THE EDUCARE (SIROHI CLASSES) TEST SERIES

XII PHYSICS TEST

FIRST BOOK

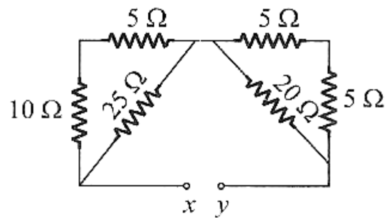
NAME-…………………………..............… DATE-…………… MM- 35 TIME-1.5 HR

1) Which one of the two, an ammeter or a milli-ammeter, has a higher resistance and why ? (1)

2) At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work? (1)

3) Why soft iron is used to make electromagnets? (1)

4) Determine the equivalent resistance of the network shown in Fig. , between the terminals *x* and y.



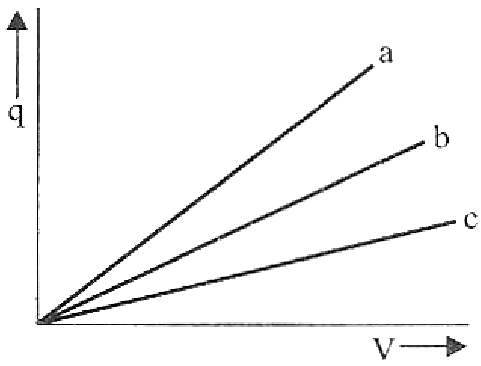
(1)

5) An α -particle and a proton are accelerated from rest through same potential difference and both enter into a uniform perpendicular magnetic field. Find the ratio of their radii of curvature. (2)

6) An electric bulb is designed to operate at 12 volt dc. If this bulb is connected to an ac source and gives normal brightness, what would be the peak value of the source ? (2)

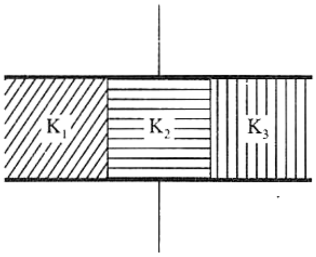
7) Identify the part of the electromagnetic spectrum which is
(i) suitable for radar system used in aircraft navigation (ii) adjacent to the low frequency end of the electromagnetic spectrum (iii) produced in nuclear reaction (iv) produced by bombarding a metal target by high speed electrons. (2)

8) Fig. shows plots of charge versus potential difference for three parallel plate capacitors which have the plate areas and separations given in the table. Which of the plots goes with which of the capacitors ? (2)



Capacitor	*Area*	*Separation*
1	A	d
2	2A	d
3	A	$2d$

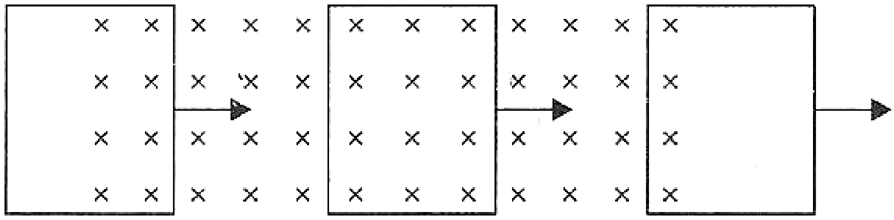
9) The space between the plates of a parallel plate capacitor of capacitance C is filled with three dielectric slabs of identical sizes as shown in Fig. If the dielectric constants of the three slabs are K_1 , K_2 and K_3, then what is the new capacitance ? (2)



10) A galvanometer coil has a resistance of 12 Ω and meter shows full scale deflection for a current of 3mA. How will you convert the galvanometer into a volt- meter of range 0 to 18 V?

A galvanometer coil has a resistance of 15 Ω and the meter shows full scale deflection for a current of 4 mA. How will you convert the meter into an ammeter of range 0 to 6 A ? (3)

11) A uniform magnetic field exists normal to the plane of the paper over a small region of space. A rectangular loop of wire is slowly moved with a uniform velocity across the field as shown in Fig.



Draw the graph showing the variation of (i) magnetic flux linked with the loop and (ii) the induced emf in the loop with time. (3)

12) How will a dia, para and a ferromagnetic material behave when kept in a non-uniform external magnetic field ? Give two examples of each of these materials. Name two main characteristics of a ferromagnetic material which help us to decide its suitability for making (i) a permanent magnet (ii) an electromagnet. Which of these two characteristics should have high or low values for each of these two types of magnets ? (5)

OR

Suppose that the electric field part of an electromagnetic wave in vacuum is

$$\vec{E} = (3.1 N/C)\cos[(1.8 rad/m)y + (5.4\times10^6 rad/s)\ t\ ]\ \hat{i}$$

a) What is the direction of propagation ?

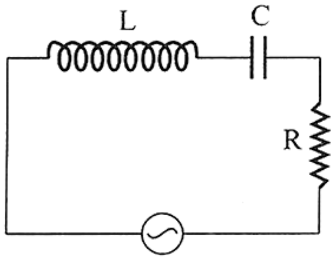
b) What is the wavelength λ ?

c) What is the frequency ν ?

d) What is the amplitude of the magnetic field part of the wave ?

e) Write an expression for the magnetic field part of the wave.

13) Fig. shows a series LCR circuit connected to a variable frequency 230 V source. L = 5.0 H, C = 80 μF , R = 40 Ω . (a) Determine the source frequency which drives the circuit in resonance. (b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.



(c) Determine the rms potential drops across the three elements of the circuit. (d) How do you explain the observation that the algebraic sum of the voltages across the three elements obtained in (c) is greater than the supplied voltage? (5)

OR

The primary coil of an ideal step- up transformer has 100 turns and the transformation ratio is also 100. The input voltage and power are 220 V and 1100 W respectively. Calculate

(i) number of turns in the secondary

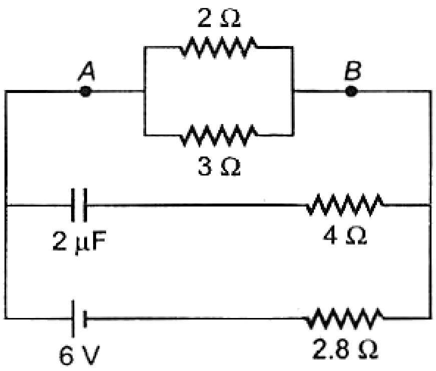
(ii) the current in the primary

(iii) voltage across the secondary

(iv) the current in the secondary

(v) power in the secondary

14) (a)Calculate the steady current through the 2 Ω resistor in the circuit shown.



(b) Derive a mathematical expression for resistivity of a conductor in terms of number density of charge carries in the conductor and relaxation time. (5)

OR

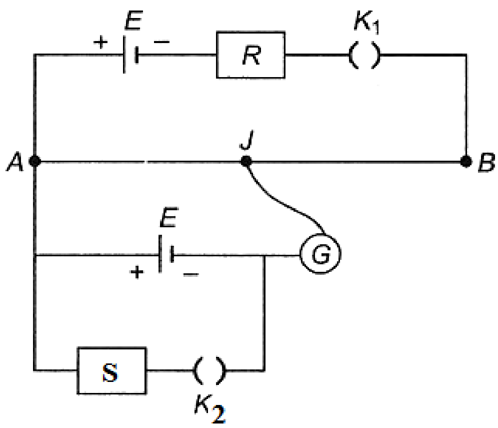
(a) State the underlying principle of a potentiometer. Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell?

(b)Two students X and Y perform an experiment on potentiometer separately using the circuit given below :

Keeping other parameters unchanged, how will the position of the null point be affected if

(i) *X* increases the value of resistance *R* in the set-up by keeping the key K_1 closed and the key K_2 open?

(ii)Y decreases the value of resistance *S* in the set-up, while the key K_2 remains open and they K_1 closed? Justify your answer.



SOLUTIONS

1) Which one of the two, an ammeter or a milli-ammeter, has a higher resistance and why (1)

SOL: Shunt resistance

$$S = \frac{I_g \times G}{I - I_g}$$

Clearly, the shunt needed to convert a galvanometer into a milliammeter has a larger value than that required to convert into ammeter. As the shunt is connected in parallel with the galvanomter, so the milliammeter will have a higher resistance than the ammeter.

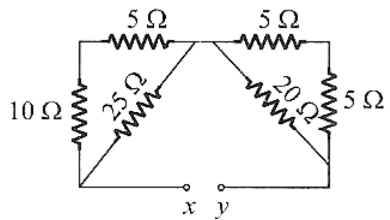
2) At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work ?

SOL: The metal detector works on the principle of resonance in ac circuits. When you walk through a metal detector, you are in-fact walking through a coil of m any turns. The coil is connected to a capacitor tuned so that the circuit is in resonance. When you walk through metal in your pocket, the impedance of the circuit changes. This results in a significant change in current in the circuit. This change in current is detected. The electronic circuitry causes a sound to be emitted as an alarm.

3) Why soft iron is used to make electromagnets ? (1)

Ans: The hysteresis loop for soft iron is narrow. So, loss of energy⁻ per unit volume in one cycle of magnetisation is small. Also, soft iron has high permeability. Thus, soft iron is used for making electromagnets.

4) Determine the equivalent resistance of the network shown in Fig. , between the terminals *x* and y.



(1)

SOL: 16.042 Ω

5) An α -particle and a proton are accelerated from rest through same potential difference and both enter into a uniform perpendicular magnetic field. Find the ratio of their radii of curvature. (2)

SOL:

$$r = \frac{mv}{Bq} = \frac{p}{Bq} = \frac{\sqrt{2mE_k}}{Bq} = \frac{\sqrt{2mqV}}{Bq}$$

$$\frac{r_\alpha}{r_p} = \sqrt{\frac{m_\alpha}{m_p} \times \frac{q_p}{q_\alpha}} = \sqrt{\frac{4}{1} \times \frac{e}{2e}} = \frac{\sqrt{2}}{1}$$

6) An electric bulb is designed to operate at 12 volt dc. If this bulb is connected to an ac source and gives normal brightness, what would be the peak value of the source ? (2)

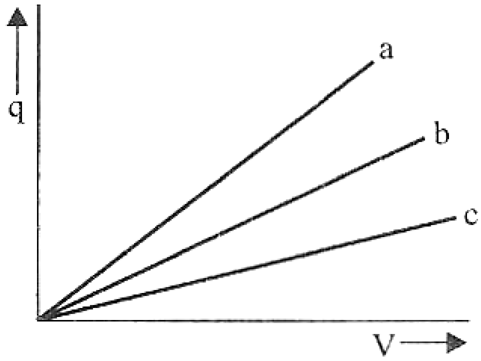
SOL:

$$\frac{12^2}{R} t = \frac{E_v{}^2}{R} t \text{ ; } E_v = 12 \text{ V}, E_0 = \sqrt{2}\, E_v = 1.414 \times 12 \text{ V} = 16.968 \text{ V} \approx 17 \text{ V}.$$

7) Identify the part of the electromagnetic spectrum which is
(i) suitable for radar system used in aircraft navigation (ii) adjacent to the low frequency end of the electromagnetic spectrum (iii) produced in nuclear reaction (iv) produced by bombarding a metal target by high speed electrons. (2)

Ans. *(i)* Microwaves *(ii)* Radiowaves *(iii)* γ -rays *(iv)* X-rays.

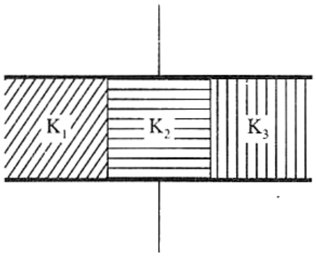
8) Fig. shows plots of charge versus potential difference for three parallel plate capacitors which have the plate areas and separations given in the table. Which of the plots goes with which of the capacitors ? (2)



Capacitor	*Area*	*Separation*
1	A	d
2	2A	d
3	A	$2d$

SOL: 1. a, 2 2. *b*, 1 3. *c*, 3.

9) The space between the plates of a parallel plate capacitor of capacitance C is filled with three dielectric slabs of identical sizes as shown in Fig. If the dielectric constants of the three slabs are K_1, K_2 and K_3, then what is the new capacitance ? (2)



SOL: The given system is equivalent to a parallel combination of three capacitors of capacities

$$K_1 \times \frac{C}{3}, K_2 \times \frac{C}{3}, K_3 \times \frac{C}{3}.$$

So, total capacity is $\frac{C}{3}(K_1 + K_2 + K_3)$.

10) A galvanometer coil has a resistance of 12 Ω and meter shows full scale deflection for a current of 3mA. How will you convert the galvanometer into a volt- meter of range 0 to 18 V?

A galvanometer coil has a resistance of 15 Ω and the meter shows full scale deflection for a current of 4 mA. How will you convert the meter into an ammeter of range 0 to 6 A ? (3)

SOL:

$G = 12\ \Omega,\ I_g = 3\text{mA} = 3 \times 10^{-3}\ \text{A}$

$V = 18$ volt

$V = I_g (R + G)$

$$R = \frac{V}{I_g} - G = \frac{18}{3 \times 10^{-3}} - 12$$

$$= 5988\ \Omega$$

A resistance of **5988 Ω** is required to be connected in series with the galvanometer.

and

$G = 15\ \Omega,\ I_g = 4\ \text{mA} = 4 \times 10^{-3}\ \text{A},$

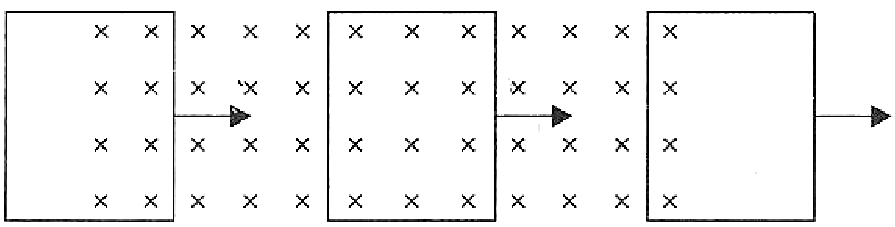
$I = 6\text{A}$

$$S = \frac{GI_g}{I - I_g}$$

$$= \frac{15 \times 4 \times 10^{-3}}{6 - 4 \times 10^{-3}}\ \Omega = 10\ \text{m}\Omega$$

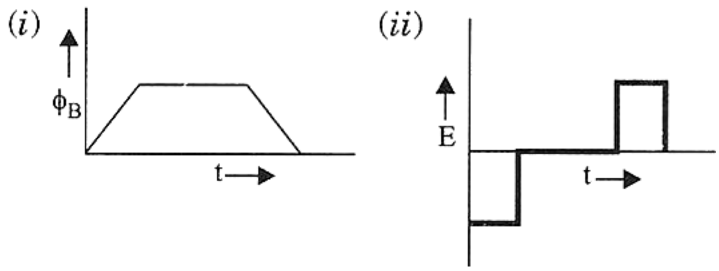
A resistance of 10 mΩ needs to be connected in parallel with the galvanometer.

11) A uniform magnetic field exists normal to the plane of the paper over a small region of space. A rectangular loop of wire is slowly moved with a uniform velocity across the field as shown in Fig.



Draw the graph showing the variation of (i) magnetic flux linked with the loop and (ii) the induced emf in the loop with time. **(3)**

SOL:



12) **How will a dia, para and a ferromagnetic material behave when kept in a non-uniform external magnetic field ? Give two examples of each of these materials. Name two main characteristics of a ferromagnetic material which help us to decide its suitability for making (i) a permanent magnet (ii) an electromagnet. Which of these two characteristics should have high or low values for each of these two types of magnets ?** **(5)**

SOL: Diamagnetic material moves (very weakly) away from strong field region towards the weak field region.

Paramagnetic material moves (weakly) towards the strong field region. Ferromagnetic material moves (strongly) towards the strong field region.

Examples : Diamagnetic (Bismuth, Copper) ; Para-magnetic (Aluminium, Oxygen); Ferromagnetic (Iron, Nickel).

Two characteristics of ferromagnetic materials : Coercivity and Retentivity.

For Permanent magnets : High Coercivity and High Retentivity.

For Electromagnets : Low Coercivity and Low Retentivity.

OR

Suppose that the electric field part of an electromagnetic wave in vacuum is
$\vec{E} = (3.1 N/C)\cos[(1.8 rad/m)y + (5.4\times10^{6} rad/s)t]\hat{i}$

a) **What is the direction of propagation ?**
b) **What is the wavelength λ ?**
c) **What is the frequency ν ?**
d) **What is the amplitude of the magnetic field part of the wave ?**
e) **Write an expression for the magnetic field part of the wave.**

SOL: (a) The wave is propagating along **negative y direction** *i.e.*, **along – $\hat{j}$.**

(b) and *(c)* Comparing the given equation with

$\vec{E} = E_0 \cos(ky + \omega t)\,\hat{i}$,

$E_0 = 3.1\ NC^{-1}$, $k = 1.8$ rad m^{-1}, $\omega = 5.4 \times 10^6$ rad s^{-1}

$$k = \frac{2\pi}{\lambda}, \lambda = \frac{2\pi}{k} = \frac{2 \times 3.14}{1.8} m = \mathbf{3.5\ m}$$

$$\nu = \frac{\omega}{2\pi} = \frac{5.4 \times 10^6}{2 \times 3.14}\ Hz = 859.87\ kHz \approx \mathbf{860\ kHz}$$

$$(d)\ B_0 = \frac{E_0}{c} = \frac{3.1}{3 \times 10^8} T = 1.03 \times 10^{-8}\ T = \mathbf{10.3\ nT}$$

$$(e)\ \vec{B} = B_0 \cos(ky + \omega t)\hat{k}$$

$$= \{(10.3\ nT) \cos[(1.8\ rad\ m^{-1})y + (5.4 \times 10^6\ rad\ s^{-1})t]\}\hat{k}.$$

13) Fig. shows a series LCR circuit connected to a variable frequency 230 V source. L = 5.0 H, C = 80 μF , R = 40 Ω . (a) Determine the source *frequency* which drives the circuit in resonance. (b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency. (c) Determine the rms potential drops across the three elements of the circuit. (d) How do you explain the observation that the algebraic sum of the voltages across the three elements obtained in (c) is greater than the supplied voltage? (5)

SOL:

$$(a)\ \text{Resonant frequency},\ \omega_0 = \frac{1}{\sqrt{LC}}$$

$$= \frac{1}{\sqrt{5 \times 80 \times 10^{-6}}}\ rad\ s^{-1} = \mathbf{50\ rad\ s^{-1}}$$

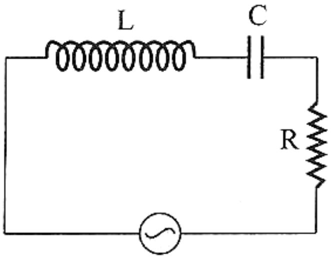
$$(b)\ \text{At}\ \omega = \omega_0,\ Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = R = \mathbf{40\ \Omega}$$

$$\text{Again},\ I_0 = \frac{E_0}{Z} = \frac{E_0}{R}$$

(at resonance)

$$= \frac{\sqrt{2} \times 230}{40}\ \text{ampere}$$

$$= \mathbf{8.13\ ampere}$$



(c) Across L, $E_{Lv} = I_v \times \omega_0 L = \frac{230}{40} \times 50 \times 5$ volt

$$= \mathbf{1437.5\ volt}$$

Across C, $E_{Cv} = I_v \times \frac{1}{\omega_0 C}$

$$= \frac{230}{40} \times \frac{1}{50 \times 80 \times 10^{-6}} \text{ volt}$$

$$= \mathbf{1437.5\ volt}$$

Across L and C, total potential drop is given by

$$E_v = I_v \left(\omega_0 L - \frac{1}{\omega_0 C} \right) = 0$$

(d) The algebraic sum of the three voltages is more than the source voltage of 230 V. These voltages are not in the same phase and cannot be added like ordinary numbers.

The voltages across L and C are out of phase and get added to zero.

V_{rms}^{R} = applied rms voltage.

OR

The primary coil of an ideal step- up transformer has 100 turns and the transformation ratio is also 100. The input voltage and power are 220 V and 1100 W respectively. Calculate

(i) **number of turns in the secondary**

(ii) **the current in the primary**

(iii) **voltage across the secondary**

(iv) **the current in the secondary**

(v) **power in the secondary**

SOL: N_p = 100, Transformation ratio = 100,

$V_P = 220$ V, $P_P = 1100$ W

(*i*) N_s = Transformation ratio × N_P

= 100 × 100 = **10000**

(*ii*) $I_P = \frac{P_P}{V_P} = \frac{1100}{220} = \mathbf{5\ A}$

(*iii*) V_s = Transformation ratio × V_P

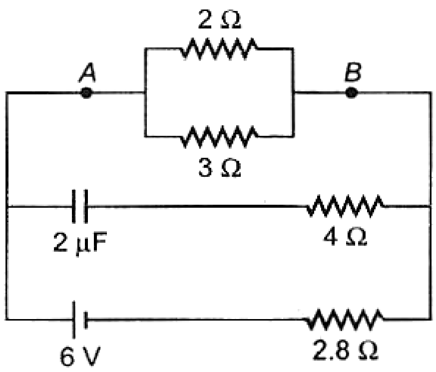
= 100 × 220 V = **22000 V**

(*iv*) $I_s = \frac{V_P I_P}{V_s} = \frac{220 \times 5}{22000} = \mathbf{0.05\ A}$

(*v*) For an ideal transformer,

$P_s = P_P = \mathbf{1100\ W}$

14) (a) Calculate the steady current through the 2 Ω resistor in the circuit shown.



(b) Derive a mathematical expression for resistivity of a conductor in terms of number density of charge carries in the conductor and relaxation time. (5)

SOL: (a) In DC circuit capacitor offers infinite resistance. Therefore, no current flows through capacitor and through 4 Ω resistance, so this resistance will have form no effect.

Effective resistance between A and *B*

$$R_{AB} = \frac{2 \times 3}{2+3} = 1.2\ \Omega$$

$$\left(\because \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R = \frac{R_1 R_2}{R_1 + R_2}\right)$$

Total resistance of the circuit = 1.2 + 2.8 (∵ These two are in series = 4 Ω)

Net current drawn from the cell

$$I = \frac{V}{R\,(\text{Total resistance})}$$

$$= \frac{6}{1.2 + 2.8} = \frac{6}{4} = \frac{3}{2} = 1.5 \text{ A}$$

∴ Potential difference between A and B

$$V_{AB} = IR_{AB} = 1.5 \times 1.2$$

$$V_{AB} = 1.80 \text{ V}$$

Current through 2 Ω resistance

$$I' = \frac{V_{AB}}{2\,\Omega} = \frac{1.8}{2} = 0.9 \text{ A}$$

(b) When a potential difference V is applied across *l* length of a conductor then drift speed of electron is given by

$$v_d = \frac{eE\tau}{m} = \frac{eV\tau}{lm} \quad \ldots\text{(i)} \quad \left(\because\; E = \frac{V}{l}\right)$$

Also, the electric current through the conductor and drift speed are linked as

$I = neav_d$ ...(ii)

where, n= number density of electrons

e = electronic charge

a= cross-sectional area of conductor

v_d = drift speed of electron

$$I = nea\left(\frac{eV\tau}{lm}\right)$$

(Substituting the value of v_d)

$$\frac{V}{I} = \frac{ml}{ne^2\tau A} \quad \ldots\text{(iii)}$$

Also, at constant temperature

$$\frac{V}{I} = R \quad \ldots\text{(iv)}$$

(From Ohm's law)

$$R = \left(\frac{m}{ne^2\tau}\right)\frac{l}{A}$$

[From Eqs. (iii) and (iv)]

$$R = \rho\frac{l}{A}$$

where, ρ is specific resistance or resistivity of conductor

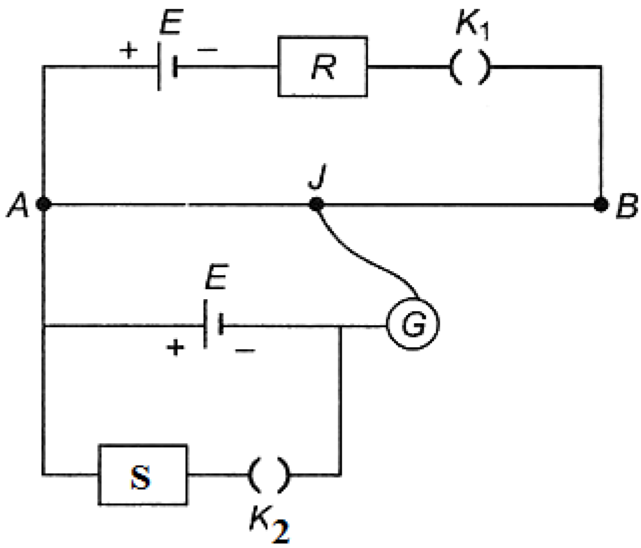
$$\rho = \frac{m}{ne^2\tau} \quad \ldots(v)$$

Thus, resistivity of material of conductor is inversely proportional to relaxation time.

OR

(a) State the underlying principle of a potentiometer. Describe briefly, giving the necessary circuit diagram, how a potentiometer is used to measure the internal resistance of a given cell?

(b)Two students X and Y perform an experiment on potentiometer separately using the circuit given below :



Keeping other parameters unchanged, how will the position of the null point be affected if

(i) *X* increases the value of resistance *R* in the set-up by keeping the key K_1 closed and the key K_2 open?

(ii)Y decreases the value of resistance *S* in the set-up, while the key K_2 remains open and they K_1 closed? Justify your answer.

SOL: (a) Principle of potentiometer The potential difference across any two points of current carrying wire, having uniform cross-sectional area and material, of the potentiometer is directly proportional to the length between the two points, i.e.,

$$V \propto l$$

$\because \quad V = IR = I\left(\rho \frac{l}{A}\right)$ (from Ohm's law)

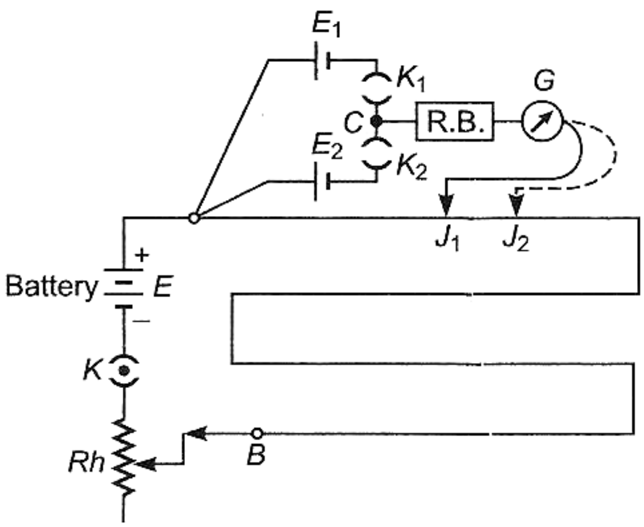
$$V = \left(\frac{I\rho}{A}\right) l$$

For uniform current and cross-sectional area

$$\frac{I\rho}{A} = \text{constant}$$

$$V \propto l$$

The circuit diagram of the potentiometer for comparing emfs of two cells in shown below.



The main circuit comprises of battery of emf *E*, key *(K)* and rheostat (Rh). The auxiliary circuit comprises of two primary cells of emfs E_1 and E_2, galvanometer, jockey and resistance Box (RB) to prevent large current flowing through the galvanometer.

When key K_1 is closed and K_2 kept open, the cell E_1 comes into action. The jockey *J* is moved on the wire *AB* till null point is obtained in galvanometer. Let null point is obtained at length l_1 then emf of first cell is given by

$E_1 = kl_2$ ...(i)

where, *k* is the potential gradient along the wire *AB* due to battery *E*.

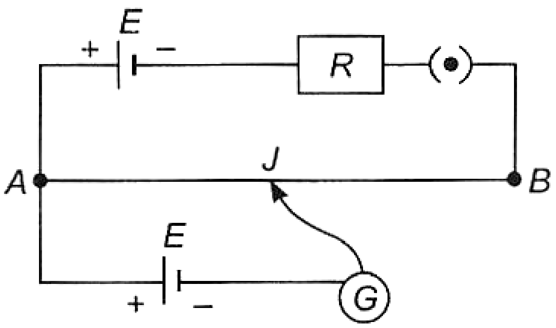
Now, key K_2 is closed and K_1 kept open and null point is obtained at length l_2, then

$$E_2 = kl_2 \quad \ldots\text{(ii)}$$

Therefore, $\dfrac{E_1}{E_2} = \dfrac{kl_1}{kl_2} = \dfrac{l_1}{l_2}$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

(b) (i) $K_1 \rightarrow$ closed, $K_2 \rightarrow$ open



Suppose null point occurs at l .

Apply KVL in smaller loop,

$E - iR = 0$

where, R= potential drop per unit length in potentiometer wire

$E = iR$

$$I = \frac{E}{R}$$

As X increases the value of resistance *R*. So, current in the circuit (wire) decreases. Hence, *R* will be increased. Then I will decrease.

p.d.= i R

$$\text{p.d.} = i.\frac{\rho l}{A}$$

$$\text{p.d.} = \left(\frac{i\rho}{A}\right) l = K\, l$$ *Where K (potential gradient) is constant.*

As K increases ,balancing length increases hence null point will shift towards right .

(ii) $K_2 \rightarrow$ open, $K_1 \rightarrow$ closed.

Then the circuit will be same as shown earlier.

We see that resistance S is not involved in the circuit because K_2 is open.

So, from Eq. (i)

$E = RI$

$$I = \frac{E}{R}$$

Here, *R* does not depend on the value of resistance *S*.
So, *R* null point is not affected by decreasing the value of resistance *S*.