# Unit 23 · DC Circuits

**HARDER PRACTICE QUESTIONS**

Full marks 28

Write your answers on separate paper. Show your working. Take $e = 1.6 \times 10^{-19}$ C, the number of free electrons in copper $8.5 \times 10^{28}$ per $m^3$ and the resistivity of copper $1.68 \times 10^{-8}$ Ω m.

## 1 Spot the error [3]

Find the mistake in the working and correct it.

Two resistors of 6.0 Ω and 3.0 Ω are joined in parallel. Utsab wrote:
"$1/R = 1/6.0 + 1/3.0 = 0.5$, so $R = \mathbf{0.5}$ Ω."

## 2 Check the readings [3]

Pratiksha measured the terminal p.d. of a cell for different currents:

| I (A) | 0.20 | 0.40 | 0.60 | 0.80 | 1.00 |
|---|---|---|---|---|---|
| V (V) | 1.40 | 1.30 | 1.05 | 1.10 | 1.00 |

Use $V = E - Ir$ to find E and r. Which reading is wrong?

## 3 Estimate it [3]

A copper wire of cross-section 1.0 $mm^2$ carries 3.0 A from a switch to a lamp 10 m away.

i. Find the drift velocity of its electrons.
ii. Estimate how long one electron would take to drift from the switch to the lamp.

## 4 Least and most [4]

A battery of e.m.f. 12 V and internal resistance 2.0 Ω is joined to a load R.

i. Find the power in the load for R = 1.0 Ω, 2.0 Ω and 4.0 Ω.
ii. Which gives the most power? State the general rule.
iii. What fraction of the battery's power is wasted inside it then?

## 5 A real setting [3]

A 25 m extension cable has two copper wires, each 0.75 $mm^2$ in cross-section. It carries a 2,000 W heater from a 230 V socket.

i. Find the resistance of the cable (both wires).
ii. Find the power wasted in the cable, and say why a thin cable can be dangerous.

## 6 Predict, then explain [3]

Write your prediction first, then explain it.

Three identical lamps, A, B and C, are lit by a battery with negligible internal resistance: A in series with B and C, which are in parallel with each other. Predict which lamp is brightest. Then predict what happens to A and B when C's filament breaks, and explain.

## 7 Show that [2]

Show that the power dissipated in a resistor can be written as $P = VI$, $P = I^2R$ and $P = V^2/R$.

## 8 Correct the misconceptions [3]

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

> Sapana wrote: “A battery's current is used up as it passes through the lamps, so less current comes back to the battery. A filament lamp obeys Ohm's law. Resistivity depends on the length and thickness of a wire.”

## 9 Design it [2]

Design a potential divider with an LDR and a fixed resistor whose output rises when it gets dark, to switch on garden lights. Say where the output is taken and why.

## 10 Make your own [2]

Using three resistors of values you choose, make a combination with a total resistance of exactly 10 Ω. Draw it and show that it works.