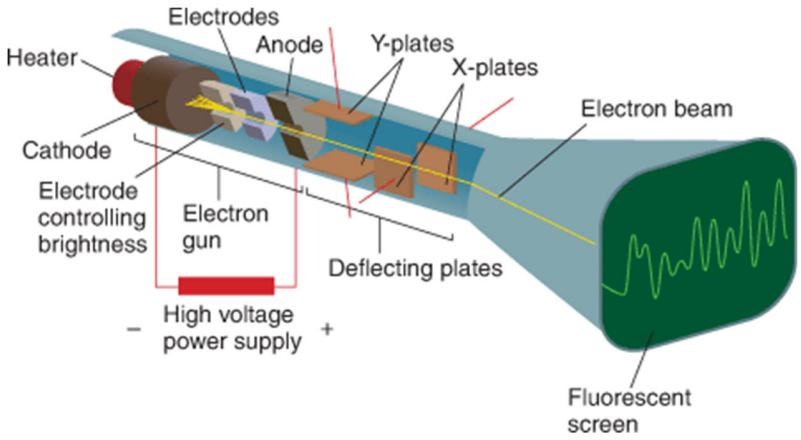
Applications of Cathode Rays

- outline the role of:
    - electrodes in the electron gun
    - the deflection plates or coil
    - the fluorescent screen

in the cathode ray tube of conventional TV displays and oscilloscopes

Parts of a cathode ray tube:



The electron gun:

- The role of the electron gun is to produce electrons at a high, fixed velocity.
- The heating filament heats the cathode, releasing electrons by thermionic emission.
- Thermionic emission is the mechanism by which electrons are set free from the metal structure of the cathode. By heating the cathode, the electrons are given enough energy to break the bond holding them in the metal.
- A number of electrodes are used to control the 'brightness' of the beam, to focus the beam and accelerate the electrons along the tube.
- The positively charged anode is supplied with a high voltage and develops a strong electric field that exerts a force on the electrons, accelerating them along the tube due to electrostatic attraction.

The deflection system:

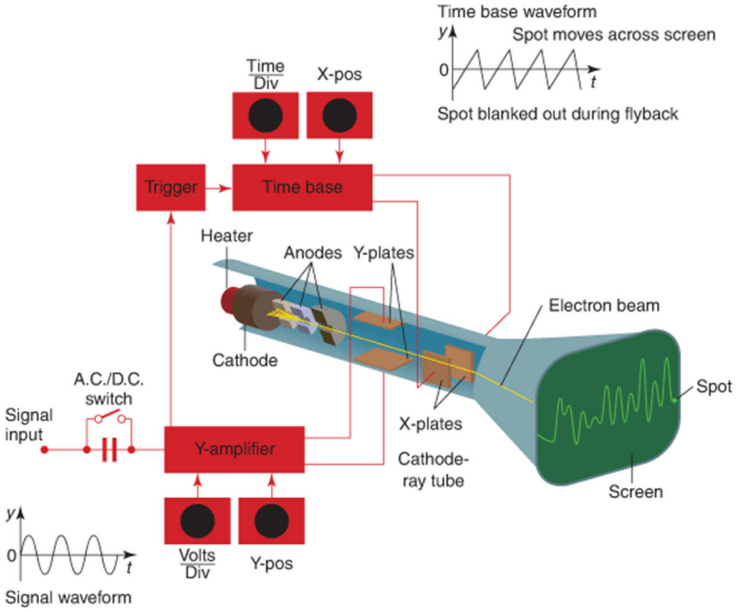
- The role of the deflecting system is to control the position that the electrons hit the screen to control the image produced.
- It consists of two sets of parallel deflecting plates which are perpendicular to each other and are charged to produce an electric field that can deflect the beam of electrons separately, up or down and left or right.
- These fields are used to move the beam so that the electrons can be directed to all points on the fluorescent screen.
- Electric current passing through coils around the cathode ray tube produces magnetic fields that control the movement of the electron beam. This movement on the screen produces the visible output.

The fluorescent screen:

- The role of the fluorescent screen is to display the light emitted by the electrons.
- It is a glass screen coated with layers of a fluorescent material. It emits light when high energy electrons strike it.
- Zinc sulphide or phosphorus are commonly used.

Cathode ray oscilloscopes (CRO):

- A CRO is a diagnostic and development device that makes voltages visible. It allows you to view electrical signals
- A CRO uses a cathode ray tube to display electrical signals of voltage versus time.
- It consists of a cathode ray tube with two perpendicular sets of deflecting **electric plates**.
    - The **vertical** set is where an input voltage is connected to the oscilloscope
    - The **horizontal** set is connected to a sweep generator / time base
        - This allows the voltage (on the vertical axis) to be plotted against time (on the horizontal axis).
        - This enables complex waveforms or very short pulses to be displayed and measured.
        - Sweep rates are able to be altered using the timebase control. This sets the 'time per division' for the figure drawn on the screen.
        - The bottom rotary switches control the amplitude of the displayed waveform.
        - Each centimetre of the grid can then be used to measure the voltage of the input waveform.



How a CRO works:
The input waveform enters from the left. One part of the signal is amplified and the voltage produced goes to the vertical deflecting plates. The other part passes to the trigger and time base and is then passed to the horizontal deflection plates.
The combination of both signals produce the waveform displayed on the screen.

Television:

- Television sets use a cathode ray tube as their output device, using magnetic fields to deflect the electron beam.
- A colour television camera records images through three coloured filters - red, blue and green.

- The information is transmitted to the receiver which directs the appropriate signal to one of three electron guns, each corresponding to one of the three colours.
- The electron beams scan the screen at a rate faster than our eyes can perceive.
    - This prevents the image from appearing to flicker.
- The images we see are actually made from many fluorescent dots.
    - It scans twice each time.
    - The odd-numbered lines are drawn first, then the beam ‘flies’ back to the start and draws in the even numbered lines.
    - Each scan is about 1/50 of a second.
    - Each television image is made up of 625 horizontal lines of dots.
- Dots of phosphorescent paint on the screen convert the energy of the electron beam into light.
- The picture is constructed on the screen by an additive process involving three coloured phosphors. Each electron gun stimulates its appropriate phosphor.