5.3 Electric Cells

Question Paper

Course	DP IB Physics
Section	5. Electricity & Magnetism
Topic	5.3 Electric Cells
Difficulty	Medium

Time allowed: 70

Score: /57

Percentage: /100

Question 1a

The diagram below shows two circuits A and B that were used by a student to test a battery of four identical cells. In circuit A, there was no load resistor and in circuit B a load resistor was connected. Assume that the meters in the circuits are ideal.
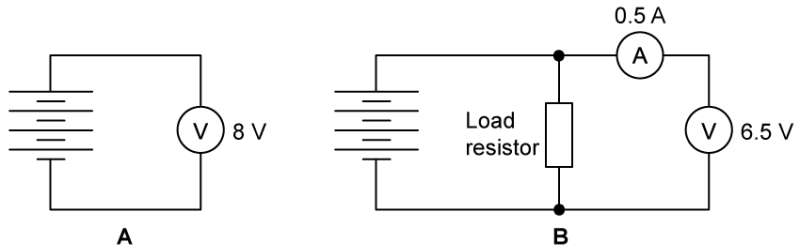
(a)
Explain why there is a difference in voltages recorded in the two circuits.
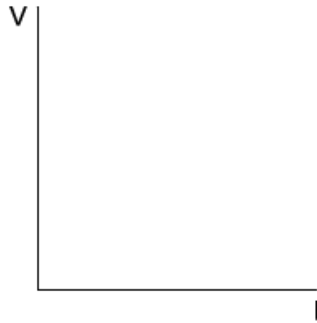
[3 marks]

Question 1b

(b)
Calculate the internal resistance of a single cell.

[3 marks]

Question 1c

In circuit **B**, the resistance of the load resistor *R* is altered so that a series of values on the voltmeter and the corresponding values of the current on the ammeter are obtained.

(c)

(i)
On the axes above, sketch the graph you would expect to obtain as *R* is changed.
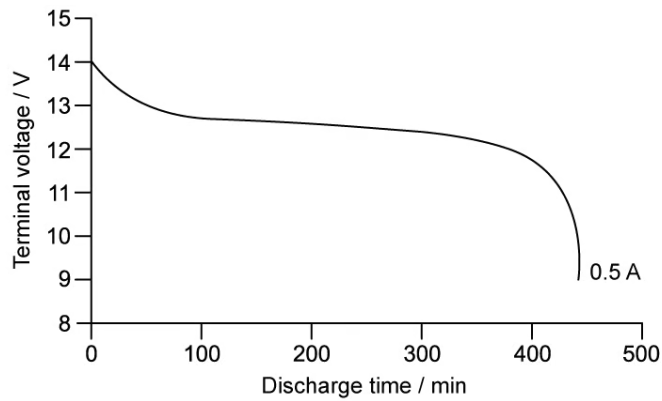
[2]

(ii)
Outline how the values of ε and *r* can be obtained from the graph.

[2]

[4 marks]

Question 1d

A cell is connected to an external resistor and the terminal voltage across the cell monitored. The graph shows the discharge time for one cell with a current of 0.5 A.
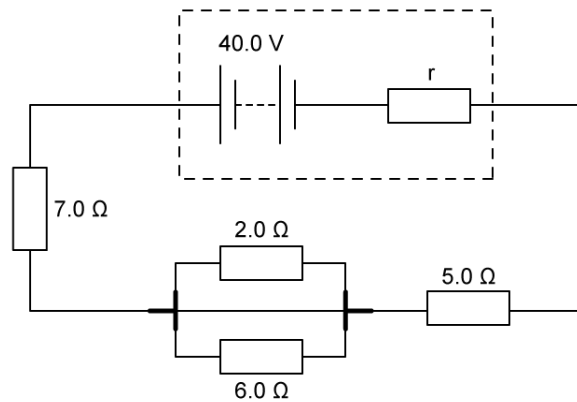

(d)

Determine the terminal voltage of the single cell. Show your working clearly.

[2 marks]

Question 2a

The diagram shows a battery of e.m.f. 40.0 V and internal resistance, r.

The current in the battery is 2.5 A.

(a)

Calculate the internal resistance r.

[4 marks]

Question 2b

(b)
Calculate the energy dissipated in the battery in 3.5 minutes.

[2 marks]

Question 2c

The circuit is amended to include a primary and a secondary cell.

(c)
Explain the function of primary and secondary cells and the role they have in an electric circuit.

[3 marks]

Question 2d

The internal resistance of the battery affects the efficiency of the transfer of energy from the battery to the circuit.
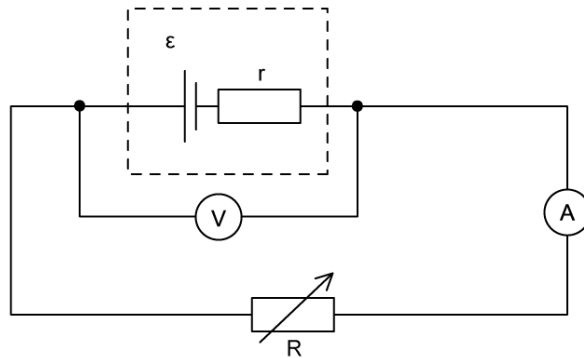
(d)
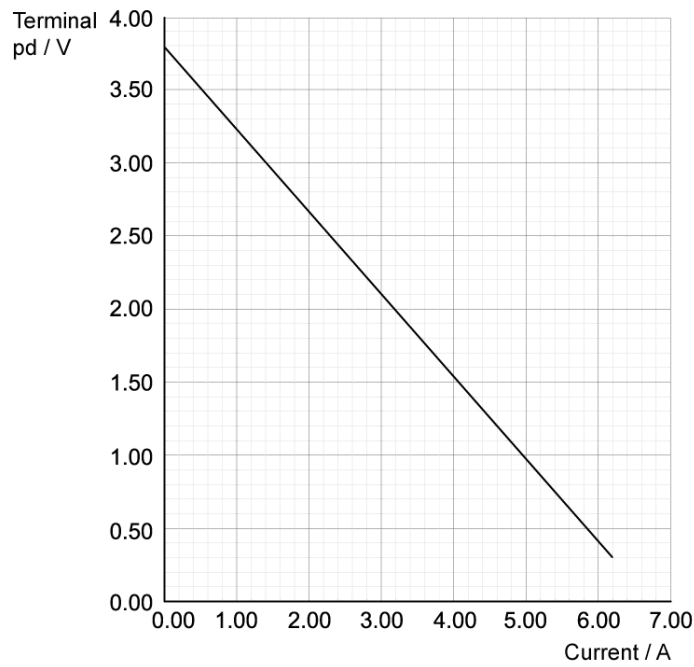Explain what causes internal resistance and why this affects the efficiency of the battery.

[3 marks]

Question 3a

The diagram shows a cell of e.m.f. ε, and internal resistance, r, is connected to a variable resistor R. The current through the cell and the terminal p.d. of the cell are measured as R is decreased.

The graph below shows the results from the experiment.

(a)
State the relationship between the terminal p.d. and current and explain why this relationship occurs.

[3 marks]

Question 3b

(b)

Find the e.m.f., ε, and the internal resistance, *r,* of the cell.

[3 marks]

Question 3c

(c)

Draw a line on the graph above to show the results obtained from a cell with the half the e.m.f. but double the internal resistance of the first cell. Label your graph **A**.
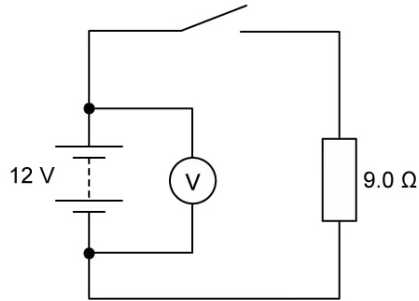
[2 marks]

Question 3d

(d)

Draw a line on the same graph to show the results obtained from a cell with the same e.m.f. but negligible internal resistance. Label your graph **B**.

[2 marks]

Question 4a

A battery is connected to an 9.0 Ω resistor. The e.m.f. of the battery is 12 V.

When the switch is open the voltmeter reads 12 V and when it is closed it reads 11.3 V.
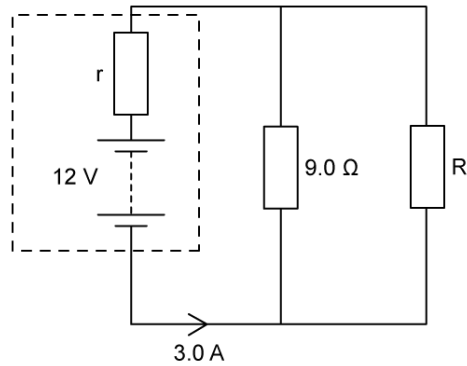
(a)
Explain why the readings are different.

[3 marks]

Question 4b

(b)
Calculate the internal resistance of the battery.

[3 marks]

Question 4c

The circuit diagram shows that the 9.0 Ω resistor is now connected in parallel with an unknown resistor, *R*. The battery now supplies a current of 3.0 A and has the same internal resistance *r* as the previous circuit.

(c)
Calculate the p.d. across the 9.0 Ω resistor.

[2 marks]

Question 4d

(d)
Calculate the resistance of *R*.

[3 marks]

Question 5a

A very high resistance voltmeter reads 11.5 V when it is connected across the terminals of a power supply.

(a)
Explain why the reading on the voltmeter is equal to the E.m.f. of the power supply.

[3 marks]

Question 5b

A battery of e.m.f. 11.5 V and internal resistance r is connected in a circuit with three identical 13 Ω resistors. A current of 0.40 A flows through the battery.
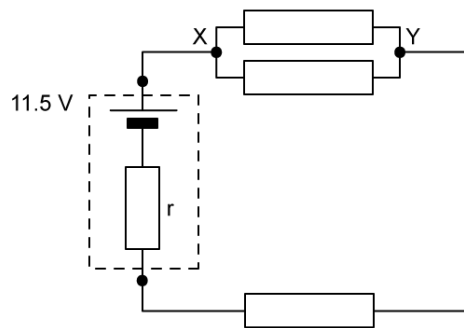
(b)
Calculate the potential difference between points **X** and **Y** in the circuit.

[2 marks]

Question 5c

(c)
Calculate the internal resistance of the battery.

[3 marks]

Question 5d

(d)

Explain the direction of the current flow required to recharge the secondary cell from the primary cell inside this circuit.

[4 marks]