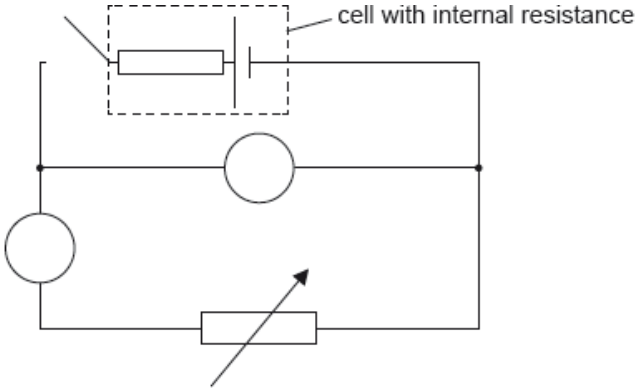
SL Paper 3

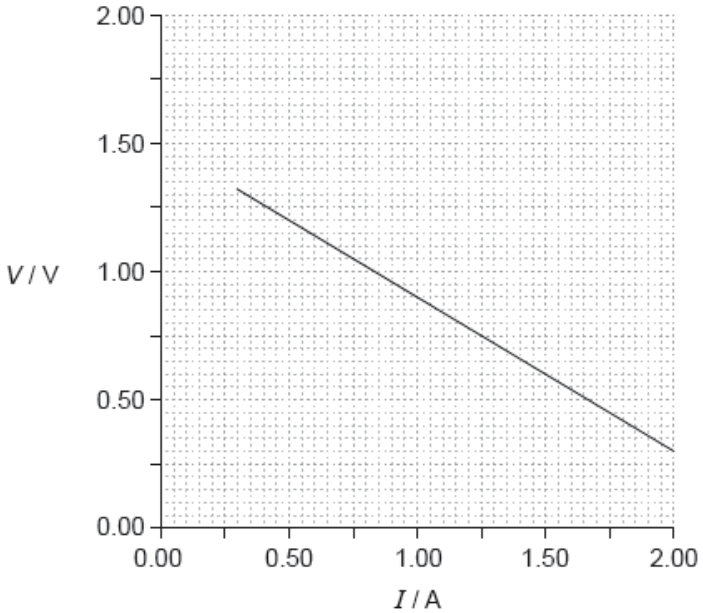
The circuit shown may be used to measure the internal resistance of a cell.



The ammeter used in the experiment in (b) is an analogue meter. The student takes measurements without checking for a “zero error” on the ammeter.

a. An ammeter and a voltmeter are connected in the circuit. Label the ammeter with the letter A and the voltmeter with the letter V. [1]

b. In one experiment a student obtains the following graph showing the variation with current *I* of the potential difference *V* across the cell. [3]



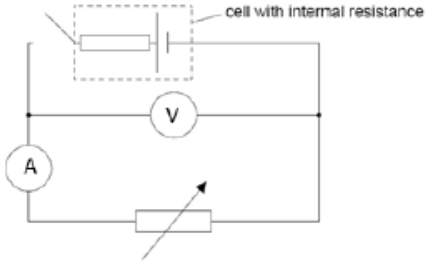
Using the graph, determine the best estimate of the internal resistance of the cell.

c.i. State what is meant by a zero error. [1]

c.ii. After taking measurements the student observes that the ammeter has a positive zero error. Explain what effect, if any, this zero error will have on the calculated value of the internal resistance in (b). [2]

Markscheme

a. correct labelling of both instruments



[1 mark]

b. $V = E - Ir$

large triangle to find gradient and correct read-offs from the line
OR
use of intercept E = 1.5 V and another correct data point

internal resistance = 0.60 Ω

For MP1 – do not award if only $R = \frac{V}{I}$ *is used.*

For MP2 points at least 1A apart must be used.

For MP3 accept final answers in the range of 0.55 Ω to 0.65 Ω.

[3 marks]

c.i. a non-zero reading when a zero reading is expected/no current is flowing

OR

a calibration error

OWTTE
Do not accept just "systematic error".

[1 mark]

c.ii. the error causes «all» measurements to be high/different/incorrect

effect on calculations/gradient will cancel out
OR
effect is that value for *r* is unchanged

Award ***[1 max]*** *for statement of "no effect" without valid argument.*

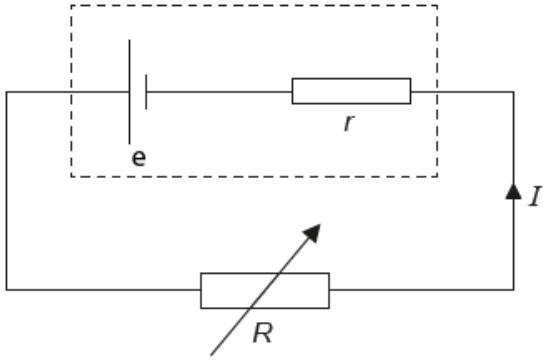
OWTTE

[2 marks]

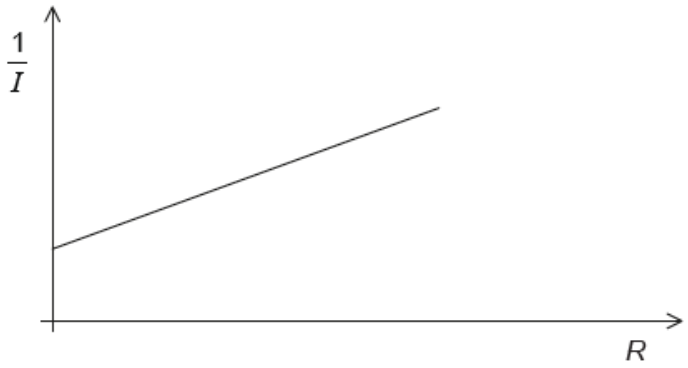
Examiners report

a. [N/A]
b. [N/A]
c.i. [N/A]
c.ii. [N/A]

An electrical circuit is used during an experiment to measure the current *I* in a variable resistor of resistance *R*. The emf of the cell is *ε* and the cell has an internal resistance *r*.



A graph shows the variation of $\frac{1}{I}$ with *R*.



a. Show that the gradient of the graph is equal to $\frac{1}{\varepsilon}$. [2]

b. State the value of the intercept on the *R* axis. [1]

Markscheme

a. «$\varepsilon = IR + Ir$»

$\frac{1}{I} = \frac{R}{\varepsilon} + \frac{r}{\varepsilon}$

identifies equation with $y = mx + c$

«hence $m = \frac{1}{\varepsilon}$»

No mark for stating data booklet equation

Do not accept working where r is ignored or ε = IR is used

OWTTE

b. «–» *r*

Allow answer in words

Examiners report

a. [N/A]
b. [N/A]