ELECTRONS

Electrons are negatively charged particles.
They are found in the orbit around the nucleus of an atom. Therefore an electron is the basic unit of charge.
Electrons can be produced by either of the following methods;-

a) Thermionic emission.
b) Photoelectric emission.

THERMIONIC EMISSION

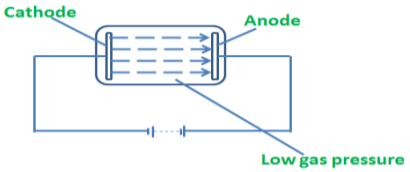
This is the process by which electrons are emitted from a metal surface when strongly heated.

Explanation:

When a metal is heated, the free electrons at the surface gain kinetic energy and they over come attraction by the nucleus hence escaping from the metal surface.

DISCHARGE TUBES

These consists of a cathode and Anode with a very high potential difference (p.d) between them placed in an evacuated glass tube as shown below.



Electrons produced at the cathode are accelerated to the Anode due to a high (p.d) between the Anode and the cathode.
When the evacuated space is filled with a gas, the tube will be colored and the colour observed depends on the gas with in the tube.

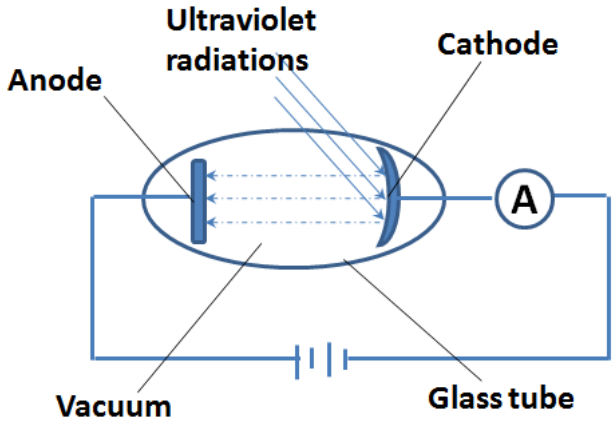
PHOTO ELECTRIC EMISSION

Photoelectric emission is the process by which electrons are emitted from a metal surface when exposed to electromagnetic radiations.

OR; This is the process by which electrons are emitted from a metal surface when electromagnetic radiations are incident on it.
Photo electric emission occurs in photo tubes (photoelectric cells). The electrons emitted are referred to as photoelectrons and the electromagnetic radiations used are ultra violet radiations.

PHOTOELECTRIC CELL

- Photoelectric cell is composed of the cathode and the anode enclosed in a vacuum tube.
- The glass tube is evacuated in order to avoid collision of cathode rays with air molecules which may lead to low current flowing due to loss in kinetic energy of cathode rays.

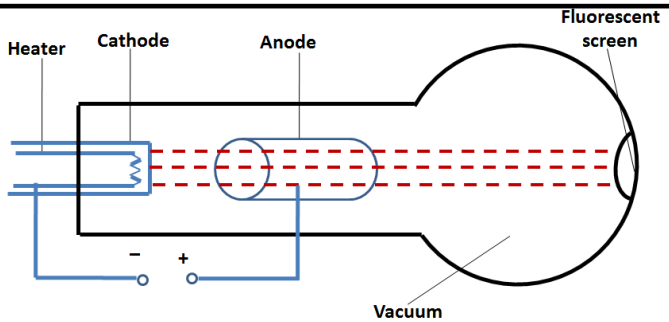


- Electromagnetic radiation is directed onto the cathode and supplies sufficient energy that causes the liberation of electrons.
- The electrons emitted are then attracted to the anode and the flow of electrons generate a current around the circuit and the ammeter deflects.
- The amount of the current is proportional to the intensity.
- The stream of electrons flowing from the cathode to the anode is referred to as cathode rays.

CATHODE RAYS

These are beams of fast moving electrons produced at the cathode.
They are produced from the cathode by thermionic emission.

Production of cathode rays



- ✓ Cathode rays are produced when the metal cathode is electrically heated using low voltage.
- ✓ The cathode rays are then accelerated by the anode.
- ✓ Some of the electrons pass through the anode and a parallel beam of electrons is obtained which is received as a spot on the fluorescent screen.
- ✓ The tube is evacuated to prevent cathode rays from colliding with air particles .

PROPERTIES OF CATHODE RAYS

- ➢ They are negatively charged.
- ➢ They move in straight lines.
- ➢ They are deflected towards the positive plate in the electric field.
- ➢ They are deflected towards the north pole in the magnetic field.
- ➢ They possess kinetic energy.
- ➢ They cause fluorescence when they strike matter.
- ➢ They produce x-rays when they strike a metal surface.

Applications of cathode rays

Cathode rays are applied in the following devices;

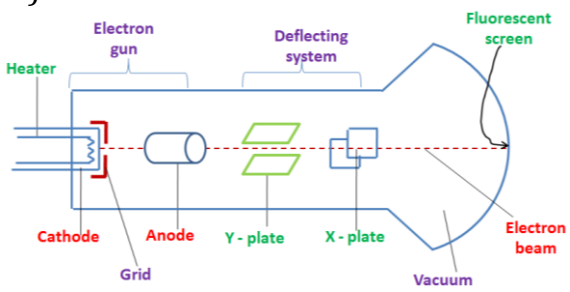
- ➢ Cathode ray oscilloscope (C.R.O)
- ➢ X- ray tube

THE CATHODE RAY OSCILLOSCOPE (C.R.O)

It is an instrument used to study current and voltage wave forms.

It has three main parts and these are

i) Electron gun
ii) Deflecting system
iii) Fluorescent screen



FUNCTIONS OF THE PARTS

CATHODE: It emits electrons by thermionic emission (when heated electrically by the heater).

CONTROL GRID: It controls the brightness of the electron spot on the screen by controlling the number of electrons reaching the screen.

ANODE: It accelerates and focuses the electrons produced by the cathode to the screen.

Y-PLATES: These deflects the electron beam vertically.

X-PLATES: These deflects the electron beam horizontally.

FLUORESCENT SCREEN: This is where the spot of electrons is formed.

VACUUM: It enables electrons to move at a high speed with out loosing their energy due to collision with air molecules.

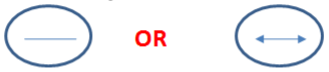
TIME BASE

A **time base** is an oscillating circuit connected across the x-plates so as to provide a wave form on the screen by sweeping the electron beam from left to right at a constant rate (repeatedly).

Diagrams to show the positions of a time base in relation to the appearance:

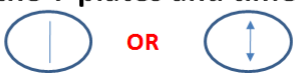
WAVE FORMS ON C.R.O

i) No p.d on the Y-plates and time base on

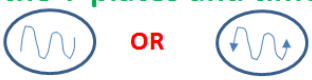


ii) No p.d on the Y-plates and time base off

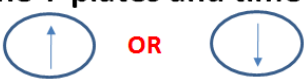
iii) A.C on the Y-plates and time base off



iv) A.C on the Y-plates and time base on



v) D.C on the Y-plates and time base off



vi) D.C on the Y-plates and time base on

USES OF THE C.R.O

- ❖ It is used as a computer out put device (monitor).
- ❖ It is used to measure frequency of the wave.
- ❖ It is used in measuring potential difference (p.d).
- ❖ It is also used to study wave forms.
- ❖ It is used in television sets.
- ❖ It is used as a timing devices i.e (measuring time intervals).
- ❖ It is used to measure phase difference between two voltages.
- ❖ It is used to measure the peak value of alternating current and direct current.

Question: State the main three parts of the C.R.O and briefly describe their functions.

Solutions:

- Deflecting system.
- Electron gun.
- Fluorescent screen.

Explanation:

The **electron gun** consists of a heater, grid and anode.

It produces electrons thermionically, accelerates them and controls the number of electrons reaching the screen hence controlling the brightness of the electron spot.

The **deflecting system** consists of X-plates and Y- plates which deflects the electron beam horizontally and vertically respectively by applying a p.d across them.

The **fluorescent screen** makes the electron spot to be visible due to the fluorescent coating on it.

DIFFERENCES BETWEEN GAMMA RAYS AND CATHODE RAYS

GAMMA RAYS	CATHODE RAYS
✓ They are not deflected by electric and magnetic fields.	✓ They are deflected by both electric and magnetic fields.
✓ They have no charge.	✓ They are negatively charged.

ADVANTAGES OF USING A C.R.O IN MEASURING VOLTAGE (over ordinary voltmer and ammeter)

- ✓ It draws very little current or no current from the circuit hence its very accurate.
- ✓ It can measure both a.c and d.c voltages.
- ✓ It responds very fast (instantaneously).
- ✓ It is not suspicious to cause burn out due to large voltage like other meters.

DISADVANTAGES OF USING A C.R.O IN MEASURING VOLTAGE (over ordinary voltmer and ammeter)

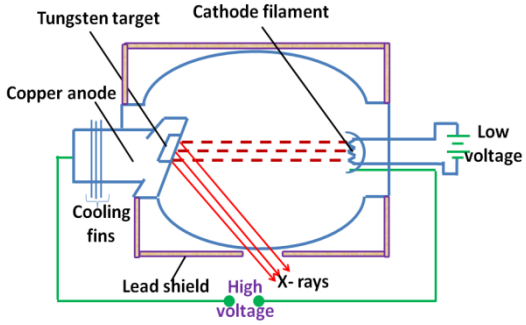
- ➢ It is bulky.
- ➢ It is expensive.
- ➢ It requires skilled labour.
- ➢ It takes a lot of time to measure voltage.

X - RAYS

These are electromagnetic radiations with very short wave length produced when fast moving electrons are stopped by a metal surface.

Question:

Describe briefly with the aid of a well labeled diagram how x-rays are produced.



- ➢ The cathode is heated by low voltage supply and the electrons are emitted by thermionic emission.
- ➢ They are accelerated to the anode by the high voltage supply connected across anode and cathode.
- ➢ When they strike the metal target about 99% of their kinetic energy is converted into heat energy and the 1% is converted into x-rays. Hence X-rays are produced.
- ➢ The heat produced is conducted out and cooled down by means of cooling fins.

PROPERTIES OF X-RAYS

→ They are electromagnetic in nature.

→ They travel in a straight line.

→ They travel at a speed of light.

→ They carry no charge.
→ They are not deflected by both electric and magnetic fields.
→ They cause fluorescence when they strike certain materials.
→ They cause ionization of gas molecules.
→ The affect photographic plates similar to light.

USES OF X-RAYS

- ❖ They are used in treatment of cancer cells.
- ❖ They are used in detection of broken bones.
- ❖ They are used in detection of cracks in metal castings.
- ❖ They are used to study the structure of crystals (crystallography).
- ❖ They are used in radiography.
- ❖ They are used in agriculture to produce high breed foods.

EFFECTS/ DANGERS OF X-RAYS

1) They cause genetic mutations when exposed to for a long time.
2) They cause cancer due to skin burns.
3) They lead to heart failure when exposed to very strong x-rays.
4) They damage blood cells and eye sight.

PRECUATIONS TAKEN WITH X-RAYS

1) The operating of x-rays tubes should be done using protective clothings.
2) Avoid un necessary exposure to x-rays.
3) The x-ray tube should be always surrounded by lead shield to absorb the stray radiations.
4) X-rays should be handled only by specialists.

TYPES OF X-RAYS

There are basically two (2) of x-rays, namely;- Hard x-rays and Soft x-rays.

Hard x-rays are those produced by a high kinetic energy voltage.

Soft x-rays are those produced by a low kinetic energy voltage.

DIFFERENCES BTN HARD X-RAYS AND SOFT X-RAYS (properties)

HARD X-RAYS	SOFT X-RAYS
Produced by a high	Produced by a low
They have a shorter wave	They have longer wave
More penetrative.	Less penetrative.
High frequency.	Lower frequency.
Very high kinetic energy	Low kinetic energy.

QUESTION:

Describe how the intensity of x-rays can be improved or increased.

SOLUTION:

This can be done by increasing the number of electrons heating the target per unit time. This is done by increasing the filament current which increase the temperature of the filament hence increasing the number of electrons emitted thermionically.

Consequently, the number of electrons heating the target will increase.

SIMILARITIES BTN X-RAYS AND GAMMA RAYS

- ✓ They are both electromagnetic waves.
- ✓ They both pass through a vacuum.
- ✓ Both are not deflected in electric and magnetic fields.
- ✓ They both have no charge.
- ✓ They both travel with a speed of light ($3x10^8$ ms^{-1})
- ✓ They are both transverse waves.

Assignment:

1. A material is wrapped in a photographic film and kept in a dark room. When the photographic material is removed it is found to be darkened. Identity the material and explain the observation.

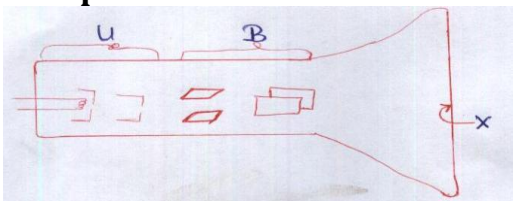
Solution;

The material is X- ray

Explanation of the observation

X – rays travel through a photographic material and hence cause the darkening of the material

2. a) The figure below shows the main parts of a C.R.O. identify the parts labeled U, B and X and briefly describe the functions of each part.



b) (i) Name the particles emitted by radioactive materials. (4 LINES)

(ii) Draw diagrams to show the path of particle named above in a cloud chamber. (6 LINES)

c) A zinc cathode was enclosed in an evacuated glass tube when the cathode was irradiated with ultraviolet radiations the ammeter gave a reading.

(i) **Explain why the ammeter gave a reading.**

→ The ammeter gave a reading because of the photoelectrons produced.

(ii)Gas was gradually introduced into the glass tube. Explain what happened.

→ The gas became charged.

NUCLEAR REACTIONS

Nuclear reaction is the process by which energy is produced.

There are twotypes of nuclear reaction i.e;-

Nuclear fusion

Nuclear fission

NUCLEAR FUSION

Nuclear fusion is the is the process by which two or more light nuclei combine to form a heavy nucleus with release of energy.

It takes place at the Sun, Stars and in hydrogen bombs.

Example:

Two