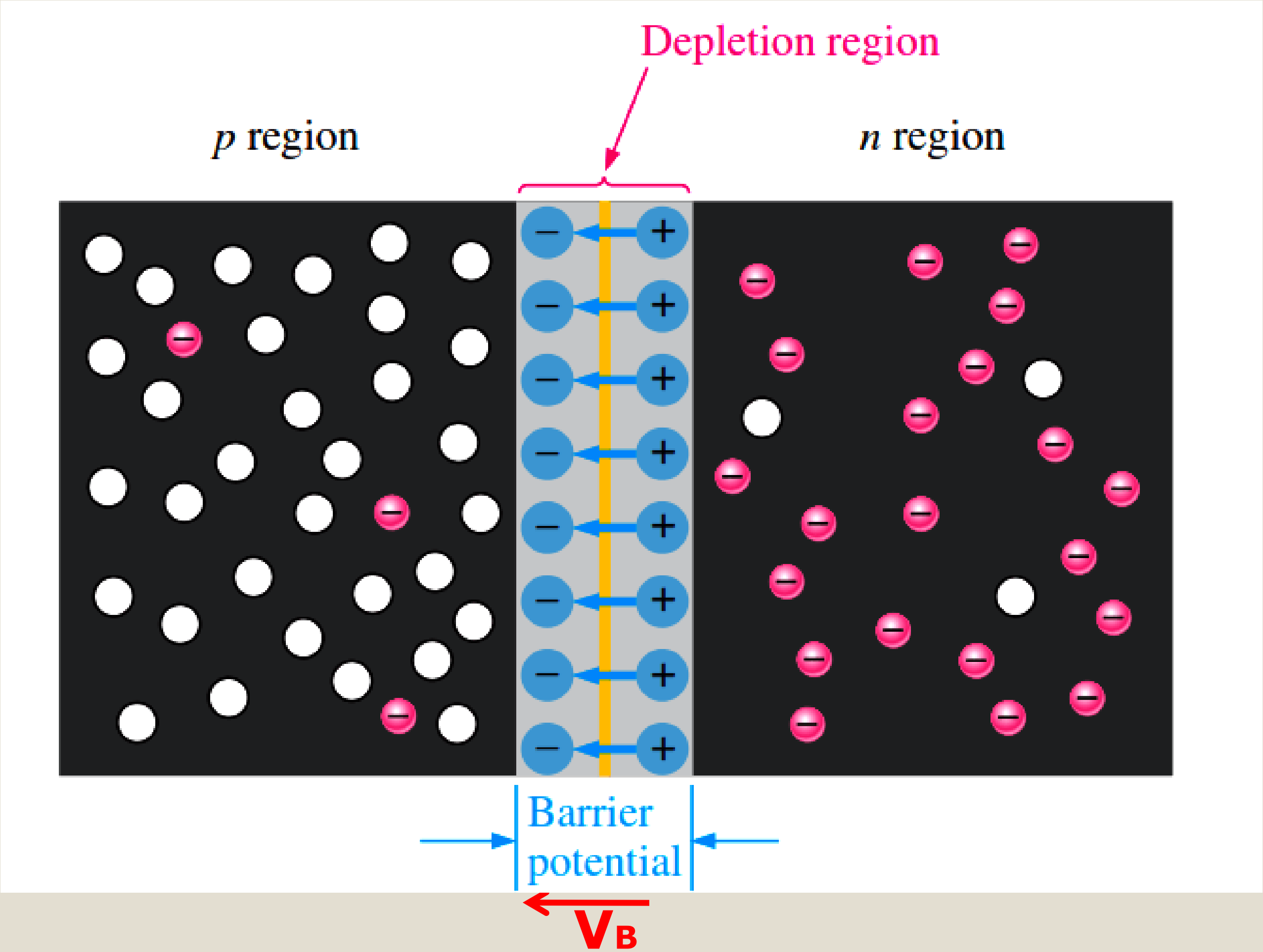


PN Junction and Depletion Layer



जब **P**-प्रकार के अर्धचालक को एक **N**- प्रकार के अर्धचालक से परमाण्वीय स्तर पर इस प्रकार जोड़ दिया जाए कि सम्पर्क तल के परमाणु एक दूसरे से मिल जाए तो इस प्रकार बने सम्पर्क तल को **P-N संधि** कहते **हैं**। इस युक्ति को **P-N संधि डायोड** कहते **हैं**।

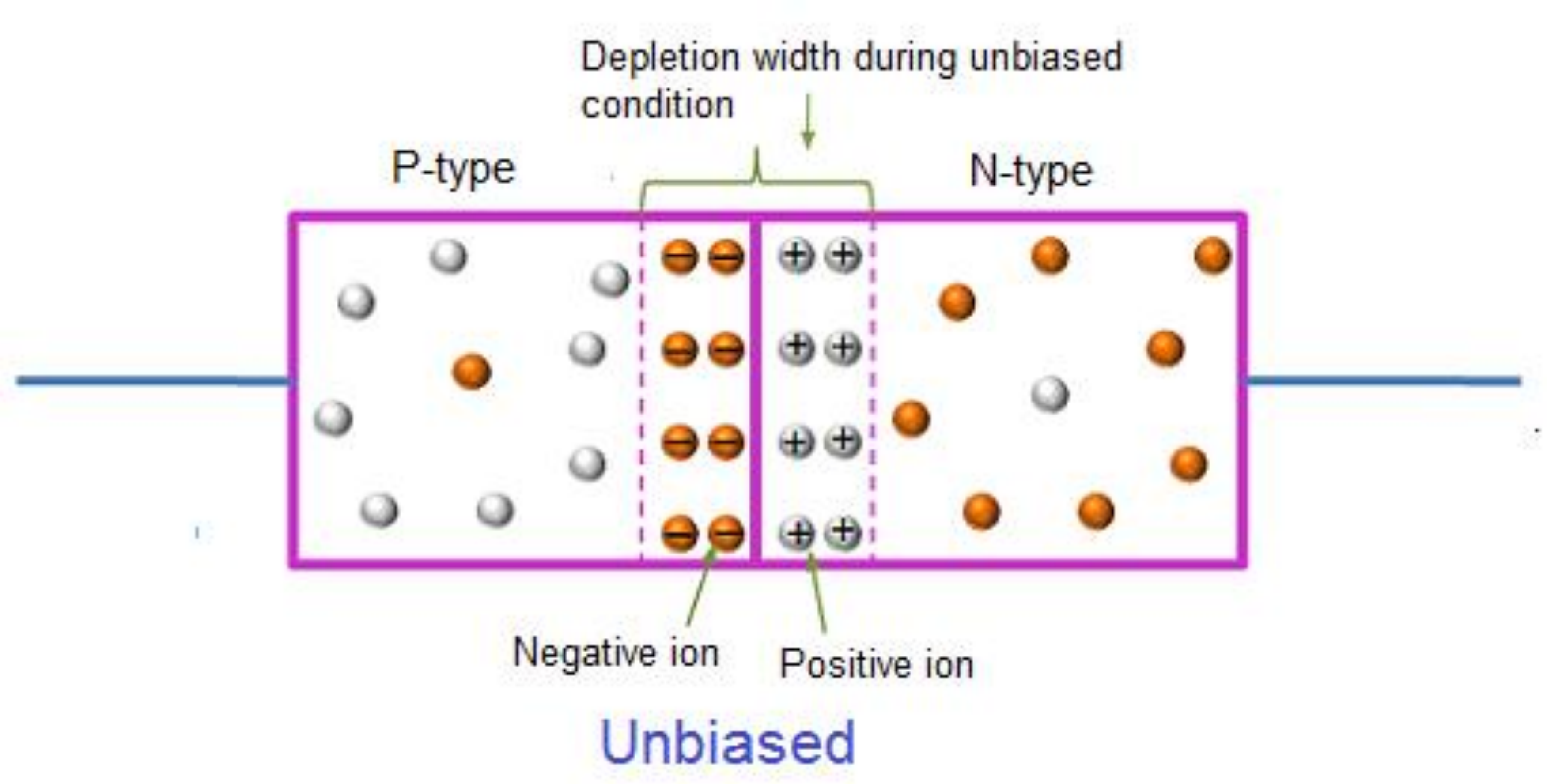
P भाग से होल तथा N भाग से इलेक्ट्रॉन आपस में मिलकर उदासीन **पर्त** का निर्माण करते हैं । इसे **अवक्षय पर्त** कहते हैं



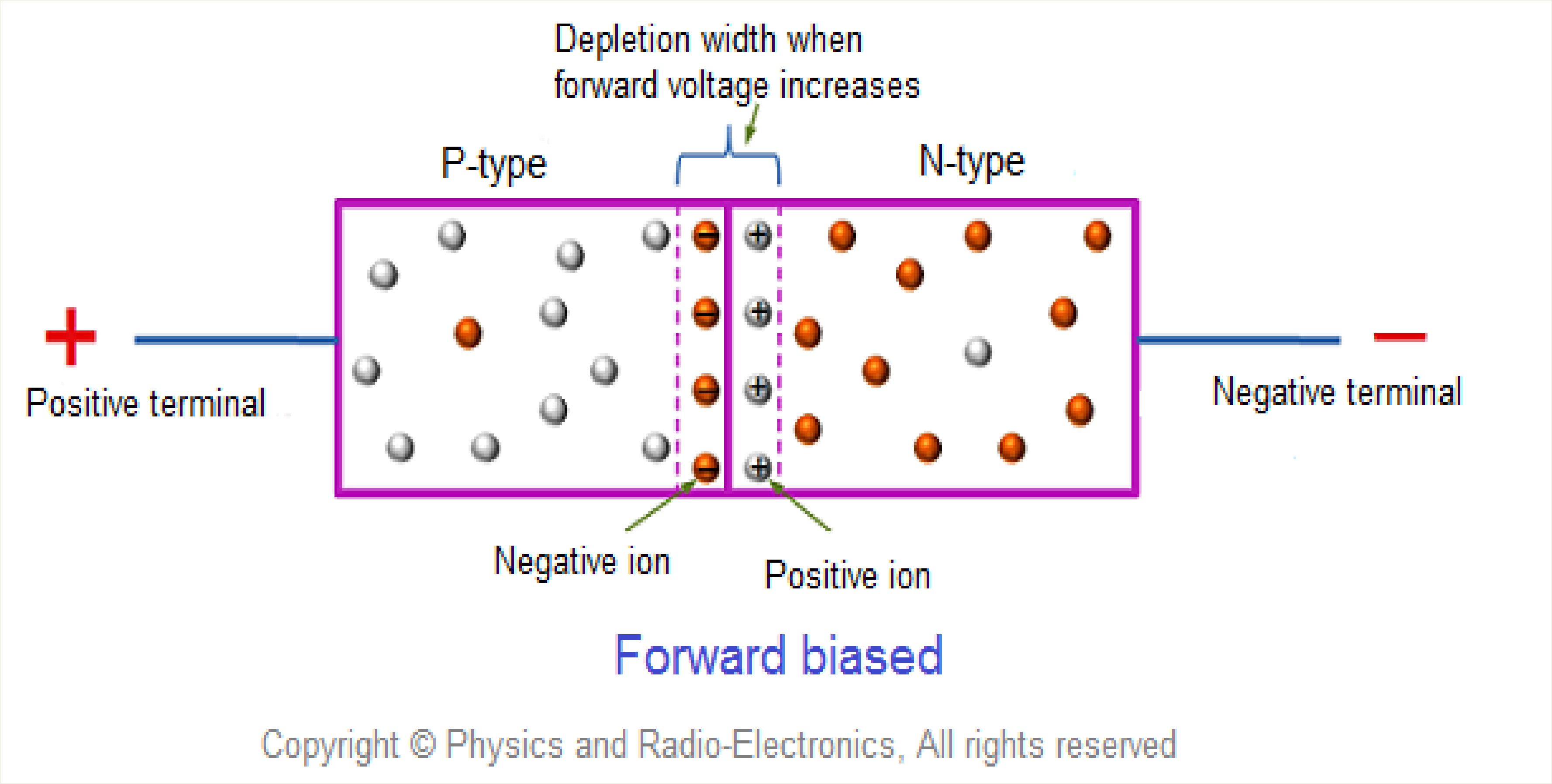
1. अवक्षय पर्त (Depletion region)
2. रोधिका विभव (Potential Barrier)

Effect of Biasing

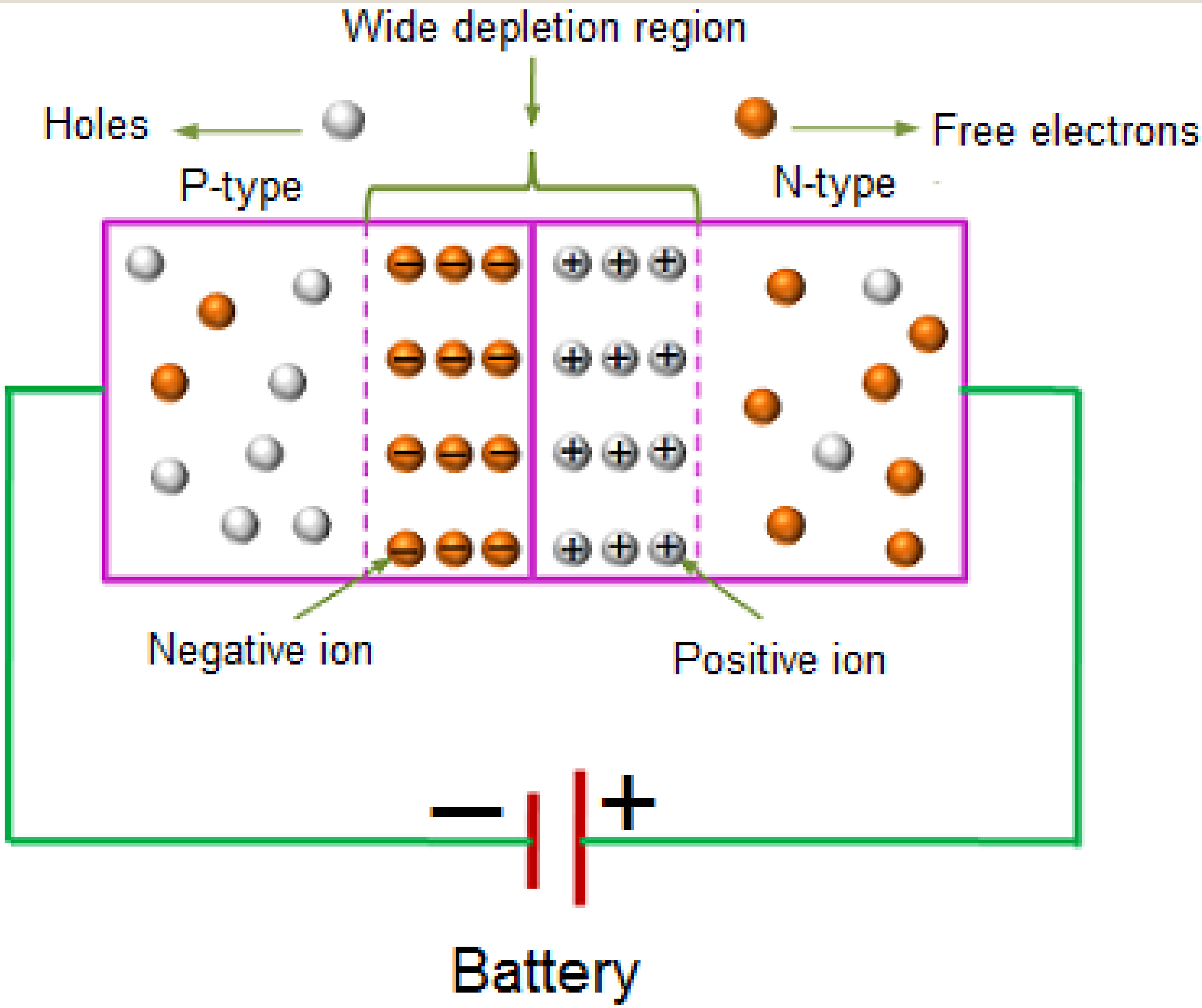
Condition – I unbiased



Condition – II Forward biased



Condition – III Reverse biased



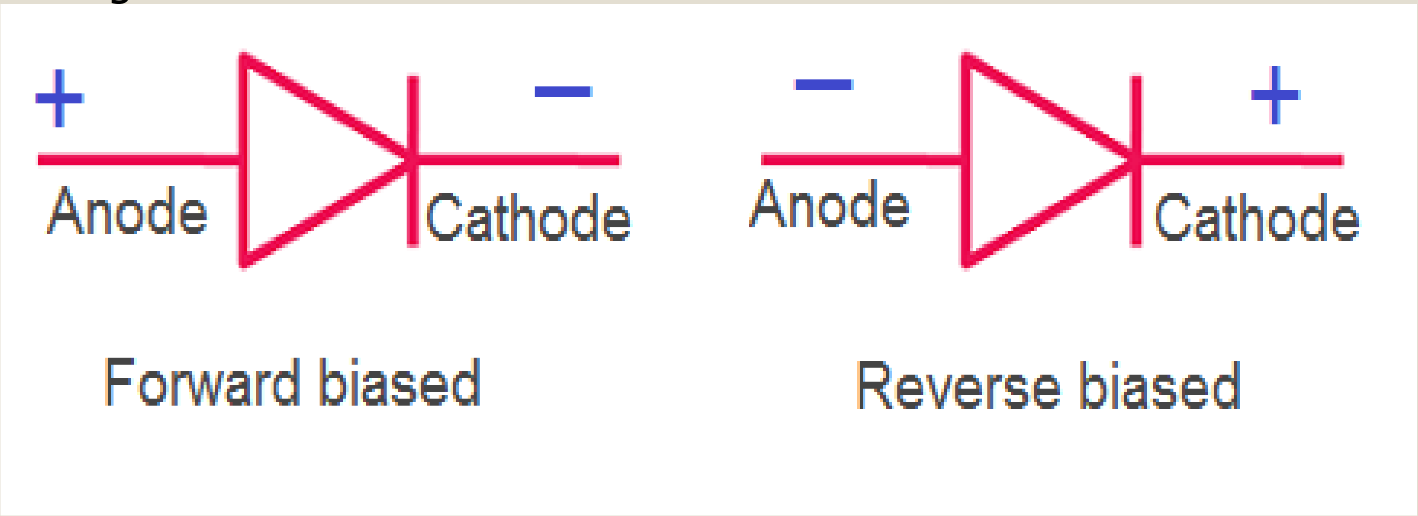
Reverse bias

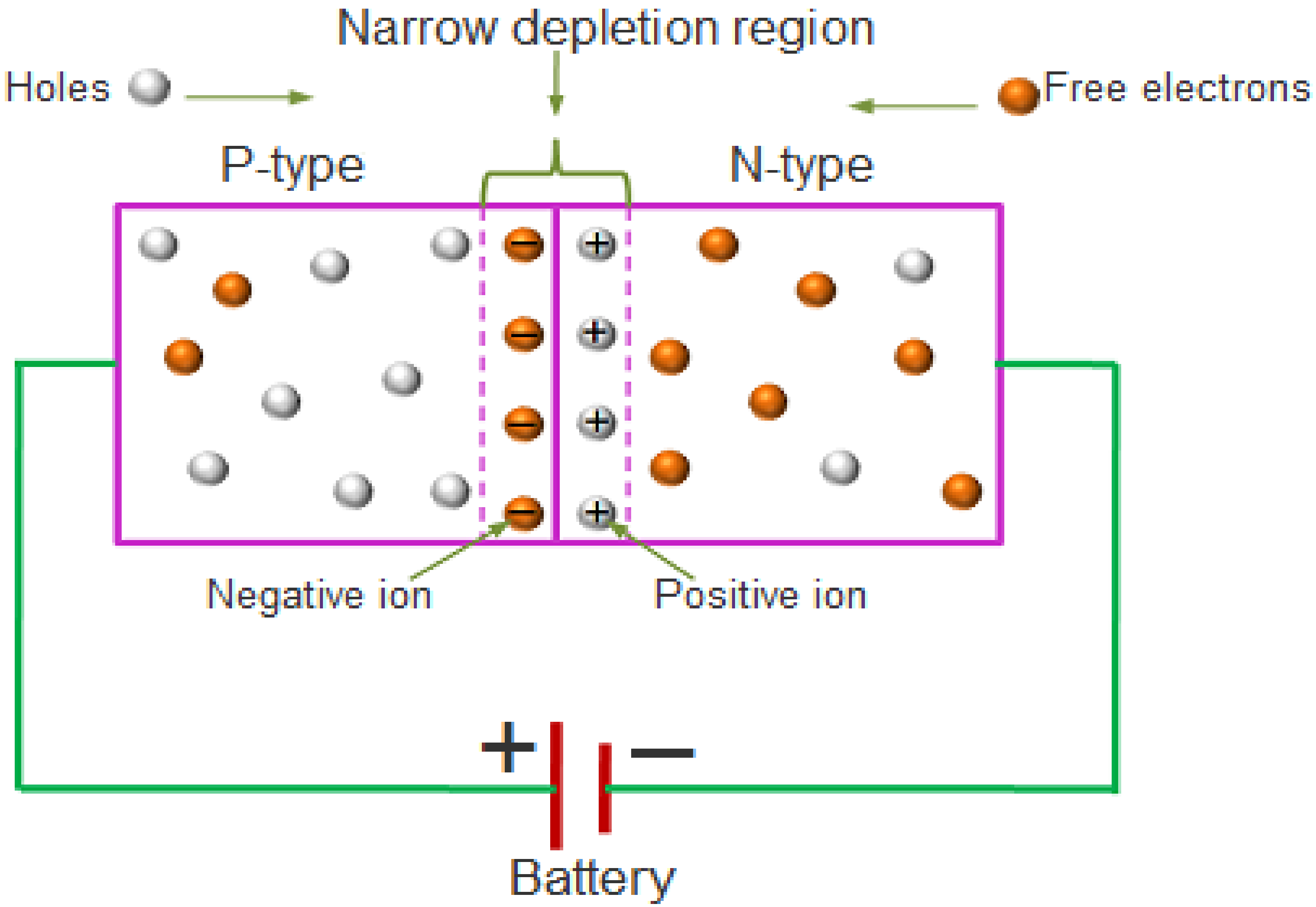
p-n junction semiconductor diode

A p-n junction diode is two-terminal semiconductor device, which allows the electric current in only one direction. If the diode is forward biased, it allows the electric current flow. On the other hand, if the diode is reverse biased, it blocks the electric current flow.

PN संधि डायोड दो टर्मिनल वाली ऐसी अर्धचालक युक्ति है जो केवल अग्र अभिनती में ही संधि से विद्‌युत्‌ धारा को प्रवाहित करता अर्थात धारा का प्रवाह डायोड से केवल एक ही दिशा में होता है.

The basic symbol of p-n junction diode under forward bias and reverse bias is shown in the below figure





Forward bias

Forward bias V-I characteristics of diode

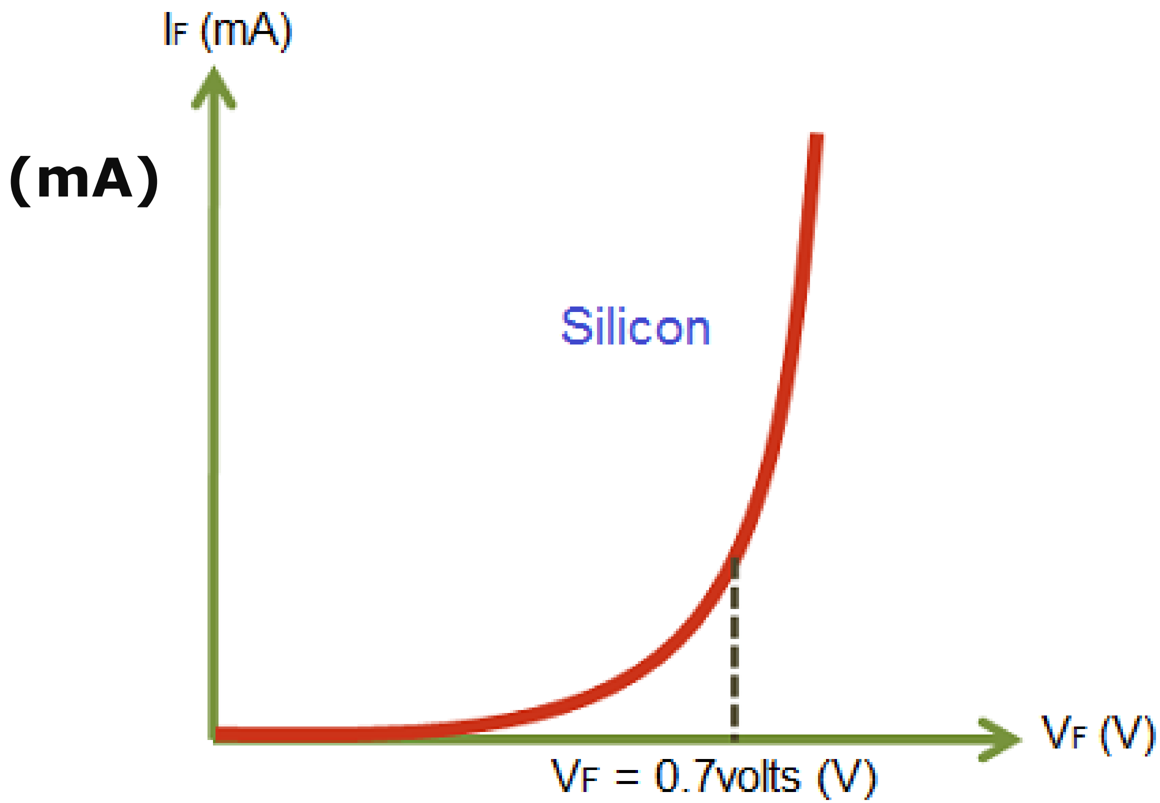
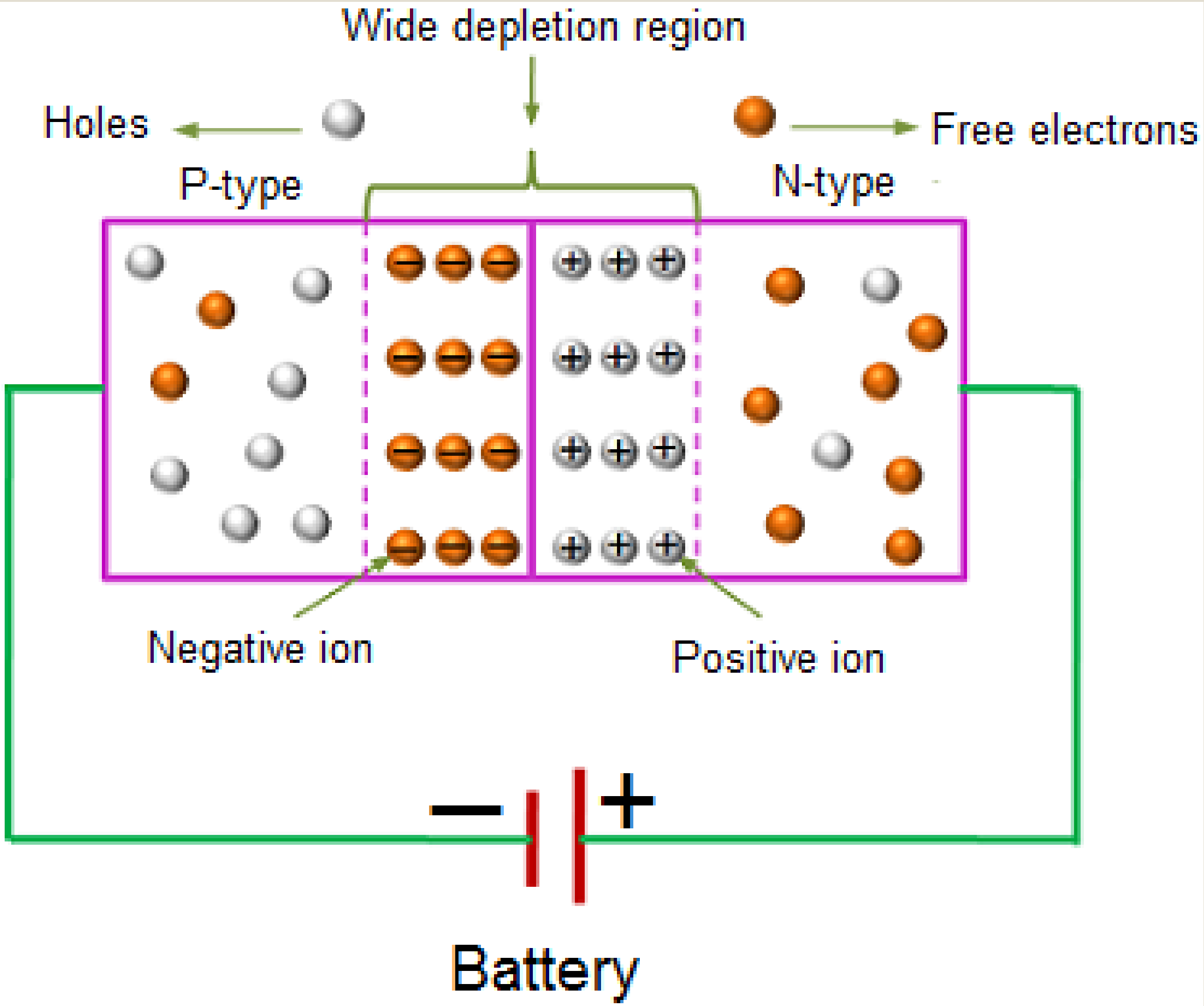


Fig: Forward characteristics of silicon diode



Reverse bias

Reverse bias V-I characteristics of p-n junction diode

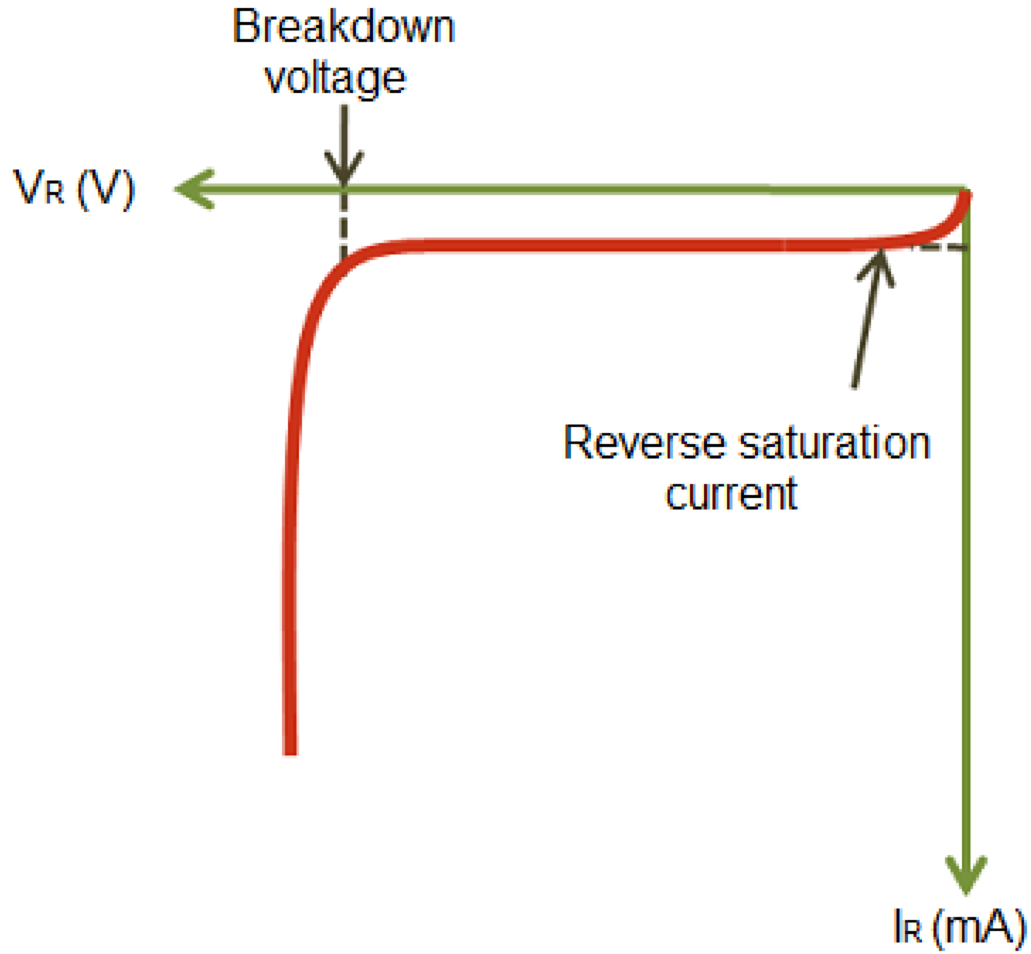
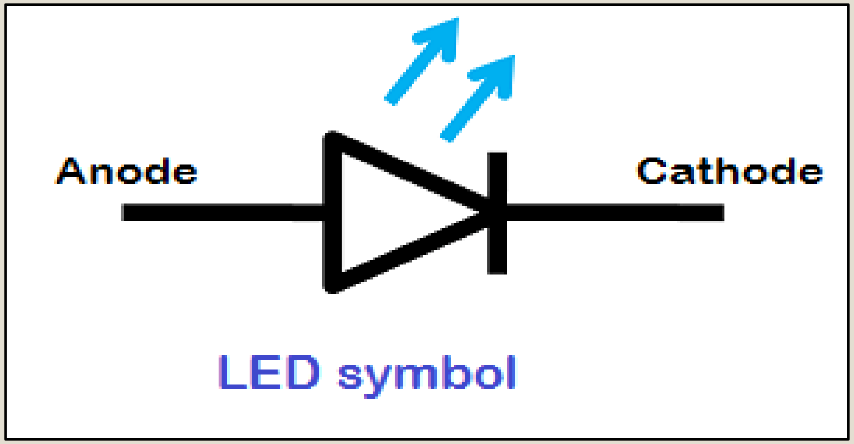
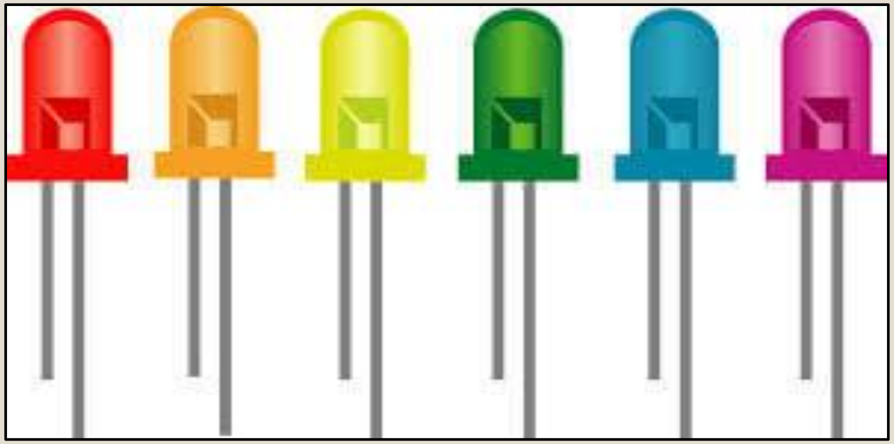


Fig: Reverse characteristics of diode

Light Emitting Diode (LED)

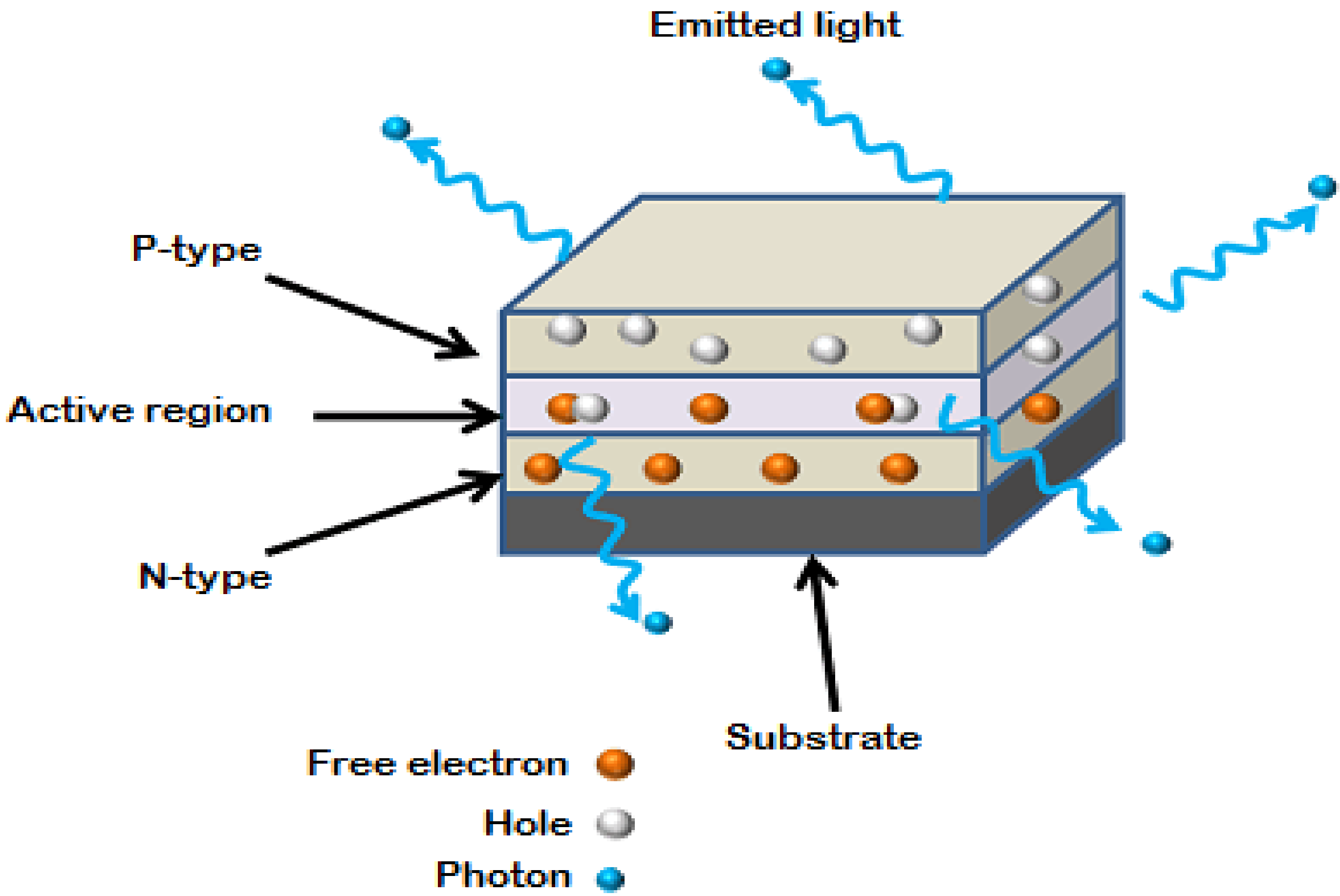
A light Emitting Diode (LED) is an optical semiconductor device that emits light when voltage is applied. In other words, LED is an optical semiconductor device that converts electrical energy into light energy.





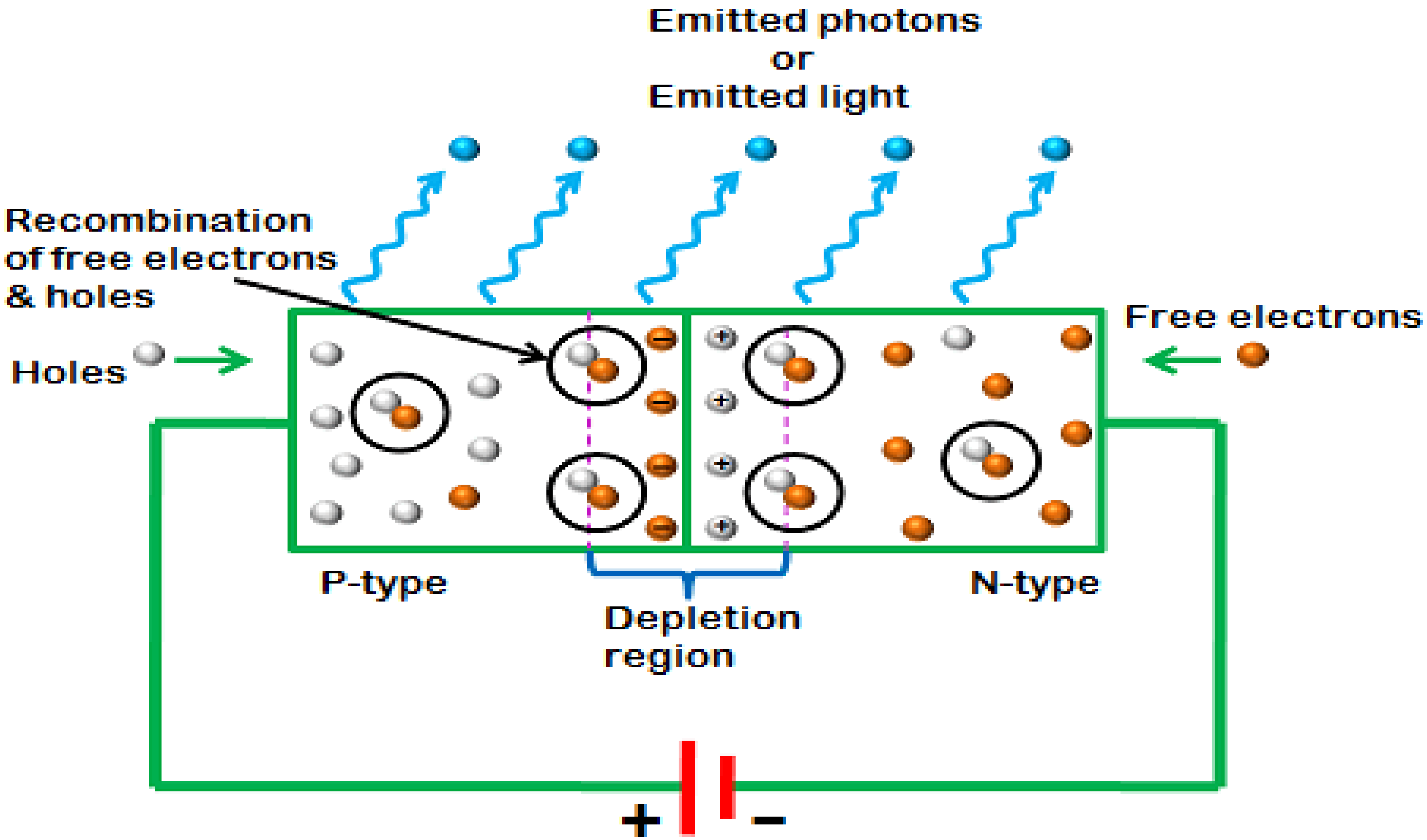
When Light Emitting Diode (LED) is forward biased, free electrons in the conduction band recombines with the holes in the valence band and releases energy in the form of light.

LEDs also operates only in forward bias condition. The construction of LED is similar to the normal p-n junction diode except that gallium, phosphorus and arsenic materials are used for construction instead of silicon or germanium materials.



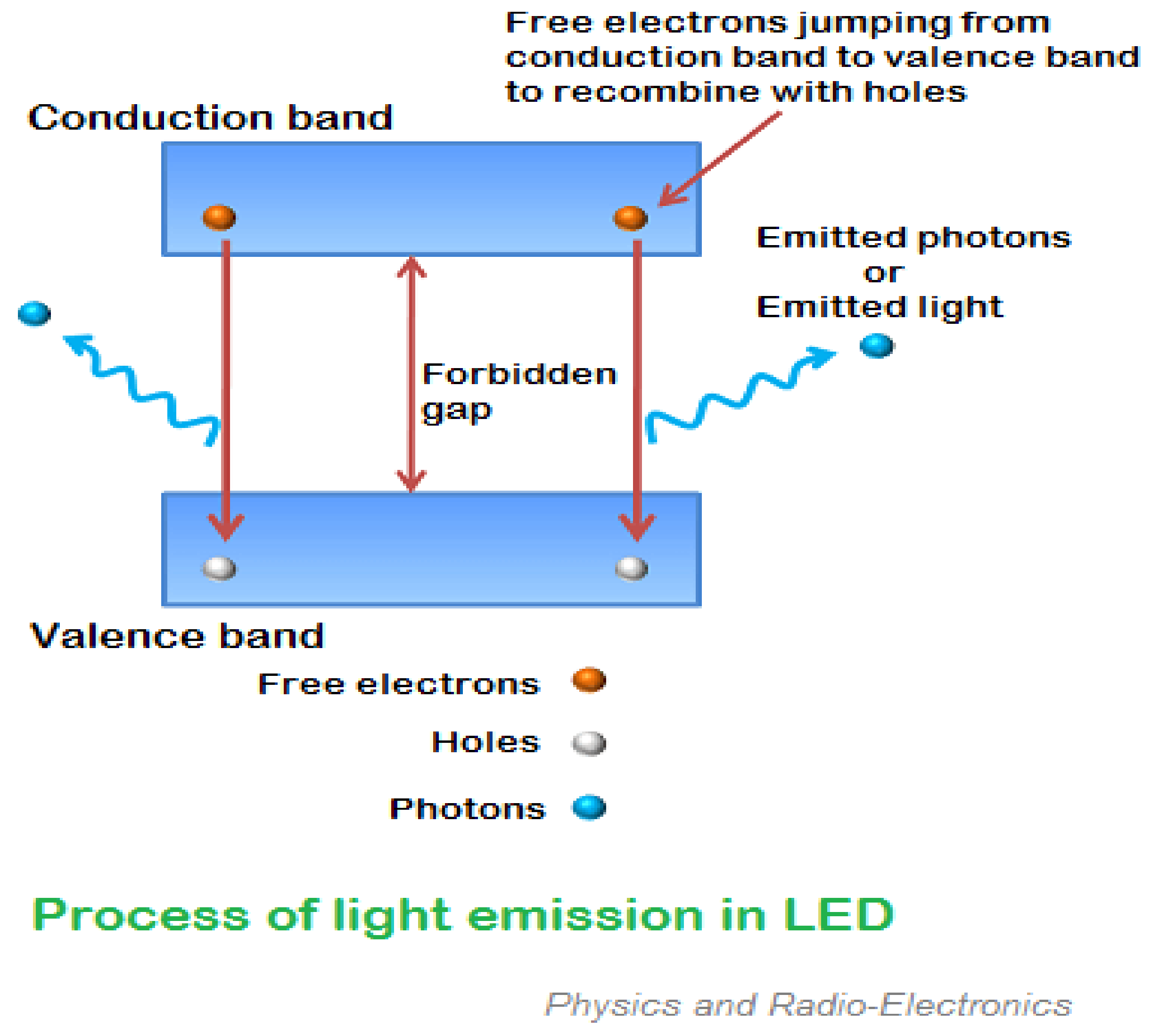
Construction of LED

Physics and Radio-Electronics



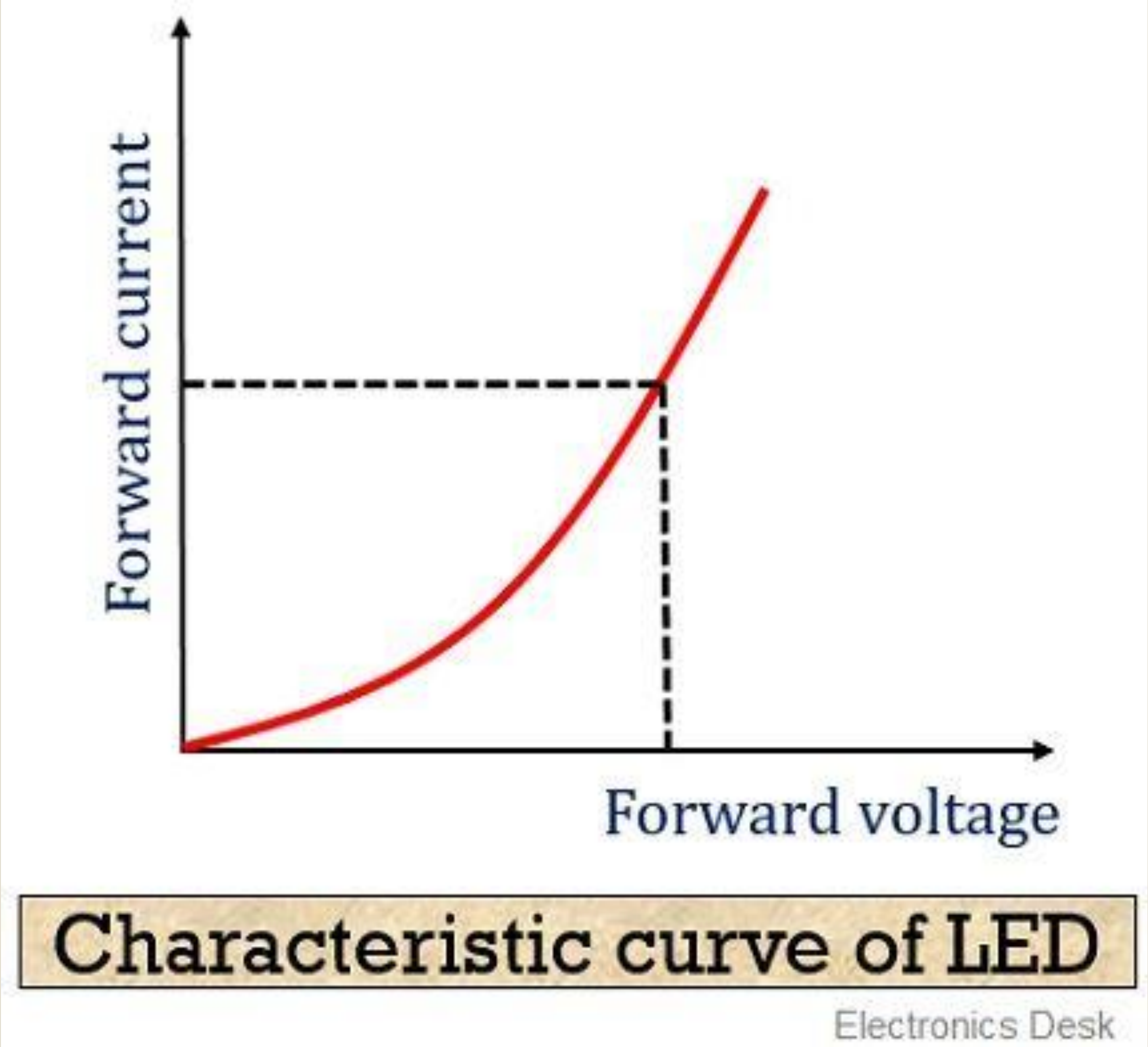
Light Emitting Diode (LED)

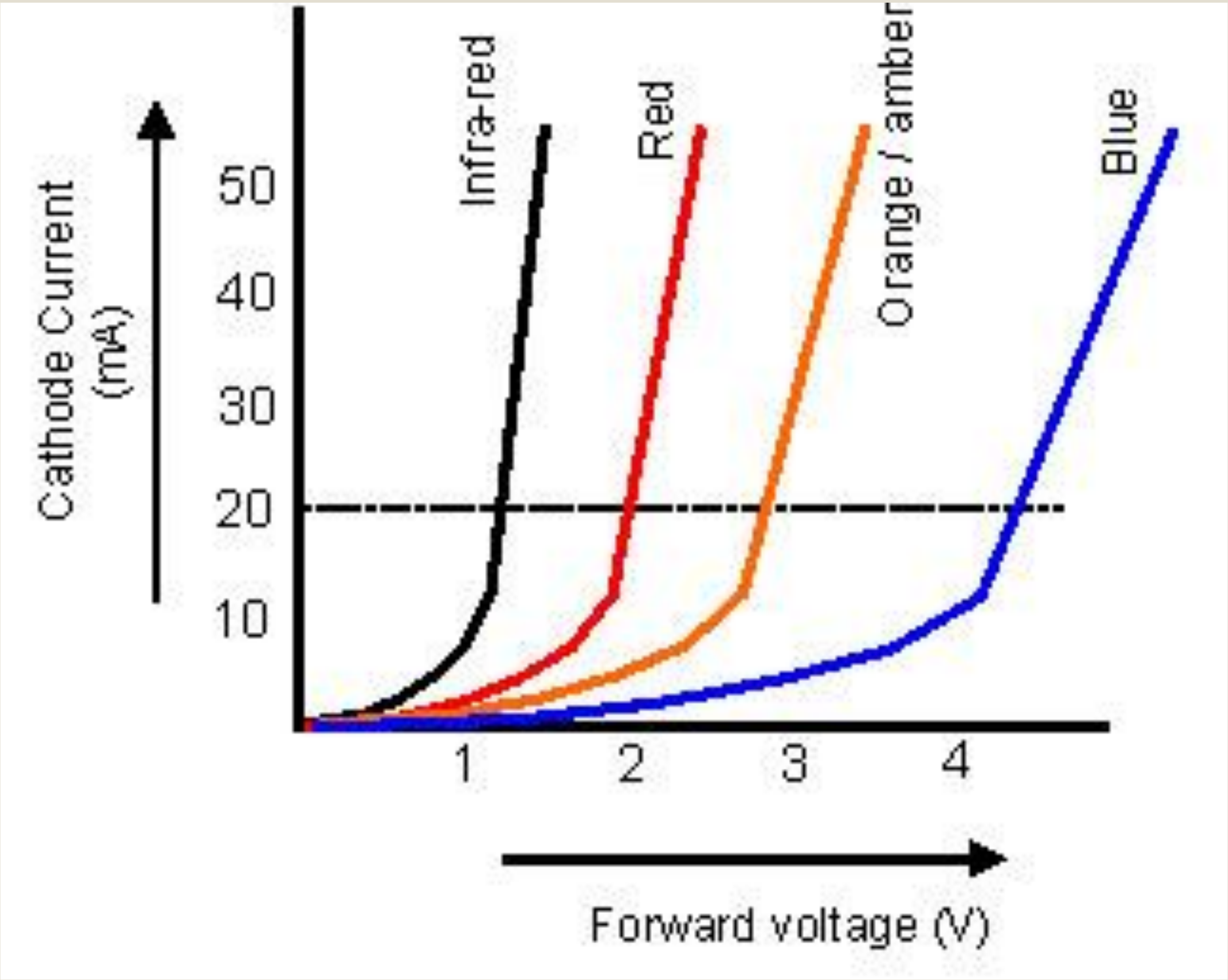
Physics and Radio-Electronics



recombination takes place in depletion region as well as in p-type and n-type semiconductor. The free electrons in the conduction band releases energy in the form of light before they recombine with holes in the valence band.

I-V Characteristics





Cathode Current (mA)
50
40
30
20
10
Infra-red
Red
Orange / amber
Blue
1
2
3
4
Forward voltage (V)