# 2023 Ph H2 Q12

Section: Electricity

Topic: Internal Resistance

## Summary of Question:

Battery of emf 12 V and internal resistance r is connected to three 16 Ω resistors in parallel (part a). Ammeter reads 0.38 A. (i) Calculate terminal p.d. of the battery. (ii) Calculate internal resistance r. (iii) Calculate power dissipated in internal resistance. (b) Circuit is rearranged (resistors in series/parallel different). State whether power dissipated in r is greater than, equal to, or less than before, and justify.

## (a)(i) Terminal potential difference

t.p.d. = emf − Ir = V. Total current I = 0.38 A flows. Equivalent resistance of external circuit (3 × 16 Ω in parallel) = 16/3 = 5.33 Ω. So terminal p.d. = I × R = 0.38 × 5.33 = 2.03 V.

## (a)(ii) Internal resistance

Using emf = V + Ir → r = (emf − V)/I = (12.0 − 2.03)/0.38 = 26.2 Ω.

## (a)(iii) Power dissipated in r

$P = I^2r = (0.38)^2 \times 26.2 = 3.79$ W.

## (b) Rearranged circuit

Now the three 16 Ω resistors are in series–parallel with higher external resistance than before. This reduces the current drawn from the battery. Since $P = I^2r$, the power dissipated in the internal resistance is less than before.

## Final Answers

(a)(i) Terminal p.d. = 2.03 V

(a)(ii) Internal resistance r = 26.2 Ω

(a)(iii) Power in r = 3.79 W

(b) Power dissipated in r is less than before (because external resistance increases, reducing current).

## Revision Tips

• Terminal p.d. = emf − Ir; also equal to current × external resistance.

• Equivalent resistance of parallel resistors: $1/R = 1/R_1 + 1/R_2 + 1/R_3$.

• Power dissipated in internal resistance = $I^2r$; decreases if total current decreases.