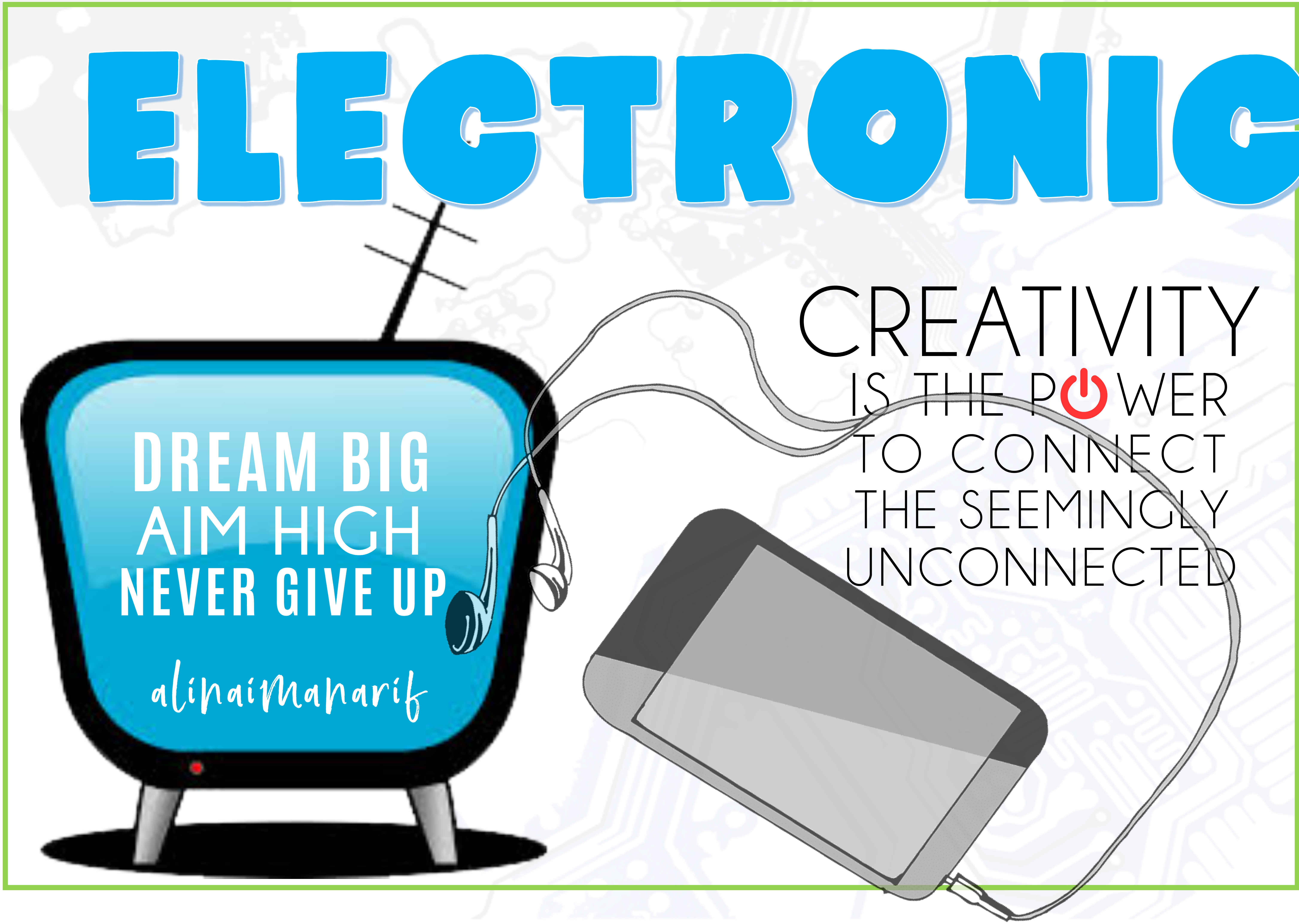
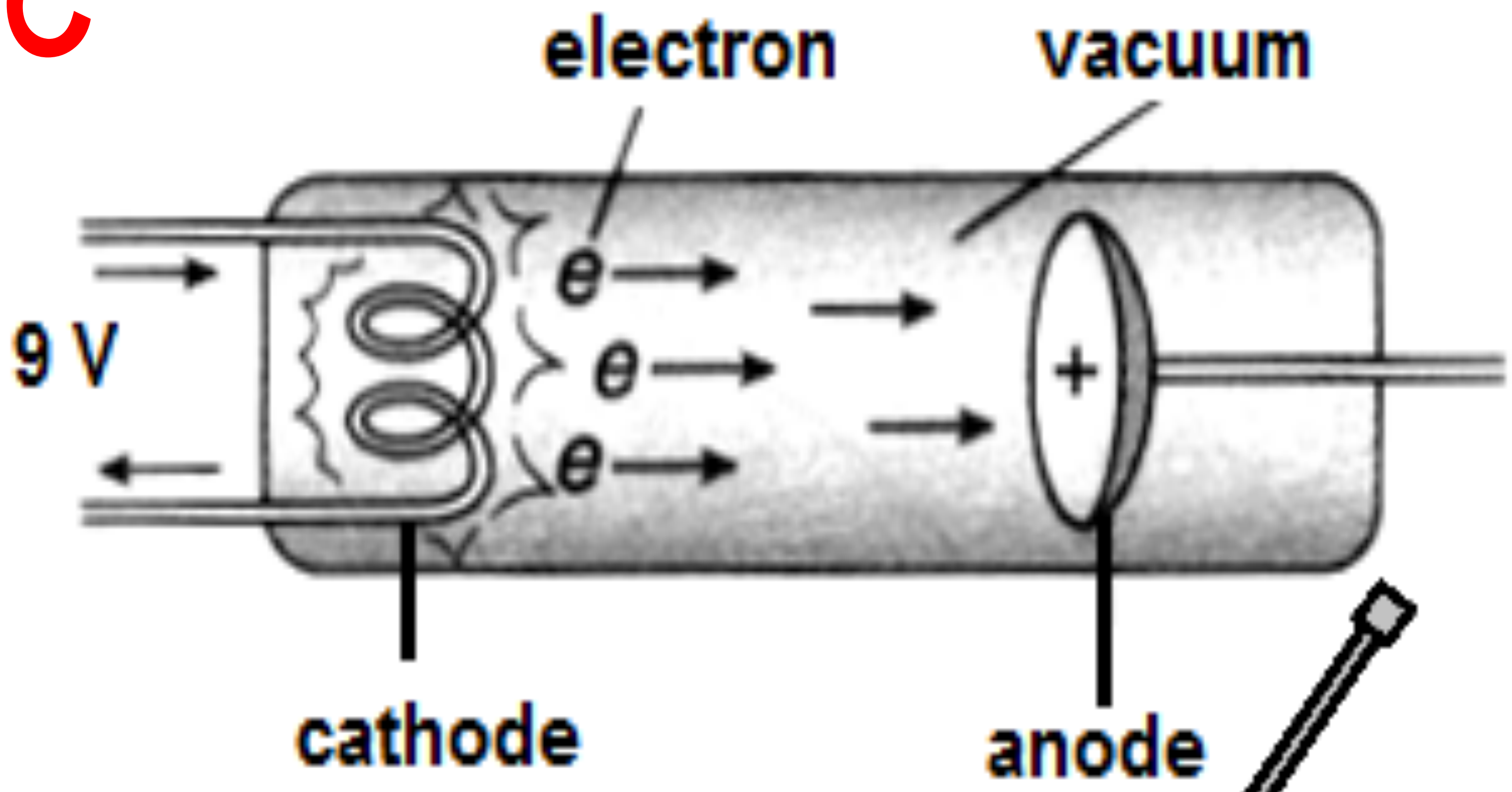

ELECTRONIC
DREAM BIG
AIM HIGH
NEVER GIVE UP
alinaimanarif
CREATIVITY
IS THE POWER
TO CONNECT
THE SEEMINGLY
UNCONNECTED

Thermionic emission

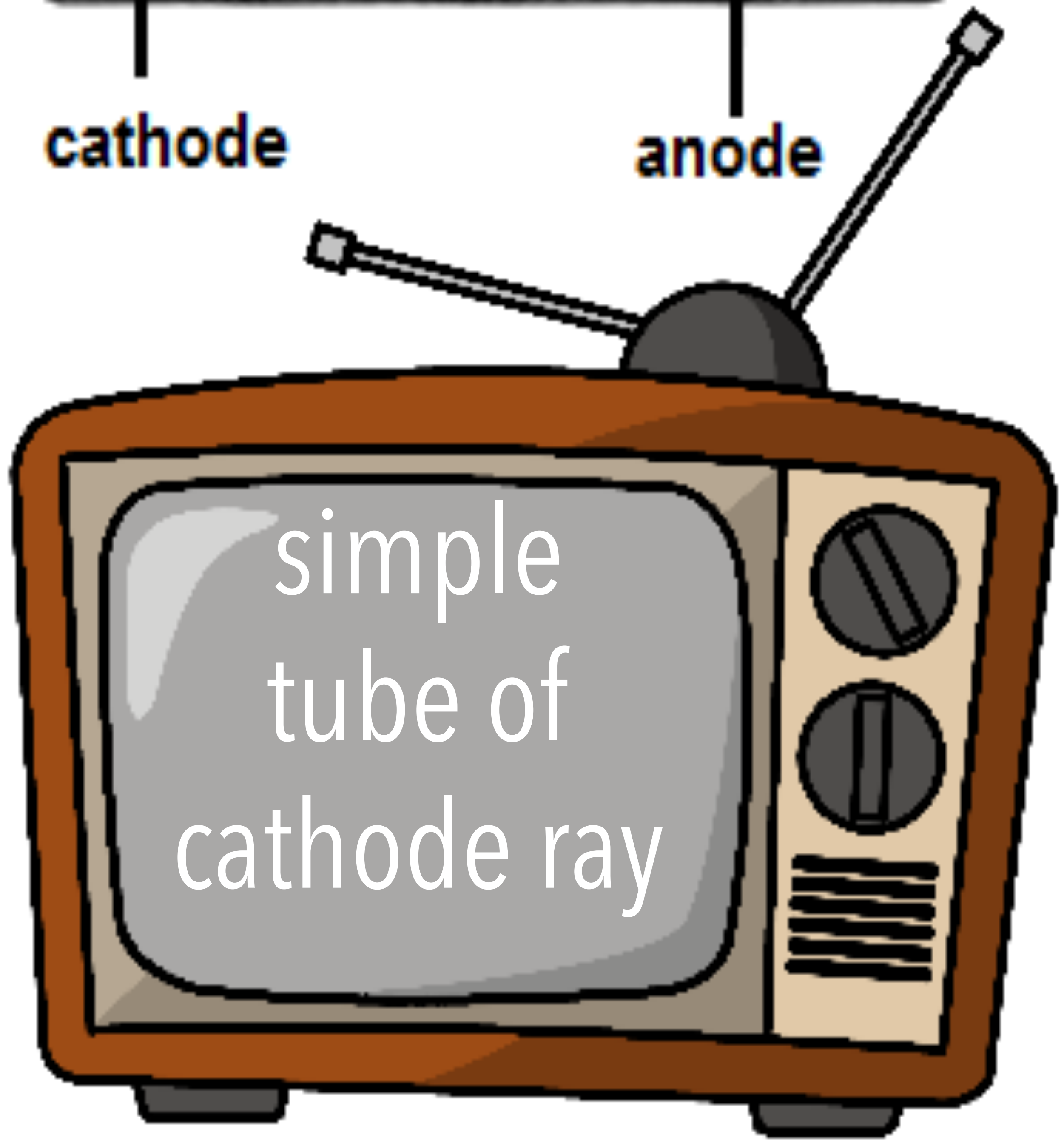
is the process of emission of electrons from a heated metal's surface.



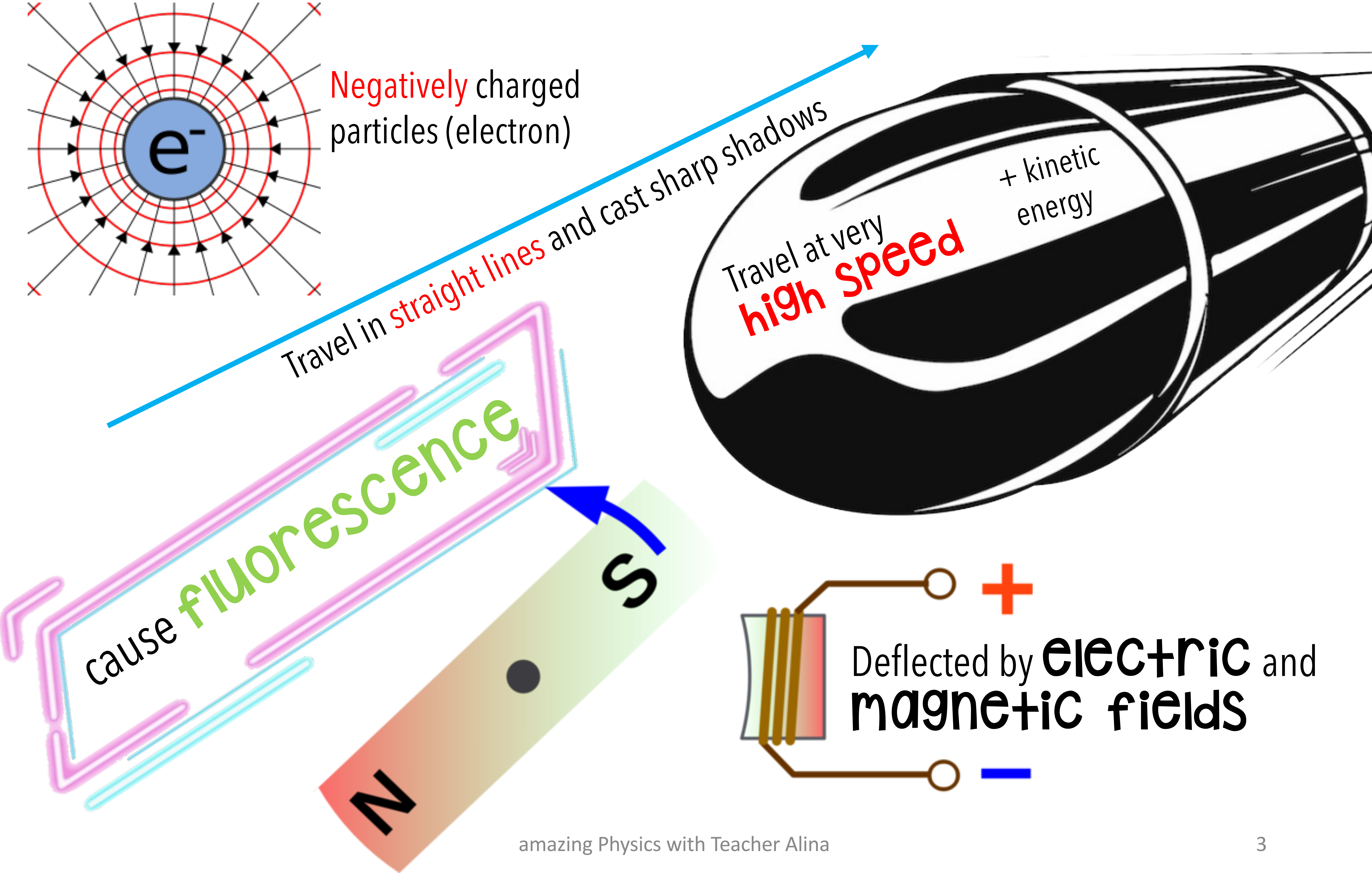
"To the electron -- may it never be of any use to anybody." -- JJ. Thomson's

cathode ray

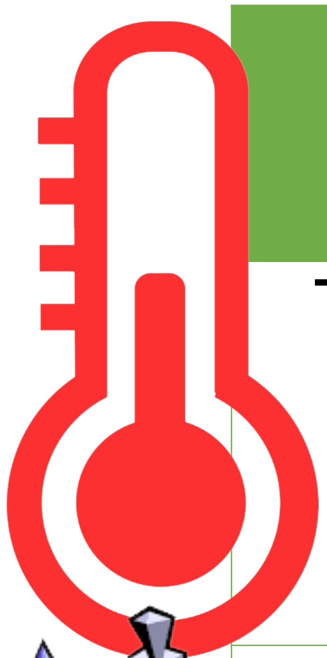
A beam of electrons moving at high speed in a vacuum.

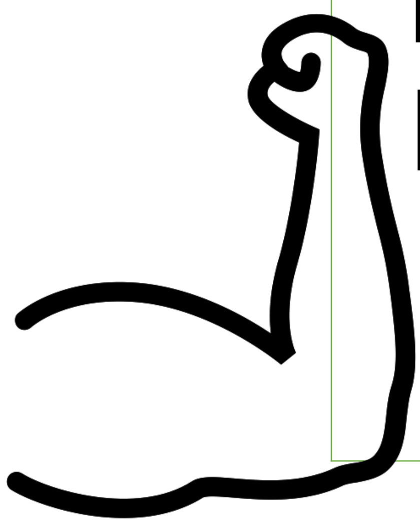


The properties of cathode rays:



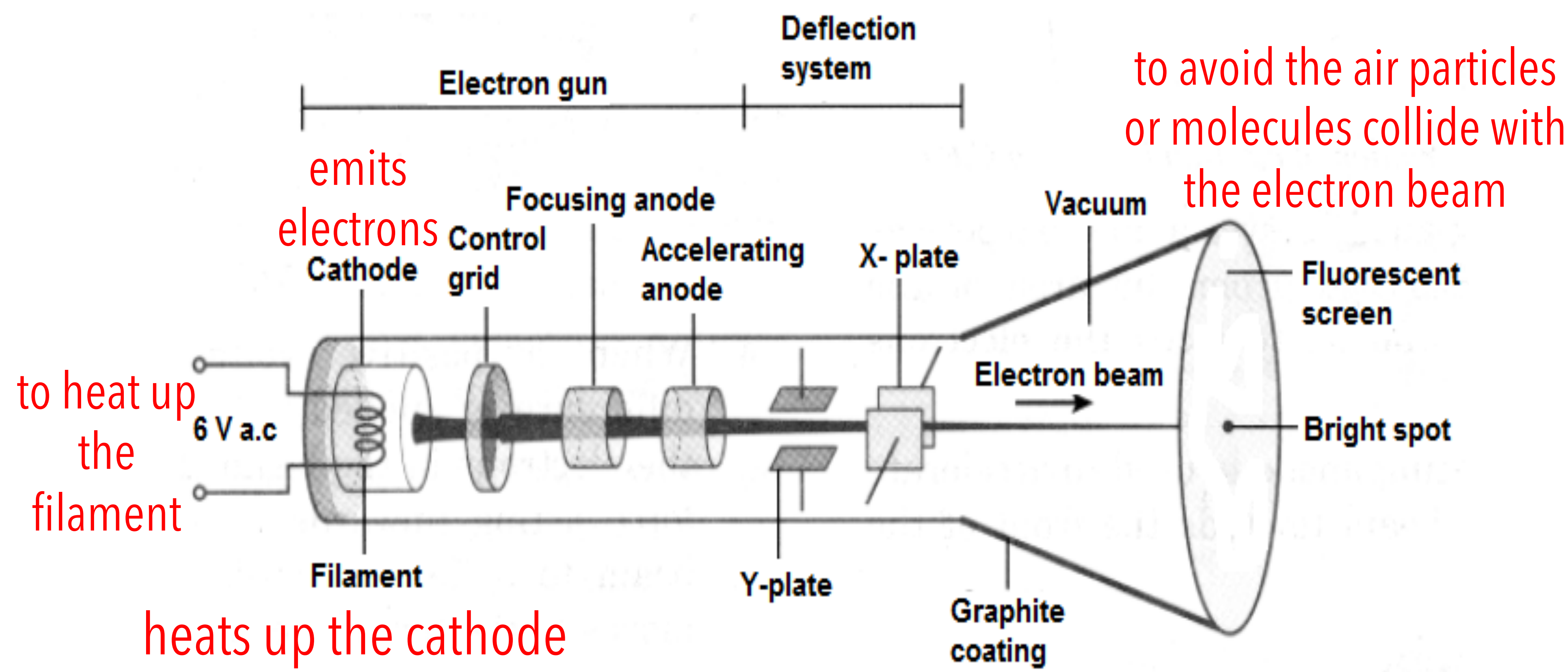
Factors that influence the rate of thermionic emission:





FACTOR	EFFECT ON THE RATE OF THERMIONIC EMISSION
Temperature of the cathode	When the temperature of the cathode increases, the rate of thermionic emission increases.
Surface area of the cathode	A larger surface area of the cathode increases the rate of thermionic emission.
Potential difference between the anode and cathode.	The rate of thermionic emission is unchanged, when the potential difference increases, but the emitted electrons accelerate faster towards the anode.

STRUCTURE OF THE CATHODE RAY OSCILLOSCOPE



Transmission of energy in cathode ray:

Electrical energy → Kinetic energy + light energy + heat energy

$$\frac{1}{2}mv^2 = eV$$

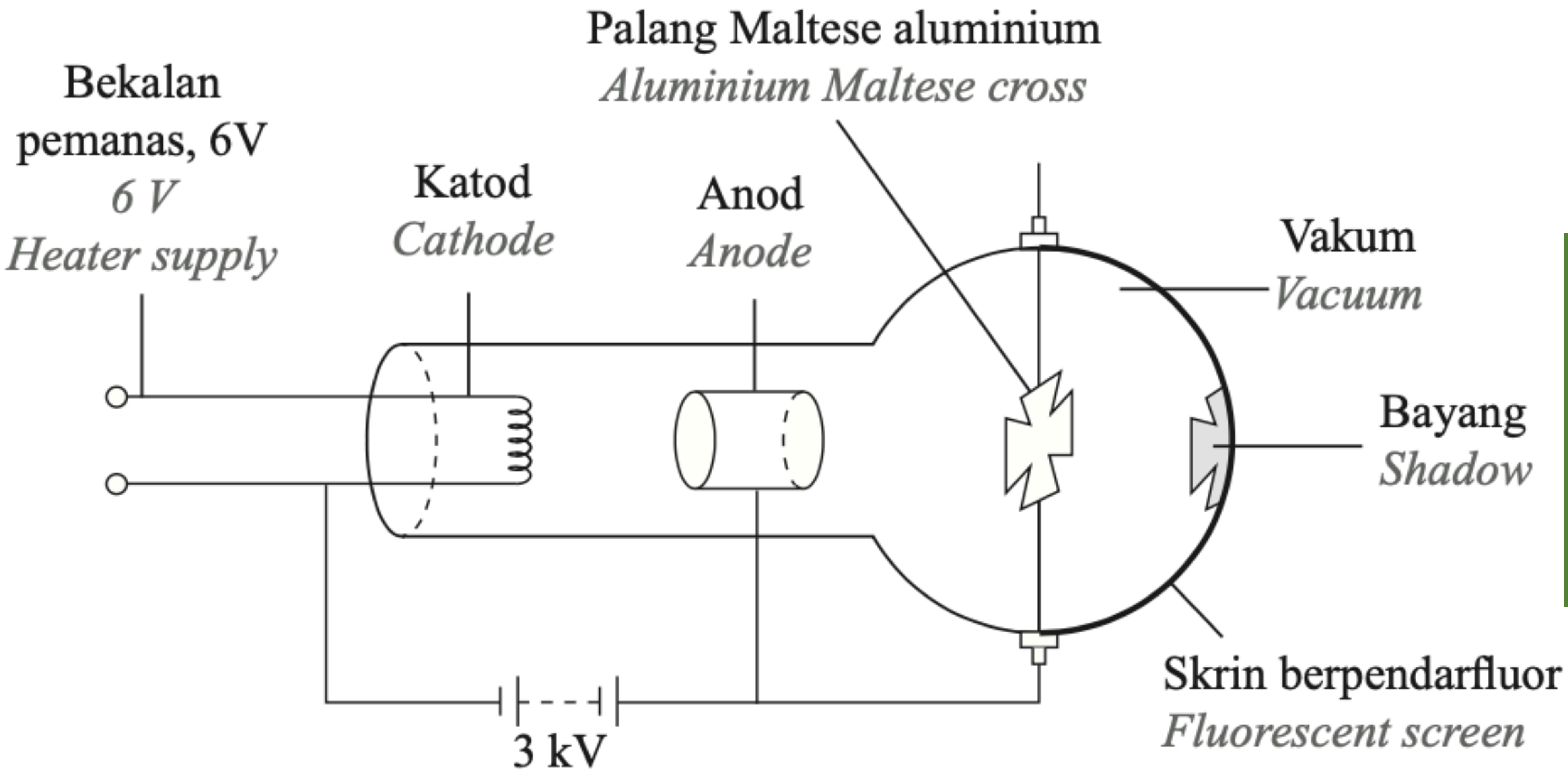
$$v = \sqrt{\frac{2eV}{m}}$$

v = velocity of electron
V = Potential difference between Anode and Cathode (EHT)
e = Charge on 1 electron = 1.6×10^{-19} C
m = mass of 1 electron = 9×10^{-31} kg

The properties of electron streams in a **Maltese cross** cathode ray tube

GO

6 V heater is **switch on**



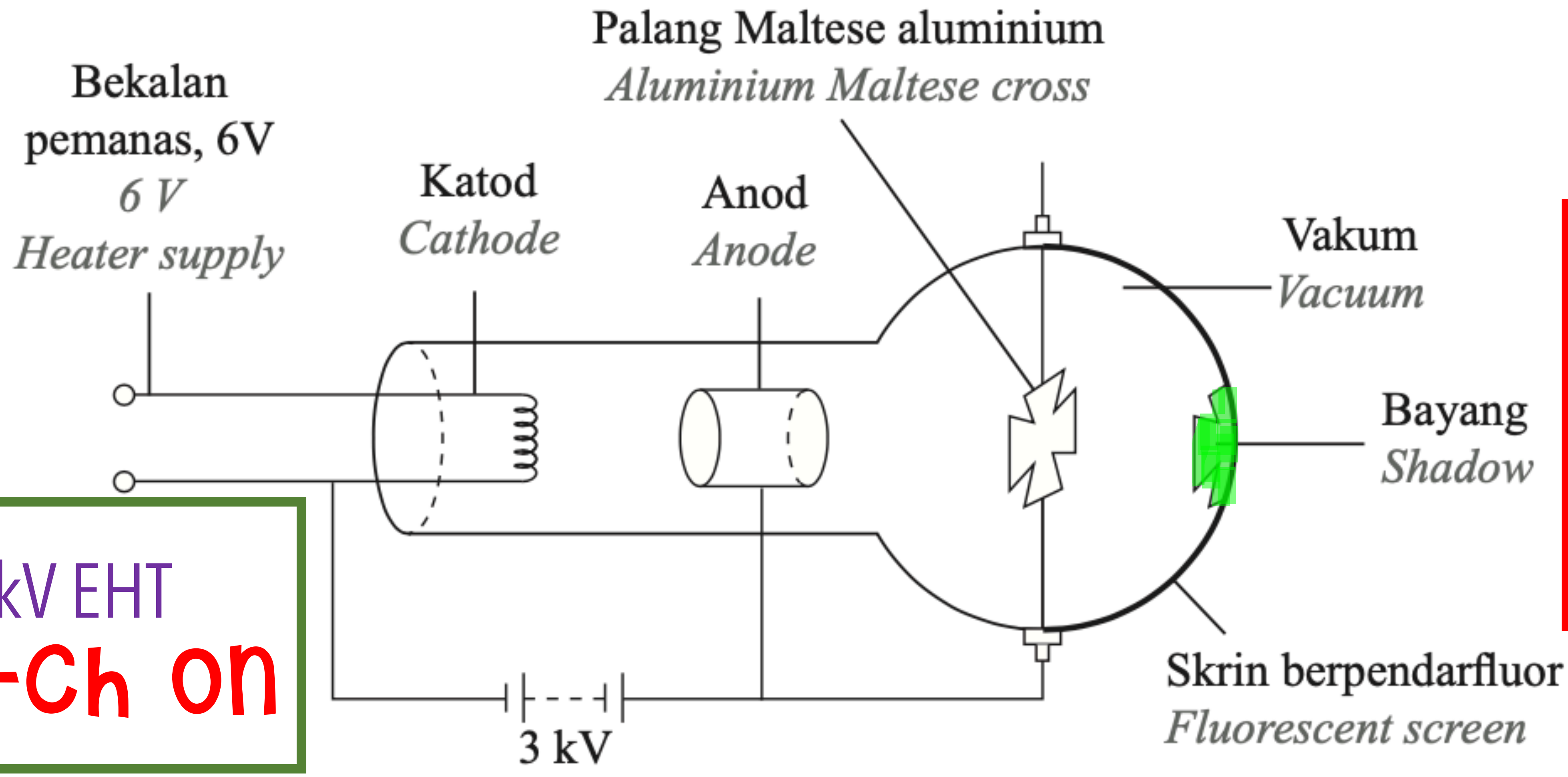
a **shadow** of cross is seen

The **shadow** is formed by the light rays from the **heated filament**

CONCLUSION: light rays travel in a **straight line**

The properties of electron streams in a **Maltese cross** cathode ray tube

GO



3 kV EHT **switch on**

a **green shadow** of cross is seen

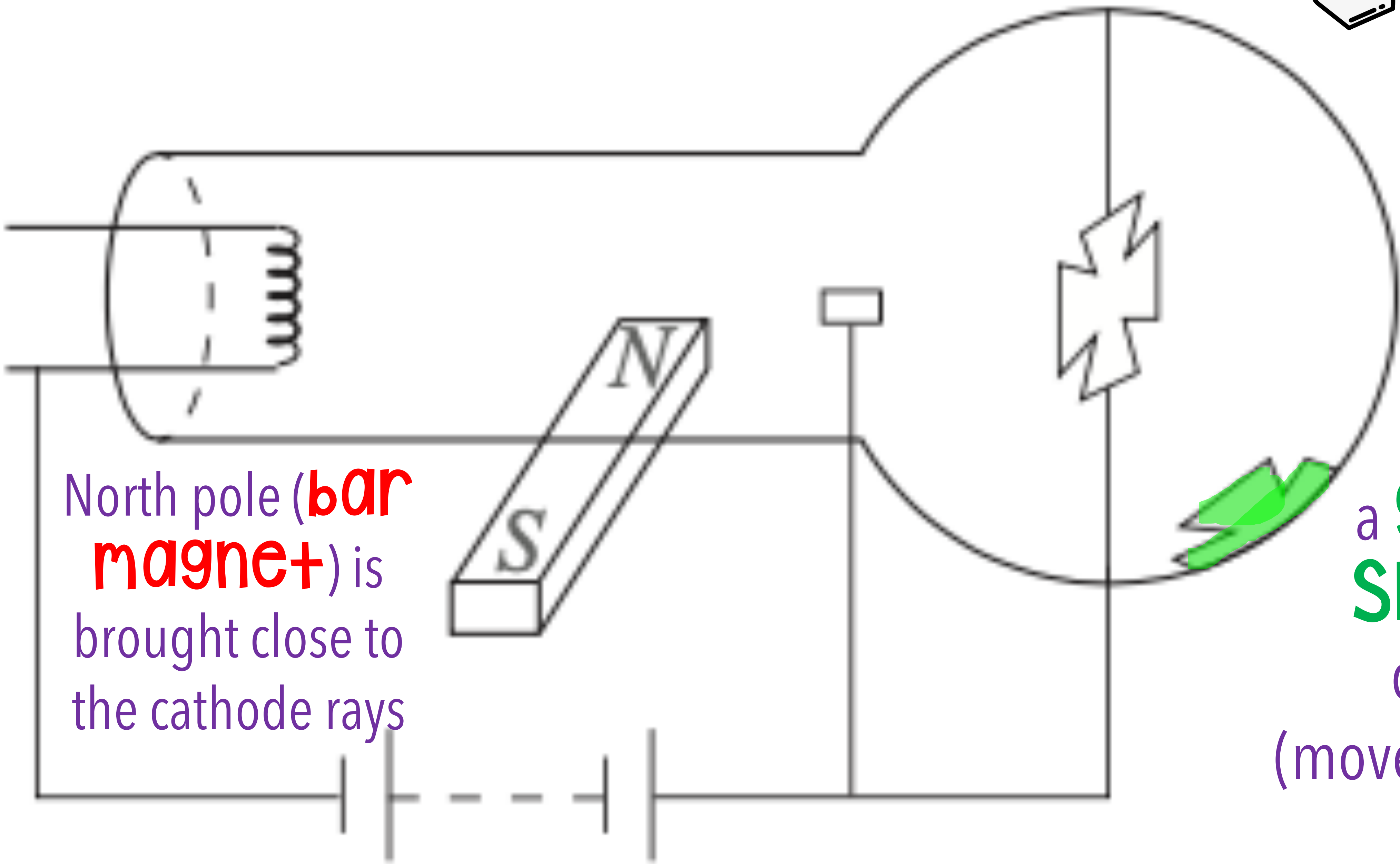
The **shadow** is formed by the **cathode rays**

Electrical energy → Kinetic energy + light energy + heat energy

CONCLUSION: **cathode rays** cause **fluorescence**

The properties of electron streams in a Maltese cross cathode ray tube

GO



North pole (bar magnet) is brought close to the cathode rays

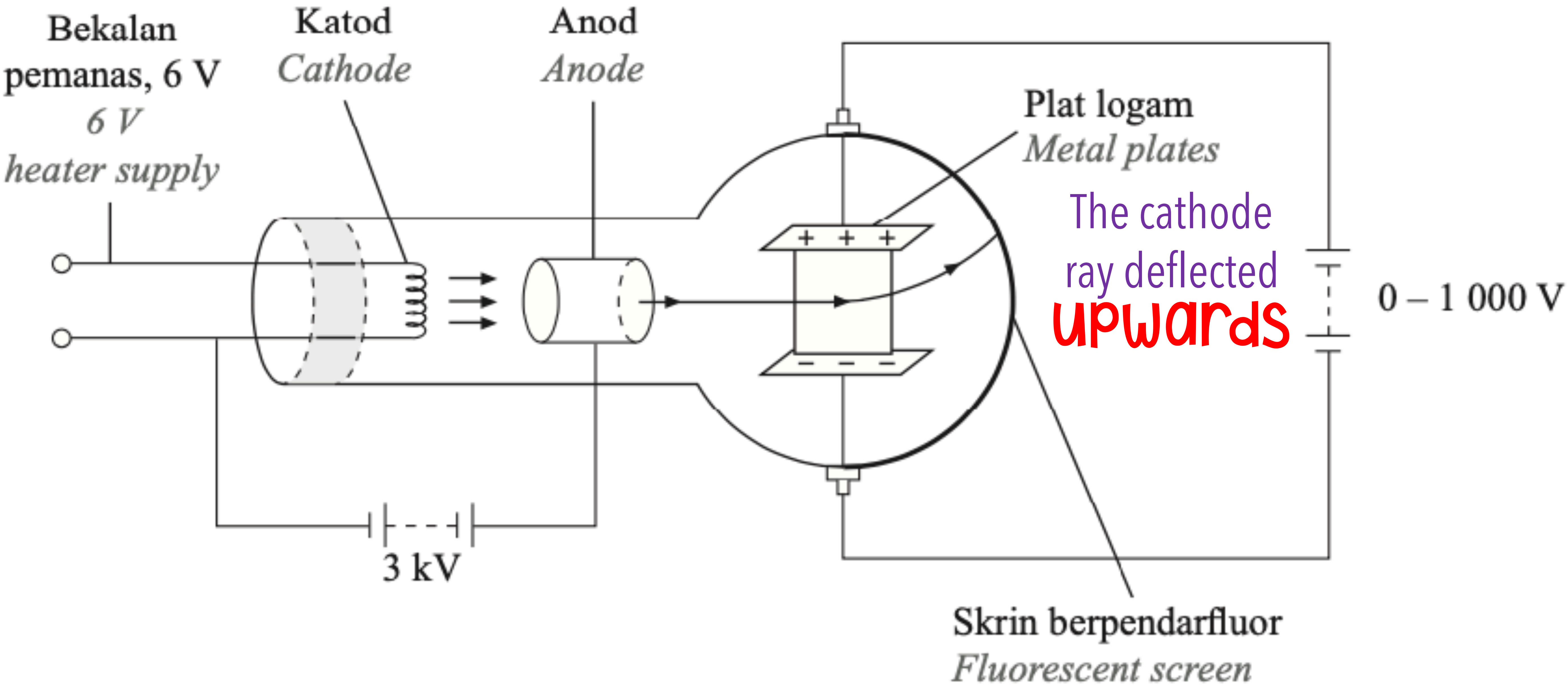
using Fleming's left hand rule

a green shadow distorted (move downwards)

CONCLUSION: cathode rays can be deflected by magnetic field

Deflection tube

GO



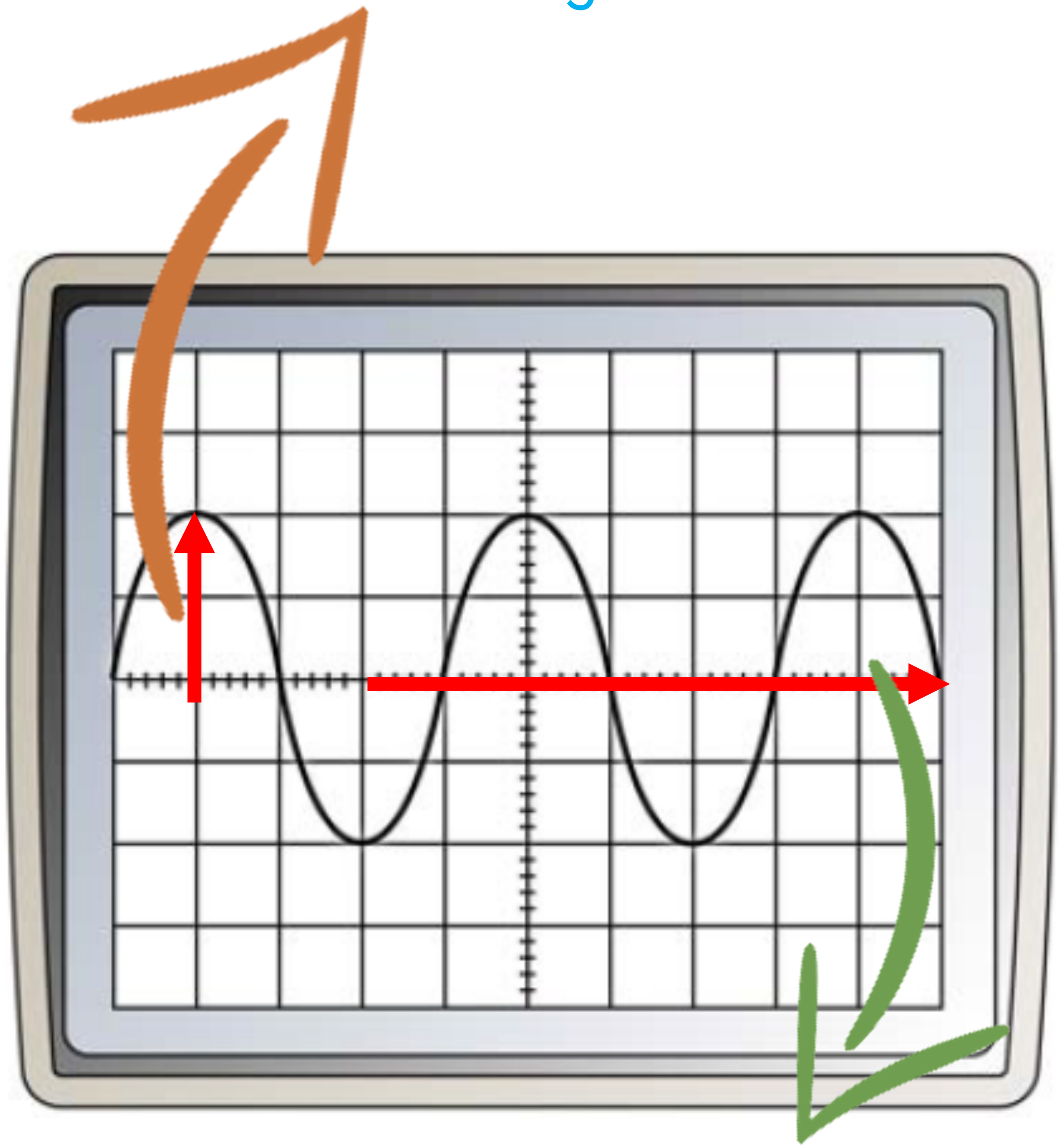
CONCLUSION: cathode rays **Negatively** charged

cathode rays can be deflected by **electric field**

Uses of cathode ray oscilloscope

GO

Vertical scale = Y-gain control



Period = time for 1 complete oscillation

Frequency,

$$f = \frac{1}{T}$$

Horizontal scale = Time base

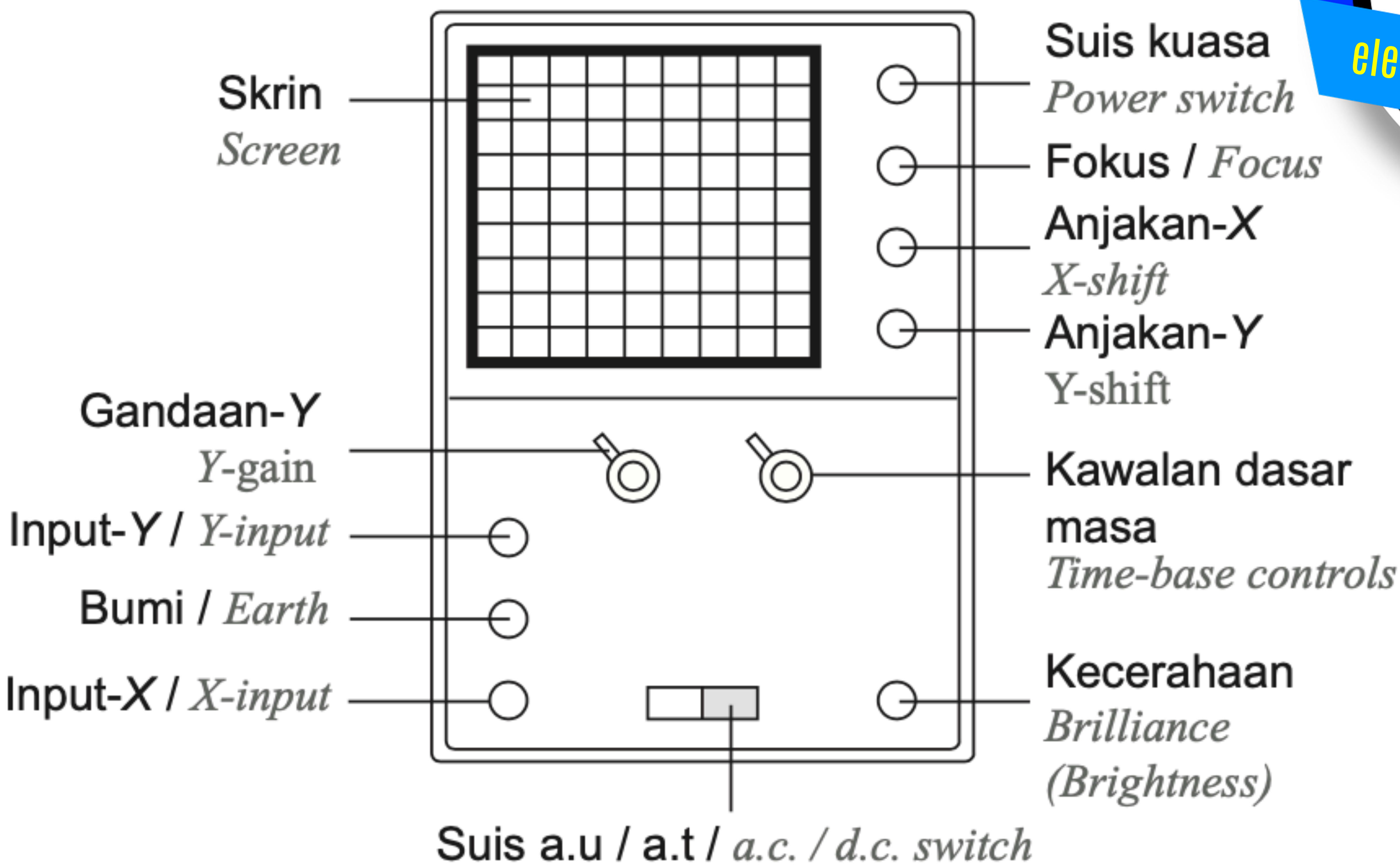
The uses of cathode-ray oscilloscope are:

1. To measure a D.C or A.C voltage
2. To measure a short time intervals
3. To display the waveform

Cathode ray oscilloscope

Display wave forms and measuring voltage from a DC source using a CRO

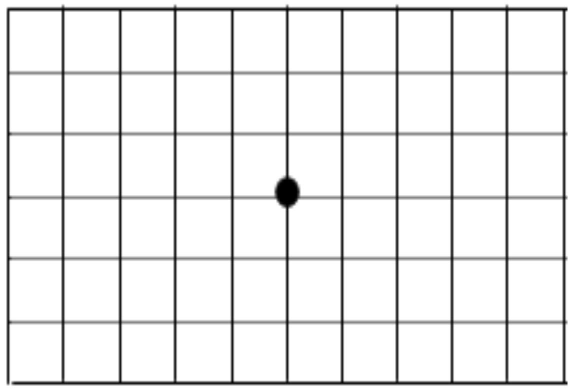
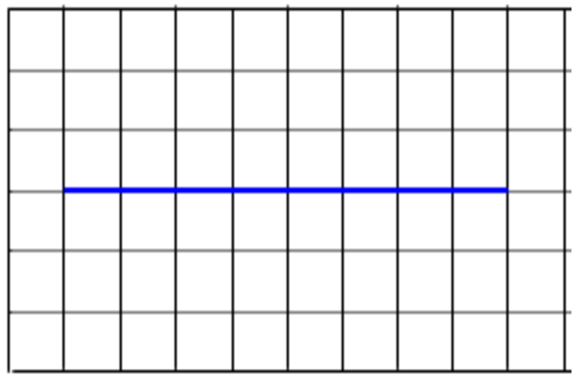
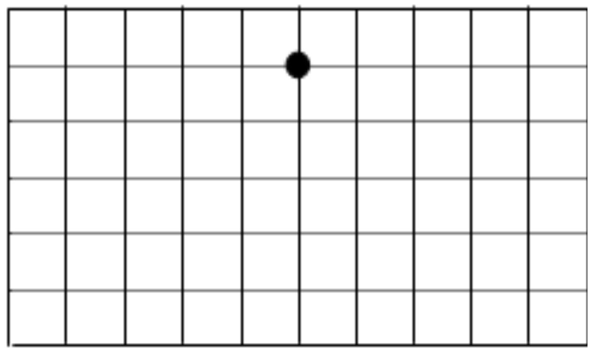
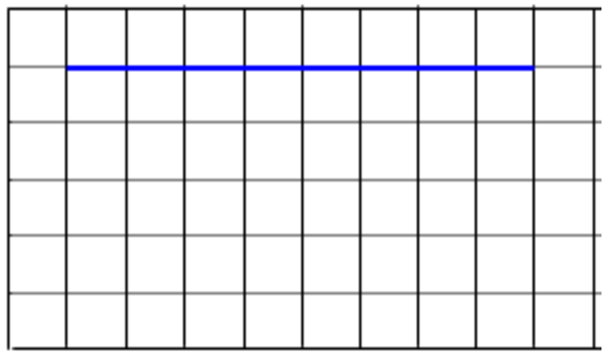
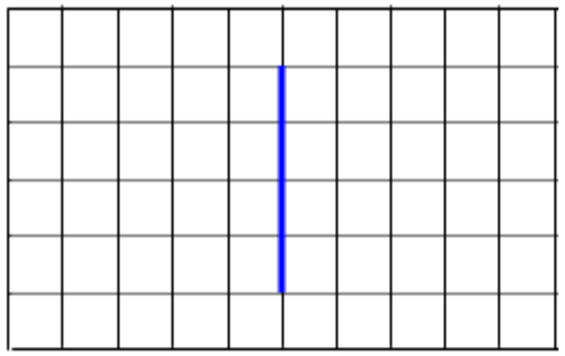
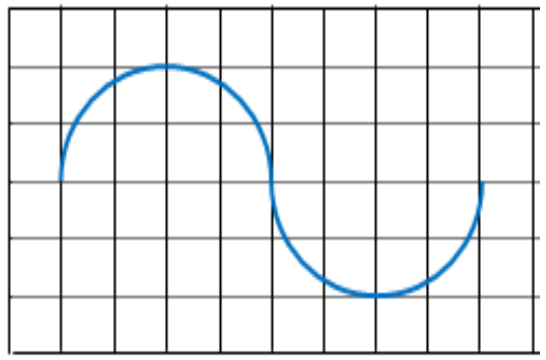
electronic



Cathode ray oscilloscope

Display wave forms and measuring voltage from a DC source using a CRO

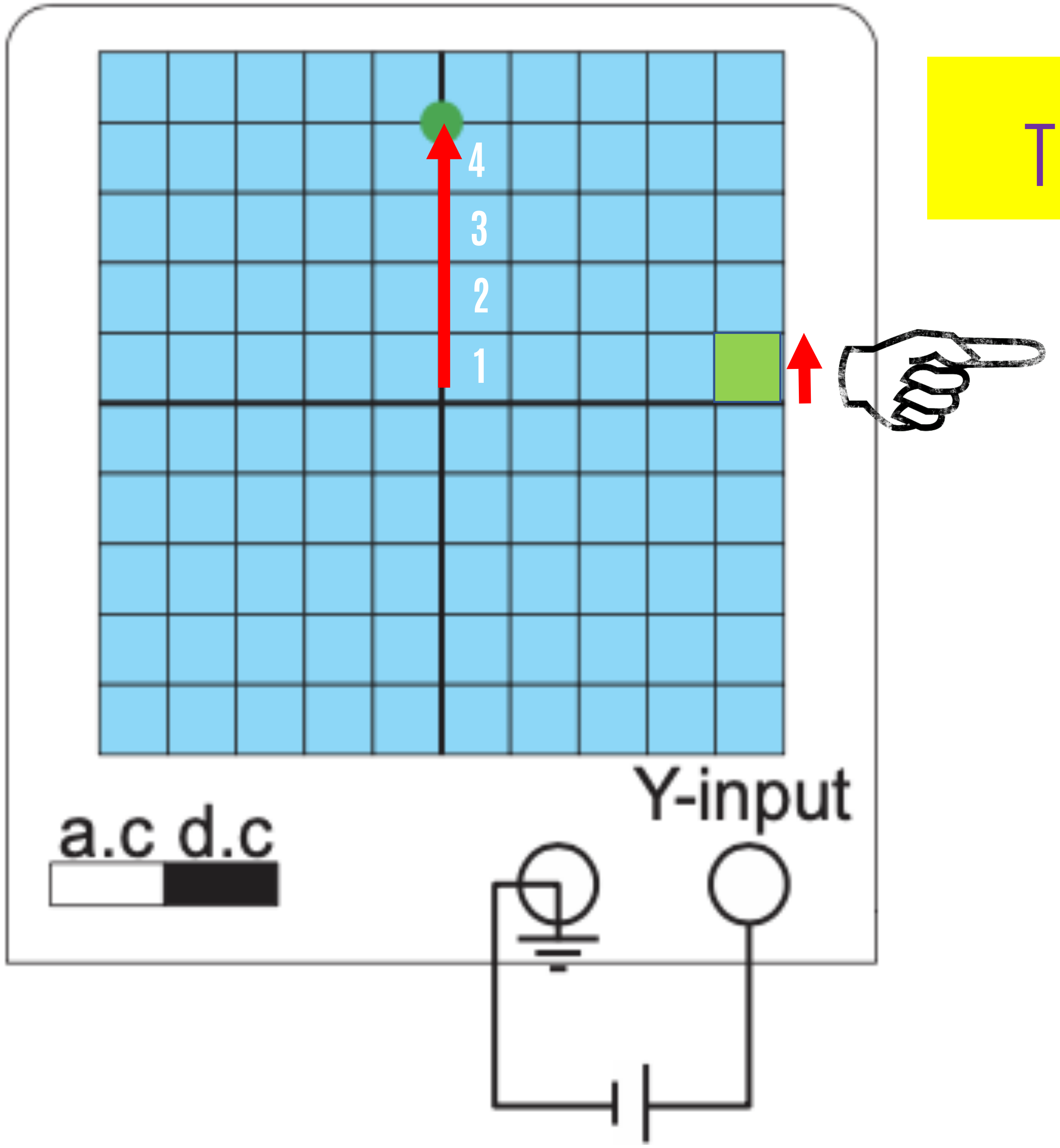
electronic

Type of power supply connected to Y-input of CRO	Time-base switched **off**	Time-base switched **on**
No input		
DC power supply		
AC power supply		

example

Measuring Potential Difference using the CRO

What is the value of the dc voltage if the Y-gain control is 1 V/div ?



Time-base switched **Off**

1 V /div

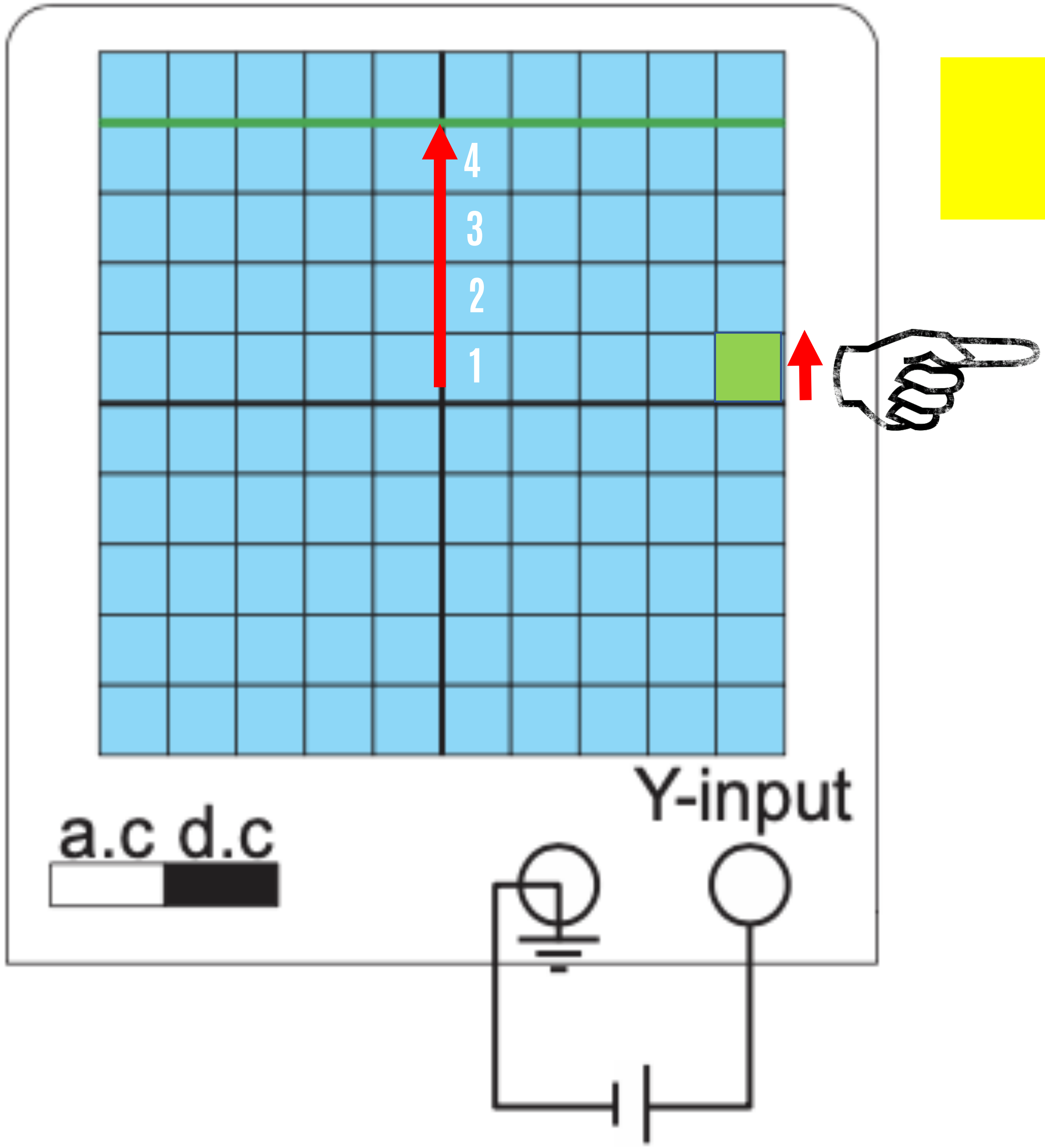
$$\text{dc voltage} = 4 \text{ div x } \frac{1\,V}{div}$$

$$= 4\text{ V}$$

example

Measuring Potential Difference using the CRO

What is the value of the dc voltage if the Y-gain control is 1 V/div ?



Time-base switched on

1 V /div

$$\text{dc voltage} = 4\ \text{div} \times \frac{1\,V}{div}$$

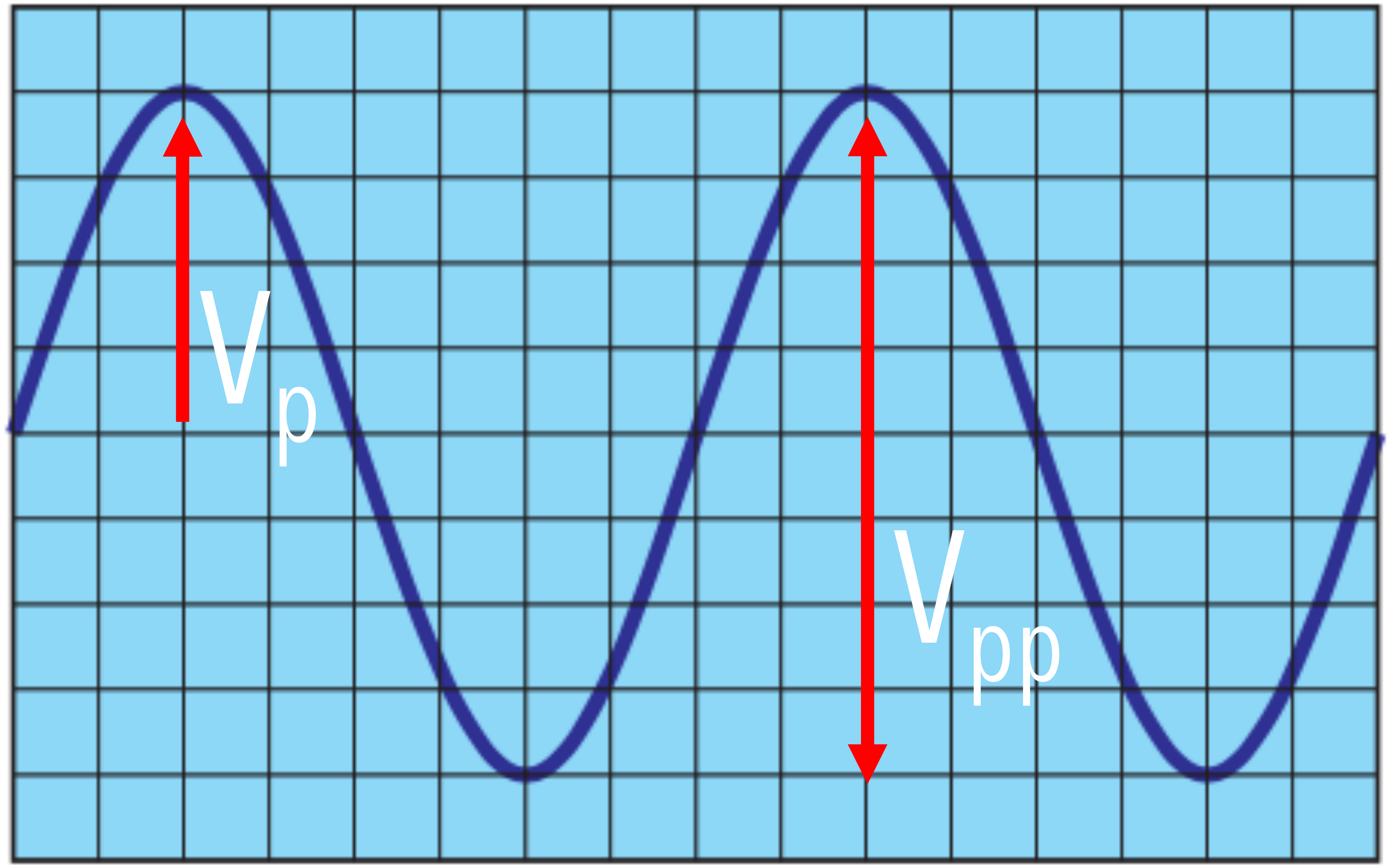
$$= 4\ \text{V}$$

example

Measuring Potential Difference using the CRO

Calculate the **peak voltage** and **peak to peak voltage**.

Y-gain = 3 V/div



peak voltage

$= 4 \text{ div} \times \frac{3\ V}{div}$

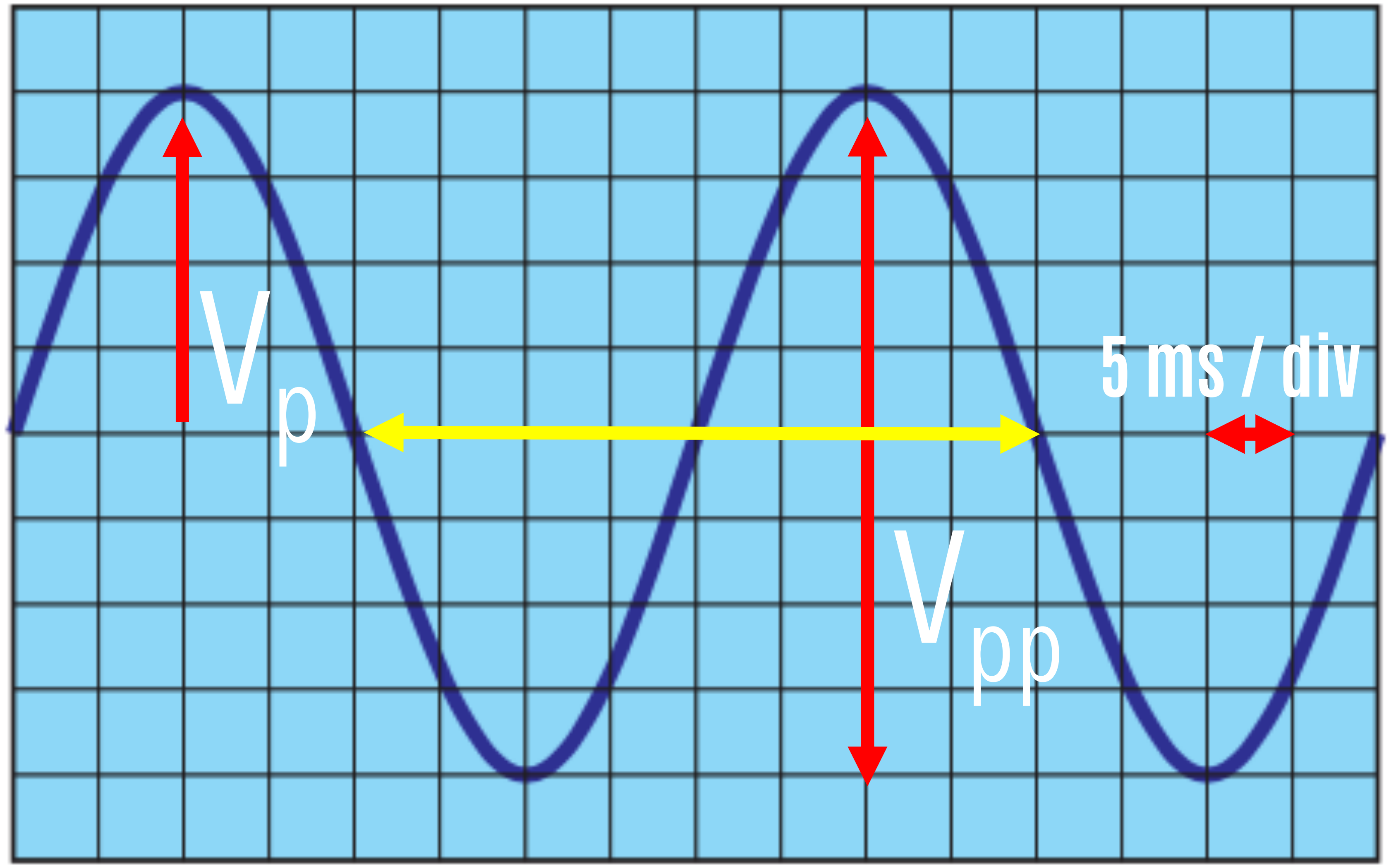
$= 12$ V

peak to peak voltage

$= 8 \text{ div} \times \frac{3\ V}{div} \quad = 24$ V example

Solve problems based on the CRO display

Y-input of an CRO setting at 20 V/div and 5 ms/div



peak voltage

$= 4 \text{ div} \times \frac{20\ V}{div} = 80\ V$

peak to peak voltage

$= 8 \text{ div} \times \frac{20\ V}{div} = 160\ V$

Period (T)

$= 8 \text{ div} \times \frac{5\ ms}{div}$

$= 40\ ms = 4.0\ x\ 10^{-3}$ s

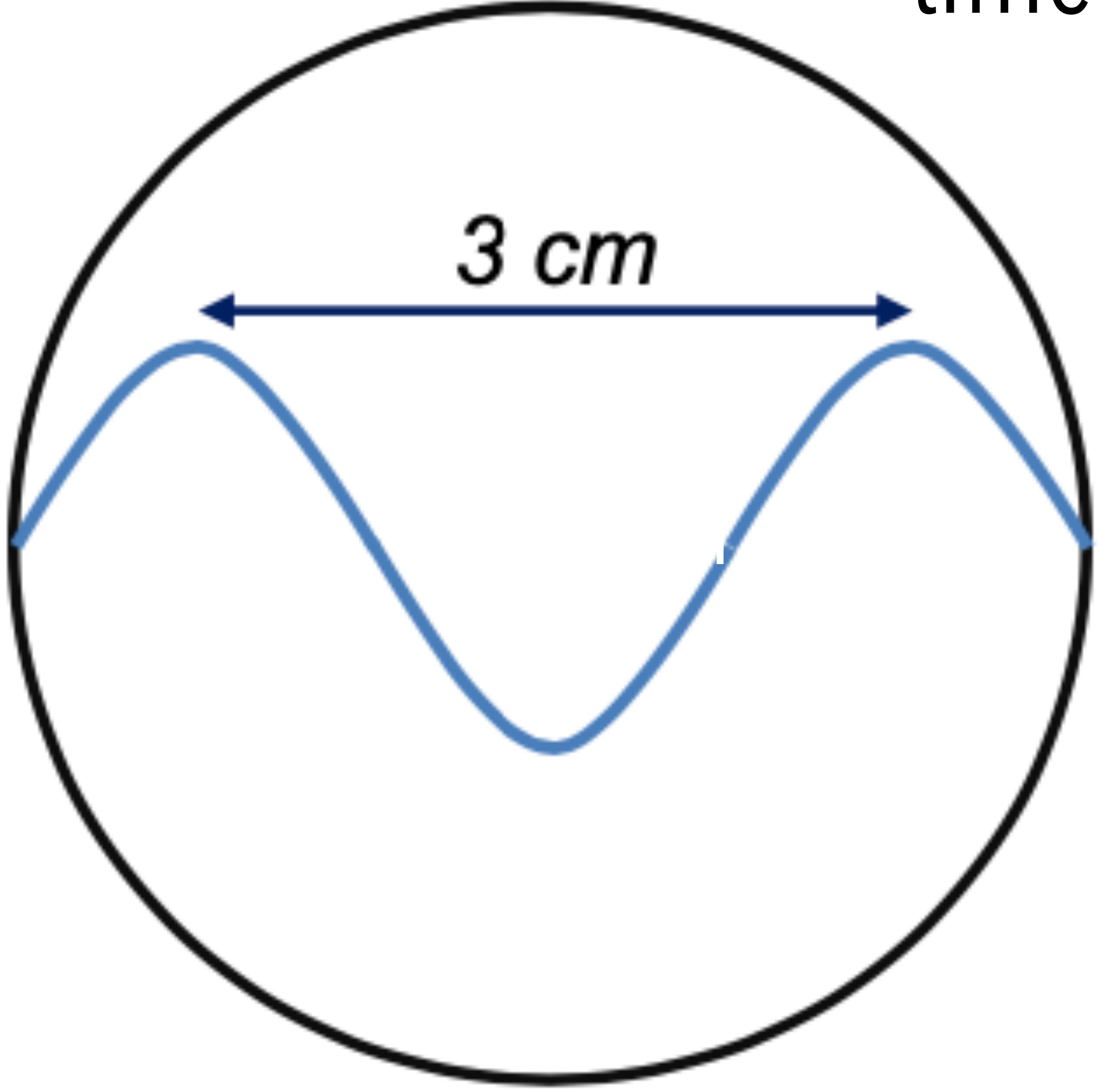
Frequency

$= \frac{1}{T} = \frac{1}{4.0\ x\ 10^{-3}} = 25\ Hz$

example

Solve problems based on the CRO display

The length between the two crests is 3 cm.
(Given 1 division = 1cm)
time-base is set to 5 ms/div



Period (T)

$= 3 \text{ div} \times \frac{5\ ms}{div}$

$= 15\ ms = 0.015$ s

Frequency

$= \frac{1}{T} = \frac{1}{0.15} = 66.67\ Hz$

When the frequency of the wave is double, what is the length between the two crests?

Frequency double (2 times)

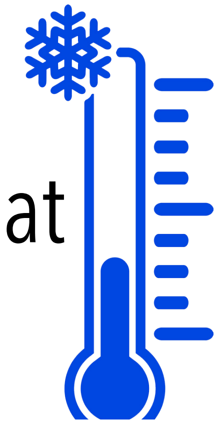
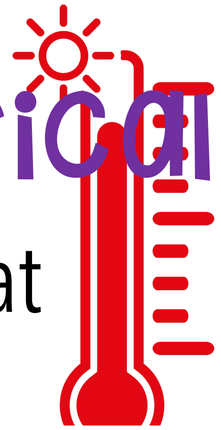
∴ Period decrease (2 times)

$\text{Length} = \frac{3}{2} = 1.5 \text{ cm}$

4.2 semiconductor

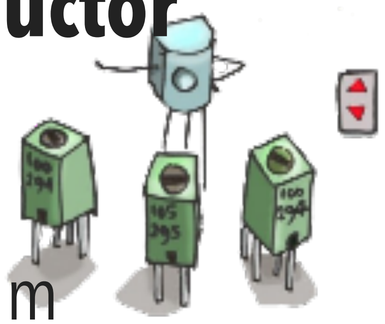
material that has **electrical conductivity** that is **between** that of a **conductor** and an **insulator**

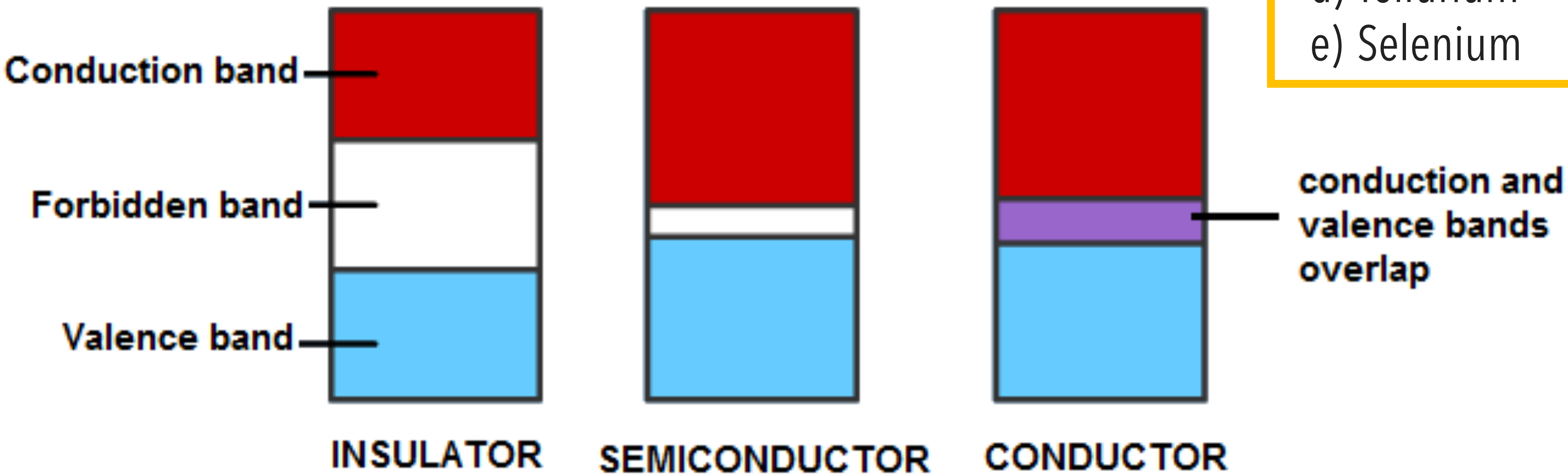
characteristic

as **insulator** at  has **good electrical conductivity** at 

Example of semiconductors are:

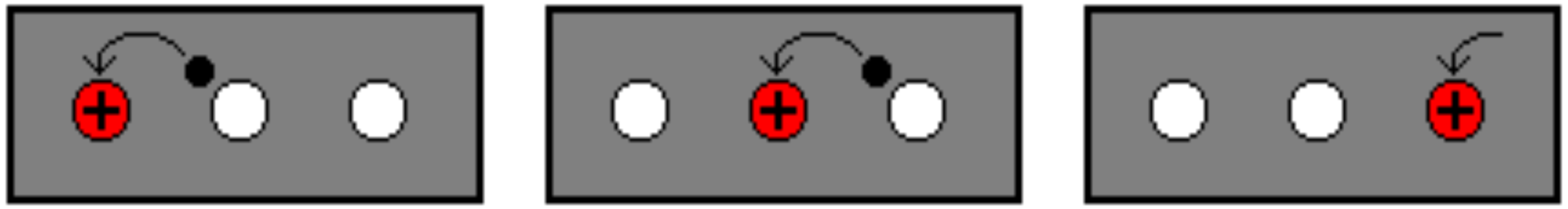
a) Silicon
b) Germanium
c) Boron
d) Tellurium
e) Selenium





Comparison between **energy gap** in insulator, semiconductor and conductor

free electrons carry negative charge
holes carry positive charge



electron moving to the left = 'holes' moving to the right

doping

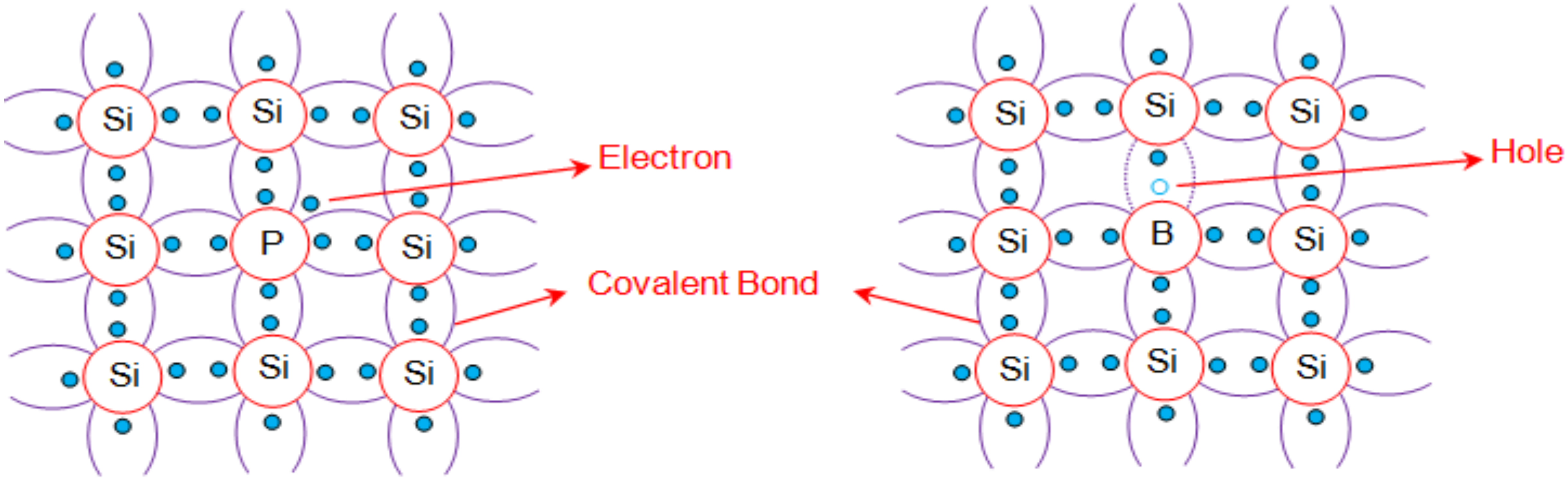
a process of adding a small amount of **impurities** to a semiconductor

3P BAGI

3 → trivalent
P → p-type
Doping material → B = Boron
A = Aluminium
G = Gallium
I = Indium
Role of doping material → atom **receiver**
Majority charge carrier → **holes**
Minority charge carrier → **free electrons**

5N APA

5 → pentavalent
N → n-type
Doping material → A = Antimony
P = Phosphorus
A = Arsenic
Role of doping material → atom **donor**
Majority charge carrier → **free electrons**
Minority charge carrier → **holes**

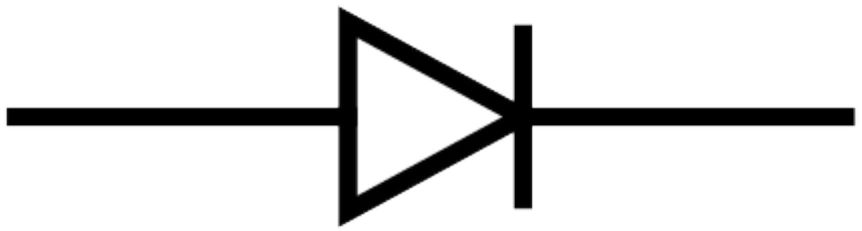


n-type

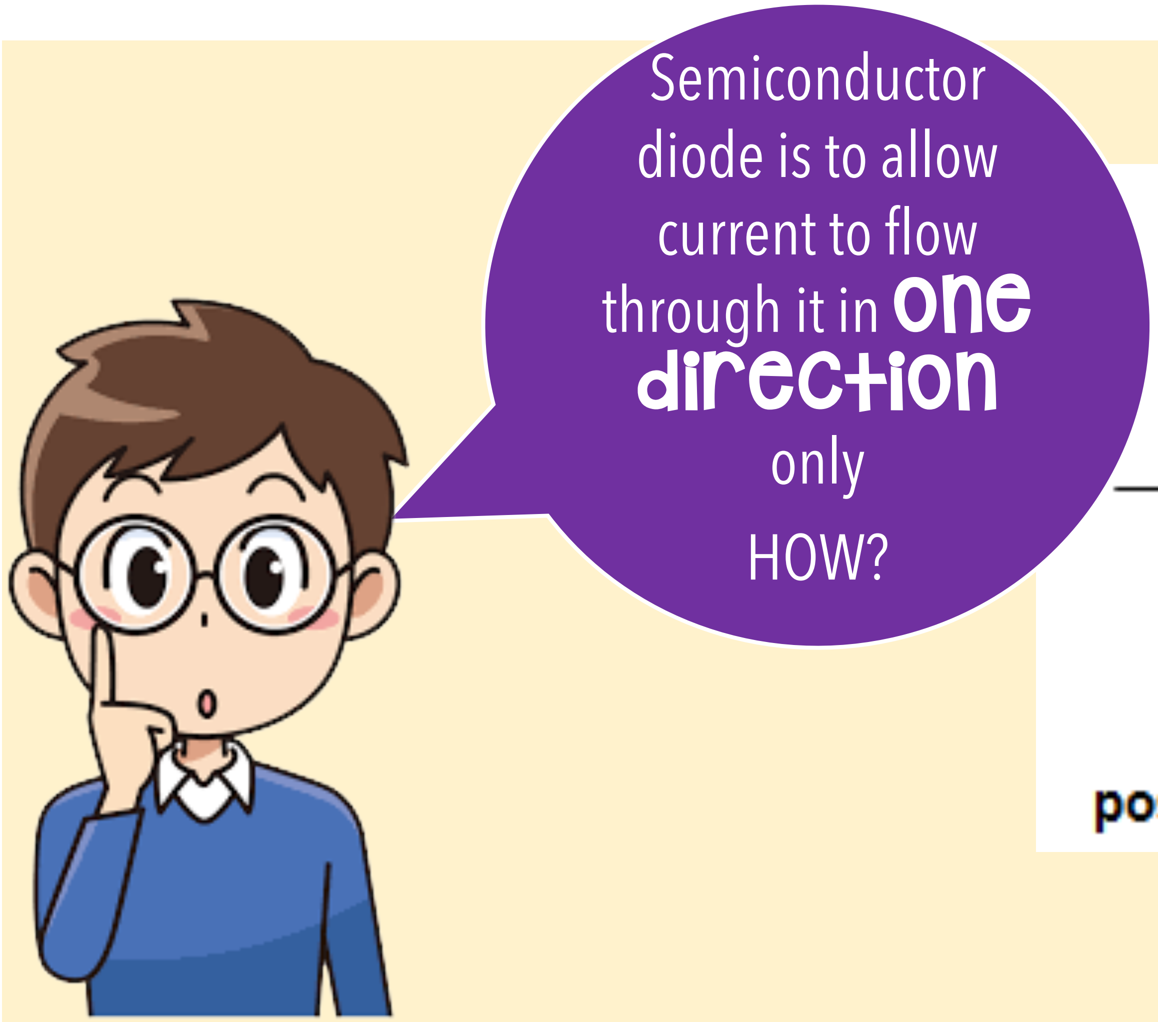
p-type

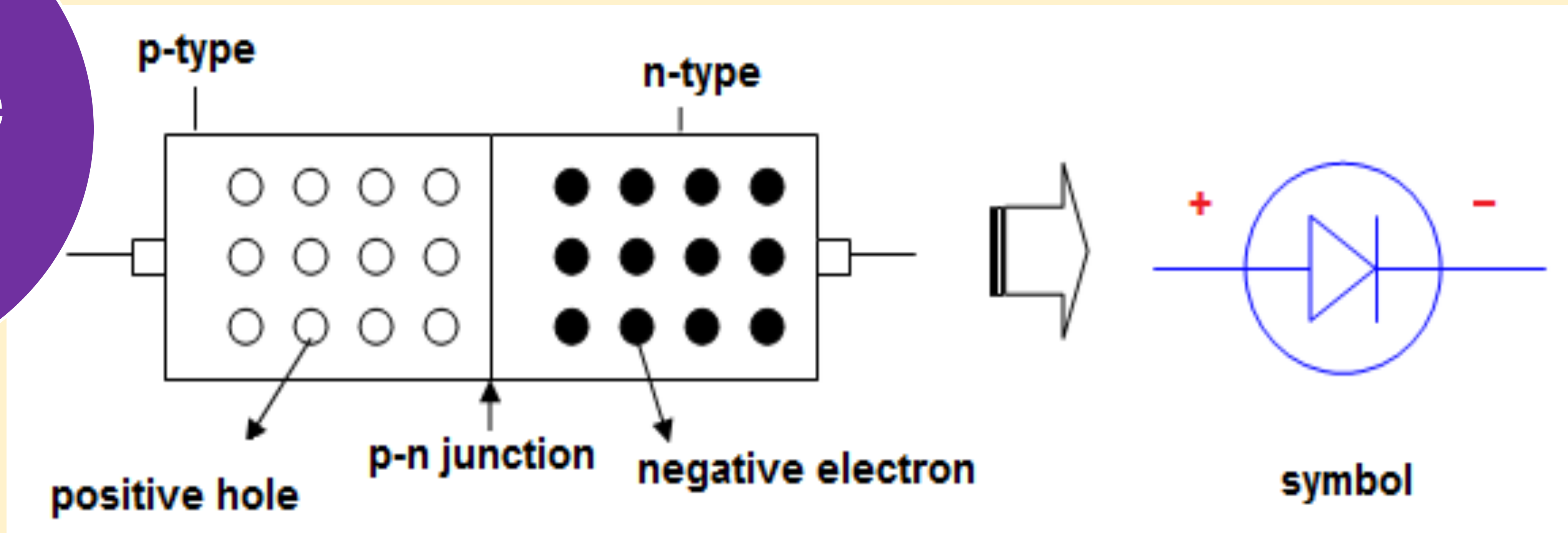
Combination of **p-type** semiconductor with **n-type** semiconductor with produce a semiconductor **Diode**

Anode (+)



Cathode (-)

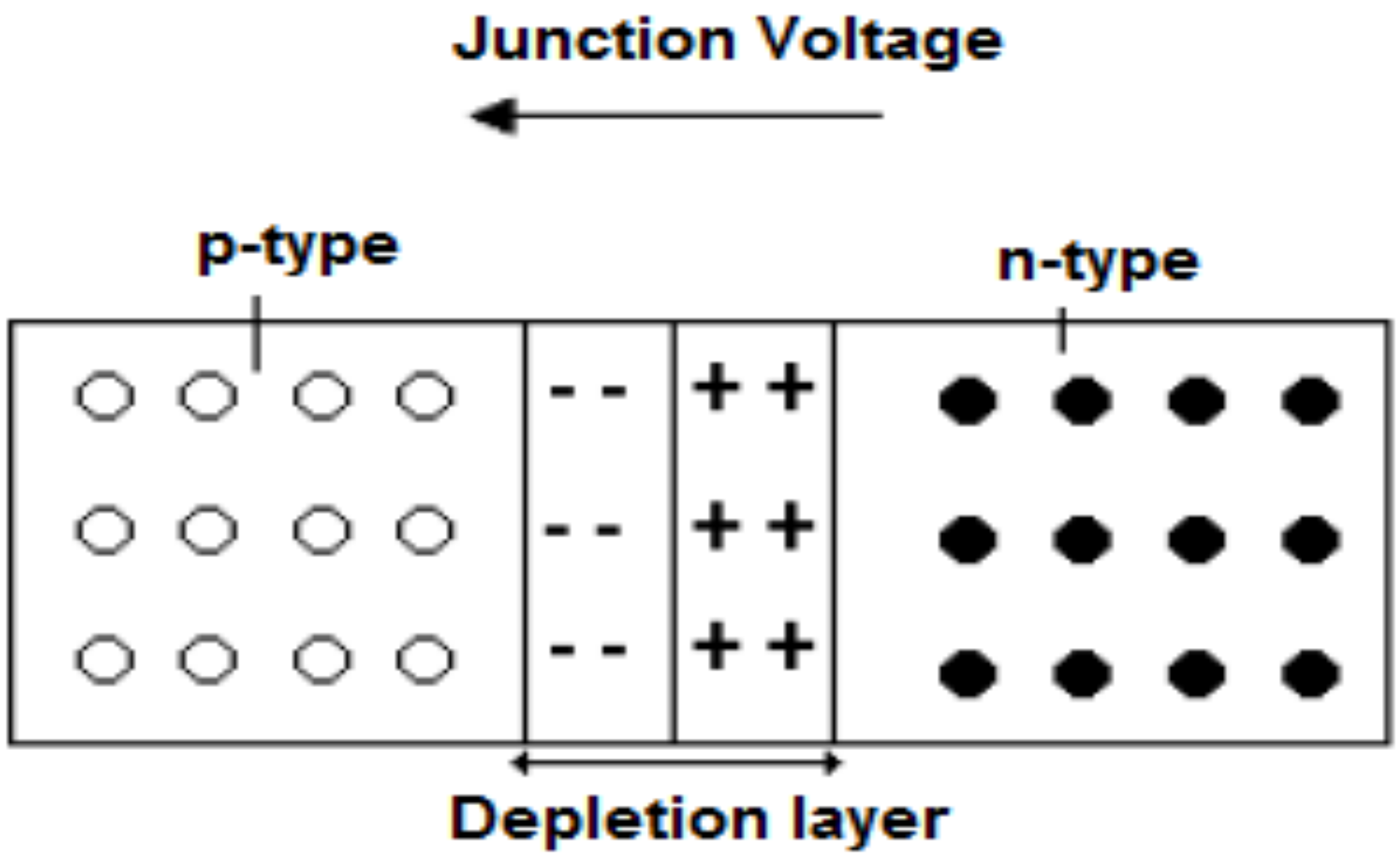




Depletion layer

neutral region which has **no charge carriers** and **poor conductor of electricity**

The **wider** the depletion layer, **no current** flow



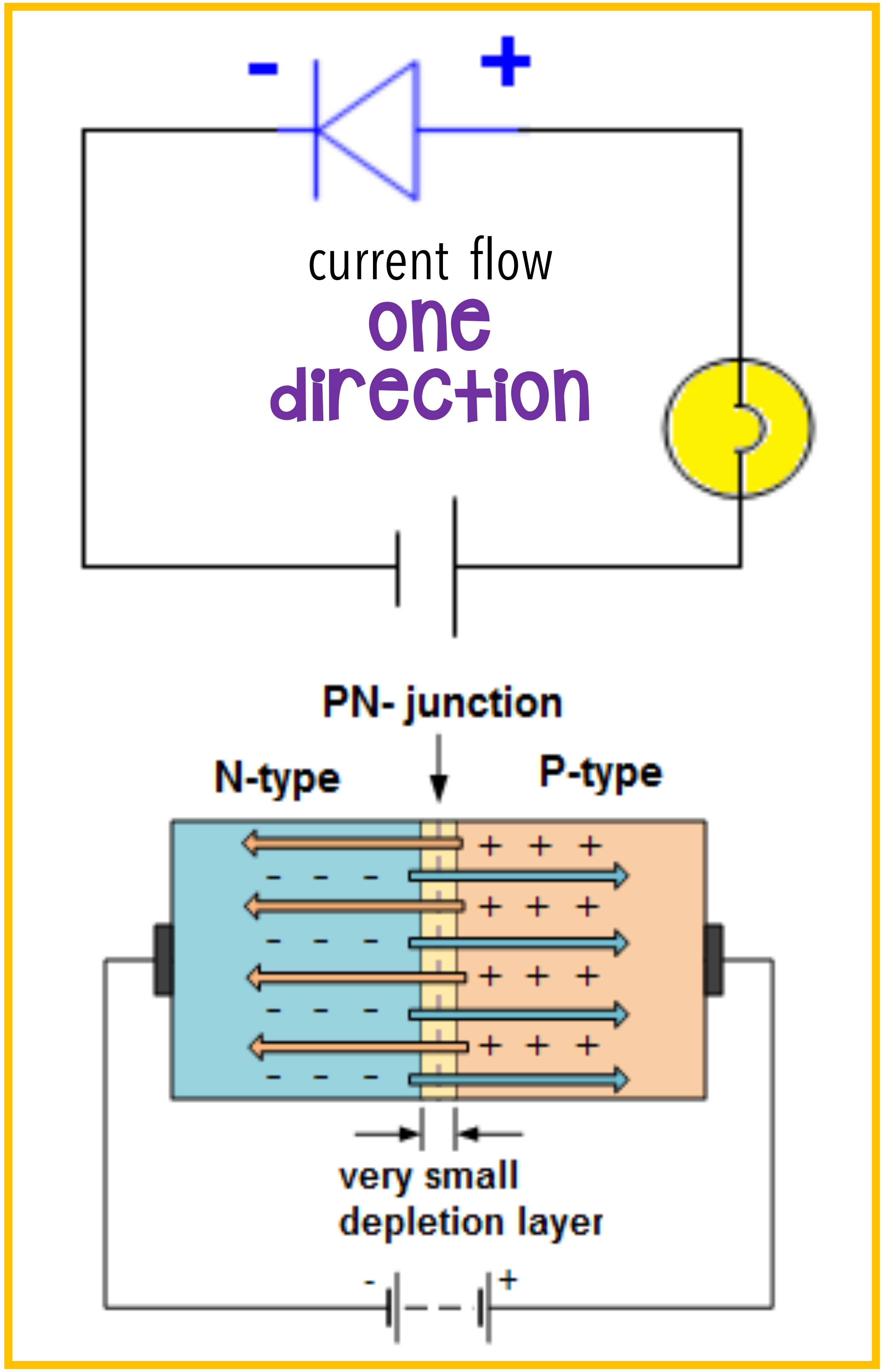
Forward bias

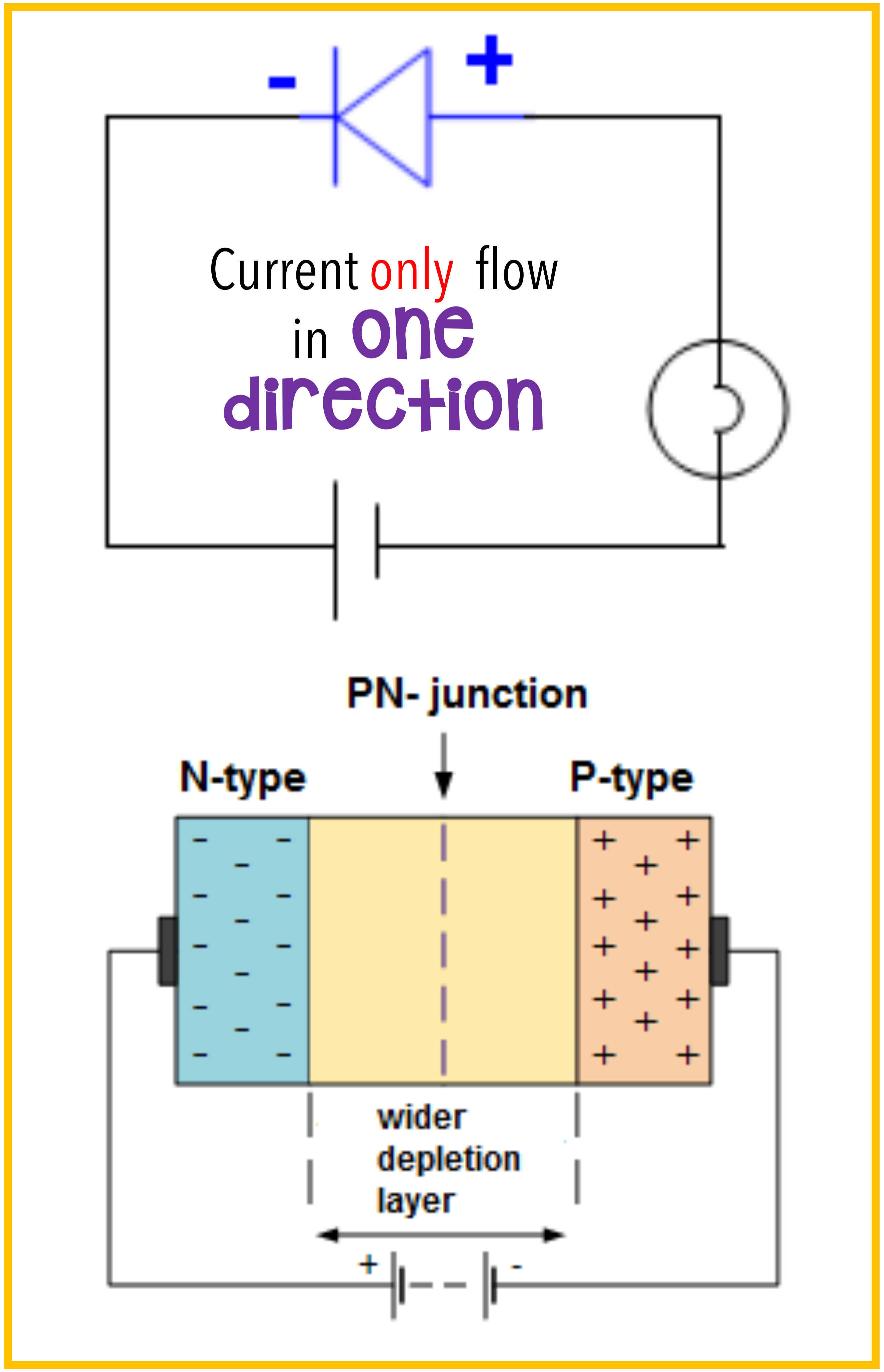
n-type semiconductor is connected to **negative dry cell**

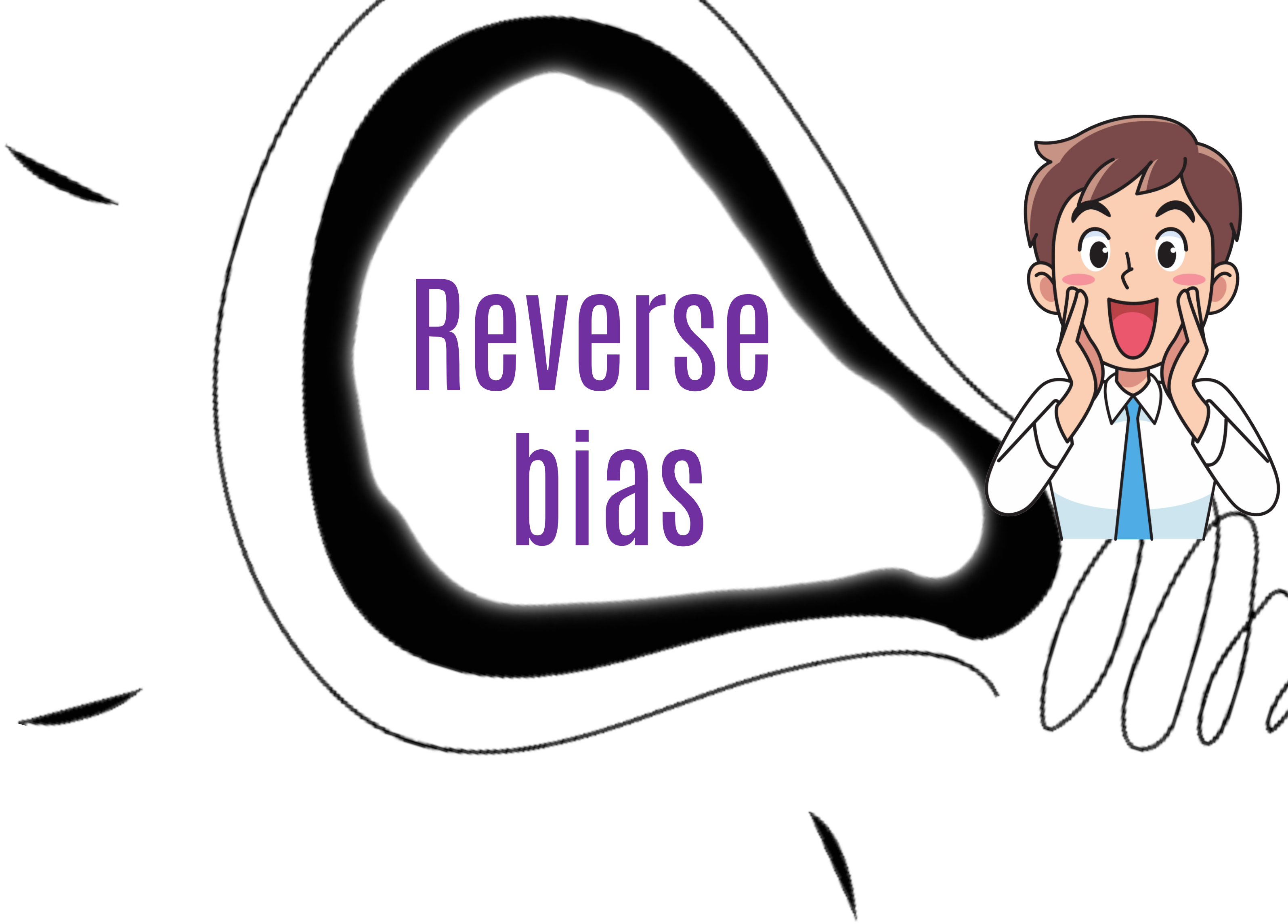
Depletion layer is **narrow**
(resistance diode decrease)

current flow

Bulb **light up**







n-type semiconductor is connected to **positive dry cell**

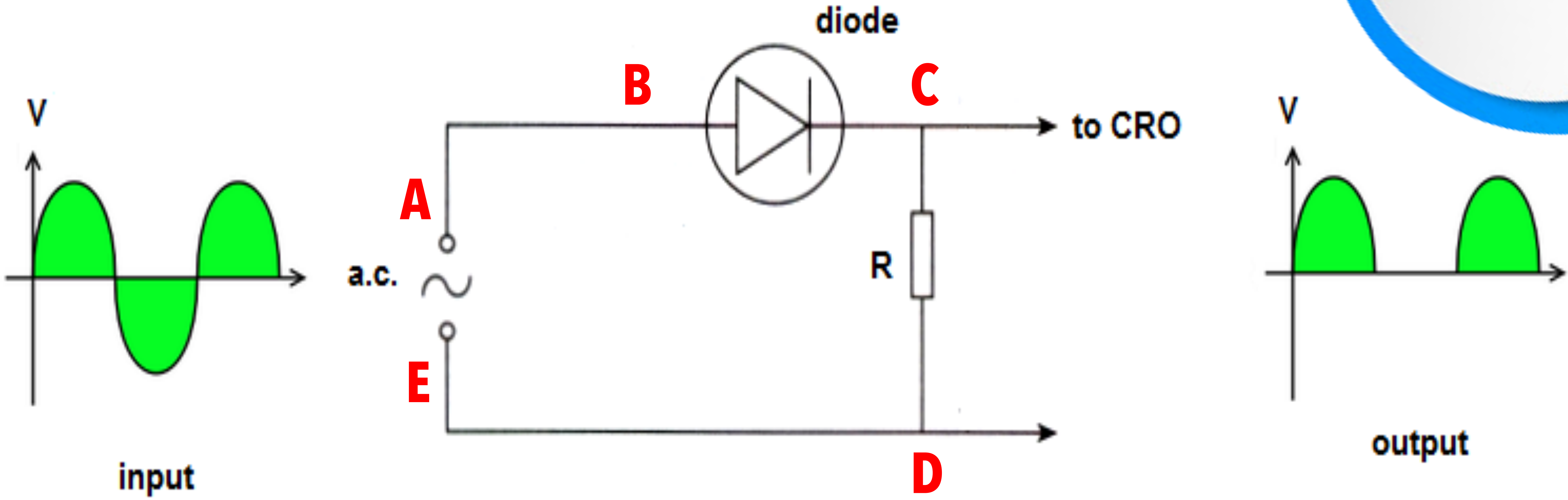
Depletion layer is **wide**
(resistance diode increase)

No current flow

Bulb **not light up**

Rectification is a process to convert an alternating current into a direct current by using a diode

Half wave rectification

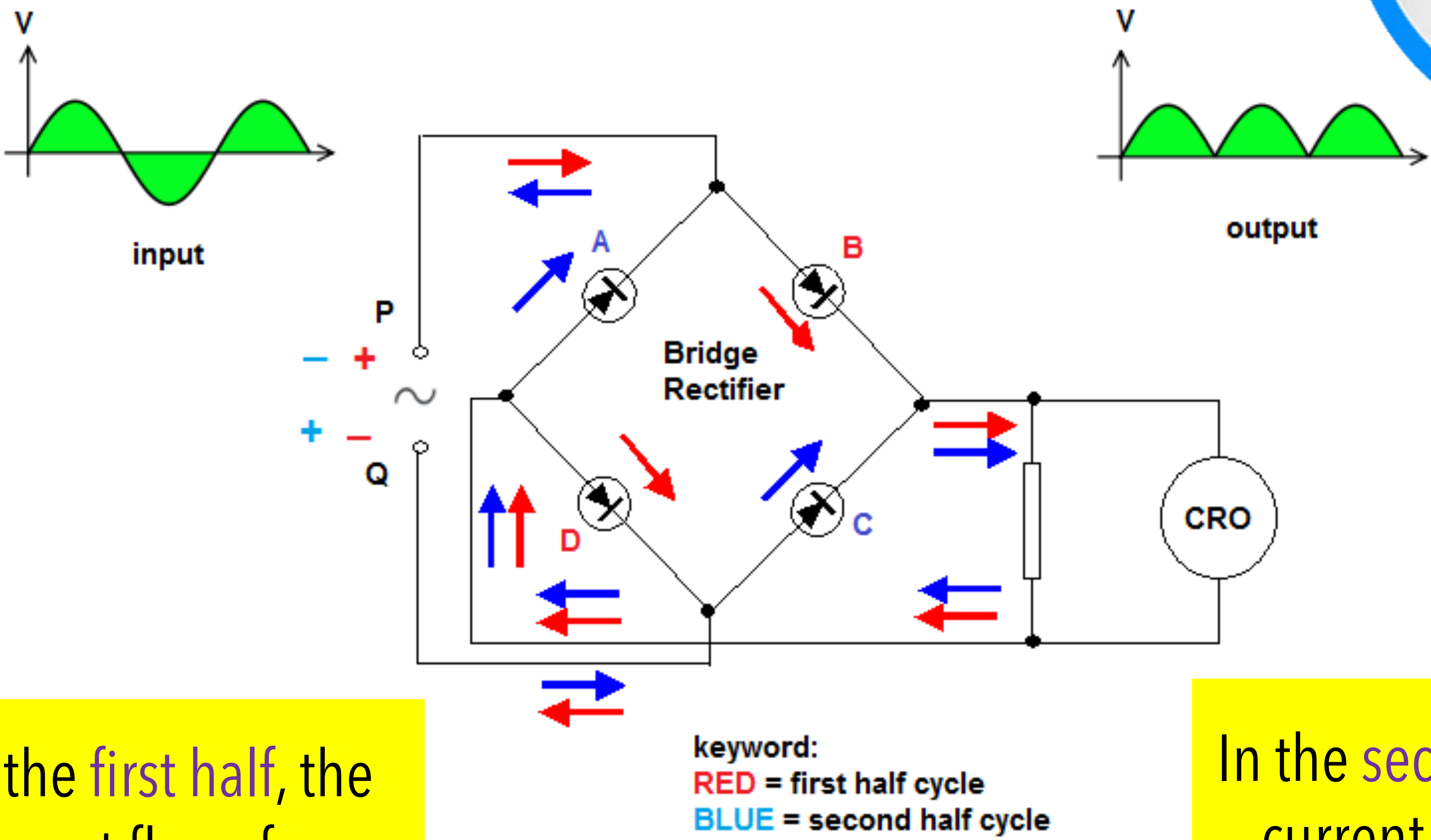


current will only flow in the first half-cycle when the diode in **forward bias** (A → B → C → D → E)

The current is blocked in the second half-cycle when the diode is in **reverse bias** (E → D → C → B → A)

Rectification is a process to **convert** an **alternating current** into a **direct current** by using a **diode**

FULL Half wave rectification



In the first half, the current flows from P → B → D → Q

In the second half, the current flows from Q → C → A → P

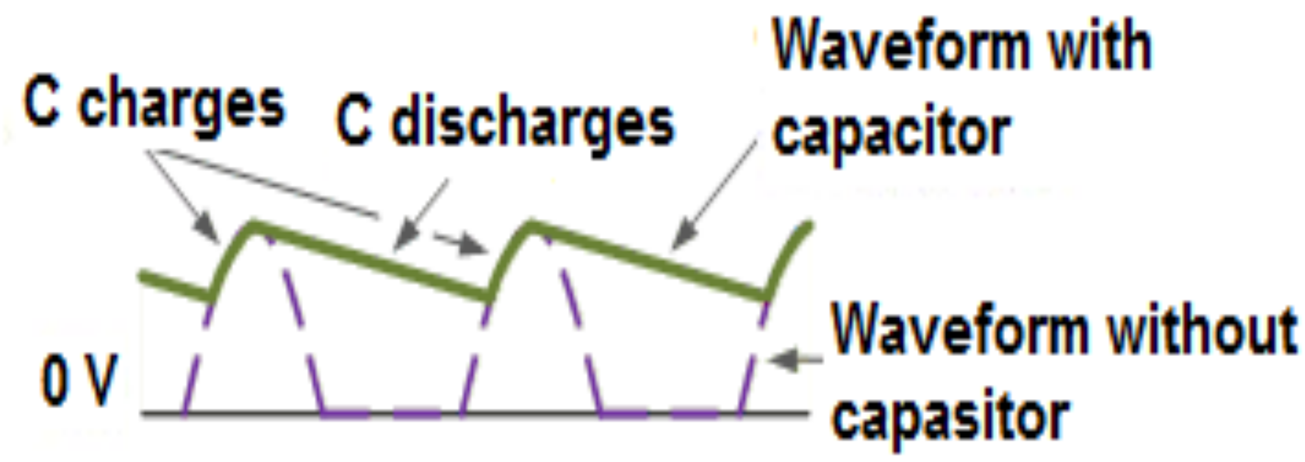
The uses of capacitor

When the **current** pass through the resistor and capacitor, the **capacitor is charged** and stores energy.

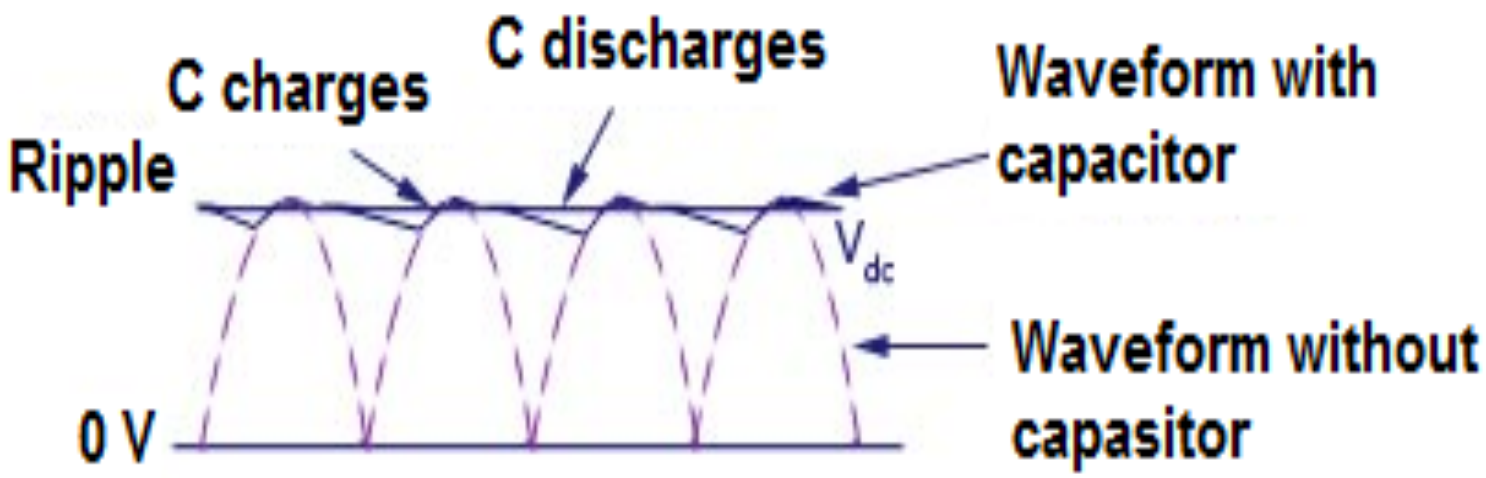
When there is **no current** pass through the resistor and capacitor, the **capacitor discharge**

The energy from it is used to produce voltage across the resistor.

As a result it produces a **smooth dc output**



half-wave

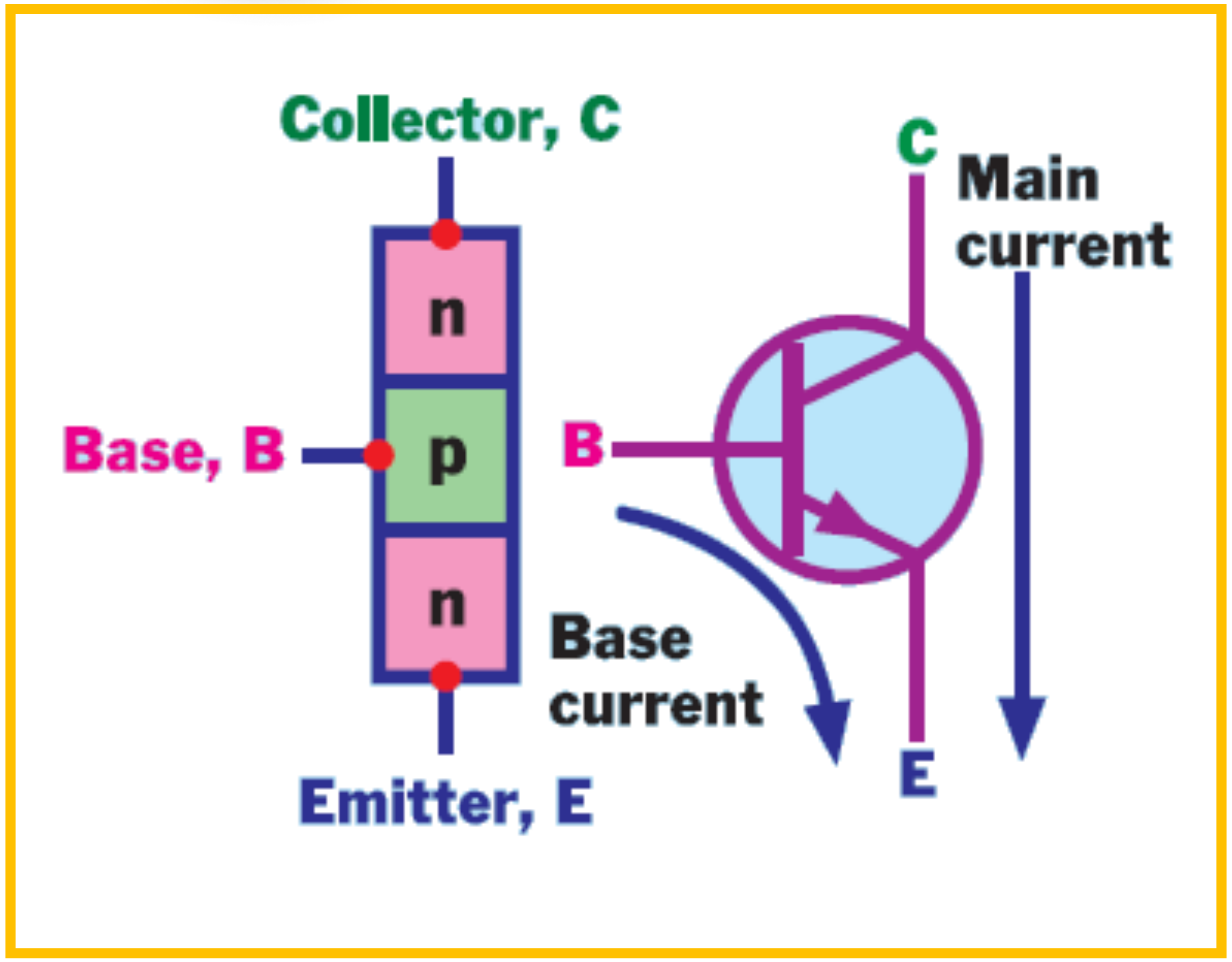


full-wave

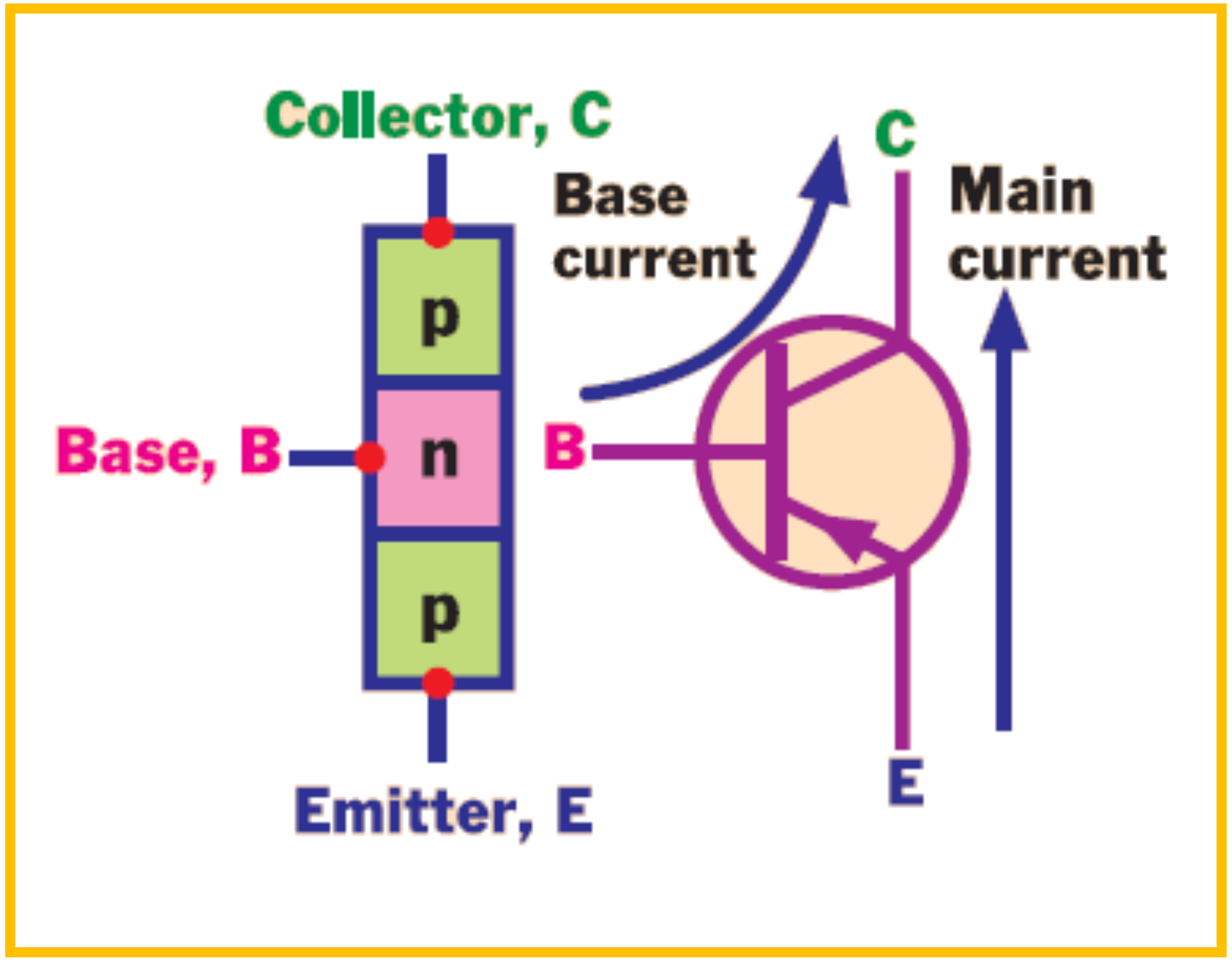
transistor

4.3

To amplify the current or act as a switch



npn transistor



pnp transistor

Transistor as a current amplifier

small I_B → bigger I_C

when $I_B = 0$, $I_C = 0$

$I_B \neq I_C$

$I_C > I_B$

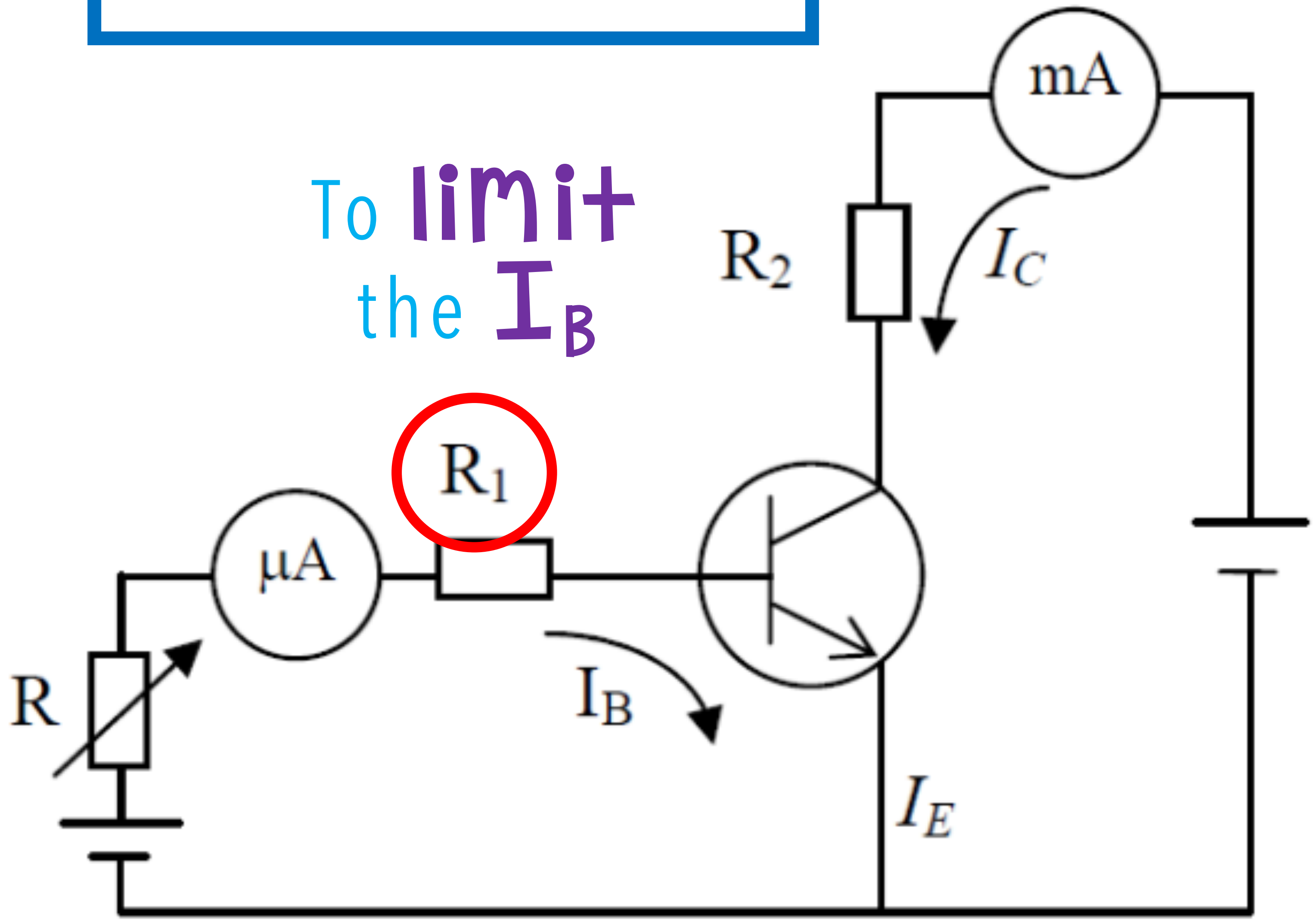
$I_E > I_C > I_B$

$I_E = I_C + I_B$

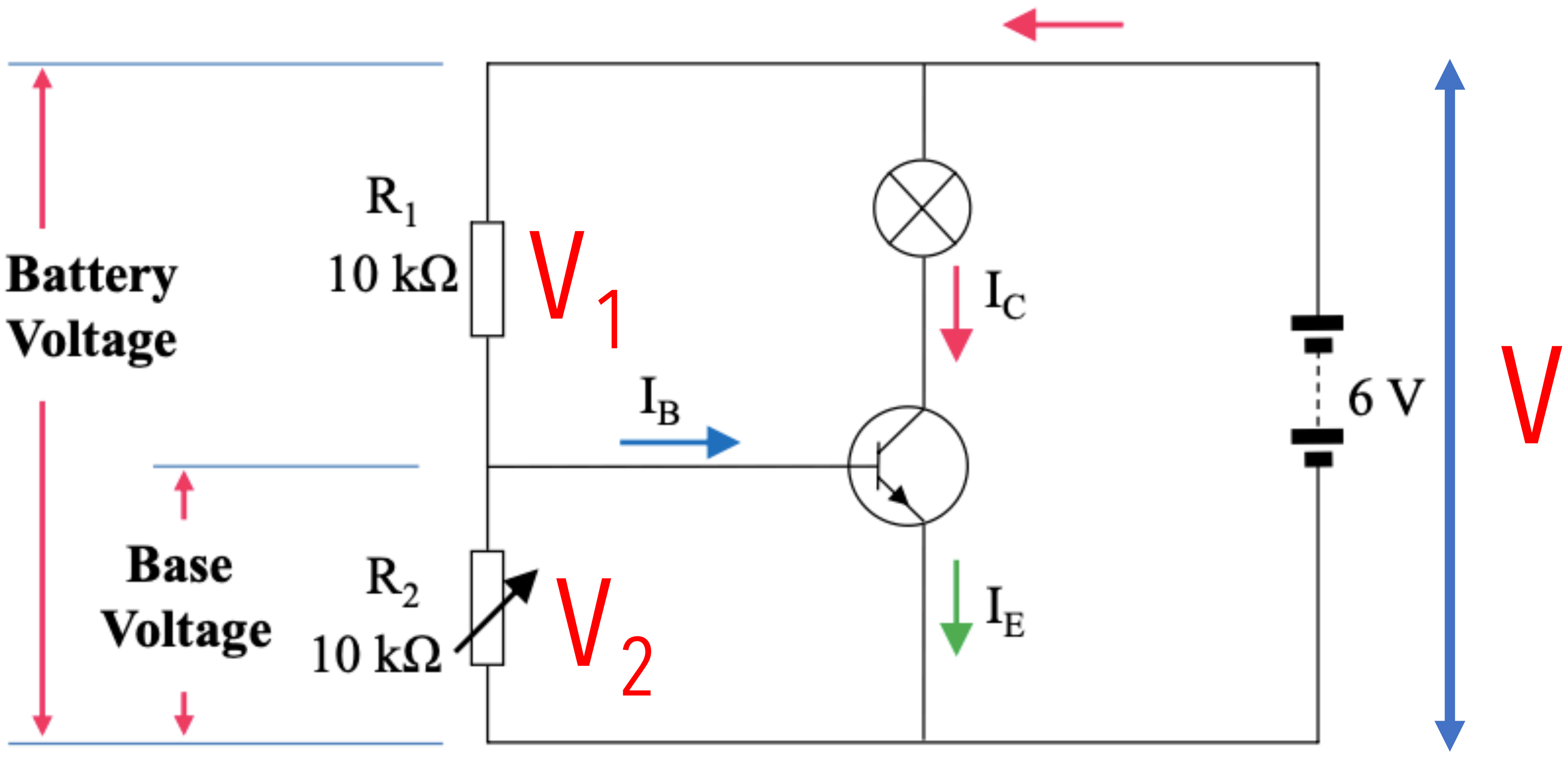
current Amplification:

$$= \frac{\Delta I_C}{\Delta I_B}$$

To limit the I_B



Transistor as a potential divider

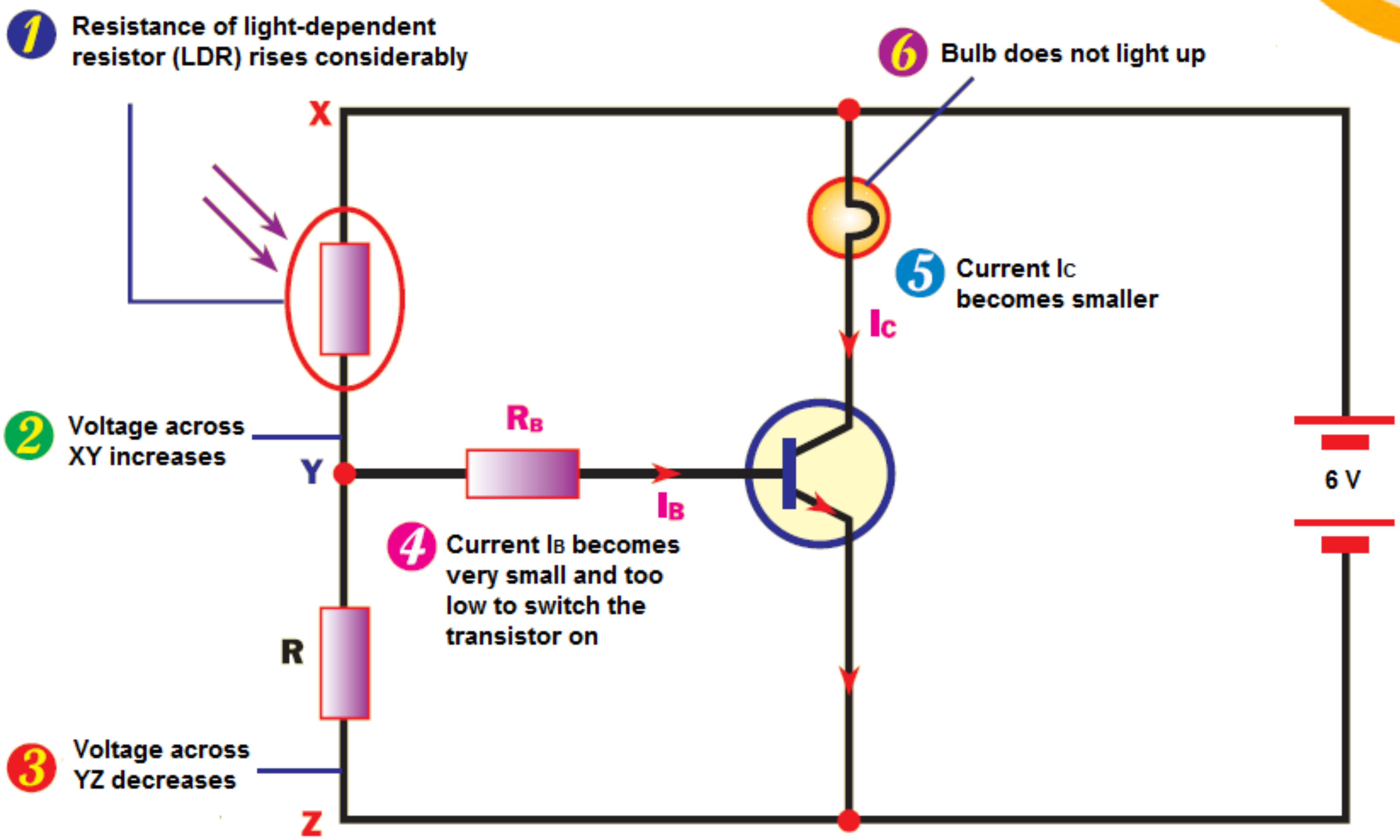


$$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) V \qquad V_2 = \left(\frac{R_2}{R_1 + R_2}\right) V$$

$$V_1 + V_2 = V$$

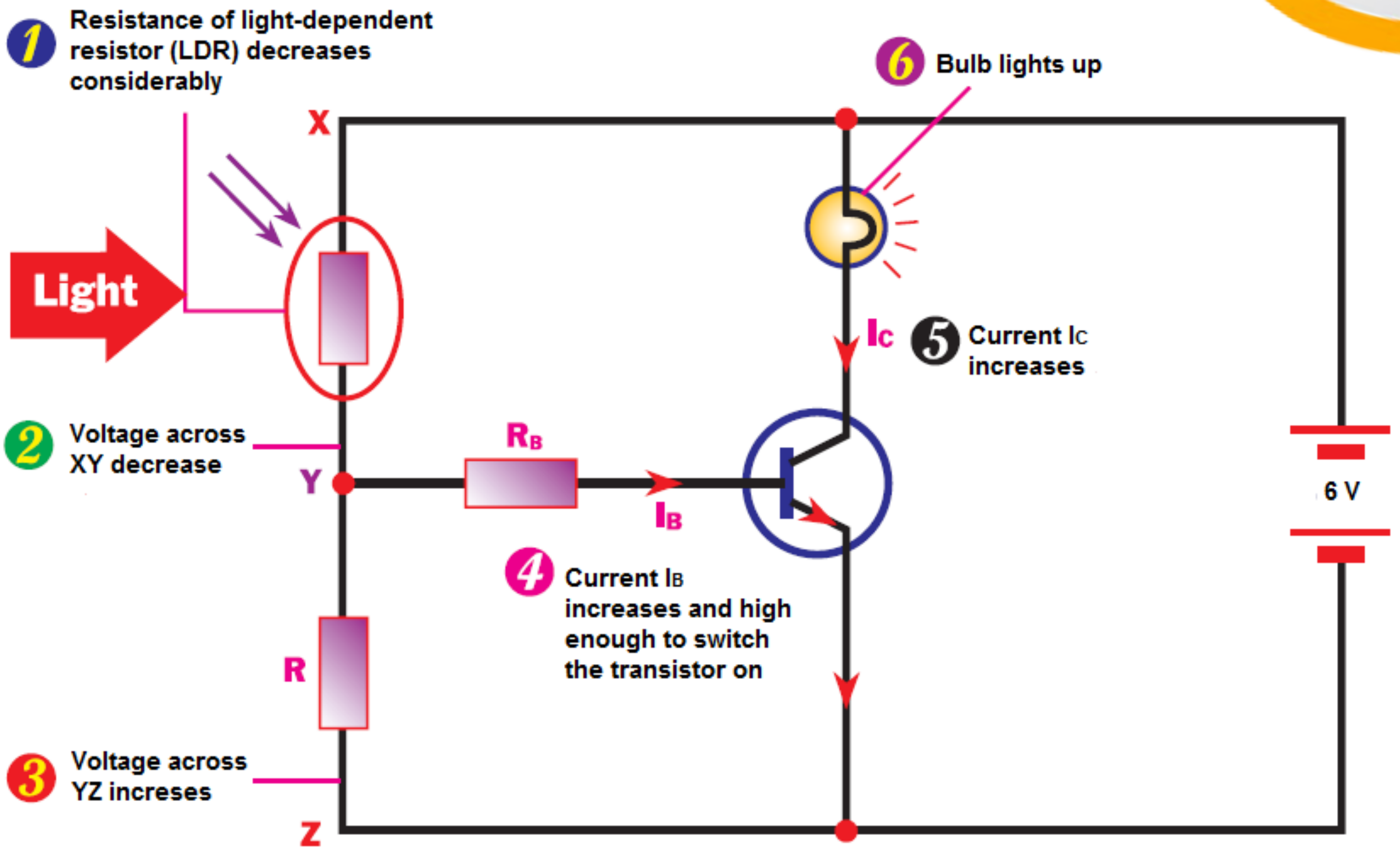
The uses of transistor

LIGHT CONTROLLED SWITCH

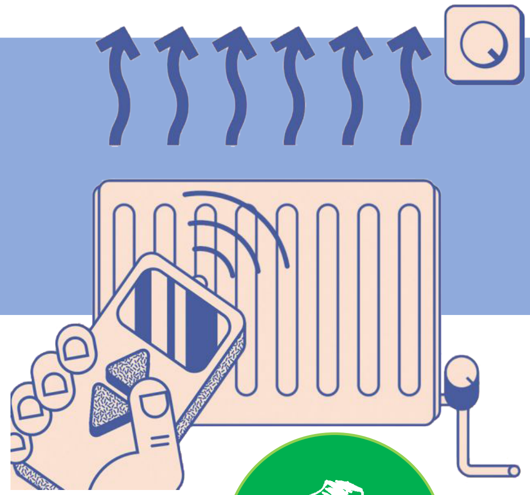


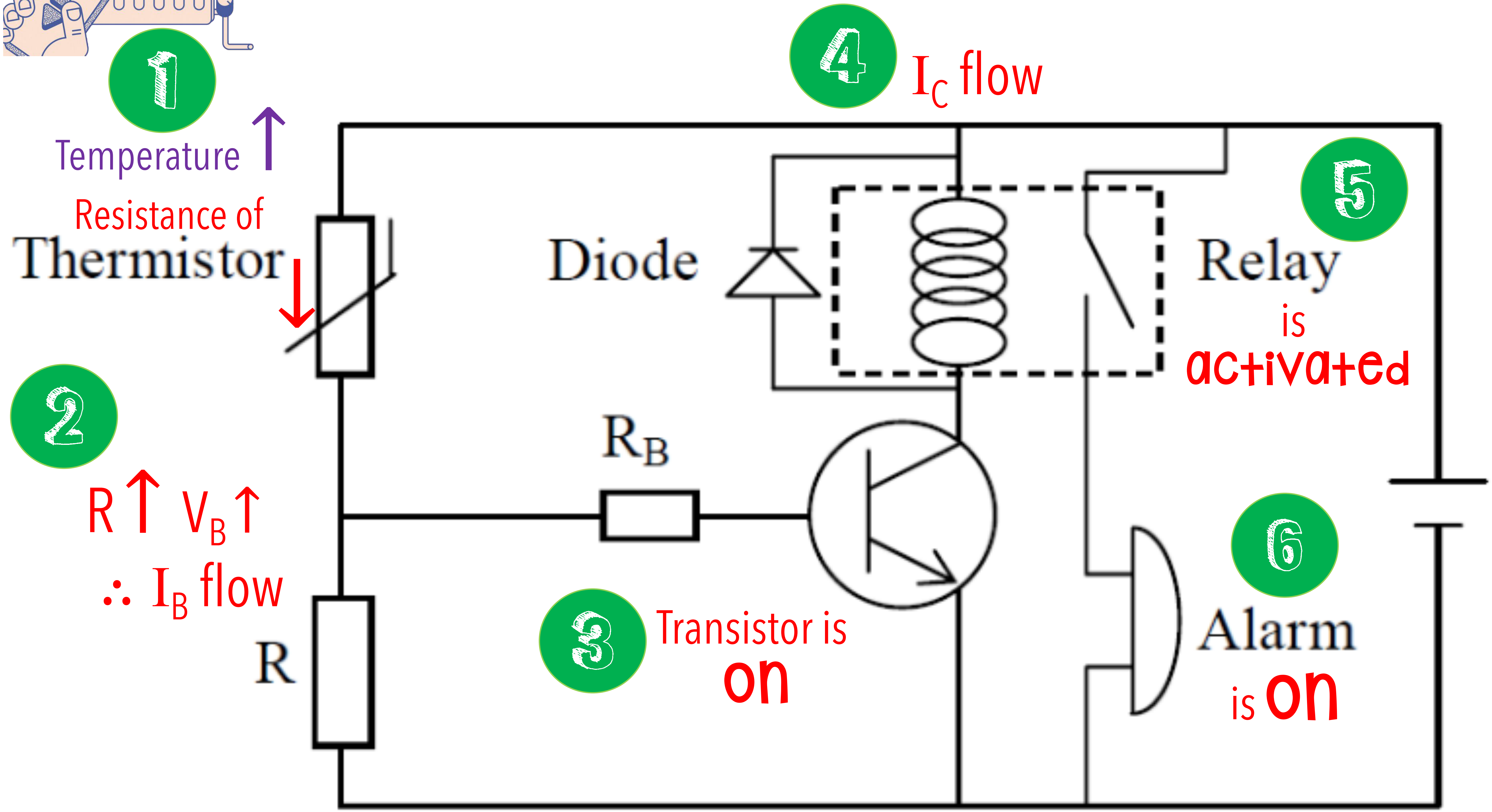
The uses of transistor

LIGHT CONTROLLED SWITCH

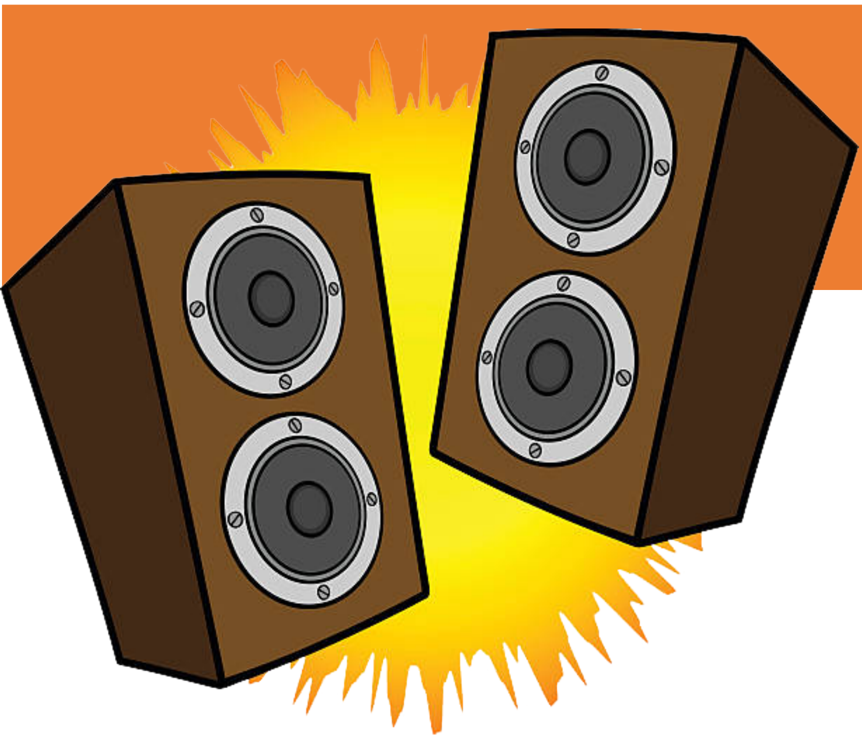


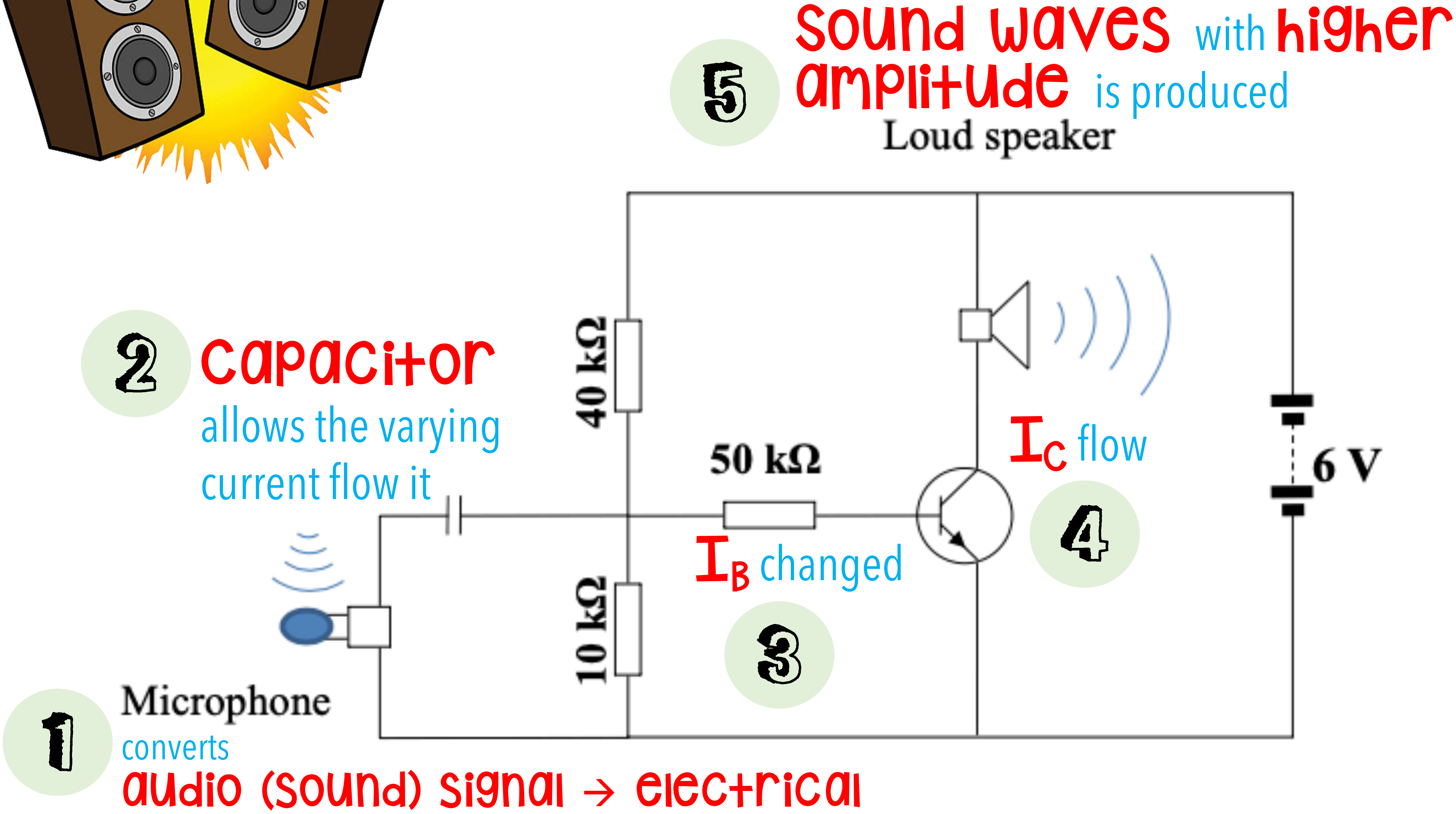
HEAT CONTROLLED SWITCH



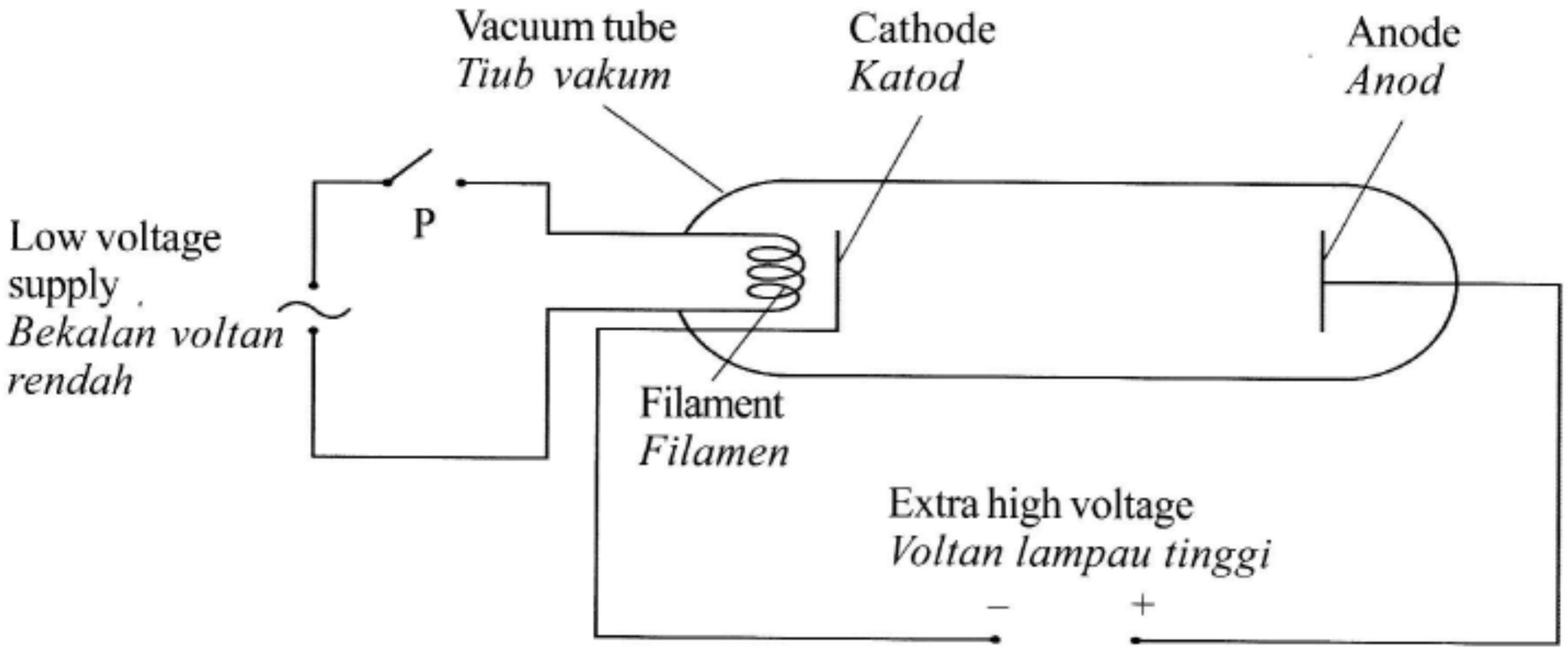


SOUND AMPLIFIER





EXAMPLE: Diagram 1 shows a simple cathode rays tube. Cathode emits electrons when switch P is closed.



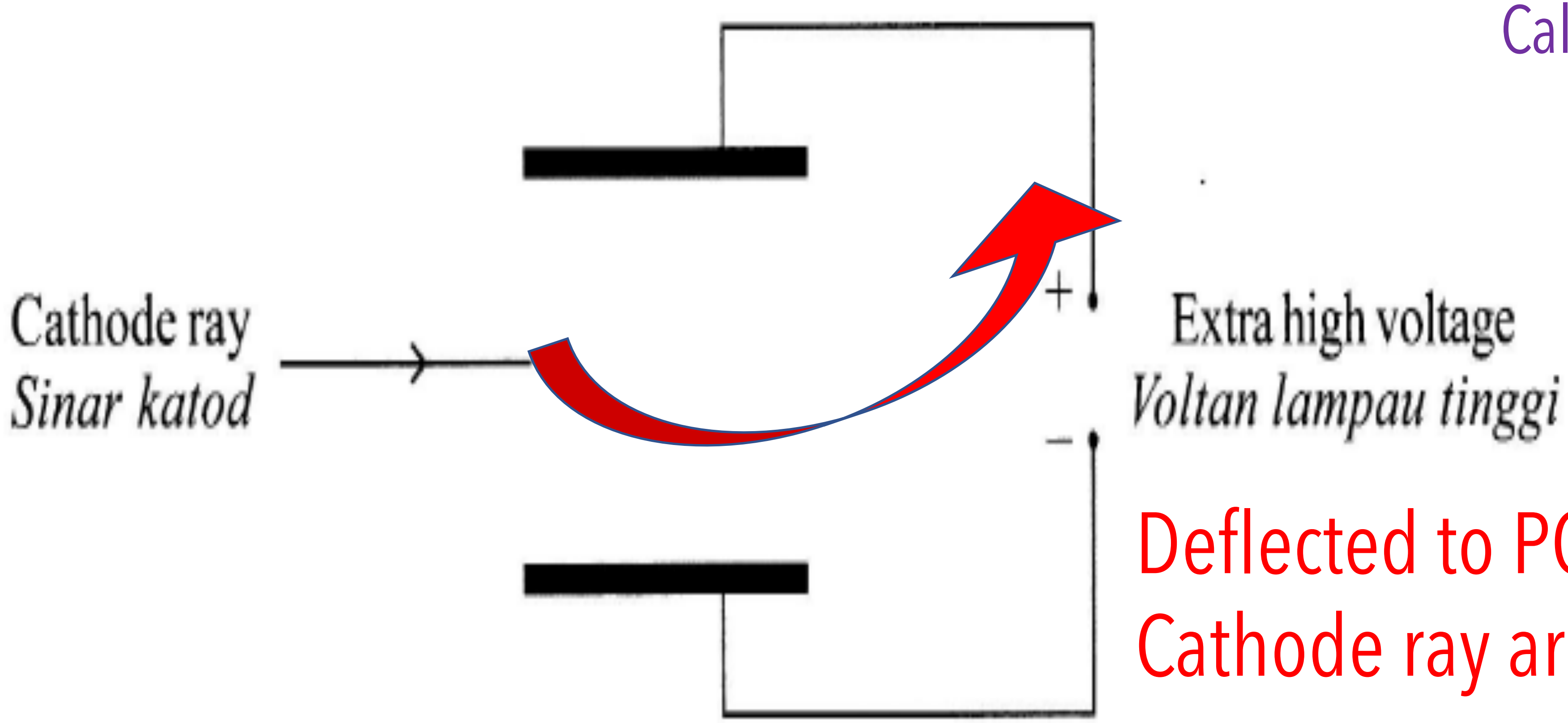
(a) Name the process that enables the emission of electrons at the cathode.

Thermionic Emission

(b) State one reason why the extra high voltage is used

To accelerate the electron

(c) complete the path of the cathode ray.



Deflected to POSITIVE

Cathode ray are negatively charge

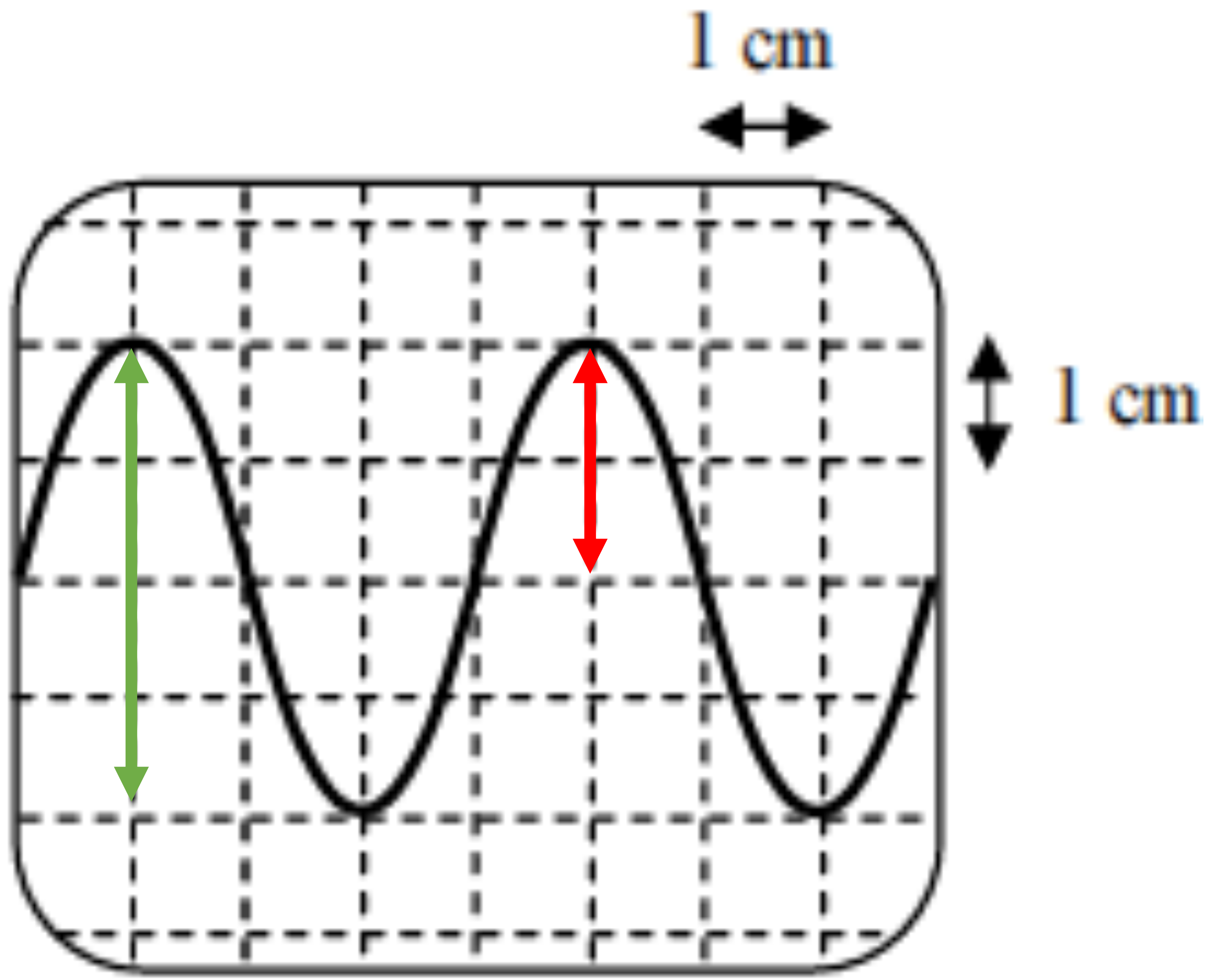
(d) When electrons flow in the cathode rays tube, the current produced in 5 seconds is 0.01A. Calculate the total charge of the electrons.

$Q = I\,t = (0.01)(5)$

$Q = 0.05\ C$

EXAMPLE:

Diagram 2 shows a waveform on cathode ray oscilloscope (CRO) screen.
If the Y-input of CRO is set at 5.0 V cm^{-1}, what is the **peak voltage**?



Y-input : 5.0 V cm^{-1}

$$V_P = 2\text{ div} \times \frac{5\,V}{div}$$

$$V_P = 10\text{ V}$$

Extra: what is the **peak to peak voltage?**

$$V_{PP} = 4\text{ div} \times \frac{5\,V}{div}$$

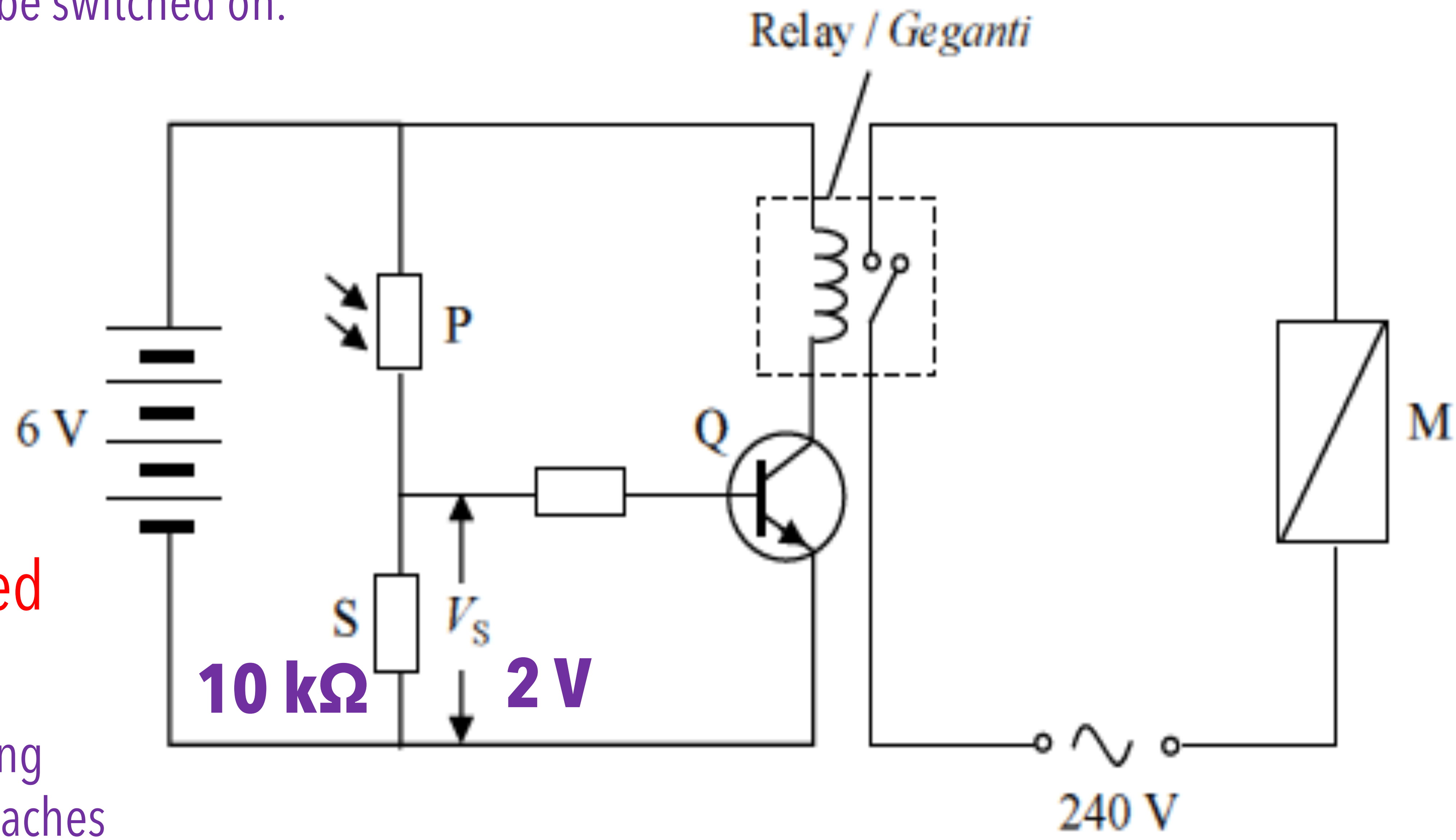
$$V_{PP} = 2\,V_P = 20\text{ V}$$

EXAMPLE:

Diagram 3 shows a circuit which acts as a switch to switch on an air conditioner, M, during the day only. P is a light dependent resistor which has a low resistance when its surroundings is bright.

Explain how the air conditioner, M, to be switched on.

- When LDR detect light, resistance of LDR ⬇️
- Resistance S ⬆️
- Vs ⬆️
  I_b flow to switch on the transistor
- I_c flow and relay is activated air conditioner, M is on



The air conditioner, M, with power rating 240 V, 2 kW, is switched on when V_S reaches 2.0 V. If the resistance of S is 10 kΩ, calculate the resistance of P.

$$V_S = \left(\frac{R_S}{R_P + R_S}\right) V$$

$$2 = \left(\frac{10k}{R_P + 10k}\right) 6$$

$$2R_P + 20\,k = 60\,k$$

$$2R_P = 40\,k$$

$$R_P = 20\,k\Omega$$

Explain why the air conditioner is not connected directly to the transistor circuit.

Air conditioner needs higher voltage to activate which is 240 V

EXAMPLE:

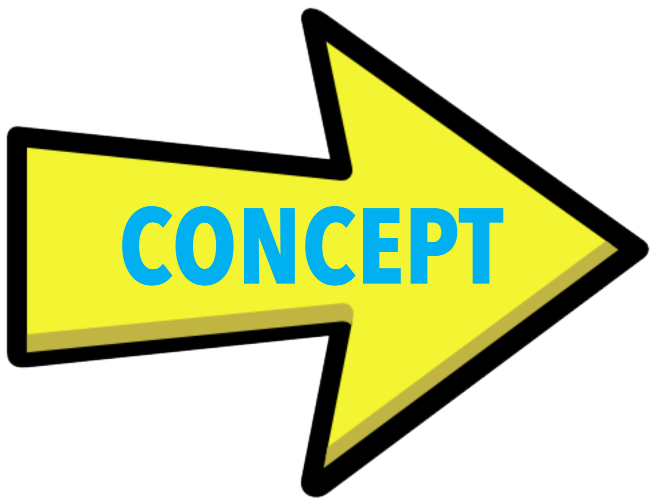
Diagram 4 shows a circuit with a transistor that acts as an automatic switch. The resistance of resistor X is 40 kΩ when it is in the dark. Calculate:

(a) The potential difference between T and U.

$$V_{TU} = \left(\frac{R_{TU}}{R_{ST} + R_{TU}}\right) V$$

$$V_{TU} = \left(\frac{40k}{10\ k + 40k}\right) 6$$

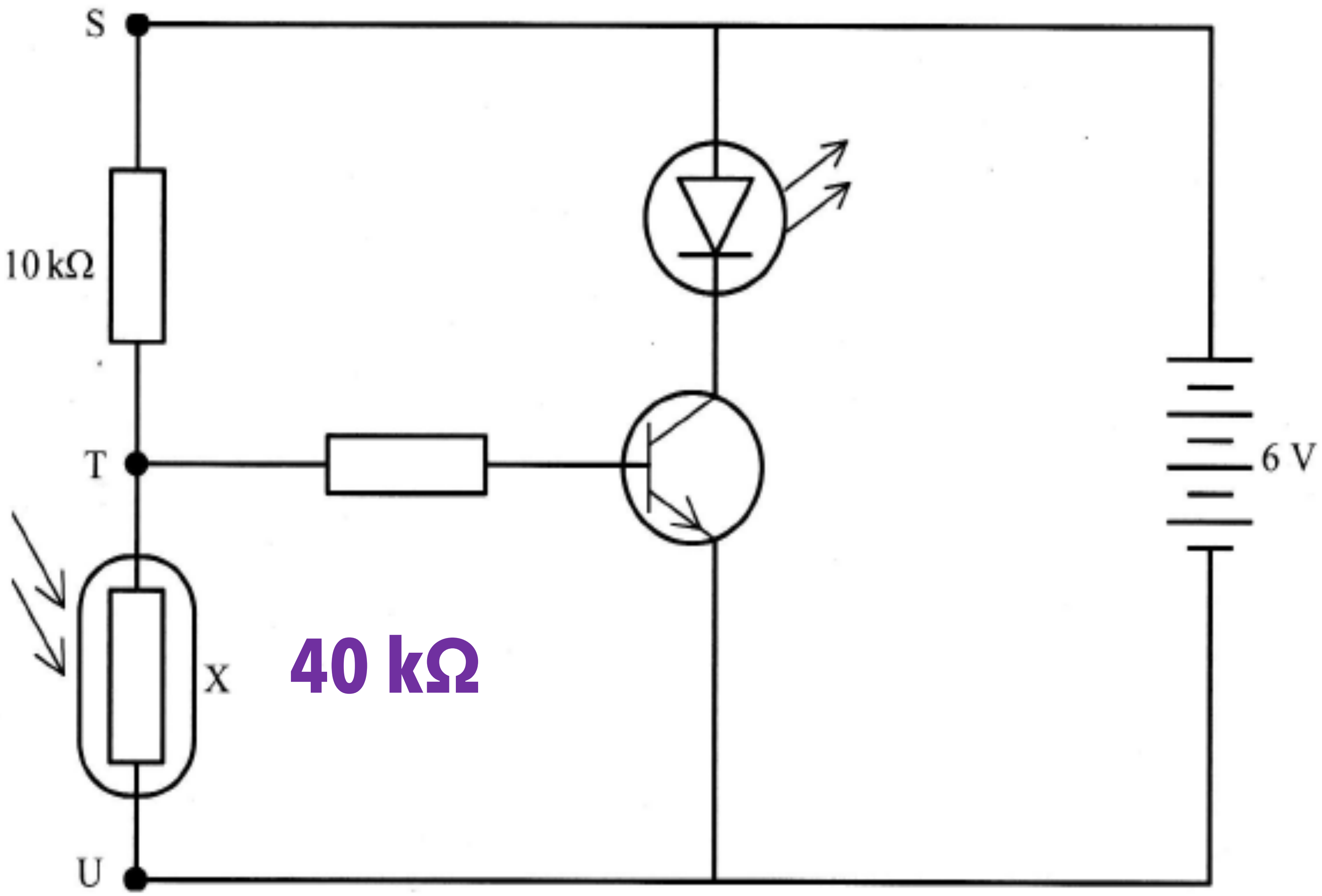
$$V_{TU} = 4.8\ V$$



$$V_{ST} + V_{TU} = 6\ V$$

$$V_{ST} + 4.8 = 6\ V$$

$$V_{ST} = 1.2\ V$$



(b) The current flows through resistor X

$$V = IR$$

$$I = \frac{V}{R} = \frac{4.8}{40\ k}$$

$$I = 1.2 \times 10^{-4}\ A$$

Awesome Physics

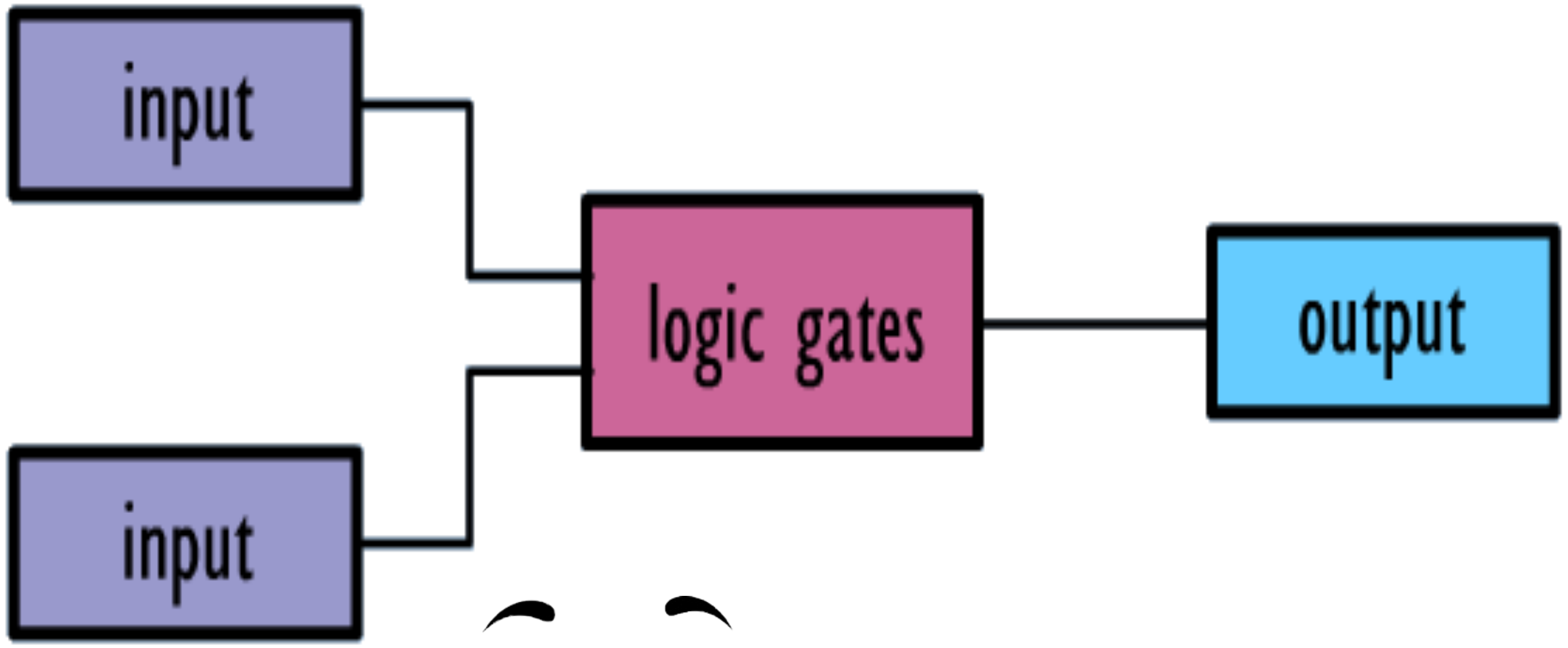
is around you

alinaimanarif

GREAT THINGS
NEVER
came from
COMFORT
ZONES

4.4 Logic Gate

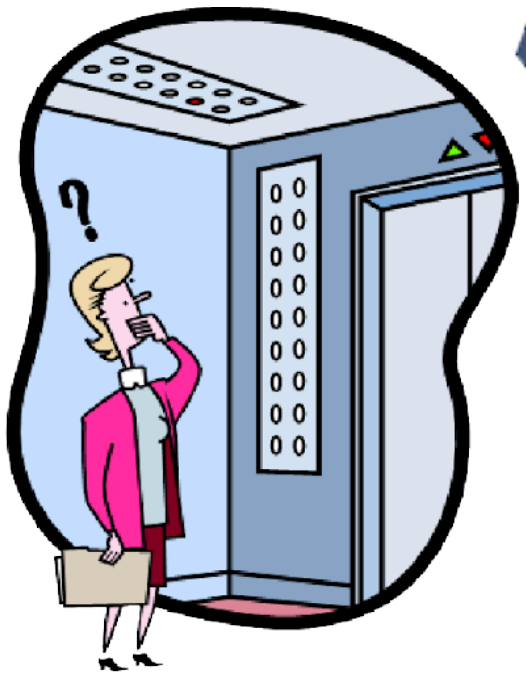
has **one** or **more input** signals but only **one output** signal



1. Logic gates as **switching circuits** in electronic systems
2. Input and output signal of he logic gates can be either

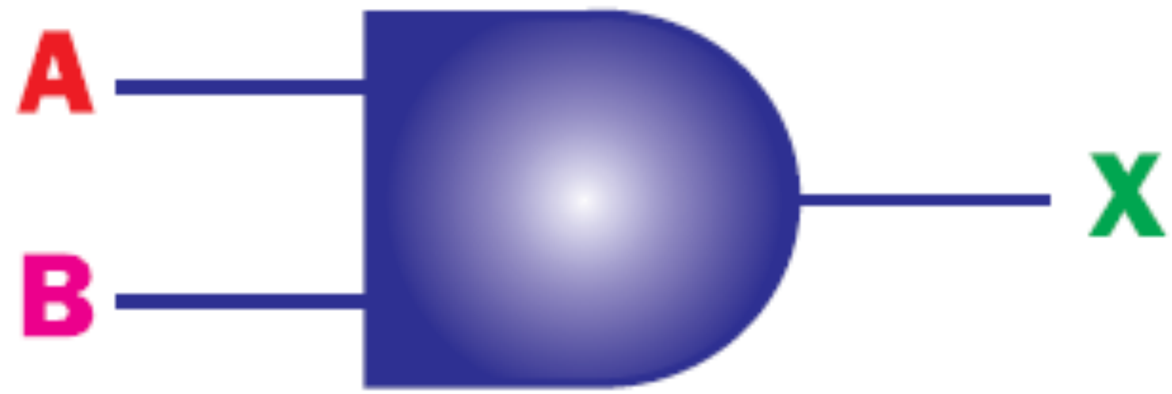
high (logic 1) or

low (logic 0).



AND Gate

SYMBOL:

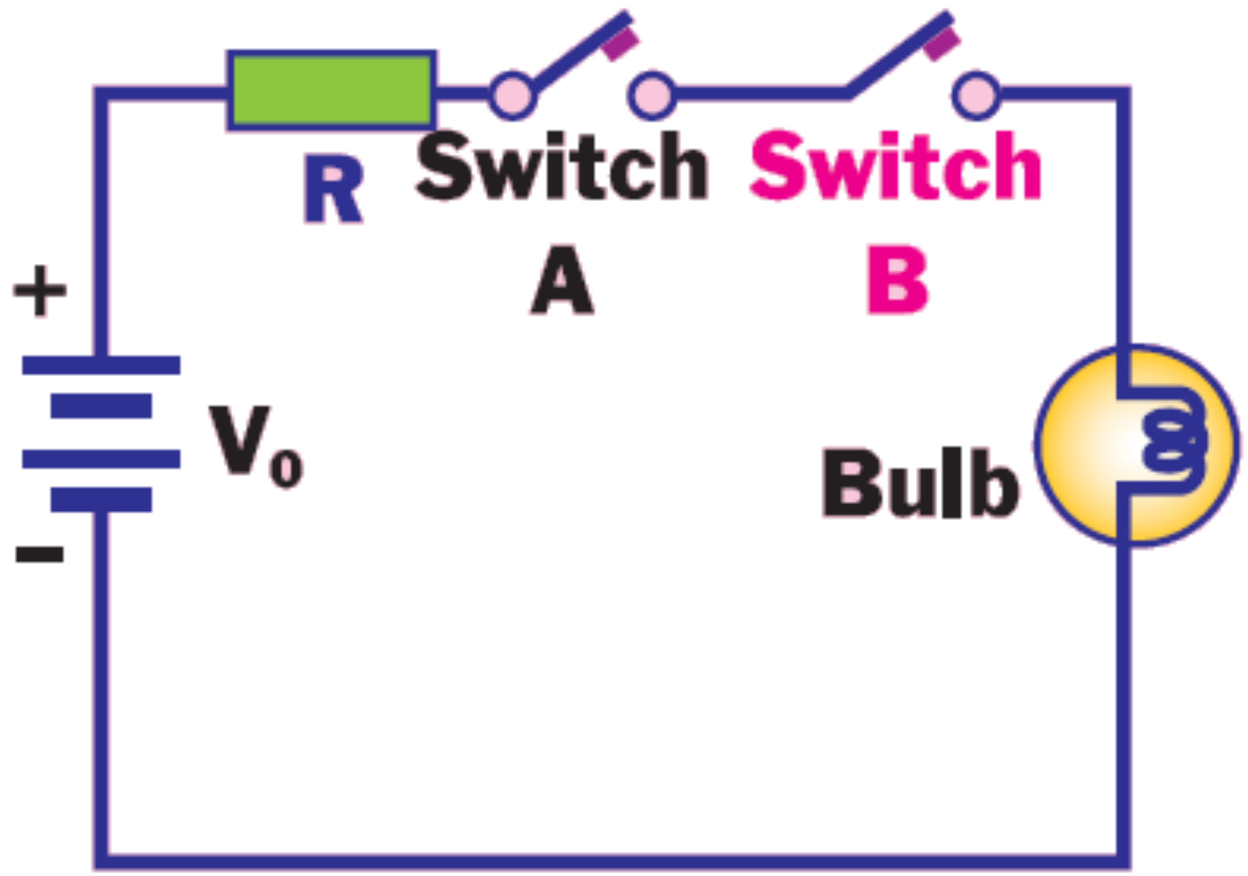


BOOLEAN EXPRESSION: $X = A \bullet B$

TRUTH TABLE:

INPUT		OUTPUT
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

CIRCUIT:



OR Gate

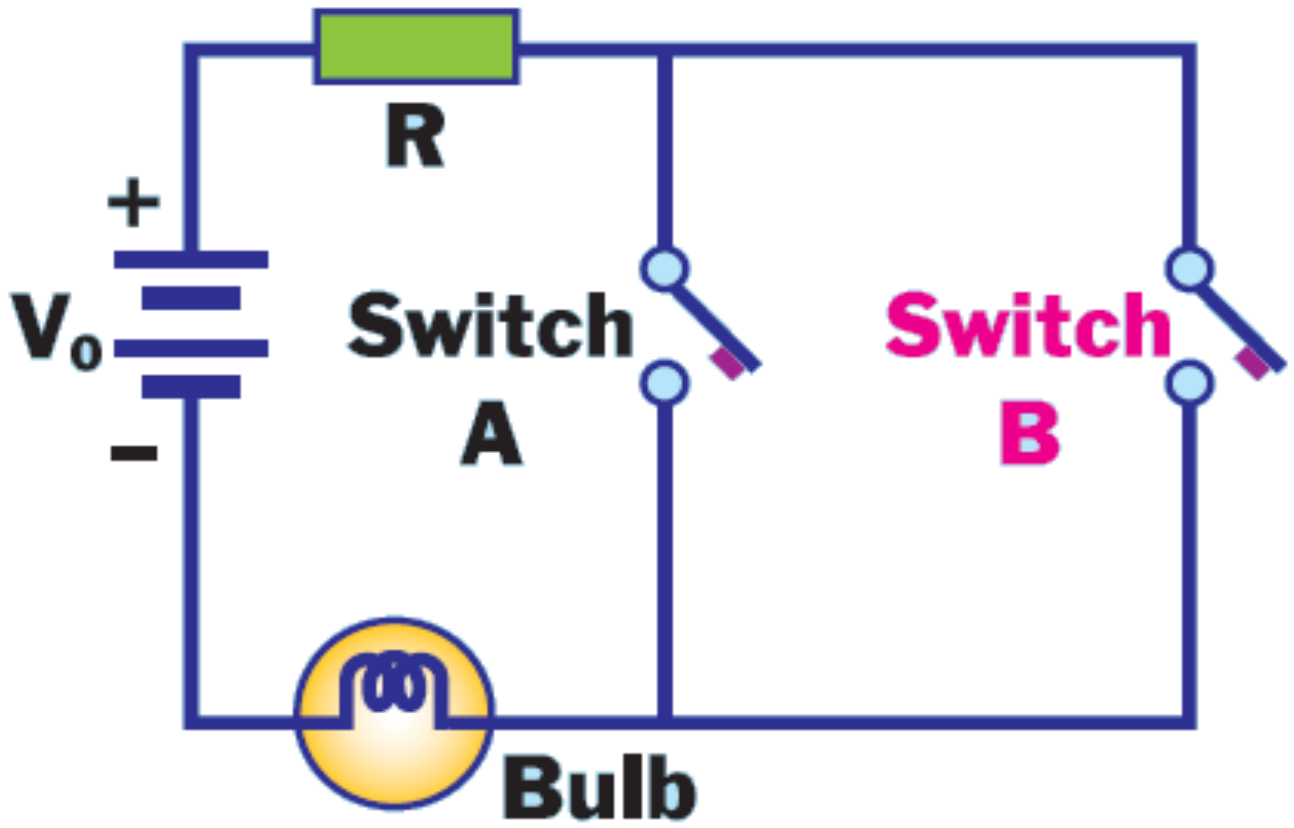
SYMBOL:

BOOLEAN EXPRESSION: $X = A + B$

TRUTH TABLE:

INPUT		OUTPUT
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

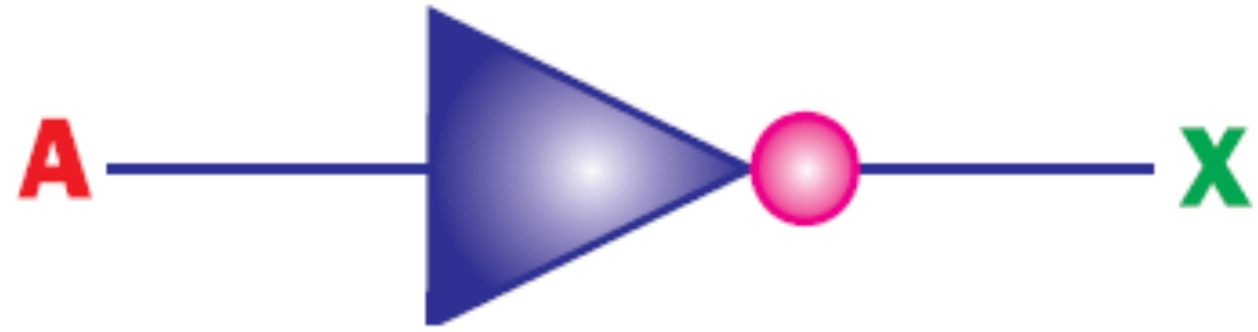
CIRCUIT:



NOT Gate

To **inverse** the **input** signal

SYMBOL:

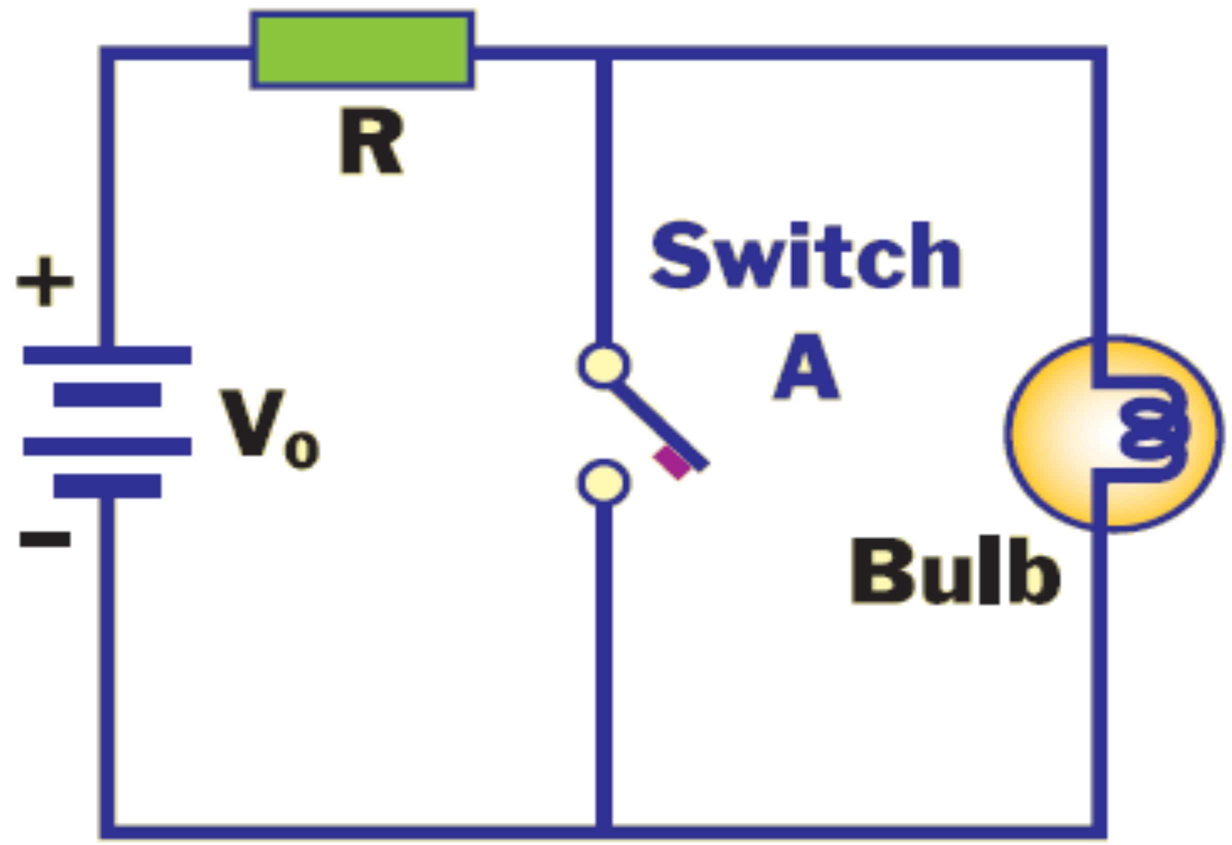


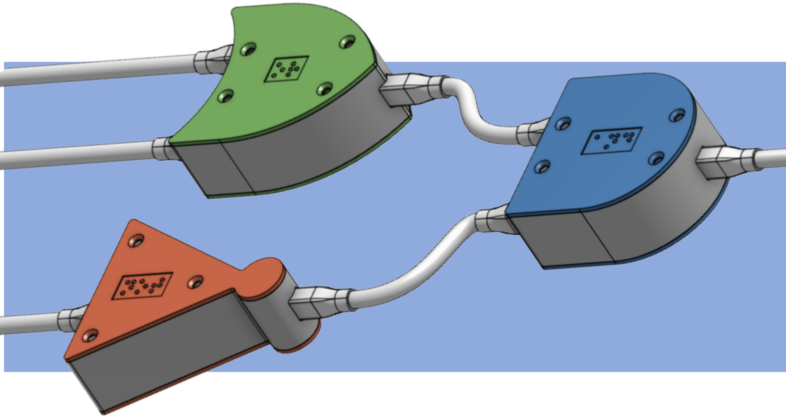
BOOLEAN EXPRESSION: $X = \overline{A}$

TRUTH TABLE:

INPUT	OUTPUT
A	X
0	1
1	0

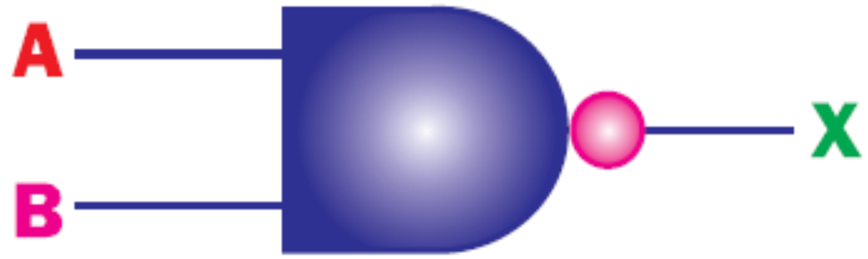
CIRCUIT:

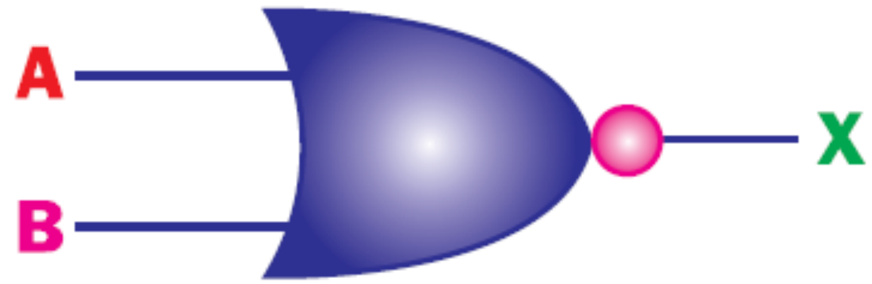




NAND Gate NOR Gate

SYMBOL:





BOOLEAN EXPRESSION:

$$X = \overline{A \bullet B}$$

$$X = \overline{A + B}$$

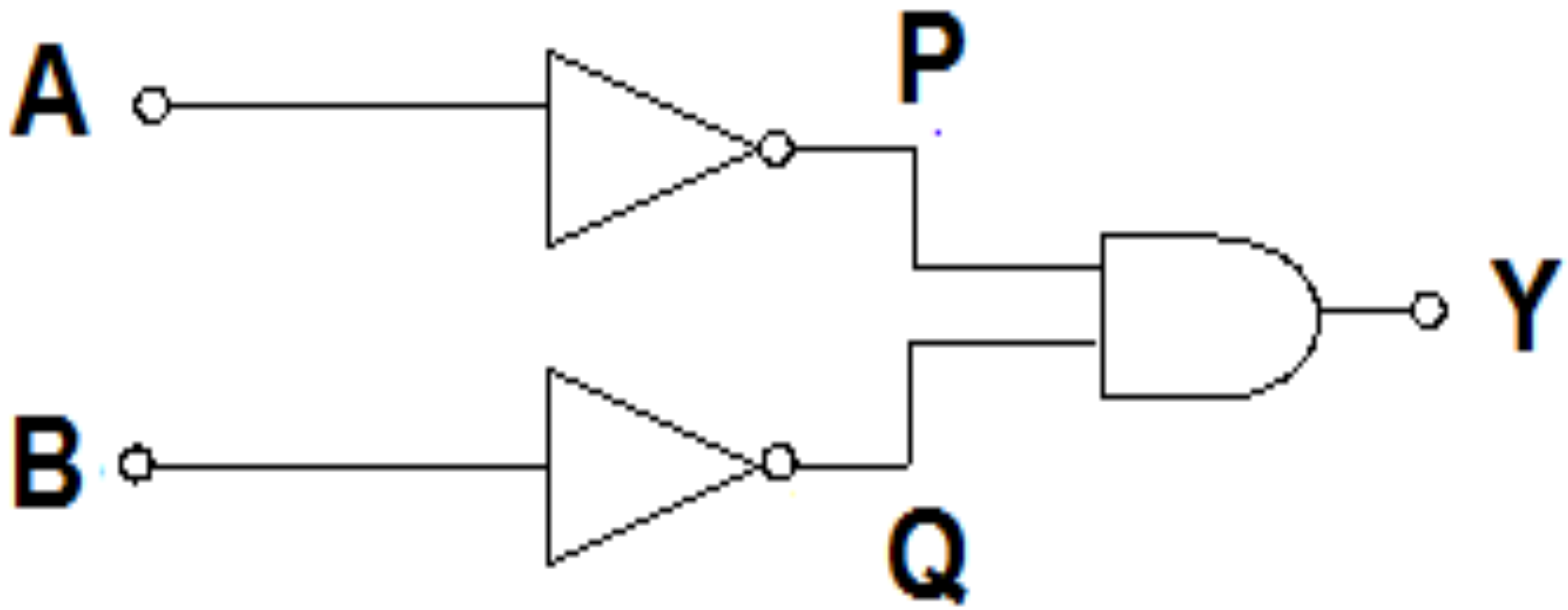
TRUTH TABLE:

INPUT		OUTPUT
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

INPUT		OUTPUT
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

COMBINATIONS OF LOGIC GATES

example 1

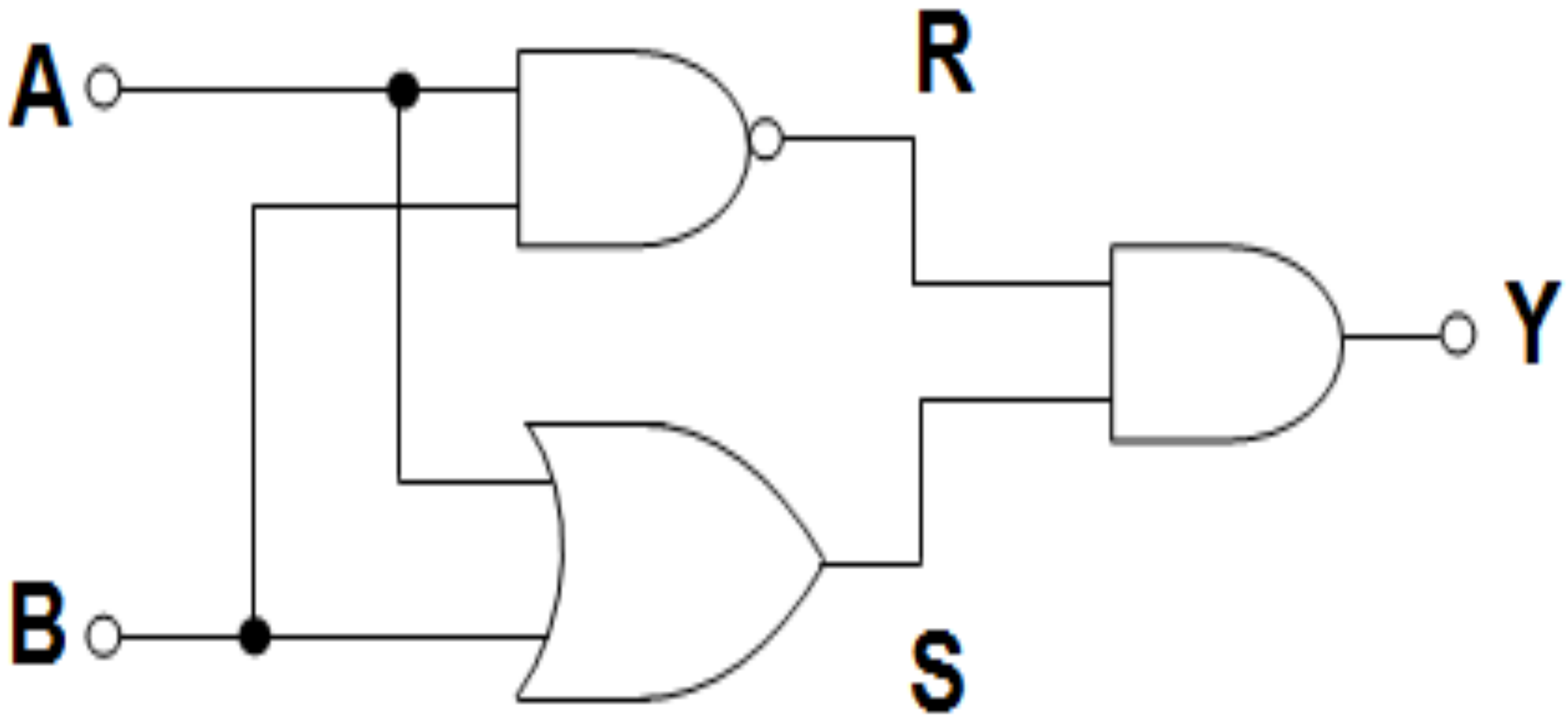


TRUTH TABLE:

INPUT		OUTPUT		
A	B	P	Q	Y
0	0	1	1	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	0

COMBINATIONS OF LOGIC GATES

example 2



TRUTH TABLE:

INPUT		OUTPUT		
A	B	R	S	Y
0	0	1	0	0
0	1	1	1	1
1	0	1	1	1
1	1	0	1	0