inkPhysics

ANSWER BOOK

EMF and internal resistance

Electricity · Year 12

AQA 3.5.1.6 · CIE 10.1 · OCR A 4.2.2, 4.3.2

10 questions · 30 marks

NAVY EDITION

SECTION A · Warm-up

A1 The emf is the energy transferred to each unit of charge by the source, $\varepsilon = W/Q$. It is measured in volts (joules per coulomb). [2]

A2 $V = \varepsilon - Ir = 6.0 - 0.50 \times 1.0 = 5.5$ V. [2]

A3 $\varepsilon = I(R + r)$, where R is the external resistance and r the internal resistance. [2]

SECTION B · Standard

B1 $I = \varepsilon/(R + r) = 12/(5.0 + 1.0) = 2.0$ A. [3]

B2 (a) $I = 9.0/(4.0 + 0.50) = 2.0$ A. (b) $V = IR = 2.0 \times 4.0 = 8.0$ V. (c) $P_{internal} = I^2r = 2.0^2 \times 0.50 = 2.0$ W. [4]

B3 Lost volts $= \varepsilon - V = 1.5 - 1.35 = 0.15$ V. $r = (\varepsilon - V)/I = 0.15/0.30 = 0.50\ \Omega$. [3]

B4 $I = \varepsilon/r = 6.0/0.20 = 30$ A. [3]

SECTION C · Stretch

C1 From $V = \varepsilon - Ir$: the intercept is the emf, $\varepsilon = 1.5$ V, and the gradient is $-r$, so $r = 0.5\ \Omega$. At 1.0 A: $V = 1.5 - 0.5 \times 1.0 = 1.0$ V. [4]

C2 Lost volts $= 12 - 10 = 2.0$ V, so $I = (\varepsilon - V)/r = 2.0/2.0 = 1.0$ A. Then $R = V/I = 10/1.0 = 10\ \Omega$. [4]

C3 Some energy per unit charge is used driving the current through the battery's own internal resistance, giving 'lost volts' Ir. As the current increases, Ir increases, so the terminal pd ($\varepsilon - Ir$) available to the external circuit falls. [3]