Q24. A 10 m long wire of uniform cross-section and 20 Ω resistances is used in a potentiometer. The wire is connected in series with a battery of 5 V along with an external resistance of 480 Ω. If an unknown emf E is balanced at 6.0 m length of the wire, calculate:

(I) The potential gradient of the potentiometer wire

(II) The value of unknown emf E

Answer:

Given L=10 m, R_{AB}=20 Ω, V = 5, *l* = 6 m , R= 480 Ω

Let I =Current through the potentiometer wire AB then

$$I = \frac{V}{R_{AB}+R} = \frac{5}{20+480} = 0.01\ A$$

Potential difference across the wire AB =$V = IR_{AB} = 0.01 \times 20 = 0.2\ V$

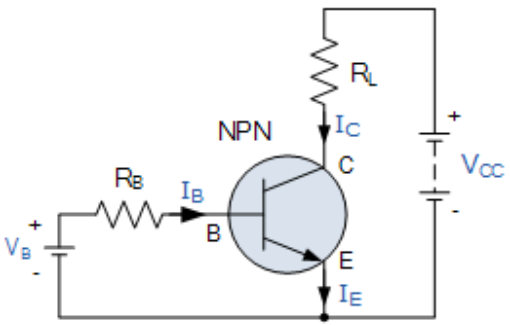
(I) Potential gradient is $= \frac{V}{L} = \frac{0.2}{10} = 0.02\ Vm^{-1}$

(II) Since unknown emf balanced at 6 m length, therefore Potential drop across 6 m wire is equal to emf of the cell. Potential drop per unit length i.e. potential gradient=0.02 so Potential drop across 6 m wire = $E = 0.02 \times 6 = 0.12\ V$

Q25. The input resistance of a transistor is 1000 Ω. On changing its base current by μA, the collector current increases by 2 mA. If a load resistance of 5 KΩ is used in the circuit, calculate:

(I) the current gain

(II) Voltage gain of the amplifier.



Answer: Given $R_{in} = 1000\ \Omega$

$\Delta I_B = 10\ \mu A = 10^{-5} A$,

$\Delta I_C = 2mA = 2 \times 10^{-3} A$

$R_L = 5k\ \Omega = 5 \times 10^3 \Omega$

Current gain, $\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2 \times 10^{-3}}{10^{-5}} = 200$

Voltage gain, $A_V = \beta \frac{R_L}{R_B} = \frac{200 \times 5 \times 10^3}{1000} = 1000$.

Q26. Define the term 'critical frequency' in relation to sky wave propagation of electromagnetic waves. On a particular day, the maximum frequency reflected from the ionosphere is 10 MHz. On another day, it was found to decrease to 8 MHz. Calculate the ratio of the maximum electron densities of the ionosphere on the two days.

Answer: Definition: Critical frequency is the **highest frequency** of the radio wave which when sent normally towards the given layer of the ionosphere gets reflected from ionosphere and return to the earth.

Critical frequency is given by, $f_C = a\,(N_{max})^{1/2}$

Where N_{max} is the maximum electron density of the ionosphere layer.

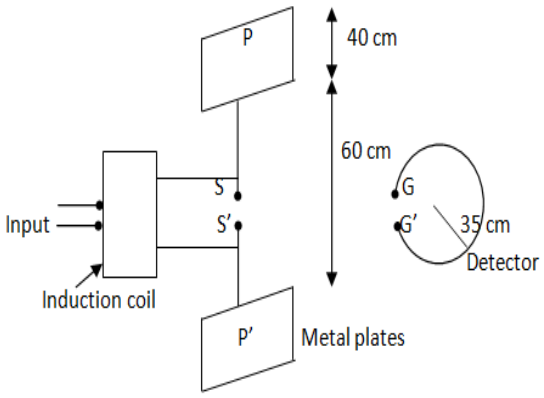
Problem:

$f_C = 10\ \text{MHz} = a(N_{max})^{1/2}$ and $f'_C = 8\ \text{MHz} = a(N'_{max})^{1/2}$

$\frac{N_{max}}{N'_{max}} = \left(\frac{f_C}{f'_C}\right)^2 = \left(\frac{10}{8}\right)^2 = 25:16$

Q27. Draw a labeled diagram of Hertz's experimental set-up to produce electromagnetic waves. Explain the generation of electromagnetic waves using this set-up.

Answer:



Experimental setup: Two large metal plates P and P' are connected to metal spheres S and S' as shown. The spheres are connected to an induction coil. High voltage is set-up across the gap by interrupting current in the coils. This voltage ionizes the air in the gap which produces oscillating current in the gap SS'.

This produces electromagnetic waves. For detection of these electromagnetic waves there is a detector which consists of a single loop of wire connected to spheres G and G'.