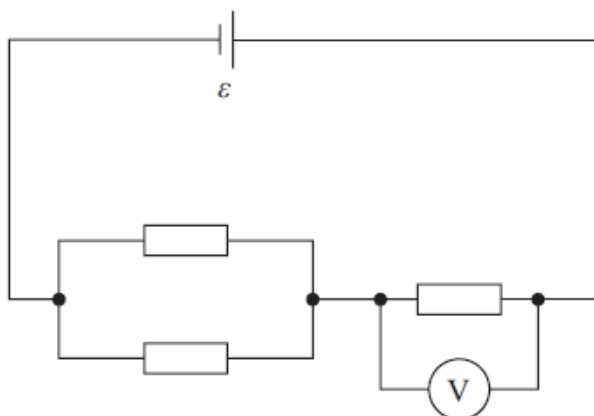


Questions

Q1.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A student connects three identical resistors in the circuit shown.



The cell has e.m.f. ϵ and negligible internal resistance.

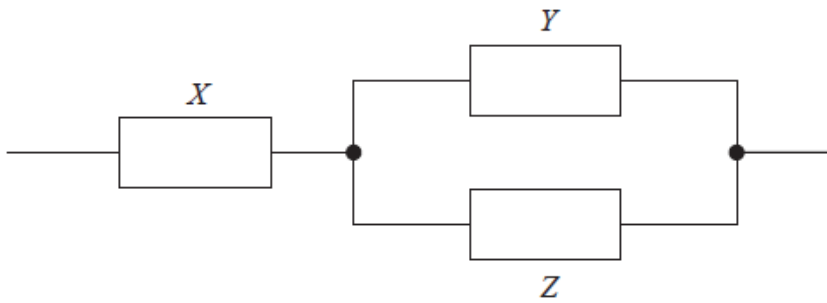
Which of the following is equal to the reading on the voltmeter?

- ☐ A $\frac{\epsilon}{2}$
- ☐ B $\frac{\epsilon}{3}$
- ☐ C $\frac{2\epsilon}{3}$
- ☐ D $\frac{3\epsilon}{2}$

(Total for question = 1 mark)

Q2.

The diagram shows a combination of three resistors of resistance X , Y and Z .



Which of the following gives the total resistance of this combination?

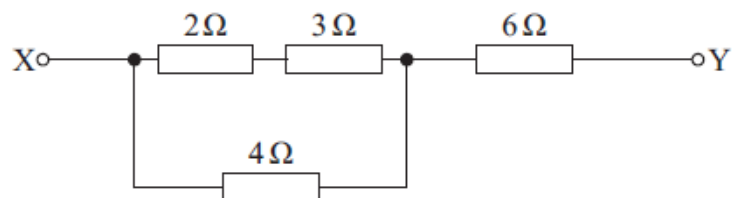
- ☐ A $X + \frac{1}{Y} + \frac{1}{Z}$
- ☐ B $\frac{1}{X} + Y + Z$
- ☐ C $X + \frac{YZ}{Y + Z}$
- ☐ D $\frac{1}{X} + \frac{Y + Z}{YZ}$

(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

The diagram shows part of an electrical circuit.



Which of the following expressions gives the total resistance, in ohms, between X and Y?

- ☐ A $\frac{1}{\frac{1}{2+3} + \frac{1}{4}} + 6$
- ☐ B $\frac{1}{2+3} + \frac{1}{4} + 6$
- ☐ C $\frac{1}{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}} + 6$
- ☐ D $\frac{1}{\frac{1}{2+3} + \frac{1}{4}} + 6$

(Total for question = 1 mark)

Q4.

Which row in the table shows the total resistance if two $5\ \Omega$ resistors are connected in series and in parallel?

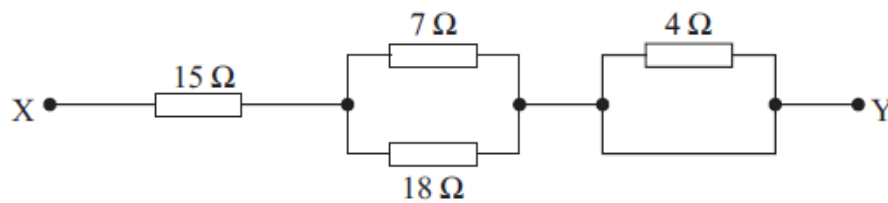
	Series	Parallel
☐ A	$2.5\ \Omega$	$10\ \Omega$
☐ B	$2.5\ \Omega$	$2.5\ \Omega$
☐ C	$10\ \Omega$	$10\ \Omega$
☐ D	$10\ \Omega$	$2.5\ \Omega$

(Total for question = 1 mark)

Q5.

Answer the question with a cross in the box you think is correct (☐). If you change your mind about an answer, put a line through the box (☐) and then mark your new answer with a cross (☐).

A student connects four resistors between points X and Y, as shown.



Which of the following expressions gives the total resistance, in ohms, between X and Y?

- ☐ A $15 + \frac{1}{7} + \frac{1}{18}$
- ☐ B $15 + \frac{1}{7} + \frac{1}{18} + 4$
- ☐ C $15 + \frac{1}{\left(\frac{1}{7} + \frac{1}{18}\right)}$
- ☐ D $15 + \frac{1}{\left(\frac{1}{7} + \frac{1}{18}\right)} + \frac{1}{4}$

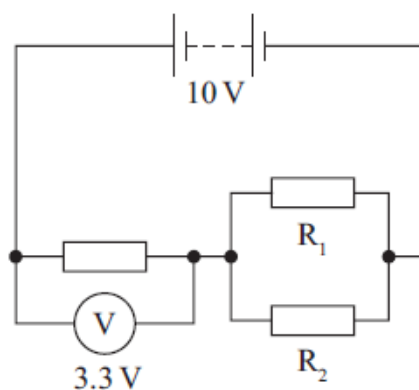
(Total for question = 1 mark)

Q6.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

The battery in the circuit shown has a negligible internal resistance.

Resistor R_1 and resistor R_2 are identical.



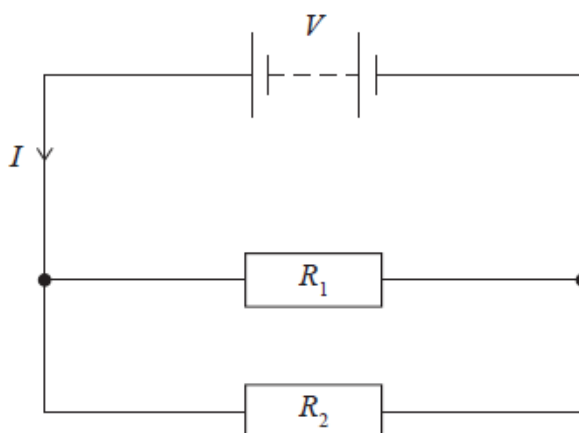
Which of the following expressions gives the potential difference across resistor R_1 in volts?

- ☐ A $\frac{1}{2} \times 3.3$
- ☐ B 3.3
- ☐ C $\frac{1}{2} \times (10 - 3.3)$
- ☐ D $10 - 3.3$

(Total for question = 1 mark)

Q7.

Two resistors are connected in a circuit, as shown.



An expression for the combined resistance of the two resistors is $\frac{R_1 R_2}{R_1 + R_2}$

Derive this expression.

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q8.

(a) Two resistors of resistance R_1 and R_2 are connected in parallel in a circuit.

Derive a formula for the total resistance R_T of the combination.

(3)

.....

.....

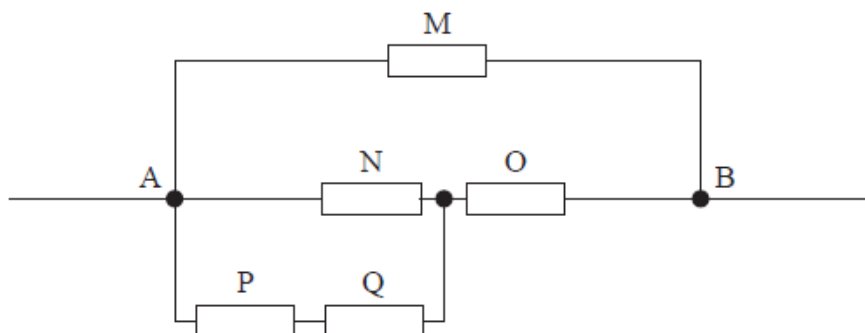
.....

.....

.....

.....

(b) The diagram shows a combination of five resistors, M, N, O, P and Q. Each resistor has a resistance of $5.0\ \Omega$.



(i) Show that the resistance between points A and B is about $3\ \Omega$.

(3)

.....

.....

.....

.....

.....

.....

(ii) A student is told to modify the combination of resistors so that the combined resistance between A and B is greater than $5.0\ \Omega$. She cannot change the arrangement of the resistors, but she can replace one of the $5.0\ \Omega$ resistors with a $20.0\ \Omega$ resistor.

Explain, without further calculations, which of the five resistors should be replaced.

(2)

.....

.....

.....

.....

(Total for question = 8 marks)

Q9.

The photograph shows a rear window heater in a car.



(Source: © narai chal/Shutterstock)

(a) (i) Each metal strip in the heater has a rectangular cross-section of width $1.64\ \text{mm}$ and height $0.20\ \text{mm}$.

Show that the resistance of each metal strip is about $5\ \Omega$.

resistivity of metal in strip = $1.70 \times 10^{-6}\ \Omega\ \text{m}$
length of metal strip = $0.95\ \text{m}$

(3)

.....

.....

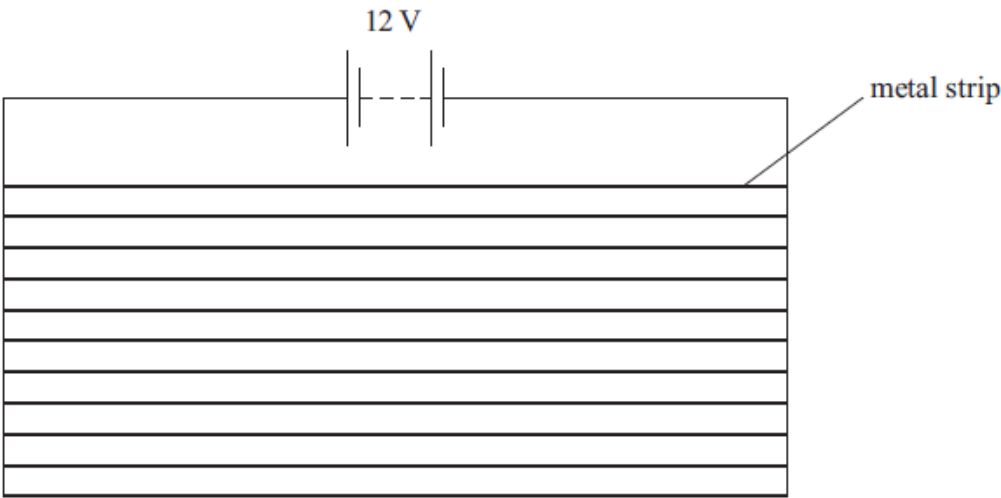
.....

.....

.....

.....

(ii) The heater has 11 identical metal strips connected in parallel, as shown.



Determine the total resistance of the metal strips.

(2)

.....

.....

.....

.....

Total resistance =

(iii) The potential difference across the heater is 12 V and the internal resistance is negligible.

Determine the current entering the heater.

(2)

.....

.....

.....

.....

(b) An alternative design is to connect the metal strips in series.

Explain why this would **not** result in the same power being dissipated by the heating circuit.

You do not need to include calculations in your answer.

(2)

.....

.....

.....

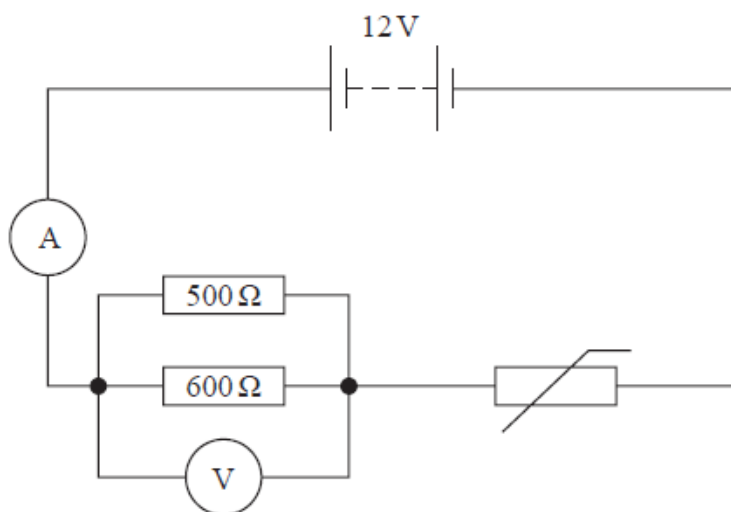
.....

.....

(Total for question = 9 marks)

Q10.

A student set up the circuit shown to investigate the properties of a negative temperature coefficient thermistor.



The power supply has negligible internal resistance.

(a) (i) Show that the voltmeter reading was about 6 V.

ammeter reading = 23 mA

(3)

.....

.....

.....

.....

.....

.....

(ii) Calculate the power dissipated by the thermistor.

(3)

.....

.....

.....

.....

.....

Power =

(b) The student decreases the temperature of the thermistor.

Explain the effect of decreasing the temperature of the thermistor on the ammeter and voltmeter readings.

(4)

.....

.....

.....

.....

.....

.....

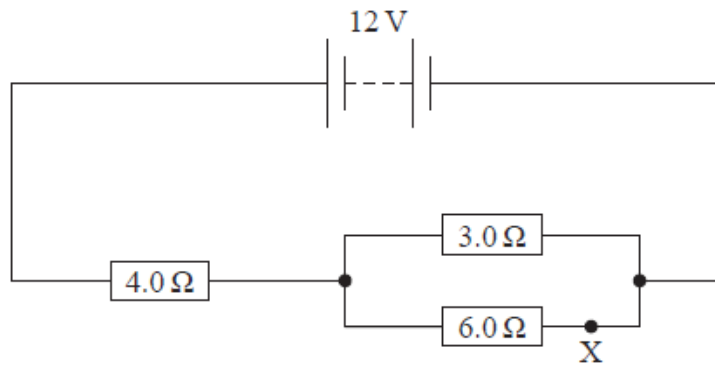
.....

.....

(Total for question = 10 marks)

Q11.

A student set up the circuit shown.



(a) Calculate the number of electrons passing point X each second.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

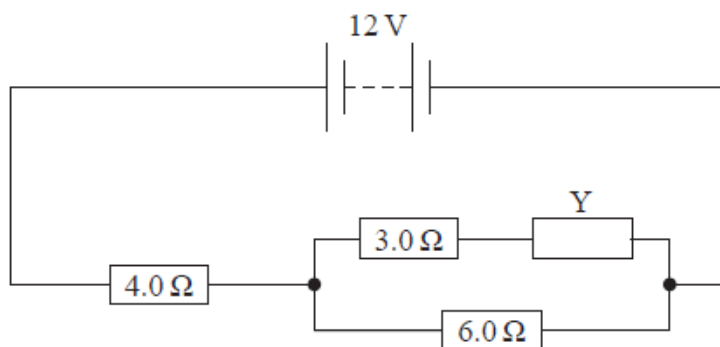
.....

.....

.....

Number of electrons in one second =

(b) Another resistor, Y, is added to the circuit as shown.



The student wrote the following statement.

When resistor Y is added, the resistance of the parallel section increases, the resistance of the whole circuit increases, and so, by $P = I^2R$, the power dissipated by the whole circuit also increases.

Evaluate the student's statement.

(4)

.....

.....

.....

.....

.....

.....

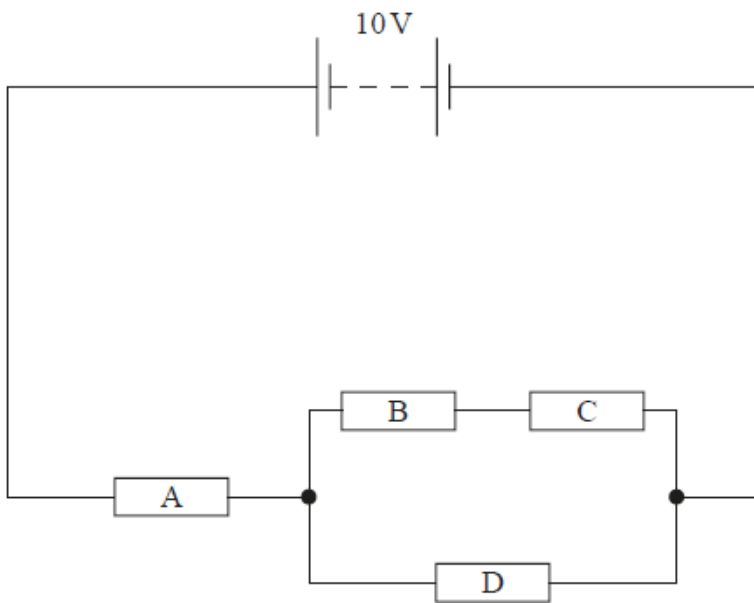
.....

.....

(Total for question = 10 marks)

Q12.

Four identical resistors, A, B, C and D, are placed in a circuit as shown.



(a) Determine the power dissipated in each of the resistors.

resistance of each resistor = 2.0 Ω

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Explain, without further calculation, what would happen to the power dissipated by resistor A if resistor D were disconnected from the circuit.

(2)

.....

.....

.....

.....

(c) If the resistors in the circuit used in (a) were replaced with filament lamps, the resistance of each lamp would be different depending on the potential difference across it.

Explain, in terms of particles, why the resistance of a filament lamp increases as the potential difference across the filament increases.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 12 marks)

Q13.

Resistors are included in circuits that are used as potential dividers.

(a) Derive an equation for the combined resistance R_T for two resistors, R_1 and R_2 , in series.

(3)

.....

.....

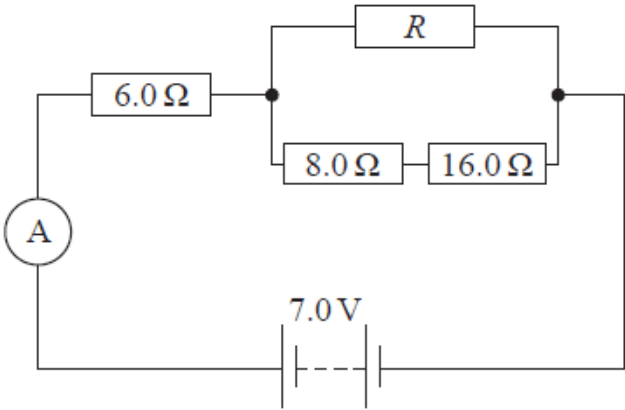
.....

.....

.....

.....

(b) The diagram shows a circuit that includes a resistor combination. The battery has negligible internal resistance.



The ammeter displays a current of 0.50 A.
 Calculate the resistance R.

(3)

.....

.....

.....

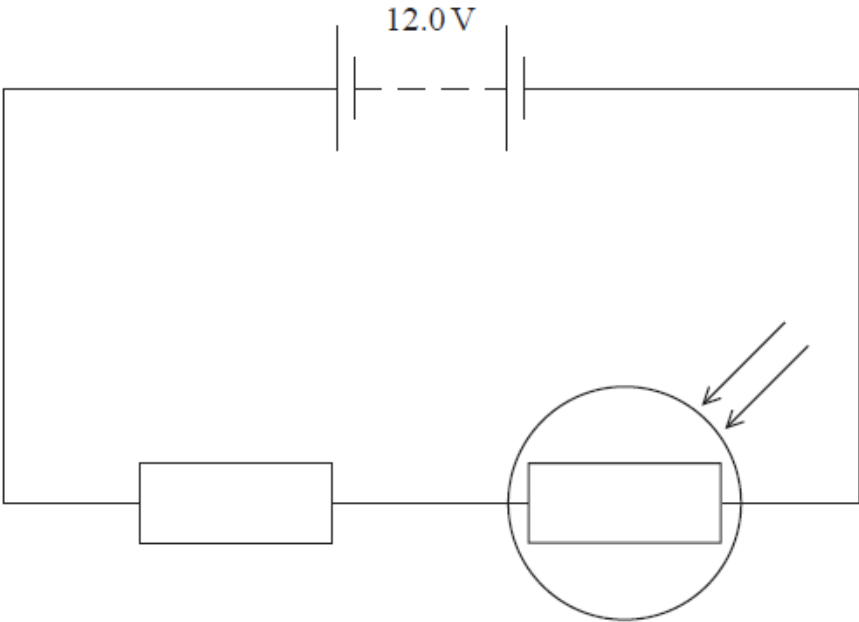
.....

.....

.....

Resistance *R*

(c) The circuit shown below includes a light dependent resistor (LDR). The battery has no internal resistance.



Calculate the power dissipated in the fixed resistor in normal daylight.

resistance of fixed resistor = 8.00 k Ω

(3)

Power =

(ii) As the light intensity incident upon the LDR decreases, the power dissipated in the fixed resistor decreases.

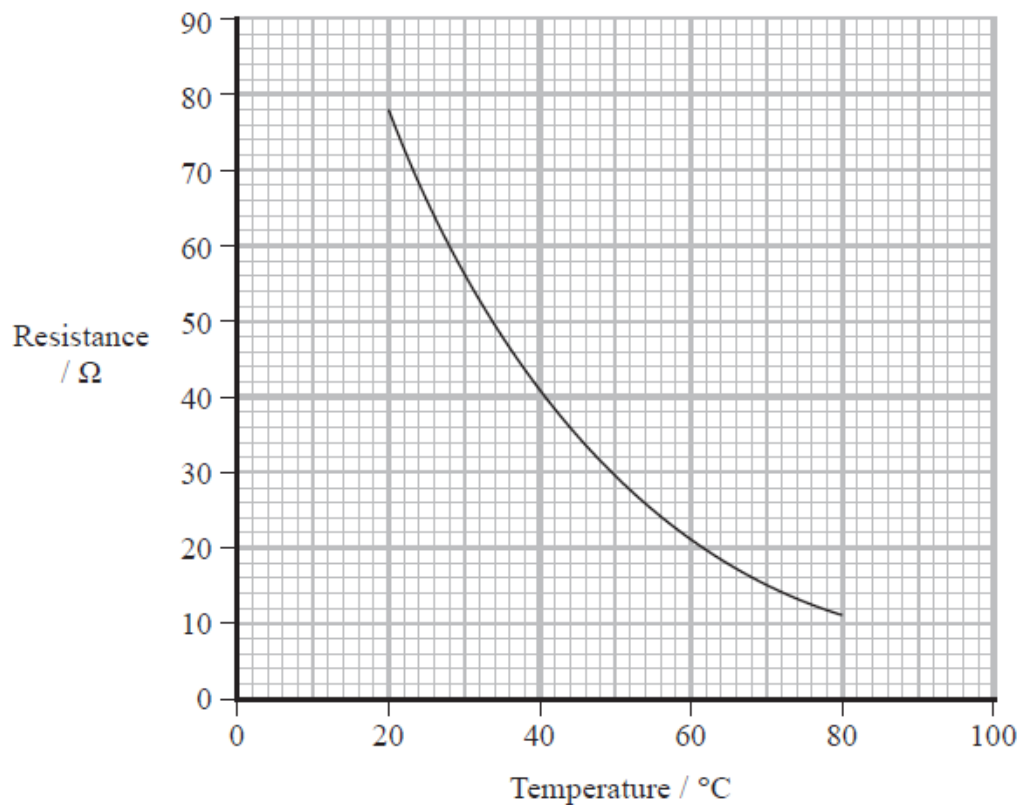
Explain why the power in the fixed resistor decreases. Your answer should include reference to the electrons in the LDR.

(4)

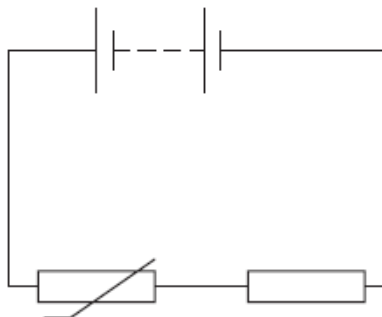
(Total for question = 13 marks)

Q14.

The resistance of a particular thermistor varies with temperature, as shown.



(a) A student connected the thermistor in series with a battery and a resistor, as shown. The resistor was made from a long length of wire.



At a temperature of 45°C , the resistance of the thermistor was four times the resistance of the resistor. The power P dissipated in the resistor was 0.38 W .

(i) Derive the equation $P = \frac{V^2}{R}$

(2)

.....

.....

.....

.....

(ii) Determine the potential difference across the battery.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

Potential difference =

(b) (i) Explain why the resistance of a thermistor decreases as the temperature increases.

(2)

.....

.....

.....

.....

(ii) The student increased the temperature of both the wire resistor and the thermistor from 80 °C to 90 °C.

Explain why the current in the circuit decreased.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

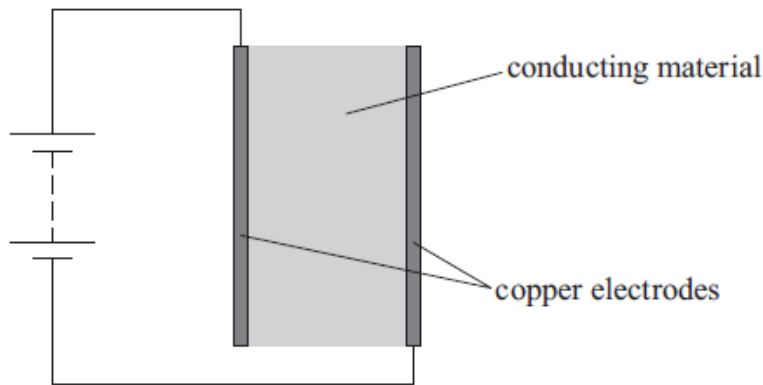
.....

(Total for question = 13 marks)

Q15.

An electrical heating system consists of heating panels.

Each panel is made from a thin sheet of conducting material attached to two copper electrodes. The electrodes are connected to a power supply, as shown.



- (a) A student uses a sample of the conducting material to determine its resistivity.
- (i) State what is meant by resistivity of a material.

(1)

.....

.....

- (ii) Describe how the student could determine a value for the resistivity of the conducting material.

You do **not** need to draw a circuit diagram.

(4)

.....

.....

.....

.....

.....

.....

.....

(b) Copper has a low resistivity compared with the resistivity of the conducting material.

Explain how the low resistivity of copper affects the drift velocity of electrons in the copper electrodes.

(2)

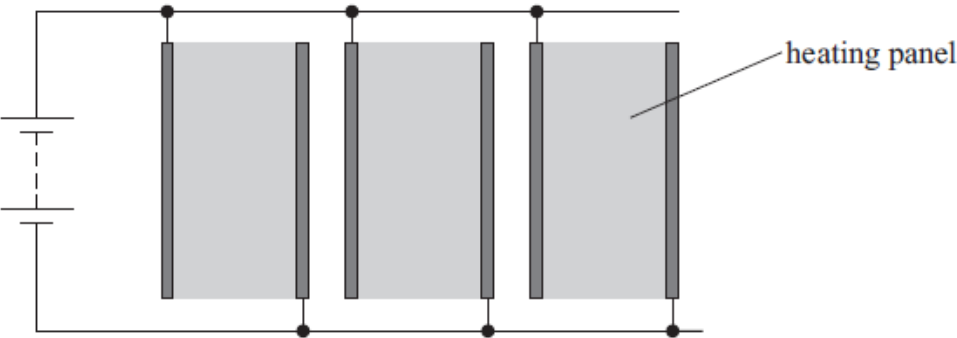
.....

.....

.....

.....

(c) The power output of the heating system can be changed by connecting more panels in parallel with the power supply, as shown.



Explain how adding panels in parallel changes the power output of the system.

(2)

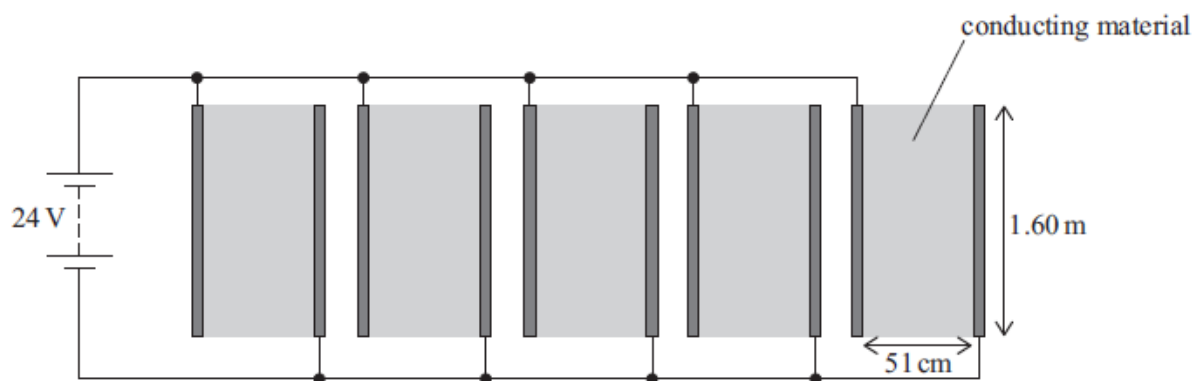
.....

.....

.....

.....

(d) A student designs a heating system using five heating panels, as shown.



To be safe, the maximum power of the student's heating system should be less than 350 W.

Deduce whether the student's heating system is safe.

resistivity of conducting material = $6.4 \times 10^{-3} \Omega \text{ m}$

thickness of conducting material = 0.48 mm

(5)

.....

.....

.....

.....

.....

.....

.....

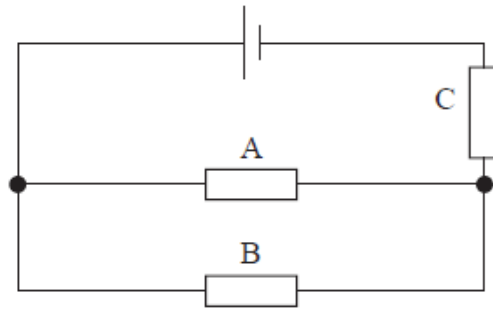
.....

.....

.....

(Total for question = 14 marks)

The diagram shows a circuit containing three identical resistors, A, B and C. The cell has negligible internal resistance.



*(a) Explain how measurements of current and potential difference could be used to demonstrate that charge and energy are both conserved in this circuit. Your answer should refer to resistors A, B and C.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) (i) Calculate the total resistance of the circuit.

resistance of each resistor = $12.5\ \Omega$

(3)

.....

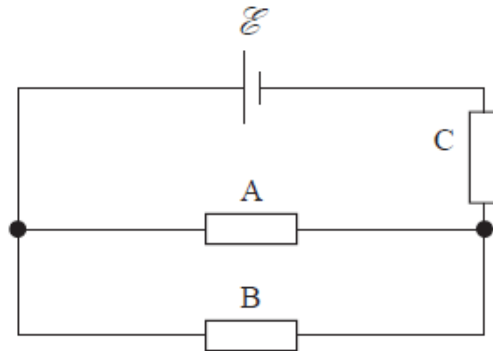
.....

.....

.....

.....
Total resistance =

(ii) The resistors are connected to a different cell, with e.m.f. $\mathcal{E}$, as shown. The cell has an internal resistance.



Describe how a single ammeter reading can be used to determine the internal resistance of the cell. You should add to the diagram to show the position of this ammeter.

(3)

.....

.....

.....

.....

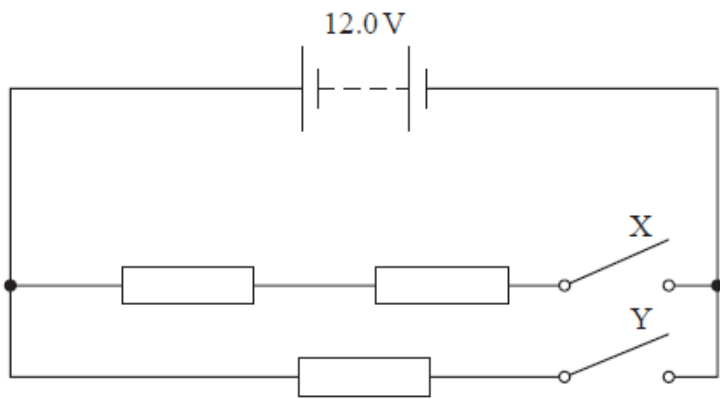
.....

.....

(Total for question = 12 marks)

Q17.

The circuit diagram shows three identical resistors and two switches, X and Y.
The battery has negligible internal resistance.



Each resistor consists of a wire of diameter 0.181 mm and length 55.0 cm. At room temperature, the resistivity of the wire is $1.10 \times 10^{-6} \, \Omega \, \text{m}$.

(a) Show that the resistance of one resistor at room temperature is about $24 \, \Omega$.

(3)

.....

.....

.....

.....

.....

.....

(b) A student suggests that the maximum power output from the resistors in this circuit will be greater than 12 W.

Assess whether the student's suggestion is correct.

(4)

.....

.....

.....

.....

.....

.....

.....

(c) Switch X was open and switch Y was closed.

(i) Calculate the number of conduction electrons passing through the resistor every second

immediately after switch Y
was closed.

(3)

.....

.....

.....

.....

.....

Number of electrons =

(ii) After switch Y had been closed for a few minutes, the power dissipated by the resistor decreased.

Explain why.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 13 marks)