1. Ans When the sliding contact is in middle, a resistance of R_0 is connected in series with a parallel combination of R^2 and $\frac{R_0}{2}$

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 through AB decreases, so potential gradient decreases Hence, a ~~greater~~ 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 ~~less~~ 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.

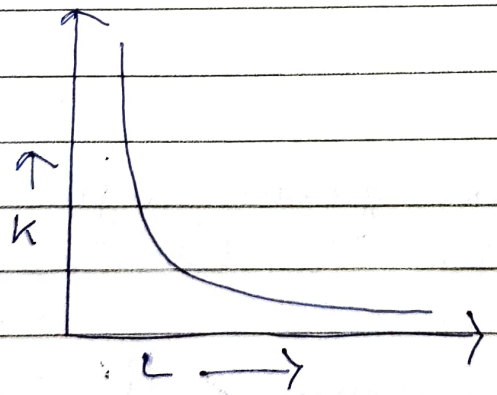
3. a) Principle of potentiometer:
The potential drop across the length of a steady current carrying wire of uniform cross-section is proportional to the length of the wire.

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 wire' as per the principal of the potentiometer

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

b) Potential gradient $K = V/L$
The required graph is as shown below.



Now, as the length increases potential gradient will stand.

4. a) The purpose of high resistance R_2 is to reduce the current through the galvanometer when jockey is far from balance point

this saves the galvanometer and the cell (of emf ε) from being damaged.

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

c) i) The balance point is not obtained because maximum emf across potentiometer wire is 2 V.

ii) When key (K) is closed, the terminal potential difference of cell is zero; so balance point cannot be ~~obtained~~ between A and B.
(since, $V = kI \Rightarrow I = 0$ for $V = 0$)

5.

a) Decreases
Reason → The potential gradient would increase

b) Increases
Reason → The terminal potential difference across the cell would increase.