Candidate 2 evidence (Batteries)

Batteries

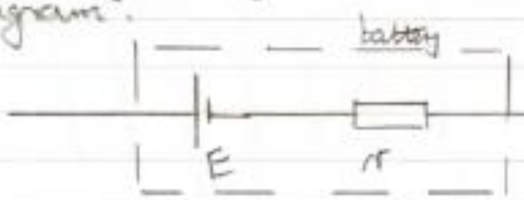
Aim

I am going to measure the internal resistance of a 1.5V Battery using two methods

Underlying Physics

An electrical cell is made from materials (metal or chemicals for example). All materials have some resistance. Therefore a cell must have resistance. This resistance is called the INTERNAL RESISTANCE of the cell. (1)

You can think of a battery as a source of Voltage (emf) and a resistance, like this diagram.



E is the voltage (emf) and r is the resistance.

If you connect the battery into a circuit with another resistor R, a current will flow through the circuit and there will be a voltage across R and the same voltage across the battery. This is called V, the terminal potential difference (t.p.d.)

V is less than E because of the resistance of the battery inside. (r)

Using Ohm's Law,

$$E = I(R+r) \text{ and } V=IR$$

So $V = E - Ir$

and a graph of V against I will have a gradient of $-r$.

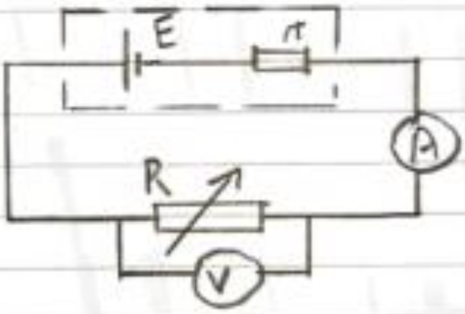
also $V = IR$

so $V = I / \frac{1}{R}$

And a graph of R against V will hit the R axis at r.

Method

I set up this circuit



I was measured using a digital multimeter on the Amps setting.

V was measured using a digital multimeter on the Volts setting.

R was a resistance box.

Table

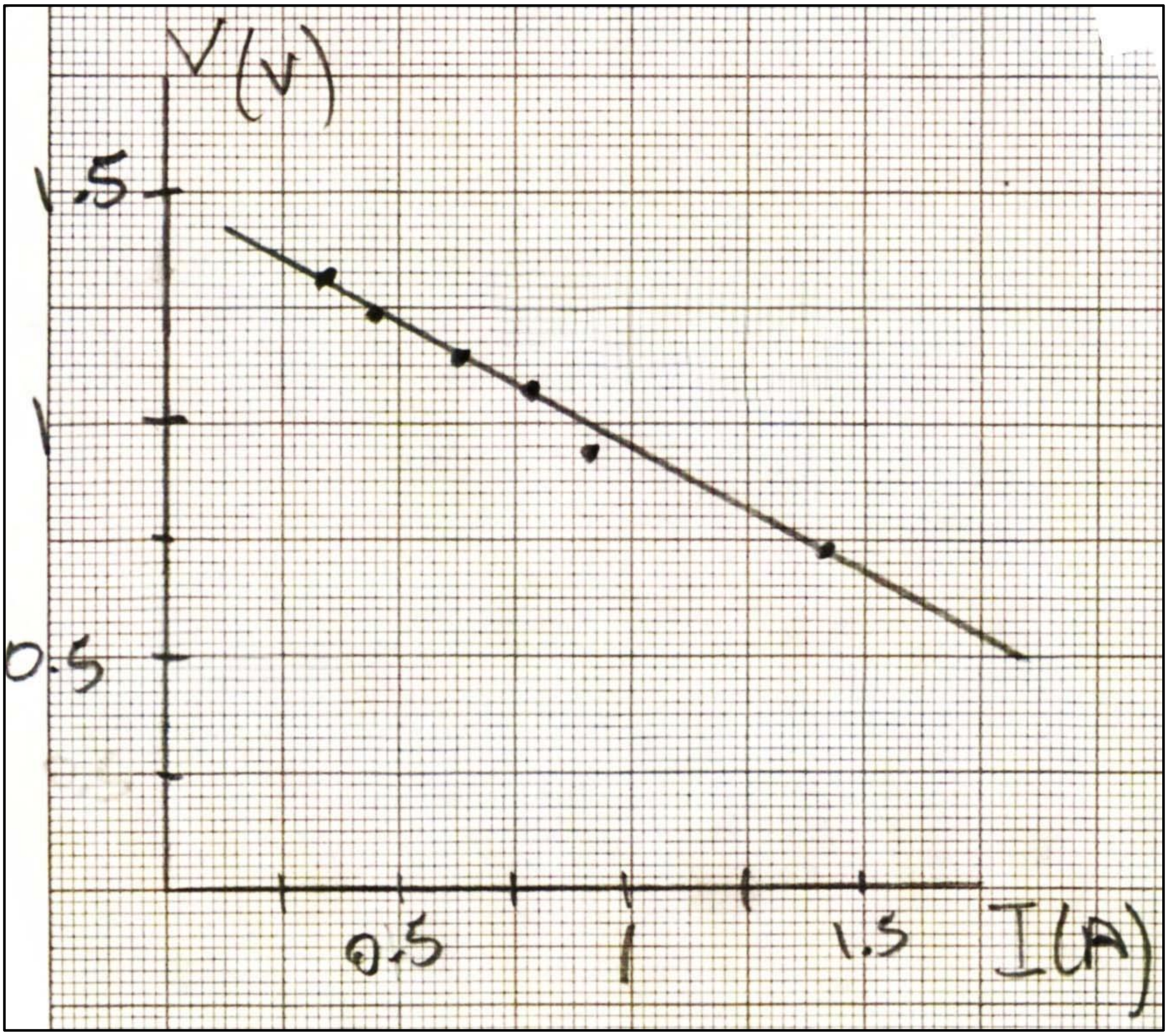
Voltmeter reading (V)	Ammeter reading (A)
1.32	0.35
1.24	0.44
1.16	0.64
1.08	0.78
0.94	0.91
0.77	1.43

The scale reading uncertainty in the ammeter was ± 0.01 A and in the voltmeter was ± 0.01V

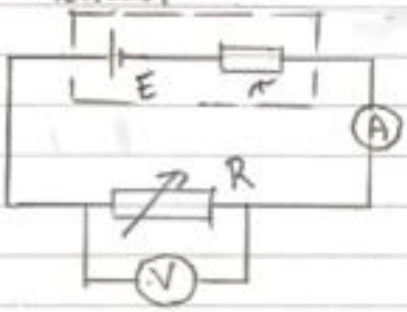
Graph

The graph of V against I is on the next page

The gradient of the graph is 0.555, and so the internal resistance of the battery is 0.555 Ω.



I set up this circuit



I was measuring using a digital multimeter on the Amps setting

R was measured using a digital multimeter on the Ohms setting.

R was a resistance box.

Table

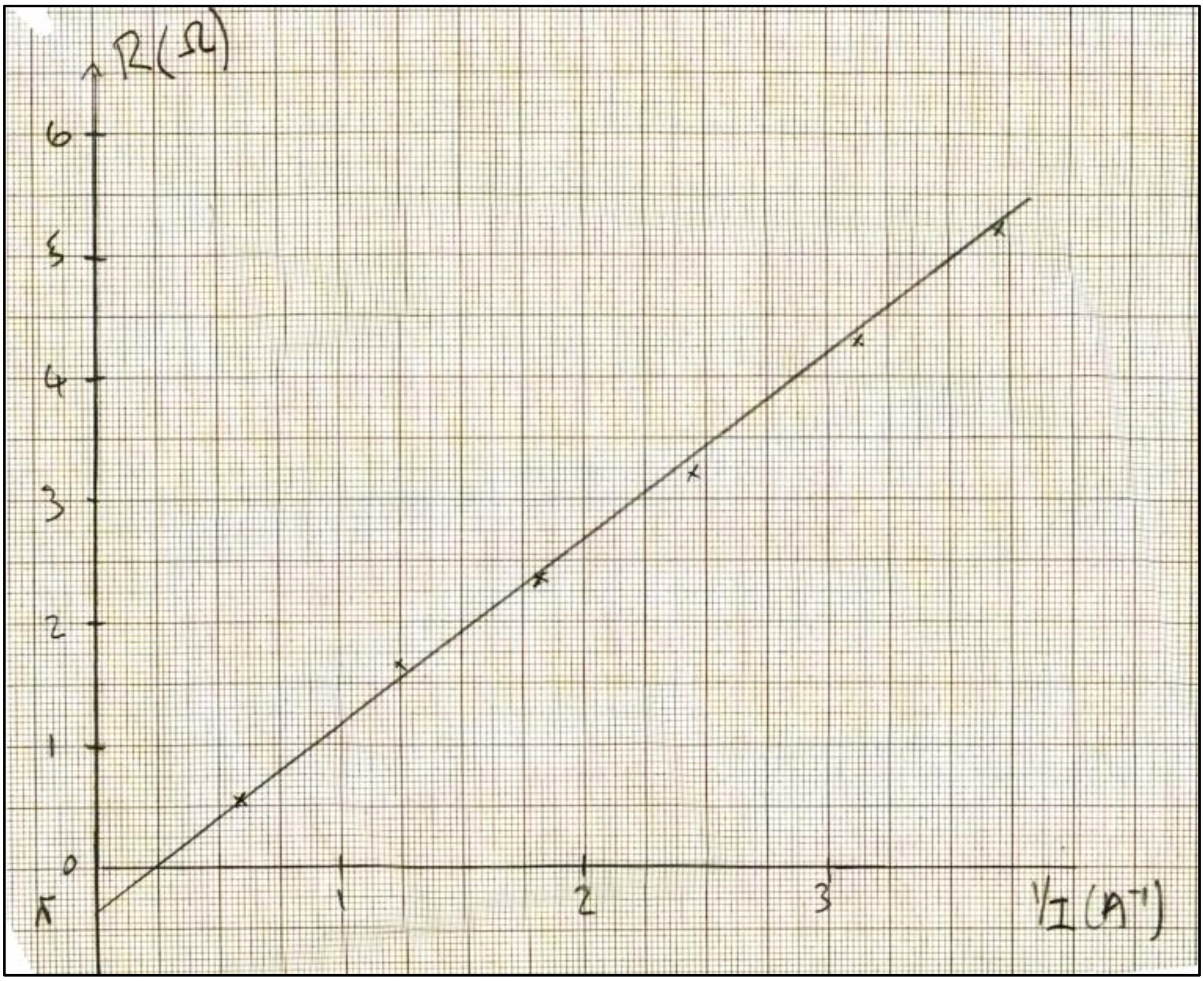
Ohmmeter Reading (V)	Ammeter reading (A)	$1/I$ (A^{-1})
0.53	1.75	0.57
1.61	0.76	1.32
2.33	0.55	1.82
3.22	0.41	2.44
4.27	0.32	3.13
5.19	0.27	3.70

The scale reading uncertainty in the ammeter was ± 0.01 A and in the ohmmeter was ± 0.01 Ω

Graph

The graph of R against $1/I$ is on the next page

The intercept on the y-axis is 0.45, so the internal resistance is 0.45 Ω.


R (Ω)
6
5
4
3
2
1
0
1
2
3
1/I (A⁻¹)

Conclusion

The first experiment gave me r = 0.555 Ω and the second was r = 0.45 Ω, so my average internal resistance is

$(0.555 + 0.45) \div 2 = 0.5025\ \Omega$

Evaluation

The multimeters only read to 2 decimal places. If I had meters that read to more decimal places, the readings would have been more accurate.

I could have repeated my measurements and worked out a random uncertainty. This would have made the errors in my results more realistic, because the reading uncertainty in the metres was very small.

I could have tried to find the internal resistance of another 1.5V battery to compare with the one I used to see if my results were correct.

Reference

1. https://www.bbc.co.uk/education/guides/zxx66sg/revision.