GET BETTER AT PHYSICS · MARK SCHEME

EMF & Internal Resistance: tiered multiple choice

AQA A-level Physics · 7407 / 7408 · Specification 3.5.1.6 · 8 questions · 8 marks

1 mark per correct letter

Worked reasoning for every question

How students did = from AQA examiner reports, where available

Answer key

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
D	D	C	A	B	D	A	A

Easy

Questions 1–2

1 **D**

Terminal pd with internal resistance · AQA June 2024 · A-level Paper 1 · Q27

$I = \varepsilon / (R + r) = 2.0 / (12 + 4.0) = 0.125$ A. pd across the resistor = $IR = 0.125 \times 12 = 1.50$ V.

Watch out: 0.50 V is the pd across the internal resistance (the lost volts), not across the resistor.

How students did: Over 70% of students got this right in June 2024.

2 **D**

Combining cells for maximum current · AQA June 2017 · AS Paper 2 · Q7

An emf of 1.5 V means the cells must be in parallel (in series the emfs would add). Three in parallel have internal resistance 0.6 / 3 = 0.2 Ω, so the maximum (short-circuit) current is 1.5 / 0.2 = 7.5 A: arrangement D.

How students did: Just over 50% of students got this right in June 2017.

Medium

Questions 3–5

3 **C**

Voltmeter reading halves · AQA June 2019 · AS Paper 2 · Q33

Switch open: no current, so the voltmeter reads the emf ε. Switch closed: it reads the terminal pd, ε/2. The other ε/2 is lost inside the cell. Same current through both, so r = R = 2.0 Ω.

How students did: Almost half of students got this right in June 2019.

4 **A**

Two ideal cells in parallel · AQA June 2018 · AS Paper 2 · Q32

Identical cells in parallel give the same emf as one cell: 3.0 V. They have no internal resistance, so the voltmeter reads 3.0 V across the 12 Ω resistor and the current is 3.0 / 12 = 0.25 A.

Watch out: 6.0 V (C and D) treats the cells as if they were in series.

How students did: 34.5% of students got this right in June 2018.

5 **B**

Batteries in parallel with a resistor · AQA November 2021 · A-level Paper 1 · Q28

The two batteries in parallel act like one source of emf 1.5 V and internal resistance 1.6 / 2 = 0.8 Ω. I = 1.5 / (2.4 + 0.8) = 0.47 A.

> **Watch out:** 0.38 A (A) uses 1.6 Ω, forgetting that the internal resistance halves when the batteries are in parallel.

Hard

Questions 6–8

6 **D**

Internal resistance from two readings · AQA June 2016 · AS Paper 2 · Q34

Switch open: emf = 1.45 V. Switch closed: terminal pd = 1.26 V, so I = 1.26 / 10 = 0.126 A. Lost volts = 1.45 − 1.26 = 0.19 V, so r = 0.19 / 0.126 = 1.5 Ω.

> **Watch out:** Find the current from the external resistor (1.26 V / 10 Ω), not from the emf.

How students did: 27% of students got this right in June 2016.

7 **A**

Three cells in parallel · AQA June 2019 · AS Paper 2 · Q30

Three identical cells in parallel: emf 1.5 V and internal resistance 6.0 / 3 = 2.0 Ω. I = 1.5 / (6.0 + 2.0) = 0.19 A.

> **Watch out:** 0.25 A (B) uses 1.5 / 6.0 and ignores the internal resistance completely.

How students did: Around 27% of students got this right in June 2019.

8 **A**

Terminal pd against current · AQA June 2016 · AS Paper 2 · Q33

V = ε − Ir. As the current increases, more pd is lost inside the cell, so the terminal pd falls in a straight line from ε (at I = 0) with gradient −r: graph A.

> **Watch out:** B is the graph for a resistor (V = IR), not for a cell's terminal pd.

How students did: Only about 20% of students got this right in June 2016; B was the most popular answer.

End of mark scheme. Answers from AQA's published keys; explanations written for this pack. AQA material is © AQA. More free packs and 1-to-1 tuition: **www.getbetteratphysics.co.uk**

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