2017 H2 Q12

Section: Electricity

Topic: e.m.f., internal resistance, terminal p.d., power

Two identical cells in the battery: e.m.f. 1.5 V each, internal resistance 2.7 Ω each. Circuit current (ammeter) is 64 mA. Voltmeter is across the lamp.

(a) Meaning of an e.m.f. of 1.5 V

The e.m.f. is the energy supplied per coulomb of charge by the cell. An e.m.f. of 1.5 V means the cell provides 1.5 J of energy to each coulomb of charge passing through it.

(b)(i) Lost volts in the battery

Lost volts = current × total internal resistance.

Total internal resistance = $r_{total} = r_1 + r_2 = 2.7 + 2.7 = 5.4\ \Omega$.

Lost volts = $I\, r_{total} = 0.064 \times 5.4 = 0.3456\ V \approx 0.35\ V$.

Answer: 0.35 V

(b)(ii) Voltmeter reading (terminal p.d. across lamp)

Total e.m.f. of the battery = 1.5 + 1.5 = 3.0 V.

Terminal p.d. = E_total − lost volts = 3.0 − 0.3456 = 2.6544 V.

Answer: ≈ 2.65 V

(b)(iii) Power dissipated by the lamp

P = VI across the lamp.

P = 2.6544 × 0.064 = 0.1699 W.

Answer: ≈ 0.17 W

Revision tips

- Lost volts = I r_internal; terminal p.d. = E − Ir.
- In series: e.m.f.s add; internal resistances add.
- Power in a component: P = VI = I^2R = V^2/R (use whichever data are given).