Unit 14 · Electrical Circuits

HARDER PRACTICE QUESTIONS

Full marks 33

Write your answers on separate paper. Show your working.

1 Spot the error [3]

Find the mistake in the working and correct it.

In a meter bridge, Aayusha put a known 20 Ω resistance in the left gap and the unknown resistance X in the right gap. The balance point was 36 cm from the left end. She wrote:

"$X = \frac{l}{100 - l} R = \frac{36}{64} \times 20 = 11.25\ \Omega$."

2 Design it [4]

Nischal wants a potentiometer to measure the small e.m.f. of a thermocouple, a few millivolts. His wire is 10 m long with a resistance of 5.0 Ω, and his driver cell has an e.m.f. of 2.0 V and negligible internal resistance.

i. What series resistance must he join with the wire to make the p.d. across the whole wire 10 mV?

ii. What is the potential gradient then, in mV/m?

iii. Where would a thermocouple of e.m.f. 6.3 mV balance?

iv. Why is this better than joining the cell straight across the wire?

3 Predict, then explain [3]

Write your prediction first, then explain it.

A meter bridge is balanced. Predict what happens to the balance point when i. the cell is replaced by one of twice the e.m.f., ii. the cell and the galvanometer are interchanged, iii. the resistances in the two gaps are interchanged.

4 Show that [3]

A galvanometer of resistance G gives full-scale deflection with a current I_g. Show that to make it an ammeter whose range is n times I_g, the shunt needed is $S = \frac{G}{n - 1}$, and that the resistance of the ammeter is then $\frac{G}{n}$.

5 Check the readings [4]

To find a cell's internal resistance, Sneha found the balance length with no resistance across it, $l_1 = 80.0$ cm, and then with five resistances R across it in turn.

R (Ω)	2	4	6	8	10
l_2 (cm)	53.3	64.0	66.0	71.1	72.7

i. Copy the table and add a row for the internal resistance r found from each reading.

ii. What is the internal resistance of the cell?

iii. Which reading does not fit, and what should l_2 have been?

6 Work backwards [4]

A 6.0 V cell of negligible internal resistance is joined in series with a 10 Ω and a 20 Ω resistor. A cell of e.m.f. E and internal resistance 1.0 Ω is joined across the 20 Ω resistor, + terminal to + terminal, with a galvanometer in series with it. The galvanometer reads zero.

i. Find E.

ii. The cell is replaced by one of e.m.f. 3.0 V and internal resistance 1.0 Ω. Use Kirchhoff's laws to find the current through it, and say which way it flows.

7 What if? [3]

A heater's coil burns through near one end. Bibek mends it by cutting off a quarter of the coil and joining the rest back to the same 230 V supply. What happens to the power of the heater? Is this safe?

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Pratik wrote: “A potentiometer takes a small current from the cell at the balance point, but less than a voltmeter does. To change a galvanometer into a voltmeter, a high resistance is joined in parallel with it. A superconductor is just a perfect conductor: it keeps whatever magnetic field is inside it.”

9 Which explanation fits? [2]

A voltmeter of resistance 50 Ω is joined across a cell of e.m.f. 1.5 V and internal resistance 2 Ω. Sushant says it reads less than 1.5 V because the voltmeter is badly calibrated. Anjali says it is because the voltmeter takes current from the cell. Who is right? Find the reading.

10 Think [2]

In a potentiometer experiment, the galvanometer deflects the same way wherever the jockey touches the wire. Give the two possible faults, and say how you would find out which it is.

11 Make your own [2]

Write a meter bridge problem whose answer is “the unknown resistance is 25 Ω”, with the balance point not at the middle of the wire. Solve it to show it works.