Federal Board SSC-II Examination
SLOs Based Annual Question Paper
PHYSICS (SSC-II) 10th
(Annual Paper 2023) Version No. 2071

SECTION – A (Marks 12)

Q1. Fill the relevant bubble against each question according to curriculum:

1. If the time period of a vibrating body is 20×10^{-3} s, its frequency of oscillation will be:

A. 50 Hz ○ B. 60 Hz ○
C. 70 Hz ○ D. 80 Hz ○

2. Echo is produced by _____ of sound waves.

A. Refraction ○ B. Reflection ○
C. Diffraction ○ D. Interference ○

3. What should be the location of an object to form an erect and virtual image by a convex lens?

A. At $2F$ ○ B. At F ○
C. Between F and optical center ○ D. Between F and $2F$ ○

4. Electroscope is used to detect:

A. Resistance ○ B. Voltage ○
C. Current ○ D. Charge ○

5. If 3 μF and 6 μF capacitors are connected in series in a circuit, the equivalent capacitance of this combination is equal to:

A. 2 μF ○ B. 3 μF ○
C. 9 μF ○ D. 18 μF ○

6. The units of electromotive force (emf) is the same as units of potential difference which are equivalent to:

A. J/C ○ B. C ○
C. N ○ D. NC^{-1} ○

7. 1 kwh = _____.

A. $3000\ W$ ○ B. $1000\ J$ ○
C. $3.6 \times 10^6\ J$ ○ D. 0.36 hrs ○

8. The function of brushes and split rings in D.C motor is:

A. To increase the speed of coil ○
B. To decrease the speed of coil ○
C. To increase current in the coil ○
D. To reverse the direction of current in coil ○

9. The logic operation performed by this gate is:

A. AND ○ B. NOR ○
C. NAND ○ D. OR ○

10. Which of the following is used as data storage device in a computer?

A. Monitor ○ B. Printer ○
C. Scanner ○ D. Hard disk ○

11. $^{60}_{27}Co$ (Cobolt-60) decays by gamma emission. What will be the atomic number of daughter element?

A. 33 ○ B. 27 ○
C. 60 ○ D. 28 ○

12. The refractive index of glass is 1.52, the critical angle for this glass will be:

A. 40° ○ B. 41.1° ○
C. 42° ○ D. 43° ○

SECTION – B (Marks 33)

Q2. Answer any ELEVEN parts from the following. All parts carry equal marks. (11 × 3 = 33)

(i) If the length of simple pendulum is doubled. What will be the change in its time period?

Ans: Since, $T = 2\pi\sqrt{\frac{l}{g}}$ ..... (i)

When length is doubled then new length is $l' = 2l$.

$$T' = 2\pi\sqrt{\frac{2l}{g}} \quad \Rightarrow \quad T' = 2\pi \times \sqrt{2}\sqrt{\frac{l}{g}} \quad \Rightarrow \quad T' = \sqrt{2} \times \left(2\pi\sqrt{\frac{l}{g}}\right)$$

Since by using equation (i);

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \Rightarrow \quad T' = \sqrt{2}T \quad \Rightarrow \quad T' = 1.14\,T$$

If length of simple pendulum is doubled, then its time period increases by factor 1.41 times $(\sqrt{2}\ \textbf{times})$ of initial time period.

(ii) What is meant by noise pollution? Write harmful effects of noise on human health.

Ans: **Noise nuisance (irritation) Noise pollution:**

Noise is an undesirable sound that is harmful for health of human and other species.

Noise pollution is the disturbing or excessive noise that may harm the activity or balance of human or animal life. The source of most outdoor noise worldwide is mainly caused by machines and transportation systems, motor vehicles, aircrafts, and trains.

Harmful Effects of noise on human health:

Effects of noise nuisance:

Generally, problems caused by ***noise nuisance*** include stress related illnesses, speech interference, hearing loss, sleep disruption, and lost productivity (efficiency).

Negative effects of noise pollution:

Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbances, aggression, and high stress levels. Noise can also cause accidents by interfering with communication and warning signals.

(iii) The intensity of loud singing is $3.2 \times 10^{-5}\ \text{Wm}^{-2}$. Express the intensity level of this sound in decibel. $(I_0 = 1 \times 10^{-12}\ \text{Wm}^{-2})$

Ans:

- **Given data:**

  Intensity of sound $= I = 3.2 \times 10^{-5}\ \text{Wm}^{-2}$

  Here faintest sound intensity $= I_o = 1 \times 10^{-12}\ \text{Wm}^{-2}$ $(1\ \text{Bell} = 10\ \text{dB})$

- **Required:**

  Intensity level = ?

- **Solution:**

  Intensity level $= 10 \log \frac{I}{I_o}\ \text{dB}$ ..... (i)

  Intensity level $= 10 \log \frac{3.2 \times 10^{-5}}{1 \times 10^{-12}} = 10 \log 3.2 \times 10^{6}$

  We know $\log(\text{mn}) = \log \text{m} + \log \text{n}$

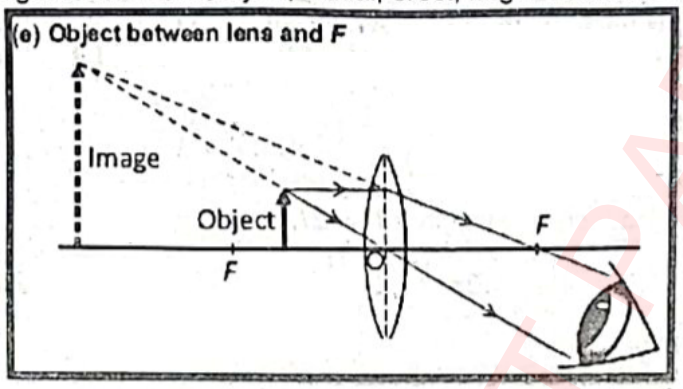
  Intensity level $= 10(\log 3.2 + \log 10^{6})$

  $= 10(0.51 + 6 \times \log 10) = 10(0.51 + 6 \times 1) = 10(6.51) = 65.1\ \text{dB}$

(iv) Under what condition will a converging lens form a virtual image? Illustrate your answer with the help of a ray diagram.

Ans: When an object is placed between principal focus (F) and optical center (O) then its image is virtual and is formed on the same side of the object.

When object is placed between principal focus (F) and optical center (O) then image formed will be virtual. The image is behind the object, virtual, erect, larger than the object.



(v) A biologist with a near point distance of $N = 26\ cm$, examines an insect wing through a magnifying glass whose focal length is $4.3\ cm$. Find angular magnification:

a) At the near point b) At infinity

Ans:

- **Given:** Focal length of magnifying glass $= f = 4.3\ cm$
  Near point distance $= N = 26\ cm$
- **Required:** Angular Magnification $= M_\theta = ?$
- **Solution:**

(a) The magnification when the image is at near point for magnifying lens is: $M_\theta = \frac{N}{f} + 1$

Putting values: $M_\theta = \frac{26\ cm}{4.3\ cm} + 1 \Rightarrow M_\theta = 6.05 + 1 \Rightarrow M_\theta = 7.05$

(b) The magnification when the image is at infinity for magnifying lens is: $M_\theta = \frac{N}{f}$

Putting values: $M_\theta = \frac{26\ cm}{4.3\ cm} \Rightarrow M_\theta = 6.05$

The relaxed eye magnification is smaller than the near point distance by 1.

(vi) What is meant by the term 'electrostatic potential'? Also write its formula and S.I unit.

Ans: **Electric Potential:**

Electric potential at a point in an electric field is defined as:

The amount of work done in bringing a unit positive charge from infinity to that point inside the electric field.

Consider "W" amount of work is done on a charge "q" in bringing it form infinity to a point inside the field, then electric potential at that point will be given by:

$$V = \frac{W}{q} \qquad \ldots\ldots\ldots (1)$$

This work done is stored in the charge in form of potential energy, called potential energy (U). Therefore, the above equation can also be written as:

$$V = \frac{W}{q} = \frac{U}{q} \qquad \ldots\ldots\ldots (2)$$

Electric potential is a scalar quantity unlike electrostatic force and electric field intensity. It has only magnitude which is given by equation (2).

Unit of electric potential:

Unit of electric potential is joule per coulomb (JC^{-1}) which is named as volt (V), in honor of Italian scientist Alessandro Volta.

The electric potential at any point will be one volt if 1 joule of work is needed to be done a unit positive charge ($q = +1\ C$) in bringing it from infinity to that point inside electric field.

$$1\ \text{Volt} = \frac{1\ \text{Joule}}{1\ \text{Coulomb}}$$

(vii) Two charges $q_1 = 5\ \mu C$ and $q_2 = 10\ \mu C$ repel each other with $0.2\ N$ force. What is the separation between these two charges?

Ans:

- **Given data:**

  $q_1 = 5\ \mu C = 5 \times 10^{-6}\ C$; $q_2 = 10\ \mu C = 10 \times 10^{-6}\ C$

  Force $= F = 0.2\ N$; $k = 9 \times 10^9\ Nm^2C^{-2}$

- **Required:** Distance $= r = ?$

- **Solution:** According to Coulomb's law:

$$F = k\frac{q_1 q_2}{r^2} \implies r^2 = k\frac{q_1 q_2}{F}$$

$$\implies r^2 = 9 \times 10^9 \times \frac{5 \times 10^{-6} \times 10 \times 10^{-6}}{0.2} = \frac{450 \times 10^{-3}}{0.2} = 2250 \times 10^{-3}$$

$$\implies r^2 = \frac{2250}{1000} \implies r^2 = 2.25 \implies r = \sqrt{2.25} \implies r = 1.5$$

(viii) Differentiate between alternating current and direct current.

Ans: Difference between A. C and D. C current:

Alternating current (A.C)	Direct current (D.C)
1. A.C is that current which changes its direction many times in one second.	**1.** D.C does not change its direction and travels in one direction.
2. A.C can travel a long distance.	**2.** D.C cannot travel long distance.
3. A.C can be converted into D.C.	**3.** D.C. cannot be converted into A.C.
4. A.C consists of both positive and negative half cycles.	**4.** D.C consists of only positive half cycles.
5. A.C. is more useful than D.C.	**5.** D.C. can be used only for specific purpose.
6. AC current is a phase or (vector).	**6.** DC current is scalar
7. AC changes direction continuously. For example, household current changes direction at a rate of 50 or 60 full cycles per second, depending on the region.	**7.** DC is current that goes in one direction only for example, current from a dry cell or car battery.

(ix) The resistance of a bulb is $500\ \Omega$. Find the power of the bulb when a potential difference of $250\ V$ is applied across its ends.

Ans:

- **Given data:**

  Given that, $R = 500\ \Omega, = 250\ V$

- **Formula:**

  Using the formula, $I = V/R$

- **Solution:**

  We get, current $I = \frac{250\ V}{500}\Omega = 0.5A$ and Power $P = I^2R = (0.5\ A)^2\ 500\ \Omega = 125\ W$

(x) Which factors can affect the magnitude of induced e.m.f?

Ans: Factors Affecting Induced e.m.f:

The magnitude of induced e.m.f. in a circuit depends on the following factors:

1. Speed of relative motion of the coil and the magnet.
2. Number of turns of the coil
3. Amount of current passing through the coil.

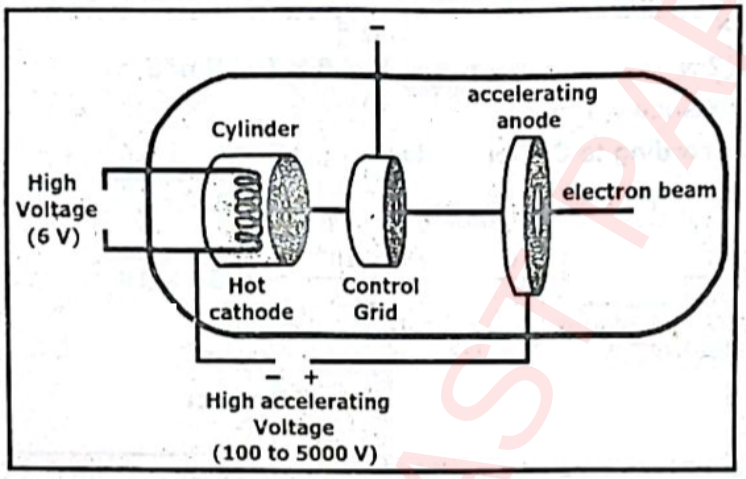
(xi) Can a transformer operate on direct current? Comment.

Ans: No, a transformer operate on direct current. The primary coil has to induce current in the secondary coil. The only way this can happen is if there is a varying magnetic field in the primary which then will induce a varying magnetic field in the secondary which results in a current in the sec.

(xii) Briefly describe the construction and working of electron gun.

Ans: **Construction of Electron gun:**

Electron gun consists of a glass tube at very low pressure, with negatively charged electrode called cathode and positively charged electrode called anode as shown in figure below.



ELECTRON GUN

➢ **Working of Electron gun:**

The electrons are emitted through the indirectly heated cathode. Indirectly heated cathode means the cathode electrode surrounds the filament and emits electrons when the filament is heated up by the power supply. For getting the high emission of electrons at the moderate temperature, the layer of barium and strontium oxide is applied at the end of the cathode. The current and voltage required by the indirectly heated cathode are approximately equal to the $600\ mA$ and $6.3\ V$ respectively.

(xiii) How NAND gate is made? Draw symbol for NAND gate and write its truth table.

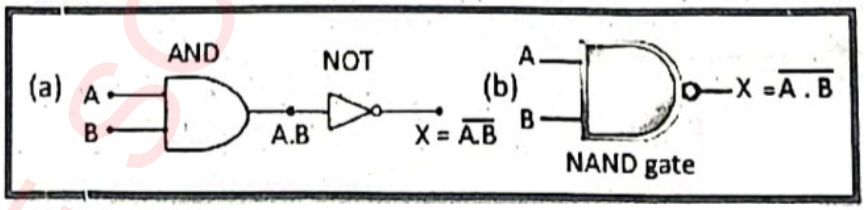
Ans: **Formation of NAND GATE:**

The combination of AND gate with NOT gate is called NAND gate. A NAND gate as an AND gate with a NOT gate at its output.

The symbol for a NAND gate is made from an AND gate with the inversion circle (bubble) at its output as shown in figure below.

The logic equation for the NAND gate is written $X = \overline{A \cdot B}$ **(Read as X equals not A and B).** From truth table we can see that the output is low **(0)** when both inputs **A** and **B** are high **(1)** otherwise output is low **(0)**.

➢ **Symbol of NAND Gate:**



➢ **Truth table for NAND Gate:**

A	B	A.B	Out put = X = $\overline{A.B}$
0	0	0.0 = 0	$\overline{0} = 1$
0	1	0.1 = 0	$\overline{0} = 1$
1	0	1.0 = 0	$\overline{0} = 1$
1	1	1.1 = 1	$\overline{1} = 0$

(xiv) Enlist the uses of internet. (Any three)

Ans: Internet has proved to be very beneficial to us. Here is the list of use of internet.

1. Faster Communication
2. Big Source of Information
3. Source of Entertainment
4. Access to Social Media
5. Access to Online Services
6. E-commerce

(xv) What is meant by background radiations? Write the names of main sources of background radiation.

Ans: **Background Radiations:**

A measure of the level of ionizing radiations present in the environment which is not due to deliberate introduction of radiation sources but due to different radioactive substances are called background radiations.

Sources of background radiations:

Radioactive elements are everywhere in the planet Earth; in rocks, soil, water, and in air. These natural radiations are called background radiations.

It is as much part of our environment as sunshine and rain. Only places where radiation is very high can be injurious to health while its normal ratio is not harmful for us.

The Earth and all living things on it also receive radiations from outer space. This radiation is called cosmic radiation which primarily consists of protons, electrons, alpha particles and larger nuclei.

The cosmic radiations (consists of high-energy charged particles, x-rays and gamma rays produced in space) interact with atoms in the atmosphere to create a shower of secondary radiations, including X-rays, muons, protons, alpha particles, electrons, and neutrons.

Natural Background Sources:

Natural background radiation comes from the following three sources:

- Cosmic Radiation
- Terrestrial Radiation
- Internal Radiation

SECTION – C (Marks 20)

Note: Attempt any TWO questions. All questions carry equal marks. (2 × 10 = 20)

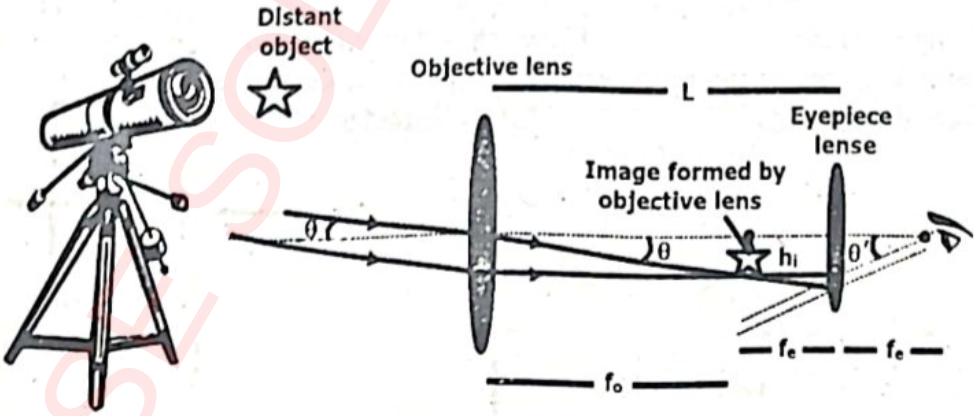
Q3. a. What is a telescope? Using a ray diagram explain its working, angular magnification and mention its magnifying power.

Ans: **Telescope:**

A telescope is an instrument used for magnifying distant objects, such as stars and planets.

Working:

Like a microscope, a telescope consists of an objective lens that forms a real image of the object; and an eyepiece is used to view this real image. Simple refracting telescope consists of two lenses as shown in the figure below, the first lens through which light from a celestial object passes is called the objective lens. A second lens, referred to as the eyepiece lens, is placed behind the focal plane and enables the observer to view the enlarged, or magnified, image.



TELESCOPE

Angular Magnification of Telescope:

The angular magnification of the telescope is $\mathbf{m} = \frac{f_o}{f_e}$. The length of the telescope barrel is $(f_o + f_e)$.

Magnification Power of Telescope:

The magnifying power of the telescope is the ratio of the angle subtended at the eye by the image to the angle subtended at the unaided eye by the object.

$$\text{Magnifying power} = m = \frac{f_o}{f_e} \times \frac{(1 + f_e)}{D}$$

- f_o = focal length of the object
- f_e = focal length of the eyepiece
- D = least distance of the distinct vision

b. A certain sound signal has a frequency 8 kHz and wavelength 4.25 cm in air; calculate the speed of sound in air.

Ans:

- **Given data:**

  Wavelength $= \lambda = 4.25\ \text{cm} = \frac{4.25}{100} = 0.0425\ \text{m}$

  Frequency $= f = 8\ \text{kHz} = 8 \times 10^3\ \text{Hz}$

- **Required:**

  Speed of sound in air $= v = ?$

- **Solution:**

  Speed of sound in air $= v = f\lambda$

  $v = 8 \times 10^3 \times 0.0425 = 0.34 \times 10^3$

  $v = 0.34 \times 1000 = 340\ \text{ms}^{-1}$

Q4. a. What is a capacitor? Describe capacitance and its S.I unit. How can one determine equivalent capacitance for different capacitors connected in series?

Ans: **Capacitor:**

A device used to store electrical charges or electrical energy is called capacitor.

Capacitance of a capacitor:

The ability or capacity of a capacitor to store charge per unit applied voltage is called capacitance of a capacitor.

The charge stored on the plates of a capacitor depends upon the applied voltage, greater the applied voltage greater will be the stored charge.

Mathematically, Replacing proportionality by equality and putting a constant:

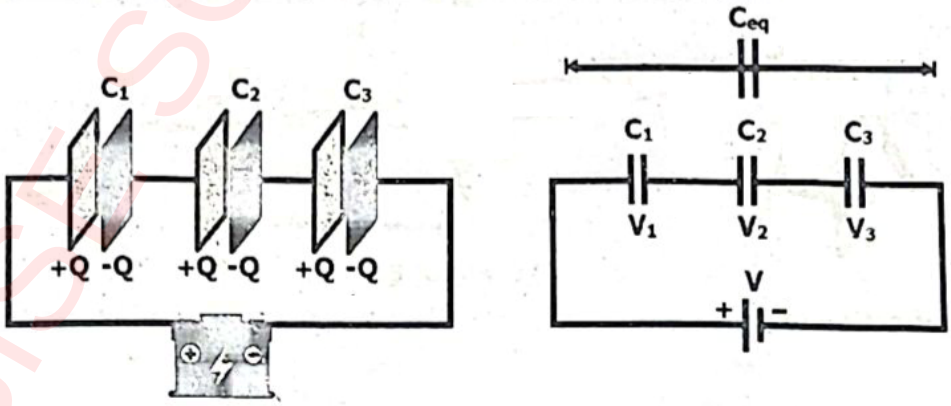
$$Q = CV \quad \Rightarrow \quad C = \frac{Q}{V} \qquad \ldots\ldots\ldots (1)$$

Whereas "C" is proportionality constant and is called capacitance of a capacitor.

SI unit of capacitance:

The S.I unit of capacitance is farad (F), which is defined as "the capacitance of a capacitor will be 1 F if 1 C of charge is stored on the plates when the applied voltage is 1 V."

Equivalent capacitance for different capacitors connected in series:



SERIES COMBINATION OF CAPACITORS

The potential difference across each capacitor is different due to different values of capacitances. But the sum of all potential differences will be equal to the source potential difference given by:

$$V = V_1 + V_2 + V_3 \qquad \ldots\ldots\ldots (1)$$

The equivalent capacitance will be smaller than the individual capacitors, which is calculated as follows:

The capacitance of a capacitor is given by:

$$Q = CV \quad \Rightarrow \quad V = Q/C \qquad \ldots\ldots\ldots (2)$$

Putting equation (2) in (1): $\frac{Q}{C_{eq}} = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$

$$\Rightarrow \quad \frac{\cancel{Q}}{C_{eq}} = \cancel{Q}\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right) \quad \Rightarrow \quad \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \qquad \ldots\ldots\ldots (3)$$

For "n" number of capacitors connected in series, the equivalent capacitance will be given by:

$$\Rightarrow \quad \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \frac{1}{C_5} + \ldots\ldots\ldots + \frac{1}{C_n} \qquad \ldots\ldots\ldots (4)$$

From equations (3) and (4), it is clear that in series combination the equivalent capacitance is always smaller than any individual capacitance in combination. That's why series combination of capacitors is used when we need a smaller capacitance than the available.

b. A transformer converts 240 V A.C mains to 12 V. It has 4000 turns on primary coil. How many turns should be on the secondary coil? If the transformer were 100% efficient, what current would flow through the primary coil when the current in the secondary coil was 0.4 A?

Ans:

- **Given data:**

  $V_p = 240\ V$; $V_s = 12\ V$; $N_p = 4000$

  $\eta = 100\ \%$; $I_s = 0.4\ A$

- **Required:**

  $I_p = ?$

- **Solution:**

$$\Rightarrow \quad \frac{N_p}{N_s} = \frac{V_p}{V_s} \quad \Rightarrow \quad \frac{4000}{N_s} = \frac{240}{12} \Rightarrow \quad \frac{4000}{N_s} = 20 \quad \Rightarrow \quad N_s = 200$$

$$\Rightarrow \quad I \propto \frac{1}{N} \quad \Rightarrow \quad \frac{I_p}{I_s} = \frac{N_s}{N_p} = \frac{200}{4000} = \frac{1}{20} \quad \Rightarrow \quad \frac{I_p}{I_s} = \frac{1}{20} \quad \Rightarrow \quad I_p = \frac{0.4}{20} = \frac{0.04}{2} = 0.02\ A$$

Q5. a. Describe the construction and working of Cathode ray oscilloscope with the help of a labelled diagram.

Ans: **Cathode Ray Oscilloscope (CRO):**

The cathode ray oscilloscope (CRO) is a type of electrical instrument which converts electric signal to visual signal and is used for showing the measurement and analysis of waveforms and other electronic and electrical phenomenon.

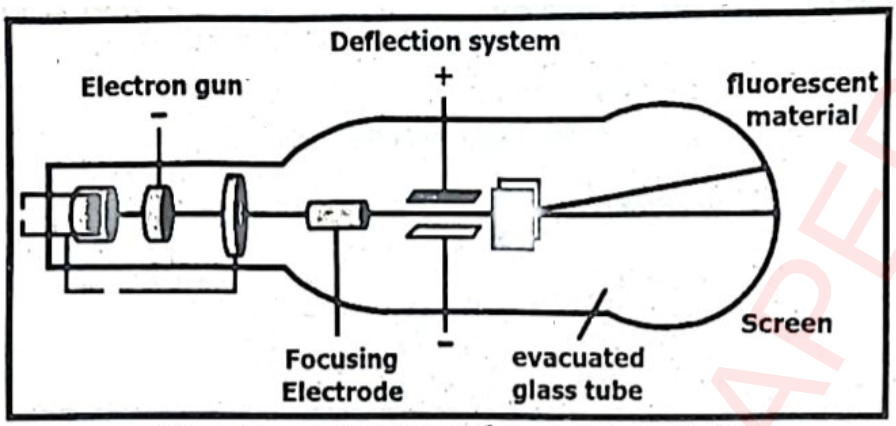
Components of Cathode-Ray Oscilloscope (CRO):

The cathode-ray oscilloscope (CRO) consists of the following components:

(i) The electron gun **(ii)** The deflecting plats **(iii)** A fluorescent screen

Construction of Cathode Ray Oscilloscope (CRO):

The block diagram of CRO is shown in the figure below, in which the accelerated electron beam from the electron gun is brought to the focal point on a fluorescent screen, with the help of focusing electrode. Thus, the screen produces a visible spot at center where the electron beam strikes it. The visible spot on the screen is observed because it is coated with a thin layer of phosphor (a material that gives light when electrons strike it).



CATHODE RAY OSCILLOSCOPE (CRO)

The horizontal and vertical plates are placed between the focusing electrode and the screen, thus it can detect the beam according to the input signal.

The deflector has two mechanisms, one to change the vertical direction and one to change the horizontal direction of the beam. This allows the electron beam to sweep over the entire screen.

Working Principle:

Working principle of CRO depends on the electron ray movement because of the electrostatic force.

Once an electron ray hits a phosphor face, then it makes a bright spot on it. A Cathode Ray Oscilloscope applies the electrostatic energy on the electron ray from two vertical ways.

The spot on the phosphor monitor turns due to the effect of these two electrostatic forces which are mutually perpendicular. It moves to make the necessary waveform of the input signal.

b. What are radio isotopes? Explain their uses for various applications.

Ans: Radioisotopes:

Isotopes of elements that occur naturally are mostly stable. But artificial isotopes, manufactured in nuclear laboratories by bombarding of subatomic particles, usually have a short life span, mostly due to their unstable nature and radioactivity. The half-life of such unstable nuclei is ranging from microseconds to billions of years.

The isotopes that are unstable and emit radiations are called radioactive isotopes or simply radioisotopes.

Uses of Radioisotopes for various applications:

Radioisotopes are frequently used in medicine, industry and agriculture for variety of useful purposes. Following are few applications of radioisotopes in different fields.

i. Tracers / Use in Industries:

Radioactive tracers can be used to explore the metabolism of chemical reactions inside the human body, animals or plants. Radioisotopes are used as tracers in medicine, industry and agriculture. For example, radio iodine-131 readily accumulates in the thyroid gland and can be used for the monitoring of thyroid functioning. The malignant part of the body absorbs more quantity of isotopes, and this helps in tracing the affected part of the body.

Tracers can be used in industries to locate the wear and tear of the moving parts of the machinery. They can be used for the location of leaks in underground pipes. In agriculture, phosphorous-32 is used as a tracer to find out how well the plants are absorbing the phosphate fertilizer which are crucial to their growth.

ii. Medical Treatment / Use in Medicine:

Radioisotopes are used for diagnosis and therapy purposes. Radioisotopes are used in nuclear medicines for curing various diseases. For example, cobalt-60 is used for curing cancerous tumors cells. The radiations kill the cells of the malignant tumor in the patient.

iii. Carbon Dating / Use in Research:

The Carbon-14 (with half-life 5730 yrs) present inside the plant starts decaying when a tree dies. The age of a dead tree can be calculated by comparing the activity of carbon-14 in the live and dead tree. The activity of the live tree remains almost constant as the carbon-14 is being replenished while the carbon-14 in the dead tree is no more replenished.

Other radioisotopes are also used to estimate the age of geological specimens. For example, some rocks contain the unstable potassium isotope K-40. This decays to the stable argon nuclide Ar-40 with half-life of 2.4×10^8 years.

The age of rock sample can be estimated by comparing the concentrations of K-40 and Ar-40.

iv. Food Preservation / Use in Industries:

A method of treating food in order to make it safer to eat and have a longer shelf life is called food preservation. Even after it has been packaged, gamma rays can penetrate the packing and be used to kill bacteria, mould and insects in food.

v. Sterilizing / Use in Industries:

Gamma rays are used to sterilize hospital equipment by irradiation, especially plastic syringes that would be damaged if heated.