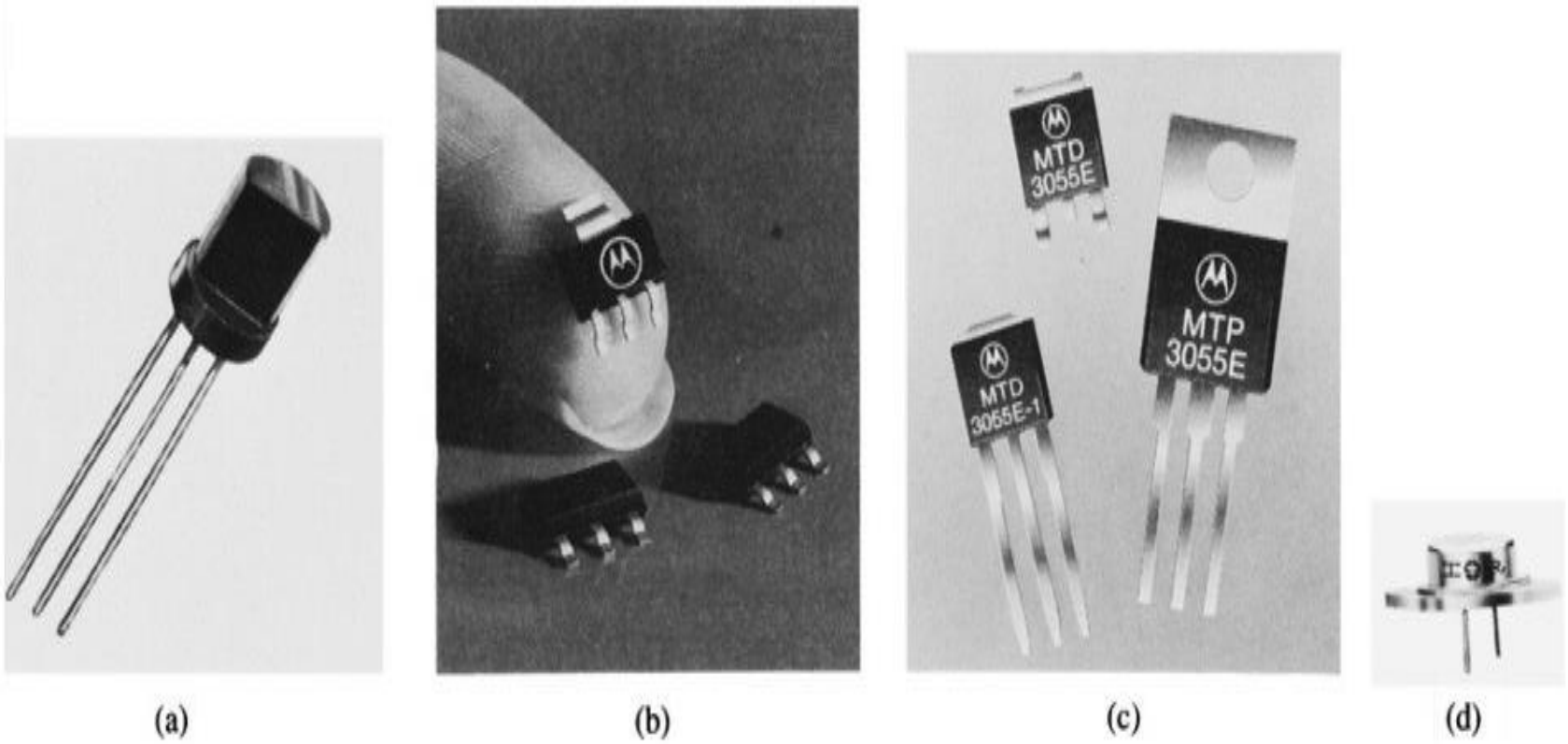
Unit-4:
TRANSISTOR - Introduction



Introduction

- Beside diodes, the most popular semiconductor devices is transistors. Eg: Bipolar Junction Transistor (BJT)

- If cells are the building blocks of life, transistors are the building blocks of the digital revolution.

Without transistors, technological wonders you use every day -- cell phones, computers -- would be vastly different, if they existed at all.

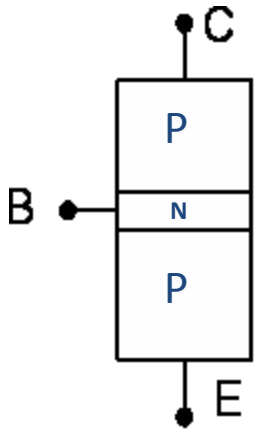
- Transistors are more complex and can be used in many ways Most important feature: can amplify signals and switch

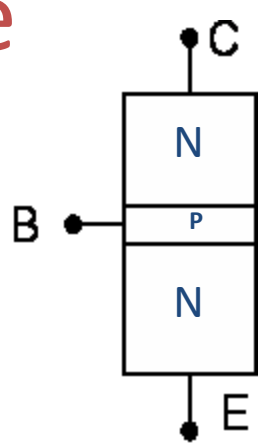
- Amplification can make weak signal strong (make sounds louder and signal levels greater), in general, provide function called Gain

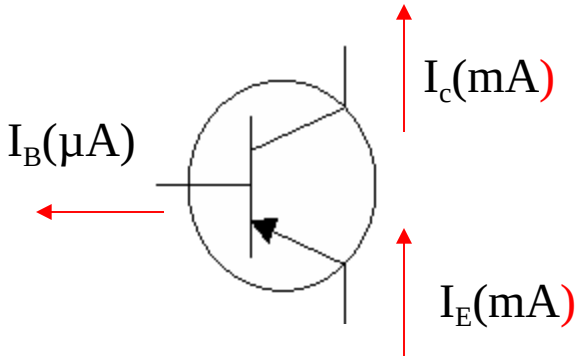
Transistor Structure

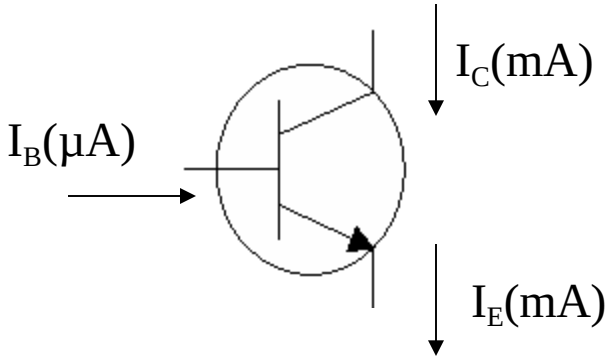
- BJT is bipolar because both holes (+) and electrons (-) will take part in the current flow through the device
  - N-type regions contains free electrons (negative carriers)
  - P-type regions contains free holes (positive carriers)
- Types of BJT
  - NPN transistor
  - PNP transistor
- The transistor regions are:
  - Emitter (E) – send the carriers into the base region and then on to the collector
  - Base (B) – acts as control region. It can allow none, some or many carriers to flow
  - Collector (C) – collects the carriers

PNP and NPN transistor structure







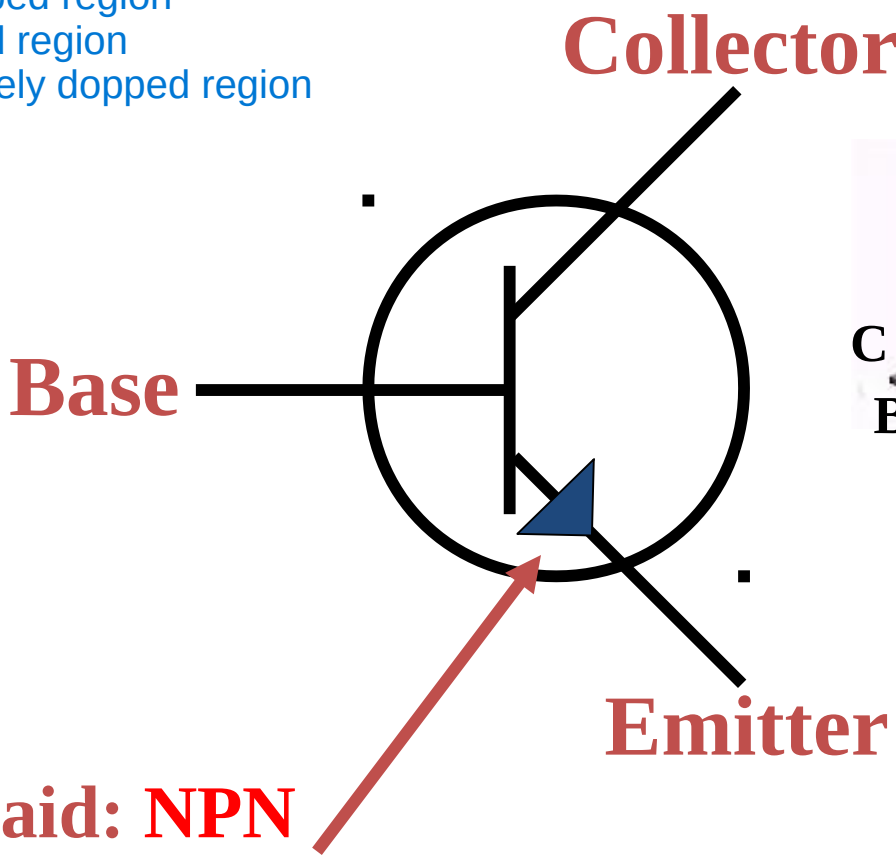


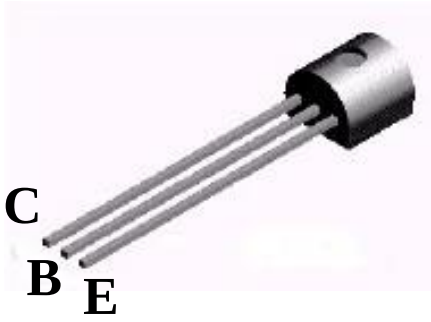
Arrow shows the current flows

NPN Schematic Symbol

Emitter:Highly doped region
Base:lightly doped region
Collector:moderately dopped region

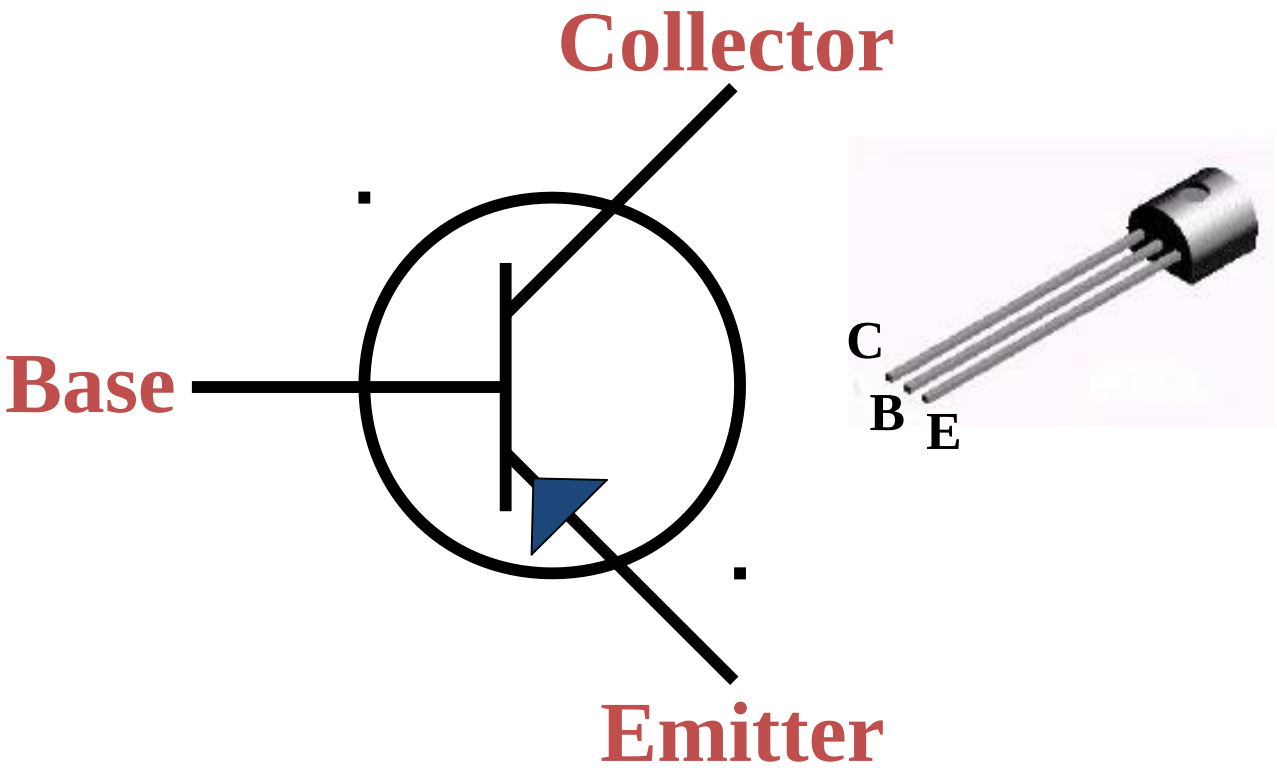
size
collector:large size
base:thin
emitter:in between





Memory aid: NPN means Not Pointing iN.

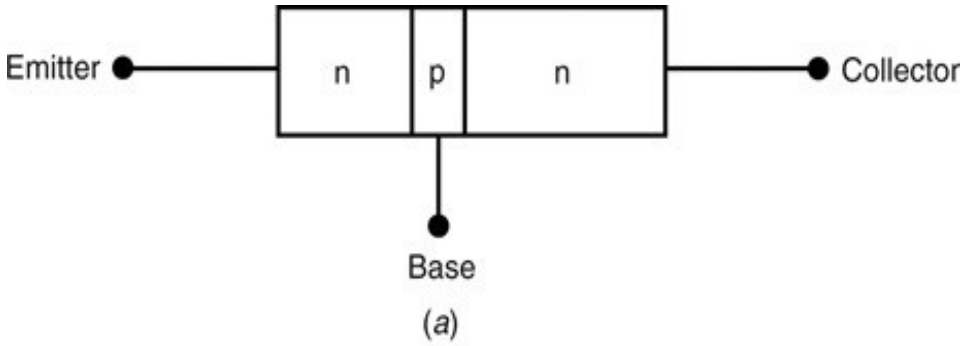
PNP Schematic Symbol



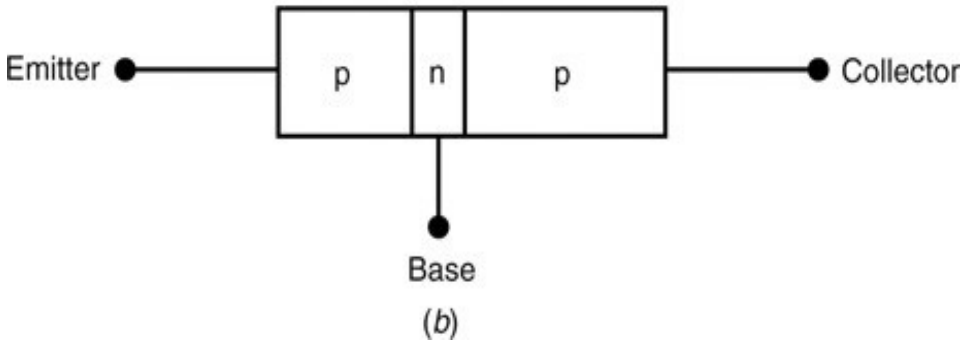
Memory aid: NPN
means Pointing iN Properly.

Transistor Construction

- **A transistor has three doped regions.**
- **For both types, the base is a narrow region sandwiched between the larger collector and emitter regions.**



(*a*)



(*b*)

▪**The emitter region is heavily doped and its job is to emit carriers into the base.**

▪**The base region is very thin and lightly doped.**

▪**Most of the current carriers injected into the base pass on to the collector.**

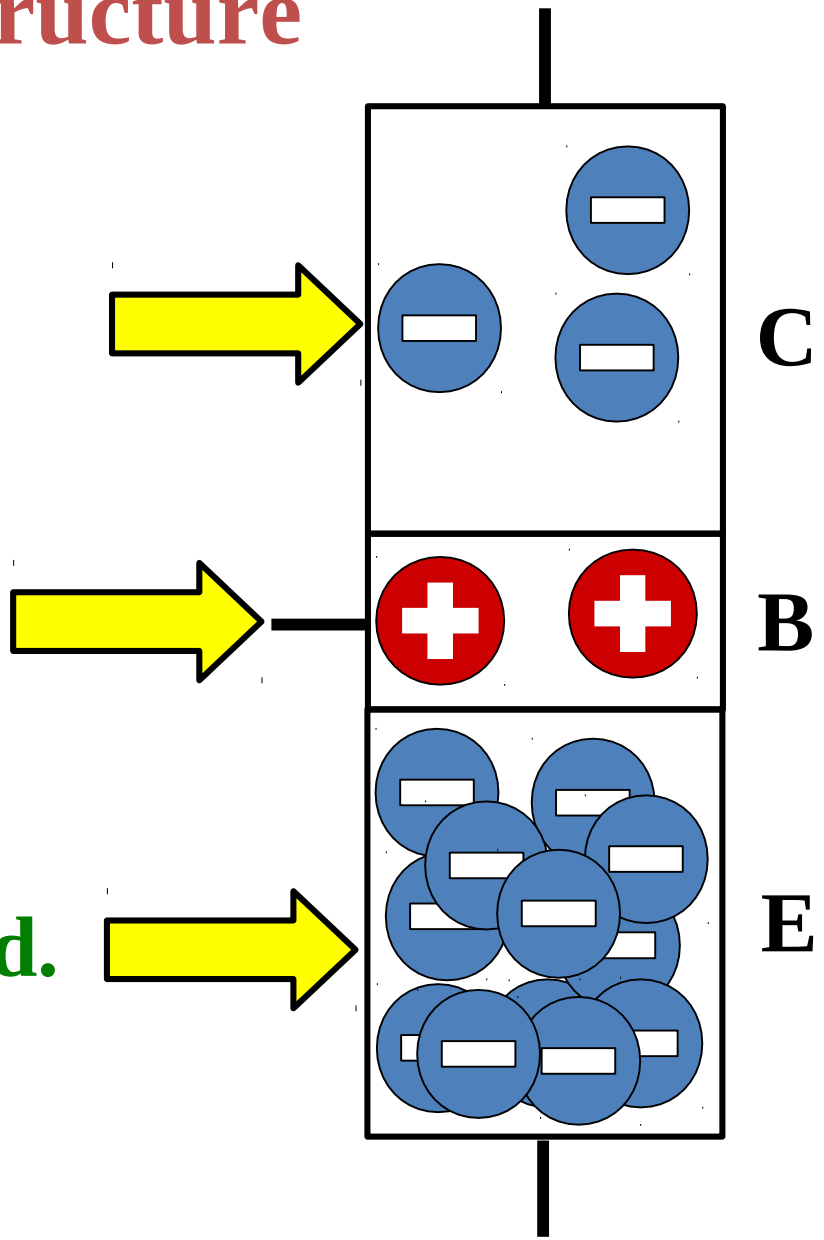
▪**The collector region is moderately doped and is the largest of all three regions.**

NPN Transistor Structure

The collector is Moderately doped.

The base is thin and is lightly doped.

The emitter is heavily doped.



Transistor configuration

Transistor configuration –is a connection of transistor to get variety operation.

3 types of configuration:

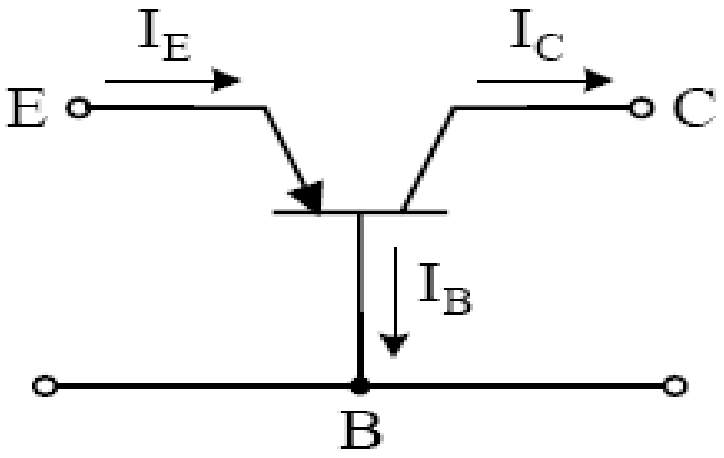
- *Common Base*
- *Common Emitter*
- *Common Collector*

Common-Base Configuration

- Base terminal is a common point for input and output.
- Input – EB
- Output – CB
- Not applicable as an amplifier because the relation between input current gain (I_E) and output current gain (I_C) is approximately 1

Ie=Ic+Ib

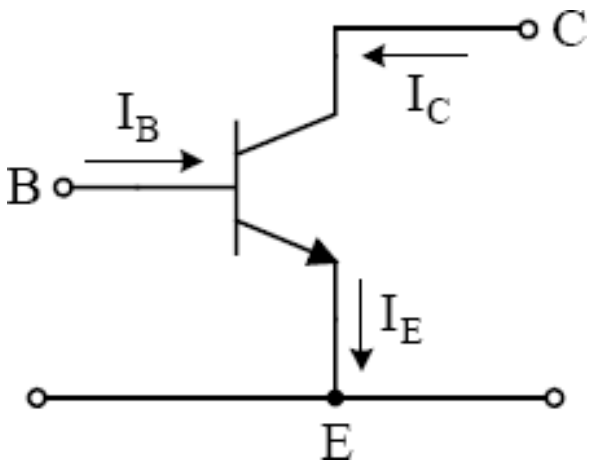
@=Ic/Ie<1~~1



Common-Emitter Configuration

- Emitter terminal is common for input and output circuit
- Input – BE
- Output – CE
- Mostly applied in practical amplifier circuits, since it provides good voltage, current and power gain

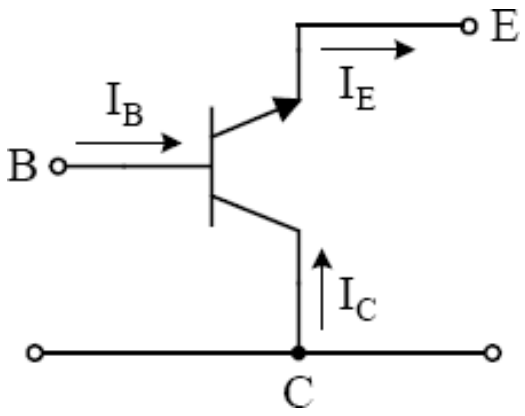
B=Ic/Ib>1



Common-Collector Configuration

- The input signal is applied to the base terminal and the output is taken from the emitter terminal.
- Collector terminal is common to the input and output of the circuit
- Input – BC
- Output – EC

y=Ie/Ib



Current Relationships

- Relations between I_C and I_E:

$$\alpha = \frac{I_C}{I_E}$$

- Value of α usually 0.9998 to 0.9999, $\alpha \approx 1$
- Relations between I_C and I_B:

$$I_C = \beta I_B$$

- Value of β usually in range of 50 to 400
- The equation, $I_E = I_C + I_B$ can also written in β

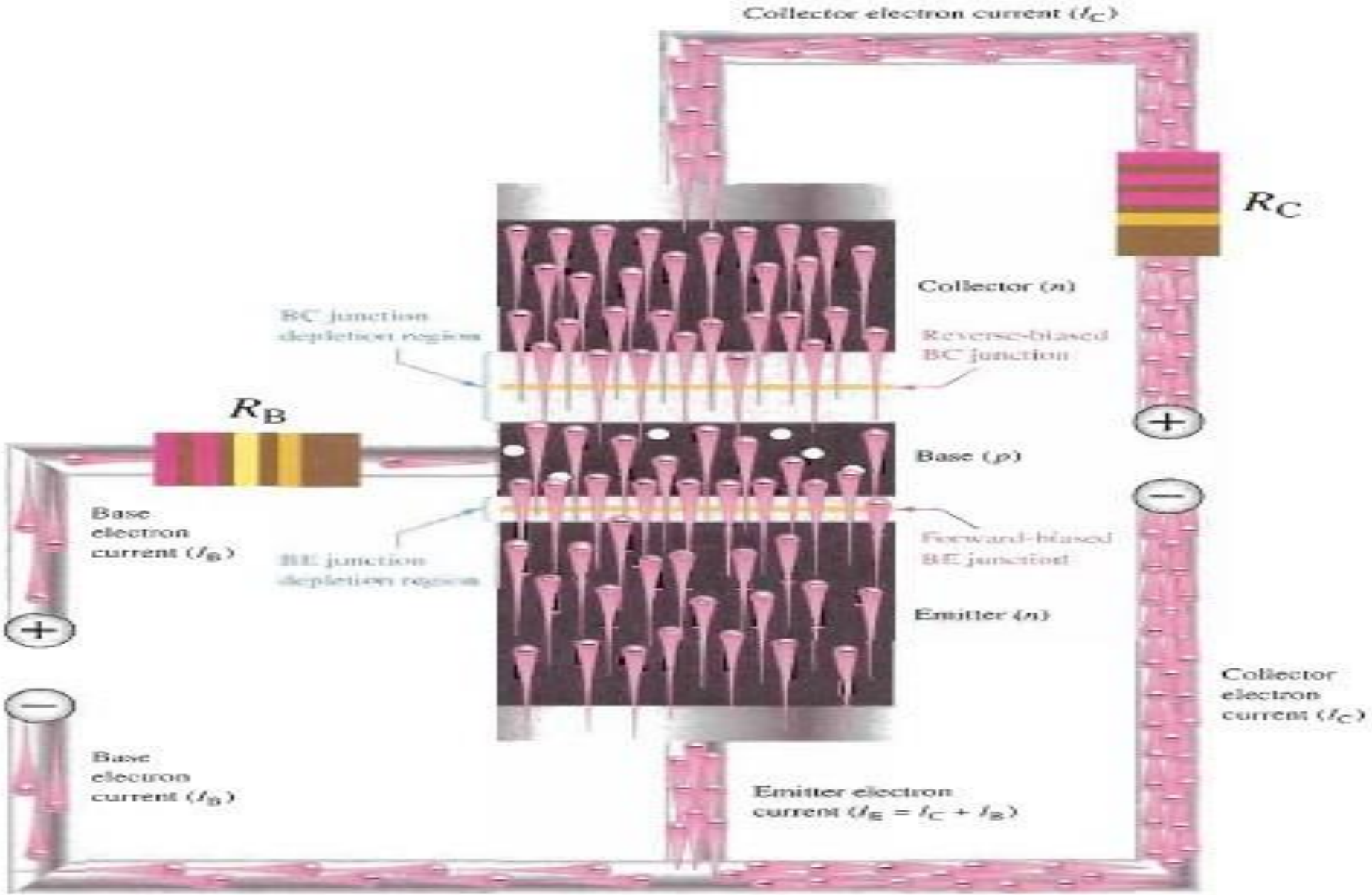
$$I_C = \beta I_B$$

$$I_E = \beta I_B + I_B \Rightarrow I_E = (\beta + 1) I_B$$

- The current gain factor , α and β is:

$$\alpha = \frac{\beta}{\beta + 1} \quad @ \quad \beta = \frac{\alpha}{\alpha - 1}.$$

Transistor operation

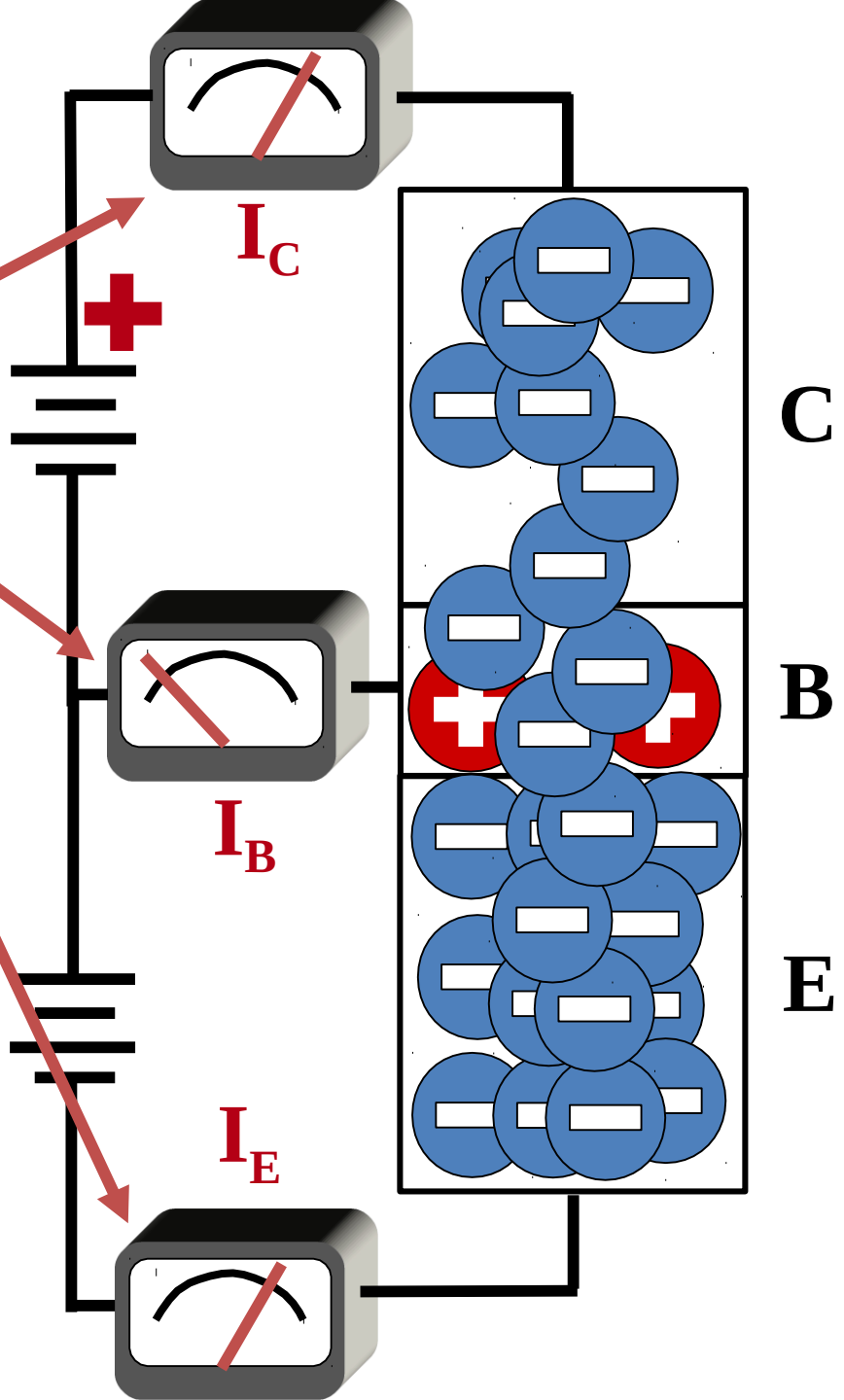


NPN Transistor Bias

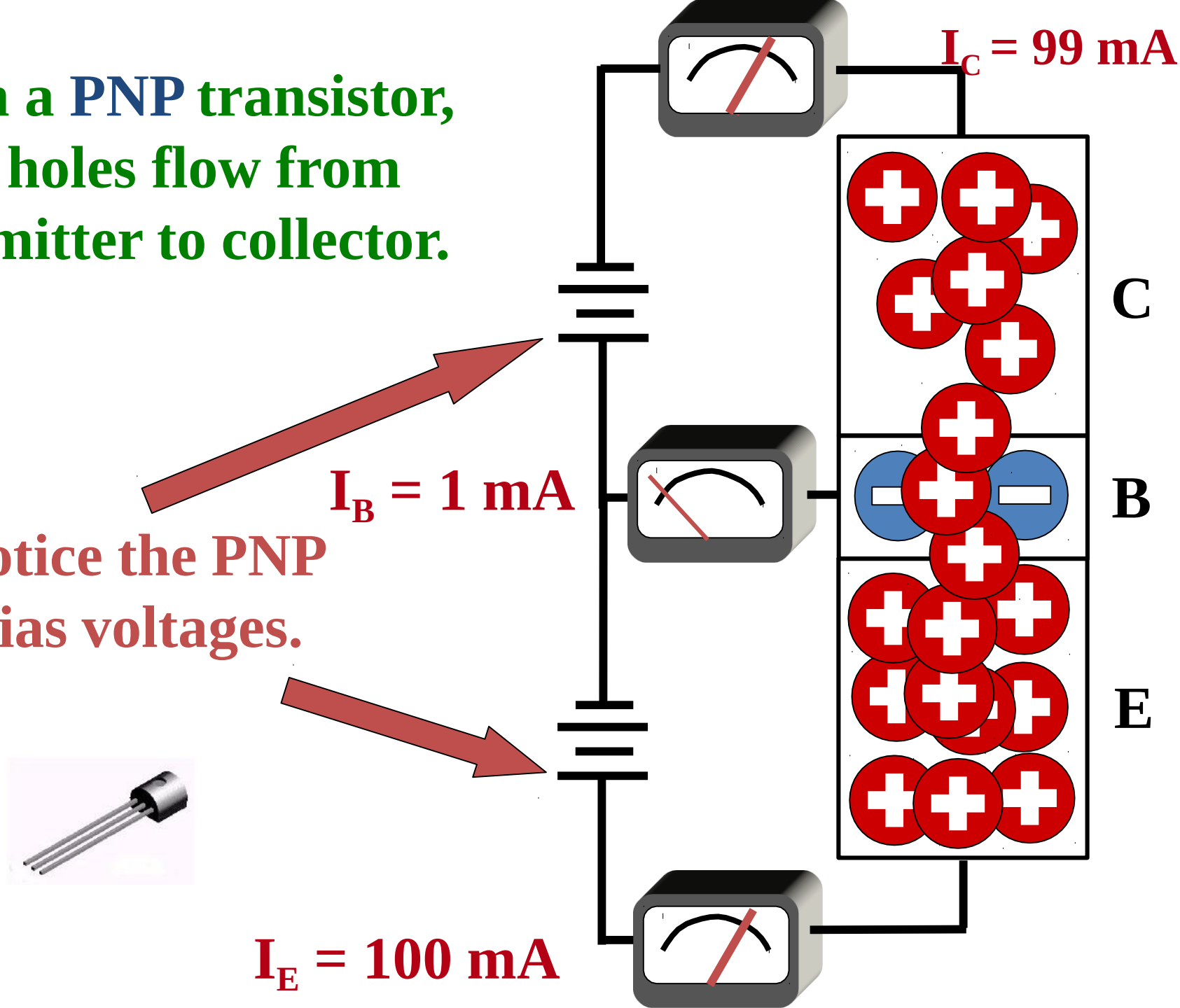
Current flows everywhere.

When both junctions are biased....

Note that I_B is smaller than I_E or I_C.



In a PNP transistor, holes flow from emitter to collector.



Notice the PNP bias voltages.

MCQ

A transistor has ……

1.one pn junction

2.two pn junctions

3.three pn junctions

4.four pn junctions

MCQ

The number of depletion layers in a transistor is ……

(a) Four

(b) Three

(c) One

(d) two

MCQ

The element that has the biggest size in a transistor is ……..

(a) Collector
(b) Base
(c) Emitter
(d) collector-base-junction

MCQ

In a npn transistor, ……. are the minority carriers

(a) free electrons

(b) Holes

(c) donor ions

(d) acceptor ions

MCQ

The emitter of a transistor is …… doped

(a) Lightly
(b) Heavily
(c) Moderately
(d) none of the above

MCQ

In a transistor ……..

(a) $I_C = I_E + I_B$

(b) $I_B = I_C + I_E$

(c) $I_E = I_C - I_B$

(d) $I_E = I_C + I_B$