# Higher EMF and Internal Resistance Questions

**1.** State the definition of the following terms:

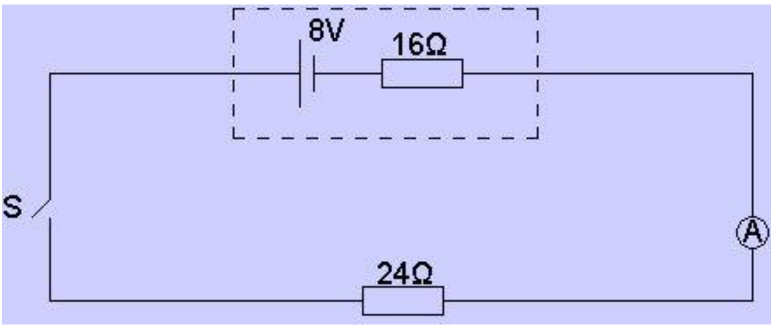
a) EMF.

b) Terminal Potential Difference.

c) Lost Volts.

d) List the **three forms** of the **equation** which links the quantities involved in a),b) and c).

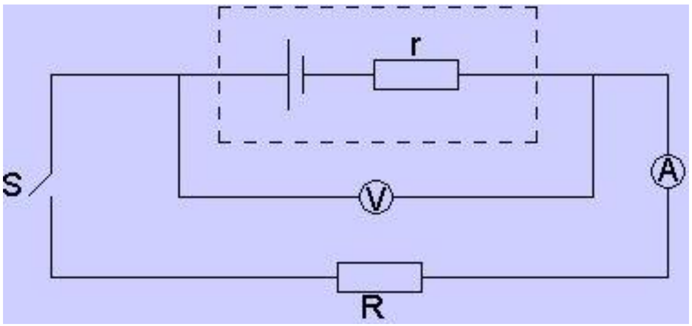
**2.**




Calculate or find:

a) **Reading on the ammeter** when the switch is closed.
b) **T**erminal **P**otential **D**ifference.
c) **L**ost **V**olts.
d) **What is noticeable** when the answers for **b) and c)** are **added up**?

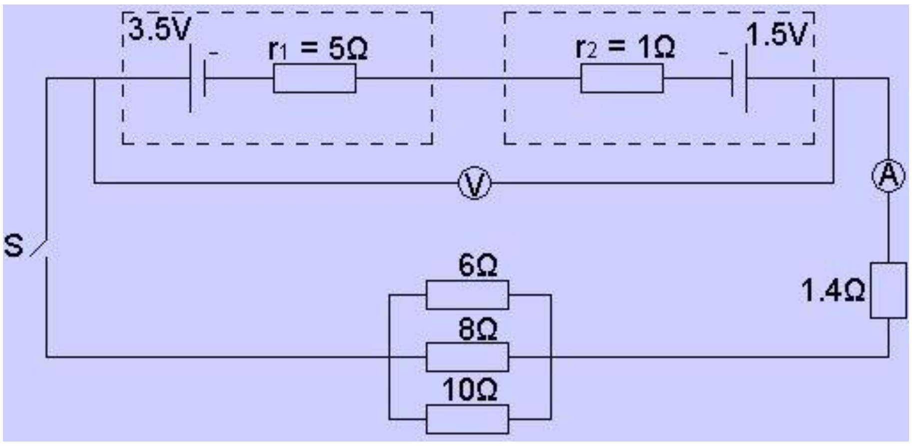
**3.**




| Switch conditions | Ammeter Reading (mA) | Voltmeter Reading (V) |
|---|---|---|
| Open | 0 | 9 |
| Closed | 250 | 7 |

a) Why does the reading on the **voltmeter drop** when the **switch is closed**?
b) Calculate the unknown **external load resistance R**.
c) Calculate the **internal resistance r**.

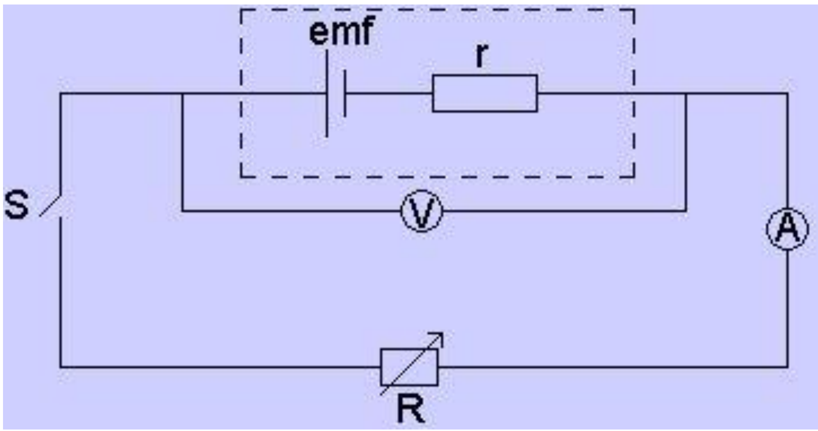
**4.**




When the switch **S is closed**, calculate or find:

a) **Total EMF** in the circuit.
b) **Total internal resistance** in the circuit.
c) **Total external load resistance** in the circuit.
d) **Reading** on the **ammeter**.

**5.**




In the circuit above, the switch is closed for a short time. The readings are then recorded from the **ammeter** and the **voltmeter** and shown **in the table below**.

| | | | | | |
|---|---|---|---|---|---|
| **Voltmeter Readings (V)** | 6.75 | 6.00 | 5.25 | 4.50 | 3.00 |
| **Ammeter Readings (mA)** | 30 | 60 | 90 | 120 | 180 |

a) **Draw a graph** on **graph paper** of **Voltmeter** Readings **against Ammeter** Readings.

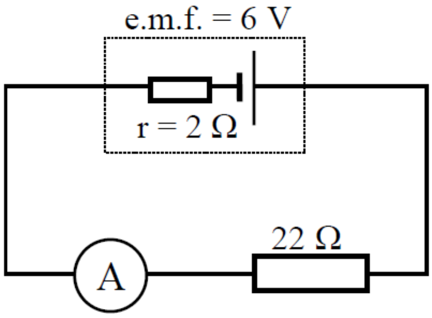
b) Find the following information from the graph:
i**)** **EMF** of the battery.
ii) **Internal Resistance** of the battery.

c) A switch is then placed in parallel with the variable resistor. When the switch is closed the battery will short circuit.

**Calculate the short-circuit current** from the battery.

**6.**

A 22 Ω resistor is connected in series with a cell of e.m.f. 6 V and with an internal resistance of 2 Ω.




(*a*) (i) Find the current flowing through the ammeter.

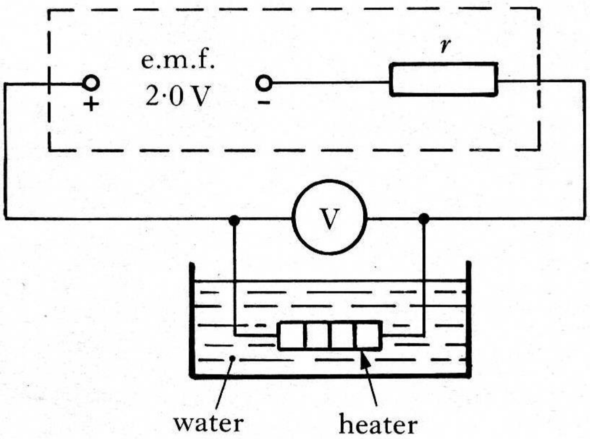
(ii) What will be the voltage across the terminals of the cell?

(iii) What is the value of the lost volts in the circuit?

(*b*) The 22 Ω resistor is replaced by a resistor with only 18 Ω resistance. State the effect this change will have on the value of the lost volts in the circuit. Explain your answer.

**7.**

A heater of resistance 0·32 ohms is connected to a power supply of e.m.f. 2·0 volts and internal resistance *r* as shown below.




(*a*) State what is meant by the term electromotive force (e.m.f.).

(*b*) The power output of the **heater** is 8·0 watts.

Calculate:

(i) the current in the heater;

(ii) the reading on the voltmeter;

(iii) the internal resistance of the power supply.

(*c*) Another identical heater is now placed in the water and connected in parallel with the original heater.

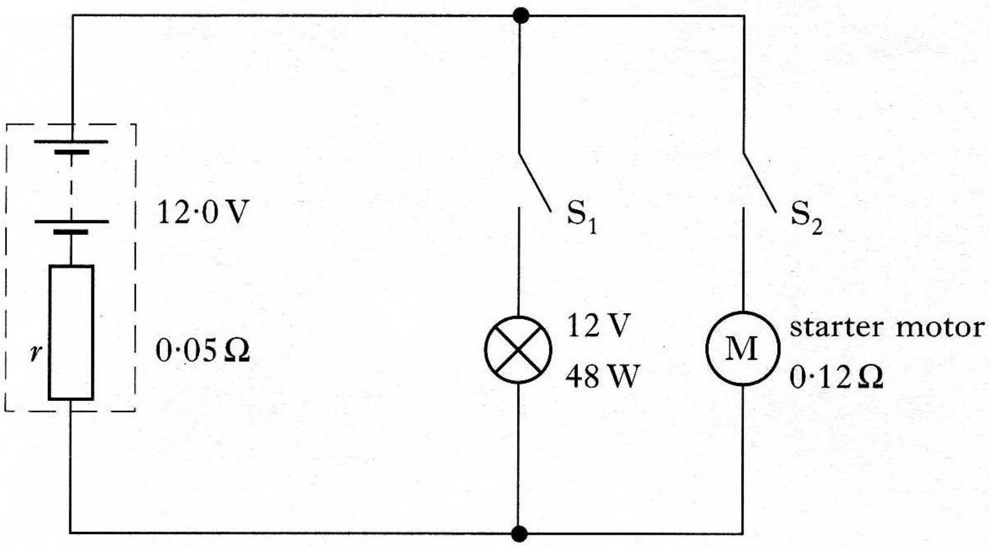
The rest of the circuit is unaltered.

How does this affect the rate at which heat is supplied to the water?

Justify your answer by calculation.

**8.**

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.

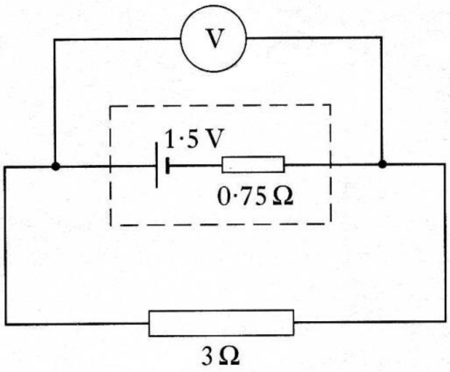
Assuming that the resistance of the headlamp does not change, calculate:

(i) the total resistance of the circuit;

(ii) the current from the battery.

**9.**

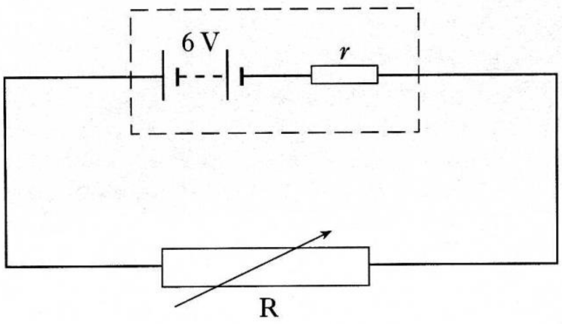
A cell of e.m.f. 1·5 V and internal resistance 0·75 Ω is connected as shown in the following circuit.



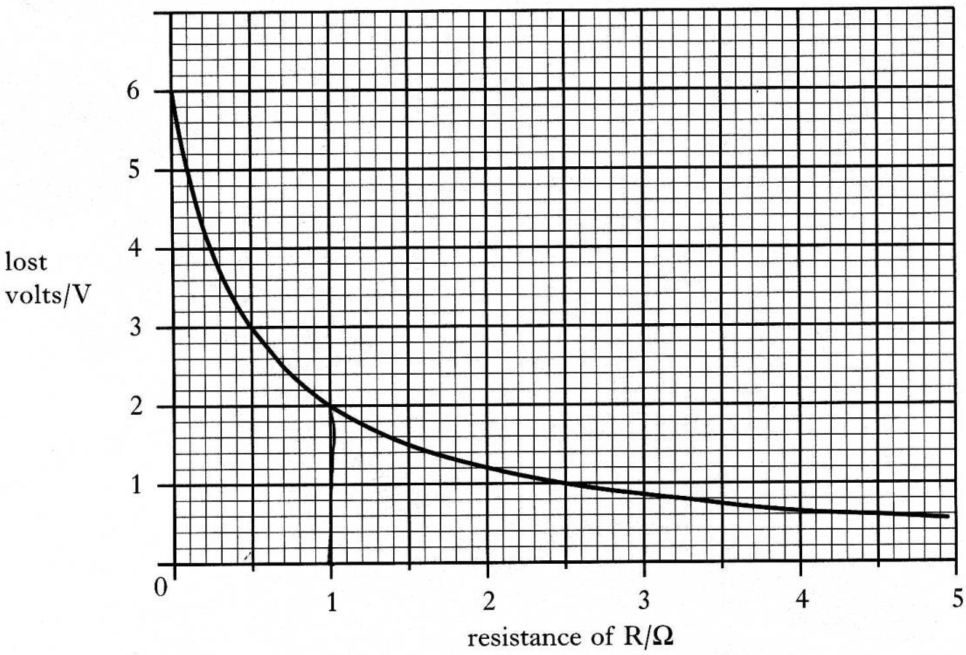

(i) Calculate the value of the reading on the voltmeter.

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

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.

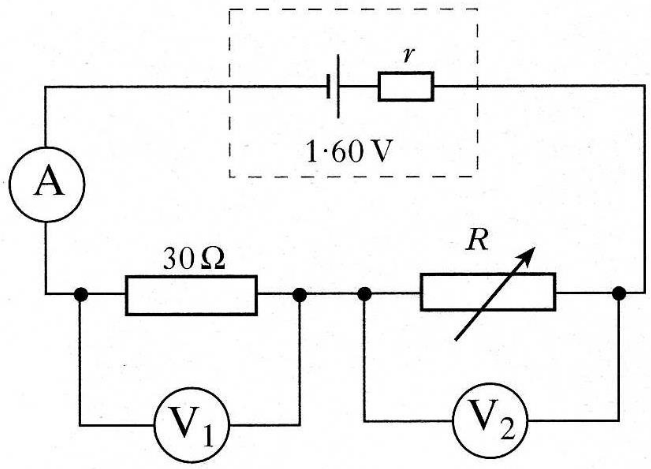



(i) Use information from the graph to calculate the p.d. across the terminals of the battery (t.p.d.) when the resistance of R is 1 Ω.

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

**10.**

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 $= 0{\cdot}04$ A
reading on the voltmeter $V_1 = 1{\cdot}20$ V
reading on the voltmeter $V_2 = 0{\cdot}30$ V

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

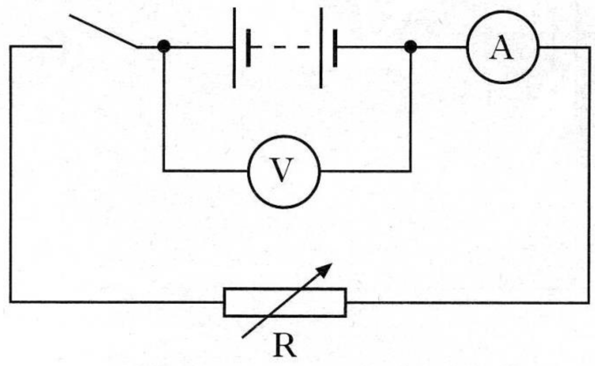
(*b*) Calculate the internal resistance, $r$, of the cell.

(*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?

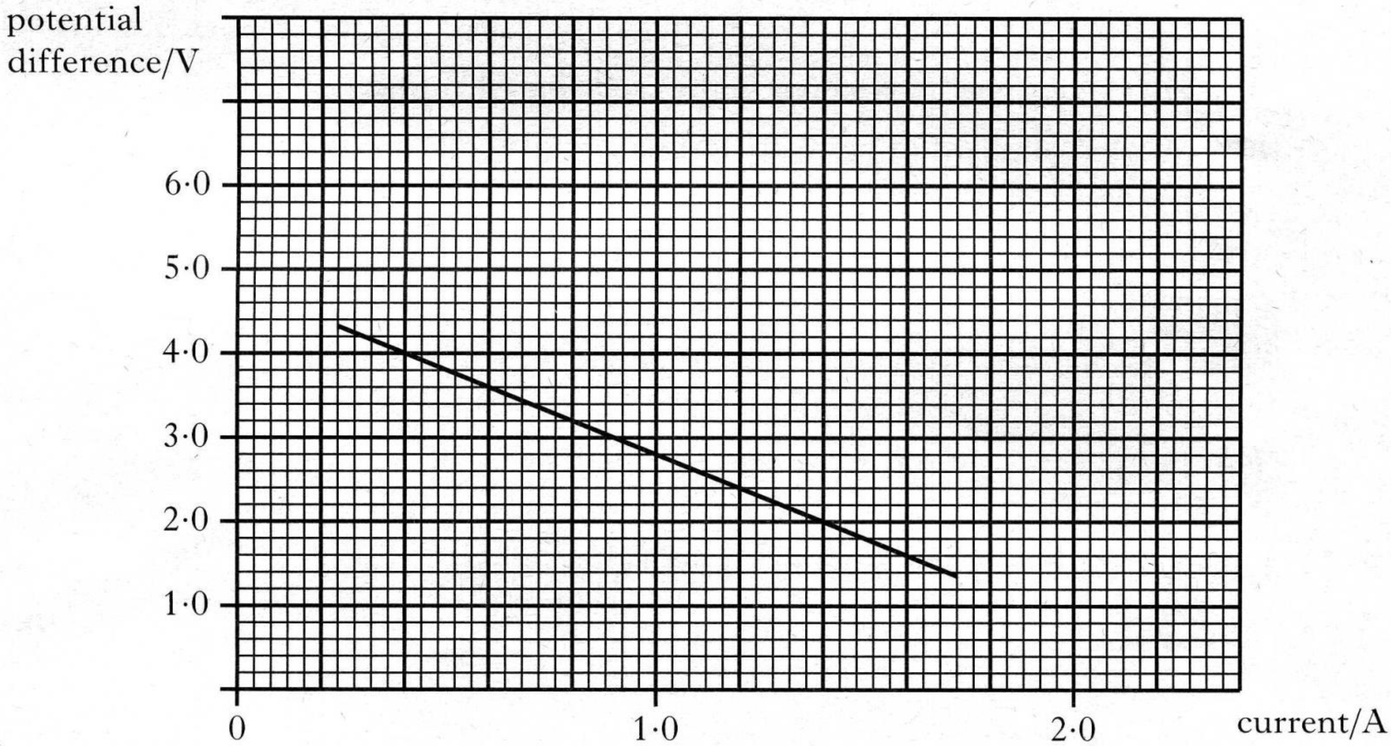
(ii) The resistance, $R$, of the variable resistor is now decreased. What effect has this on the terminal potential difference, $V_{tpd}$, of the cell? You must justify your answer.

**11.**

(*a*) The following circuit is used to measure the e.m.f. and the internal resistance of a battery.




Readings of current and potential difference from this circuit are used to produce the following graph.




Use information from the graph to find:

(i) the e.m.f. of the battery, in volts;

(ii) the internal resistance of the battery.

(*b*) A car battery has an e.m.f. of 12 V and an internal resistance of 0·050 Ω.

(i) Calculate the short circuit current for this battery.

(ii) The battery is now connected in series with a lamp. The resistance of the lamp is 2·5 Ω. Calculate the power dissipated in the lamp.

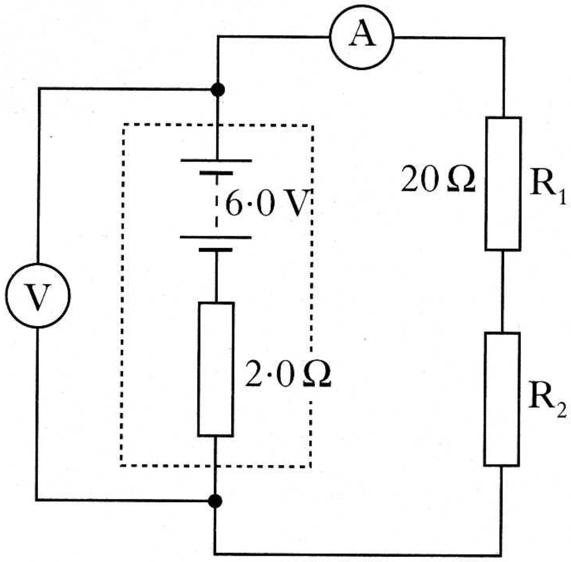
**12.**

A battery has an e.m.f. of 6·0 V and internal resistance of 2·0 Ω.

(*a*) What is meant by an *e.m.f. of 6·0 V*?

(*b*) The battery is connected in series with two resistors, $R_1$ and $R_2$. Resistor $R_1$ has a resistance of 20 Ω.

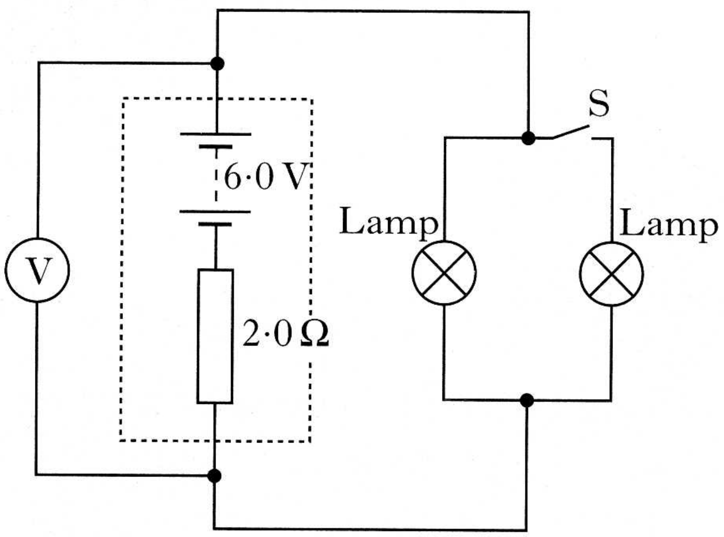
The reading on the ammeter is 200 mA.




(i) Show by calculation that $R_2$ has a resistance of 8·0 Ω.

(ii) Calculate the reading on the voltmeter.

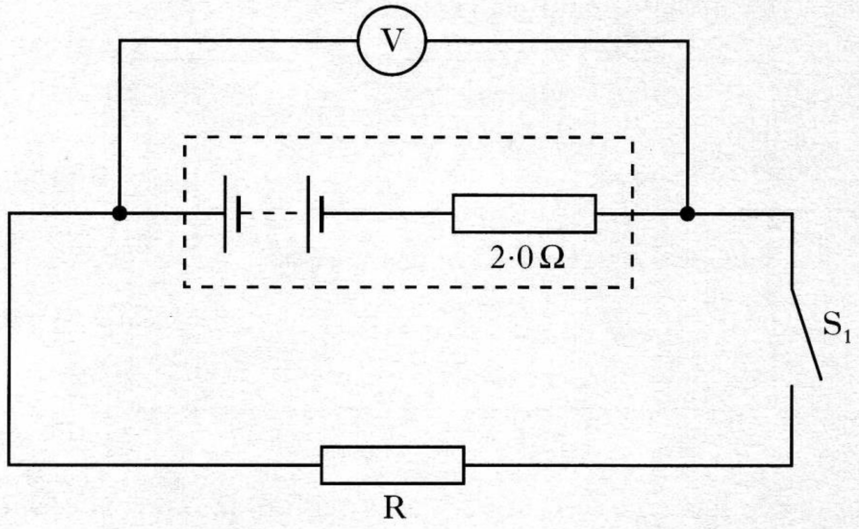
(*c*) The battery is now connected to two identical lamps as shown below.




Describe and explain what happens to the reading on the voltmeter when switch S is closed.

**13.**

A student sets up the circuit shown.




The internal resistance of the battery is 2·0 Ω.

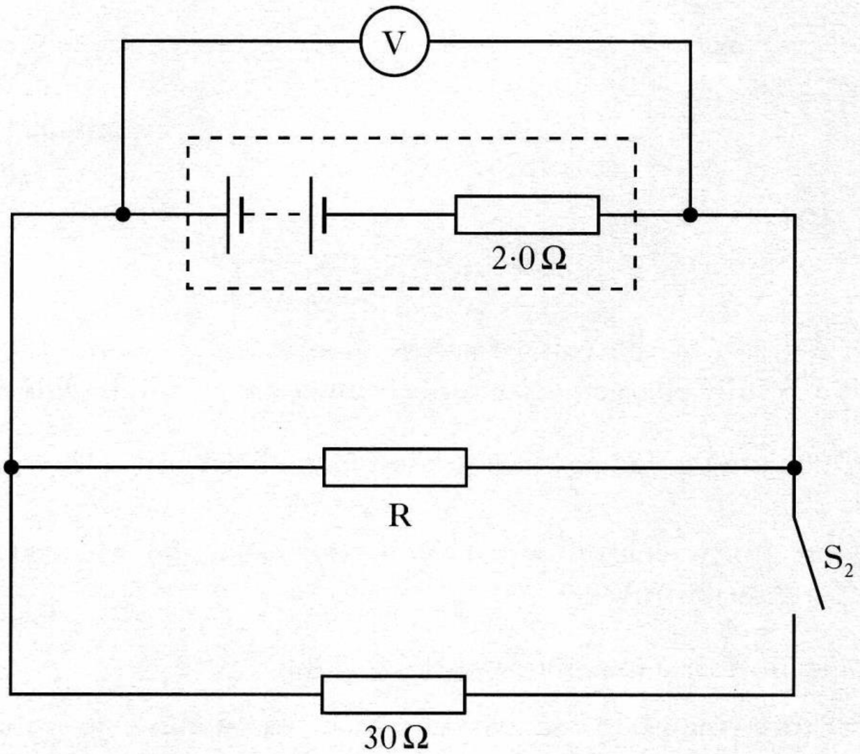
With $S_1$ open, the student notes that the reading on the voltmeter is 9·0 V.

The student closes $S_1$ and notes that the reading on the voltmeter is now 7·8 V.

(*a*) (i) Calculate the resistance of resistor R.

(ii) Explain why the reading on the voltmeter decreases when $S_1$ is closed.

(*b*) The student adds a 30 Ω resistor and a switch $S_2$ to the circuit as shown.




The student now closes $S_2$.

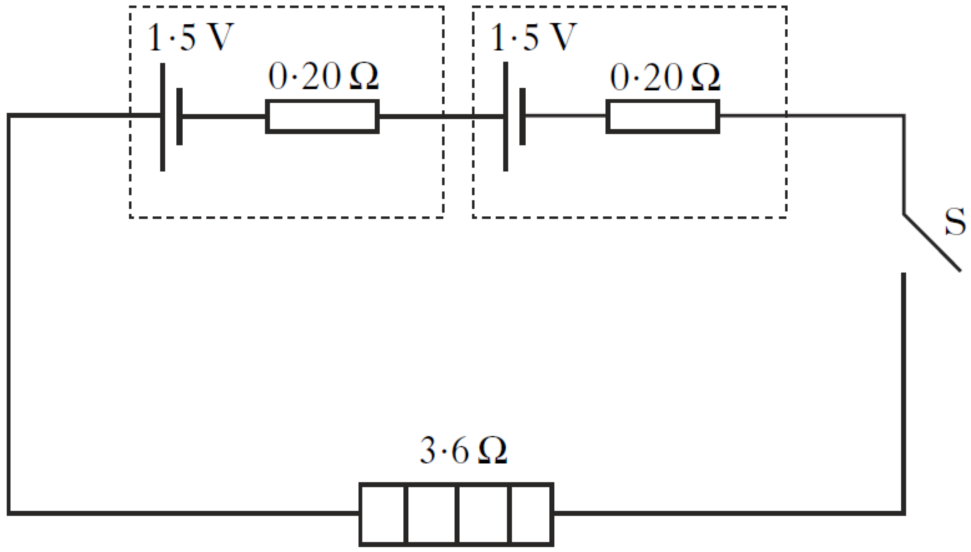
Explain what happens to the reading on the voltmeter.

**14.**

Electrically heated gloves are used by skiers and climbers to provide extra warmth.

(*a*) Each glove has a heating element of resistance 3·6 Ω.

Two cells, each of e.m.f. 1·5 V and internal resistance 0·20 Ω, are used to operate the heating element.




Switch S is closed.

(i) Determine the value of the total circuit resistance.

(ii) Calculate the current in the heating element.

(iii) Calculate the power output of the heating element.

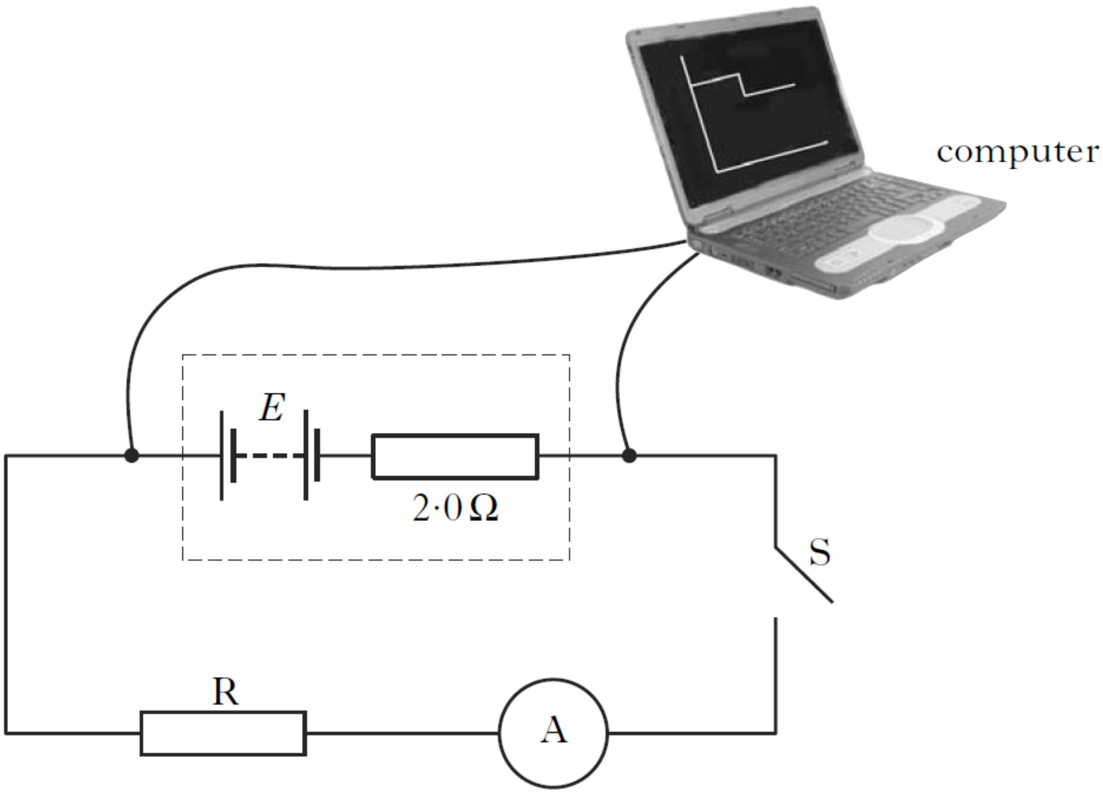
(*b*) When in use, the internal resistance of each cell gradually increases.

What effect, if any, does this have on the power output of the heating element?

Justify your answer.

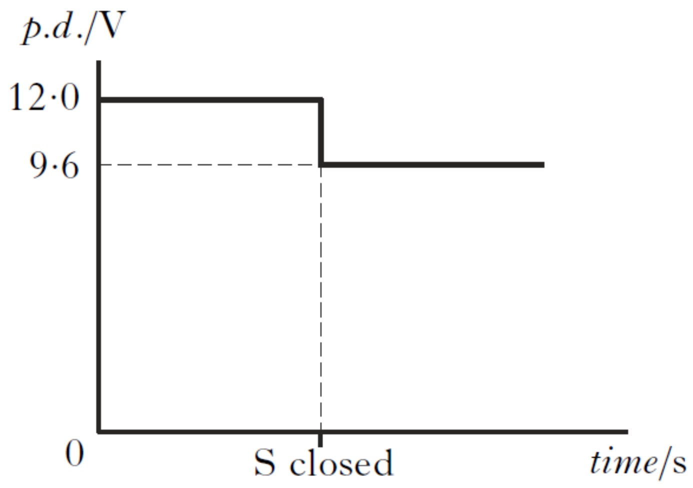
**15.**

A power supply of e.m.f. $E$ and internal resistance $2{\cdot}0\,\Omega$ is connected as shown.




The computer connected to the apparatus displays a graph of potential difference against time.

The graph shows the potential difference across the terminals of the power supply for a short time before and after switch S is closed.



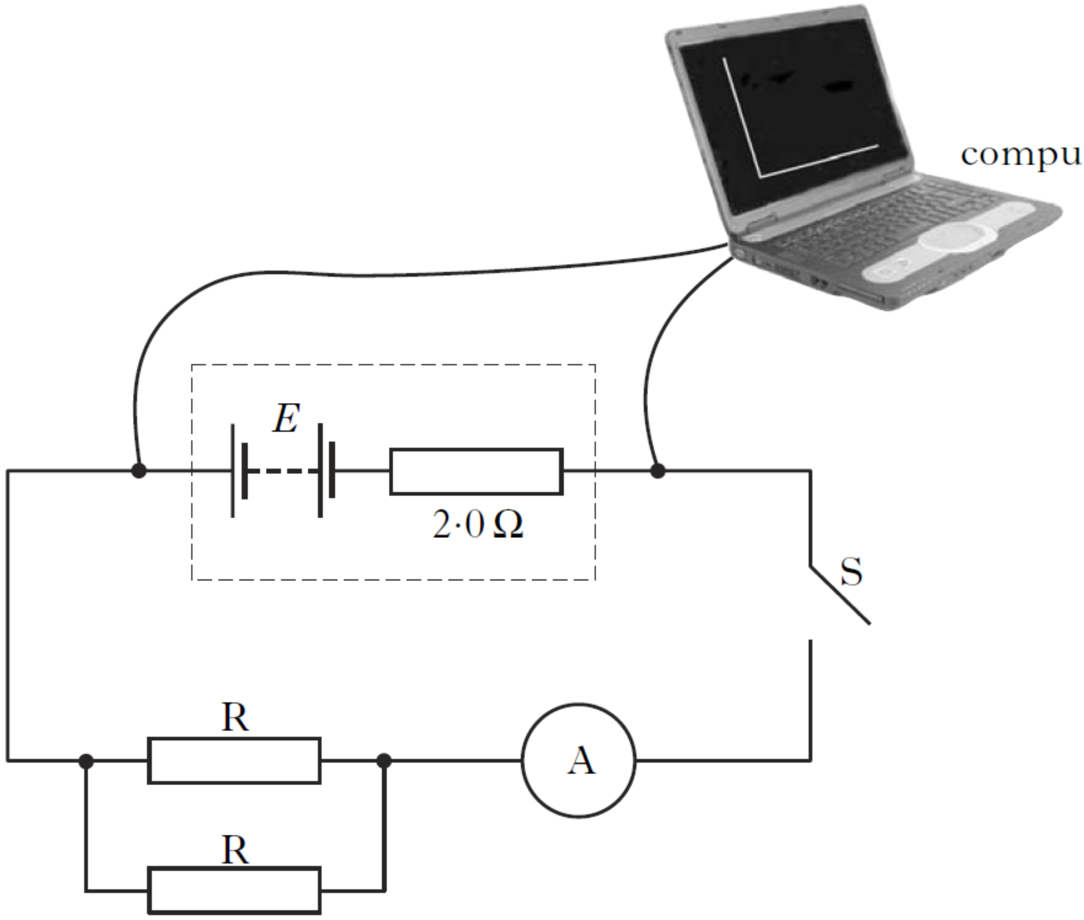

(*a*) State the e.m.f. of the power supply.

(*b*) Calculate:

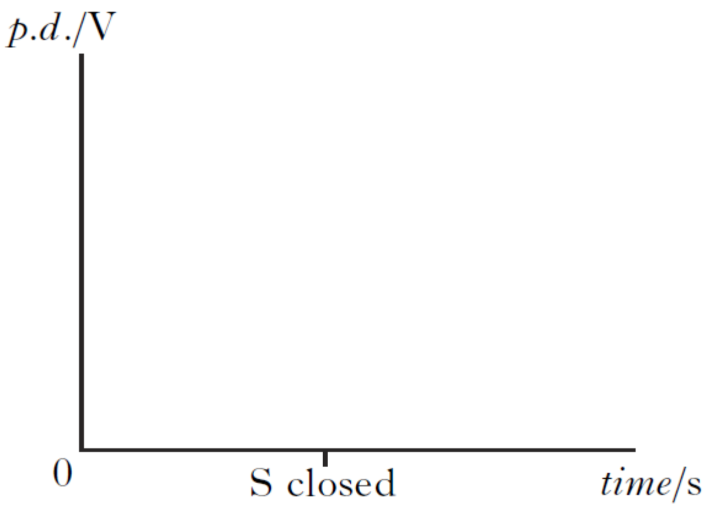
(i) the reading on the ammeter after switch S is closed;

(ii) the resistance of resistor R.

(*c*) Switch S is opened. A second identical resistor is now connected in parallel with R as shown.




The computer is again connected in order to display a graph of potential difference against time.




Copy and complete the new graph of potential difference against time showing the values of potential difference before and after switch S is closed.