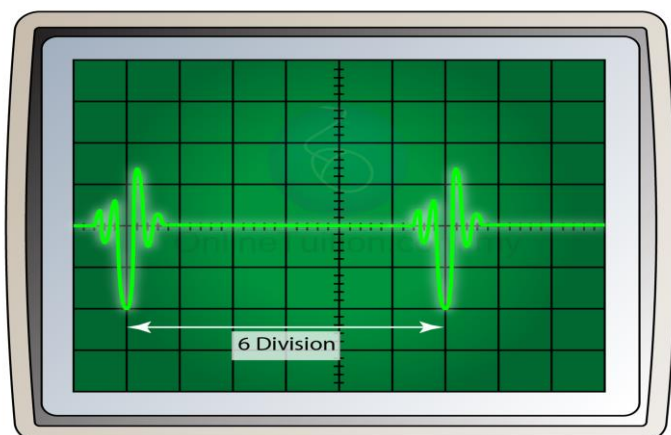
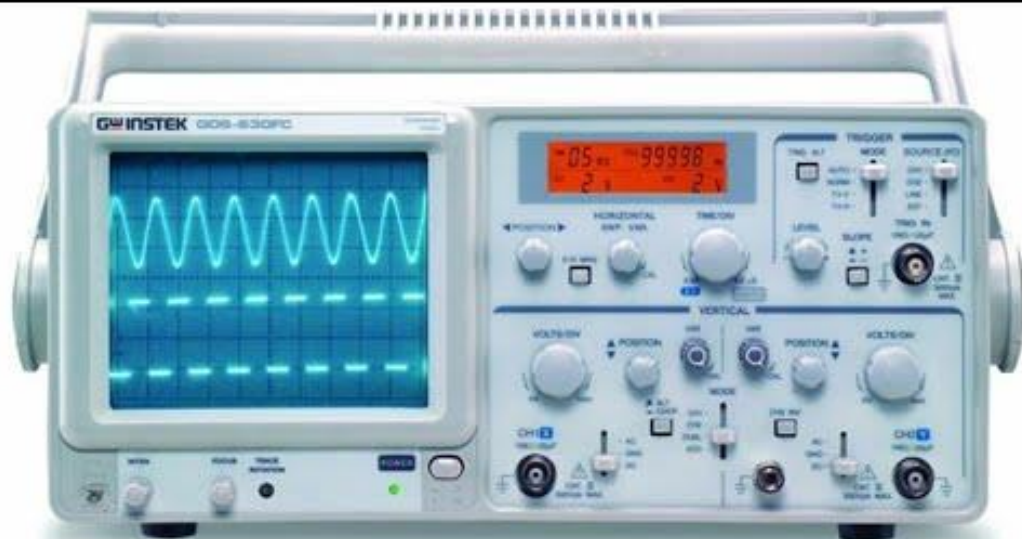


CATHODE RAYS AND C.R.T



Time base: 2ms/div

1. State TWO properties of cathode rays. (2 marks)
 - *They travel in straight lines*
 - *They cause fluorescent materials to glow*
2. State one property that shows cathode rays have both wave and particulate nature. (1mk)
 - ✓ *They undergo diffraction and interference*
3. State two uses of the CRO.
 - ✓ *Measuring the frequency of a wave*
 - ✓ *Used to measure voltage*
4. Distinguish between a photon and a quantum.
 - ✓ *A photon is an energy packet while a quantum is a particle where energy is propagated*
5. Name a suitable substance for coating inside the screen (1 mk)
 - ✓ *Zinc sulphide (Phosphor)*
6. Explain why the cathode of a CRO is coated with oxides of metals such as barium and strontium.
 - ✓ *The oxides have low work function hence they can emit electrons easily.*
7. State the two functions of anode in the C.R.O (2mks)
 - ✓ *Attract the electrons from the cathode*
 - ✓ *Accelerate the electrons towards the screen*
8. **State** the function of the grid in a cathode ray tube (CRT) (1mk)
 - ✓ *It controls the rate of flow of electrons hence the brightness of the spot on the screen*
9. State one similarity and one difference between cathode rays and x – rays(2mk)
 - ✓ *Similarity- both travel in straight lines*
 - ✓ *Difference- cathode rays are charged while x-rays are neutral*
10. Give the similarities and differences between cathode rays and light. (3 mk)
 - ✓ *Similarities- - both travel in straight lines*
 - *Both have effects on photographic plates*
 - ✓ *Differences- cathode rays are charged and hence are deflected by electric and magnetic fields while light rays are neutral hence not affected either magnetic or electric fields*
11. State how the deflection system of a television differs from that of a CRO. 1mk

- ✓ *In a television, magnetic coils which produce magnetic fields while in a CRO electric fields are used*

12. State and explain three uses of main parts of a CRT in an oscilloscope.

- ✓ *Electron gun- produces the electron beam, accelerates it and focuses it on the screen*
- ✓ *Deflecting system- determines the position of the beam on the screen*
- ✓ *The display system- produces a bright spot when the electron beam strikes the fluorescent material on the screen*

13. State the purpose of the grid in the cathode ray oscilloscope. (1mk)

- ✓ *It controls the rate of flow of electrons hence the brightness of the spot on the screen*

14. Give two uses of a C.R.O (2 mk)

- ✓ *Used as a voltmeter*
- ✓ *Used to measure the frequency of a wave*

15. State two advantages of a C.R.O as a voltmeter.

- ✓ *It can be used to measure large voltages without getting destroyed*
- ✓ *It responds spontaneously to changes in voltage*

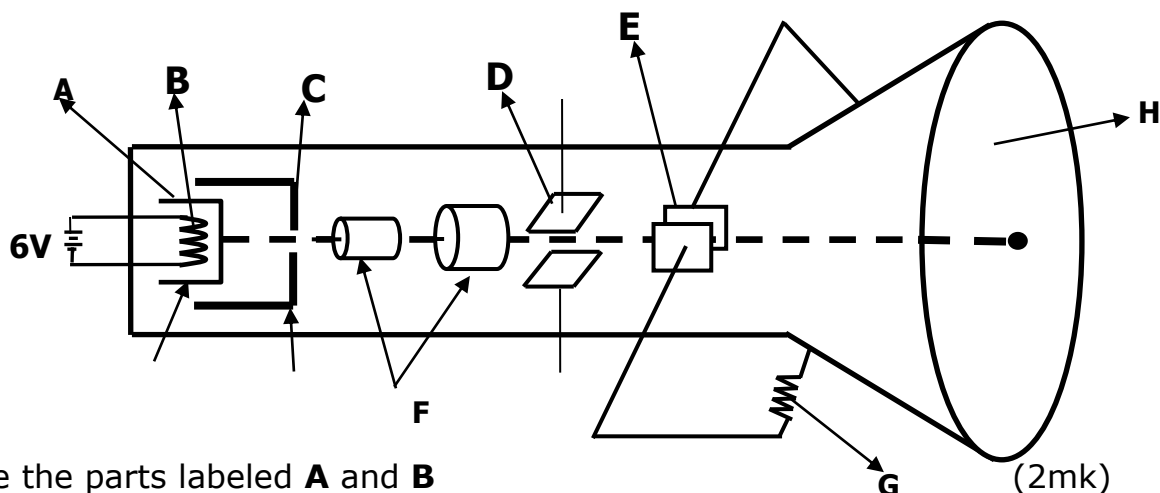
16. Explain why a C.R.O is a more accurate voltmeter than a moving coil voltmeter.

- ✓ *It has extremely high resistance and therefore it doesn't alter the current in the circuit.*

17. The control grid in a cathode ray oscilloscope (CRO) is used to control the brightness of the beam on the screen. Explain how this is achieved.

- ✓ *The negative voltage in the grid can be used to control the number of electrons reaching the screen. If the grid is made more negative compared to the cathode, less electrons pass the grid and reach the screen. Therefore, the spot appears to be less bright. However, if the grid is made more positive compared to the cathode, more electrons pass and reach the screen leading to a brighter spot.*

18. The figure below represents a cathode ray oscilloscope (C.R.O)



i) Name the parts labeled **A** and **B**

A- cathode

B- filament heater

ii) What are the functions of parts labeled **D** and **E**

D- used for vertical deflection of the electron beam

E- used for horizontal deflection of the beam

iii) Explain how electrons are produced.

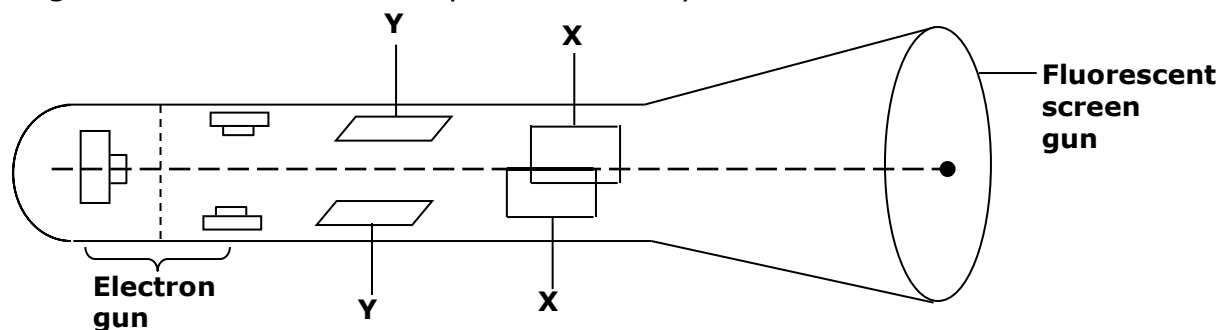
✓ **Thermionic emission** -When the cathode is heated, is heated, electrons on its surface gain enough energy to get emitted from their atomic structure.

iv) Give a reason why the tube is evacuated.

✓ **To avoid the collision of the cathode rays with air particles, which may lead to the loss of the electrons' kinetic energy.**

✓ **Ionization of the air particles can lead to formation of electric fields which interfere with the flow of electrons in the tube.**

19. The figure **below** shows a simple cathode ray tube.



(i) Explain how the electrons are produced in the tube.

✓ **Thermionic emission**- when the cathode is heated, electrons on the surface gain energy to break off from the atomic structure.

(ii) State **TWO** function of the anode.

✓ **Accelerate the electrons towards the screen**

✓ **Attract electrons from the cathode**

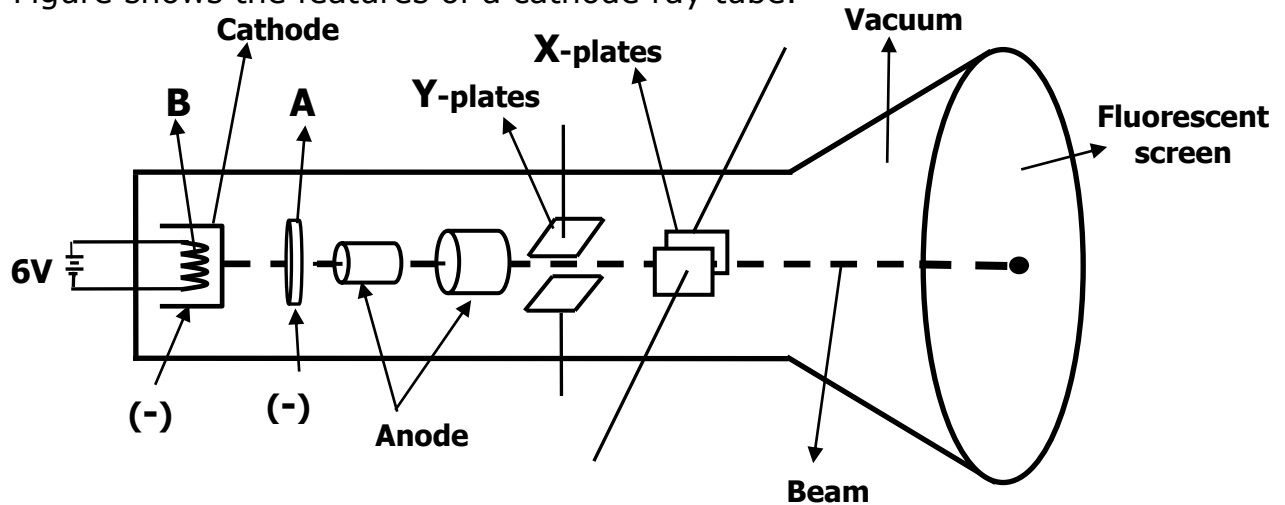
(iii) At what part of the cathode ray tube would the time base be connected.

✓ **The horizontal deflection plates**

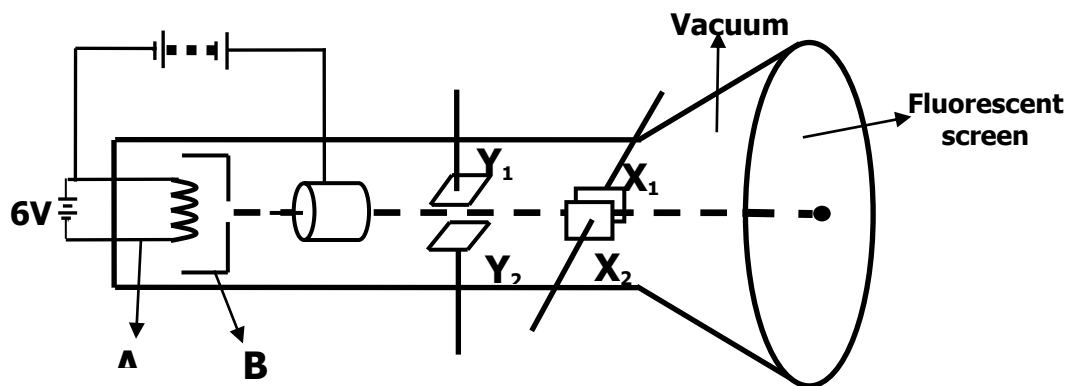
iv) What is the advantage of using the indirectly heated cathode as in the figure above to the directly heated cathode (1mk)

- ✓ *Eliminates ac noise*
- ✓ *To achieve better emission efficiency*

20. Figure shows the features of a cathode ray tube.



21. The figure shows a cathode ray oscilloscope.



(i) Name the part labeled:

- A** → cathode (1mk)
B → grid (1mk)

(ii) State the functions of **B**.

(1mk)

- ✓ *Controls the number of electrons leaving the cathode and hence the brightness of the spot on the screen*

(iii) State and explain the function of the grid

2 mks

- ✓ *It controls the number of electrons leaving the cathode and hence the brightness of the spot on the screen. By controlling its potential in relation to the cathode, the number of electrons leaving the cathode can be controlled*

iv) State and explain what would be observed on the screen if an a.c. voltage is connected across the y – plate

- ✓ *The spot moves up and down at the frequency of the signal.*
- ✓ *If the frequency is high, a vertical line is seen on the screen*

(v) state how the deflection system of a television differs from that of a C.R.O.

✓ *In a tv, magnetic field is used to deflect the beam compared to a CRO which uses electric field deflection.*

(vi) Explain why the cathode oscilloscope must be evacuated. (1mk)

✓ *To avoid the collision of the cathode rays with air particles, which may lead to the loss of the electrons' kinetic energy.*

✓ *Ionization of the air particles can lead to formation of electric fields which interfere with the flow of electrons in the tube.*

(vii) The velocity of electrons in the tube.

(3mks)

(Mass of an electron = **$9.11 \times 10^{-31} \text{kg}$**)

$$\frac{1}{2} m_e v^2 = eV$$

$$\frac{1}{2} \times 9.11 \times 10^{-31} \times v^2 = 1.6 \times 10^{-19} \times 6$$

$$v^2 = 2.108 \times 10^{12}$$

$$v = 1.452 \times 10^6 \text{m/s}$$

TELEVISION

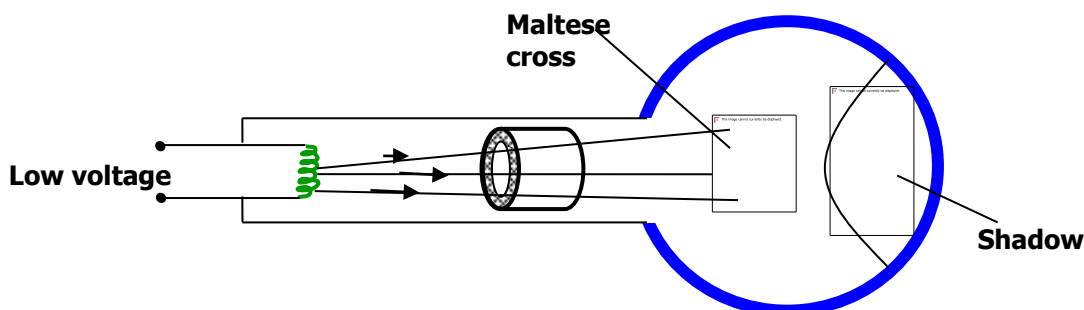
1. State two differences between the cathode ray tube (CRT) of a T.V and the cathode ray oscilloscope (CRO)

	Television	CRO
1.	<i>Deflection by magnetic field</i>	<i>Deflection by electric field</i>
2.	<i>Has two time base</i>	<i>Has one time base</i>

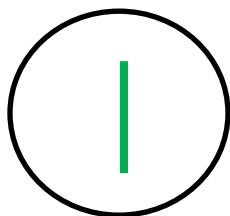
2. A Television tube is a cathode ray tube modified. State two modifications.
- ✓ *A television uses magnetic field for deflection while a CRT uses a electric field for deflection*
 - ✓ *A television has two tiny plates for deflection which light up the whole screen instead of a single line*
3. State the functions of the following parts of a C.R.O.
- i) *Grid→ controls the number of electrons leaving the cathode*
 - ii) *X-plates→ to deflect the beam horizontally*
 - iii) *Fluorescent screen→ produces a bright spot or line when the beam hits it*
4. Give a reason why a color T.V consumes more energy than a black and white TV. (1mk)
- ✓ *Three electron guns are used instead of one. Therefore the amount of energy consumed by the guns is increased.*
5. State the importance of the magnetic coils in a television tube (1mk)
- ✓ *They deflect the beams to light up the screen.*
6. In a television set, magnetic fields are preferred for use as deflection system instead of electric fields. Explain. (2mk)
- ✓ *Magnetic fields provide a wider deflection compared to electric fields*
7. State and explain why TV tube has a wider screen than cathode Rays oscilloscope (C.R.O) tube
- ✓ *A television uses magnetic field which provide a wider deflection compared to electric fields used with CRTs*
8. State why in a television set magnetic fields are used for the deflection system. (1mk)
- ✓ *Magnetic fields provide wider deflection to light up the whole screen*
9. State **one** difference between a cathode ray tube (CRT) of a TV and that of a CRO. (1mk)
- ✓ *A CRT uses electric field for deflections while a television uses magnetic fields for deflection*

THE BEAM

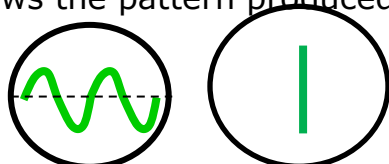
1. The fig. shows as simple form of cathode ray tube, which produces a sharp shadow of a Maltese cross on a fluorescent screen.



- (i) Explain what is meant by cathode rays. (2mks)
 ✓ *Cathode rays are streams of electrons emitted from the surface of a metal by thermionic emission*
- (ii) What property of cathode rays does the fig. above illustrate and name two other properties. (3mks)
 ✓ *They travel in straight lines*
 Other properties
 ✓ *The cause fluorescent surfaces to glow*
 ✓ *They are negatively charged*
2. Sketch the picture seen on the screen of a cathode ray oscilloscope when the oscilloscope is adjusted so that the spot is in the middle of the screen and the output terminals from a transformer connected to the mains are connected across the Y-plates.

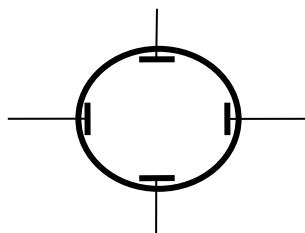


3. Figure below shows the pattern produced by an A.C voltage on a C.R.O screen.

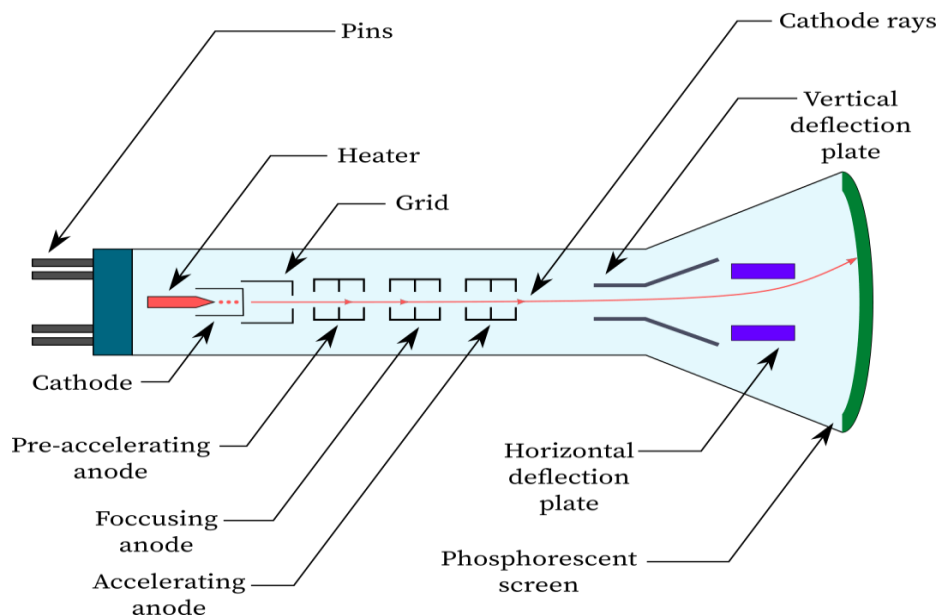


On the same figure, show the pattern produced by the same voltage when the time base is off.

4. The diagram shows the screen of a cathode ray tube, and behind it the position of the **X** and **Y** plates which deflect the electron beam. The beam forms a spot on the screen.



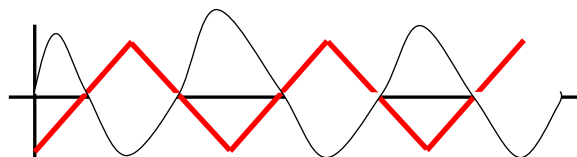
- a) Draw a labelled diagram showing a side view of the cathode ray tube.



- b) How is the brightness of the spot controlled?
 ✓ *By varying the potential of the grid relative to the cathode*
- c) The "X-shift" control on the front of the cathode ray oscilloscope moves the spot sideways on the screen. What kind of voltage direct, alternating or zero does it apply to:
- The X plates- *Alternating*
 - The Y plates- *zero*

5. The 'time-base' voltage normally applied to the X-plates in a CRO varies with time as shown.

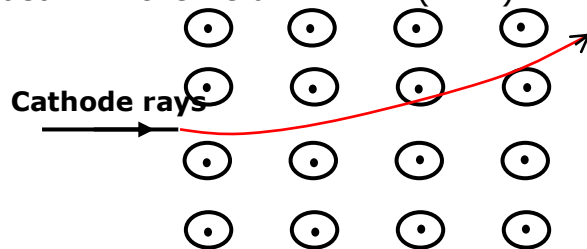
- i) Describe the motion of the spot when the time-base is on.



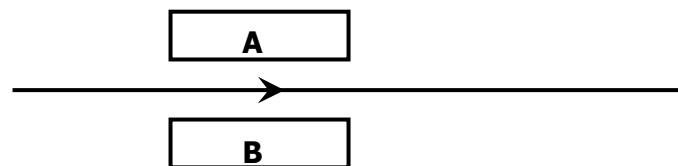
✓ *It moves forward and backward at the frequency of the voltage*

ii) Illustrate on the diagram above what is seen on the screen if an alternating voltage is applied to the Y-plates with the time-base on.

6. The figure below shows a cathode ray beam entering a magnetic field, perpendicular to the plane of the paper complete the diagram to show the path of the beam in the field. (1mk)



7. The arrow in the fig. represents a stream of electrons moving in the plane of the paper as shown.



How would the stream be deflected relative to the paper if:

- (i) A is a N-pole and B is a S-pole. (1mk)

✓ *Inside the paper*

- (ii) A is negatively charged and B is positively charged. (1mk)

✓ *Downwards (towards **B**)*

FREQUENCY AND VOLTAGE

1. A photon has an energy of $5 \times 10^{-19} \text{J}$. Calculate the wavelength associated with this photon.

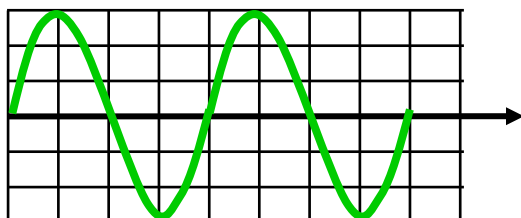
$$E = hf = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E}$$

$$\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{5 \times 10^{-19}}$$

$$= 3.978 \times 10^{-7} \text{m}$$

2. The figure below shows the trace on the screen of an a.c signal connected to the y-plates of C.R.O with time base on.



Given that the time control is **5ms/div**, and the y-gain is at **100V/div**, determine:

- i) The frequency of the a.c signal. (2mk)

$$T = 4 \text{div} \times 5 \text{ms/div} = 20 \text{ms}$$

$$f = \frac{1}{T} = \frac{1}{20 \times 10^{-3}}$$

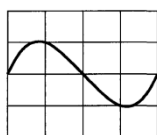
$$= 50 \text{Hz}$$

- ii) The peak voltage of the input signal (3mk)

$$V_{\text{peak}} = 3 \text{div} \times 100 \text{V/div}$$

$$= 300 \text{V}$$

3. The figure below shows the trace on the screen of an a.c signal connected to the y-plates of a C.R.O with time base on. Given that the time base control is 100ms/div and the y-gain is at 120v/d.v determine the frequency of the a.c signal (2mks)



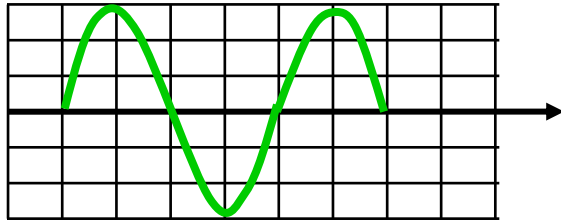
$$T = 4 \text{ div} \times 100 \frac{\text{ms}}{\text{div}} = 400 \text{ ms}$$

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

$$= \frac{1}{400 \times 10^{-3}}$$

$$= 2.5 \text{ Hz}$$

4. Figure shows the trace on the screen of a C.R.O when an a.c signal is connected to the Yplates. Time base control is set at 10ms/division and y-gain sensitivity at 120v/division.



Determine

- (i) The frequency of the a.c signal. (3mks)

$$T = 4 \text{ div} \times 10 \frac{\text{ms}}{\text{div}} = 40 \text{ ms}$$

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

$$= \frac{1}{40 \times 10^{-3}}$$

$$= 25 \text{ Hz}$$

- (ii) The peak voltage of the input signal. (2mks)

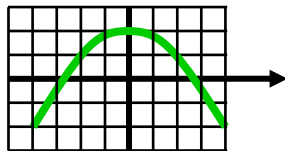
$$V_{\text{peak}} = 3 \text{ div} \times 120 \text{ V/div}$$

$$= 360 \text{ V}$$

- b) State two advantages of a CRO as a voltmeter. (2mks)

- ✓ It can be used to measure large voltages without getting destroyed
- ✓ It responds spontaneously to changes in voltage

5. A CRO screen with 1cm squares displays this trace.



The Y- gain is set 0.5v/cm and the time base is set at 5ms/cm. **Determine**

- (i) the voltage (1mk)

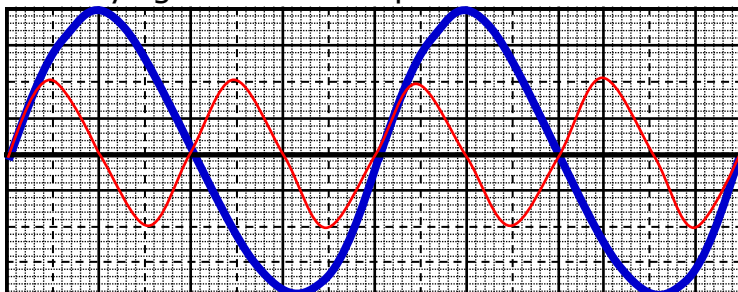
$$V = 4 \times 0.5 \text{ V/cm} = 2.0 \text{ V}$$

- (ii) the frequency of the signal (2mks)

$$T = 8 \text{ cm} \times 5 \frac{\text{ms}}{\text{cm}} = 40 \text{ ms}$$

$$f = \frac{1}{T} = \frac{1}{40 \times 10^{-3}} = 25 \text{ Hz}$$

6. The graph in Figure was obtained on a cathode ray oscilloscope (CRO) screen when the output of an a.c generator was connected to the input of the CRO. The time-base calibration of the CRO was set at 20 milliseconds per centimeter and the y- gain at 5 volts per centimeter.



- i) Determine the peak voltage of the generator. (2mks)

$$V_{peak} = 4cm \times 5V/cm = 20V$$

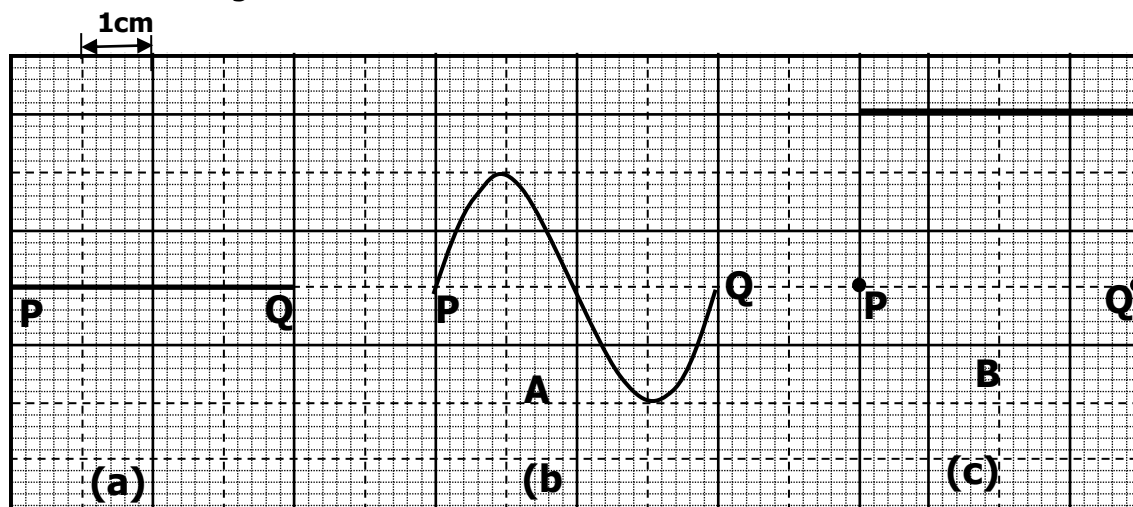
- ii) Determine the frequency of the voltage. (3mks)

$$T = 8cm \times 20ms/cm = 160ms$$

$$f = \frac{1}{T} = \frac{1}{160 \times 10^{-3}} = 6.25Hz$$

- iii) On the same grid, redraw the graph for the same voltage when the time base calibration is set at **40 milliseconds** per centimeter and the 7-gain at 10volts per centimeter. (Show at least one complete cycle). (2mks)

7. A cathode-ray oscilloscope is adjusted so that the time for the electron beam to make one traverse of the screen from **P to Q** is $\frac{1}{100}$ of a second and the **Y** – plate sensitivity is **1cm** represents **15V**. The trace on the screen is then as in fig. (a), fig. (b) and (c) shows the trace obtained when the C.R.O. is connected in turn to two voltage sources **A** and **B**.



- (i) What type of voltage sources are **A** and **B**? (2mks)

A → *alternating voltage*

B → *direct voltage*

- (ii) What is the voltage of **B** and the peak voltage of **A**? (2mks)

$$V_B = 3\text{cm} \times 15\text{ V/cm}$$

$$= 45\text{V}$$

$$V_{\text{peak}_A} = 2\text{cm} \times 15\text{ V/cm}$$

$$= 20\text{V}$$

- (iii) What is the frequency of source **A**? (2mks)

$$T = 0.01\text{s}$$

$$f = \frac{1}{T} = \frac{1}{0.01} = 100\text{Hz}$$

- 8.** A TV tube uses a voltage of 4550V to accelerate electrons released from its cathode by thermionic emission.

- (i) What is meant by thermionic emission? (1mk)

✓ *The process of emitting electrons from a metal surface due to heat*

- (ii) How is thermionic emission is achieved in the CRT. (1mk)

✓ *The cathode is heated by the heater filament inside the vacuum tube. The cathode emits electrons.*

THE END