

# 5.3 Electric Cells

## Question Paper

Course	DPIB Physics
Section	5. Electricity & Magnetism
Topic	5.3 Electric Cells
Difficulty	Easy

**Time allowed:** 80  
**Score:** /62  
**Percentage:** /100

### Question 1a

Cells used in circuits can be divided into two groups, primary cells and secondary cells.

(a)

Define a primary cell and state an example.

[2]

[2 marks]

### Question 1b

(b)

Define a secondary cell and state an example.

[3]

[3 marks]

### Question 1c

For the following descriptions of the functions of primary and secondary cells, choose the correct words from each pair in bold to complete the sentences.

(c)

During normal operation of a primary cell, the electrons flow from the **negative/positive** plate of the cell, around the circuit, to the **negative/positive** plate of the cell.

When recharging a secondary cell, the electrons are forced from the **negative/positive** plate to the **negative/positive** plate by an external current.

[2]

[2 marks]

### Question 1d

Lithium cells are widely used and have allowed for a revolution in the manufacture of portable electronics. However there are concerns with reliance on lithium as a material for making cells.

(d)

Outline two concerns with the use of lithium in cells.

[2]

[2 marks]

### Question 2a

The electromotive force,  $\varepsilon$  is defined by the equation

$$\varepsilon = I(R + r)$$

(a)

Define the following variables and state an appropriate unit for each.

(i)

$I$

[1]

(ii)

$R$

[1]

(iii)

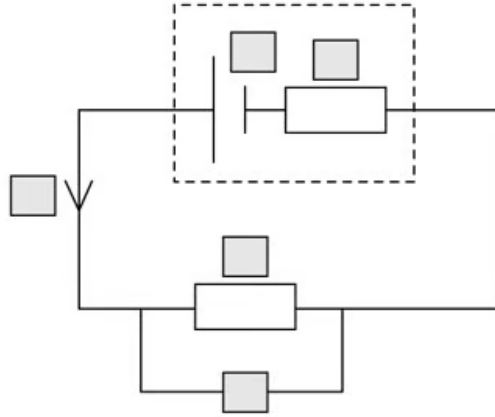
$r$

[1]

[3 marks]

**Question 2b**

The circuit shown includes a cell with internal resistance and a load resistor.



(b)  
Complete the labels on the components using each of the following variables once only.

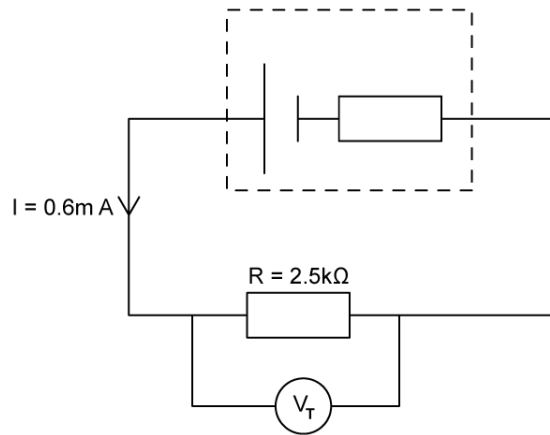
$\epsilon$	$I$	$r$	$R$	$V$
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[5]

[5 marks]

### Question 2c

A current of  $0.6 \text{ mA}$  flows through the circuit in part (a) and the resistor has a resistance of  $2.5 \text{ k}\Omega$ .



(c)  
Calculate the terminal potential difference  $V_T$  of the circuit.

[3]

[3 marks]

### Question 2d

The internal resistance of the cell is  $1.3 \text{ k}\Omega$ .

(d)  
Calculate the emf of the cell.

[3]

[3 marks]

**Question 3a**

(a)

Explain what is meant by the electromotive force of a cell and state the units.

[4]

**[4 marks]****Question 3b**

(b)

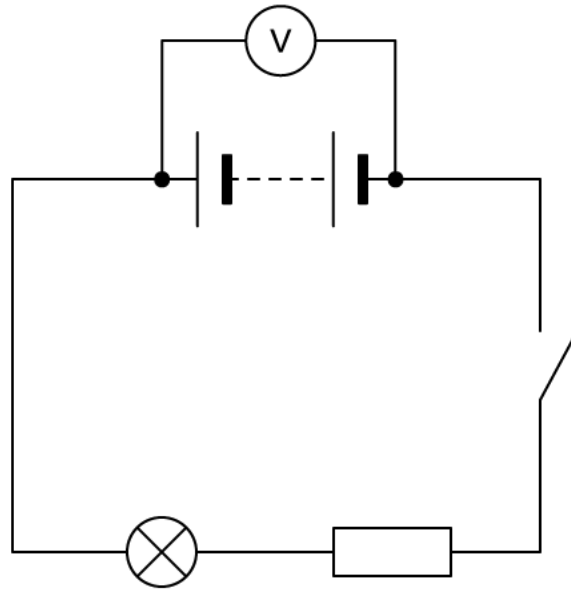
Define the internal resistance of a cell.

[1]

**[1 mark]**

### Question 3c

In the circuit shown a high resistance voltmeter is used to measure the potential difference across the terminals of a battery.



(c)  
The switch is closed.

(i)  
State how the voltmeter reading changes.

[1]

(ii)  
Explain what property of the battery causes this change.

[1]

[2 marks]

### Question 3d

(d)  
Explain why the voltmeter reading changes when the switch is closed.

[1]

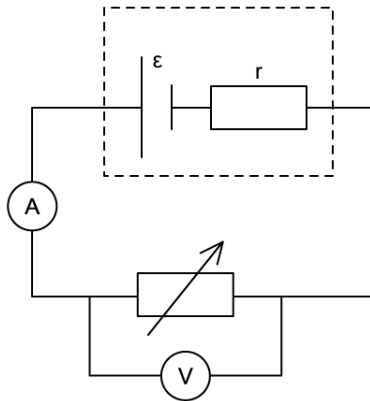
[1 mark]





**Question 4a**

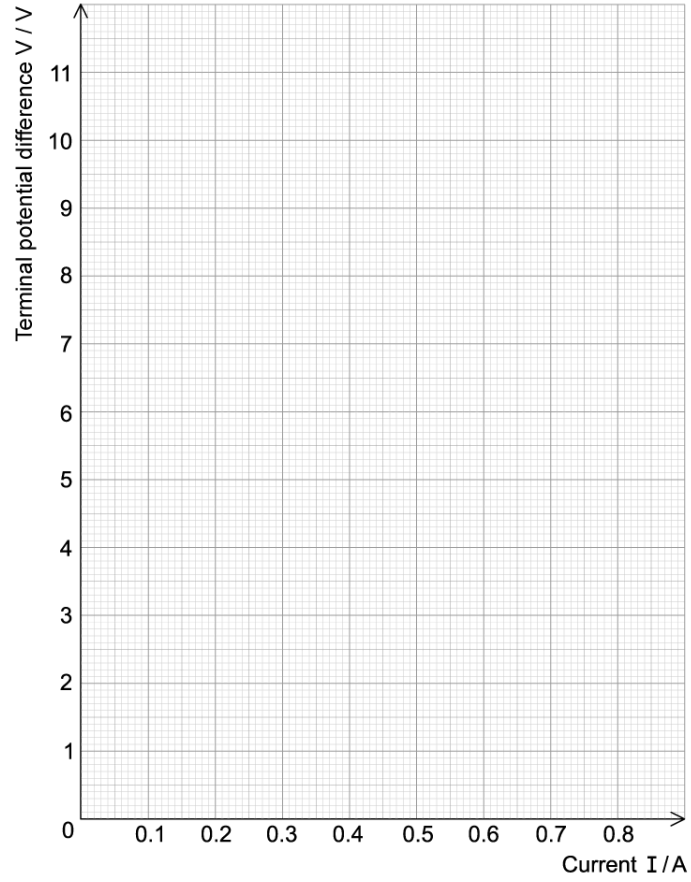
To investigate the internal resistance and emf of a cell a student uses the circuit shown. The cell has emf  $\epsilon$  and internal resistance  $r$  and is connected in series to a variable resistor with resistance  $R$ .



The student wishes to determine the relationship between the voltmeter and ammeter readings whilst decreasing  $R$ . Their results are given.

Terminal potential difference / V	Current / A
8.3	0.07
6.8	0.17
4.6	0.33
2.9	0.44
0.3	0.63

- (a)  
Plot a graph of the data using the graph layout given below.



[3]

[3 marks]

### Question 4b

(b)

Using your graph from part (a) (or the model solution provided)

(i)

Determine the value of  $\varepsilon$ .

[1]

(ii)

Explain your method.

[1]

[2 marks]

### Question 4c

(c)

Using your graph from part (a) (or the model solution provided) calculate the value of  $r$ . Show your method clearly.

[4]

[4 marks]

### Question 4d

(d)

Using your graph from part (a) (or the model solution provided) sketch a line to show the results obtained from a cell with:

(i)

The same emf but larger internal resistance. Label this A.

[2]

(ii)

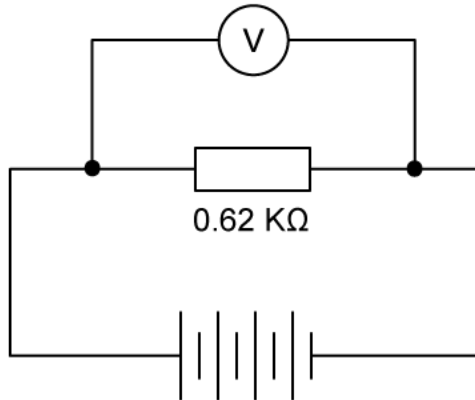
The same internal resistance but larger emf. Label this B.

[2]

**[4 marks]**

**Question 5a**

The circuit shown is used to test a battery of four identical cells each with emf  $\epsilon = 0.70 \text{ V}$ .



A fixed resistor with  $R = 0.62 \text{ k}\Omega$  is connected in series with the cell. A current  $I = 4.50 \text{ mA}$  travels through the circuit.

(a)  
For this circuit

(i)  
Calculate the emf of the battery.

[2]

(ii)  
Calculate the internal resistance of the battery.

[3]

(iii)  
State an appropriate unit for your answer.

[1]

**[6 marks]**

### Question 5b

(b)

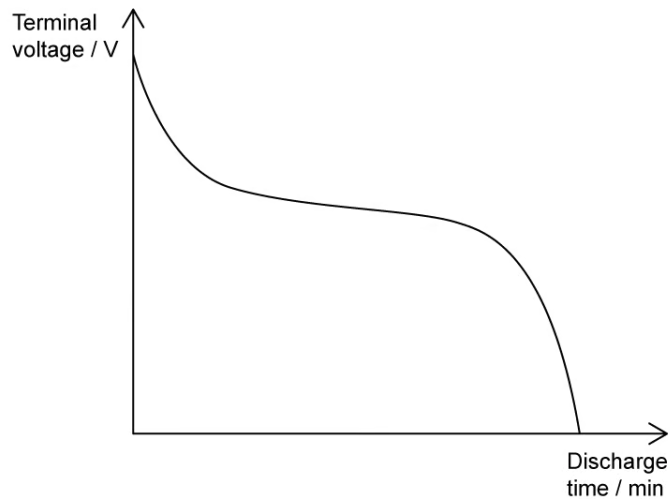
For the circuit in part (a), calculate the internal resistance of one cell.

[2]

[2 marks]

### Question 5c

As cells are used they discharge their voltage, according to a curve as shown.



(c)

To describe the graph, choose the correct word from each pair.

- When a cell is discharging, it **will/will not** discharge a constant amount of voltage.
- When the cell is new the initial high voltage will begin to discharge **slowly/fairly quickly**.
- For most of the life of the cell it discharges **slowly/fairly quickly**.
- Finally, as the cell reaches the end of its life the voltage is discharged **slowly/fairly quickly**.

[4]

**[4 marks]****Question 5d**

The graph in part (c) represents a 1.5 V AA battery discharging over time. The battery is connected so that the circuit draws a current of 2.0 A.

(d)

Using the graph from part (c), add discharge curves for two identical cells which are drawing different currents. Label your lines (i) and (ii).

(i)

Current,  $I = 1.0 \text{ A}$ **[3]**

(ii)

Current,  $I = 4.0 \text{ A}$ **[3]****[6 marks]**

