Potentiometer — problems

A Physics
Current Elec.
Potentiometer

1. The Basic circuit

(a) Can you draw from memory, a potentiometer circuit to measure the emf of a cell.

(b) Explain how you use the potentiometer, and a test cell of known emf, to measure an unknown cell emf.

(c) Can you draw the potentiometer circuit, now measuring the terminal p.d. of the test cell underload (driving current through a resistor) — again from memory!!

2 Explain how a potentiometer can measure an emf whereas a meter never can.

3 Here is some data from a potentiometer investigation ..

Standard cell emf $E_{St} = 1.25$ V

Balance length — standard cell, $l_{St} = 58.3$ cm

" — test cell $l_{test} = 82.7$ cm

(a) What is the test cell emf ?

(b) The test cell is connected to a 10 Ω resistor, new balance length $l_{new} = 77.5$ cm

Test cell current $I = 120$ mA

What is the internal resistance of the test cell ?

(c) In another test of the same cell, only this data was recorded.

Resistor = 25 Ω, new balance length $l = 79.8$ cm

Can you calculate the internal resistance from this data ?

4. A potentiometer is modified to measure the tiny emf from a thermocouple. Here is the data ...

Driver cell pd = 2.00 V series resistance in driver circuit 96 Ω.

Resistance of potentiometer wire 4 Ω Balance length 26.4 cm.

(a) Draw the full circuit

(b) Calculate the thermocouple emf.

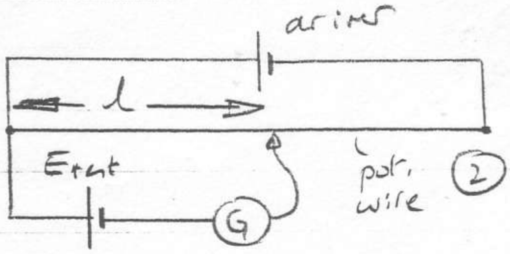
(c) How would you modify the circuit to measure the emf more accurately?

Potentiometer – Answers

A - Physics Potentiometer

1 (a)

Q1 /7



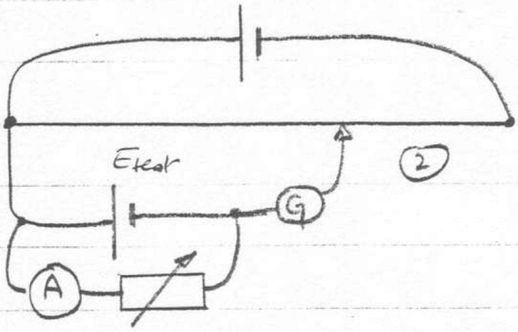
(2)

(b) Find $l_{standard}$ balance length for standard cell (3)

Find $l_{test\ cell}$ $\frac{E_{test}}{E_{standard}} = \frac{l_{test}}{l_{standard}}$

(c)

Q2 /2



(2)

(2) A potentiometer measures a p.d. by balancing it against a known p.d – so no current flows. So you measure a cell emf without taking current from the cell (2)

(3) (a) $\frac{E_{test}}{E_{st.}} = \frac{l_{test}}{l_{st}} \Rightarrow E_{test} = 1.77\text{ V}.$ (2)

(b) now V_{test} cell under load $= \frac{l_{test}}{l_{st.}} \times E_{st} = \frac{77.5}{58.3} \times 1.25 = \underline{\underline{1.66\text{ V}}}$ (1)

easy!

(1)

$E = \underset{(ext.)}{IR} + \underset{(int.)}{Ir} = V_{ext} + Ir \Rightarrow r_{int} = (E - V)/I = \underline{0.93}\ \Omega$ (1) /3

(c) You're not told I – so calculate it using $V = IR$

a bit harder!

new test cell pd. $V_{test} = 79.8/58.3 \times 1.25 = \underline{1.711}\text{ V}$ (1)

so cell current $I = V_{test}/R = 1.711/25 = 0.\underline{068}\text{ A}$ (1)

so from $E = V + Ir \longrightarrow r = (E - V)/I = (1.77 - 1.71)/0.068$

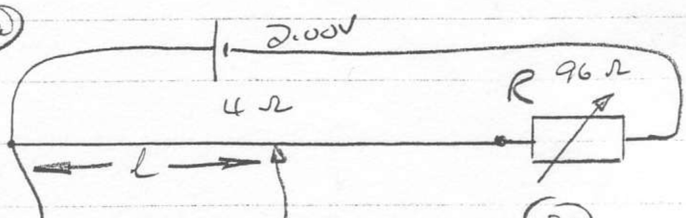
$= 0.\underline{909}$ (1) $(0.91\ \Omega)$

/3

Q.3 /8

4. Small emfs

(a)



(2)

Q4 /7

(b) p.d. across wire

$V_{wire} = \frac{4}{100}$ of $2\text{V} = 0.08\text{ V}$ (2)

(or $I = V/R = 2/100 = 0.02\text{ A}$

$V_{wire} = I R_{wire} = 0.08\text{ V}$)

so thermocouple emf $= 26.4/100 \times 0.08 = \underline{0.0211}$ (1) V

/3

(c) Readings are more accurate towards the right hand end of the wire. You want to reduce p.d. across the wire, or increase p.d. across resistor R – so increase resistor R (2)

(eg if $R = 296\ \Omega$ $R_{wire} = 4/300$ of $2\text{V} = 0.027\text{V}$ – just right!)

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