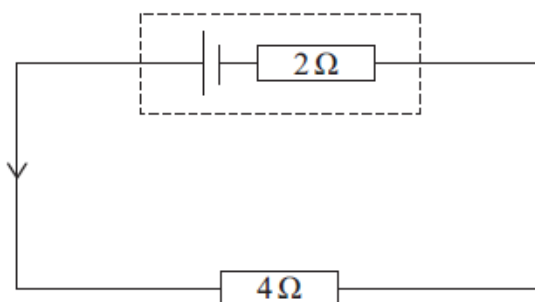


Questions

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 (☐).

The diagram shows a $4\ \Omega$ resistor connected to a cell of e.m.f. 12 V and internal resistance $2\ \Omega$.



Which of the following expressions gives the potential difference V across the internal resistance of the cell?

- ☐ A $V = 12 \times \frac{2}{4}$
- ☐ B $V = 12 \times \frac{6}{4}$
- ☐ C $V = 12 \times \frac{4}{6}$
- ☐ D $V = 12 \times \frac{2}{6}$

(Total for question = 1 mark)

Q2.

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

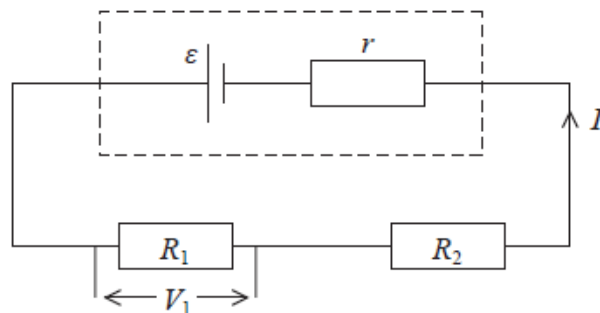
☐ **D** volt

(Total for question = 1 mark)

Q3.

Select one answer from A to D and put a cross ☐. 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** $\varepsilon = IR_1 + Ir$

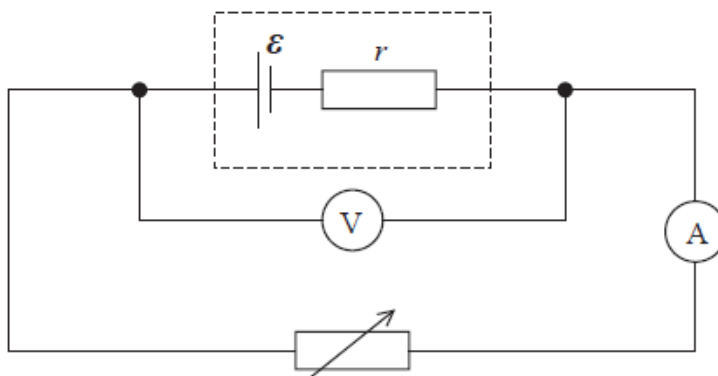
☐ **C** $\varepsilon = IR_2 + Ir$

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

(Total for question = 1 mark)

Q4.

The diagram shows a circuit used to determine the internal resistance r and e.m.f. $\mathcal{E}$ of a cell.



The resistance of the variable resistor is R .

Which of the following gives the current in the cell?

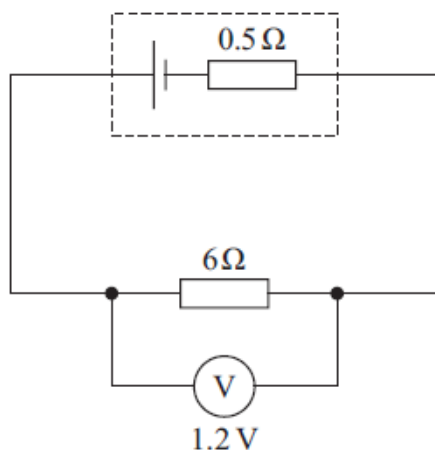
- ☐ A $\frac{\mathcal{E}}{R}$
- ☐ B $\frac{\mathcal{E}}{r}$
- ☐ C $\frac{\mathcal{E}}{(R + r)}$
- ☐ D $\frac{\mathcal{E}}{(R - r)}$

(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 (☐.

The circuit shown includes a cell with internal resistance $0.5 \, \Omega$.



Which of the following expressions gives the e.m.f., in V, of the cell?

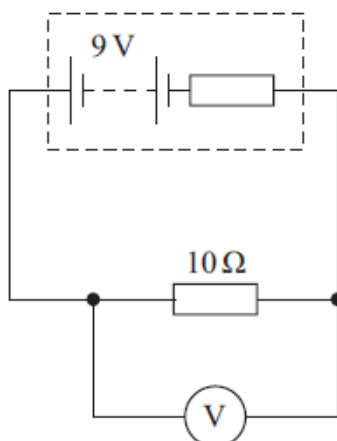
- ☐ **A** $1.2 - \frac{1.2 \times 0.5}{6}$
- ☐ **B** 1.2
- ☐ **C** $1.2 + \frac{1.2 \times 0.5}{6}$
- ☐ **D** $1.2 + \frac{6 \times 0.5}{1.2}$

(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 ☐.

A student connected the circuit shown.



The reading on the voltmeter was 6 V.

Which of the following expressions gives the internal resistance, in Ω , of the battery?

☐ **A** $\frac{10 \times (9 - 6)}{6}$

☐ **B** $\frac{6 \times (9 - 6)}{10}$

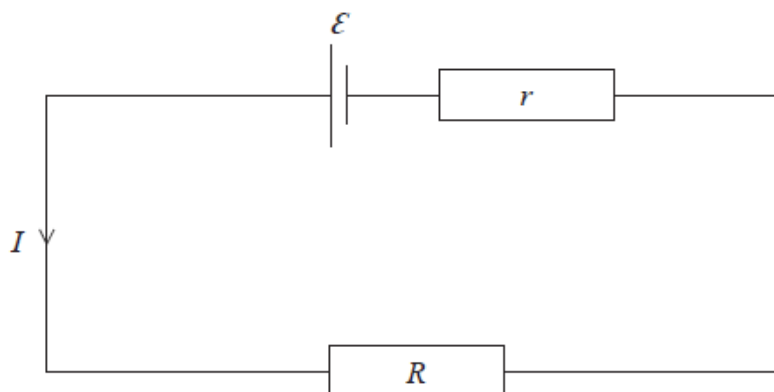
☐ **C** $\frac{10}{6 \times (9 - 6)}$

☐ **D** $\frac{6}{10 \times (9 - 6)}$

(Total for question = 1 mark)

Q7.

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** $P = I^2 R$

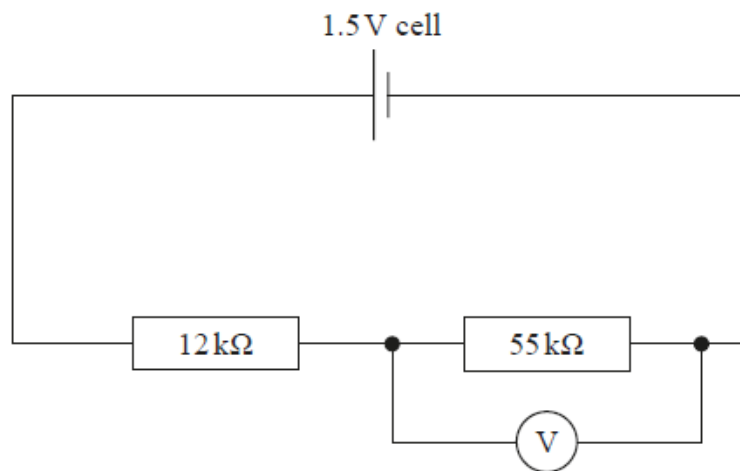
☐ **C** $P = I \varepsilon$

☐ **D** $P = V^2 / r$

(Total for question = 1 mark)

Q8.

A student is given the circuit diagram shown.



(a) Calculate a value for the voltmeter reading.

(2)

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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.

(4)

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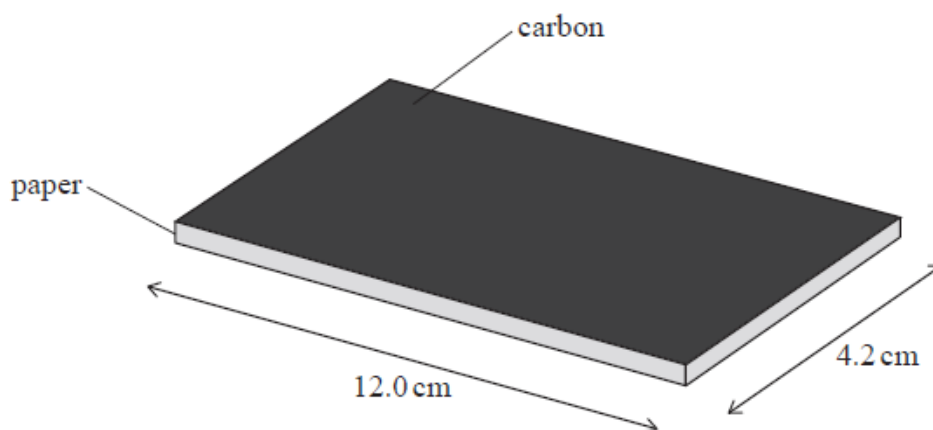
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(Total for question = 6 marks)

Q9.

'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.

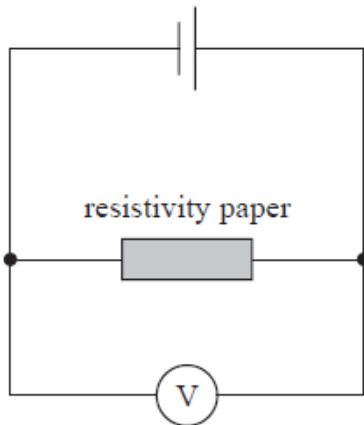
resistivity of carbon = $3.7 \times 10^{-5} \Omega \text{ m}$

(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)

Q10.

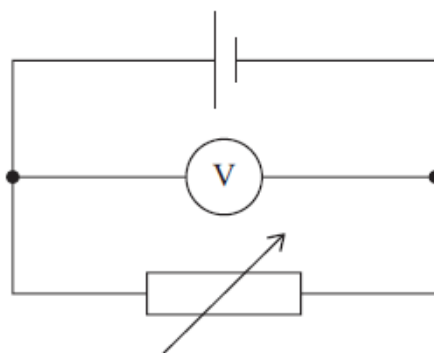
The photograph shows an electric bicycle.



(Source: © stockphoto-graf/Alamy Stock Photo)

The battery contains several identical cells connected in series. Each cell has an e.m.f. of 1.5 V.

(a) One cell is removed from the battery and connected in the circuit shown.



When the resistance of the variable resistor is $10\ \Omega$, the reading on the voltmeter is 1.4 V.

Calculate the internal resistance of the cell.

(3)

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Internal resistance = ...

(b) The battery in an electric bicycle gets warm when the battery supplies power to the motor in the bicycle.

Explain why the battery gets hot when the bicycle is going up a steep hill.

(4)

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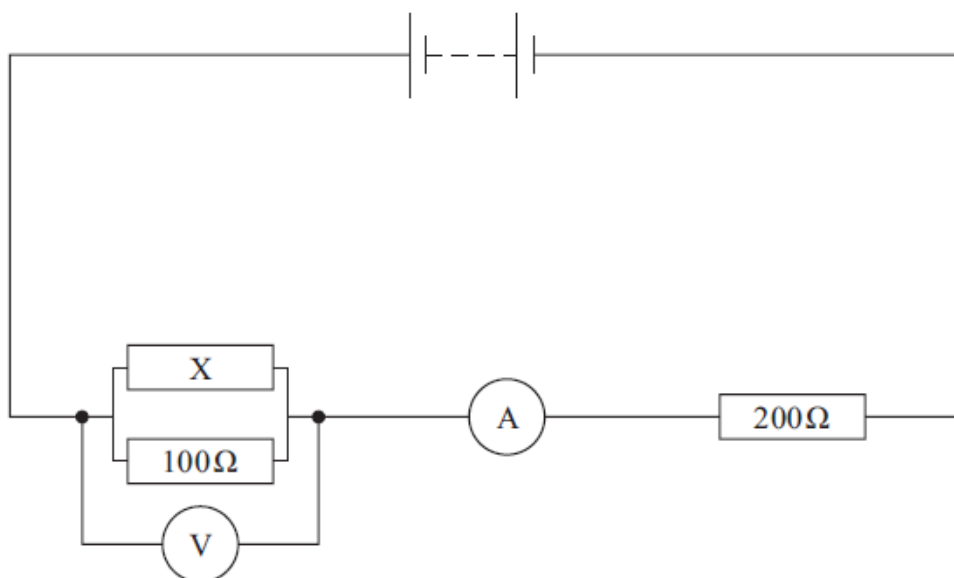
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(Total for question = 7 marks)

Q11.

A student connected the circuit shown.



The battery has an e.m.f. of 6.00 V and negligible internal resistance.

(a) State what is meant by an e.m.f. of 6.00 V.

(1)

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(b) The reading on the voltmeter is 1.64 V.

(i) Show that the reading on the ammeter is about 20 mA.

(3)

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(ii) Determine the resistance of resistor X.

(3)

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Resistance of resistor X = ...

(iii) Determine the power dissipated in the 100 Ω resistor.

(2)

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Power = ...

(c) The student makes the following prediction.

If I switch the positions of the $100\ \Omega$ resistor and the $200\ \Omega$ resistor, then the reading on the voltmeter will increase.

Discuss the student's prediction.

You do not need to include calculations in your answer.

(2)

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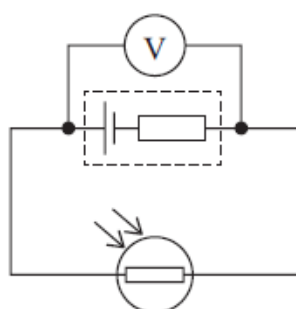
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(Total for question = 11 marks)

Q12.

The circuit shows an LDR connected in series with a cell.



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

(1)

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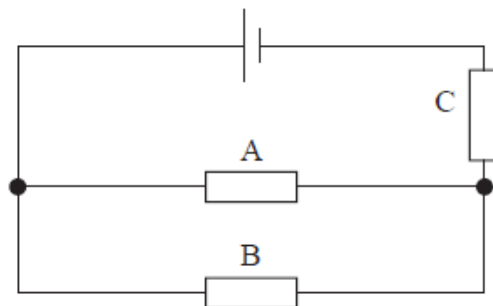
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*(b) The voltmeter measures the terminal potential difference across the cell.

Explain how increasing the intensity of light incident on the LDR affects the reading on the voltmeter.

Q13.

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



(6)

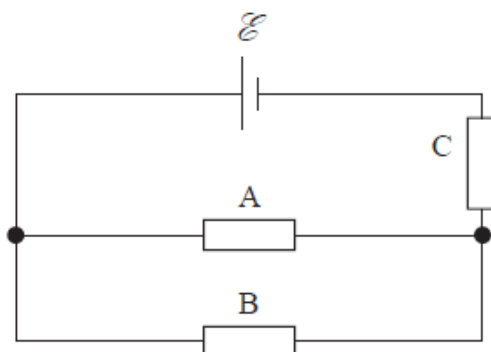
(b) (i) Calculate the total resistance of the circuit.

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)

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(Total for question = 12 marks)

Q14.

A photomultiplier is a device that can detect very low intensity light.

In a photomultiplier, a metal plate called a photocathode is connected to the negative terminal of a power supply.

Electromagnetic radiation incident on the photocathode can cause the photoelectric effect.

(a) Describe the photoelectric effect.

(2)

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(b) The photomultiplier can only detect electromagnetic radiation that causes the photoelectric effect.

Explain why the photomultiplier cannot detect some frequencies of electromagnetic radiation.

(2)

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(c) Visible light has a range of wavelengths from 380 nm to 700 nm.

The work function of the material used to make the photocathode is 1.48 eV.

Deduce whether the photomultiplier can detect all wavelengths of visible light.

(4)

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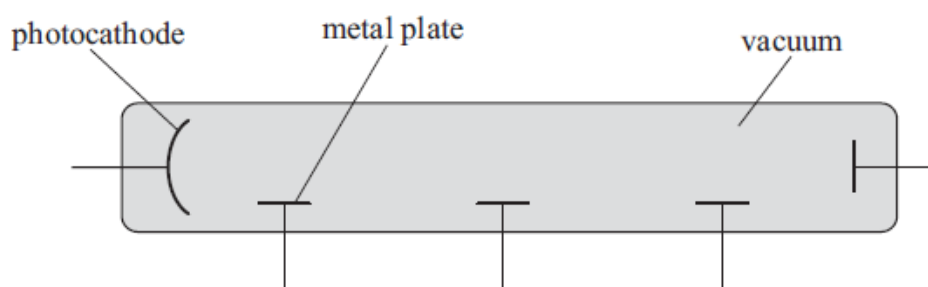
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(d) In the photomultiplier, the photocathode and several other metal plates are in a vacuum, as shown.



An electron is emitted from the photocathode with a speed of $1.35 \times 10^6 \text{ m s}^{-1}$.

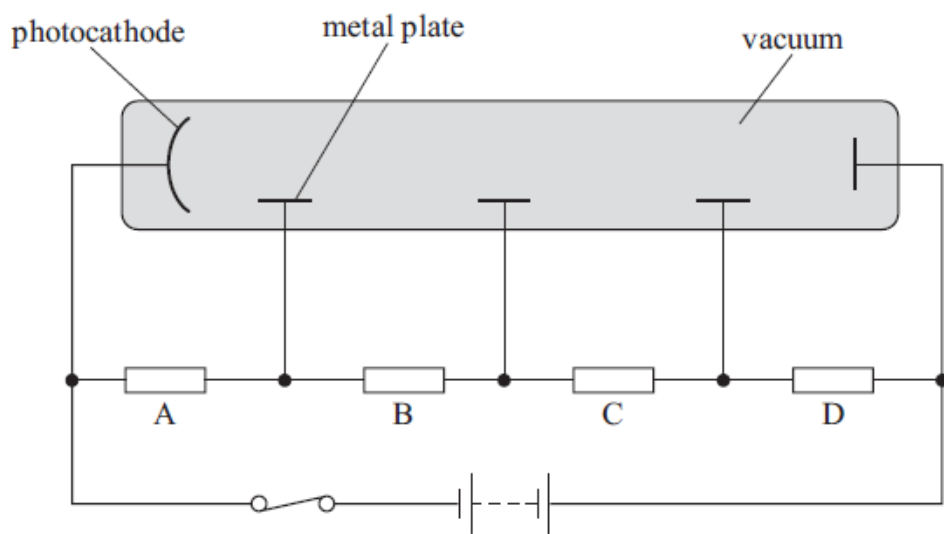
There is a potential difference (p.d.) of 108 V between the photocathode and the first metal plate. This p.d. causes the kinetic energy of the electron to increase.

Calculate the kinetic energy, in joules, of the electron at the instant it collides with the first metal plate.

(3)

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Kinetic energy = ... J

(e) The electrical circuit shown includes four resistors, A, B, C and D, which apply a p.d. between adjacent metal plates.



Each resistor has a resistance of 85.0 kΩ.
When the switch is open, the p.d. across the power supply is 1960 V.
When the switch is closed, the p.d. across resistor A is 108 V.
Calculate the internal resistance of the power supply.

(4)

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Internal resistance = ...

(Total for question = 15 marks)

