1. When the sliding contact is in middle, a resistance of $R_0/2$ is 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 is given by :

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

Potential across R is given by :

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

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

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

2. (a) By increasing R the current the current through AB decreases, so potential gradient decreases. Hence a greter 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 the same, potential gradient does not change. As K_2 is open so there is no effect of S on null point.

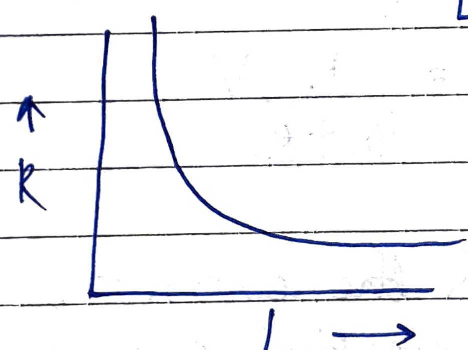
3. (a) Principle of potentiometer : The potential drop across the length of a steady current carrying wire of uniform cross section is proportional to the length of the wire.

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

(ii) The area of cross-section has to be uniform to get 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 as otherwise no balance point would be obtained.

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



4. (a) The purpose of high resistance R_2 is to protect the galvanometer by decreasing the current through it for positions, which are far away from the balance point.

(b) When resistance R_1 is increased, the current through the potentiometer wire circuit decreases. Due to it, the potential gradient across potentiometer wire decreases. As a result of it, the balance point shifts towards the end.

(c) (1) When emf ε is greater than 2V the balance point cannot be obtained on potentiometer wire because the potential drop across the potentiometer wire will be less than 2V

(2) When the key is closed, the cell emf ε gets short circuited. Due to it, the balance point is not obtained on the potentiometer wire.

5. (a) decreases. It is because as R_1 decreases, the current in potentiometer circuit increases. Due to it, the potential gradient of potentiometer wire increases. As a result of it the same emf will be balanced on smaller length of potentiometer wire.

(b) Increases. As R_2 increases the current $I \left(= \frac{\varepsilon}{r} + R_2 \right)$ decreases. This increases the terminal pot. diff. $V (\varepsilon - Ir)$ across the unknown cell. As a result of it, the terminal pot. diff. of cell ε will be balanced on larger length of potentiometer wire.