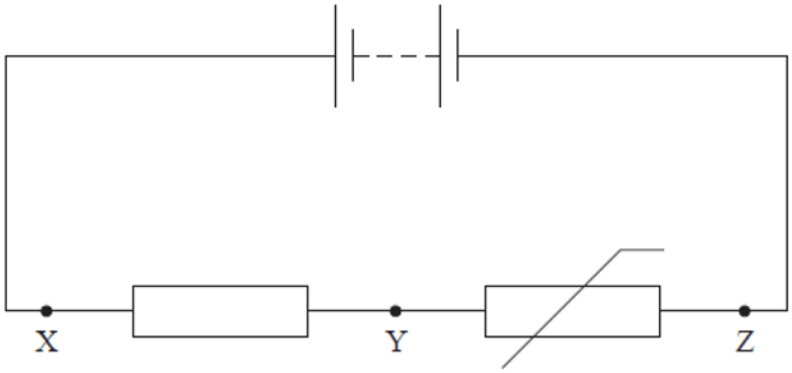
Questions

Q1.

The circuit shown includes a fixed resistor and a negative temperature coefficient thermistor.



A potential divider circuit can be created by making connections to a secondary circuit across the resistor (XY) or across the thermistor (YZ). As the temperature changes, the potential differences (p.d.) across XY and YZ both change.

Such a circuit can be used to operate an air conditioning unit in a hot classroom in order to keep the classroom cool. The air conditioning unit starts operating when the p.d. in the secondary circuit exceeds a certain value.

* (a) Explain how the circuit should be set up to keep the classroom cool. Your answer should include details of how a negative temperature coefficient thermistor works, in terms of particles.

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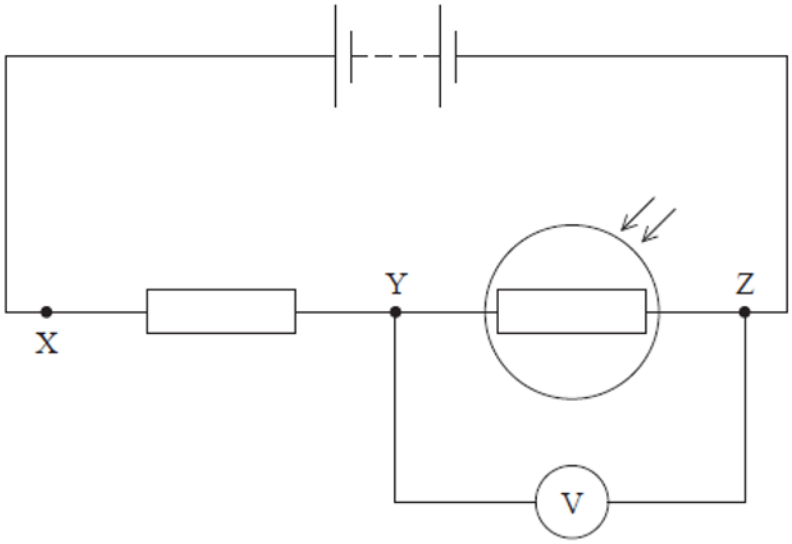
(b) The thermistor in the circuit is replaced with a light dependent resistor (LDR) and a voltmeter placed across YZ as shown.



The fixed resistor has a resistance of 1.20 kΩ. The battery has an e.m.f. of 12.0 V and negligible internal resistance. Initially the circuit is set up in a darkened room, and the voltmeter displays a reading of 4.71 V. When a light is shone directly onto the LDR, the voltmeter reads 2.16 V. Calculate the change in resistance of the LDR when the light is shone onto it.

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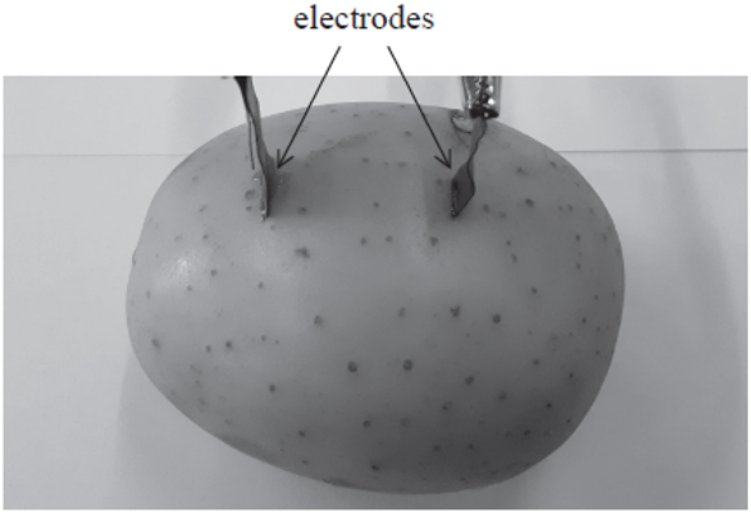
Change in resistance of the LDR = ...

(Total for question = 9 marks)

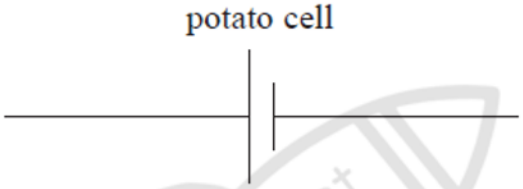
Q2.

A student carried out an experiment to determine the e.m.f. ε and internal resistance r of a potato cell. The potato used in the experiment was connected to the rest of the circuit using electrodes of two different metals as shown.

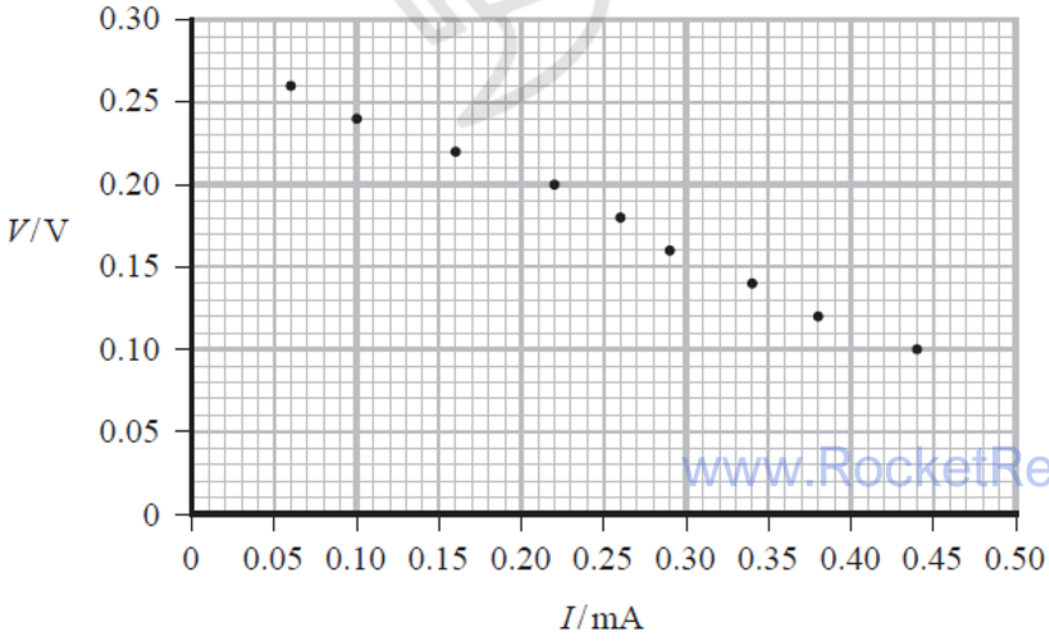


(a) Complete the diagram below to show a circuit that could be used in order to determine ε and r for the potato cell.

(2)



(b) The student completed the experiment and plotted a graph showing the relationship between potential difference V and current I as shown.



Use the graph to determine values for ε and r.

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ε = ...

r = ...

(c) In a separate experiment two resistors, with equal resistance R, are connected to a battery (with internal resistance r) with the two resistors firstly in a series arrangement (diagram A) and then in a parallel arrangement (diagram B).

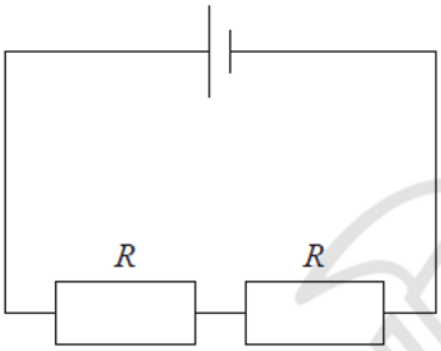

Diagram A

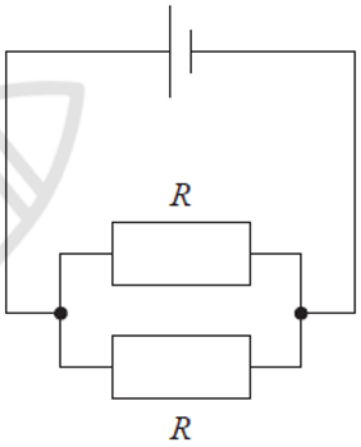

Diagram B

Explain which, if either, of the two arrangements would lead to a greater value for the terminal potential difference.

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(Total for question = 10 marks)

Q3.

Wire P and wire Q are connected in series across a battery.
Wire P has a charge carrier density n and a diameter d.
Wire Q has a charge carrier density $2n$ and a diameter $2d$.
The drift velocity of the charge carriers in wire P is v.

Which of the following is the drift velocity of the charge carriers in wire Q?

☒ **A** $\frac{v}{8}$

☒ **B** $\frac{v}{4}$

☒ **C** v

☒ **D** $4v$

(Total for question = 1 mark)

Q4.

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 ☒.

Which of the following is an SI unit for electromotive force (e.m.f)?

☒ **A** coulomb

☒ **B** joule

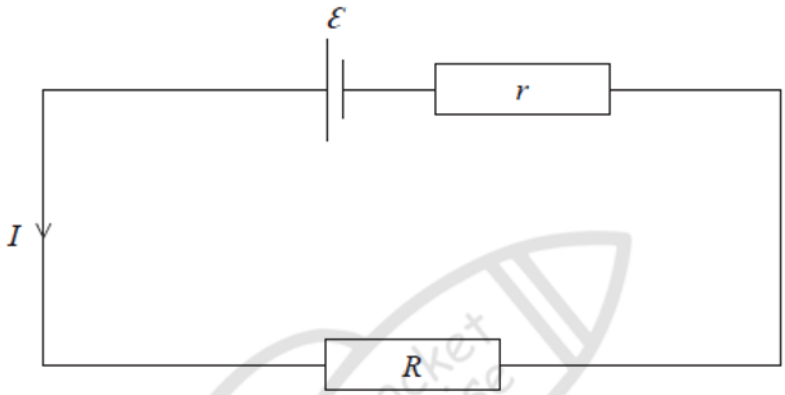
☒ **C** newton

☒ **D** volt

(Total for question = 1 mark)

Q5.

The circuit shows a resistor of resistance R connected to a cell of e.m.f. ε and internal resistance r. When the current in the circuit is I the terminal potential difference is V.



Which of the following is an expression for the power P dissipated in the internal resistance of the cell?

(1)

☒ **A** $P = I(\varepsilon - V)$

☒ **B** $P = I^2 R$

☒ **C** $P = I \varepsilon$

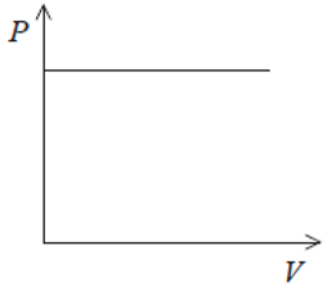
☒ **D** $P = V^2 / r$

(Total for question = 1 mark)

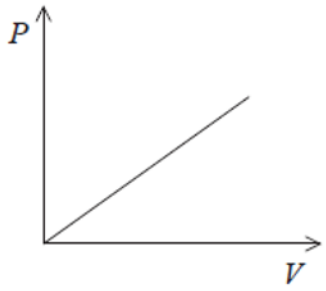
Q6.

Which of the following graphs shows how power P dissipated by an ohmic conductor varies with potential difference V across the conductor?

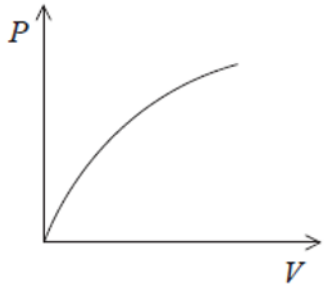
☒ **A**



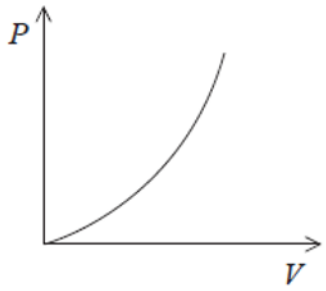
☒ **B**



☒ **C**



☒ **D**



(Total for question = 1 mark)

Q7.

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.

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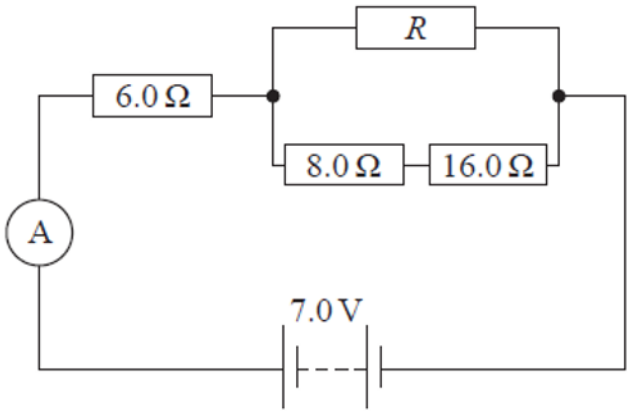
(b) The diagram shows a circuit that includes a resistor combination. The battery has negligible internal resistance.



The ammeter displays a current of 0.50 A.

Calculate the resistance R.

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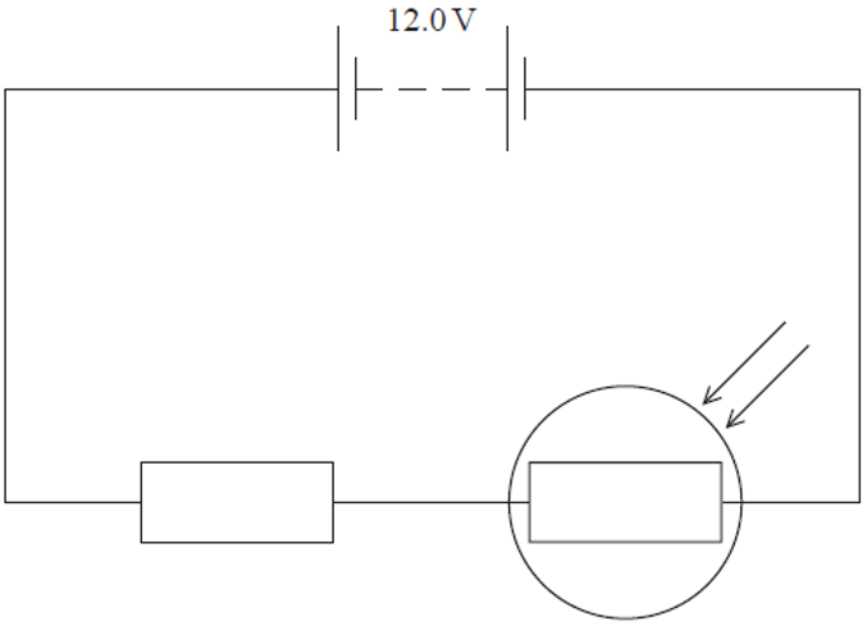
Resistance *R* .....

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



(i) In normal daylight, this particular type of LDR has a resistance of 670 Ω.

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

resistance of fixed resistor = 8.00 kΩ

(3)

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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.

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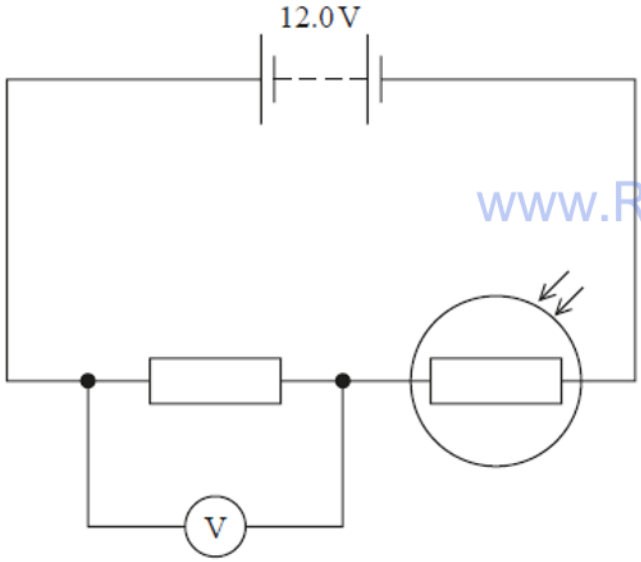
(Total for question = 13 marks)

Q8.

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 circuit shows a potential divider, including a battery of negligible internal resistance and a light dependent resistor (LDR). The potential difference (p.d.) across the fixed resistor is measured using a voltmeter.



Which of the following statements about this circuit is correct?

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A If the resistance of the LDR halves, the voltmeter reading halves.

☒ **B** Increasing the light intensity would decrease the voltmeter reading.

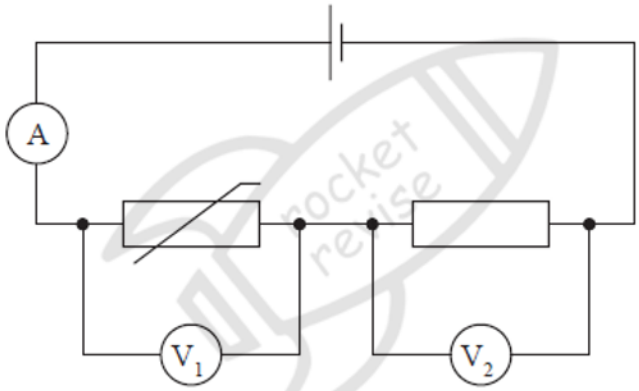
☒ **C** Increasing the light intensity would have no effect on the voltmeter reading.

☒ **D** The voltmeter reading added to the p.d. across the LDR will always be 12.0 V.

(Total for question = 1 mark)

Q9.

A negative temperature coefficient thermistor is connected in a circuit as shown.



The temperature of the thermistor is increased.

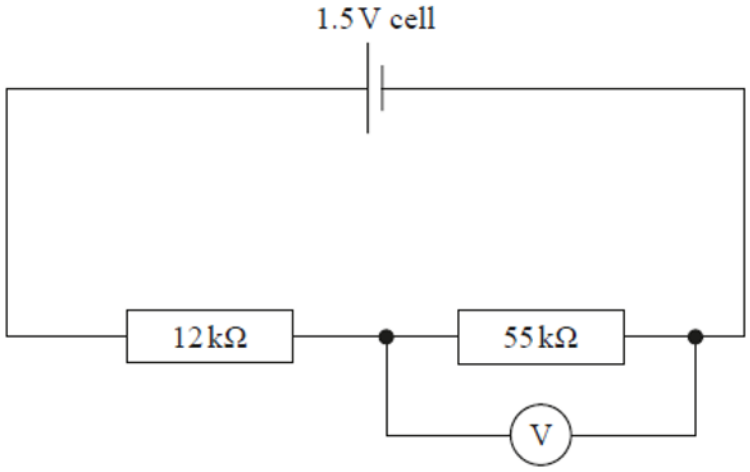
Which row of the table shows how the readings on meters V_1 and V_2 and A change?

	Reading on V_1	Reading on V_2	Reading on A
☒ **A**	decreases	increases	increases
☒ **B**	decreases	stays the same	increases
☒ **C**	increases	decreases	decreases
☒ **D**	increases	stays the same	decreases

(Total for question = 1 mark)

Q10.

A student is given the circuit diagram shown.



(a) Calculate a value for the voltmeter reading.

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Voltmeter reading = ...

(b) The student sets up the circuit and observes that the reading on the voltmeter is lower than the value calculated in (a).

Explain two reasons for the lower voltmeter reading.

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(Total for question = 6 marks)

Q11.

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

	Series	Parallel
☒ A	2.5 Ω	10 Ω
☒ B	2.5 Ω	2.5 Ω
☒ C	10 Ω	10 Ω
☒ D	10 Ω	2.5 Ω

(Total for question = 1 mark)

Q12.

A car battery is constructed using six cells connected in series, with a combined electromotive force (e.m.f.) of 12.00 V.

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

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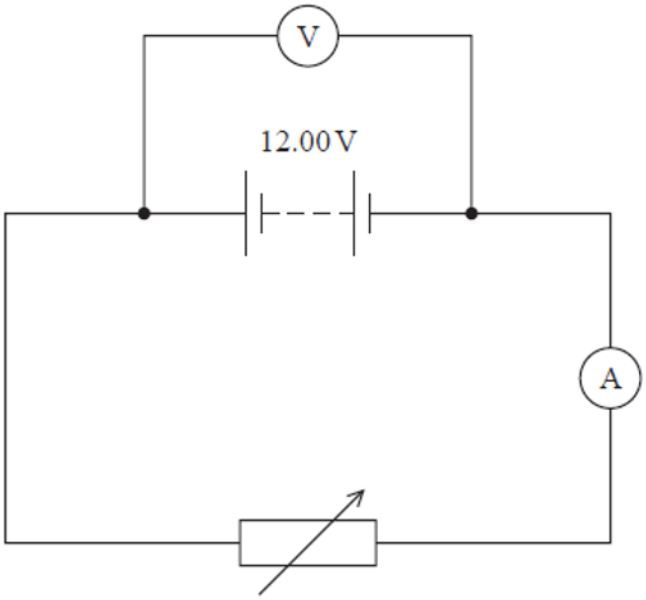
(b) A student set up the circuit shown, using the car battery.



The student adjusted the variable resistor until the reading on the voltmeter was 11.81 V. The reading on the ammeter was 9.83 A.

(i) Calculate the internal resistance of the car battery.

(2)

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Internal resistance = ...

(ii) The student adjusted the variable resistor several times and recorded corresponding values from the ammeter and voltmeter.

Describe how the values can be used to determine the internal resistance of the battery using a graphical method.

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(c) With use, the internal resistance of a battery will increase. Eventually the power available from a battery will become too small to be useful.

The student calculated the power available from a battery of e.m.f 9.0 V and internal resistance

0.10 Ω when connected across a 5.0 Ω resistor.

He concluded that when the internal resistance had risen to 0.50 Ω, the power dissipated in the 5.0 Ω resistor would reduce to 70% of its original value.

Determine whether the student's conclusion is correct.

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(Total for question = 10 marks)

Q13.

The photograph shows a typical lightning strike which occurs as a result of an electrical discharge through the atmosphere in a narrow channel between a cloud and the ground.

(Source: © Joshua Lewis/EyeEm/Getty Images)

The high current in a lightning strike heats the air sufficiently to cause rapid expansion; the resulting shock wave is heard as thunder.

(a) A teacher says that a lightning strike taking place 1 km away from the observer will result in a time of 3 s between seeing the lightning and hearing the thunder.

Determine whether the teacher is correct.

speed of sound in air = 340 m s^{-1}

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(b) The following data was collected for one particular lightning strike:

distance between cloud and ground = 400 m
current = 25 000 A
duration of lightning strike = 30 μs
potential difference between cloud and ground = 1.2×10^9 V
diameter of lightning channel = 5.0 cm

(i) Calculate the total charge transferred during the lightning strike.

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Total charge transferred = ...

(ii) Calculate the power dissipated by the lightning strike.

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Power dissipated = ...

(iii) Show that the resistivity of the air in the lightning channel is about 0.2 Ω m.

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(iv) The accepted value for the resistivity of air is 10^{16} Ω m.

Suggest why the value calculated from the data is so much less than the accepted value.

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(c) Air consists mainly of nitrogen and oxygen molecules. Analysis of the light produced during a lightning strike shows a weak line spectrum.

(i) Explain the process by which nitrogen atoms produce a line spectrum.

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(ii) State why the line spectrum produced by oxygen atoms in the air would be different from the line spectrum produced by nitrogen atoms.

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(Total for question = 16 marks)

Q14.

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 ☒ .

Which of the following statements about physical quantities or units is correct?

☒ **A** Current is a derived quantity.

☒ **B** Power is a derived quantity.

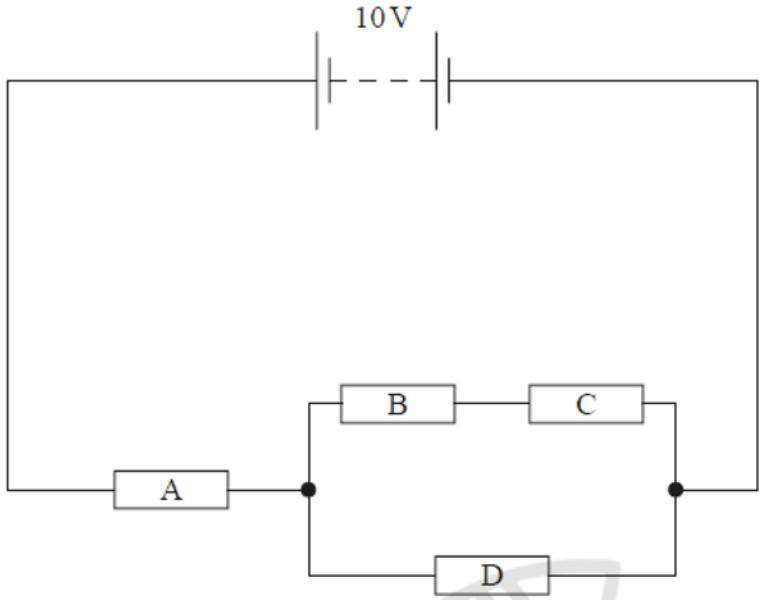
☒ **C** The coulomb is a base unit.

☒ **D** The volt is a base unit.

(Total for question = 1 mark)

Q15.

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

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(b) Explain, without further calculation, what would happen to the power dissipated by resistor A

if resistor D were disconnected from the circuit.

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(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.

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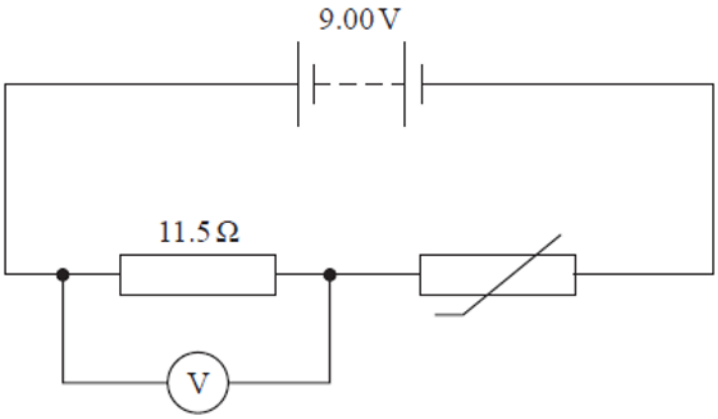
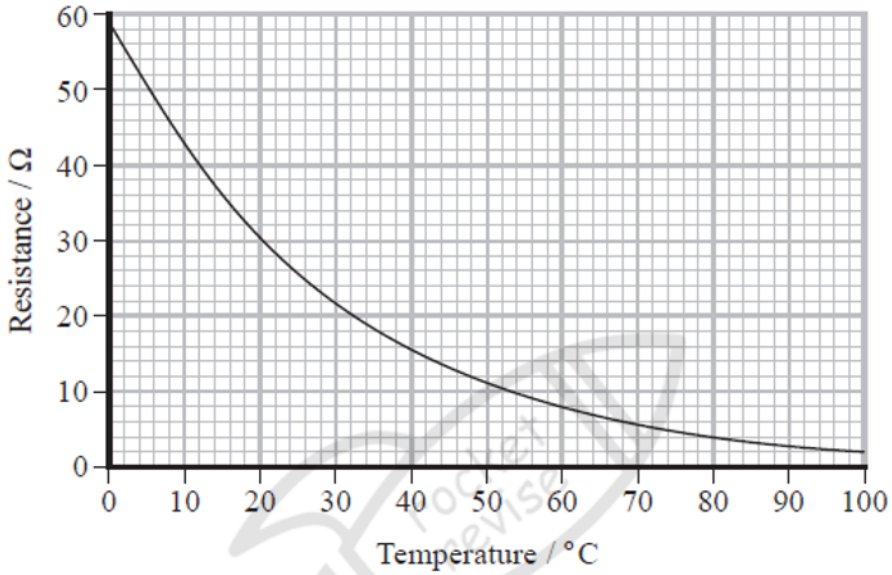
(Total for question = 12 marks)

Q16.

A student connected the circuit shown. The battery has negligible internal resistance.



The graph shows how the resistance of the thermistor varies with temperature.



(a) The reading on the voltmeter is 3.42 V.

Determine the temperature of the thermistor.

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Temperature = ...

(b) The student suggests that if the e.m.f. of the battery is doubled, the reading on the voltmeter will double.

Assess whether the student's suggestion is correct.

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(Total for question = 8 marks)

Q17.

(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.

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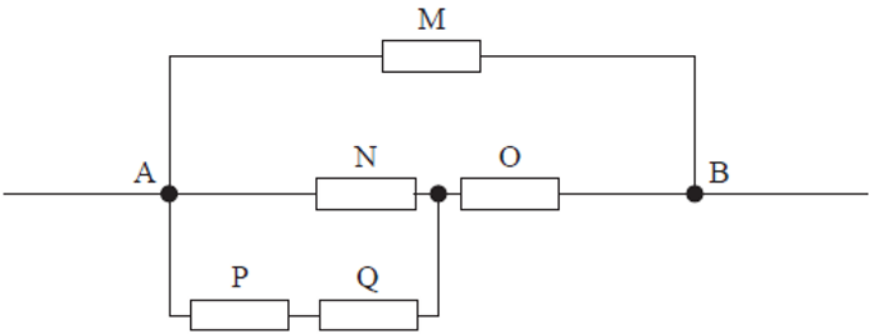
(b) The diagram shows a combination of five resistors, M, N, O, P and Q. Each resistor has a resistance of 5.0 Ω.



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

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(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 Ω. She cannot change the arrangement of the resistors, but she can replace one of the 5.0 Ω resistors with a 20.0 Ω resistor.

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

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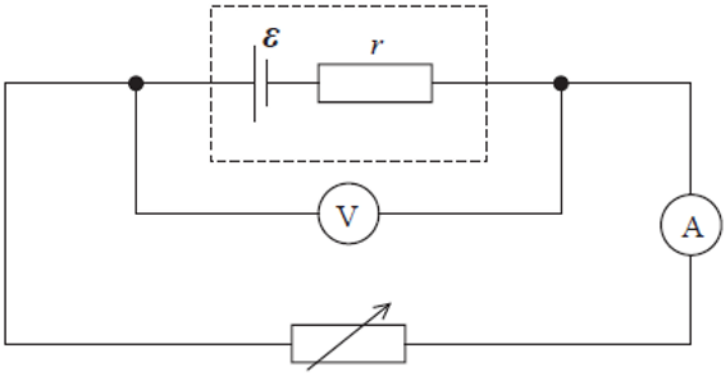
(Total for question = 8 marks)

Q18.

The diagram shows a circuit used to determine the internal resistance *r* and e.m.f. ε of a cell.



The resistance of the variable resistor is R.

Which of the following gives the current in the cell?

☒ **A** $\frac{\varepsilon}{R}$

☒ **B** $\frac{\varepsilon}{r}$

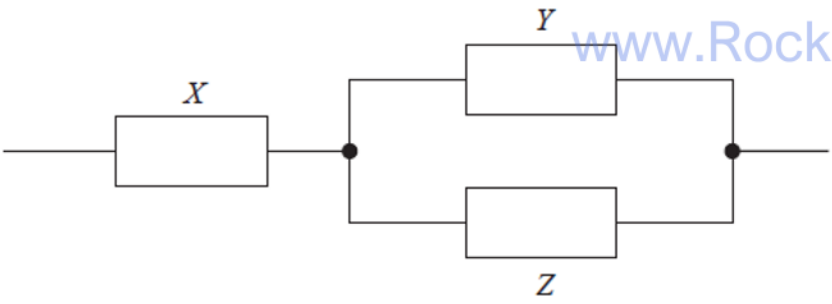
☒ **C** $\frac{\varepsilon}{(R+r)}$

☒ **D** $\frac{\varepsilon}{(R-r)}$

(Total for question = 1 mark)

Q19.

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** $\frac{1}{X} + Y + Z$

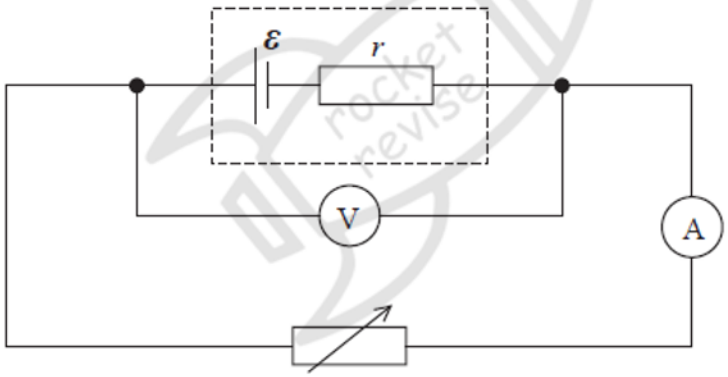
☒ **C** $X + \frac{YZ}{Y + Z}$

☒ **D** $\frac{1}{X} + \frac{Y + Z}{YZ}$

(Total for question = 1 mark)

Q20.

The diagram shows a circuit used to determine the internal resistance *r* and e.m.f. ε of a cell.



Corresponding values of potential difference *V* and current *I* were taken after adjusting the variable resistor. A graph of *V* on the *y*-axis against *I* on the *x*-axis was plotted.

Which of the following is correct?

☒ **A** The area underneath the graph is the total energy dissipated in the cell.

☒ **B** The gradient of the graph is *r*.

☒ **C** The graph shows that *V* and *I* are directly proportional.

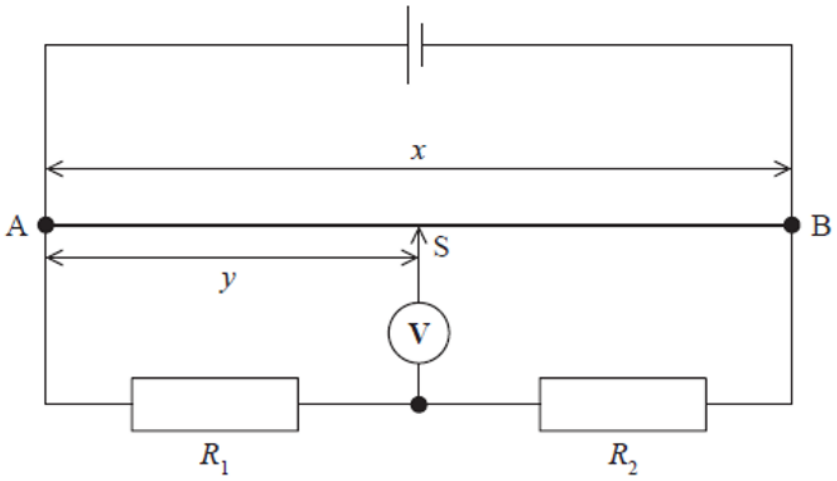
☒ **D** The *y*-intercept of the graph is ε.

(Total for question = 1 mark)

Q21.

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 current-carrying wire AB of length *x* and uniform diameter is connected in a circuit as shown.



The slider S is moved along the wire until the reading on the voltmeter is 0 V.

Which of the following equations is correct?

☒ **A** $\frac{y}{x} = \frac{R_1}{R_2}$

☒ **B** $\frac{y}{x-y} = \frac{R_1}{R_2}$

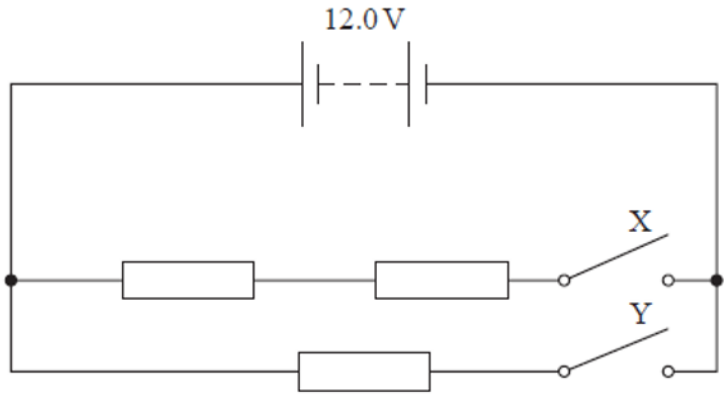
☒ **C** $\frac{x}{y} = \frac{R_1}{R_2}$

☒ **D** $\frac{x}{y} = \frac{R_1}{R_1 + R_2}$

(Total for question = 1 mark)

Q22.

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 1.10×10^{-6} Ω m.

(a) Show that the resistance of one resistor at room temperature is about 24 Ω.

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(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)

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(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)

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Number of electrons = ...

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

Explain why.

(3)

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(Total for question = 13 marks)

Q23.

A filament lamp is marked 12 V 60 W. The filament is made from a long metal wire with a diameter of 0.25 mm. The metal has a resistivity of 5.6×10^{-8} Ω m when the wire is at normal operating temperature.

(a) Calculate the length of the wire in the filament.

(4)

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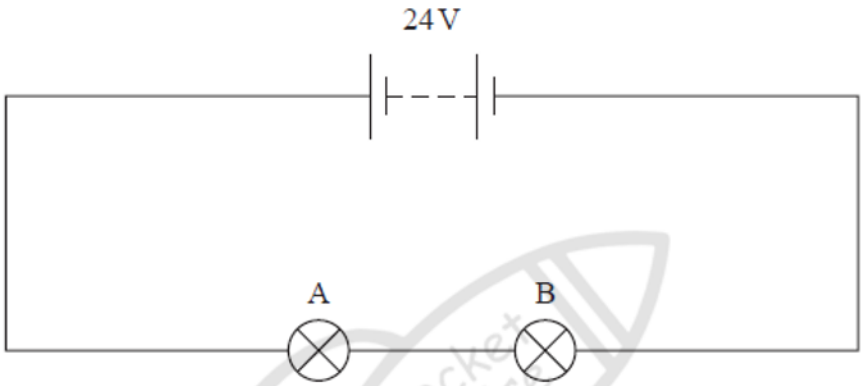
Length of wire = ...

(b) A student has two filament lamps. Lamp A is marked 12 V 60 W and lamp B is marked 12 V 30 W. The student sets up the circuit shown.



The student states that both lamps will operate normally.

Evaluate whether the student's statement is correct.

(3)

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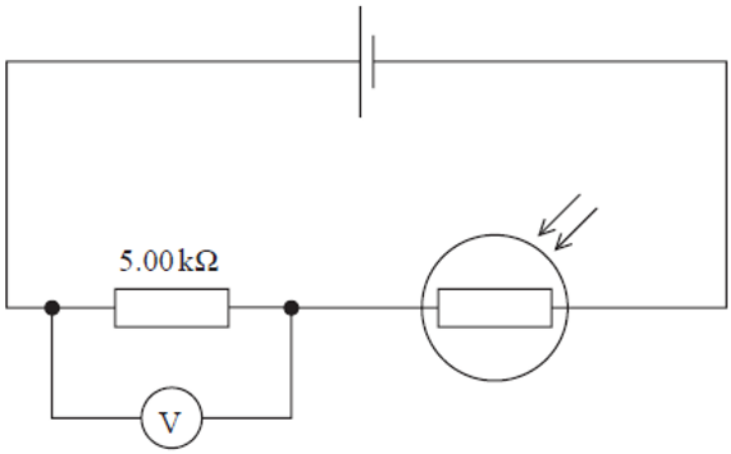
(Total for question = 7 marks)

Q24.

A student investigated how light intensity affects the resistance of a light dependent resistor (LDR).

She set up a circuit using a cell with negligible internal resistance, as shown.



The e.m.f. of the cell was 1.50 V. When the lights in the laboratory were switched off, the voltmeter reading was 1.19 V.

(a) Calculate the resistance of the LDR when the lights were off.

(2)

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Resistance of LDR = ...

(b) When the lights were switched back on, the student discovered that it was impossible to calculate the resistance of the
LDR using this circuit. The teacher said that with the lights on, the resistance of the LDR was about 9 Ω.

Explain why the student was unable to use the circuit to determine the resistance of the LDR with the lights on. The resolution of the voltmeter was 0.01 V.

(2)

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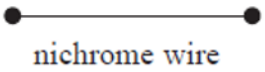
(Total for question = 4 marks)

Q25.

A student carried out an experiment to determine the resistivity of nichrome wire. Her circuit included an ammeter, a voltmeter and a variable resistor.

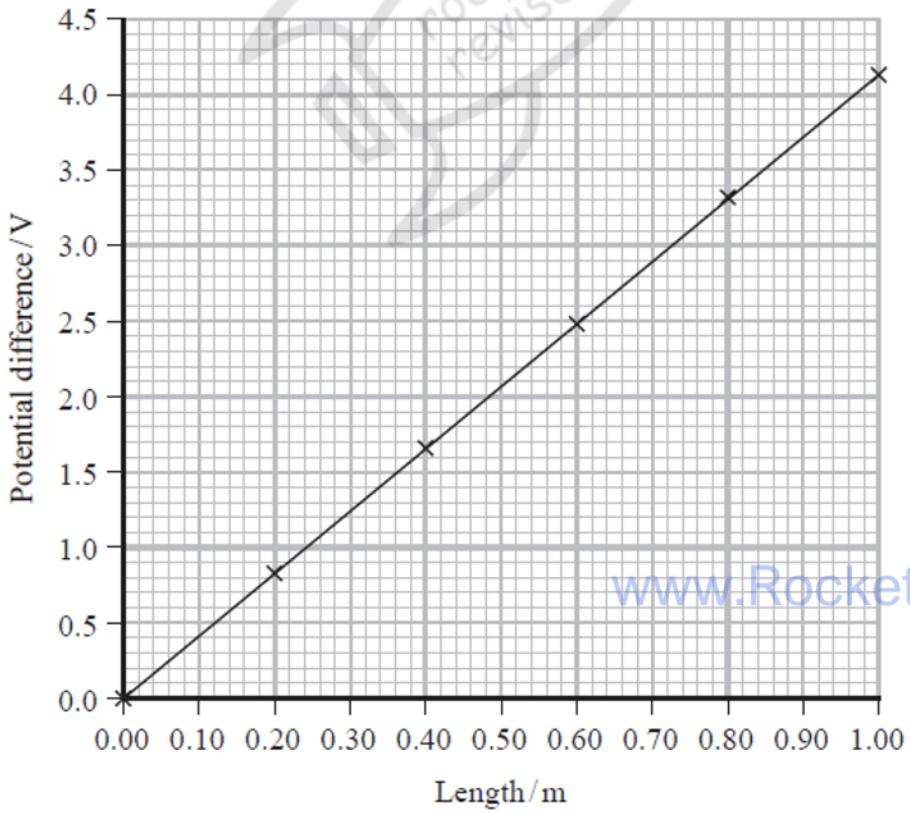
(a) Complete the circuit diagram for this experiment.

(2)



(b) The student varied the length of the nichrome wire in the circuit. For each length, she measured the potential difference across the nichrome wire. She used the variable resistor to keep the current in the wire at 0.200 A during the experiment.

The student plotted a graph of potential difference against length of nichrome wire.



(i) Determine the resistivity of nichrome.

cross sectional area of nichrome wire = 5.31×10^{-8} m^2

(4)

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Resistivity of nichrome = ...

(ii) Calculate the power dissipated from the nichrome wire to the surroundings when the length of the wire is 0.75 m.

(3)

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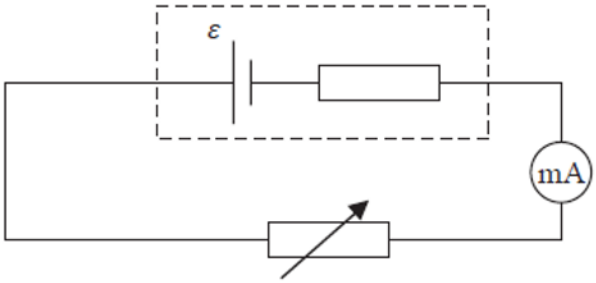
Power dissipated = ...

(Total for question = 9 marks)

Q26.

A cell of e.m.f. ε is connected in series with a variable resistor with resistance R as shown. The internal resistance of the cell is r.



When R is 12 Ω, the reading on the ammeter is 107 mA. The circuit is switched on for 300 seconds. In this time, 50 J of energy is transferred by the cell.

(a) Calculate r.

(5)

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r = ...

(b) Increasing R would make the terminal potential difference value closer to ε.

Explain why, without further calculation.

(2)

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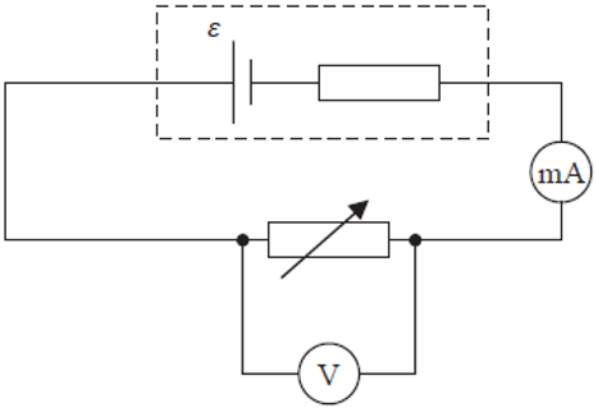
(c) A voltmeter is added to the circuit as shown.



Explain how this circuit can be used to determine a value for *r* using a graphical method.

(4)

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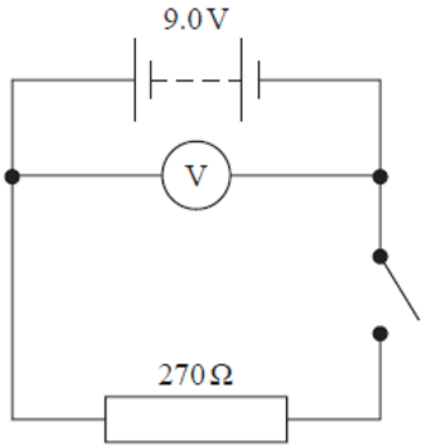
(Total for question = 11 marks)

Q27.

The circuit diagram shows a resistor of resistance 270 Ω connected to a battery of e.m.f. 9.0 V. The battery has an internal resistance of 15 Ω.



(a) Explain why the reading on the voltmeter is less than 9.0 V when the switch is closed.

(3)

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(b) Calculate the reading on the voltmeter when the switch is closed.

(3)

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Reading on voltmeter = ...

(c) The switch remains closed and 12 C of charge flows through the battery.

Calculate the decrease in the chemical energy store of the battery.

(2)

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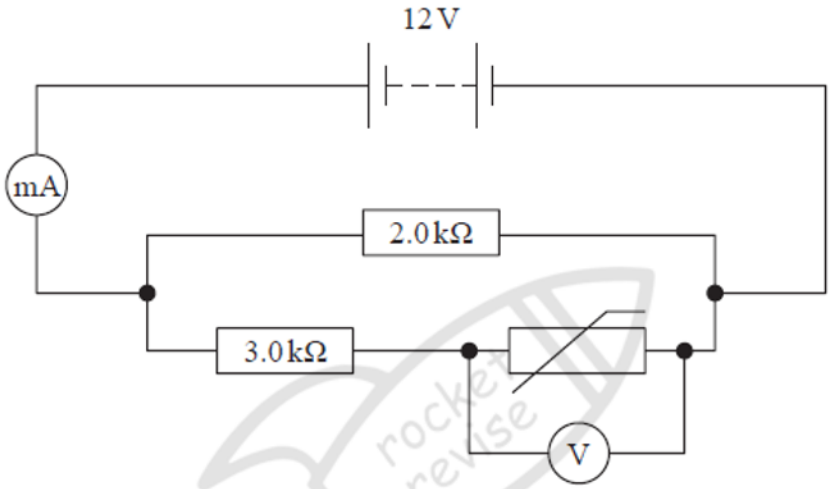
Decrease in chemical energy store = ...

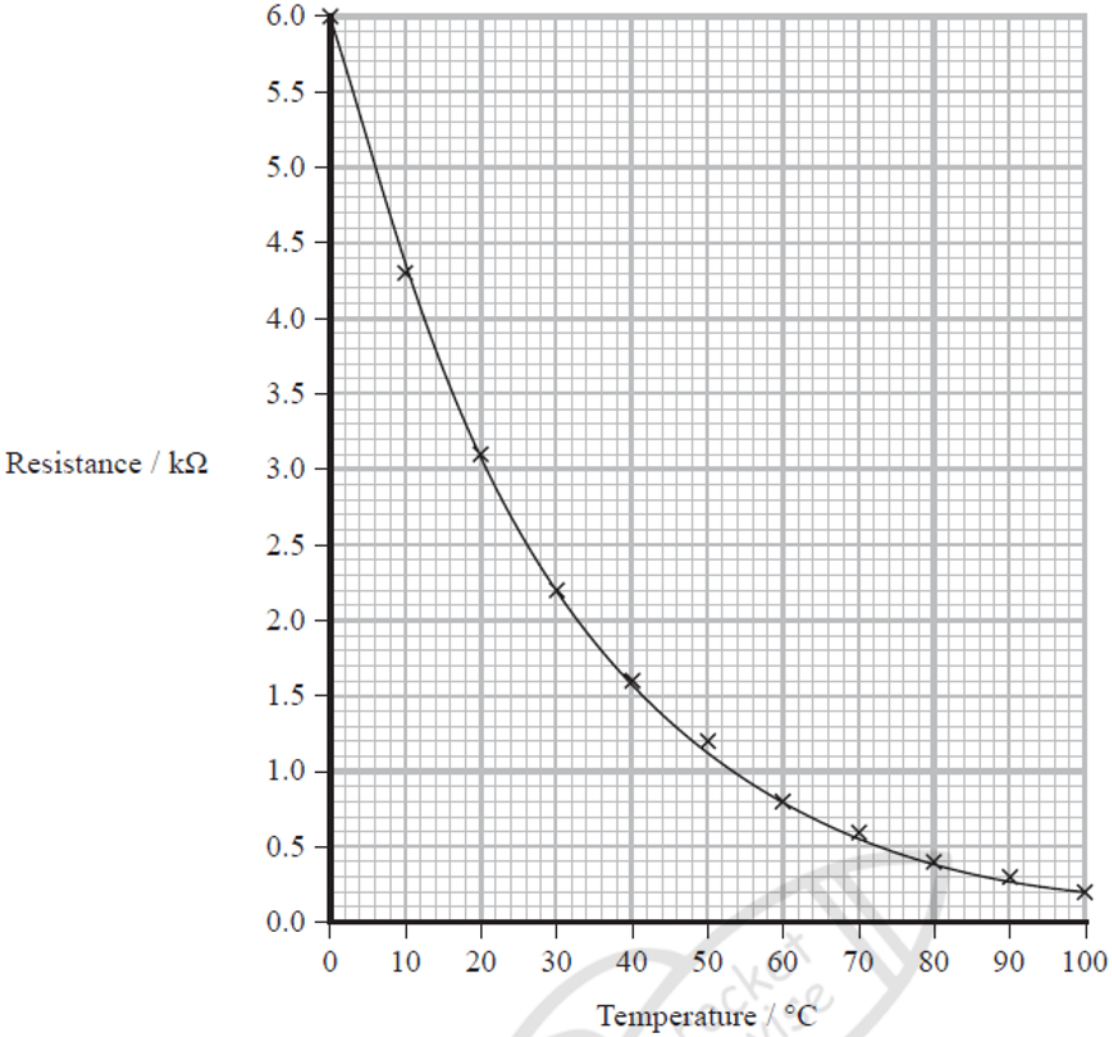
(Total for question = 8 marks)

Q28.

A student set up the circuit shown. The battery had a negligible internal resistance.



The resistance of the thermistor varies with temperature, as shown by the graph.



(a) Determine the milliammeter reading when the temperature of the thermistor is 54 °C.

(4)

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Milliammeter reading = ...mA

(b) (i) Explain how decreasing the temperature of the thermistor affects the voltmeter reading. Do not include calculations in your answer.

(2)

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(ii) Explain how decreasing the temperature of the thermistor affects the power dissipated by the 2.0 kΩ resistor. Do not include calculations in your answer.

(2)

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(Total for question = 8 marks)

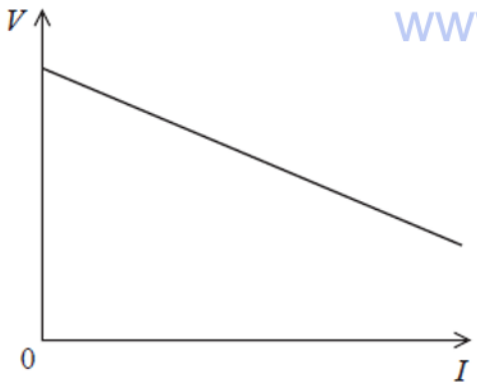
Q29.

A student carries out an experiment to determine the e.m.f. ε and internal resistance r of an electrical cell, using a circuit containing an ammeter and a voltmeter.

(a) Draw a diagram of a circuit that can be used for this experiment.

(3)

(b) The student plotted a graph of the terminal potential difference V of the cell against the current I in the cell, as shown.



Explain how ε and r for the cell can be determined from this graph.

(4)

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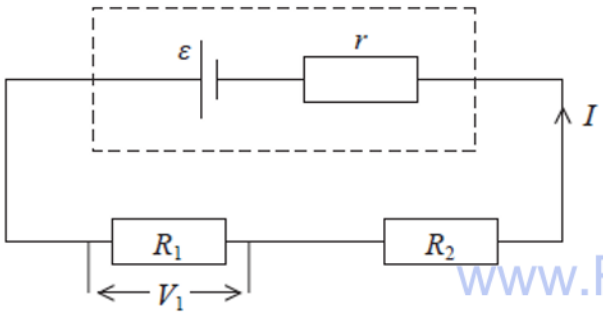
(Total for question = 7 marks)

Q30.

Select one answer from A to D and put a cross in the box ☒. 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 a cell of e.m.f. ε and internal resistance r. The cell is connected in series with two resistors of resistance R_1 and R_2. The potential difference across R_1 is V_1. The current in the circuit is I.



Which of the following expressions is correct?

☒ **A** $\varepsilon = V_1 + Ir$

☒ **B** $\varepsilon = IR_1 + Ir$

☒ **C** $\varepsilon = IR_2 + Ir$

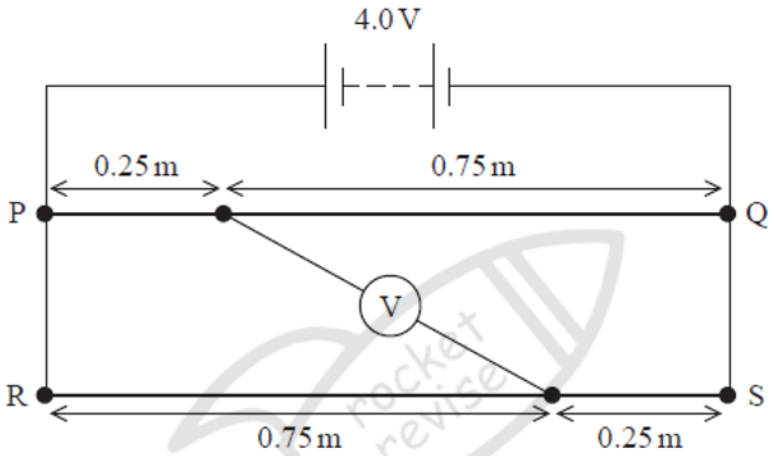
☒ **D** $\varepsilon = V_1 + IR_2 + Ir$

(Total for question = 1 mark)

Q31.

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

A battery is connected to identical, uniform, nichrome wires, PQ and RS. A voltmeter is connected to the wires as shown. The battery has negligible internal resistance.



Which of the following is the reading on the voltmeter?

☒ **A** 1.0 V

☒ **B** 2.0 V

☒ **C** 3.0 V

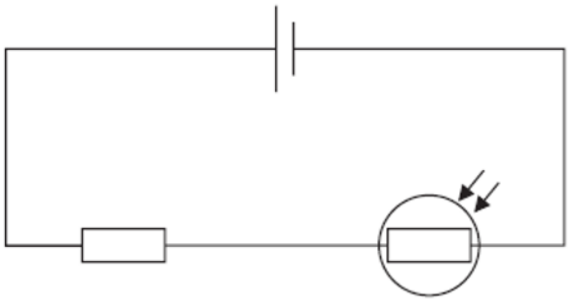
☒ **D** 4.0 V

(Total for question = 1 mark)

Q32.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A light dependent resistor (LDR) and a fixed resistor are connected in a circuit, as shown.



The intensity of the light incident on the LDR is increased.

Which of the following does **not** take place as the light intensity is increased?

☒ **A** The current in the circuit increases.

☒ **B** The potential difference across the fixed resistor increases.

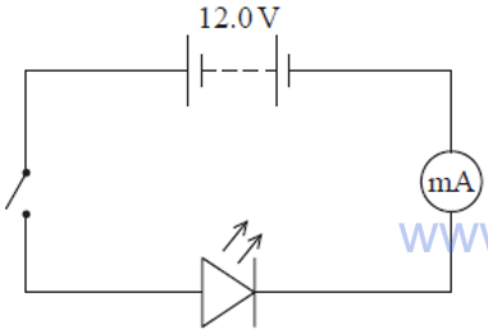
☒ **C** The total power dissipated in the circuit decreases.

☒ **D** The resistance of the LDR decreases.

(Total for question = 1 mark)

Q33.

A red light-emitting diode (LED) was placed into a circuit, as shown.



The LED emits light of wavelength of 627 nm and may be assumed to be 100% efficient. The battery has negligible internal resistance.

When the switch was closed, the reading on the ammeter was 9.2 mA.

(a) (i) Show that the power of the LED was about 0.1 W.

(2)

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(ii) Calculate the number of photons emitted by the LED in one minute.

(4)

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Number of photons emitted in one minute = ...

(b) The red LED was replaced with a green LED which emits light with a shorter wavelength than the red LED. The current in the circuit did not change.

Explain how replacing the LED affected the number of photons emitted in one minute.

(2)

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(c) The maximum intensity of sunlight at the Earth's surface is about 1100 W m^{-2}.

A student suggests that the intensity of light at a distance of 5.0 mm from an LED with a power of 0.69 W is greater than the intensity of sunlight at the Earth's surface.

Assess whether the student's suggestion is correct.

(3)

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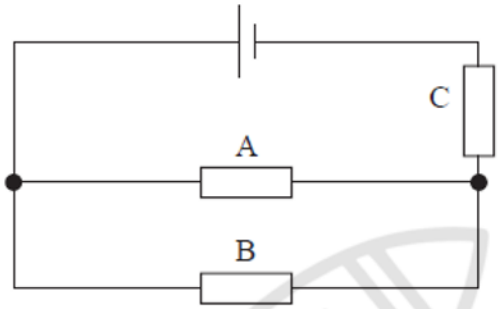
(Total for question = 11 marks)

Q34.

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)

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

resistance of each resistor = 12.5 Ω

(3)

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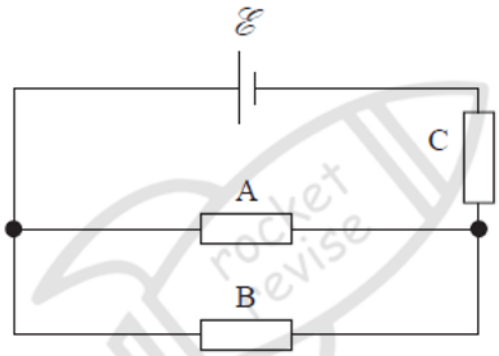
Total resistance = ...

(ii) The resistors are connected to a different cell, with e.m.f. $\mathscr{E}$, 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)

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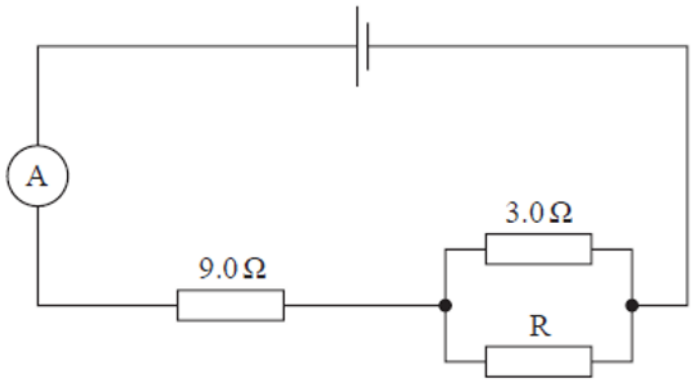
(Total for question = 12 marks)

Q35.

A student sets up the circuit shown with a cell of negligible internal resistance.

The ammeter displays a current of 0.14 A.



(a) Calculate a value for the resistance of the resistor R.

e.m.f. of the cell = 1.54 V

(4)

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Resistance = ...

(b) The student made the 9.0 Ω resistor using a thin copper wire with a diameter of 0.15 mm.

(i) Show that the cross-sectional area of this wire was about 2×10^{-8} m^2.

(2)

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(ii) Calculate the length of copper wire used by the student.

resistivity of copper = 1.68×10^{-8} Ω m

(2)

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Length of copper wire = ...

(iii) Calculate the drift velocity of the electrons in this copper wire.

number of charge carriers per unit volume = 8.49×1028 m^{-3}
current in copper wire = 0.14 A

(2)

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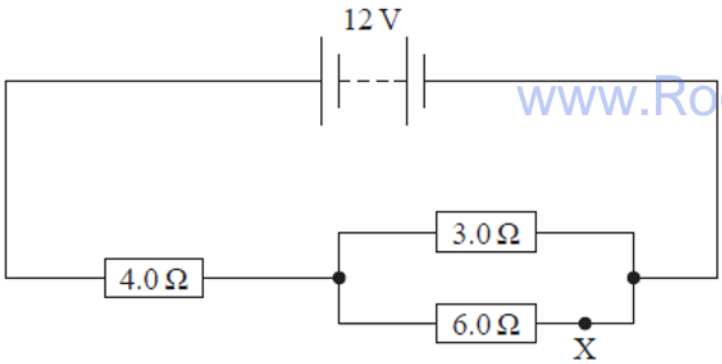
Drift velocity = ...

(Total for question = 10 marks)

Q36.

A student set up the circuit shown.



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

(6)

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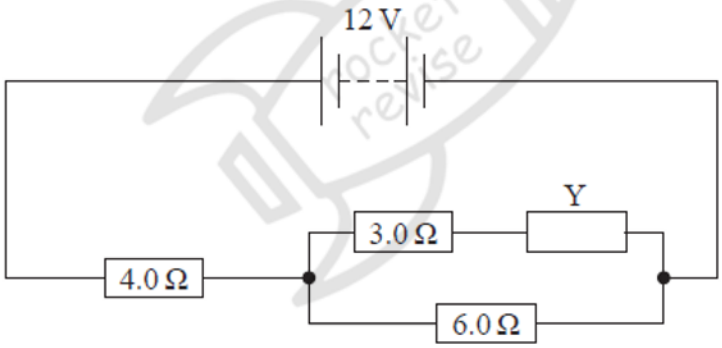
Number of electrons in one second = ...

(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)

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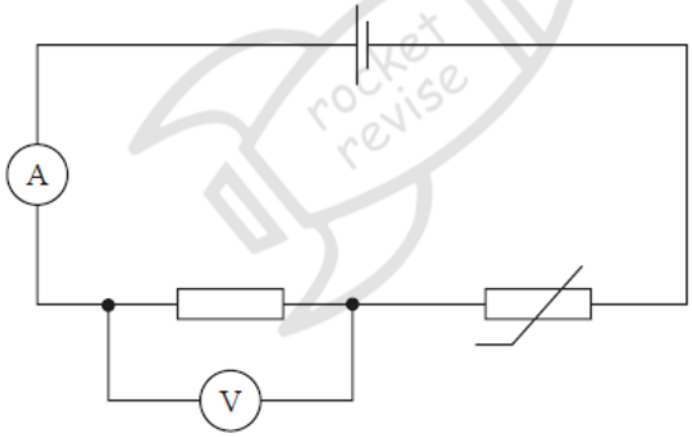
(Total for question = 10 marks)

Q37.

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 negative temperature coefficient thermistor and a fixed resistor are connected in a circuit, as shown.



The temperature of the thermistor increases.

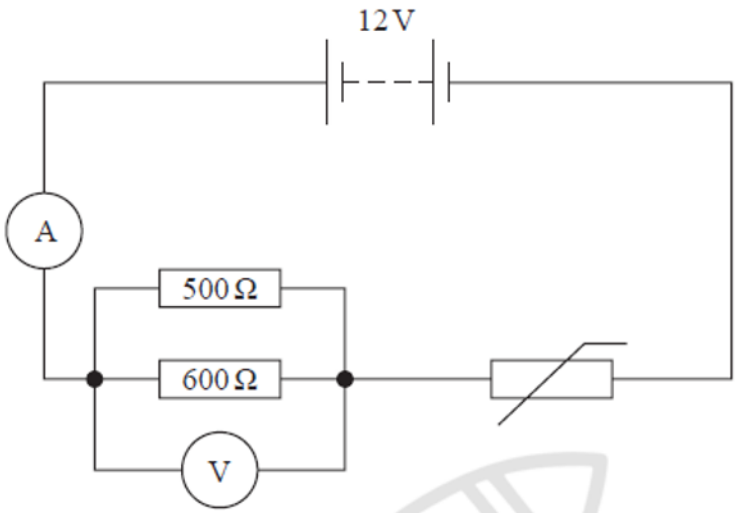
Which row of the table shows the changes to the ammeter and voltmeter readings as the temperature increases?

		Ammeter reading	Voltmeter reading
☒	**A**	decreases	decreases
☒	**B**	decreases	increases
☒	**C**	increases	decreases
☒	**D**	increases	increases

(Total for question = 1 mark)

Q38.

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)

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(ii) Calculate the power dissipated by the thermistor.

(3)

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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)

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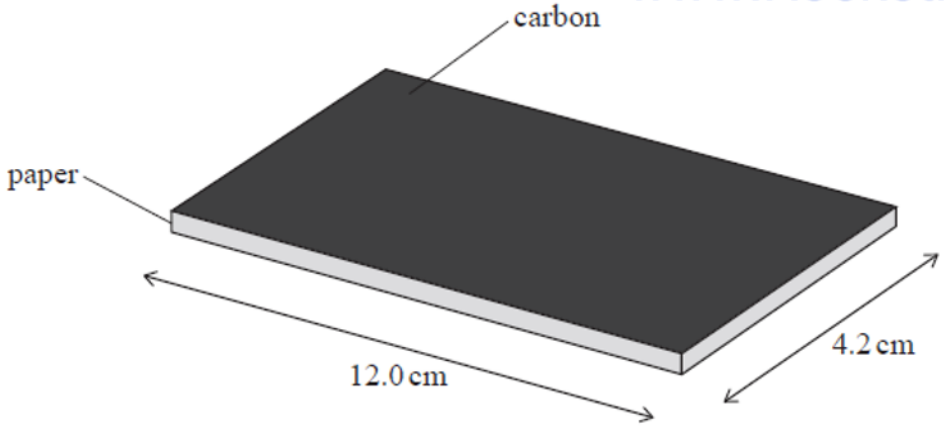
(Total for question = 10 marks)

Q39.

'Resistivity paper' is paper covered with a thin layer of carbon.

The distance between the ends of a piece of resistivity paper is 12.0 cm. The resistivity paper is 4.2 cm wide as shown.



The resistance between the ends of the resistivity paper is 8.8 Ω.

(a) Calculate the thickness of the layer of carbon.

resistivity of carbon = 3.7×10^{-5} Ω m

(3)

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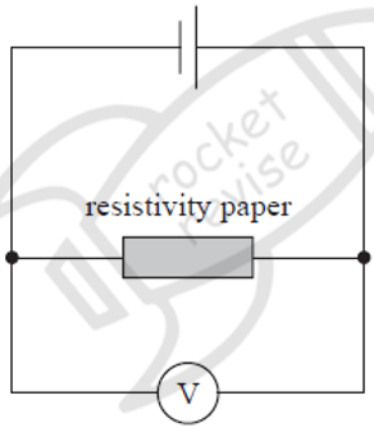
Thickness of layer of carbon = ...

(b) A student connected the ends of the resistivity paper to a cell of e.m.f. 1.5 V and a voltmeter, as shown.



(i) The reading on the voltmeter was 1.4 V.

Calculate the internal resistance of the cell.

(3)

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Internal resistance = ...

(ii) The connection to the right-hand terminal of the voltmeter was moved to a distance of 3.0 cm from the left-hand side of the resistivity paper.

Determine the reading on the voltmeter.

(1)

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Reading on voltmeter = ...

(Total for question = 7 marks)

Q40.

Part of an electrical circuit is shown.

In 60 seconds, 4.80×10^{20} electrons pass point Z.

(a) Show that the current at Z is about 1.3 A.

(3)

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(b) In 60 seconds, the resistor transfers 24 J of energy.

Calculate the potential difference across the resistor.

(2)

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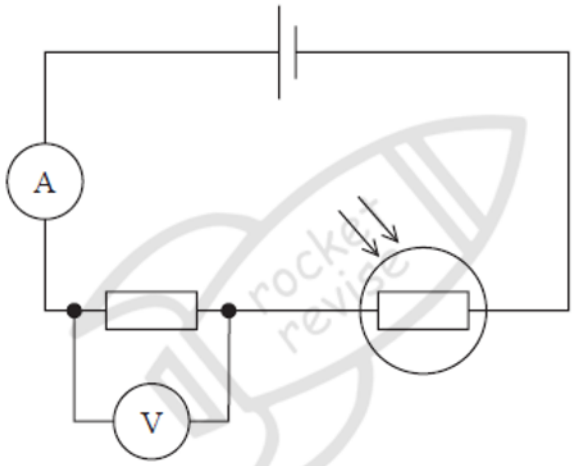
Potential difference = ...

(Total for question = 5 marks)

Q41.

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 intensity of light incident on the light dependent resistor decreases.

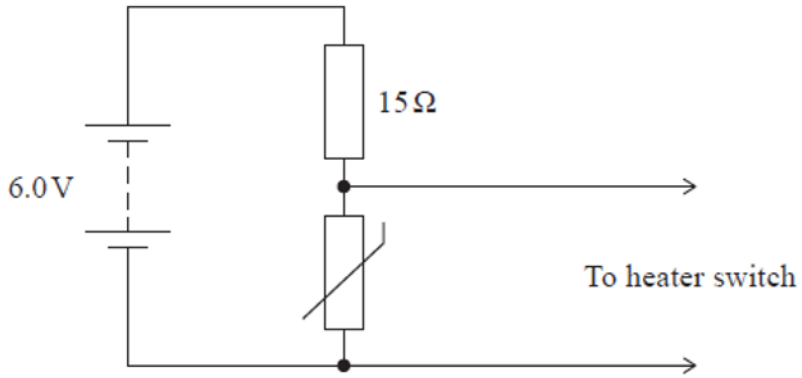
Which row of the table is correct?

		Ammeter reading	Voltmeter reading
☒	**A**	decreases	decreases
☒	**B**	increases	increases
☒	**C**	decreases	increases
☒	**D**	increases	decreases

(Total for question = 1 mark)

Q42.

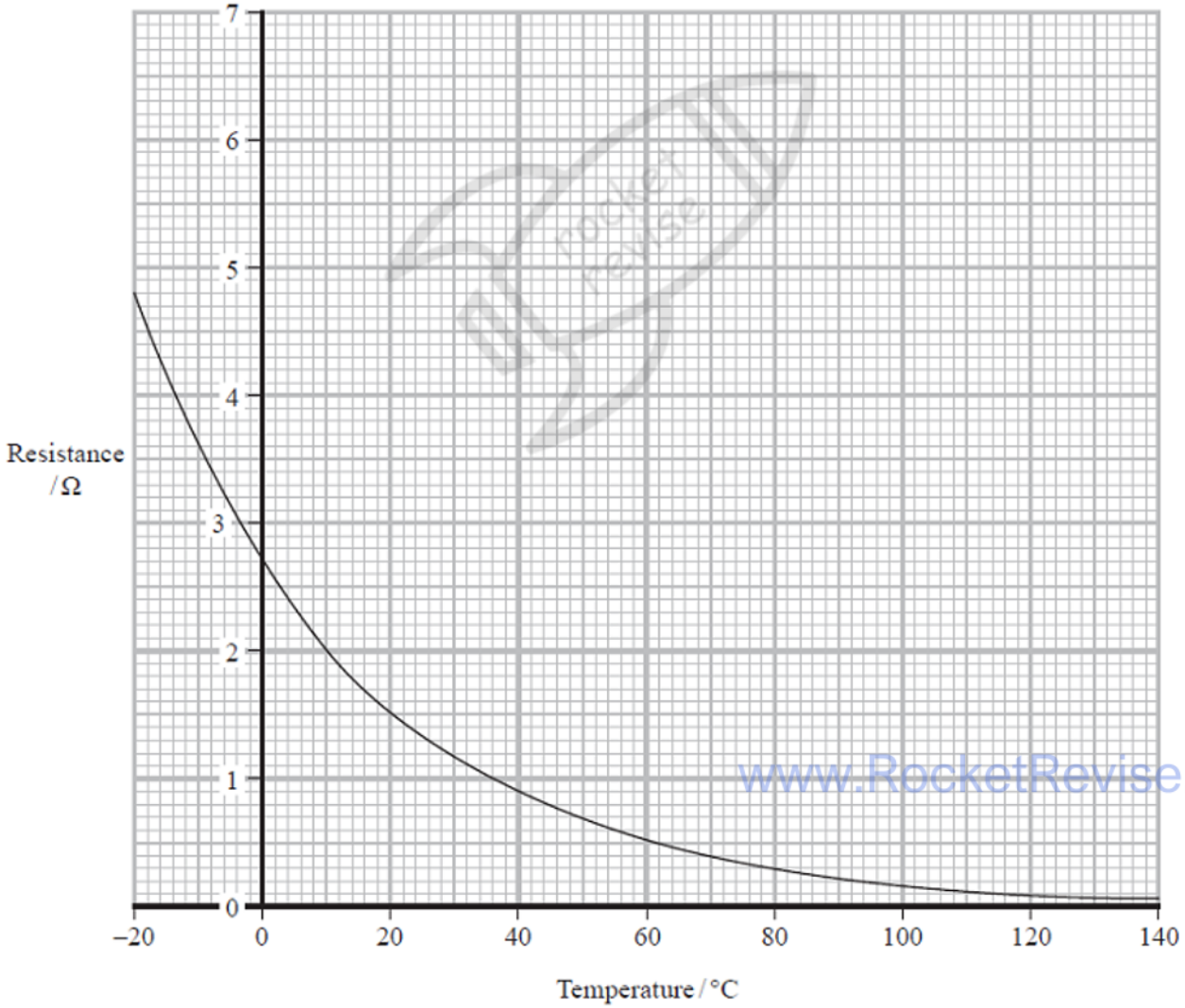
A temperature-sensing circuit consists of a fixed resistor and a thermistor, as shown.



The circuit supplies a potential difference (p.d.) to operate the heater switch.

The heater switches on when the p.d. across the thermistor is greater than 0.7 V.

The resistance of the thermistor varies with temperature as shown on the graph.



(a) Deduce whether this circuit would switch on the heater when the temperature falls below 10 °C.

You should include a calculation of the p.d. across the thermistor when the temperature is 10 °C.

(6)

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(b) Explain why the resistance of the thermistor changes with temperature.

(2)

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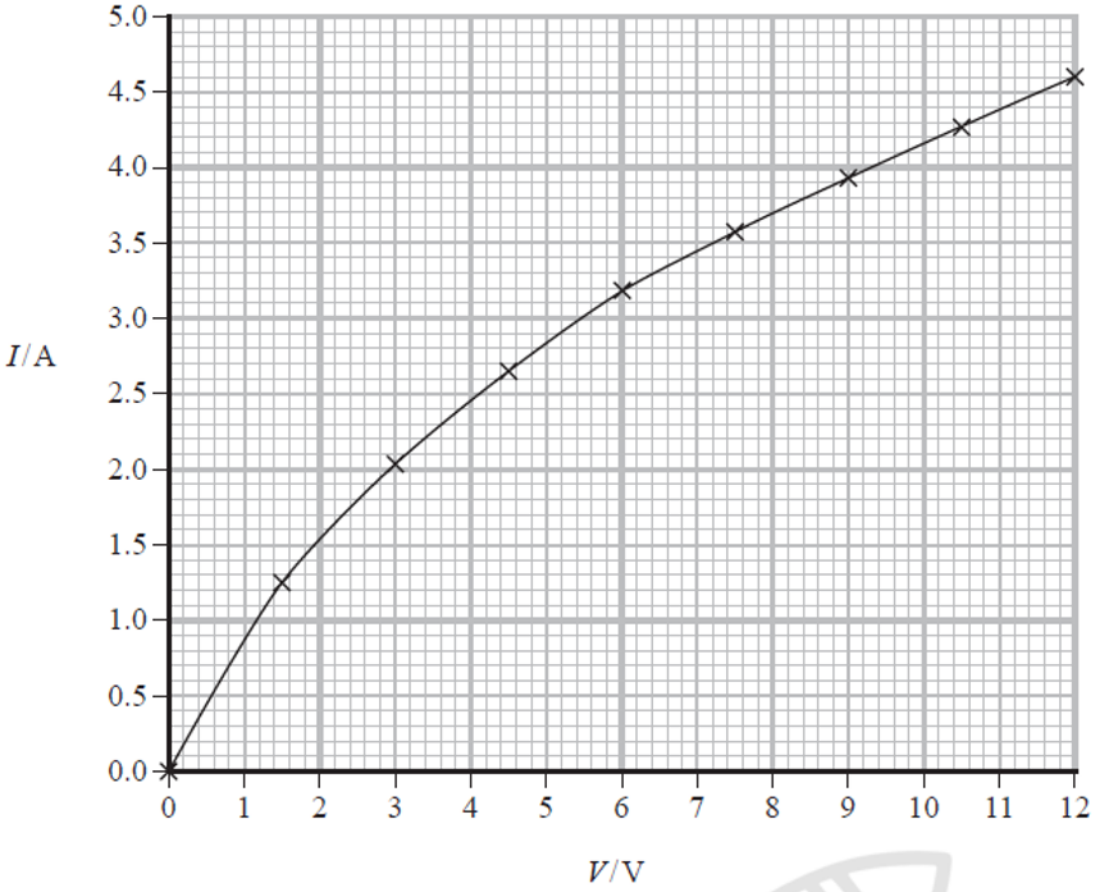
(Total for question = 8 marks)

Q43.

Drivers use car headlights to emit light in dark conditions.

The graph shows how current *I* varies with potential difference *V* for a car headlight.



The headlight will emit light when it dissipates at least 35 W of power.

(a) Determine the minimum potential difference for which the headlight will emit light.

(3)

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Minimum potential difference = ... V

(b) In a car, two headlights are connected in parallel with a 12.0 V battery. The battery has negligible internal resistance.

(i) Explain the advantages of connecting the headlights in parallel with the battery rather than in series.

(3)

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(ii) A student writes the following statement.

When connected to the 12.0 V battery, the combined resistance of two headlights in parallel is one quarter of the combined resistance of two headlights in series.

Deduce whether the student is correct.

Your answer should include calculations using data from the graph.

(3)

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(c) The headlights are connected in the circuit using copper wire. The current in the wire is 4.60 A.

Calculate the drift velocity of electrons in the copper wire.

number of charge carriers per m^3 of copper = $8.49 \times 1028\ m^{-3}$
resistivity of copper = $1.72 \times 10^{-8}\ \Omega\ m$
resistance per unit length of the copper wire = $1.75 \times 10^{-2}\ \Omega\ m^{-1}$

(3)

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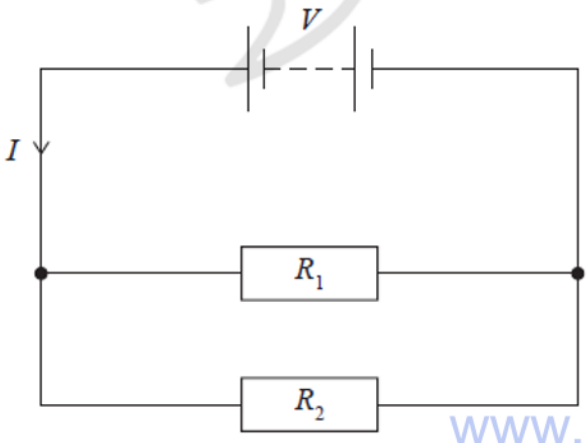
Drift velocity = ...

(Total for question = 12 marks)

Q44.

Two resistors are connected in a circuit, as shown.



An expression for the combined resistance of the two resistors is $\frac{R_1R_2}{R_1 + R_2}$

Derive this expression.

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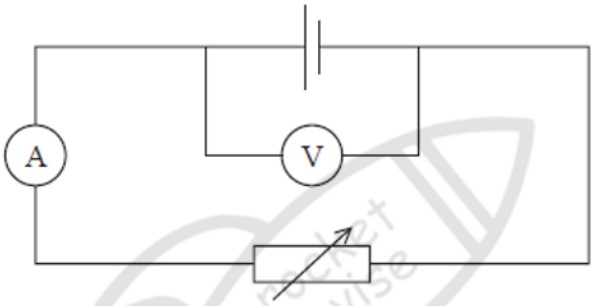
(Total for question = 3 marks)

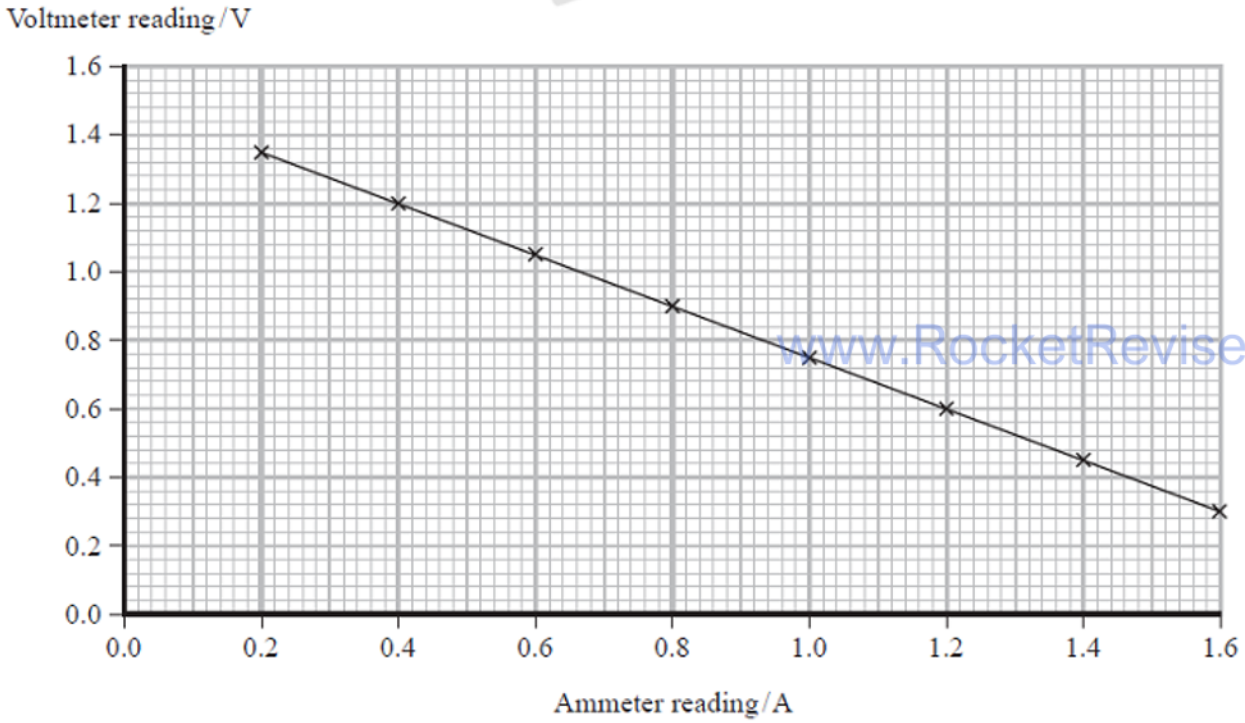
Q45.

A student investigated the internal resistance of a cell, using the circuit shown.



The student used the variable resistor to vary the reading on the ammeter. He recorded corresponding readings from the voltmeter.

The student plotted the results on a graph, as shown.



(a) Determine the e.m.f. ε of the cell, and the internal resistance r of the cell.

(3)

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ε = ...

r = ...

(b) The student placed an identical cell in series with the original cell in the circuit.

He connected the voltmeter across both cells and repeated the investigation.

The student plotted a new graph of these voltmeter and ammeter readings.

Describe how the new graph is different from the graph for one cell.

(2)

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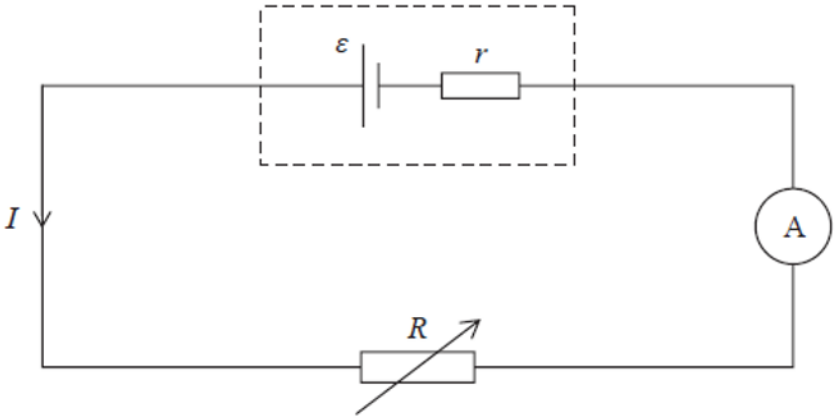
(Total for question = 5 marks)

Q46.

A student set up the circuit shown to determine the e.m.f. ε and internal resistance r of a cell.

I is the current in the circuit and R is the resistance of the variable resistor.



(a) Show that, for this circuit, $R = \frac{\varepsilon}{I} - r$

(2)

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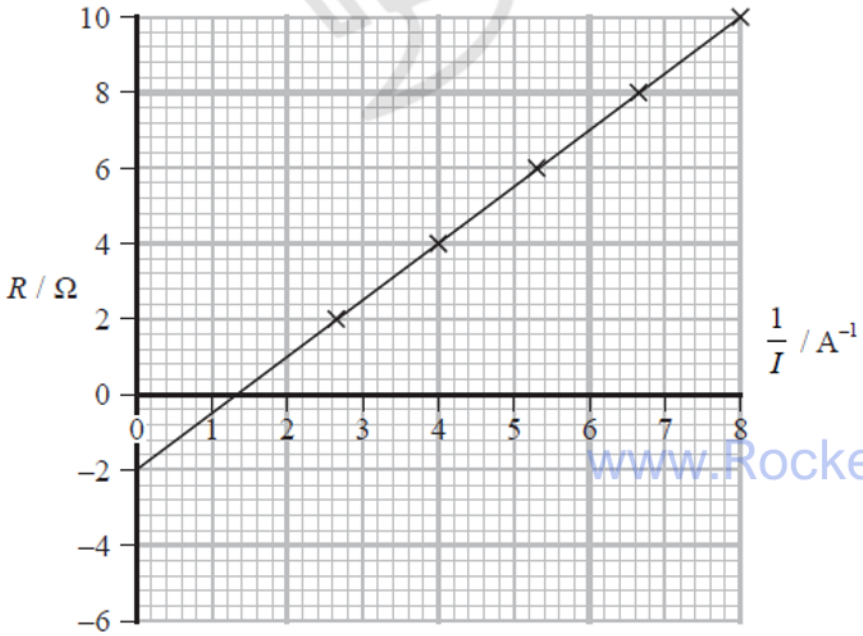
(b) The student varied R and measured corresponding values of I.

The student then plotted a graph of R against , $\frac{1}{I}$ as shown.



Determine values of ε and r for the cell.

(3)

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ε = ...

r = ...

(c) The student suggested that the power dissipated by the internal resistance r decreases as R increases.

Comment on the student's suggestion.

No further calculations are required.

(3)

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(d) The student added a second, identical cell in series with the first cell and repeated the experiment.

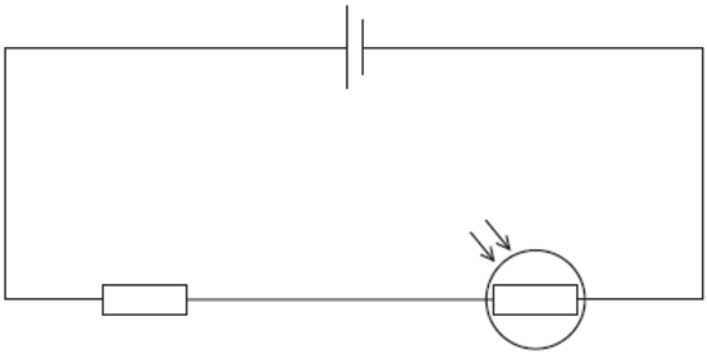
Add a line to the graph to show the result of this experiment.

(3)

(Total for question = 11 marks)

Q47.

* The circuit shown contains a fixed resistor and a light dependent resistor (LDR).



Explain why the power dissipated by the whole circuit changes as the intensity of the light incident on the LDR increases.

You should refer to why the resistance of an LDR changes as light intensity increases.

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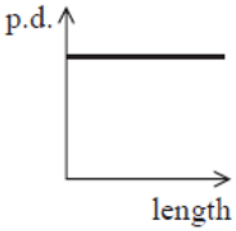
(Total for question = 6 marks)

Q48.

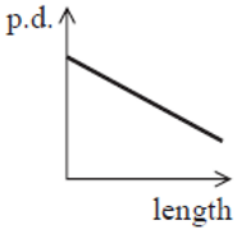
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The current in a length of uniform wire is constant.

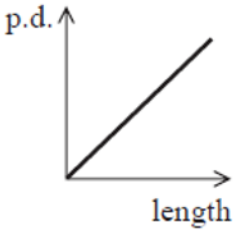
Which of the following graphs shows how the potential difference (p.d.) across the wire varies with the length of the wire?



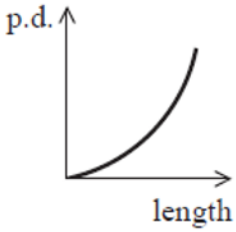
☒ **A**



☒ **B**



☒ **C**

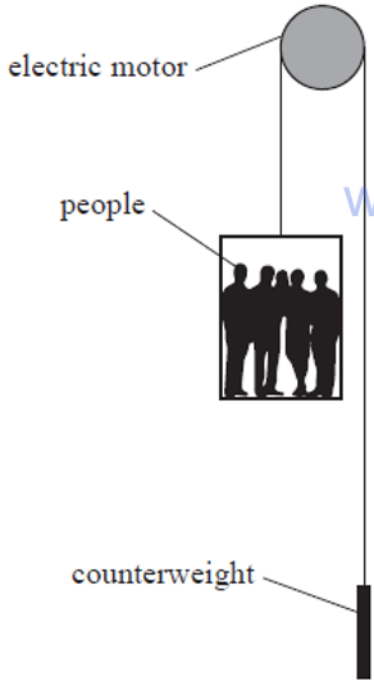


☒ **D**

(Total for question = 1 mark)

Q49.

The diagram shows a lift system for moving people up and down a tall building. There is a counterweight to balance the weight of the lift. An electric motor is used to raise and lower the lift.



(a) Explain how the counterweight affects the amount of work required from the electric motor to raise the lift.

(2)

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(b) The electric motor raises the lift through a height of 40.0 m in a time of 30.0 s.

Show that the output power of the electric motor is about 12 kW.

total mass of lift and people = 2 250 kg
mass of counterweight = 1 300 kg

(4)

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(c) The electric motor dissipates energy to the surroundings at a rate of 3 600 W.

Determine the efficiency of the electric motor.

(2)

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Efficiency = ...

(Total for question = 8 marks)