Higher
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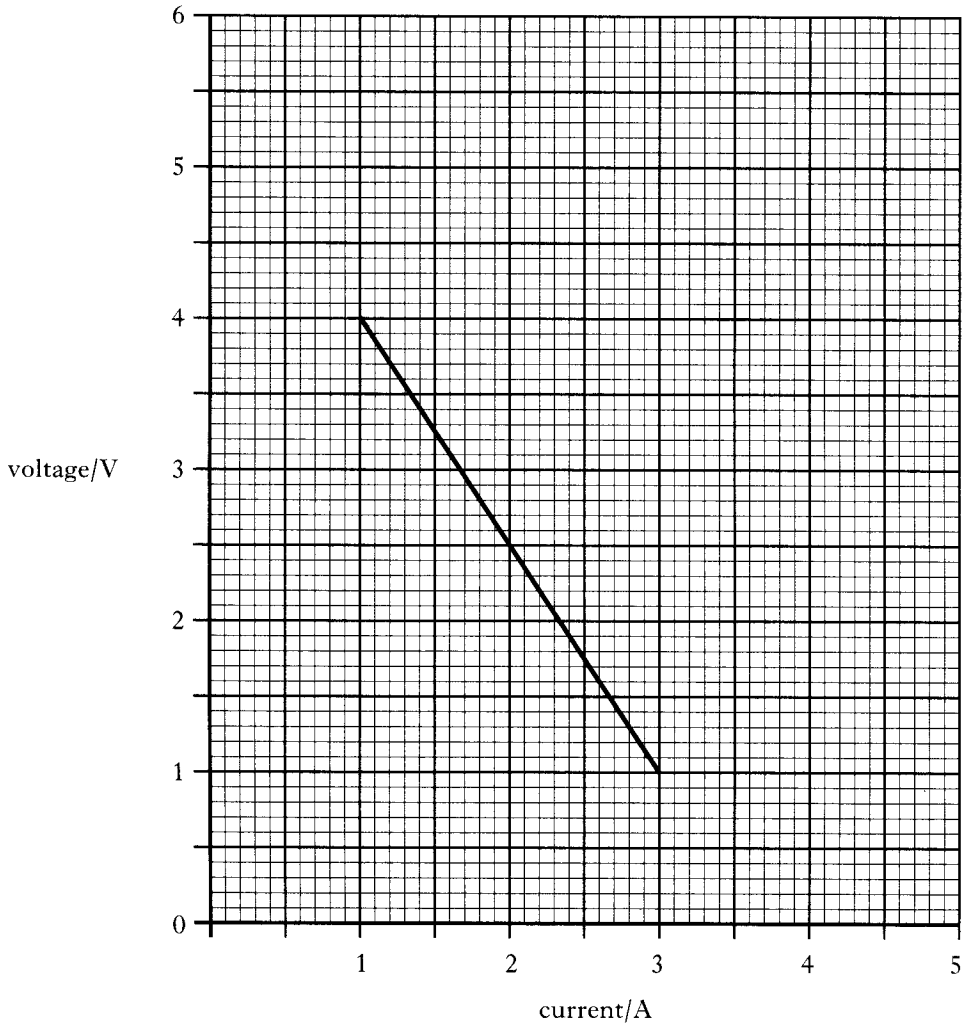
Past Paper questions 1991 - 2003

1996 Q33.

A cell of e.m.f. 1.5 V and internal resistance 0.2 Ω is connected across a lamp.
A second identical lamp is now connected in parallel with the first lamp.
Describe and explain what happens to the brightness of the first lamp.

1997 Q35.

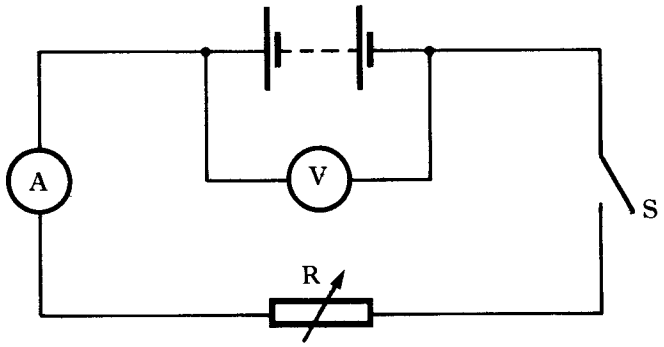
The graph shows how the voltage across the terminals of a battery changes as the current from the battery is varied.



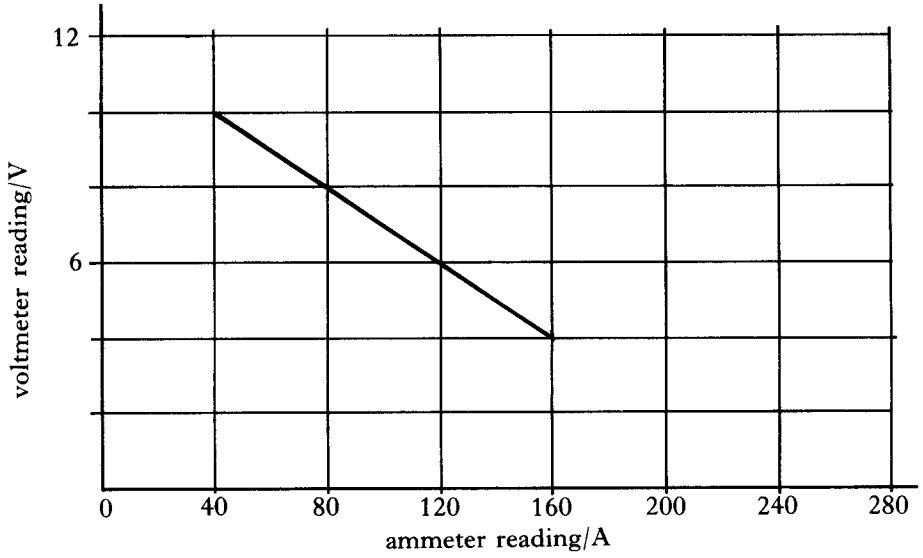
(a) Calculate the internal resistance of the battery.
(b) What is the value of the current from the battery when it is short-circuited?

1991 Q5.

A car battery is connected in a circuit as shown to study how the voltage across the battery varies with the current drawn from it.



For each setting of the variable resistor R, switch S is closed momentarily and the voltmeter and ammeter readings are recorded. A graph of the results is shown below.



(a) Explain why the reading on the voltmeter decreases as the ammeter reading increases.

(b) Use information from the graph to find:

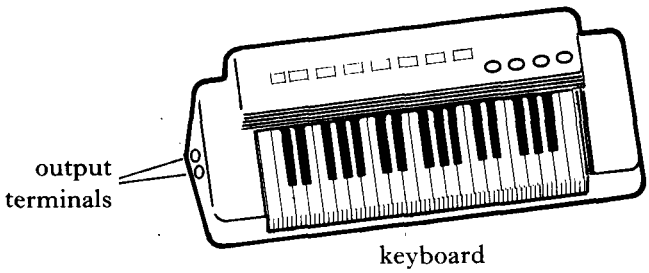
(i) the e.m.f. of the battery;

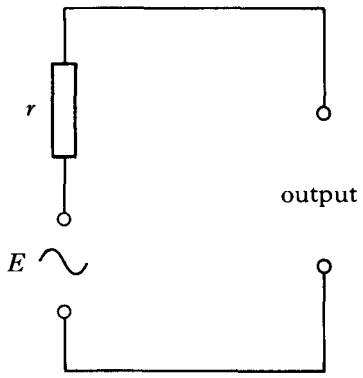
(ii) the internal resistance of the battery;

(iii) the current from the battery if it is short circuited.

1992 Q5.

(a) An electronic keyboard contains an audio amplifier with output terminals which can be connected to a loudspeaker.
When a key is pressed, the amplifier may be considered as a source of e.m.f. E and internal resistance r in series, as shown below.

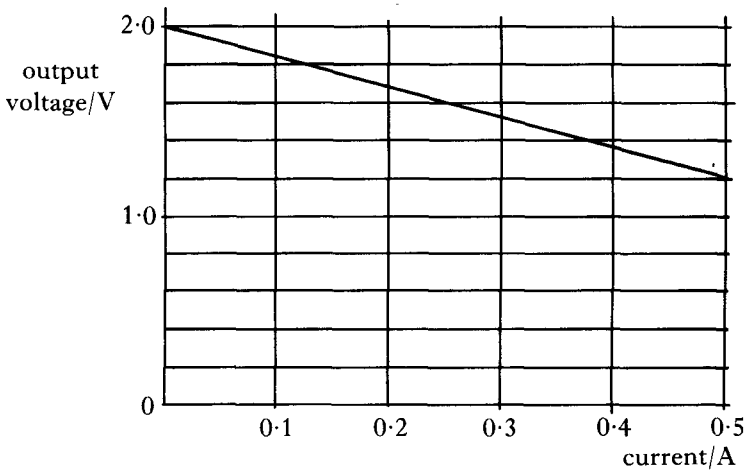




In an experiment to measure the internal resistance of the amplifier, the following equipment is used:

keyboard
a.c. ammeter
a.c. voltmeter
variable resistor.

The graph below displays the results of the experiment.



(i) Describe how the apparatus is used to obtain the data for this graph.
Your answer must include a circuit diagram.

(ii) Calculate the value of the internal resistance of the amplifier.

(iii) A loudspeaker of resistance 4.0 Ω is now connected across the output terminals of the amplifier and a key is pressed.
What is the output voltage across the loudspeaker?

(b) The internal resistance of a power supply can be measured with a voltmeter and a calibrated variable resistor.
First, the e.m.f. of the power supply is measured using the voltmeter as shown in Figure 1.

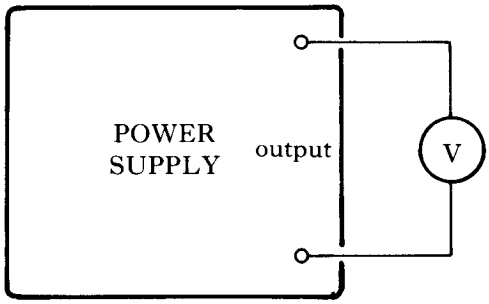


Figure 1

The variable resistor is then connected, as in Figure 2, and adjusted until the output p.d. is equal to half the e.m.f.

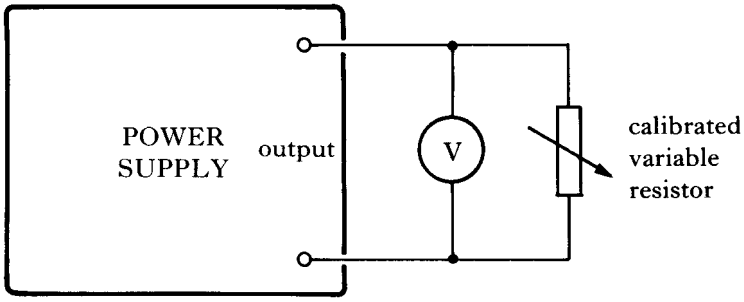


Figure 2

Explain how these measurements can be used to obtain the value of the internal resistance of the power supply.

1994 Q6.

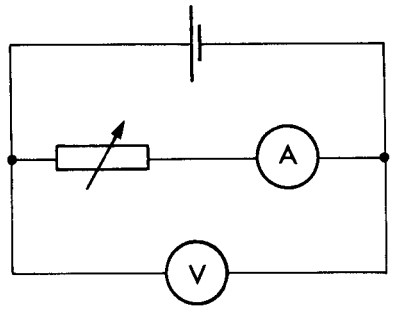
(a) A rechargeable cell is rated at 0.50 Ah (ampere hour). This means that, for example, it can supply a constant current of 0.50 A for a period of 1 hour. The cell then requires to be recharged.

(i) What charge, in coulombs, is available from a fully charged cell?

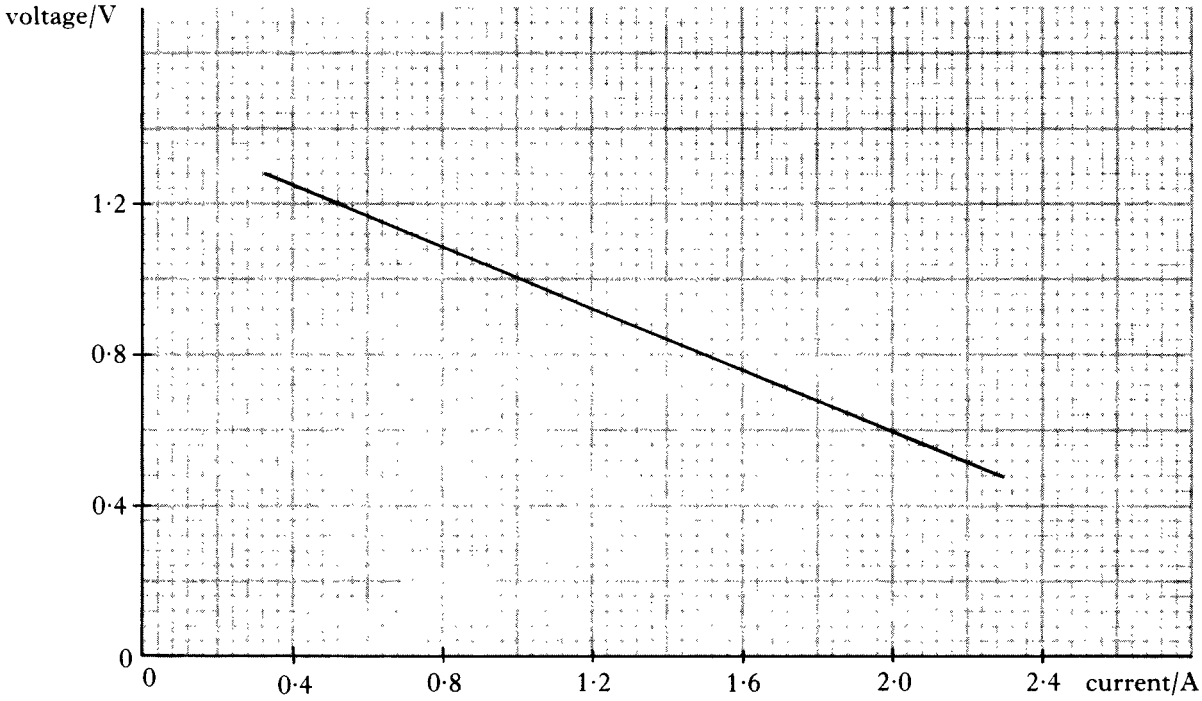
(ii) A fully charged cell is connected to a load resistor and left until the cell requires recharging. During this time, the p.d. across the terminals of the cell remains constant at 1.2 V. Calculate the electrical energy, supplied to the load resistor in this case.

(b) (i) State what is meant by the e.m.f. of a cell.

(ii) The Circuit shown below is used in an experiment to find the e.m.f. and internal resistance of the rechargeable cell.



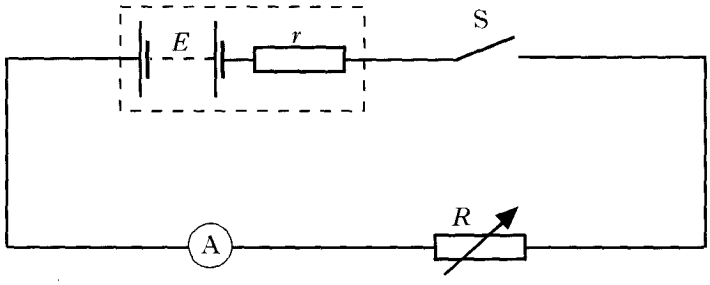
The voltmeter and ammeter readings for a range of settings of the variable resistor are used to produce the graph below.



Use the graph to find the values for the e.m.f. **and** internal resistance of the cell.

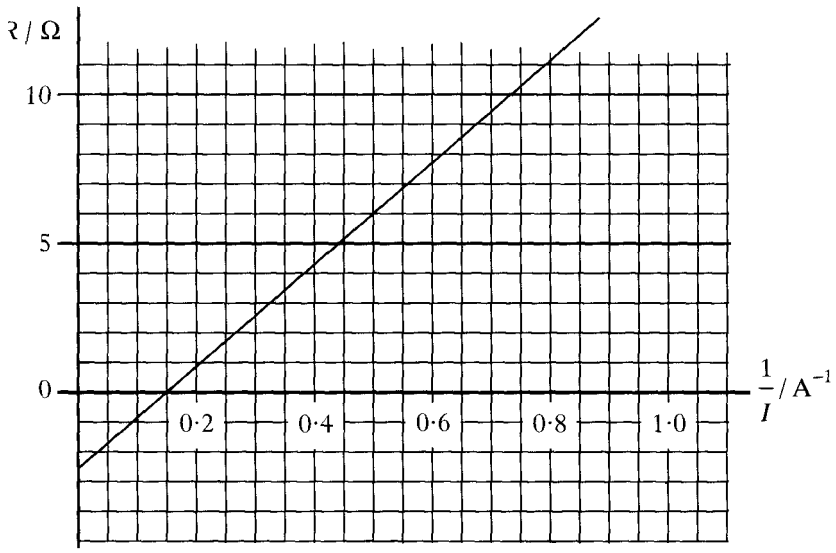
1995 Q7.

The circuit below is used to determine the internal resistance r of a battery of e.m.f. E.



The variable resistor provides known values of resistance R.
For each value of resistance R, the switch S is closed and the current I is noted.
For each current, the value of $^1/_I$ is calculated.

In one such experiment, the following graph of R against $^1/_I$ is obtained.



(a) Conservation of energy applied to the complete circuit gives the following relationship.

$$E = I(R + r)$$

Show that this relationship can be written in the form

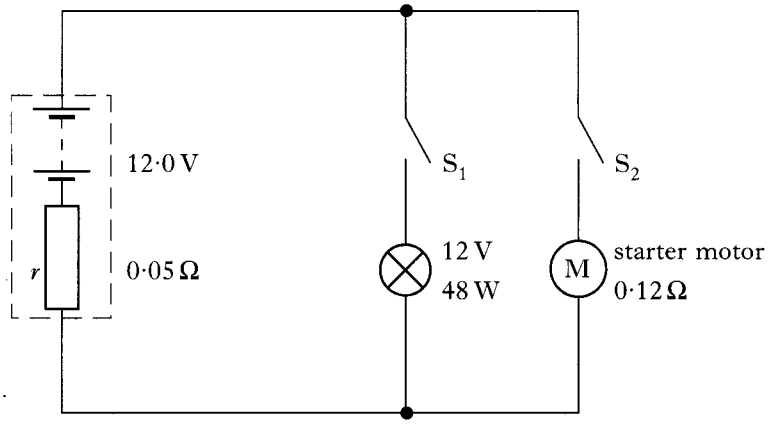
$$R = \frac{E}{I} - r \ .$$

(b) Use information from the graph to find:
  (i) the internal resistance of the battery;
  (ii) the e.m.f. of the battery.

(c) The battery is accidentally short-circuited,
Calculate the current in the battery when this happens.

1997 Q5.

The diagram shows a circuit for part of the electrical system of a car.



The battery has an e.m.f. of 12.0 V and an internal resistance r of 0.05 Ω. The battery is connected across a 12 V, 48 W headlamp and a starter motor of resistance 0.12 Ω as shown.

(a) State what is meant by "the battery has an e.m.f. of 12.0 V".

(b) (i) What is the resistance of the headlamp when used at its rated voltage?

(ii) Show that there is a p.d. of 11.8 V across the headlamp when switch S_1 is closed and switch S_2 is open. Assume that the resistance of the headlamp does not change.

(c) Both switches S_1 and S_2 are now closed.

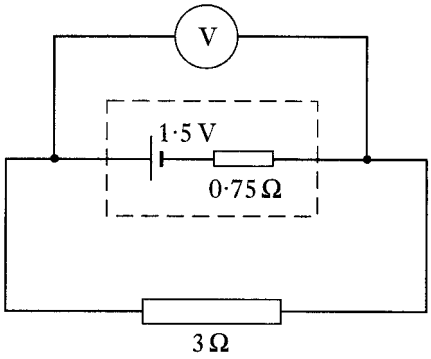
Assuming that the resistance of the headlamp does not change, calculate:

(i) the total resistance of the circuit;

(ii) the current from the battery.

1998 Q5

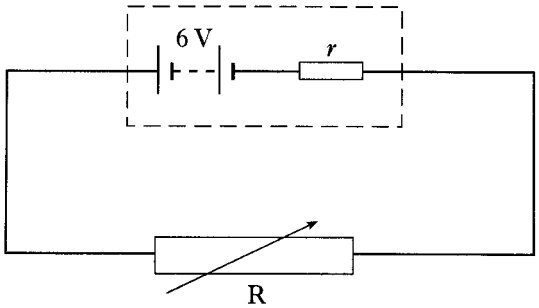
(a) A cell of e.m.f. 1.5 V and internal resistance 0.75 Ω is connected as shown in the following circuit.



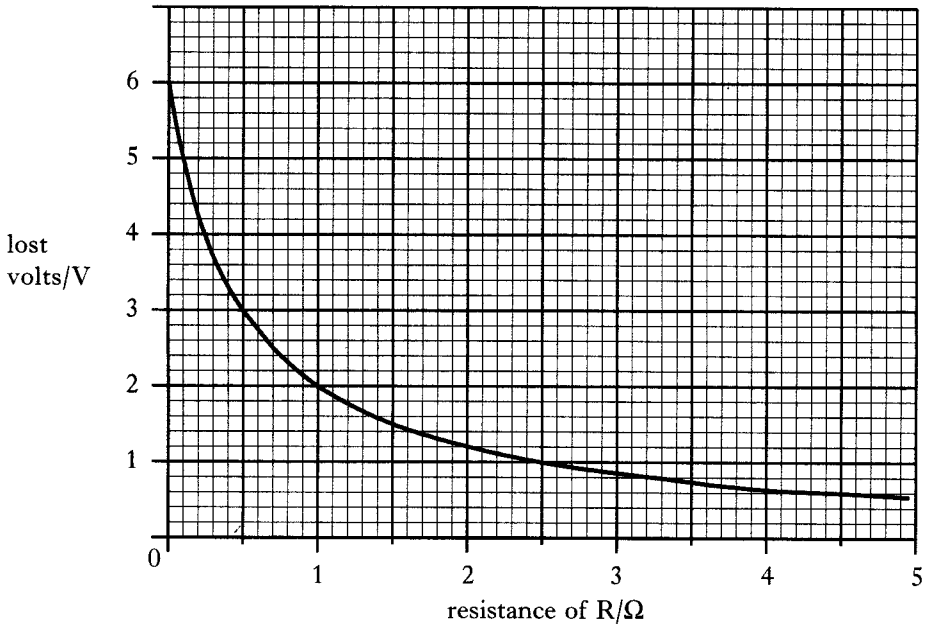
(i) Calculate the value of the reading on the voltmeter.

(ii) What is the value of the "Lost volts" in this circuit?

(b) A battery of e.m.f. 6 V and internal resistance, r, is connected to a variable resistor R as shown in the following circuit diagram.



The graph below shows how the "lost volts" of this battery changes as the resistance of R increases.

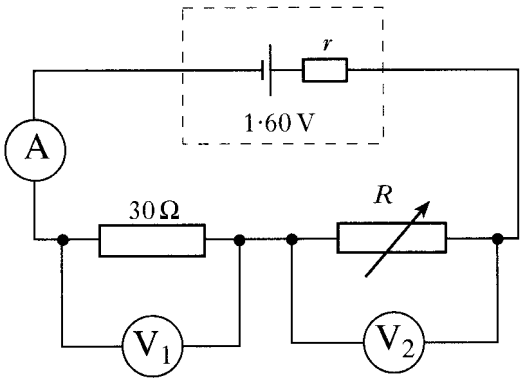


(i) Use information from the graph to calculate the p.d. across the terminals of the battery (t.p.d.) when the resistance of R is 1 Ω

(ii) Calculate the internal resistance, r, of the battery.

1999 Q6.

The circuit below includes a cell with an e.m.f. of 1.60 V and internal resistance r.



The following readings are taken from the meters.

reading on the ammeter = 0.04 A
reading on the voltmeter V_1 = 1.20V
reading on the voltmeter V_2 = 0.30 V

(a) Calculate the value of the lost volts in the circuit.

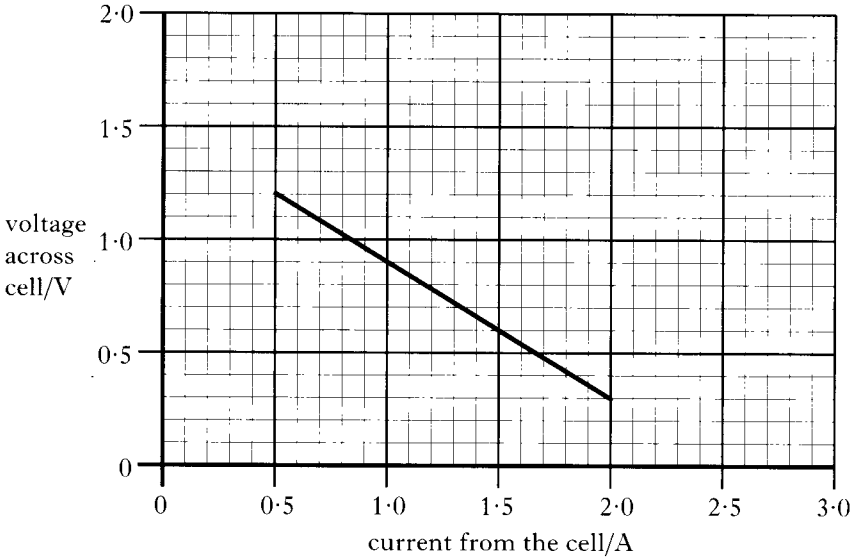
(b) Calculate the internal resistance, r, of the cell.

(c) (i) The resistance of the variable resistor is altered so that the reading on the ammeter is 0.02 A. What is the resistance of the variable resistor now?

(ii) The resistance, R, of the variable resistor is now decreased. What effect has this on the terminal potential difference, V_{tpd}, of the cell? You must justify your answer.

2000 Q5.

During an experiment to measure the e.m.f. and internal resistance of a cell, the following graph is obtained.

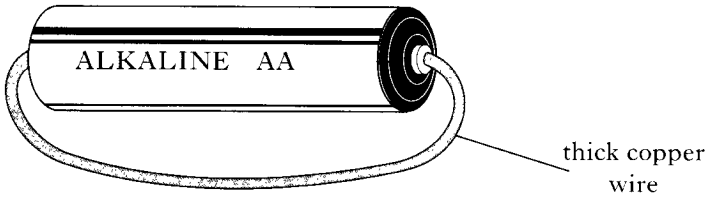


(a) Draw a circuit which could be used to obtain the data for this graph.

(b) (i) What is the value of the e.m.f. of the cell?

(ii) Calculate the internal resistance of the cell.

(c) A thick copper wire is used to short circuit the cell as shown below.



What is the value of the short circuit current in the thick copper wire?

(d) After some time, the cell becomes "flat".

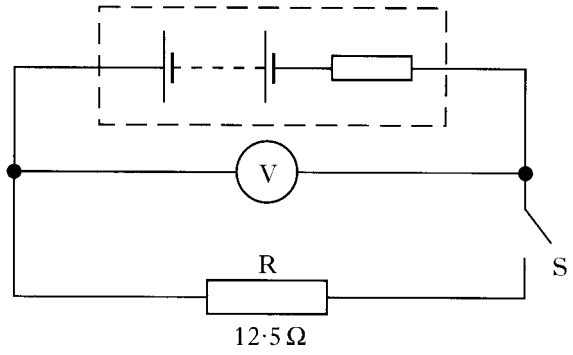
Although its e.m.f. remains unchanged, very little current may be drawn from the "flat" cell.

(i) What has happened to the value of the internal resistance of the cell?

(ii) The original experiment is to be repeated with the "flat" cell and a new graph drawn. In what way will the new graph differ from the graph shown above?

2001 Q5.

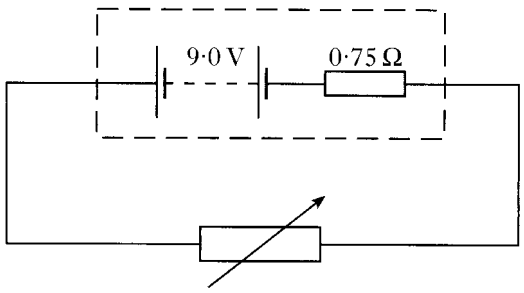
A student is determining the e.m.f. and the internal resistance of a battery and sets up the circuit shown below.



(a) State what is meant by the e.m.f. of a battery.

(b) With switch S open, the voltmeter reading is 3.90 V.
When the switch is closed, the voltmeter reading falls to 3.75 V.
Resistor R has a resistance of 12.5 Ω.
(i) State the value of the e.m.f. of the battery.
(ii) Calculate the internal resistance of the battery.

(c) The student now uses another battery and sets up the following circuit.



This battery has e.m.f. of 9.0 V and an internal resistance of 0.75 Ω.
The variable resistor is set to 12.5 Ω.
(i) Calculate the power dissipated **in the battery**.
(ii) The resistance of the variable resistor is now reduced.
What effect does this have on the power dissipated **in the battery**?
You must justify your answer.