Chapter = 16

INTRODUCTORY ELECTRONICS

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ELECTRONICS

Definition:- It is the branch of applied physics that deals with the development of electron emitting devices and their utilization. OR

It is the branch of physics in which the flow of electrons is controlled and used according to the need in semiconductors. OR

It is the branch of applied physics which deals the control of electrons in different devices for various useful purposes.

BRANCHES OF ELECTRONICS

There are two main branches electronics which are given below

(1) Analogue electronics.

(2) Digital electronics.

APPLICATIONS OF ELECTRONICS

Electronics have influenced our daily life because

(**i**) It provides us radio.

(ii) It provides us television.

(iii) It provides us stereo hi – fi sound system.

(iv) It provides us automatic washing machine.

(v) It provides us microwave ovens.

(vi) It provides us robots.

(vii) It provides us telephone system.

(viii) It provides us pocket calculators.

(ix) It provides us satellites for various purposes.

**(x)** It provides us computers etc.

THERMIONIC EMISSION

History:- This effect was first of all introduced by **J.J Thomson** in 1897.

Definition:- The process of emission of electrons from metal surfaces due to heat is known as thermionic emission. OR

The process in which electrons are emitted by hot metal surfaces is known as thermionic emission. OR

The temperature which induced electrons ejection is known as thermionic emission.

Explanation:- As we known as that metals contains a large number of free electrons . At room temperature electrons cannot escape from the metal surfaces due to attractive forces of the atomic nucleus. If the metal is heated to a high temperature some of the free electrons may gain sufficient energy to escape the metal surface.

Figure 16.1 - Thermionic emission
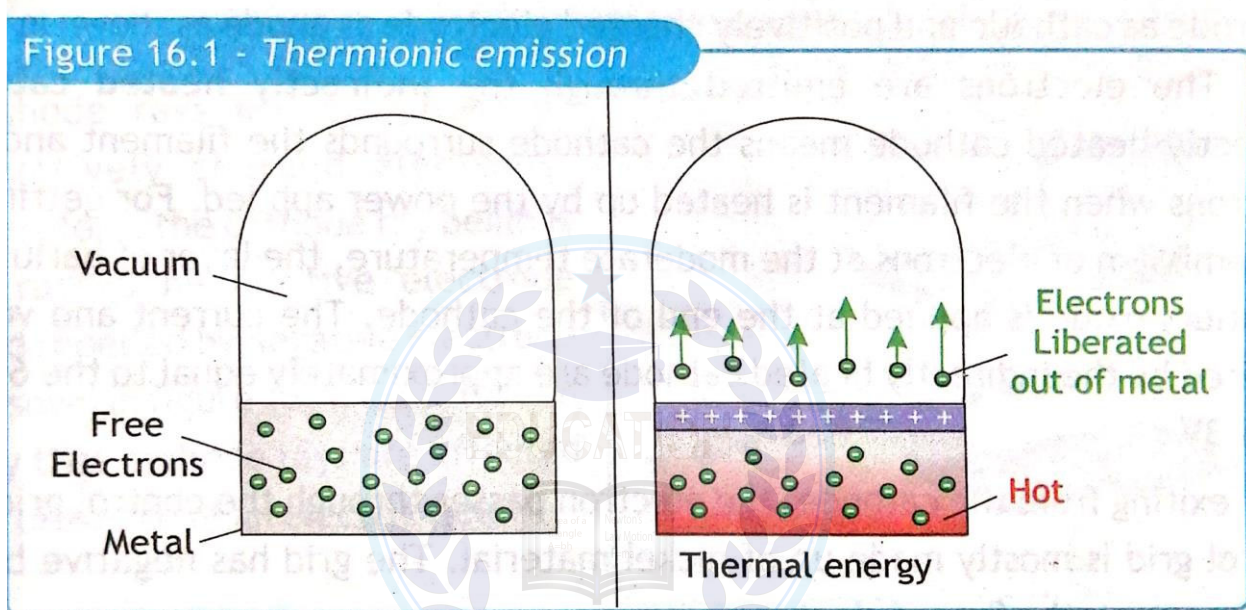
Factors of thermionic emission:-

(i) Nature of metal.

(ii) Temperature of the metal.

(iii) Surface area of the metal.

Production of thermionic emission: -

Thermionic emission can be achieved by passing electric current through tungsten filament as shown in figure 16.2. The electric current heats up the filament and electron are emitted.

Figure 16.2 - Thermionic Emission from a filament
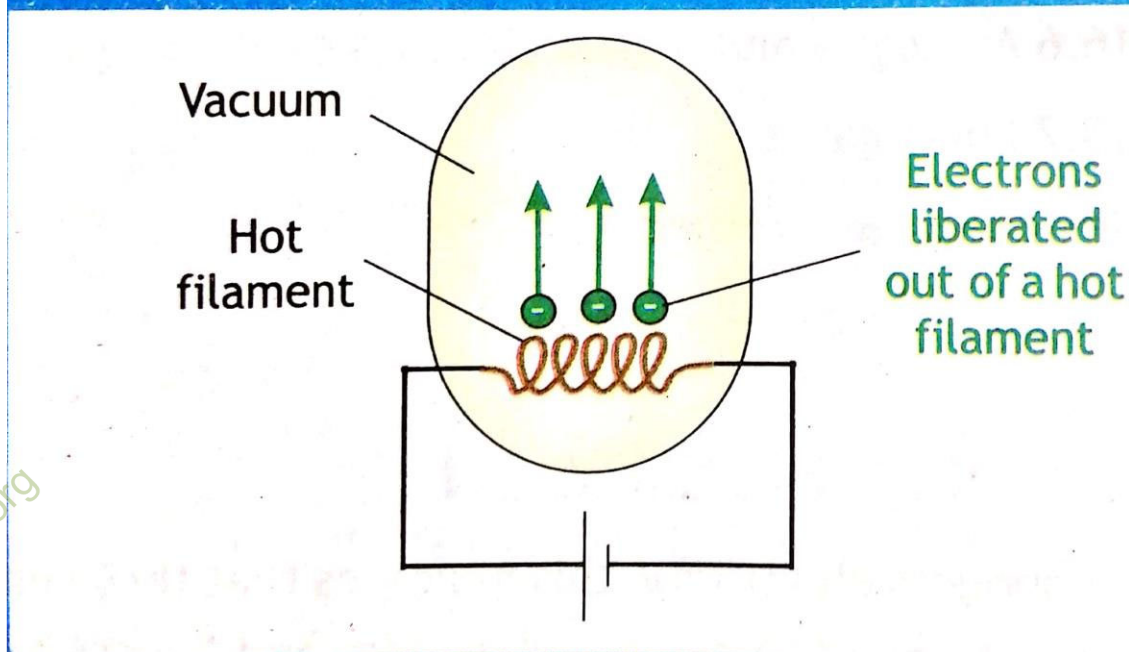
**Use**: - It effect is used to produce electrons for scientific study.

ELECTRON GUN

Definition:- It is a device which used to study the properties of electrons beams. OR It is a source of focused and accelerated electron beam.

Construction:-It consist of

- Glass tube at very low pressure.
- Tungsten filament.
- High voltage battery.
- Low voltage battery (6 volt).
- Narrow anode or cylindrical anode. As shown in figure 16.3.

Figure 16.3 - Electron gun
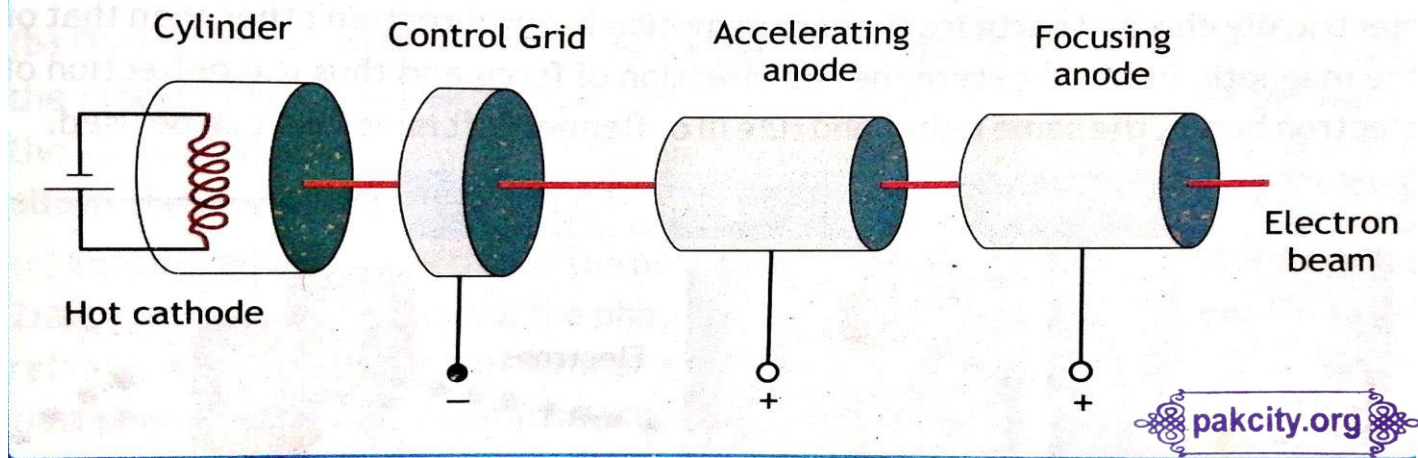
(i)When the filament is heated by a typically 6 v battery. It emits electrons.

(ii)These electrons are then accelerated towards the anode through a high tension battery.

(iii)The electronic beam then passes through a narrow hole. This beam is also called cathode rays.

(iv) As cathode rays has negative charge so it can be affected both by electric and magnetic field.

CATHODE RAYS

**Definition:-** The beam of electrons are known as cathode rays.

Explanation:-

(i) These rays carry negative charge.

(ii) These are emitted from cathode plate that is why they are called cathode rays.

(iii) These rays can be affected by electric and magnetic fields because of charged nature.

Deflection by electric field:-

Arrangement:- An electric field can be setup by applying a potential difference across two parallel plates placed horizontally at some distance apart.

Explanation:- We know that electrons are charged particles so when a beam of

electrons are passing between two horizontal placed plates it is observed that the beam of electrons will be deflected towards the positive plate, as electrons has negative charge.

Figure 16.4 - Electric field deflection
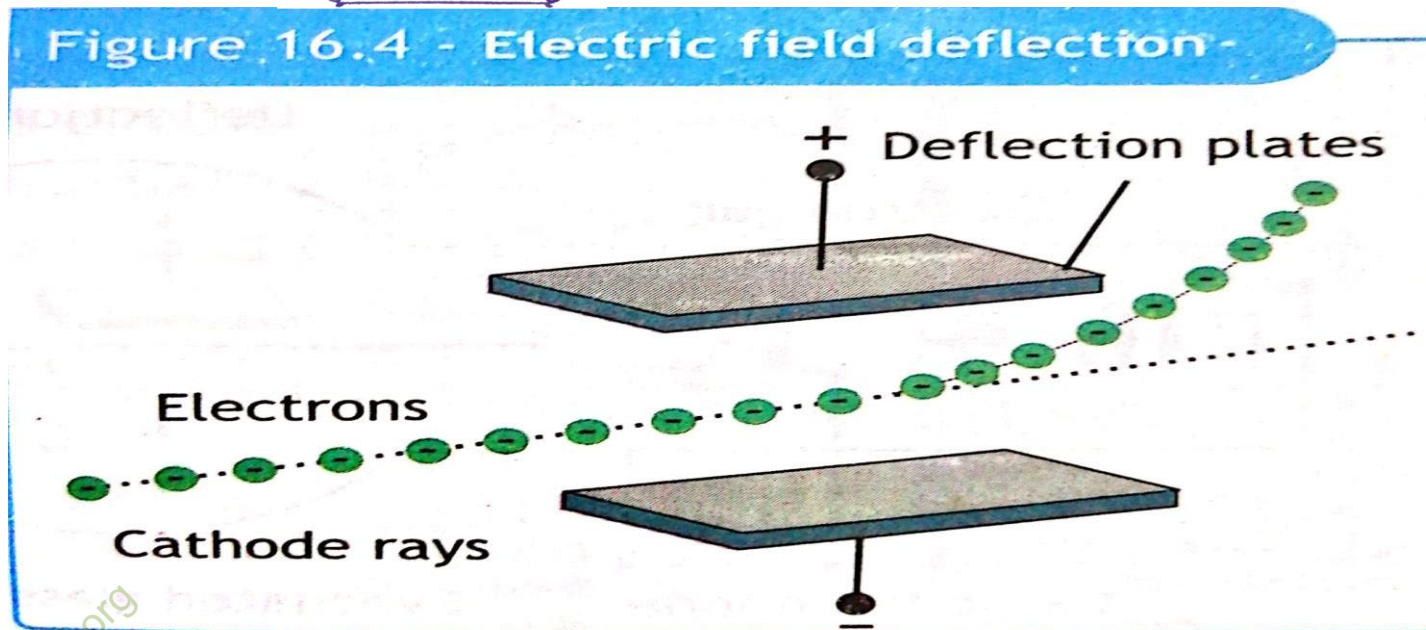
Result:- It is found that the greater the strength of the electric field greater would be the degree of deflection of the electron beam.
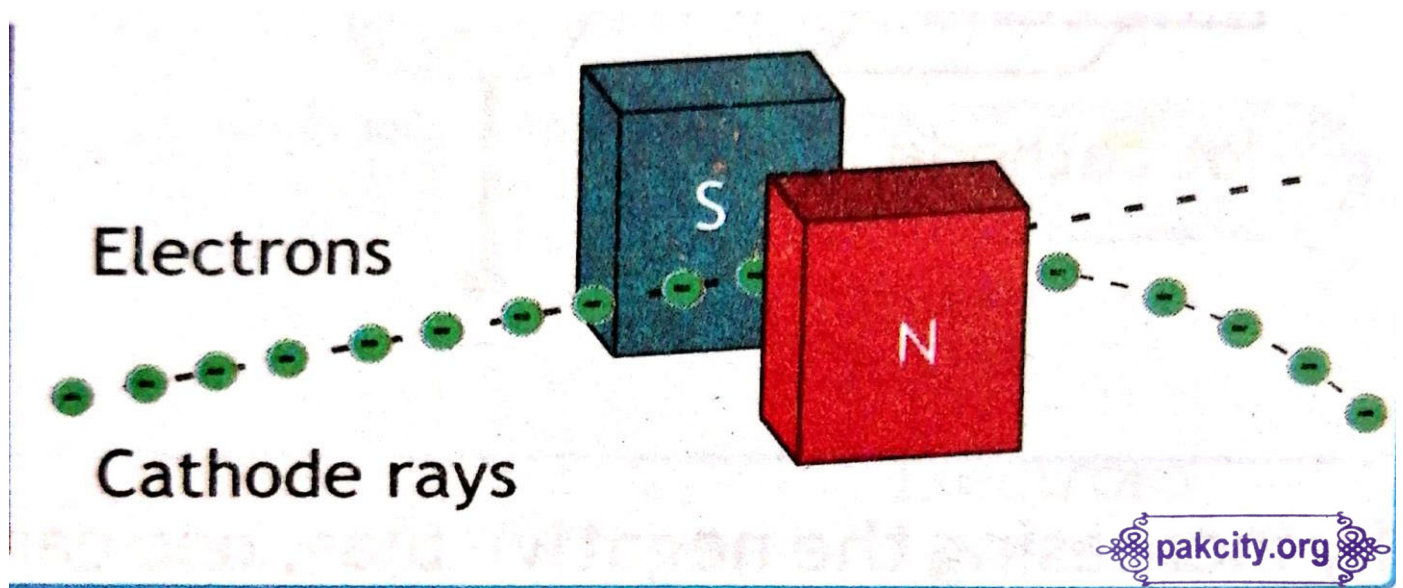
Deflection by magnetic field:-

Arrangement:- A magnetic field is applied at right angles to the beam of electrons by having poles of the magnet placed as shown in figure.

Explanation:- As the beam of electrons are also consider cathode rays. When a charge particle moving it produced a magnetic field, if we apply a suitable magnetic field we can deflect beam of electrons in any desired direction.

Result: - It is found that the greater the strength of the magnetic field greater would be the degree of deflection of the electron beam.

CATHODE RAY OSCILLOSCOPE

Definition:- It is a device which is used to display the magnitude of changing electric current or potential. OR

It is a high speed graph plotting device. OR

It is an electronic device which is used to display the magnitudes of rapidly changing electric current or potential as a function of time.
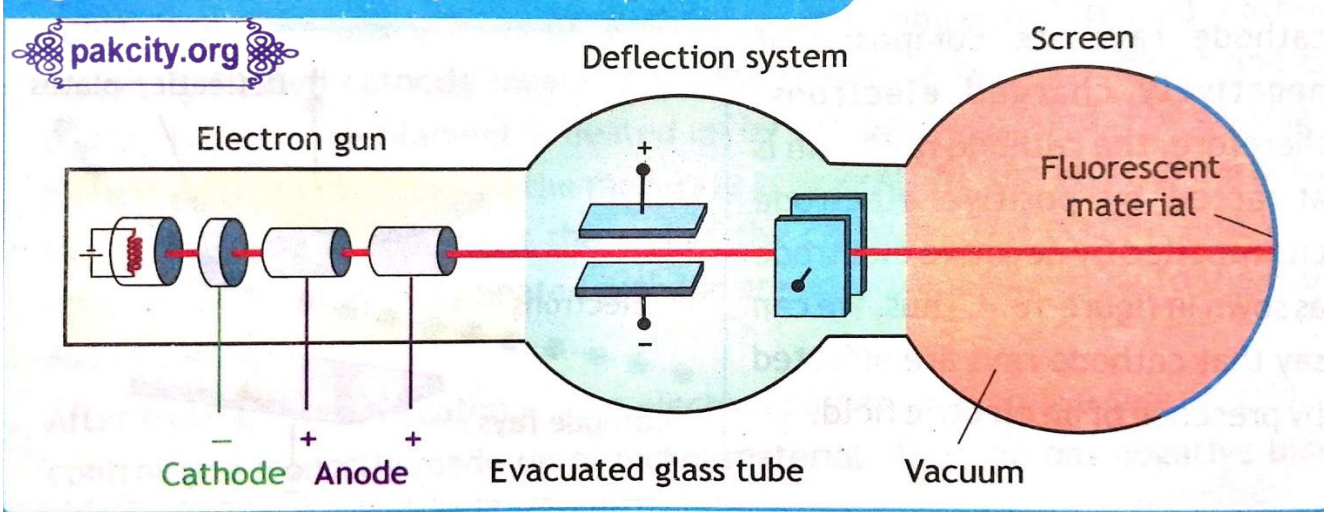
Other Name: - It is also called Cathode ray tube.

Abbreviation: - It is abbreviated by C.R.O.

Construction:- It consists of

(1) Electron gun.

(2) Deflecting System.

(3) Screen.

Figure 16.6 - Cathode Ray Oscilloscope (C.R.O.)

Working:-
(1) The electron gun:-
(i) The electron beam is generated at the cathode in the electron gun.
(ii) When the potential is applied, which strips off and accelerates the electrons by accelerating anode.
(iii) The electrons then travels to the electrons beam focusing anode.
(iv) An electrostatics mechanisms is used to focus the beam.
(2)The deflecting plates system: - This system consist of two pair of parallel plates
(a)The Y-Plates

(b) The X-Plates
(a) The Y-Plates:- When voltage is applied across Y-Plates it deflect the beam of electron toward the Y- axis (vertically).
(b) The X-Plates :- When voltage is applied across the X-Plates it deflect the beam of electron towards the horizontal direction.
Result:- So this effect the electron beam to sweep over the entire screen.
(3) The florescent screen:- The screen is coated with a fluorescent salt i-e Zinc sulphide. When the electrons hit the screen it will cause the salt to produce a flash of light and hence a bright spot on the screen.
Uses of CRO :-
(i) It is used in laboratory to display wave form of various voltages.
(ii) It is used to estimate time interval.

(iii) It is used as D.C circuits or A.C circuits.
(iv) It is used in TV.
(v) It is used in computer.   pakcity.org
(vi) It is used to measure the potential difference etc.

BRANCHES OF ELECTRONICS

There are two branches of electronics which are given below.
(1) Analogue Electronics.
(2) Digital Electronics.
(1) Analogue Electronics:-

Definition: - The branch of electronics which processing analogue quantities is called analogue electronics. OR
The branch of electronics consisting of such circuits which processes analogue quantities is known as analogue electronics.

Analogue Quantities: -

Definition:-Those quantities which remain constant or change regularly with the time are called analogue quantities.

Example: -

The temperature of air in the atmosphere is continuously changing during day and night. If we plot a graph between time and temperature recorded at different time we get a graph as shown in figure. This graph shows that the temperature is varies continuously with time. Therefore we can say the temperature is an analogue quantity.

Other Examples of analogue quantities:- Time , Pressure , Distance etc.

DIGITAL ELECTRONICS

Definition:- The branch of electronics which processes the data provided in the form of digits is called digital electronics.

Digital Quantities: -

Definition:- Those quantities whose values vary non-continuous manner are known as digital quantities.

Explanation: - In modern system of electronics two digits 1(one) and 0 (zero) are uses. This system is called binary system. Modern telephone system, radar system of military importance, uses digital electronic technology.

Note:-It must be noted that all quantities which we perceives through our senses are analogue quantities so we built a special circuit in modern system which are given below.

(i) Analogue to digital converter (ADC)

(ii) Digital to analogue converter (DAC)

(i) Analogue to digital converter (ADC):- It is a circuit which convert analogue quantities into digital quantities.

(ii) Digital to analogue converter (DAC):- It is a circuit which convert the digital quantities into analogue quantities.

BOOLEAN VARIABLES

Definition:-Those variable which has only two possible state are called Boolean variables.

Explanation:-

(i) For binary digits the Boolean algebra is used.

(ii) The Boolean variable are usually represented by the digits 0 and 1.

(iii) State 1:- True, Yes, On, Close these states are represented by 1 (one).

(iv) State 2:- False, No, Off, Open these states are represented by 0 (zero).

TRUTH TABLE

The table which gives information about the function of logic gates .

BASIC OPERATION OF DIGITAL ELECTRONICS

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LOGIC GATES

Definition:- The circuits which implement the various logic operations are known as logic gates.

Base:- Boolean variables OR Boolean algebra.

Explanation:-

(i) Logic gates are the building blocks of an electronic circuit.

(ii) An electronic circuit may consist of one or more than one logic gates.

(iii) They have one or two inputs and only output.

(iv)They have truth table.

(v)Some logic gates are simple but some are very complex.

Examples of logic gates:-Following are some simple logic gates.

AND gate

Definition:-

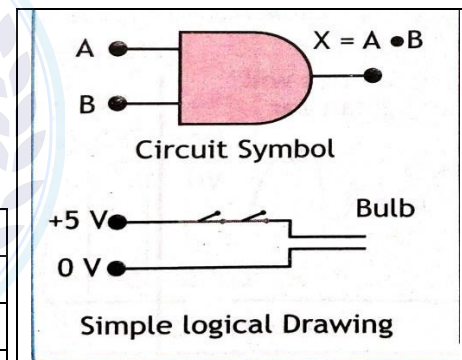It is an electronic circuit which gives a high output (1) if both input are high .

Explanation:-

(i) It has two inputs.

(ii) It has one out output.

(iii) AND-gate operation is A.B or AB.

Symbol of AND gate in circuit:-

Truth table:-

TRUTH TABLE		
Input		Output
A	B	X = AB
0	0	0
0	1	0
1	0	0
1	1	1

OR gate

Definition:- It is an electronic circuit which gives a high output (1) if one or more of its inputs are high.
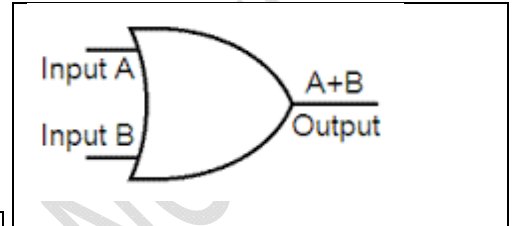
Explanation:-
(i) It has two inputs.
(ii) It has one output.
(iii) OR – gate operation is A+B.
Symbol of OR-gate operation:-
Truth table:-

TRUTH TABLE		
Input		Output
A	B	X = A +B
0	0	0
0	1	1
1	0	1
1	1	1

NOT gate

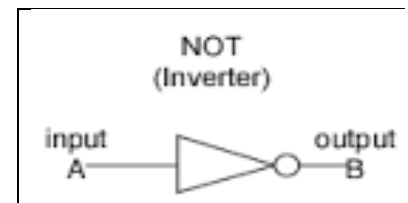**Definition:-** It is an electronic circuit which produces an inverted version **of** the input at its output.
Other Name:- This gate is also called an inverter because it gives the invert value of an input value of an input at its output.
Explanation:-
(i) It has one input..
(ii) It has one output.
(iii) NOT – gate operation is A = $\bar{A}$ (**A negation**) .
Symbol of OR-gate operation:-

TRUTH TABLE	
Input	Output
A	$\overline{A}$
0	1
1	0

NAND gate

Definition:- It is an electronic circuit which is formed by the combination of AND gate and NOT gate .

Explanation:-

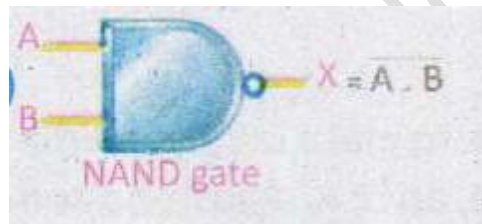**(i)** It has two inputs.

(ii) It has two outputs.

(iii) NAND- gate operation is $\overline{AB}$.

Note:-A NAND gate is the inverter of a AND gate i.e the output of NAND gate is the invert

of NAND gate . The output of a NAND gate is high (or "I" or "On") If any of its input key is low (or "O") .

Symbol:-

The truth table :-

Input		Output
A	B	Y= $\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

NOR gate: -

Definition:- It is an electronic circuit which is formed by combination of Not gate and OR gate.

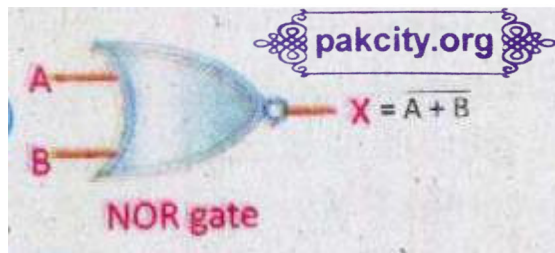**Explanation:-**

(i) It has two inputs.

(ii) It has one output.

(iii) NOR gate operation is $X = \overline{A+B}$.

Symbol:-

NOR gate

Truth Table:-

Input		Output
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Uses of logic gates :-

Logic gates are the building blocks of all computers cellular phone , calculator radar system etc. logic gates are uses to perform different tasks.

For example:

In house safety alarm , in burglar alarm, in thermo state etc.

For example:-

A logic gate installed at the main gate tells you whether someone opens the door or goes out of the home etc. As the door open the logic gate issued an alarm.

Wireless door and window alarm: - To prevent that your child do not walked outside the front door without telling you, a special type wireless door alarms can prevent such a risk and keep your child safely inside. When the door is opened the alarm emits a continuous 120 dB sound (until the door is shut) to tell you that your child is at risk of leaving. Thus digital electronics has facilitated us in all respect of our daily life.

<u>Automatic light bulb switching:-</u> Logic gates are used to turn ON or turn OFF the streets lights after appropriate time and light level or intensity. pakcity.org

<u>Working:</u>- During day when light shines on light dependent resistor (LDR), the resistance is high and current in the wire is low (0). In the evening when light fades out, the resistance of LDR decreases and it starts conducting and turns to light (1).


Figure 16.16 - Automatic Street light switching
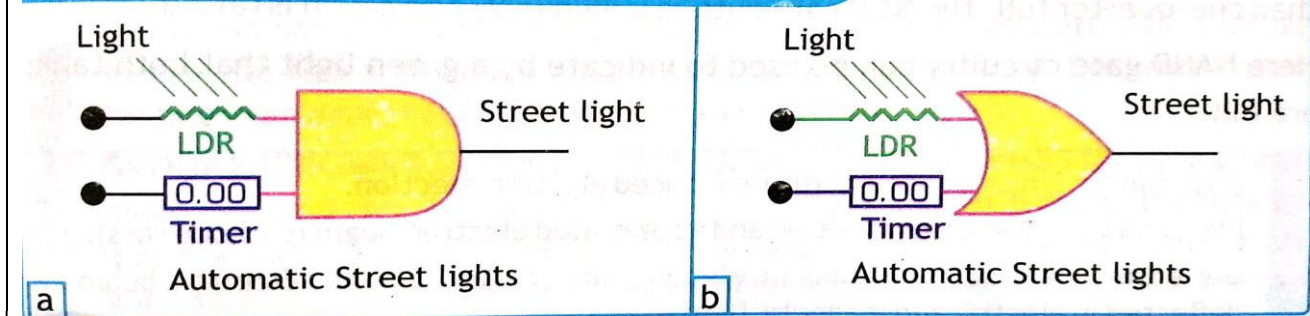
<u>Textile coloring plant:-</u> It consists of two tanks to store red and green color. Each tank has a sensor that detects when the color level drops to 25% of full (one-quarter).Then the sensor assume an alarm.

For this purpose NOR gate is used. when the level of color in any tank fall below the 25% the sensor produce an voltage 5v (1) and when the level is above the 25% it produce an voltage of 0v (0).

Figure 16.17 - Color level indicator
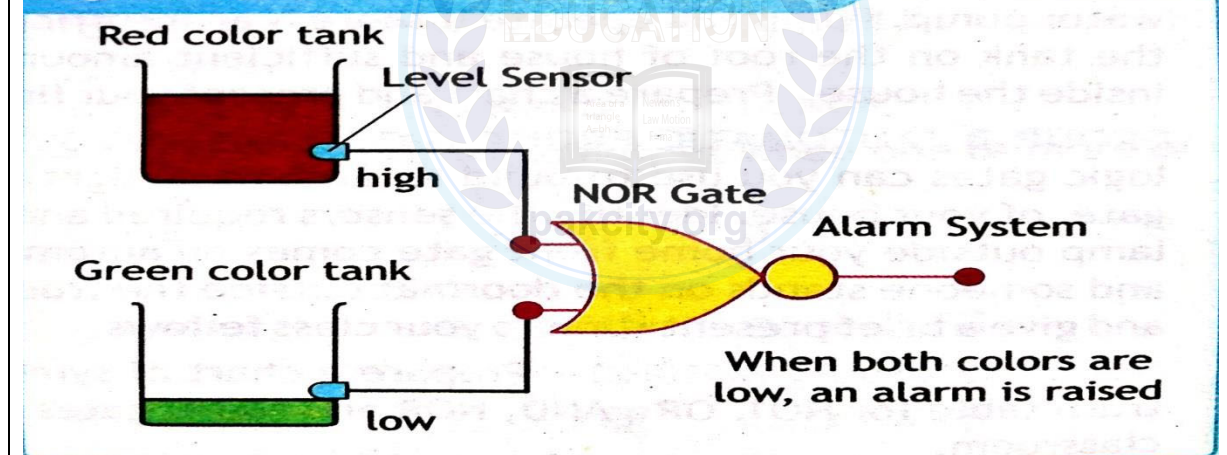
Name of five digital device that are commonly used in every daily life .
Ans:- (1) Computer.(2) Digital watch.(3) Television.(4) Radar system.(5) Mobile
Phone. 🙰 pakcity.org 🙰

CONCEPTUAL QUESTIONS

Q#01:- What are free electrons?

Ans: **FREE ELECTRONS**:-

Definition: - The electrons of outermost shell of an atom with low work function are known as free electrons.

Other Name: - They are also called **Delocalized Electrons**.

Explanation:- The electrons which are not attached to the atom are called free electrons. When we apply energy in the form of electric field or heat. Some of the valence electrons in the atom gains enough energy and breaks the bonding with the atom. The valence electrons which breaks the bonding with the atom and jumps into conduction band are called free electrons.

Function:- Free electrons carry the electric current by moving freely from one place to another place.

Q#02:- What is the function of accelerating anode in an electron gun?

Ans:- **Statement:-** The main function of accelerating anode in an electron gun is to accelerate the electrons towards the fluorescent screen.

Explanation:- As we know that an electron gun is an electrical device which produces a beam of electrons. The electrons are emitted from the filament by thermionic emission. These electrons are then directed towards the screen at very high speed with the help of accelerating anode. When these hit the screen produce fluorescence for creating images on it .

Q#03:- If the electron beam in a television tube is striking just one point on the screen at a time how can we get a full picture? Explain.

Ans:- Statement:- If the electron beam in a television tube is striking just one point on the screen at a time we can get a full picture. pakcity.org

Explanation:- As we know that in a C.R.T we have a system of deflection plates called

X-plates and Y-plate. When the time base generator is applied to the x-axis and sinusoidal voltage is applied to y-axis then we get a full size picture on the screen. When the electron beam in a television tube is striking just one point on the screen at a time .

Conclusion:- As conclusion we find that if the electron beam in a television tube is striking just one point on the screen at a time we can get a full picture.

Q#04:- Why image is distorted when a magnetic is brought close to old television screens or monitors with cathode ray tube (CRT) inside?

Ans:- Statement:- The image is distorted when a magnetic is brought close to old television screens or monitors with cathode ray tube (CRT) inside.

Reason:- It is because of interaction of two fields.

Explanation:- As we know that cathode rays is stream of electrons. The image on the C.R.T is due to beam of electrons. Since the electrons are charged particles so it produced a magnetic field in the near region of the C.R.T. When a magnet is brought near the CRT then it will deflect the beam of electrons. Hence that is why the picture distorted.

Conclusion:- As conclusion we find that the image is distorted when a magnetic is brought close to old television screens or monitors with cathode ray tube (CRT) inside.

Q#05:-Assuming that cathode rays are a beam of charged particle , how could you demonstrate that these particle are negatively charged ? Explain.

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Ans:- Statement:- We can easily demonstrate that the cathode rays are a beam of negatively charged particle by passing these rays through an electric and magnetic fields.

Reason:- It is because that the cathode rays can be effected by the presence of electric and magnetic fields.

Explanation:- As we know that electrons are negatively charged particle and they can be effected by the presence of electric and magnetic fields. **pakcity.org**

Examples:-

(1) Deflection by electric field:- If we applied an electric field to beam of electrons then it will deflect towards the positive plates showing that it has negative charge.

(2)Deflection by magnetic field:- If we applied a perpendicular magnetic field to beam of electrons. The electron starts motion on circular path. With the help of right hand rule we can prove that they have negative charge.

Conclusion:- As conclusion we find that we can easily demonstrate that the cathode rays are a beam of negatively charged particle by passing these rays through an electric and magnetic fields.

Q#06:- If there are 4 inputs in any logic gates how many combination are possible?

Ans:- **Statement:-** If there are 4 inputs in any logic gates, there will be 16 different possible combination.

Explanation:- As we know that

Number of possible inputs states = N = 2^n .... (1)

In equation (1) "n" represents the number of inputs .

For 4-inputs: - n=4

From equation (1):-

$N = 2^4 = 2 \times 2 \times 2 \times 2 = 16$ inputs .

Conclusion:- As a result we conclude that **:-** If there are 4 inputs in any logic gates, there will be 16 different possible combination.

Q#07:-What conditions produce a high (1) output for an AND gate and NOR gate?

Ans:- **Statement:-** To produce high (1) outputs for an AND gate both inputs (A and B) must be high (1).

Reason:- It is because of function of AND gate =X= A.B = AB.

Explanation:- As we know that the truth table AND gate is given below.

TRUTH TABLE		
INPUTS		OUTPUTS
A	B	X = A.B = AB
0	0	0
0	1	0
1	0	0
1	1	1

Statement:- To produce high (1) outputs for an NOR gate both inputs (A and B) must be low (0).

Reason:- It is because of function of AND gate =X= $\overline{A + B}$.

Explanation:- As we know that the truth table NOR gate is given below.

TRUTH TABLE		
INPUTS		OUTPUTS
A	B	X = $\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

Q#08:-What are the algebraic Boolean expressions to represent the output of AND, NOT, NAND AND NOR gates?

LOGIC GATES	BOOLEAN EXPRESSION
AND	A.B OR AB
OR	A + B
NOT	$\overline{A}$
NAND	$\overline{A . B}$ OR $\overline{AB}$
NOR	$\overline{A + B}$