
Shrabanee Samantaray
"XII" "DB"
School no.: 9888
Home Assignment
Date :28-6-2021...1-7-2021
PHYSICS

Potentiometer-Principle and its applications to measure P.D and for comparing EMF of two cells

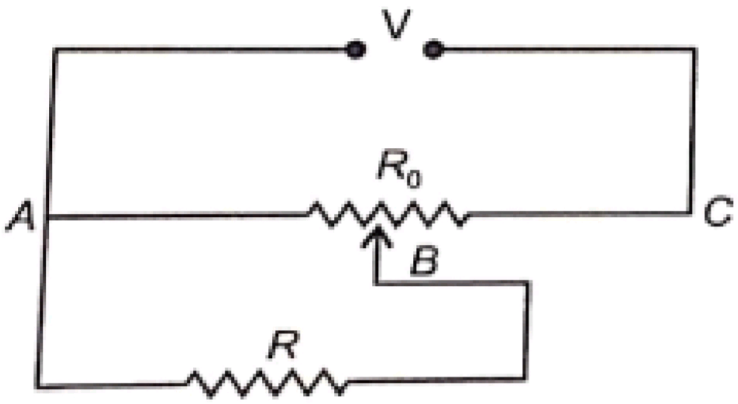
CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 03
CHAPTER NAME : CURRENT ELECTRICITY

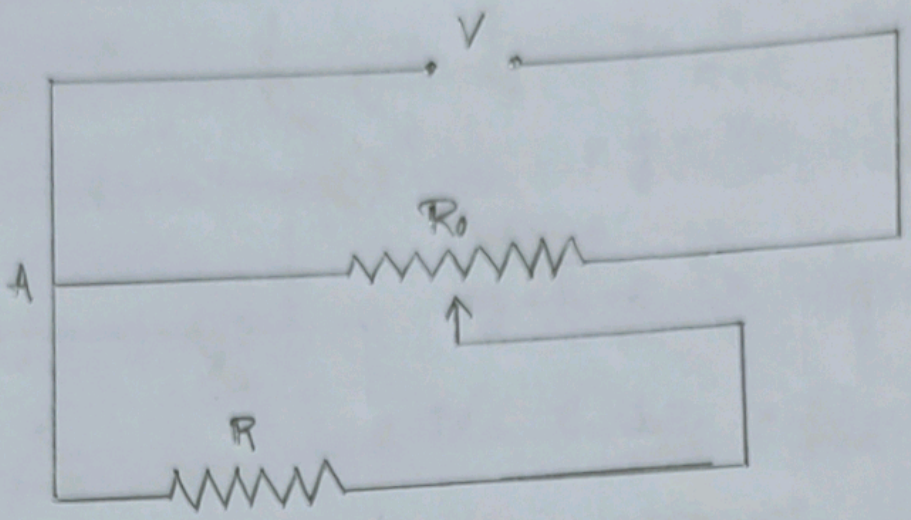
CHANGING YOUR TOMORROW

Home Assignment

Question: A resistance R draws current from a potentiometer of resistance R_0 as shown. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentiometer wire. (NCERT**)**



Answer 1:-



When sliding contact in middle, a resistance of $R_0/2$ connected in series with a parallel combination of R and $R_0/2$.

Hence, net resistance is given by:-

$$R_{eq} = \frac{R_0}{2} + \frac{R_0}{2} \parallel R$$

Current flowing through the circuit:-

$$I = \frac{V}{R_{eq}}$$

Potential across R:-

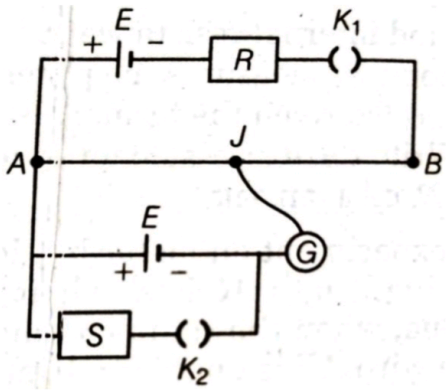
$$V_R = I\left(\frac{R_0}{2} \parallel R\right)$$

$$= \frac{V}{R_{eq}}\left(\frac{R_0}{2} \parallel R\right)$$

Now $$V_R = \frac{2R}{4R + R_0} V \Rightarrow V_R = \frac{2RV}{4R+R_0} = \frac{2VR}{4R+R_0} = \underline{\underline{\frac{2}{3}R}}$$

Home Assignment

Question: 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

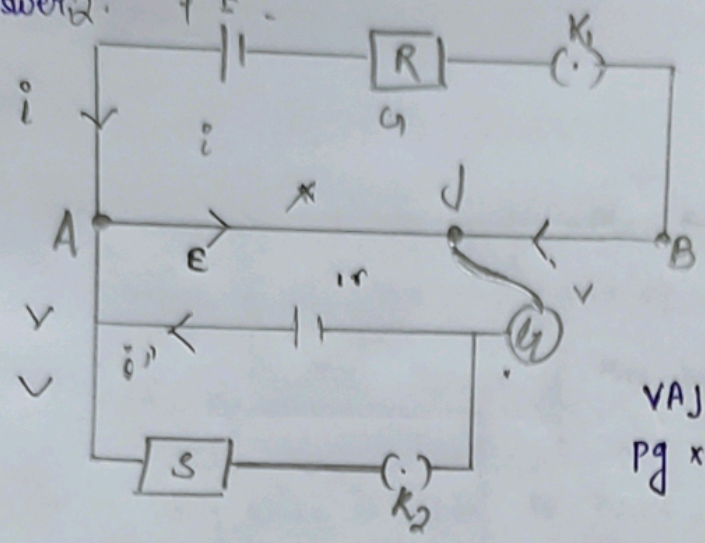


a) X increases the value of resistance R in the setup by keeping the key K_1 closed and the key K_2 open?

b) Y decreases the value of resistance S in the setup, while the key K_2 remains open and then K_1 closed?

Justify your answer.

Answer 2.



uncharged

$R_{AB} = R'$

$i = \frac{E}{R+R'}$ $\quad V_{AB} = iR' = \frac{ER'}{R+R'}$

$p.g = \frac{V_{AB}}{L} = \frac{ER'}{L(R+R')}$

$V_{AJ} = \epsilon$

$pg \times x = \epsilon \uparrow x = \frac{\epsilon}{pg} = \frac{\epsilon}{ER'} L(R+R')$

$i' = \frac{\mathcal{E}}{r+S}$ $\quad \epsilon - ir = \epsilon - \frac{\mathcal{E}r}{r+S} = \frac{\epsilon S}{r+S} = V_{AJ} = p.g\, x.$

$x = \frac{\mathcal{E}S}{r+S} \Big| \frac{ER'}{L(R+R')}$ $\quad = \frac{\epsilon}{E} \frac{L(R+R')}{R'} \times \frac{1}{\frac{r}{S}+1} \uparrow\downarrow$

a) x increases value of R ... key K_2 open.

By increasing resistance R the current through AB decreases, so potential gradient decreases, so potential gradient decreases. Hence a greater length of wire is needed to balance the same potential difference. So null point would shift towards B.

b) V decreases value of S ... K_1 closed.

By decreasing resistance S, current through AB remains same, potential gradient doesnot change.

As K_2 is open so, there's no effect of S on null point.

Home Assignment

Question: Answer the following.

a) State the underlying principle of a potentiometer. Why is it necessary to
   i. use a long wire,
   ii. have uniform area of cross-section of the wire and
   iii. use a driving cell whose emf is taken to be greater than the emfs of the primary cells?

b) In a potentiometer experiment, if the area of the cross-section of the wire increases uniformly from one end to the other, draw a graph showing how potential gradient would vary as the length of the wire increases from one end.

Answer 3:

a)

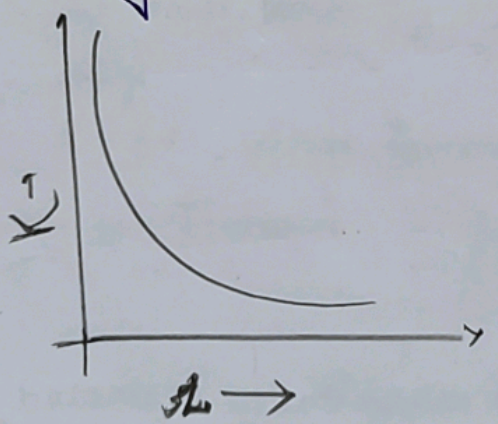
(iv) The potential drop across length of steady current carrying wire of uniform cross section is proportional to the length of the wire.

(i) Long wire is used to have lower value of potential gradient i.e. ⇒ a lower or least count ' greater sensitivity of the potentiometer.

(ii) The area of cross-section has to be uniform to get a "uniform wire' as according to the principle of potentiometer.

(iii) The emf of driving cell need to be greater than emf of primary cells otherwise no balance point would be obtained

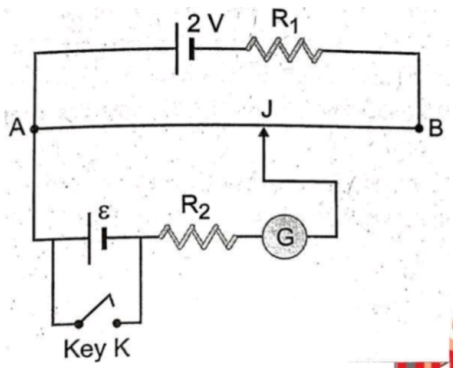
b) Potential gradient $k = \frac{V}{L}$



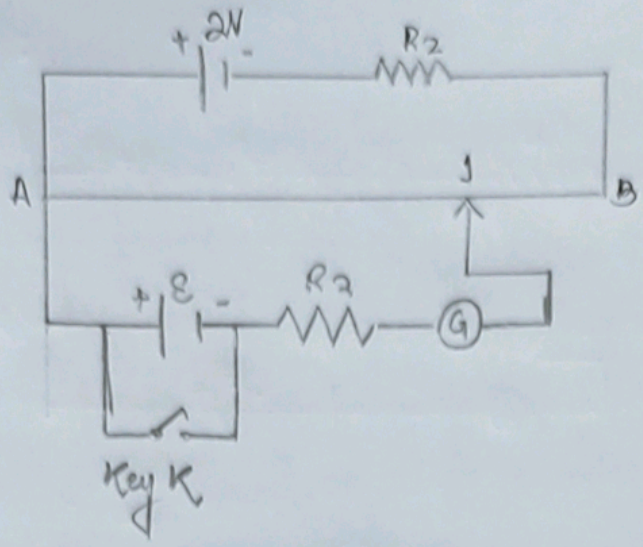
∴ The required graph

Question: Below figure shows the circuit diagram of a potentiometer for determining the emf ε of a cell of negligible internal resistance.

a) What is the purpose of using high resistance R_2?
b) How does the position of balance point (J) change when the resistance R_1, is increased?
c) Why cannot the point be obtained,
   1) When the emf ε is greater than 2V, and
   2) When the key K is closed.



Answer 4:-



a) Purpose of using high resistance R_2?

- R_2 is used to protect galvanometer, by reducing the current (I) flowing through it.
- This saves galvanometer and the cell from being damaged when jockey is far away.

b) How position of balance point (J) change when R_1 is increased?

$\downarrow K = \frac{V \downarrow}{\ell}$, $2V \cdot \varepsilon = K \times \uparrow$ $\rightarrow$ so, shifts toward B.

- When R_1 decreases, potential gradient of potentiometer wire increases, thus, balance point (J) shift to longer length of wire.

resistance

c) Why can't point be obtained when :-

i) emf ε greater than 2 V.

as $\varepsilon = K \times$ i.e Balance point not obtained as maximum emf across potentiometer wire = 2V.

ii) key K is closed.

as $0 = K \times$

i.e Key is closed, terminal potential difference of cell = 0 (zero)

Thus balance point can't be b/w A and B.

($\because V = kl \Rightarrow l = 0$ for $V = 0$)

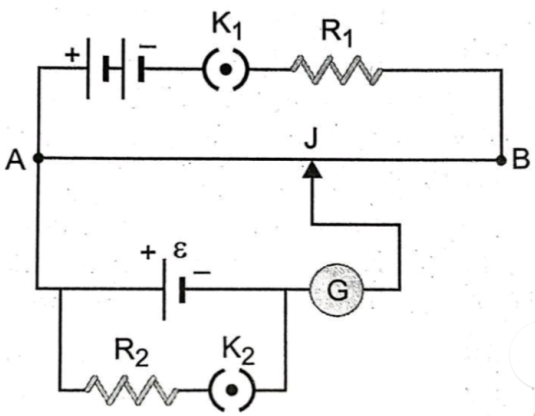
Home Assignment

Question: For the circuit shown in the below figure would the balancing length increase, decrease or remain the same if

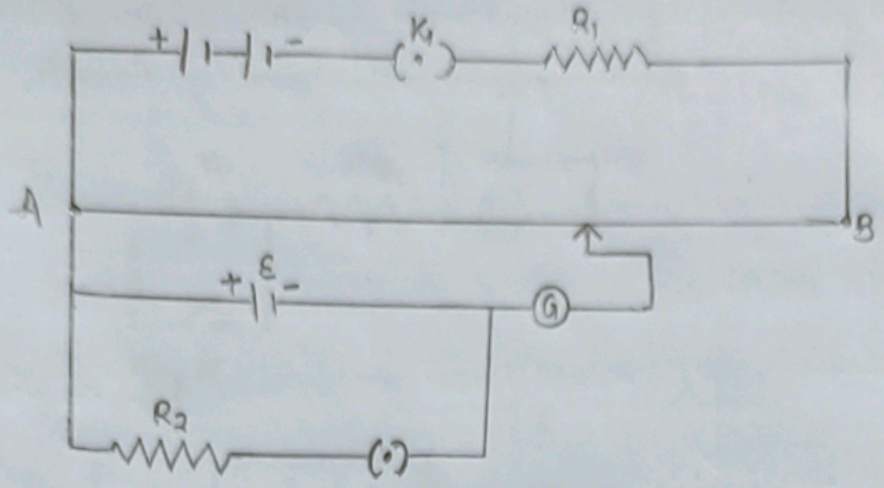
a) R_1, is decreased

b) R_2 is increased,

without any change (in each case) in the rest of the circuit ? Justify your answer in each case.



Answer 5 :



a)

* When R_1 decreases ... balance length decreases.

i.e When R_1 decreases, I increases through potentiometer. Thus, potential gradient increases, that results in decrease of balancing length

justified

* When R_2 increases, balancing length increases.

i.e R_2 increases, $I = \frac{E}{r + R_2}$ decreases,

→ voltage

$\Rightarrow V = E - Ir$, voltage increases, thus balancing length too increases justified

* At balance, potentiometer draws no current from voltage source, thus measurement of emf and potential difference will be more accurate.


THANK YOU !