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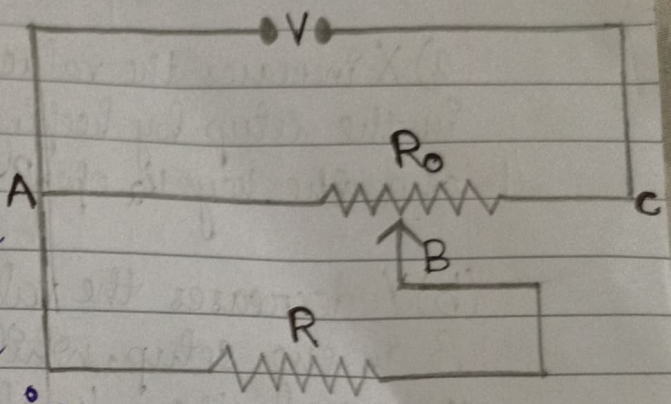
Home Assignment - 1

1. A resistance of R Ω draws current from a potentiometer. The potentiometer has a total resistance R_0 Ω. A voltage V is supplied to the potentiometer. Derive an expression for the voltage across R when the sliding contact is in the middle of the potentimeter.



ans While the slide is in the middle of the potentimeter only half of its resistance ($R_0/2$) will be between the points A and B. Hence, the total resistance between A and B, say R_1, will be given by the following expression :-

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

Current flowing through the circuit is given by :-

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

Potential across R is given by :-

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

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

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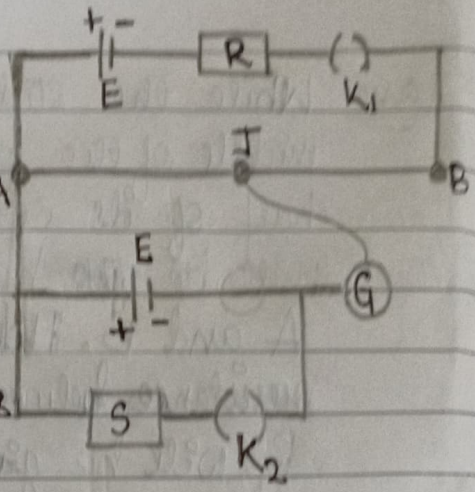
Solving, $V_R = \frac{R}{4R+R_0} V$

2. Two students X and Y perform an experiment on potentiometer separately using the circuit given below. Keeping other parameters unchanged, how will be position of 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 K_2 remains open and then K_1 closed?

ans (a) By increasing R the current through AB decreases, so potential gradiant decreases, hence a greater length of wire would be needed for balancing the same potential difference. So the null point would shift towards **B**.

(b) By decreasing resistance S, the current through AB remains, and same potential gradient doesn't change. As K_2 is open so there is no effect of S on NP.

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3. (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 gradiant would vary as the length of the wire increases from one end.

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

i) We use a long wire to have a lower value of potential gradiant i.e., a lower 'least count' or greater sensitivity of the potentiometer.

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

iii) The emf of the driving cell has to be greater than the emf of the primary cells by otherwise no balance point would be obtained.

(b) potential gradiant, $x = V/L$

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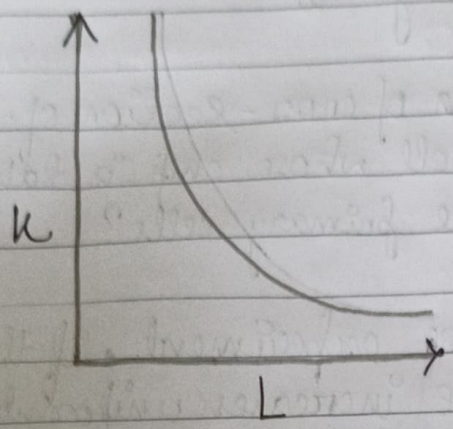
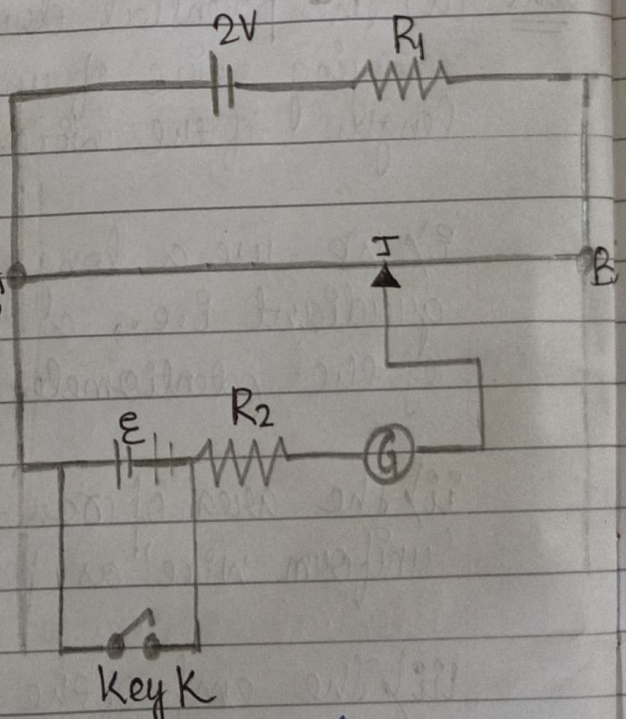
∴ The required graph is as show below,



4. Below figure shows the circuit diagram of a potentiometer for determining the emf ε of a cell of ~~me~~ negligible internal resistance.

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



Ans (a) The purpose of high resistance R_2 is to reduce the current through the galvonometer, when jockey is far from balance point, this saves the galvonometer and the cell of emf ε from being damage it.

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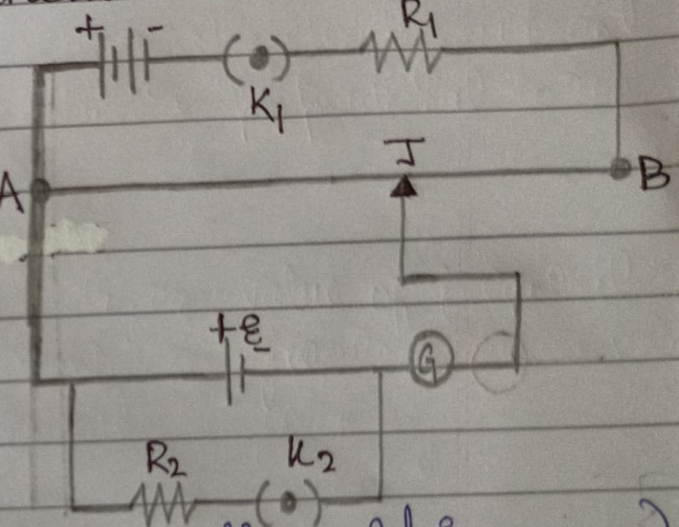
(b) When resistance R_1 is decreased, the potential gradient of potentiometer wire increases, so balance point (J) shifts to longer length of wire.

(c) 1) The balance point isn't obtained because maximum emf across potentiometer wire is 2V.

2) When key(k) is closed, the terminal potential difference of cell is zero; so balance point cannt be between A and B. (since $V = kl$, $\Rightarrow l = 0$ for $V = 0$).

5. For the circuit show in the below figure would the balancing length increases, decreases 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.



ans a) Decreases (k increases)
b) Increases (The terminal p.d across the cell would increases)

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