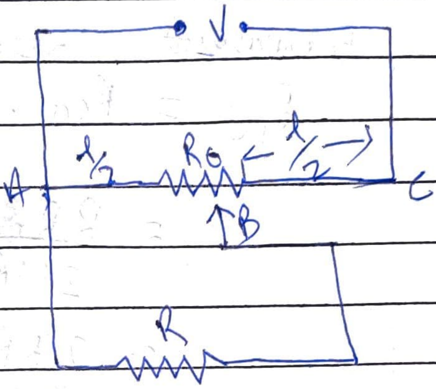
CHAPTER-3

Current Electricity

Q-1 Ans

Given that,
The sliding contact is
the middle of the
potentiometer wire



So,
lets consider the
length of the wire
to be l.
So the sliding contact is in the middle of the
wire.
The length will be $AB = BC = \frac{l}{2}$

Now,
As the Resistance is directly proportional to the
length;
$R = \frac{\rho l}{A}$, $\Rightarrow R \propto l$

So, According to the length the corresponding
resistance will be
$R_{AB} = \frac{R_0}{2}$ & $R_{BC} = \frac{R_0}{2}$

The resistance R is in parallel with resistance
R_{AB} of the potentiometer
So,
Equivalent resistance of R & R_{AB} is

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

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The equivalent resistance R_{eq} will be in series with Resistance R_{BC}.
So,
Equivalent resistance of R_{eq} & R_{BC} is
$R_{net} = R_{eq} + R_{BC}$

$$= \frac{RR_0}{2R+R_0} + \frac{R_0}{2}$$

$$= \frac{2RR_0 + R_0(2R+R_0)}{2(2R+R_0)}$$

$$= \frac{2RR_0 + 2RR_0 + R_0^2}{2(2R+R_0)}$$

$$= \frac{4RR_0 + R_0^2}{2(2R+R_0)}$$

∴ The Expression for the current will be

$$I = \frac{V}{R_0}$$

$$\Rightarrow I = \frac{V}{\frac{4RR_0 + R_0^2}{2(2R+R_0)}} = \frac{2V(2R+R_0)}{4RR_0+R_0^2}$$

Here, current flowing through the potentiometer is obtained.

Hence the expression for voltage across R will be:

$$V_0 = I R_{eq}$$

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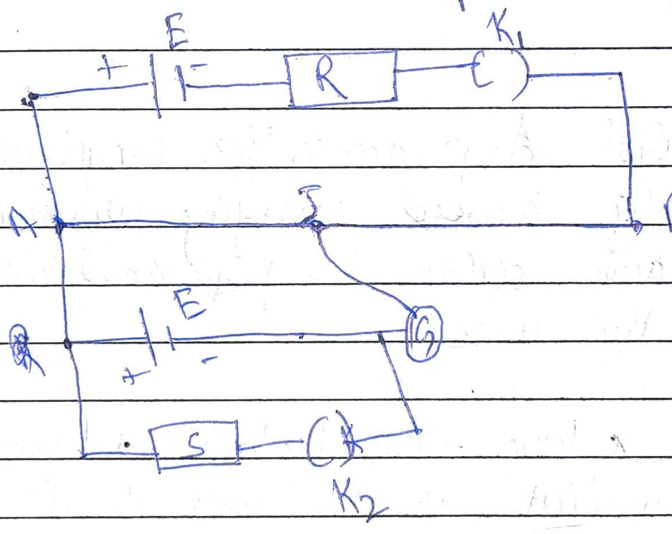
$$= \frac{2V(2R+R_0)}{4RR_0+R_0^2} \times \frac{RR_0}{2R+R_0}$$

$$= \frac{2V}{R_0(4R+R_0)} \times RR_0$$

$$\Rightarrow V_0 = \frac{2VR}{4R+R_0}$$

Q2 Ans (a) X increase the value of resistance R in the setup by keeping the ~~setup by~~ key K_1 Closed.

So, as the resistance R in the ~~cir~~ circuit is increased the potential gradient decreases.



A greater length of wire is needed inorder to have the balancing point for some ~~point~~ potential on the standard cell and across AB wire

So, as the potential $V_{AJ} = E$ should be the condition to meet.

The length AJ should be increased as $V_{AJ} \propto l$

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~~The~~
Therefore, the null point will shift towards R

(b) ~~The~~ Here,
Y decreases the resistances, But as the resistance S is along the standard cell. it will have no effect on the potential Across AB.
Aand also as K_2 is open, no current will pass through resistance S.
Hence,
The resistance S will have no effect on the null point and the null point will remain unchanged

(3) (a) The potential drop across the length of a ~~Stea~~ Steady current carrying wire of Uniform across section is proportional to the length of the wire.

(i) We use a long wire to have a lower value of potential gradient ie a lower least ~~cou~~ 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~~ of the potentiometer.

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

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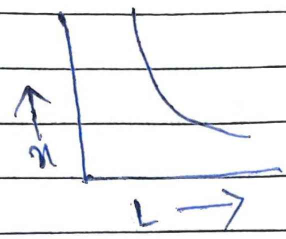
(b) potential gradient $K = \frac{V}{L}$

∴ The required graph is as shown below



(4) (i) 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 ~~or~~ and the cell of emf from being damaged.

~~(ii) when Resistance R is decreased, the point gradient of potential or grad of potentiometer wire increases, so balance and the cell of emf~~

(ii) when Resistance is decreased, the point gradient of potentiometer wire increases, so balance point shifts to longer length of wire

(iii) (a) when key (K) is closed, the terminal potential differencence of cell is zero so balance point cannot be between A and B.

(b) The balance point is not obtained because maximum emf across potentiometer wire ~~is~~ ~~I~~ is 2V

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(5) (i) Decreases (K increase)
(ii) Increases β