SA-STUDENT

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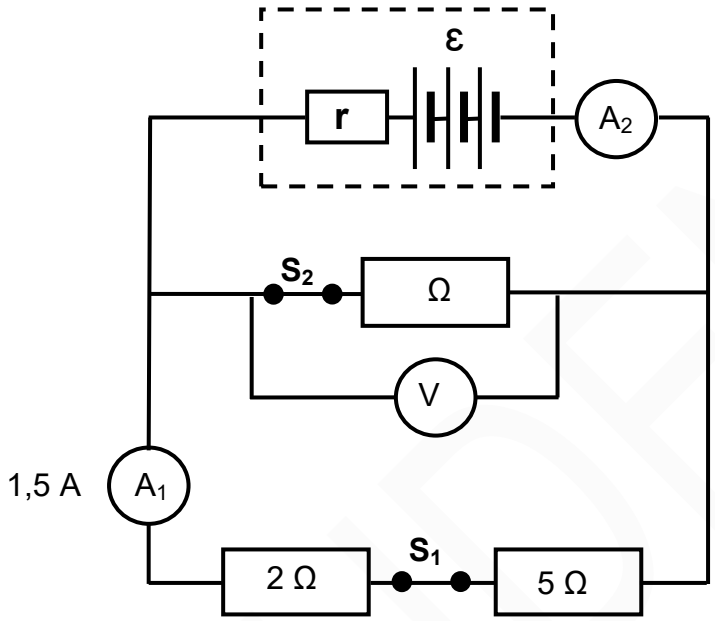
QUESTION 8 (Start on a new page.)

A battery with unknown emf (**ε**) and unknown internal resistance (**r**) is connected to three resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



8.1 State Ohm's law in words. (2)

Both switch S_1 and switch S_2 are CLOSED. The reading on ammeter A_1 is 1,5 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Reading on ammeter A_2 (4)

8.2.3 Power dissipated in the 3 Ω resistor (3)

Switch S_1 is now OPENED, while switch S_2 remains CLOSED. The reading on ammeter A_2 is now 3,64 A.

8.3 Calculate the emf of the battery. (5)

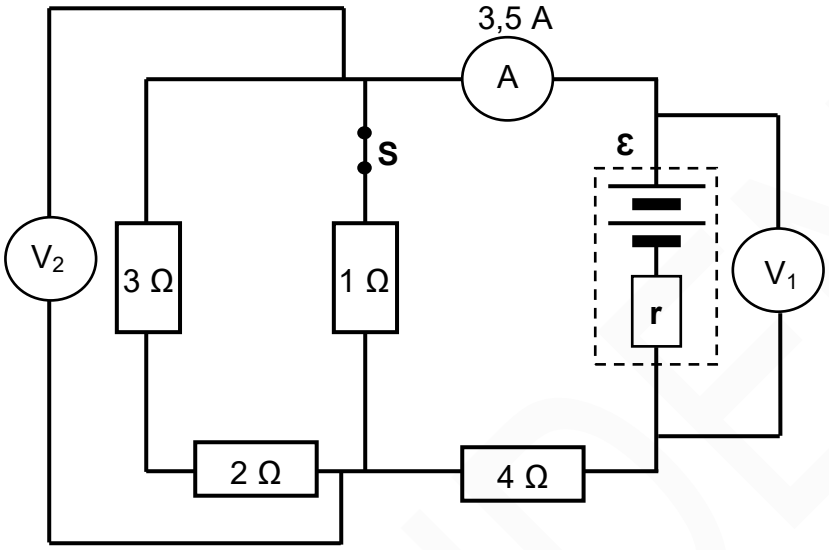
Switch S_2 is now OPENED, while switch S_1 is CLOSED.

8.4 How does the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer. (4)
[21]

QUESTION 8 (Start on a new page.)

The circuit diagram below shows four resistors connected to a battery of emf **ε** and internal resistance **r**. The resistances of the ammeter and the connecting wires are negligible, while the voltmeters have very high resistances.



8.1 State Ohm's law in words. (2)

Switch **S** is CLOSED.

8.2 The reading on the ammeter is 3,5 A.

8.2.1 Calculate the total external resistance of the circuit. (4)

8.2.2 Calculate the reading on voltmeter V_1. (3)

8.2.3 How does the reading on voltmeter V_2 compare to the reading on voltmeter V_1? Choose from SMALLER THAN, EQUAL TO or GREATER THAN. (1)

8.3 A learner concludes that the emf of the battery is equal to the reading on voltmeter V_1.

8.3.1 Define the term *emf*. (2)

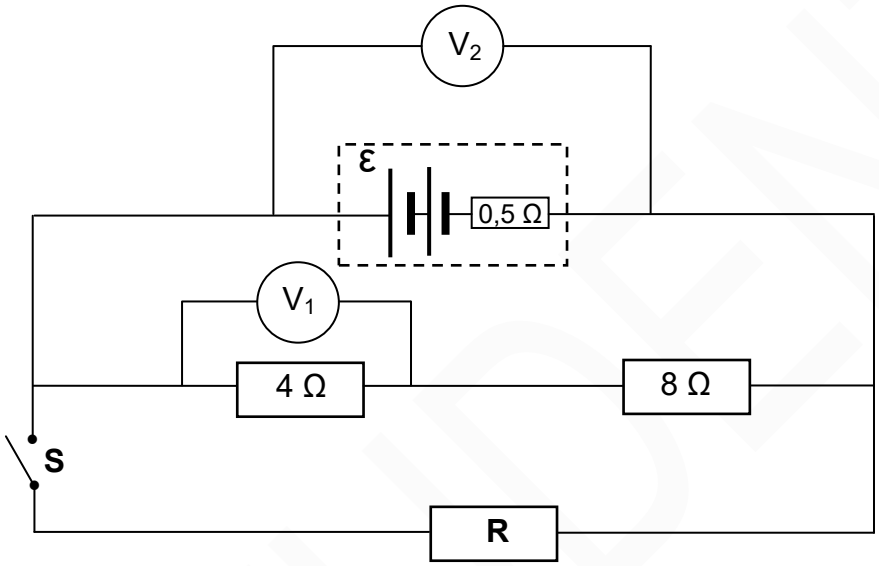
8.3.2 Is the learner's conclusion CORRECT? Choose from YES or NO. (1)

8.3.3 Give a reason for the answer to QUESTION 8.3.2. (1)

QUESTION 8 (Start on a new page.)

In the circuit below a battery of UNKNOWN emf and an internal resistance of 0,5 Ω is connected to two resistors of 4 Ω and 8 Ω each, and a resistor **R** of unknown resistance.

Ignore the resistance of the connecting wires.



8.1 The three external resistors are ohmic conductors.

Explain the meaning of the term *ohmic conductor*. (2)

8.2 When switch **S** is OPEN, voltmeter V_1 reads 3,2 V.

Calculate the:

8.2.1 Current through the battery (3)

8.2.2 Emf of the battery (4)

8.3 When switch **S** is CLOSED, voltmeter V_2 reads 8,8 V.

8.3.1 Calculate the resistance of resistor **R**. (5)

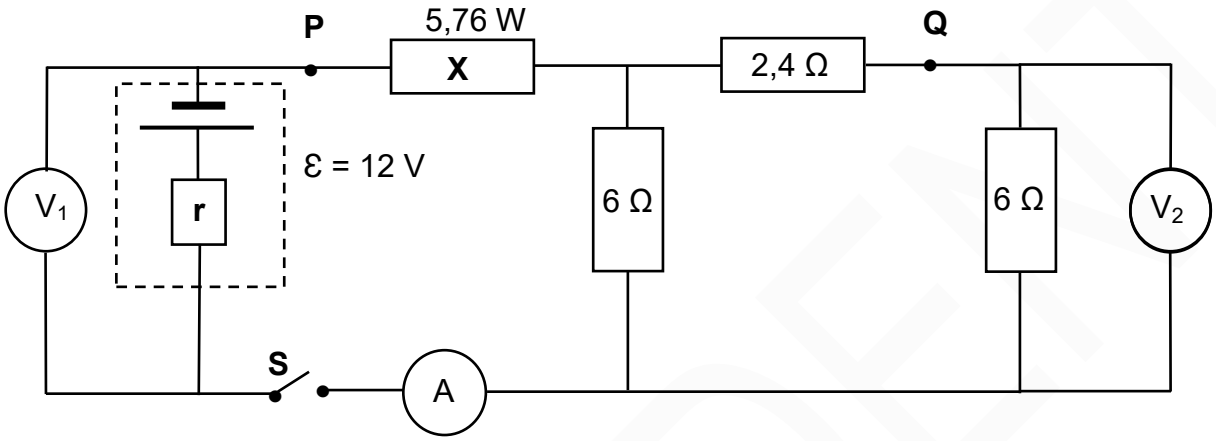
8.3.2 The battery becomes heated when voltmeter V_2 is replaced by a connecting wire. Explain this observation. (3)

[17]

QUESTION 8 (Start on a new page.)

The battery in the circuit shown below has an emf of 12 V and an unknown internal resistance **r**.

The resistance of the connecting wires and the ammeter is negligible.



Switch **S** is OPEN.

8.1 Write down the reading on:

8.1.1 Voltmeter V_1 (1)

8.1.2 Voltmeter V_2 (1)

Switch **S** is now CLOSED.

The reading on the ammeter is 1,2 A and the power dissipated in resistor **X** is 5,76 W.

8.2 Define the term *power.* (2)

Calculate the:

8.3 Resistance of resistor **X** (3)

8.4 Total EXTERNAL resistance of the circuit (3)

8.5 Reading on voltmeter V_2 (5)

A length of wire of negligible resistance is used to connect point **P** to point **Q** in the circuit.

8.6 How will the reading on voltmeter V_1 be affected?

Choose from INCREASES, DECREASES or NO EFFECT.

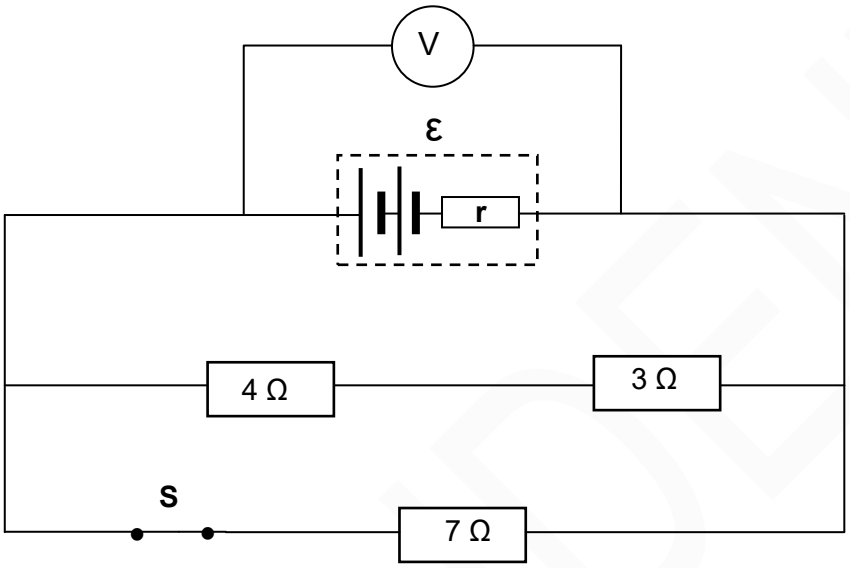
Explain the answer. (4)

[19]

QUESTION 8 (Start on a new page.)

Three resistors are connected to a battery with an unknown emf and unknown internal resistance **r**, as shown below.

Ignore the resistance of the connecting wires.



8.1 In the definition of the emf of a battery given below, (a) and (b) represent missing words or phrases.

The emf of the battery is the maximum (a) … *supplied by a battery per* (b) …. *passing through it.*

Write down (a) and (b) in your ANSWER BOOK and next to each the missing word or phrase. (2)

With switch **S** CLOSED, the voltmeter reads 2,63 V.

8.2 Calculate the equivalent external resistance of the circuit. (4)

Switch **S** is now OPENED and the voltmeter reads 2,8 V.

8.3 Calculate:

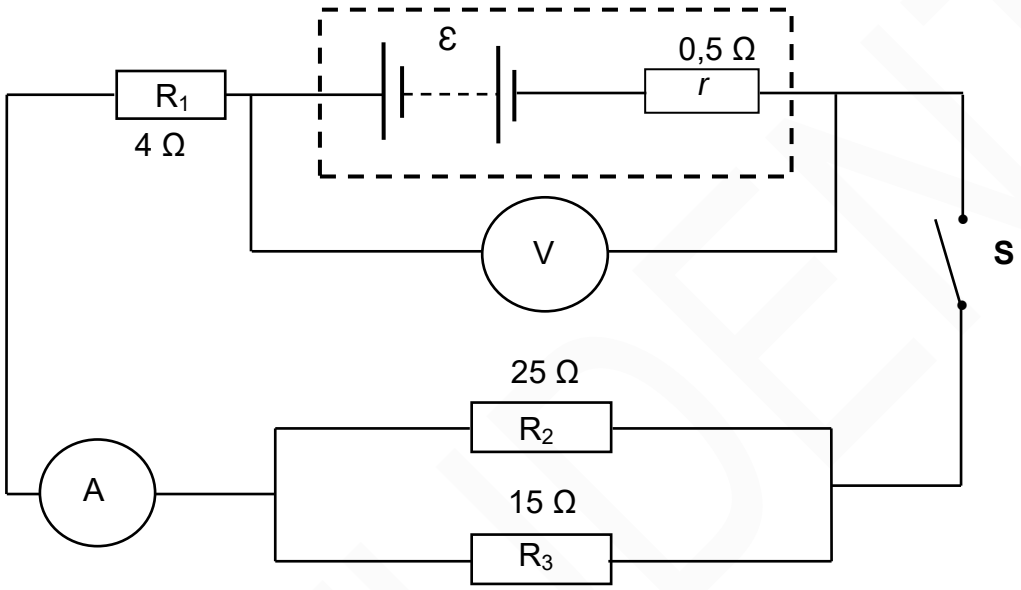
8.3.1 The internal resistance of the battery (8)

8.3.2 The emf of the battery (2)
[16]

QUESTION 8 (Start on a new page.)

A battery with an internal resistance of 0,5 Ω and an unknown emf (ε) is connected to three resistors, a high resistance voltmeter and an ammeter of negligible resistance, as shown in the circuit diagram below.

The resistance of the connecting wires must be ignored.



8.1 Define the term *emf* of a battery. (2)

The reading on the voltmeter DECREASES by 1,5 V when switch **S** is closed.

8.2 Give a reason why the voltmeter reading decreases. (2)

8.3 Calculate the following when switch **S** is closed:

8.3.1 Reading on the ammeter (3)

8.3.2 Total external resistance of the circuit (4)

8.3.3 Emf of the battery (3)

8.4 A learner makes the following statement:

The current through resistor R_3 is larger than the current through resistor R_2.

Is this statement CORRECT? Choose from YES or NO. Explain the answer. (3)

8.5 The 4 Ω resistor is now removed from the circuit.

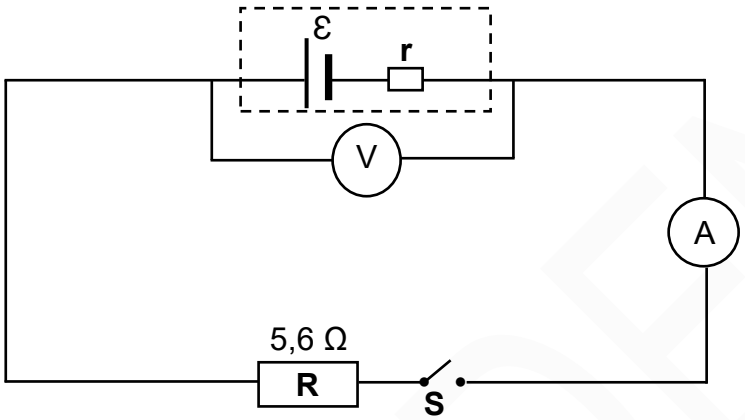
How will this affect the emf of the battery? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[18]

QUESTION 8 (Start on a new page.)

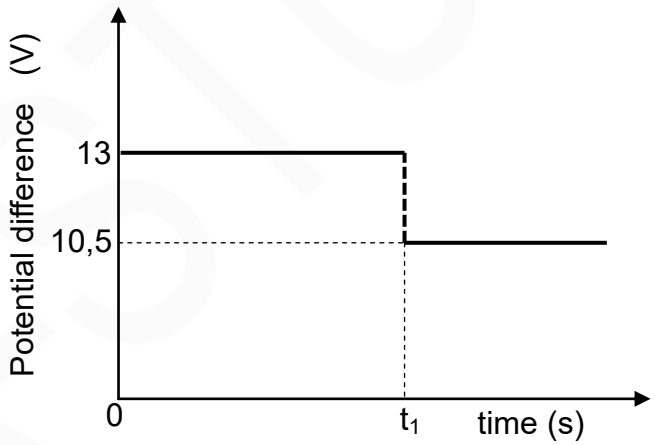
In the circuit diagram below, resistor **R**, with a resistance of 5,6 Ω, is connected, together with a switch, an ammeter and a high-resistance voltmeter, to a battery with an unknown internal resistance, **r**.

The resistance of the connecting wires and the ammeter may be ignored.



The graph below shows the potential difference across the terminals of the battery as a function of time.

At time t_1, switch **S** is closed.



8.1 Define the term *emf* of a battery. (2)

8.2 Write down the value of the emf of the battery. (1)

8.3 When switch **S** is CLOSED, calculate the:

8.3.1 Current through resistor **R** (3)

8.3.2 Power dissipated in resistor **R** (3)

8.3.3 Internal resistance, **r**, of the battery (3)

QUESTION 8 (Start on a new page.)

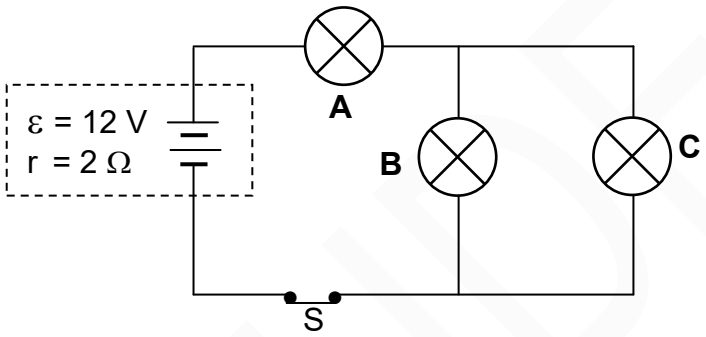
8.1 Three identical light bulbs, **A**, **B** and **C**, are each rated at 6 W, 12 V.

8.1.1 Define the term *power*. (2)

8.1.2 Calculate the resistance of EACH bulb when used as rated. (3)

The light bulbs are connected in a circuit with a battery having an emf (ε) of 12 V and internal resistance (r) of 2 Ω. Refer to the diagram below.

Assume that the resistance of each light bulb is the same as that calculated in QUESTION 8.1.2. Switch S is closed.

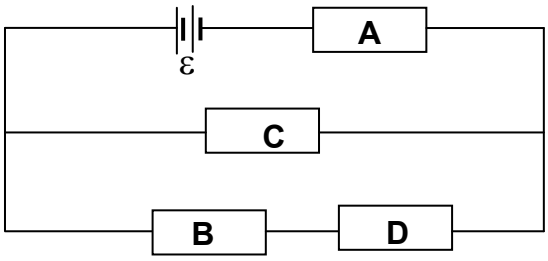


8.1.3 Calculate the total current in the circuit. (5)

8.1.4 Calculate the potential difference across light bulb **C**. (3)

8.1.5 Explain why light bulb **C** in the circuit will NOT burn at its maximum brightness. (3)

8.2 Resistors **A**, **B**, **C** and **D** are connected to a battery having emf (ε) and negligible internal resistance, as shown in the diagram below.



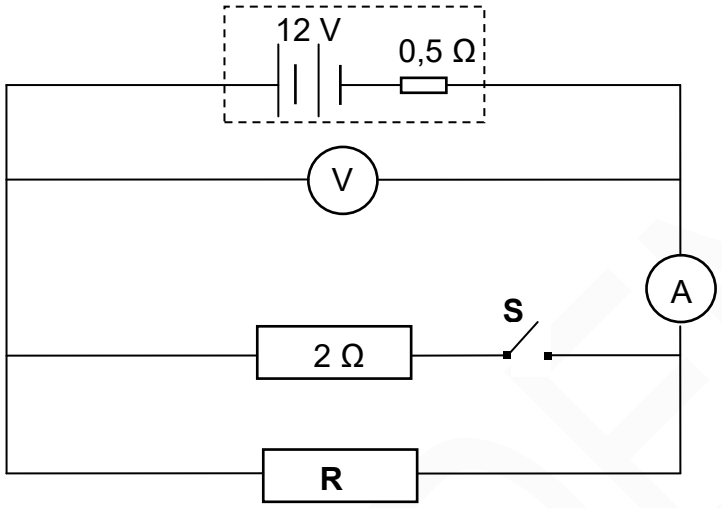
8.2.1 Give a reason why the current in resistor **A** is greater than that in resistor **C**. (2)

8.2.2 Resistor **C** is removed. How will the current in resistor **B** compare to the current in **A**? Give a reason for the answer. (2)

[20]

QUESTION 8 (Start on a new page.)

The battery in the circuit diagram below has an emf of 12 V and an internal resistance of 0,5 Ω. Resistor **R** has an unknown resistance.



8.1 What is the meaning of the following statement?

The emf of the battery is 12 V. (2)

The reading on the ammeter is 2 A when switch **S** is OPEN.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

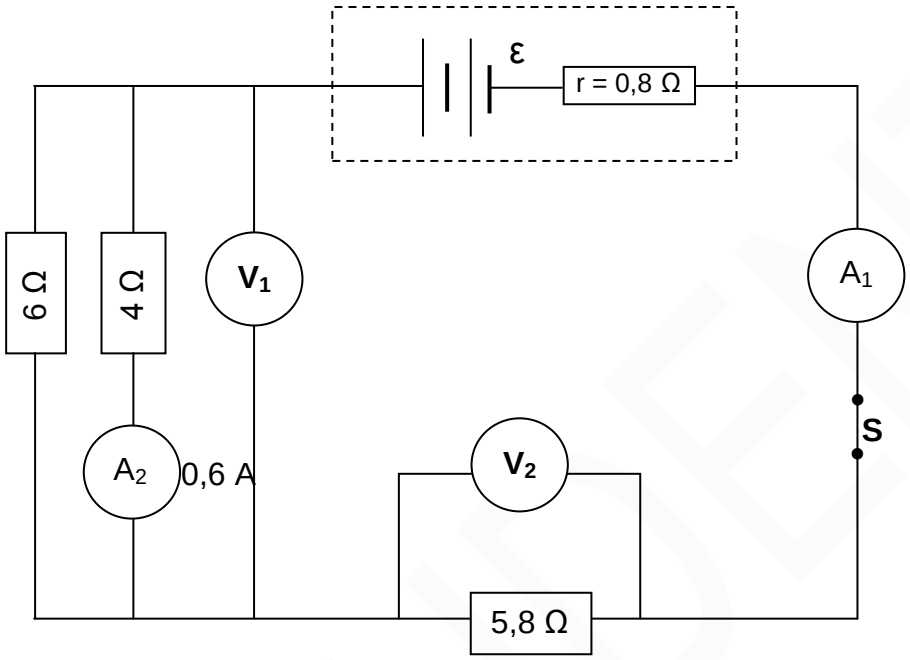
8.2.2 Resistance of resistor **R** (2)

Switch **S** is now CLOSED.

8.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (4)
[11]

QUESTION 9 (Start on a new page.)

9.1 In the circuit diagram below the battery has an unknown emf (ε) and an internal resistance (r) of 0,8 Ω.



9.1.1 State Ohm's law in words. (2)

The reading on ammeter A_2 is 0,6 A when switch **S** is closed.

Calculate the:

9.1.2 Reading on voltmeter $\mathbf{V_1}$ (3)

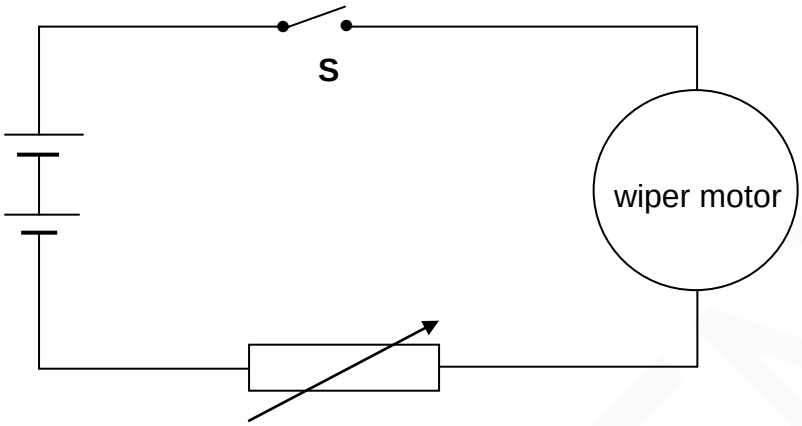
9.1.3 Current through the 6 Ω resistor (2)

9.1.4 Reading on voltmeter $\mathbf{V_2}$ (2)

9.1.5 Emf (ε) of the battery (3)

9.1.6 Energy dissipated as heat inside the battery if the current flows in the circuit for 15 s (3)

9.2 A simplified circuit diagram for the windscreen wiper of a car consists of a variable resistor and a wiper motor connected to a 12 volt battery.



When switch **S** is closed, the potential difference across the variable resistor is 2,8 V and the current passing through it is 0,7 A.

9.2.1 Calculate the resistance of the variable resistor. (2)

The resistance of the variable resistor is now decreased.

9.2.2 State whether the speed at which the wiper turns will INCREASE, DECREASE or REMAIN THE SAME.

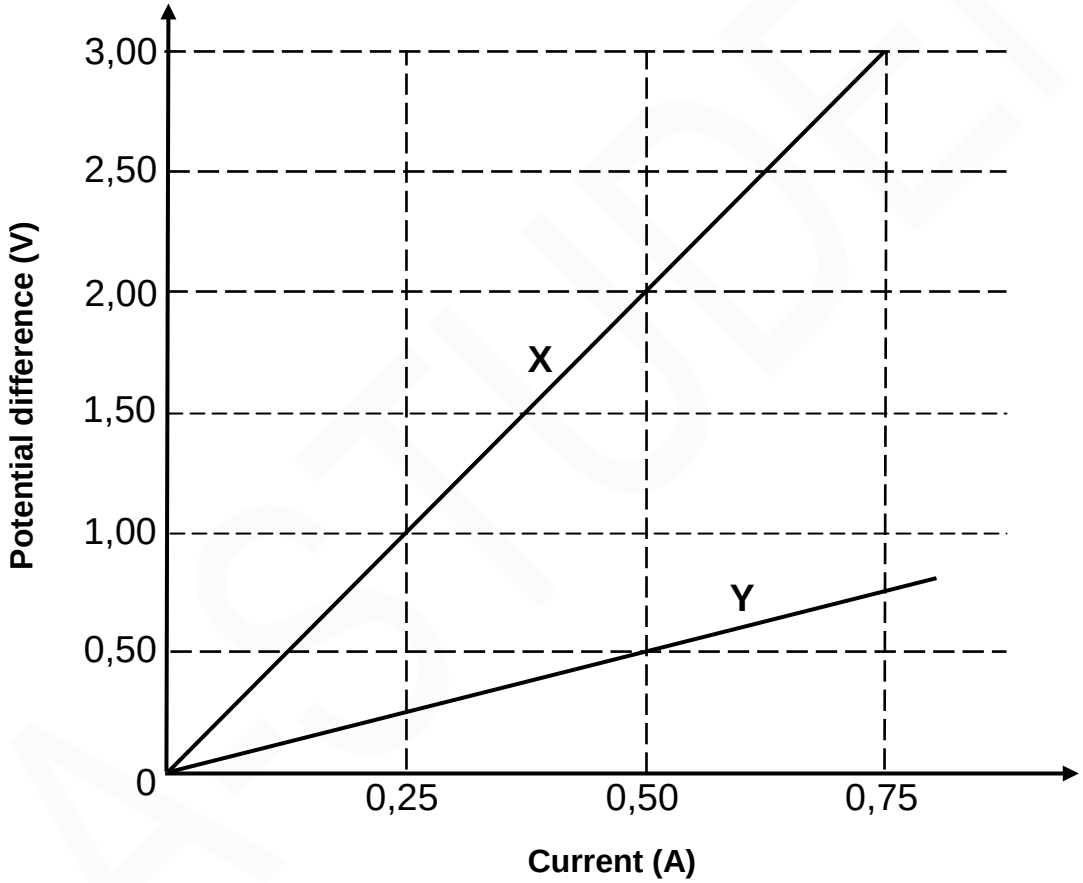
Give a reason for the answer. (3)
[20]

QUESTION 9 (Start on a new page.)

9.1 Learners investigated the relationship between potential difference (V) and current (I) for the combination of two resistors, $\mathbf{R_1}$ and $\mathbf{R_2}$. In one experiment, resistors $\mathbf{R_1}$ and $\mathbf{R_2}$ were connected in parallel. In a second experiment, resistors $\mathbf{R_1}$ and $\mathbf{R_2}$ were connected in series.

The learners then plotted graph **X**, the results of one of the experiments, and graph **Y**, the results of the other experiment, as shown below.

GRAPHS OF POTENTIAL DIFFERENCE VERSUS CURRENT FOR THE COMBINATION OF TWO RESISTORS IN SERIES AND IN PARALLEL



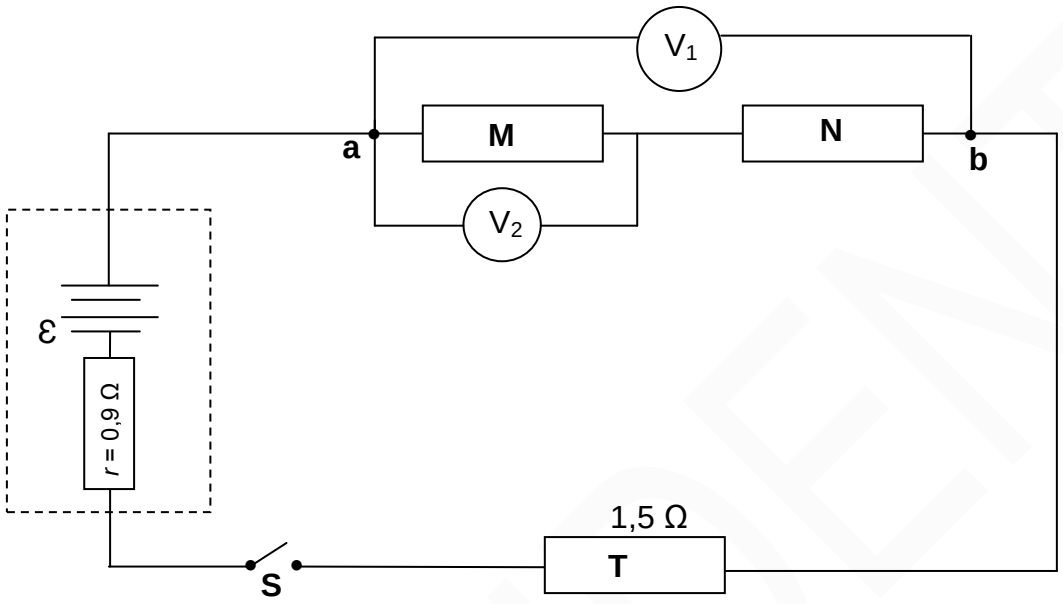
9.1.1 State Ohm's law in words. (2)

9.1.2 What physical quantity does the gradient (slope) of the V-I graph represent? (1)

9.1.3 Calculate the gradient (slope) of graph **X**. (2)

9.1.4 Determine the resistance of resistor $\mathbf{R_1}$. (4)

9.2 The circuit below consists of three resistors, **M**, **N** and **T**, a battery with emf Ɛ and an internal resistance of 0,9 Ω. The effective resistance between points **a** and **b** in the circuit is 6 Ω. The resistance of resistor **T** is 1,5 Ω.



When switch **S** is closed, a high-resistance voltmeter, V_1, across **a** and **b** reads 5 V.

Calculate the:

9.2.1 Current delivered by the battery (3)

9.2.2 Emf (Ɛ) of the battery (4)

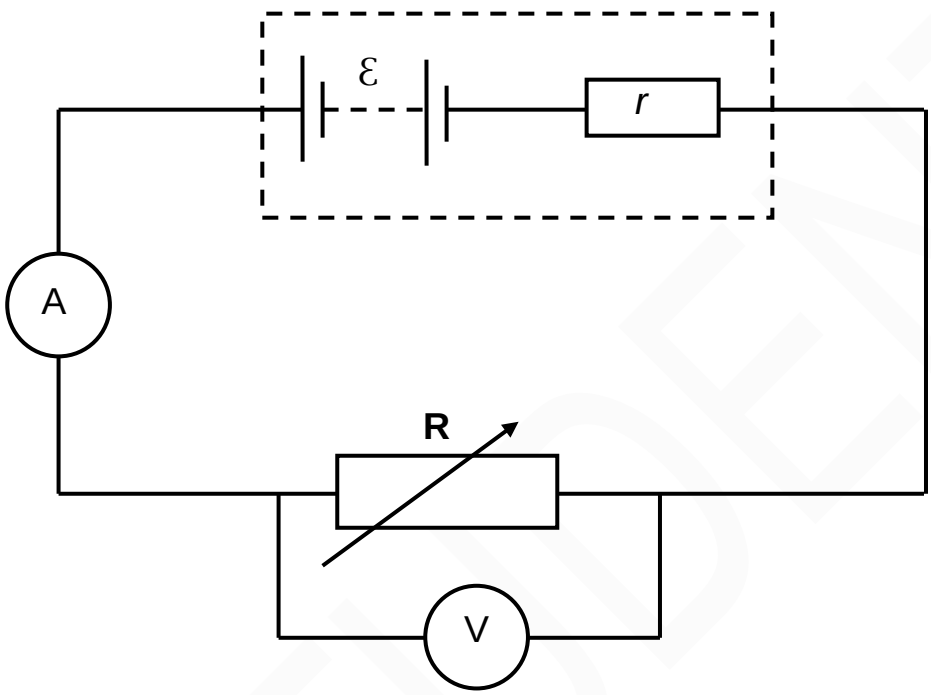
Voltmeter V_2 reads 2,5 V when the switch is closed.

9.2.3 Write down the resistance of **N**. (No calculations required.) Give a reason for the answer. (2)
[18]

QUESTION 9 (Start on a new page.)

9.1 The emf and internal resistance of a certain battery were determined experimentally.

The circuit used for the experiment is shown in the diagram below.



9.1.1 State Ohm's law in words. (2)

The data obtained from the experiment is plotted on the attached graph sheet.

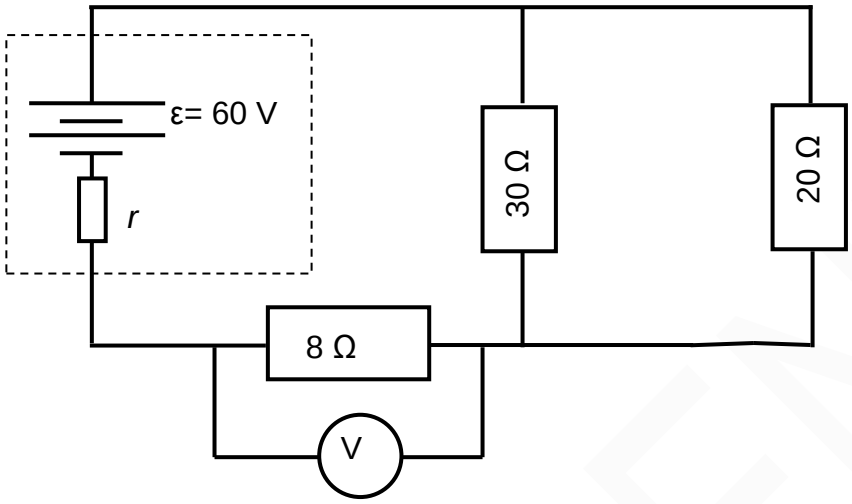
9.1.2 Draw the line of best fit through the plotted points. Ensure that the line cuts both axes. (2)

Use information in the graph to answer QUESTIONS 9.1.3 and 9.1.4.

9.1.3 Write down the value of the emf (ε) of the battery. (1)

9.1.4 Determine the internal resistance of the battery. (3)

9.2 The circuit diagram below shows a battery with an emf (ε) of 60 V and an unknown internal resistance *r,* connected to three resistors.



A voltmeter connected across the 8 Ω resistor reads 21,84 V.

Calculate the:

9.2.1 Current in the 8 Ω resistor (3)

9.2.2 Equivalent resistance of the resistors in parallel (2)

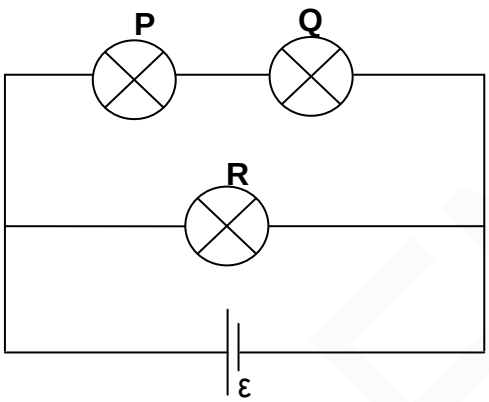
9.2.3 Internal resistance *r* of the battery (4)

9.2.4 Heat dissipated in the external circuit in 0,2 seconds (3)
[20]

QUESTION 8 (Start on a new page).

8.1 In Circuit 1 below three identical light bulbs, **P**, **Q** and **R**, with the same resistance, are connected to a battery with emf ε and negligible internal resistance.

Circuit 1



8.1.1 How does the brightness of bulb **P** compare with that of bulb **Q**?

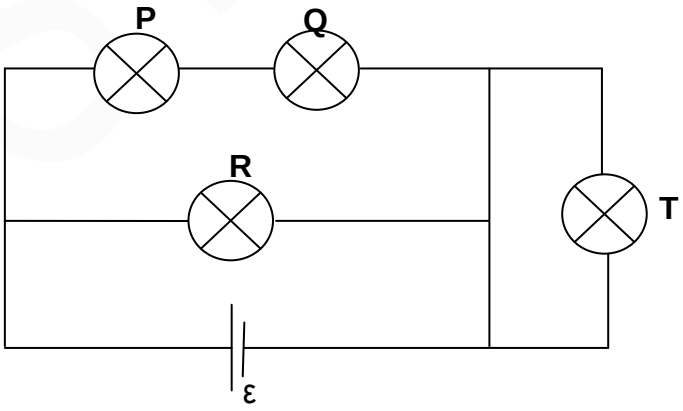
Give a reason for the answer. (2)

8.1.2 How does the brightness of bulb **P** compare with that of bulb **R**?

Give a reason for the answer. (2)

A fourth, identical bulb **T**, with the same resistance as the other three, is connected to the circuit by means of an ordinary wire of negligible resistance, as shown in Circuit 2 below.

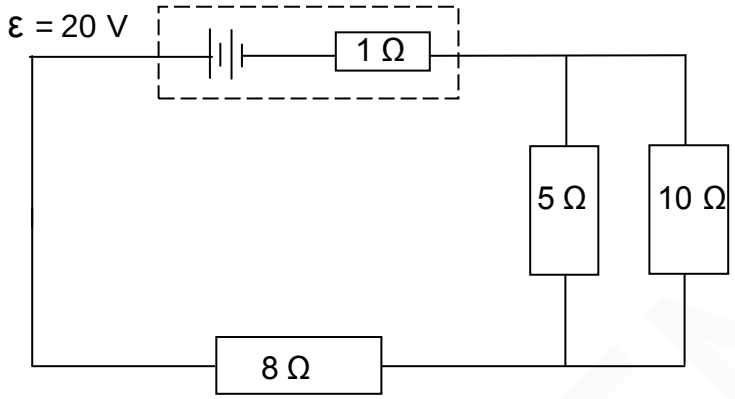
Circuit 2



8.1.3 How does the brightness of bulb **T** compare with that of bulb **R**?

Give a reason for the answer. (2)

8.2 A battery with an emf of 20 V and an internal resistance of 1 Ω is connected to three resistors, as shown in the circuit below.



Calculate the:

8.2.1 Current in the 8 Ω resistor (6)

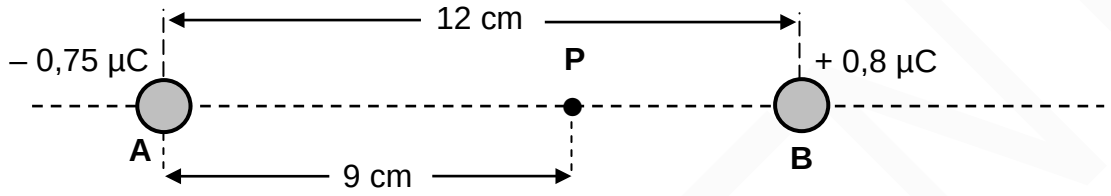
8.2.2 Potential difference across the 5 Ω resistor (4)

8.2.3 Total power supplied by the battery (3)
[19]

7.2 A charged sphere, **A**, carries a charge of – 0,75 µC.

7.2.1 Draw a diagram showing the electric field lines surrounding sphere **A**. (2)

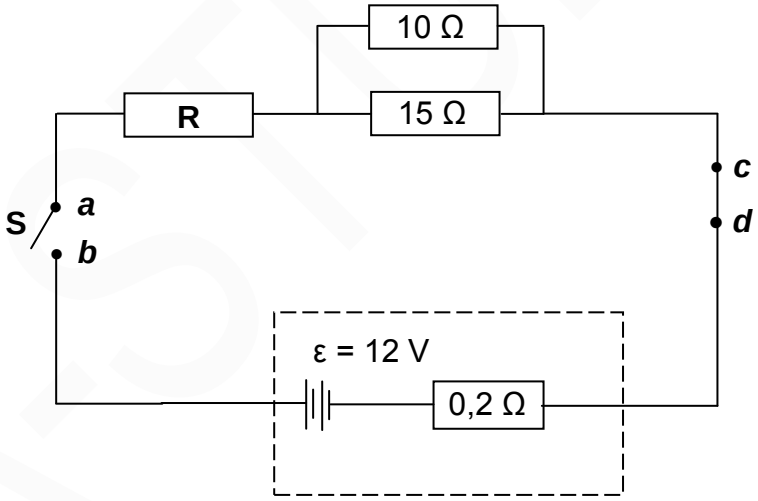
Sphere **A** is placed 12 cm away from another charged sphere, **B**, along a straight line in a vacuum, as shown below. Sphere **B** carries a charge of +0,8 µC. Point **P** is located 9 cm to the right of sphere **A**.



7.2.2 Calculate the magnitude of the net electric field at point **P**. (5)
[17]

QUESTION 8 (Start on a new page.)

8.1 In the circuit below the battery has an emf (ε) of 12 V and an internal resistance of 0,2 Ω. The resistances of the connecting wires are negligible.



8.1.1 Define the term *emf of a battery.* (2)

8.1.2 Switch **S** is open. A high-resistance voltmeter is connected across points ***a*** and ***b***.
What will the reading on the voltmeter be? (1)

8.1.3 Switch **S** is now closed. The same voltmeter is now connected across points ***c*** and ***d.***
What will the reading on the voltmeter be? (1)

When switch **S** is closed, the potential difference across the terminals of the battery is 11,7 V.

Calculate the:

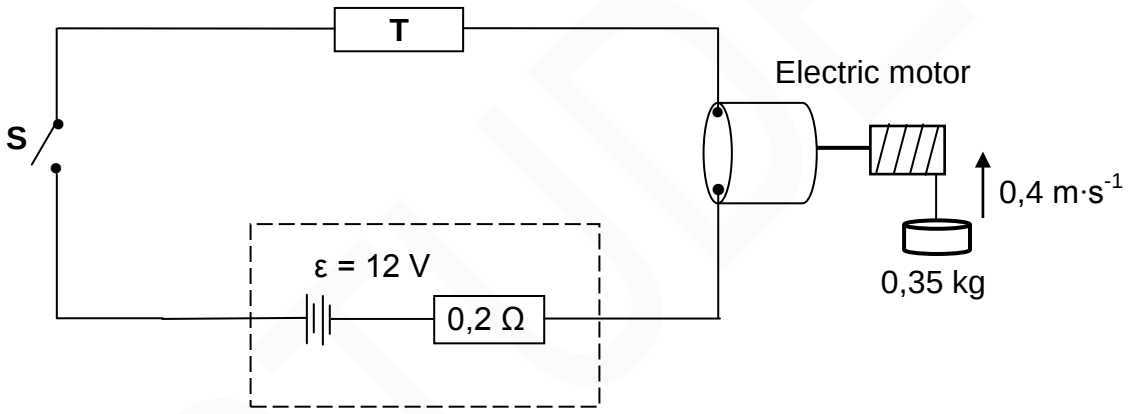
8.1.4 Current in the battery (3)

8.1.5 Effective resistance of the **parallel** branch (2)

8.1.6 Resistance of resistor **R** (4)

8.2 A battery with an emf of 12 V and an internal resistance of 0,2 Ω are connected in series to a very small electric motor and a resistor, **T**, of unknown resistance, as shown in the circuit below.

The motor is rated **X** watts, 3 volts, and operates at optimal conditions.



When switch **S** is closed, the motor lifts a 0,35 kg mass vertically upwards at a constant speed of 0,4 $m \cdot s^{-1}$. Assume that there is no energy conversion into heat and sound.

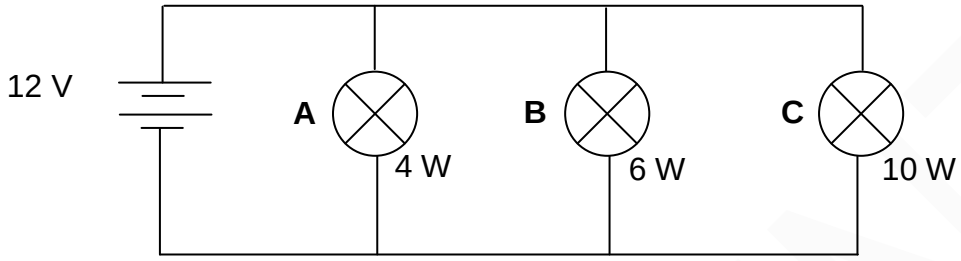
Calculate the value of:

8.2.1 **X** (3)

8.2.2 The resistance of resistor **T** (5)
[21]

QUESTION 9 (Start on a new page.)

9.1 In the diagram below, three light bulbs, **A**, **B** and **C**, are connected in parallel to a 12 V source of negligible internal resistance. The bulbs are rated at 4 W, 6 W and 10 W respectively and are all at their maximum brightness.



9.1.1 Calculate the resistance of the 4 W bulb. (3)

9.1.2 How will the equivalent resistance of the circuit change if the 6 W bulb burns out? Write down only INCREASES, DECREASES or NO CHANGE. (1)

9.1.3 How will the power dissipated by the 10 W bulb change if the 6 W bulb burns out? Write down only INCREASES, DECREASES or NO CHANGE. Give a reason for the answer. (2)

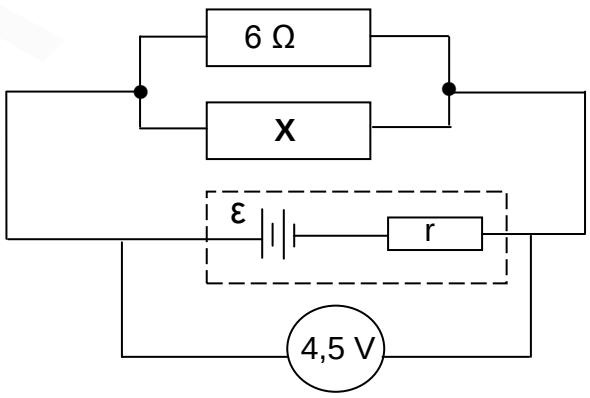
9.2 A learner connects a high-resistance voltmeter across a battery. The voltmeter reads 6 V.

She then connects a 6 Ω resistor across the battery. The voltmeter now reads 5 V.

9.2.1 Calculate the internal resistance of the battery. (4)

The learner now builds the circuit below, using the same 6 V battery and the 6 Ω resistor. She connects an unknown resistor **X** in parallel with the 6 Ω resistor. The voltmeter now reads 4,5 V.

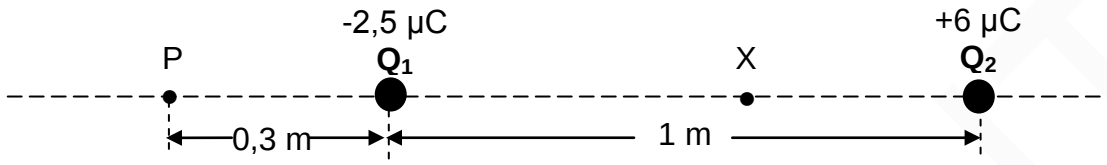
9.2.2 Define the term *emf* of a cell. (2)



9.2.3 Calculate the resistance of **X** when the voltmeter reads 4,5 V. (5)
[17]

QUESTION 8 (Start on a new page.)

A sphere $\mathbf{Q_1}$, with a charge of -2,5 µC, is placed 1 m away from a second sphere $\mathbf{Q_2}$, with a charge +6 µC. The spheres lie along a straight line, as shown in the diagram below. Point **P** is located a distance of 0,3 m to the left of sphere $\mathbf{Q_1}$, while point **X** is located between $\mathbf{Q_1}$ and $\mathbf{Q_2}$. The diagram is not drawn to scale.

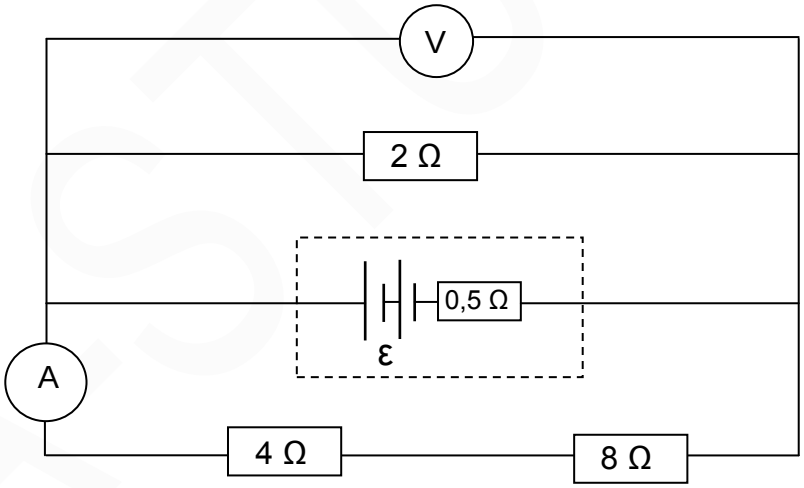


8.1 Show, with the aid of a VECTOR DIAGRAM, why the net electric field at point **X** *cannot be zero.* (4)

8.2 Calculate the net electric field at point **P**, due to the two charged spheres $\mathbf{Q_1}$ and $\mathbf{Q_2}$. (6)
[10]

QUESTION 9 (Start on a new page.)

A battery of an unknown emf and an internal resistance of 0,5 Ω is connected to three resistors, a high-resistance voltmeter and an ammeter of negligible resistance, as shown below.



The reading on the ammeter is 0,2 A.

9.1 Calculate the:

9.1.1 Reading on the voltmeter (3)

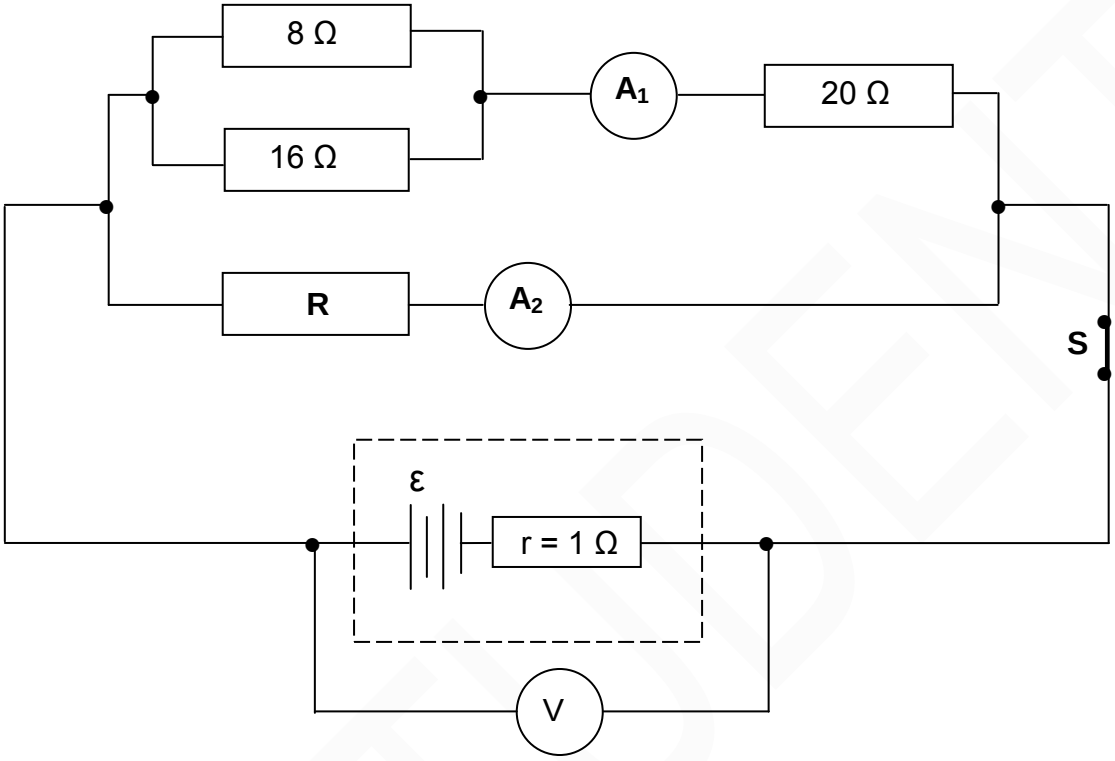
9.1.2 Total current supplied by the battery (4)

9.1.3 Emf of the battery (5)

9.2 How would the voltmeter reading change if the 2 Ω resistor is removed from the circuit? Write down INCREASE, DECREASE or REMAIN THE SAME. Explain the answer. (3)
[15]

QUESTION 9 (Start on a new page.)

A battery with an internal resistance of 1 Ω and an unknown emf (ε) is connected in a circuit, as shown below. A high-resistance voltmeter (V) is connected across the battery. **A_1** and **A_2** represent ammeters of negligible resistance.



With switch **S** closed, the current passing through the 8 Ω resistor is 0,5 A.

9.1 State Ohm's law in words. (2)

9.2 Calculate the reading on ammeter **A_1**. (4)

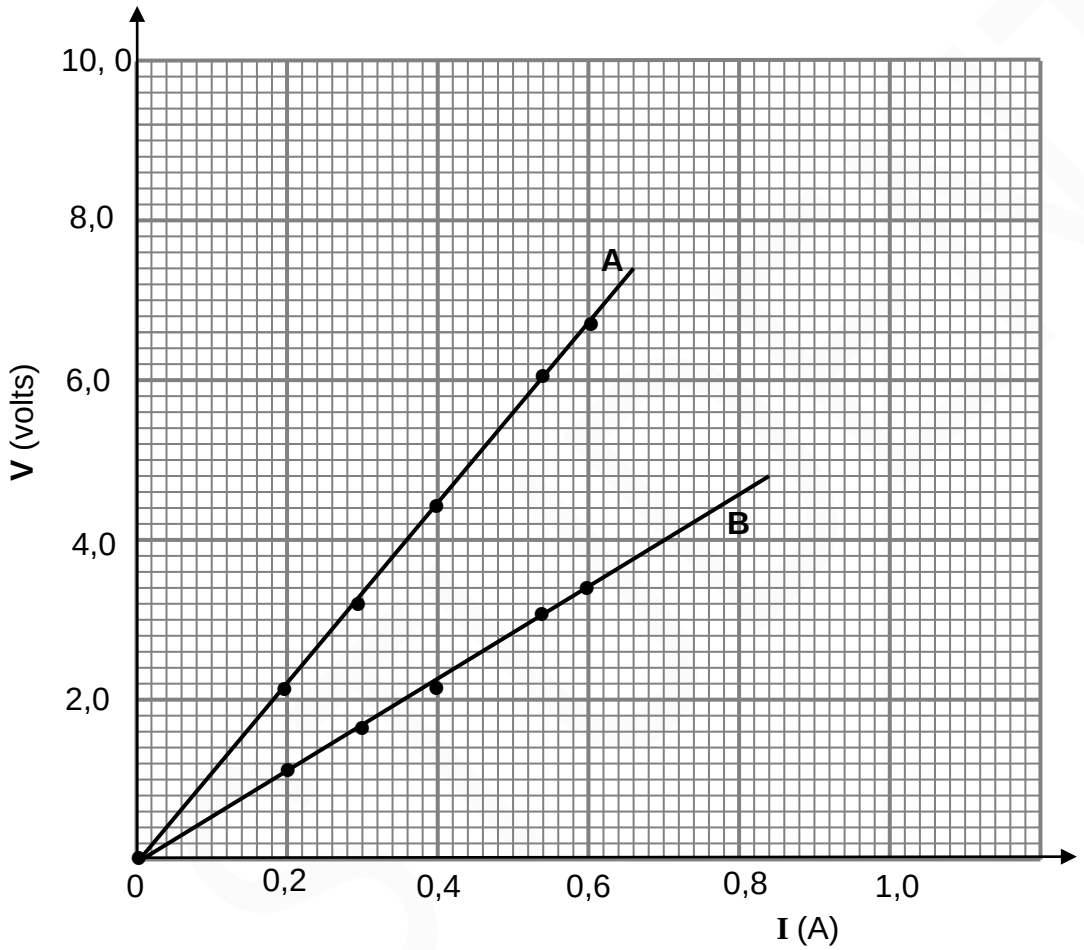
9.3 If device **R** delivers power of 12 W, calculate the reading on ammeter **A_2**. (5)

9.4 Calculate the reading on the voltmeter when switch **S** is open. (3)
[14]

QUESTION 8 (Start on a new page.)

8.1 Learners want to construct an electric heater using one of two wires, **A** and **B**, of different resistances. They conduct experiments and draw the graphs as shown below.

Graph of V versus I for resistors A and B

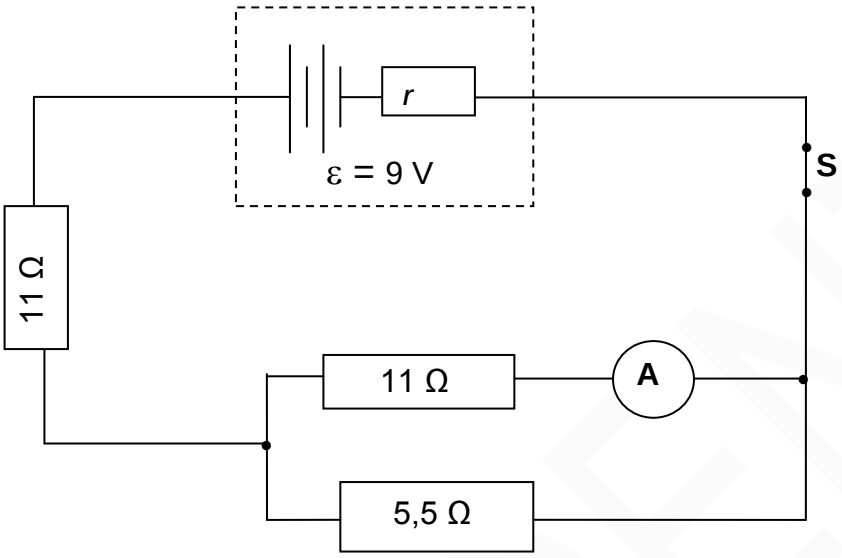


8.1.1 Apart from temperature, write down TWO other factors that the learners should consider to ensure a fair test when choosing which wire to use. (2)

8.1.2 Assuming all other factors are kept constant, state which ONE of the two wires will be the most suitable to use in the heater.

Use suitable calculations to show clearly how you arrive at the answer. (8)

8.2 In the circuit below the reading on ammeter **A** is 0,2 A. The battery has an emf of 9 V and internal resistance *r*.



8.2.1 Calculate the current through the 5,5 Ω resistor. (3)

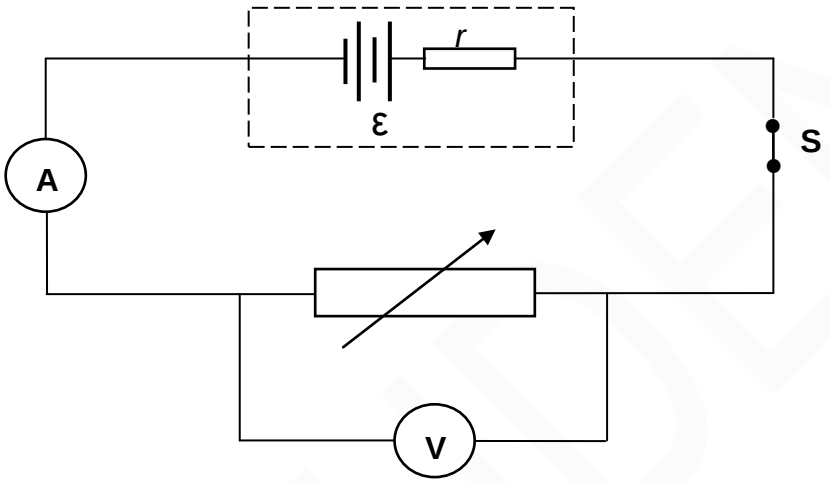
8.2.2 Calculate the internal resistance of the battery. (7)

8.2.3 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 5,5 Ω resistor is removed from the circuit? Give a reason for the answer. (2)
[22]

QUESTION 8 (Start on a new page.)

NOTE: The graph for QUESTION 8.1.2 must be drawn on the GRAPH SHEET attached at the end of the QUESTION PAPER.

8.1 A group of learners conduct an experiment to determine the emf (ε) and internal resistance (*r*) of a battery. They connect a battery to a rheostat (variable resistor), a low-resistance ammeter and a high-resistance voltmeter as shown in the diagram below.



The data obtained from the experiment is displayed in the table below.

READING ON VOLTMETER (V)	READING ON AMMETER (A)
2	0,58
3	0,46
4	0,36
5	0,24
6	0,14

8.1.1 State ONE factor which must be kept constant during the experiment. (1)

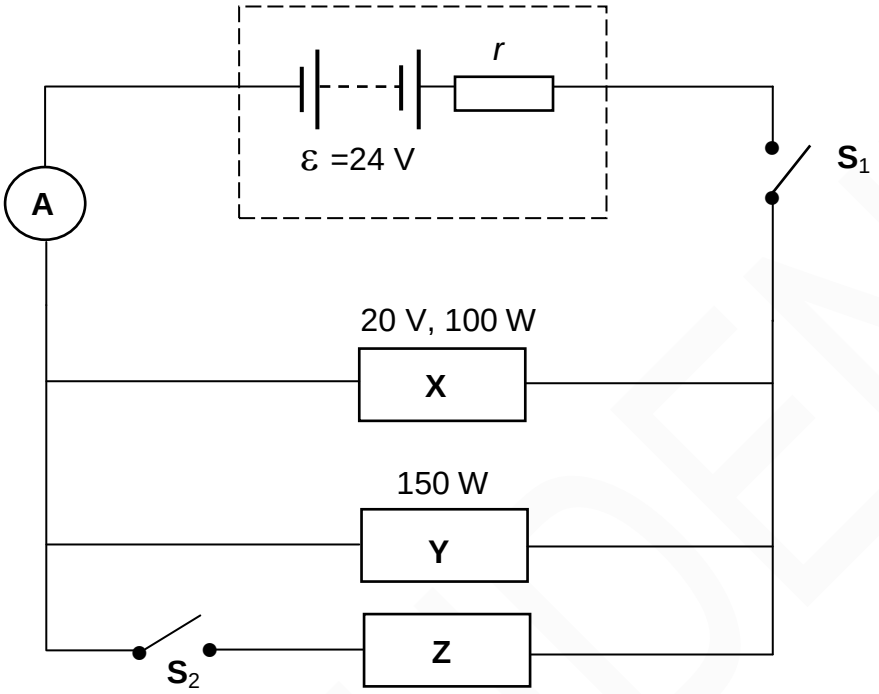
8.1.2 Using the information in the table above, plot the points and draw the line of best fit on the attached GRAPH SHEET. (3)

Use the graph drawn in QUESTION 8.1.2 to determine the following:

8.1.3 Emf (ε) of the battery (1)

8.1.4 Internal resistance of the battery, WITHOUT USING ANY FORM OF THE EQUATION $\varepsilon = I(R + r)$ (3)

8.2 Three electrical devices, **X**, **Y** and **Z**, are connected to a 24 V battery with internal resistance *r* as shown in the circuit diagram below. The power rating of each of the devices **X** and **Y** are indicated in the diagram.



With switch S_1 closed and S_2 open, the devices function as rated.

Calculate the:

8.2.1 Current in **X** (3)

8.2.2 Resistance of **Y** (3)

8.2.3 Internal resistance of the battery (5)

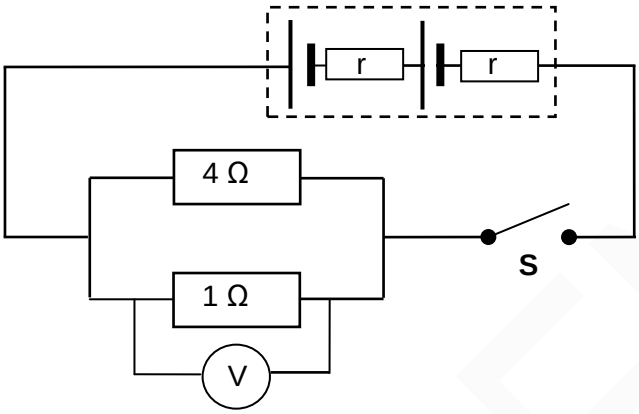
Now switch S_2 is also closed.

8.2.4 Identify device **Z** which, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged. (1)

8.2.5 Explain how you arrived at the answer to QUESTION 8.2.4. (2)
[22]

QUESTION 9 (Start on a new page.)

Two identical cells, EACH with an emf of 1,5 V and an internal resistance *r*, are connected in series with each other and to the resistors as shown below.



9.1 Define, in words, the term *electromotive force* (emf). (2)

9.2 Write down the total emf of the circuit. (1)

When switch **S** is closed, the potential difference across the 4 Ω resistor is 2,8 V.

9.3 Calculate the total current in the circuit. (5)

9.4 Calculate the internal resistance *r* of EACH cell. (5)

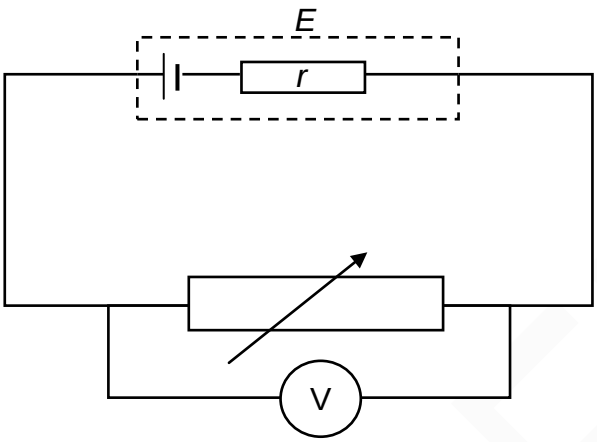
9.5 An unknown resistor is now connected in parallel with the 4 Ω and 1 Ω resistors. How will this change affect the magnitude of:

9.5.1 The internal resistance of the battery
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

9.5.2 The reading on the voltmeter
Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer by referring to resistance, current and 'lost volts'. (4)
[18]

QUESTION 9 (Start on a new page.)

9.1 In an experiment, learners use the circuit below to determine the internal resistance of a cell.

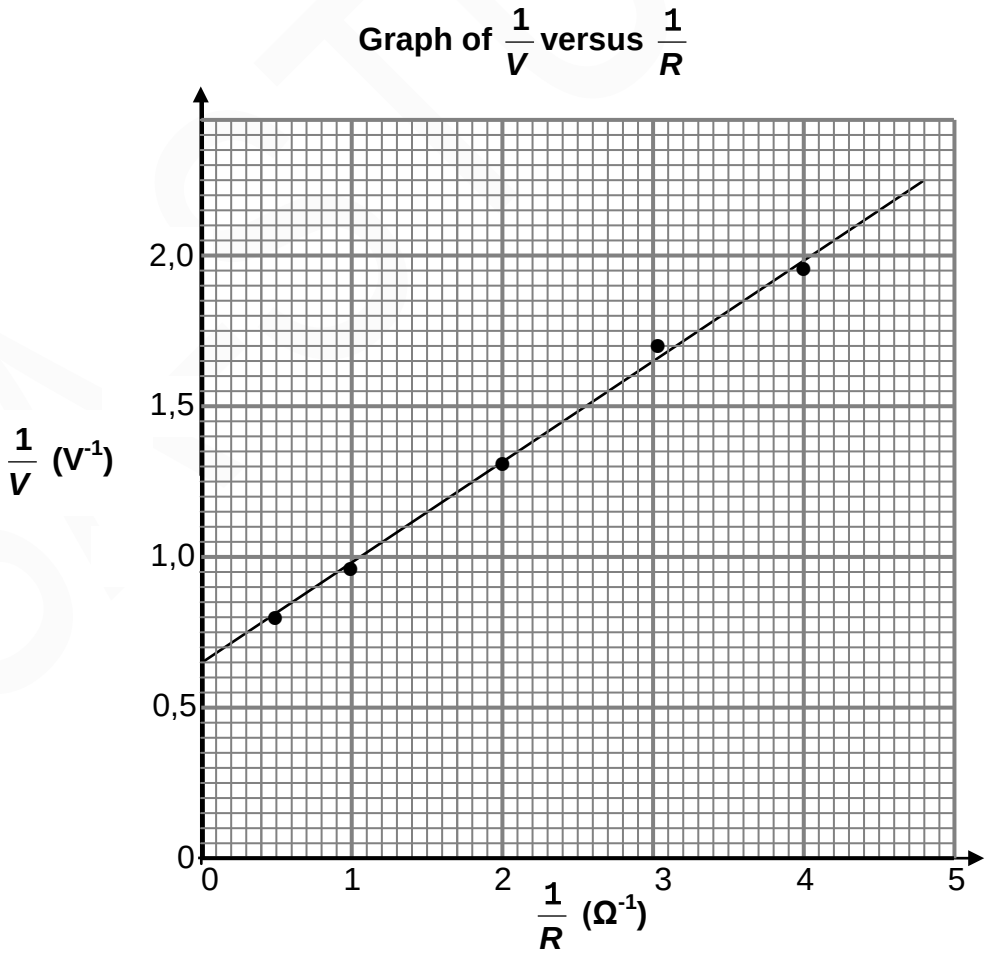


The circuit consists of a cell of emf *E* and internal resistance *r*. A voltmeter is placed across a variable resistor which can be set to *known values* R.

The equation used by the learners is:

$$\frac{1}{V} = \frac{r}{ER} + \frac{1}{E}$$

They obtain the graph below.



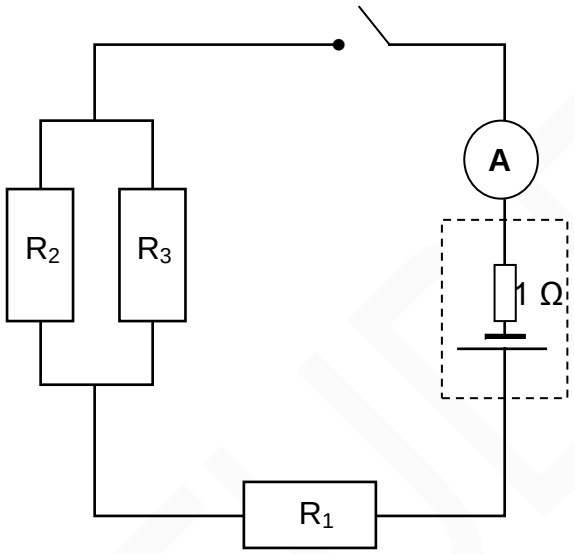
9.1.1 Write down a mathematical relationship for the slope of the graph. (1)

Use the information in the graph and calculate the:

9.1.2 Emf of the cell (2)

9.1.3 Internal resistance of the cell (3)

9.2 In the electrical circuit shown below, the battery has an emf of 6 V and an internal resistance of 1 Ω. The total external resistance of the circuit is 9 Ω.



9.2.1 Calculate the current in R_1 when the switch is closed. (3)

The power dissipated in resistor R_1 is 1,8 W. The resistance of resistor R_3 is 4 times that of resistor R_2. ($R_3 = 4R_2$)

9.2.2 Calculate the resistance of resistor R_2. (5)

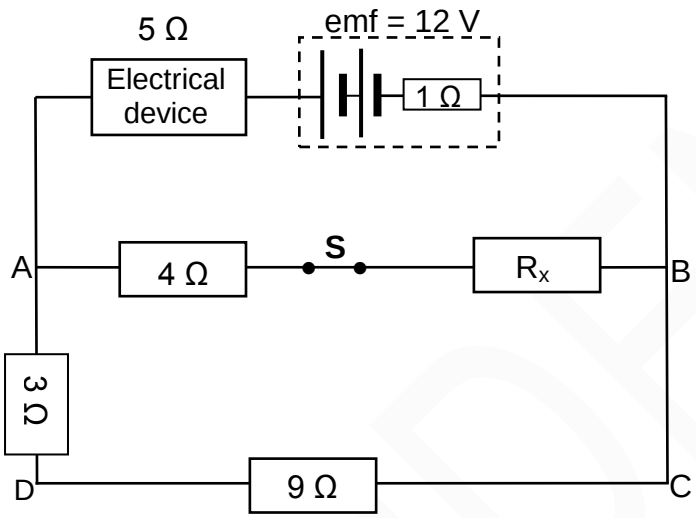
9.3 A hair dryer operates at a potential difference of 240 V and a current of 9,5 A.

It takes a learner 12 minutes to completely dry her hair. Eskom charges energy usage at R1,47 per unit. Calculate the cost of operating the hairdryer for the 12 minutes. (1 unit = 1 kW·h) (4)
[18]

QUESTION 9 (Start on a new page.)

A learner wants to use a 12 V battery with an internal resistance of 1 Ω to operate an electrical device. He uses the circuit below to obtain the desired potential difference for the device to function. The resistance of the device is 5 Ω.

When switch **S** is **closed** as shown, the device functions at its maximum power of 5 W.



9.1 Explain, in words, the meaning of *an emf of 12 V*. (2)

9.2 Calculate the current that passes through the electrical device. (3)

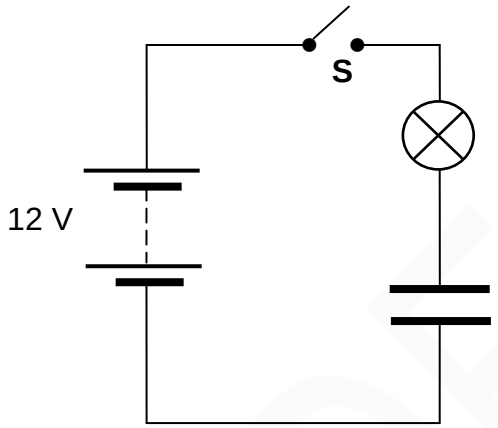
9.3 Calculate the resistance of resistor $\mathbf{R_x}$. (7)

9.4 Switch **S** is now **opened**. Will the device still function at maximum power? Write down YES or NO. Explain the answer without doing any calculations. (4)
[16]

QUESTION 8 (Start on a new page.)

8.1 Write down the main function of a capacitor in a circuit. (1)

A high-resistance light bulb and an uncharged parallel plate capacitor are connected in series with a 12 V battery and a switch **S**, as shown below. The internal resistance of the battery and the resistance of the connecting wires should be ignored.



Switch **S** is now closed and the capacitor charges.

8.2 Describe how the brightness of the light bulb changes during the charging process. (1)

The capacitor is NOW fully charged.

8.3 Write down the potential difference across the:

8.3.1 Light bulb (1)

8.3.2 Capacitor (1)

8.4 The distance between the plates of the capacitor is 5,4 mm.

For the fully charged capacitor, calculate the magnitude of the:

8.4.1 Electric field between the plates (3)

8.4.2 Electrostatic force exerted on an electron between the plates (3)

8.5 An electron is positioned 3,8 mm from the positive plate of the capacitor.

Calculate the:

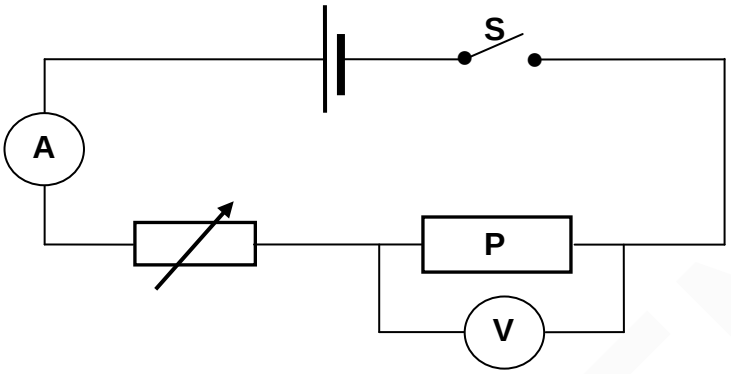
8.5.1 Distance (in mm) between the electron and the negative plate (1)

8.5.2 Work that must be done to move the electron to the negative plate (Ignore the effects of gravitational force.) (4)

[15]

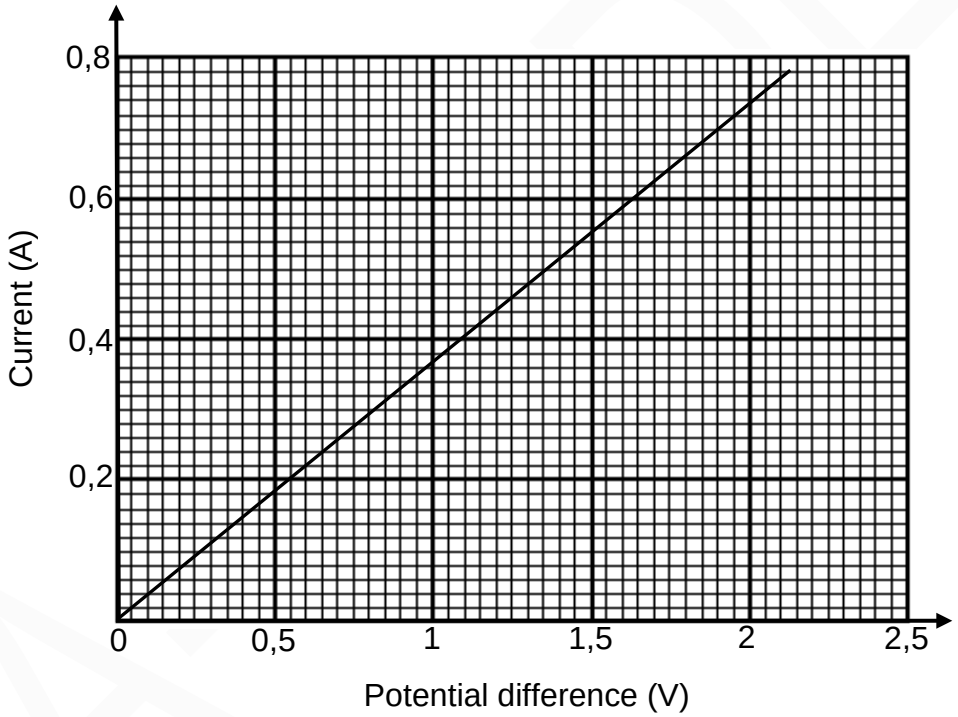
QUESTION 9 (Start on a new page.)

9.1 The circuit represented below is used to investigate the relationship between the current passing through and the potential difference across resistor **P**.



The results obtained are used to draw the graph below.

Graph of current versus potential difference



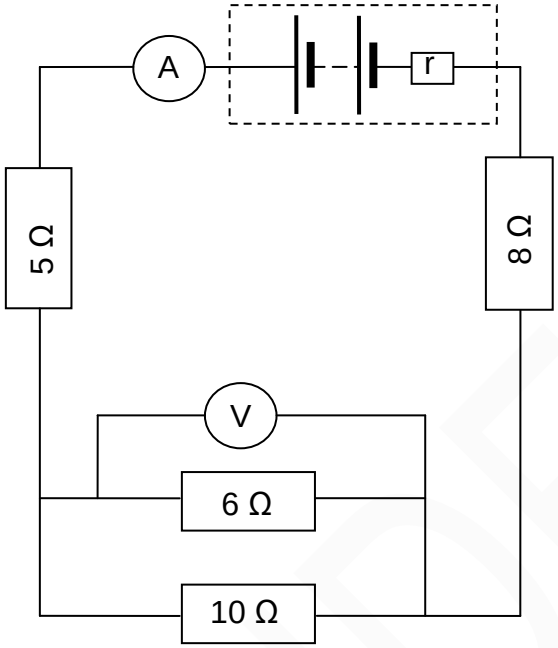
9.1.1 Write down the independent variable. (1)

9.1.2 Write down the variable that must be controlled. (1)

9.1.3 Write down the conclusion that can be obtained from the graph. (2)

9.1.4 Using the gradient of the graph, calculate the resistance of resistor **P**. (4)

9.2 In the circuit represented below, a battery of emf 30 V and unknown internal resistance *r* are connected to resistors, as shown. Ignore the resistance of the ammeter and the connecting wires.



The current passing through the 10 Ω resistor is 0,6 A.

Calculate the:

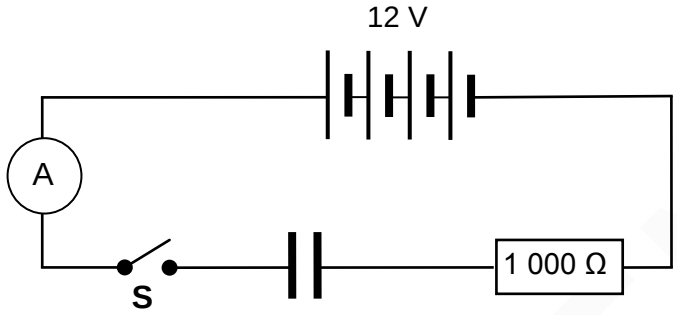
9.2.1 Equivalent resistance of the two resistors in parallel (3)

9.2.2 Current through the 8 Ω resistor (4)

9.2.3 Internal resistance of the battery (4)
[19]

QUESTION 8 (Start on a new page.)

In the circuit represented below, an uncharged capacitor is connected in series with a 1 000 Ω resistor. The emf of the battery is 12 V. Ignore the internal resistance of the battery and the ammeter.



8.1 Calculate the initial current in the circuit when switch **S** is closed. (3)

8.2 Write down the potential difference across the plates of the capacitor when it is fully charged. (1)

The capacitor has a capacitance of 120 μF and the space between its plates is filled with air.

8.3 Calculate the charge stored on the plates of the capacitor when it is fully charged. (3)

After discharging the capacitor, it is connected in the same circuit to a resistor of HIGHER resistance and switch **S** is closed again.

8.4 How would this change affect each of the following:
(Write down INCREASES, DECREASES or REMAINS THE SAME.)

8.4.1 The initial charging current (1)

8.4.2 The time it takes for the capacitor to become fully charged (1)

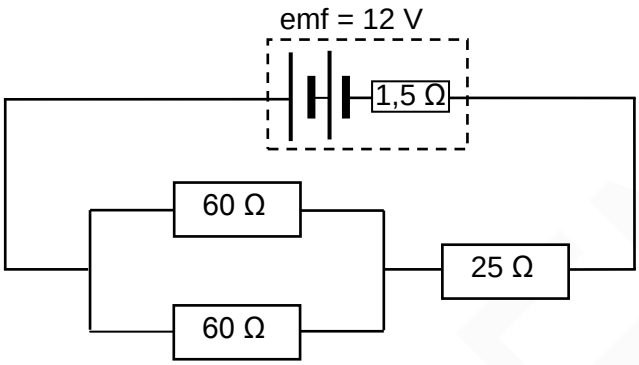
8.5 The two parallel plates of the fully charged capacitor are 12 mm apart.

8.5.1 Sketch the electric field pattern between the parallel plates. (3)

8.5.2 Calculate the magnitude of the electric field at a point midway between the plates. (3)
[15]

QUESTION 9 (Start on a new page.)

9.1 In the circuit represented below, two 60 Ω resistors connected in parallel are connected in series with a 25 Ω resistor. The battery has an emf of 12 V and an internal resistance of 1,5 Ω.



Calculate the:

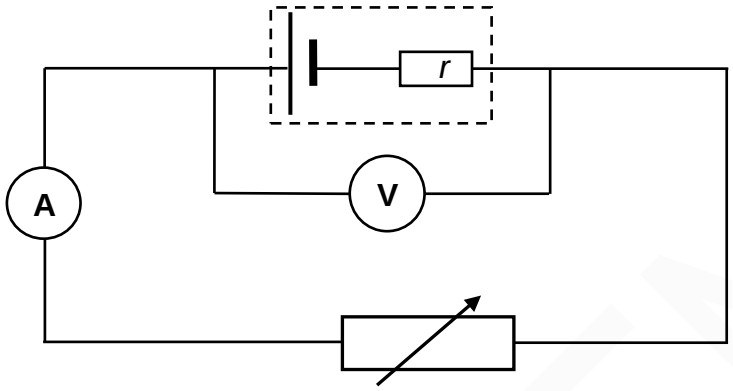
9.1.1 Equivalent resistance of the parallel combination (3)

9.1.2 Total current in the circuit (5)

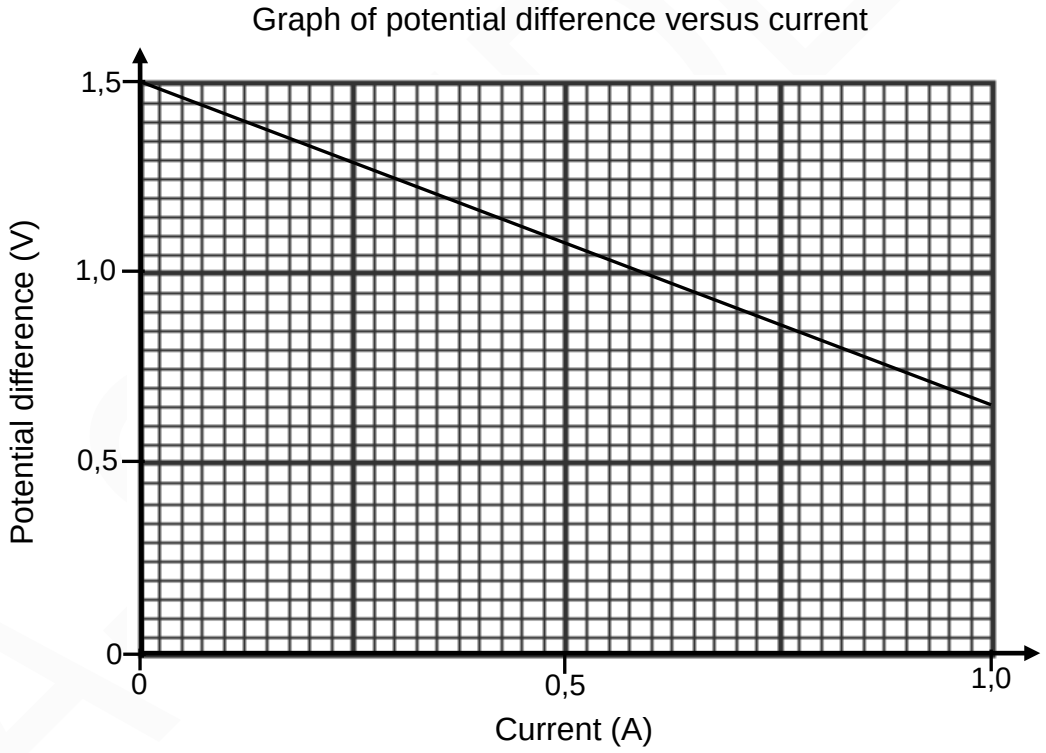
9.1.3 Potential difference across the parallel resistors (3)

9.2 Learners conduct an investigation to determine the emf and internal resistance (*r*) of a battery.

They set up a circuit as shown in the diagram below and measure the potential difference using the voltmeter for different currents in the circuit.



The results obtained are shown in the graph below.



9.2.1 Use the graph to determine the emf of the battery. (1)

9.2.2 Calculate the gradient of the graph. (3)

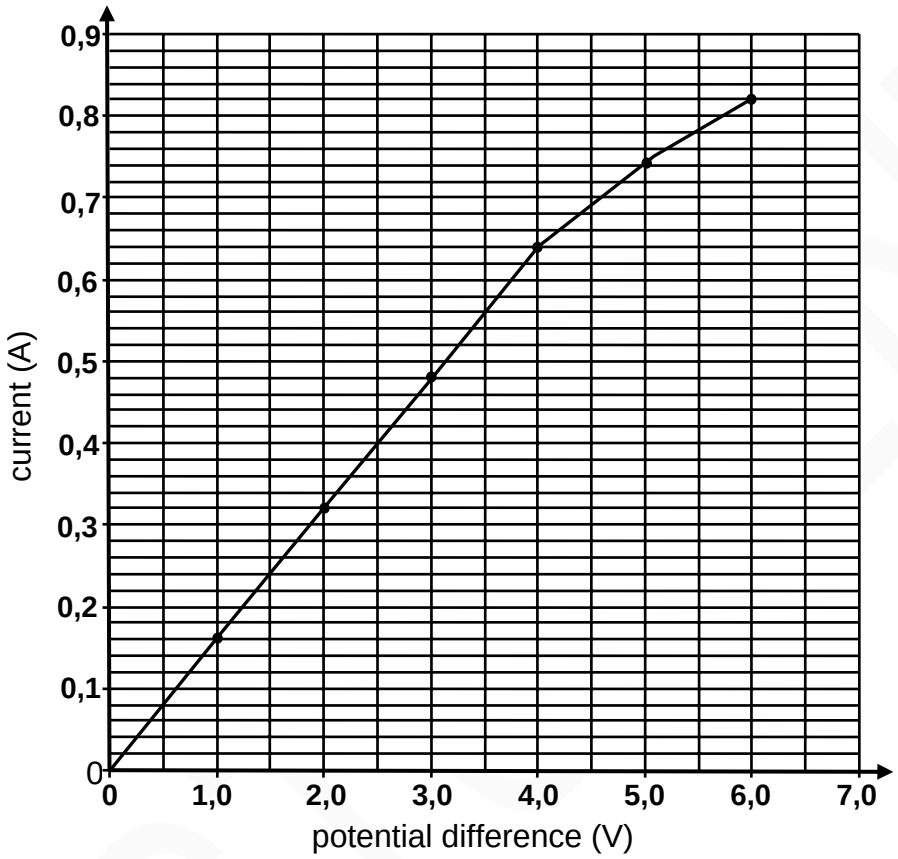
9.2.3 Which physical quantity is represented by the magnitude of the gradient of the graph? (2)

9.2.4 How does the voltmeter reading change as the ammeter reading increases? Write down INCREASES, DECREASES or REMAINS THE SAME. Use the formula emf = IR + Ir to explain the answer. (3)

[20]

QUESTION 9 (Start on a new page.)

Learners conduct an investigation to verify Ohm's law. They measure the current through a conducting wire for different potential differences across its ends. The results obtained are shown in the graph below.



9.1 Which ONE of the measured quantities is the dependent variable? (1)

9.2 The graph deviates from Ohm's law at some point.

9.2.1 Write down the coordinates of the plotted point on the graph beyond which Ohm's law is not obeyed. (2)

9.2.2 Give a possible reason for the deviation from Ohm's law as shown in the graph. Assume that all measurements are correct. (2)

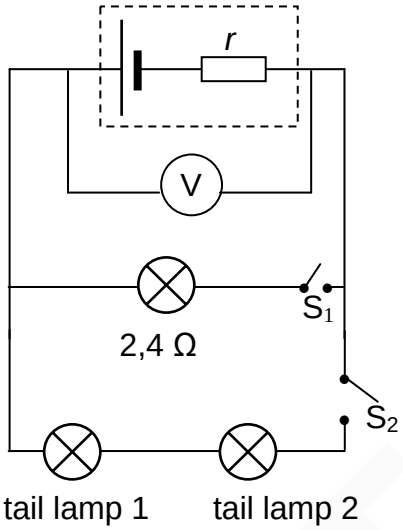
9.3 Calculate the gradient of the graph for the section where Ohm's law is obeyed.

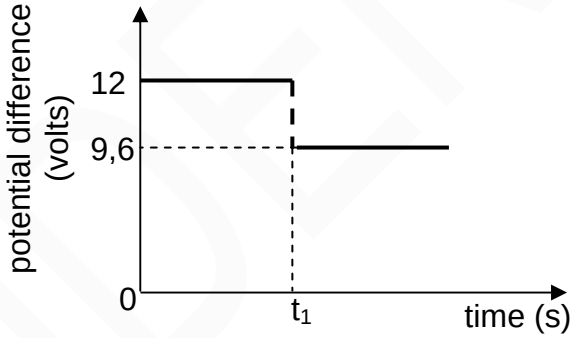
Use this to calculate the resistance of the conducting wire. (4)
[9]

QUESTION 10 (Start on a new page.)

The headlamp and two IDENTICAL tail lamps of a scooter are connected in parallel to a battery with unknown internal resistance as shown in the simplified circuit diagram below. The headlamp has a resistance of 2,4 Ω and is controlled by switch **S_1**. The tail lamps are controlled by switch **S_2**. The resistance of the connecting wires may be ignored.

The graph alongside shows the potential difference across the terminals of the battery before and after switch **S_1** is closed (whilst switch **S_2** is open). Switch **S_1** is closed at time t_1.





10.1 Use the graph to determine the emf of the battery. (1)

10.2 WITH ONLY SWITCH **S_1** CLOSED, calculate the following:

10.2.1 Current through the headlamp (3)

10.2.2 Internal resistance, *r*, of the battery (3)

10.3 BOTH SWITCHES **S_1** AND **S_2** ARE NOW CLOSED. The battery delivers a current of 6 A during this period.

Calculate the resistance of each tail lamp. (5)

10.4 How will the reading on the voltmeter be affected if the headlamp burns out? (Both switches **S_1** and **S_2** are still closed.)

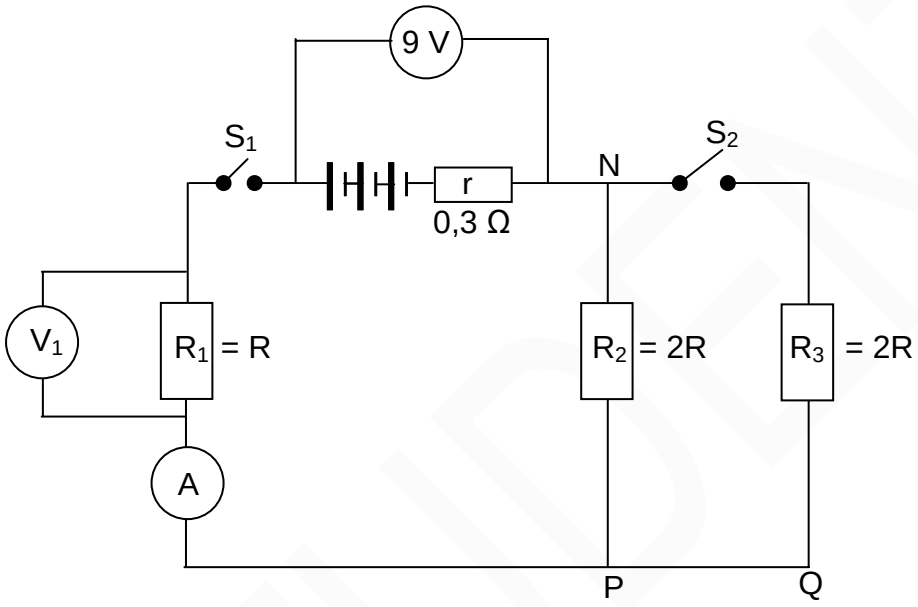
Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give an explanation. (3)
[15]

QUESTION 11 (Start on a new page.)

Three resistors, R_1, R_2 and R_3, are connected to a battery, as shown in the circuit diagram below. The internal resistance of the battery is 0,3 Ω. The resistance of R_2 and R_3 is equal. The resistance of R_1 is half that of R_2.

When both switches are open, the voltmeter across the battery reads 9 V.



11.1 What is the value of the emf of the battery? Give a reason for your answer. (2)

11.2 When **only switch S_1 is closed**, the reading on the ammeter is 3 A. Calculate the resistance of R_1. (5)

11.3 Both switches S_1 and S_2 are now closed.

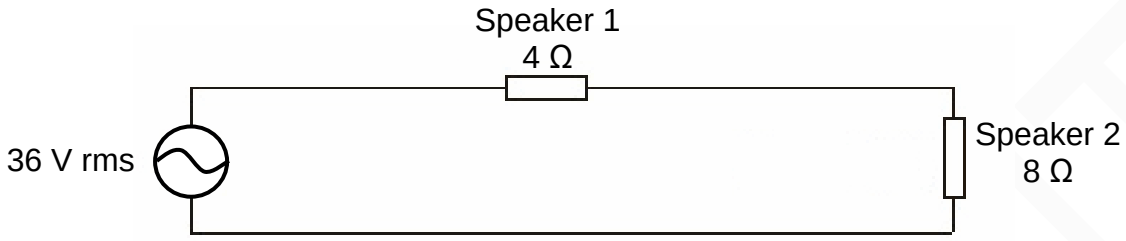
11.3.1 How will the resistance of the circuit change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.3.2 A conducting wire of negligible resistance is connected between points Q and N. What effect will this have on the 'lost volts'? Explain the answer. (3)

[11]

QUESTION 12 (Start on a new page.)

A source provides an rms potential difference of 36 V to a 4 Ω and an 8 Ω speaker connected in series, as shown in the diagram below.



12.1 Calculate the following:

12.1.1 rms current through the 4 Ω speaker (3)

12.1.2 Peak current through each speaker (3)

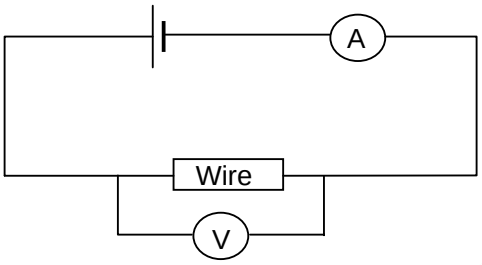
12.1.3 Average power dissipated by the 4 Ω speaker (3)

12.2 Without using a calculation, state how the average power dissipated by the 4 Ω speaker compares with the power dissipated by the 8 Ω speaker. Give a reason for the answer. (3)

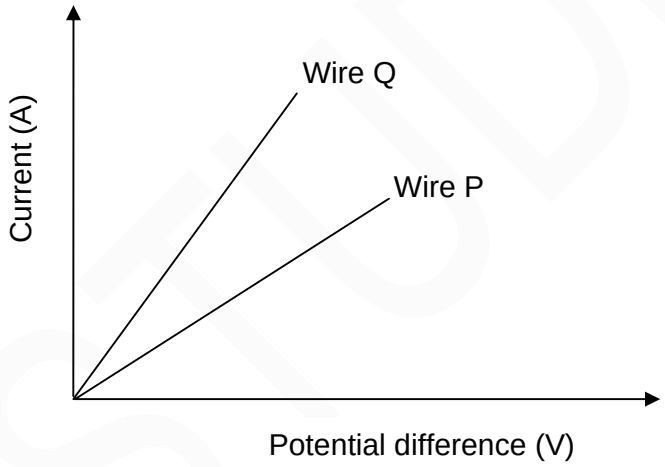
[12]

QUESTION 11

Learners investigate the conducting ability of two metal wires P and Q, made of different materials. They connect ONE wire at a time in a circuit as shown below.



The potential difference across each wire is increased in equal increments, and the resulting current through these wires is measured. Using the measurements, the learners obtained the following sketch graphs for each of the wires.

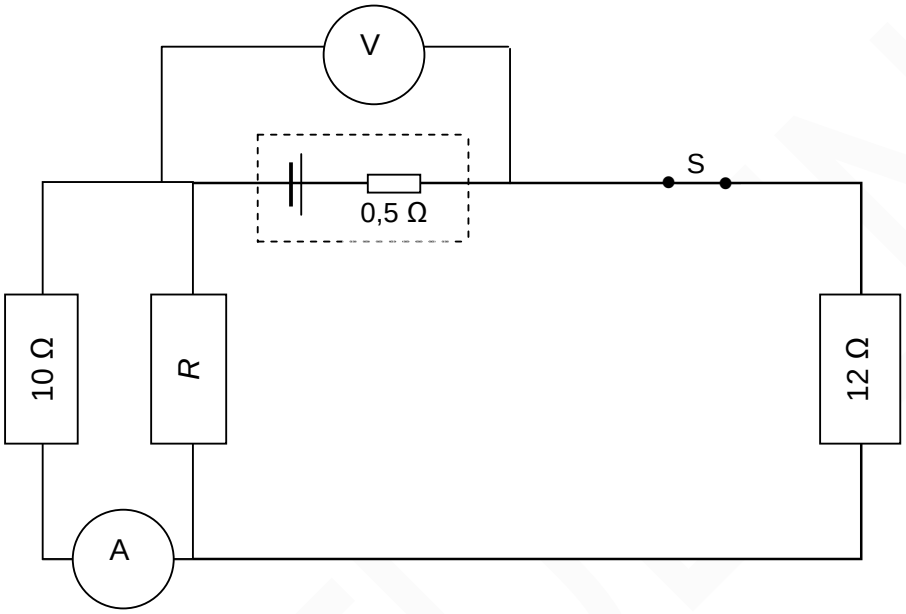


11.1 Name TWO variables that the learners would have controlled in each of the experiments. (2)

11.2 Which one (P or Q) is the better conductor? Explain your answer. (4)
[6]

QUESTION 12

A circuit is connected as shown below. The resistance of *R*, which is connected in parallel with the 10 Ω resistor, is unknown. With switch S closed, the reading on voltmeter V decreases from 45 V to 43,5 V. The internal resistance of the battery is 0,5 Ω.



12.1 Calculate the reading on ammeter A. Show ALL your calculations. (8)

12.2 Determine the resistance of resistor *R*. (3)

12.3 How will the reading on voltmeter V change if resistor *R* burns out? Give a reason for your answer. (4)
[15]