Internal Resistance of Cells Questions WJEC Physics A Level

1.

An equation which can be applied to a circuit containing a cell of e.m.f. E and internal resistance r is

$$V = E - Ir$$

(a) Explain carefully, **in terms of energy**, the meanings of V, E and Ir. [4]

(b) Four cells, each of e.m.f. 1·5 V and internal resistance 0·2 Ω, are connected in series to make a battery of e.m.f. 6·0 V. A 4·0 Ω resistor is connected across the battery.

(i) Draw a circuit diagram of this arrangement which includes the internal resistance of the battery. [1]

(ii) Calculate the current. [2]

(iii) Calculate the p.d. across the 4·0 Ω resistor. [1]

(c) After the resistor has been left connected for some time, one of the cells starts to show signs of running down. Its e.m.f. has dropped to 1·20 V and its internal resistance has risen to 0·40 Ω.
Investigate whether or not, in order to maximise the current through the 4·0Ω resistor, it would be better to remove the run down cell, leaving the other three in series. [4]

2.

(a) Define the *e.m.f.* of a cell. [2]

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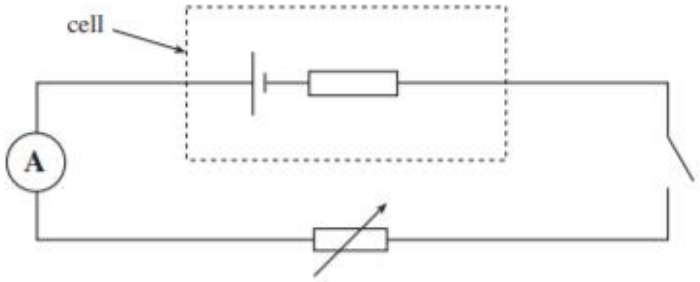
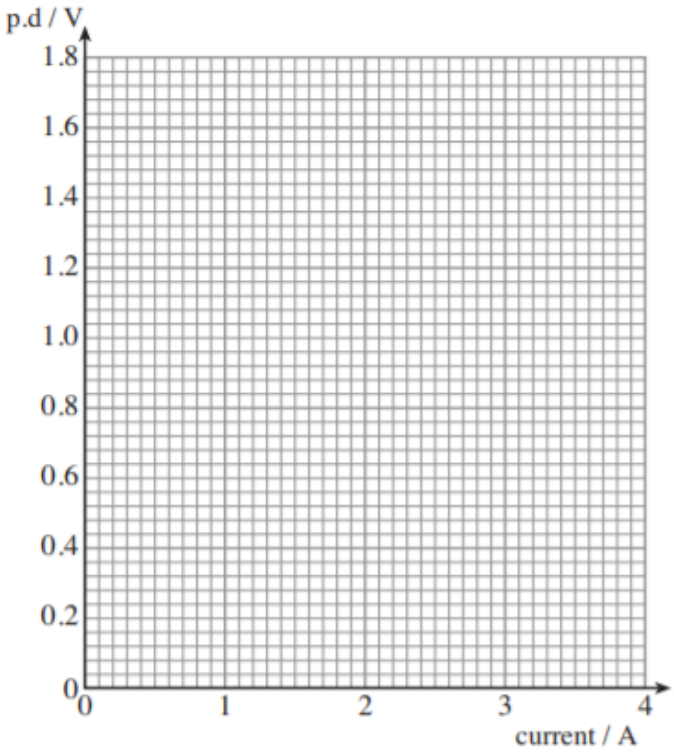
(b) A student sets up the following circuit to find the e.m.f. and internal resistance of a cell. Complete the circuit diagram by adding a voltmeter. [1]



(c) With the circuit complete the student obtains the following results. Plot these results on the grid and draw a line through your points. [3]

p.d. across cell terminals /V	Current /A
1.4	0.6
1.2	1.2
1.0	1.8
0.8	2.4
0.6	3.0



(d) Use your graph to determine

(i) the e.m.f of the cell; [1]

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(ii) the internal resistance of the cell. [2]

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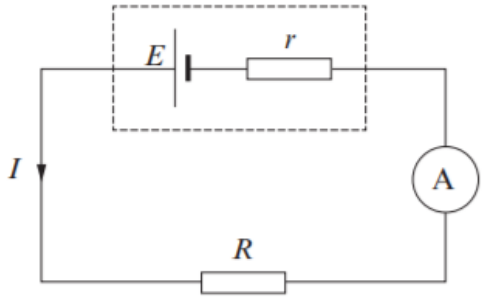
3.

A student sets up the following circuit using a cell of emf E and internal resistance r.

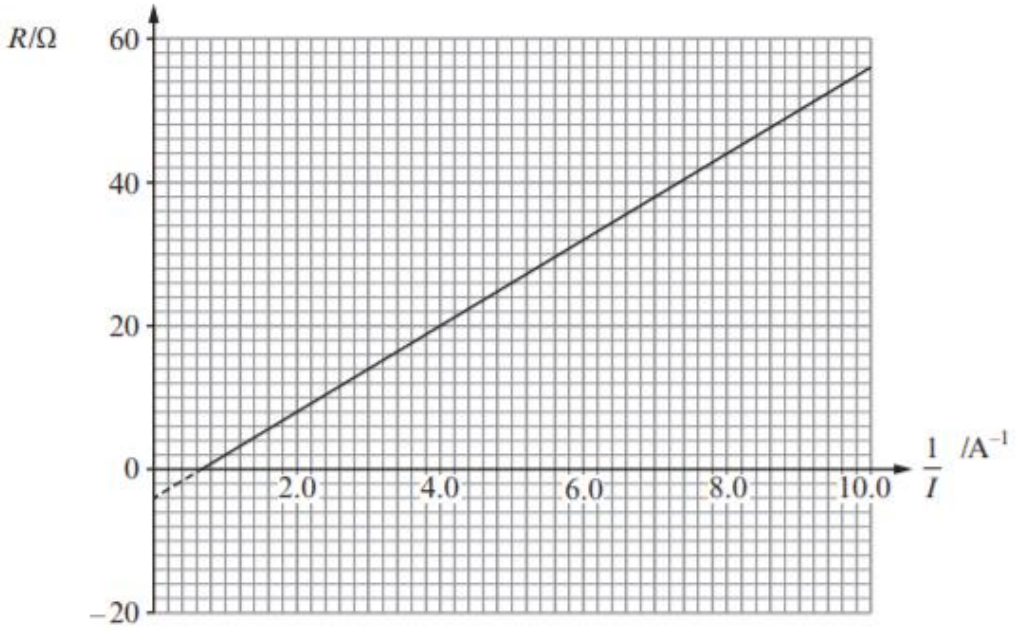


(a) An equation which can be applied to the above circuit is

$$V = E - Ir$$

Explain, **in terms of energy**, the meanings of V, E and Ir. [4]

(b) The student measures the current I for different values of R. She then plots a graph of R against $\frac{1}{I}$.



The equation for this graph is

$$R = \frac{E}{I} - r$$

(i) Use the graph to find the internal resistance, r, of the cell. [1]

(ii) Determine the emf of the cell. [2]

(iii) Referring to the graph, calculate the power dissipated in the resistor R when there is a current of 0.25 A. [4]

4.

(a) An equation which can be applied to a cell of emf E and internal resistance r is

$$V = E - Ir$$

(i) What does V represent? [1]

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(ii) What does Ir represent? [1]

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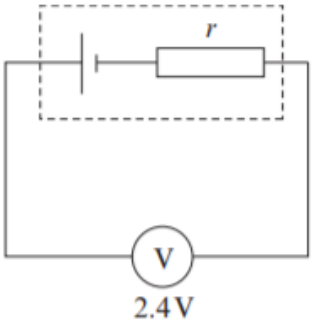
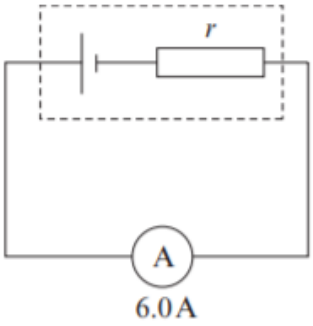
(b) A voltmeter connected across the terminals of a cell reads 2.4 V. An ammeter (whose resistance is zero) reads 6.0 A when connected briefly across the cell.





(i) Write down the emf of the cell. [1]

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(ii) Calculate the internal resistance of the cell. [1]

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(iii) Give one reason for not leaving the ammeter connected to the cell. [1]

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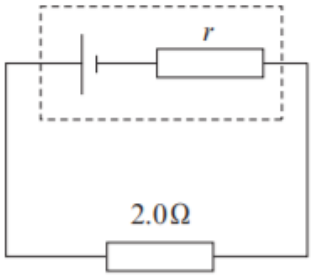
(c) Calculate the current through a 2.0Ω resistor when it is connected across the cell. [2]



(d) Determine the number of cells of this type which, when connected in series with the 2.0Ω resistor, will produce a current of 3.0 A. [4]

5.

A car battery has an emf of 12.0 V. When the car is started the battery supplies a current of 120 A to the starter motor. The potential difference between the battery terminals [terminal pd] drops at this time to 8.4 V due to the internal resistance of the battery.

(a) Explain, **in terms of energy**,

(i) what is meant by 'an emf of 12.0 V', [2]

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(ii) why the terminal pd drops when the battery supplies a current. [1]

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(b) Calculate the internal resistance of the battery. [2]

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(c) The manufacturer warns against accidentally short-circuiting the battery. Calculate the current that would flow if the battery terminals were short-circuited with a spanner of negligible resistance. [1]

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(d) The battery will become 'flat' (i.e run out of energy) if it is continually run for a long period of time. It can then be fully recharged by a current of 3.0 A supplied for 16 hours.

(i) Calculate how much charge flows through the battery in this time. [2]

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(ii) Estimate how long the starter motor could be operated on a fully-charged battery. [1]

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6.

(a) Define the *emf* of a cell. [2]

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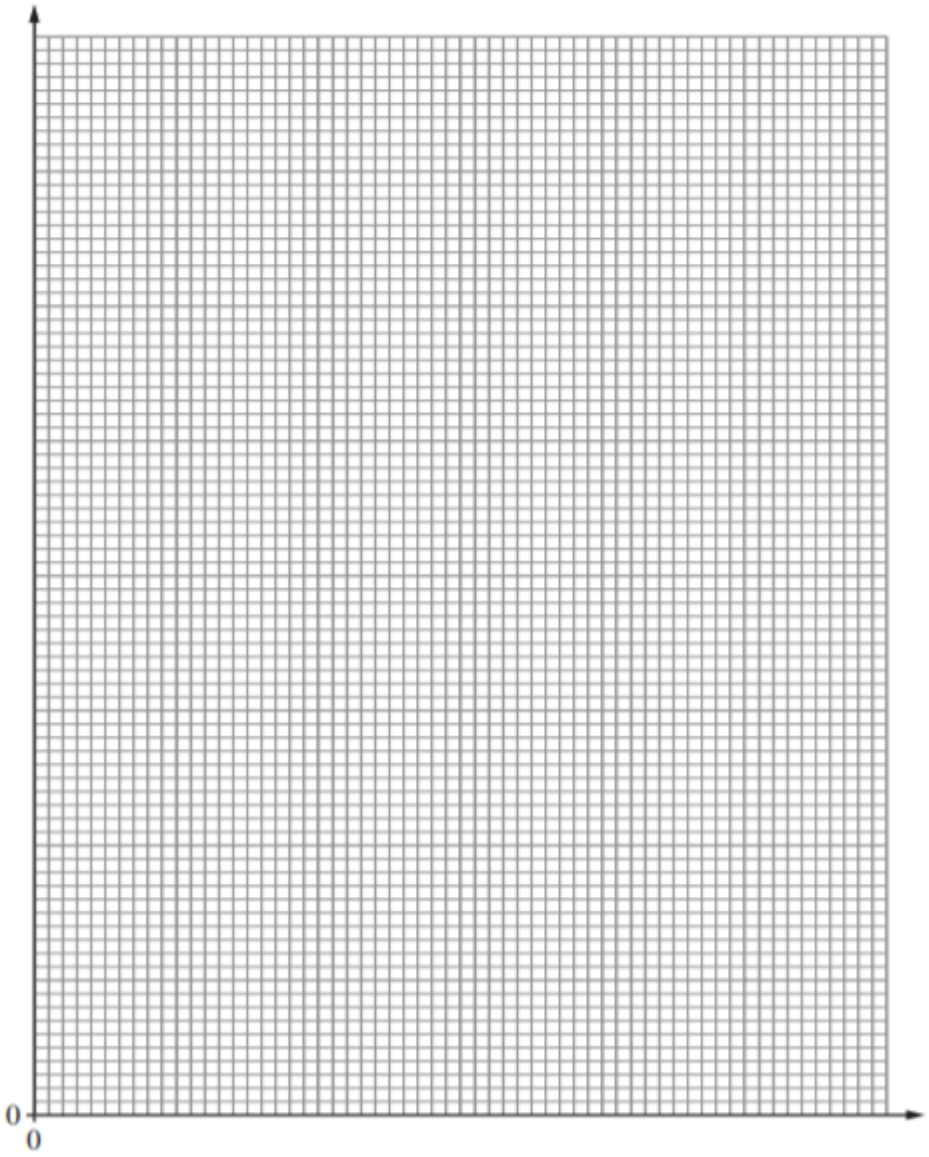
(b) A student carries out an experiment to determine the emf and internal resistance of a cell. The pd across the cell is measured when it is supplying various currents. The following readings are obtained. Plot these results on the grid (pd on the *y*-axis and current on the *x*-axis) and draw a line through your points. [3]

Current / A	0.20	0.42	0.66	0.96	1.20
pd / V	1.31	1.13	0.93	0.68	0.48



(c) Use your graph to determine:

(i) the emf of the cell; [1]

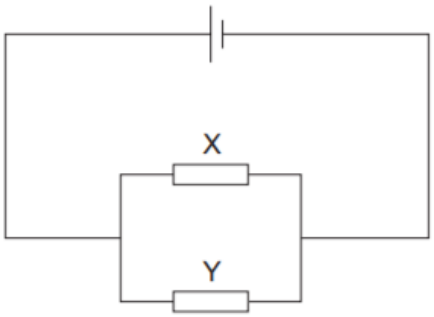
(ii) the internal resistance of the cell. [2]

(d) The cell is then connected to a torch bulb of resistance 6.0Ω for 20 minutes. Calculate the charge that flows through the bulb in this time. Assume the emf remains constant. [4]

7.

(a) In the following circuits the resistance of X is **greater than** the resistance of Y.

Circuit A



(i) For Circuit A, compare the current through, and the potential difference across X and Y. [1]

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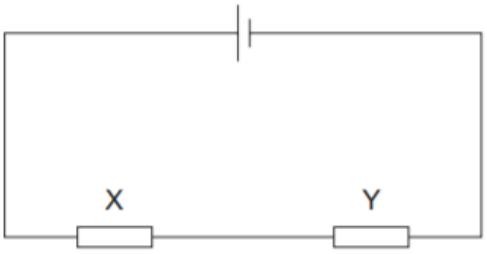
(ii)

Circuit B



For Circuit B, compare the current through, and the potential difference across X and Y. [1]

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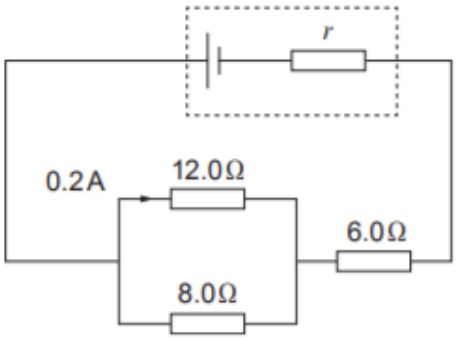
(b) The diagram below shows three resistors connected together as part of a circuit. The internal resistance, r, of the cell is also shown.



(i) Show in clear steps that the current in the 8.0Ω resistor is 0.3A. [2]

(ii) Show that the potential difference across the combination of three resistors is 5.4V. [3]

(iii) Explain why the potential difference across the combination of three resistors is less than the emf of the cell. [2]

(iv) Calculate the internal resistance, r, of the cell given that its emf is 6.0V. [2]