

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.2.1 CURRENT, POTENTIAL DIFFERENCE AND RESISTANCE (PACK 4)

SCORE

/129

PERCENTAGE

%

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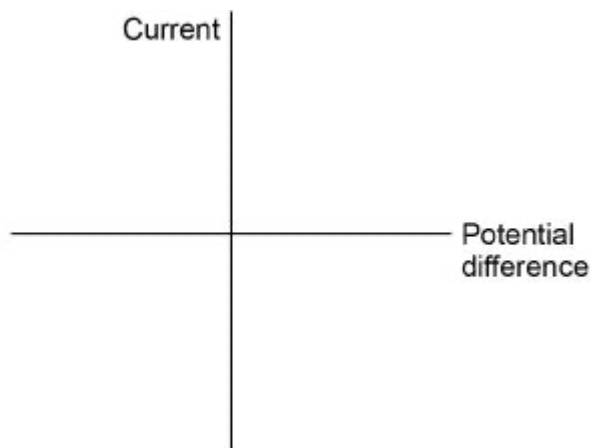
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Q1.

A student built a circuit using filament lamps.

- (a) Sketch a current potential difference graph for a filament lamp on **Figure 1**

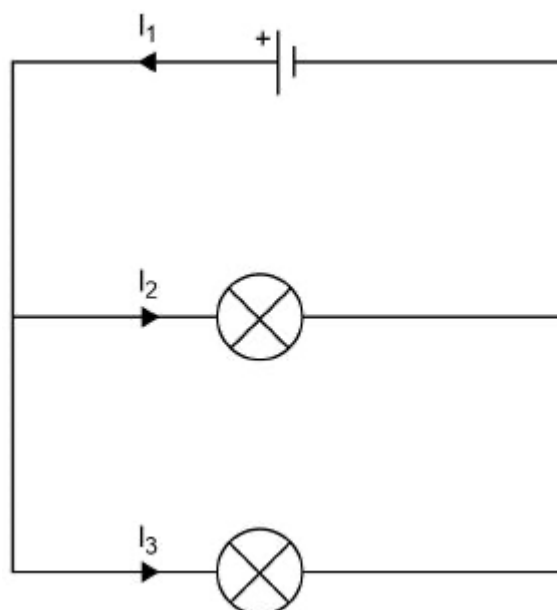
Figure 1



(2)

Figure 2 shows the circuit with two identical filament lamps.

Figure 2



- (b) Compare the currents I_1 , I_2 and I_3

(2)

- (c) Calculate the charge that flows through the cell in 1 minute.

Each filament lamp has a power of 3 W and a resistance of $12\ \Omega$

Write any equations that you use.

Give the unit.

Charge = _____

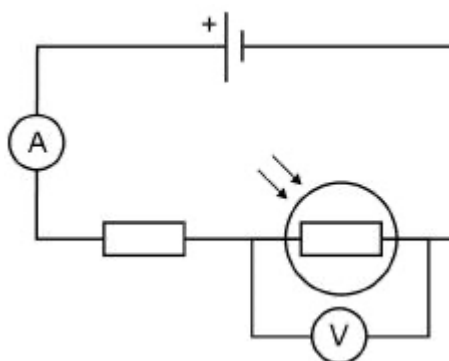
Unit = _____

(6)

- (d) The student builds a different circuit.

Figure 3 shows the circuit.

Figure 3

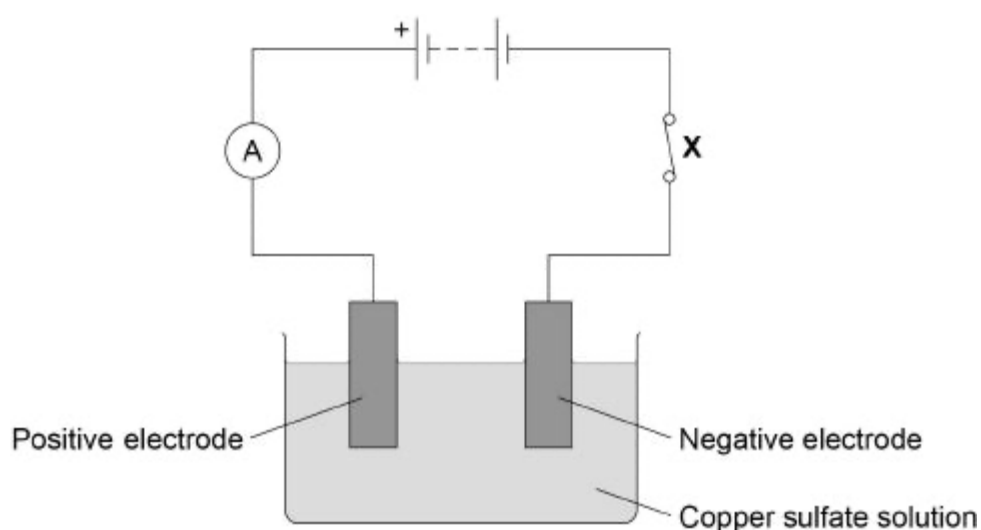


Explain how the readings on both meters change when the environmental conditions change.

(6)
(Total 16 marks)

Q2.

The diagram below shows the apparatus used to pass a current through copper sulfate solution.



- (a) What is the name of component **X** in the diagram above?

Tick **one** box.

Ammeter

☐

Battery

☐

Fuse

☐

Switch

☐

(1)

- (b) What is the name of the process happening in the diagram above?

Tick **one** box.

Combustion

☐

Crystallisation

☐

Distillation

☐

Electrolysis

☐

(1)

A student investigated how the concentration of copper sulfate solution affects the mass of copper deposited on the negative electrode.

(c) What are the independent and dependent variables in this investigation?

Draw **one** line from each type of variable to the correct description.

Type of variable

Description

Independent
variable

Concentration of copper
sulfate solution

Distance between electrodes

Dependent
variable

Mass of copper deposited

Time circuit is switched on for

(2)

The table below shows the student's results.

Concentration of copper sulfate solution in g/dm ³	Mass of copper deposited in grams
30	0.04
60	0.08
90	0.12
120	0.07
150	0.20

- (d) The result for the concentration of 120 g/dm^3 is anomalous.

What may have caused the anomalous result?

Tick **one** box.

Some copper fell off the electrode

☐

The circuit was switched on for too much time

☐

The concentration of the solution was too high

☐

(1)

- (e) Predict the expected mass of copper deposited for the concentration of 120 g/dm^3

Use the table above.

Mass of copper = _____ g

(1)

- (f) During the investigation copper ions move to the negative electrode.

Choose the answer from the box.

a negative charge	a positive charge	no charge
-------------------	-------------------	-----------

Copper ions move to the negative electrode because copper ions have

_____.

(1)

- (g) Solid copper sulfate does **not** conduct electricity.

What is the reason for this?

Tick **one** box.

The charge on the ions is too high

☐

The ions are too big

☐

The ions are too small

☐

The ions cannot move

☐

(1)

- (h) In a different investigation, a student passed a current of 0.6 A through copper sulfate solution for 300 s

Calculate the charge flow through the solution.

Use the equation:

$$\text{charge flow} = \text{current} \times \text{time}$$

charge flow = _____ coulombs

(2)

(Total 10 marks)

Q3.

A light dependent resistor (LDR) is connected in a circuit.

- (a) Draw the circuit symbol for an LDR.

(1)

- (b) A student investigated the relationship between current and potential difference for an LDR.

How should the student have connected the ammeter and voltmeter in the circuit?

Tick **one** box.

Ammeter

Voltmeter

in parallel with LDR

in parallel with LDR

☐

in parallel with LDR

in series with LDR

☐

in series with LDR

in parallel with LDR

☐

in series with LDR

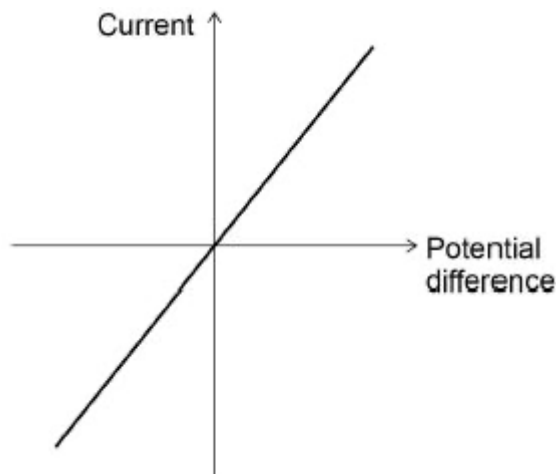
in series with LDR



(1)

The diagram below shows a sketch graph of the student's results.

The LDR was in a constant bright light.



- (c) The student concluded that the current in the LDR is inversely proportional to the potential difference across the LDR.

Explain why the student's conclusion is incorrect.

(2)

- (d) The student repeated the investigation with the LDR in constant dark conditions.

Sketch on the diagram above the graph for the LDR in constant dark conditions.

(2)

The LDR was placed near a light source.

The following results were recorded:

potential difference = 5.50 V

current = 12.5 mA

- (e) Write down the equation that links current, potential difference and resistance.

(1)

- (f) Calculate the resistance of the LDR.

Resistance = _____ Ω

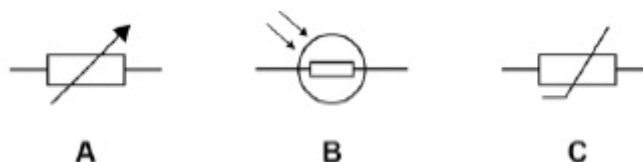
(4)

(Total 11 marks)

Q4.

Figure 1 shows the circuit symbol for three different components.

Figure 1



- (a) Which component is a variable resistor?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

(1)

- (b) Which component is a thermistor?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

(1)

- (c) In which component will the resistance decrease when the temperature increases?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

(1)

- (d) In which component will the resistance decrease when the light intensity increases?

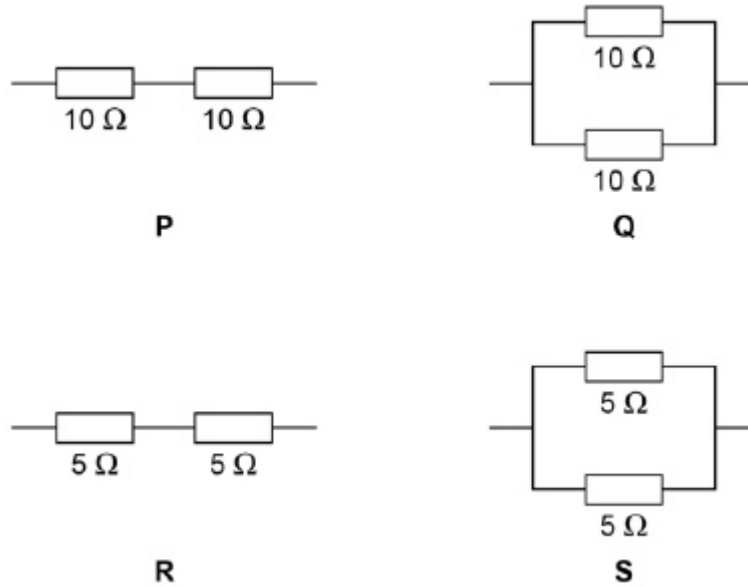
Tick **one** box.

A ☐ B ☐ C ☐

(1)

Figure 2 shows four different arrangements of resistors.

Figure 2



- (e) Two of the arrangements are in series and two are in parallel.

Describe the difference between a series and a parallel arrangement.

(2)

- (f) Which arrangement has a resistance of $10\ \Omega$?

Tick **one** box.

P ☐ Q ☐ R ☐ S ☐

(1)

- (g) Which arrangement has the highest resistance?

Tick **one** box.

P ☐ Q ☐ R ☐ S ☐

(1)

- (h) A student connects a resistor to a cell for 60 seconds.

The current through the resistor is 0.97 A

Calculate the charge flow.

Use the equation:

$$\text{charge flow} = \text{current} \times \text{time}$$

Give your answer to 2 significant figures.

Charge flow = _____ C

(3)

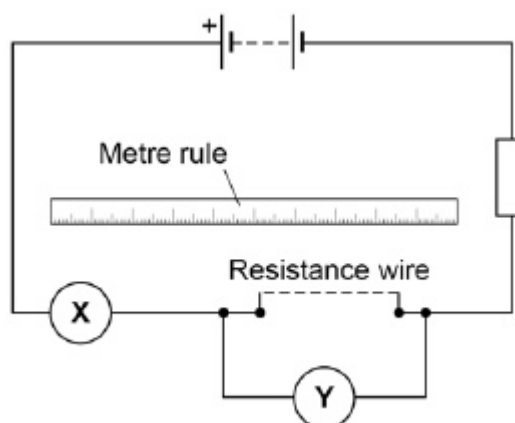
(Total 11 marks)

Q5.

A student investigated how length affects resistance of a wire.

Figure 1 shows the circuit the student used.

Figure 1



- (a) The student took measurements using the meters **X** and **Y**.

Name meters **X** and **Y**.

Meter **X** _____

Meter **Y** _____

(2)

The table shows the results.

Length in m	Resistance in Ω			
	Test 1	Test 2	Test 3	Mean
0.100	0.66	0.67	0.74	0.69
0.200	1.36	1.40	1.34	1.37
0.300	2.02	2.02	2.03	2.02
0.400	2.77	2.72	2.68	2.72
0.500	3.37	3.35	3.40	3.37
0.600	4.03	4.02	3.96	4.00

- (b) For which length of wire are the readings of resistance the most precise?

Give the reason for your answer.

Length = _____ m

Reason _____

_____ (2)

- (c) Why did the student do three tests and calculate a mean?

 _____ (1)

- (d) Write the equation that links current, potential difference, and resistance.

_____ (1)

- (e) The potential difference across a piece of wire is 2.1 V

The current in the wire is 0.30 A

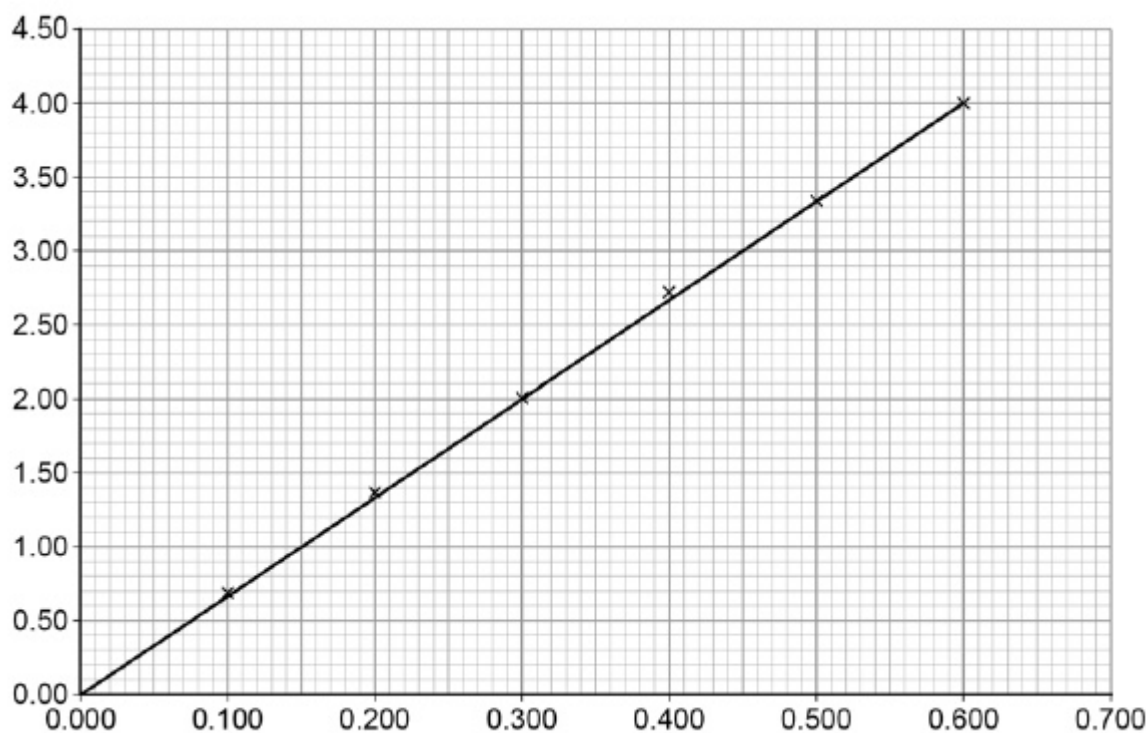
Calculate the resistance of the wire.

Write any equation that you use.

Resistance = _____ Ω (3)

Figure 2 shows a graph of the results.

Figure 2



- (f) What is the label for each axis of the graph?

x-axis _____

y-axis _____

(2)

- (g) What conclusion can be made from the graph in **Figure 2**?

(1)

(Total 12 marks)

Q6.

Some electrical appliances use electricity from the mains supply and some use electricity from a battery.

- (a) Explain the differences between the current supplied by the mains supply and the current supplied by a battery.

(b) Which set of units correctly links current, potential difference and power?

Tick **one** box.

one watt = one volt × one amp

one watt = $\frac{\text{one amp}}{\text{one volt}}$

one watt = $\frac{\text{one volt}}{\text{one amp}}$

☐

☐

☐

(1)

Electrical appliances can be connected to the mains supply using three-core cables.

The cables contain the mains wires.

(c) What are the colours of the insulation around the wires?

Tick **one** box.

Earth	Live	Neutral	Tick one box
Blue	Brown	Green and yellow	
Blue	Green and yellow	Brown	
Brown	Blue	Green and yellow	
Brown	Green and yellow	Blue	
Green and yellow	Blue	Brown	
Green and yellow	Brown	Blue	

(1)

(d) Touching the live wire of an appliance is dangerous when the appliance is connected to the mains electricity supply.

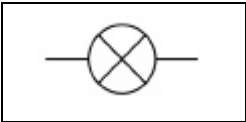
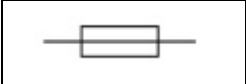
Explain why.

(4)
(Total 8 marks)

Q7.

Components can be connected in electrical circuits in different ways.

- (a) Draw **one** line from each circuit symbol to the name of the component it represents.

Circuit symbol	Name of component
	cell
	diode
	fuse
	lamp
	variable resistor

(2)

- (b) Complete the sentence.

Choose the answer from the box.

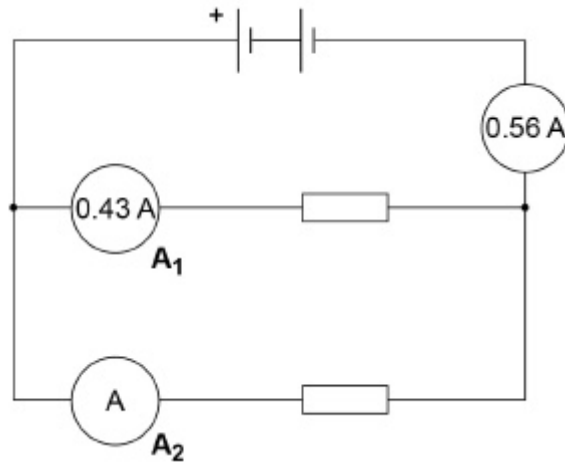
charge energy potential difference resistance

Electric current is the rate of flow of _____.

(1)

Figure 1 shows a parallel circuit.

Figure 1



- (c) Calculate the current measured by ammeter **A₂**.

Current = _____ A

(1)

- (d) The circuit is connected for 300 s

The total current in the circuit stays at 0.56 A

Calculate the total charge flow.

Use the equation:

$$\text{charge flow} = \text{current} \times \text{time}$$

Charge flow = _____ C

(2)

- (e) The potential difference supplied by the battery is 4.5 V

Calculate the total energy transferred in 300 s

Use the equation:

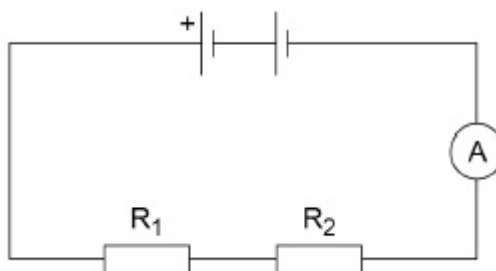
$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

Use your answer to part (d).

Energy transferred = _____ J
(2)

- (f) **Figure 2** shows a series circuit.

Figure 2



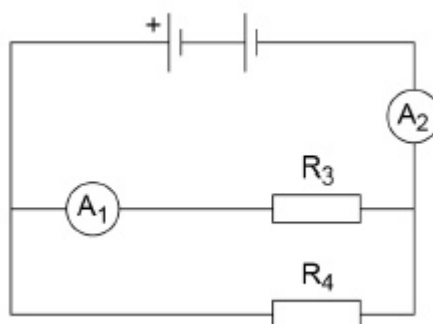
Resistor R_2 breaks.

What happens to the reading on the ammeter?

(1)

- (g) **Figure 3** shows a parallel circuit.

Figure 3



Resistor R_3 breaks.

What happens to the readings on the ammeter?

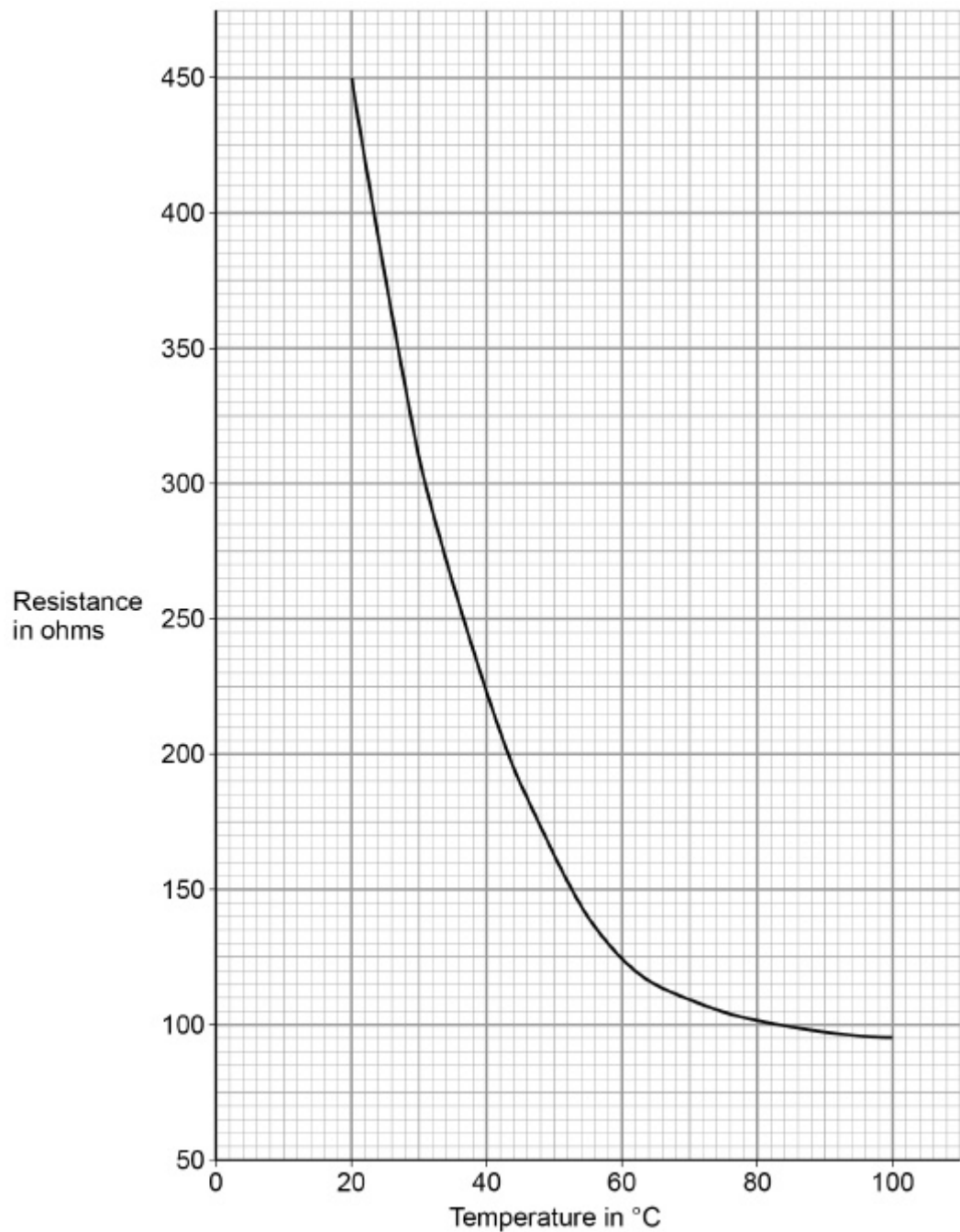
Ammeter A_1 _____

Ammeter A_2 _____

(2)

Figure 4 shows how the resistance of a component varies with temperature.

Figure 4



(h) What is the name of the component?

Tick **one** box.

LED

☐

LDR

☐

Resistor

☐

Thermistor

☐

(1)

- (i) What is the resistance of the component at a temperature of 50 °C?

Resistance = _____ Ω

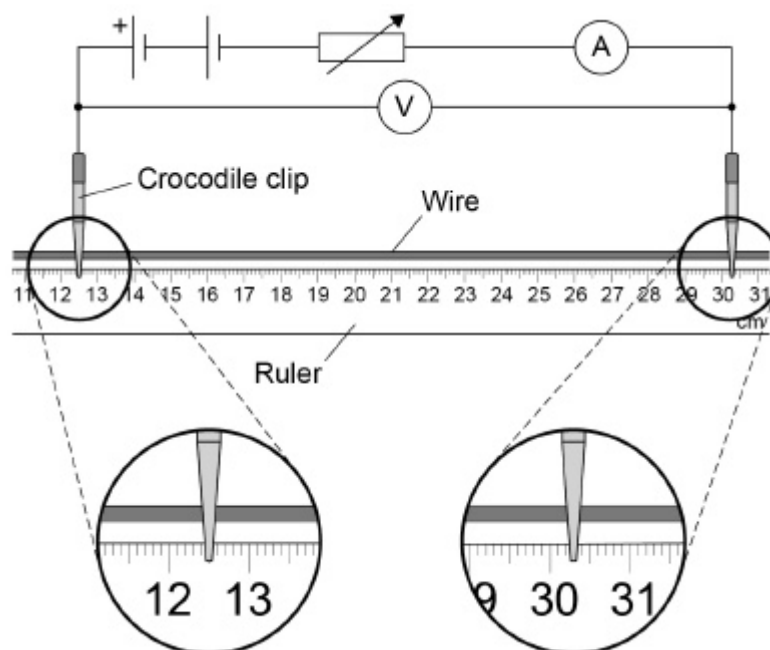
(1)

(Total 13 marks)

Q8.

A student investigates how the length of a piece of wire affects its resistance.

The diagram shows the apparatus used.



- (a) What is the length of wire between the two crocodile clips shown in the diagram?

Length = _____ cm

(1)

- (b) Write the equation which links current, potential difference and resistance.

(1)

- (c) For the experiment shown in the diagram, the student recorded:

- a potential difference of 3.22 V
- a current of 2.18 A

Calculate the resistance of the length of wire between the crocodile clips.

Give your answer to 3 significant figures.

Resistance = _____ Ω

(4)

- (d) The student used constantan wire.

The resistance of constantan only changes a small amount when its temperature changes.

Suggest why using constantan is an advantage in this experiment.

(2)

The table shows the student's results.

Length in cm	Resistance in Ω
20.0	1.67
30.0	2.49
40.0	3.31
50.0	5.26
60.0	4.98
70.0	5.78
80.0	6.65

- (e) One of the results in the table is anomalous.

For what length of wire is the resistance anomalous?

Length = _____ cm

(1)

- (f) What could have caused the anomalous result?

Tick **one** box.

The ammeter gave a reading that was too low.

☐

The wire was shorter than the measured value.

☐

The temperature of the wire decreased.

☐

The voltmeter gave a reading that was too low.

☐

(1)

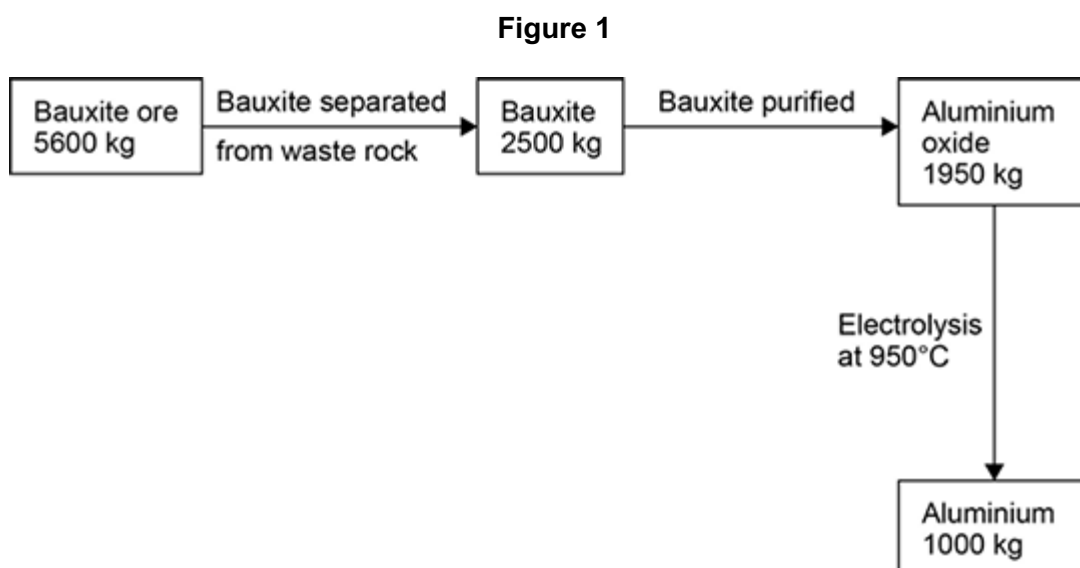
(Total 10 marks)

Q9.

Aluminium is produced from an ore called bauxite.

Bauxite contains aluminium oxide.

Look at **Figure 1**.



- (a) Calculate the percentage of bauxite that is converted into aluminium oxide.

Percentage = _____

(2)

- (b) Show by calculation that the mass of aluminium produced is less than that expected from 1 950 kg aluminium oxide (Al_2O_3).

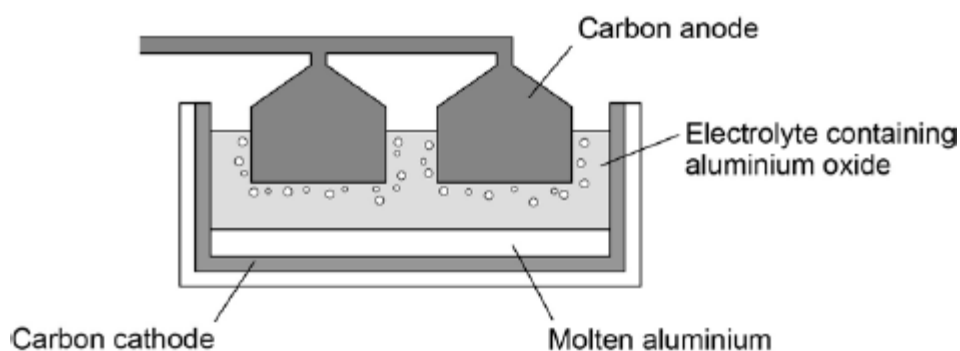
You should state the difference in the mass of aluminium expected and the mass of aluminium produced to three significant figures.

Relative atomic masses (A_r): O = 16; Al = 27

(3)

- (c) **Figure 2** shows an electrolysis cell used to extract aluminium.

Figure 2



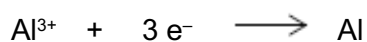
Why does the carbon anode used in the electrolysis cell need to be continually replaced?

(3)

- (d) In an electrolysis cell the current is 1.5×10^5 A, at a potential difference of 4V.
Calculate the energy transferred by the electrolysis cell in 24 hours.

Energy transferred = _____ J

- (e) The half equation at the cathode is:



Calculate the number of moles of electrons needed to produce 1 000 kg of aluminium.

Give your answer to three significant figures.

Relative atomic mass (A_r): Al = 27

Answer = _____ moles

(3)

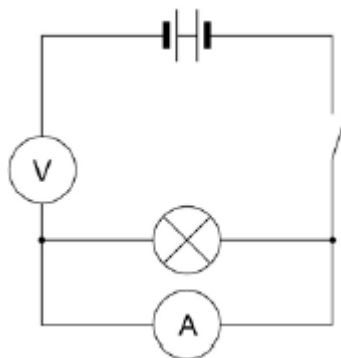
(Total 16 marks)

Q10.

A student used electrical circuits to investigate the relationship between resistance, potential difference and current.

Figure 1 shows how the student connects the first circuit he set up.

Figure 1



- (a) The circuit does not work.

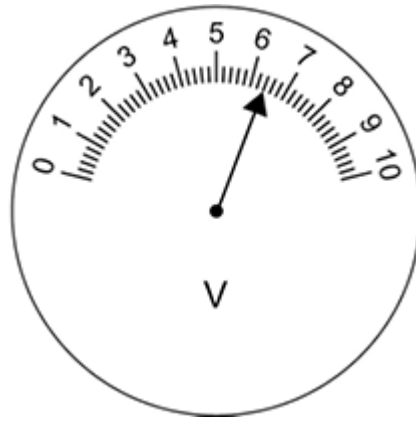
Draw the correct circuit.

(2)

- (b) The student then sets up the circuit correctly.

Look at **Figure 2**.

Figure 2



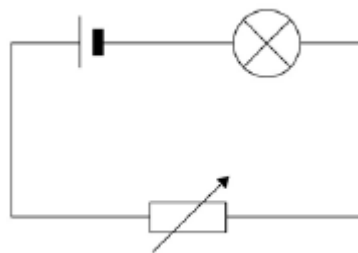
What is the reading on the voltmeter?

(1)

- (c) The student then set up a circuit to investigate how resistance affects the brightness of a lamp.

Figure 3 shows the circuit he set up.

Figure 3



The student increases the resistance of the variable resistor.

What effect does this have on the brightness of the lamp?

Explain your answer.

(2)

- (d) Write down the equation that links current, potential difference and resistance.

(1)

- (e) When the potential difference across the lamp is 3.3 V the current is 0.15 A.

Calculate the resistance of the lamp in the student's experiment.

Resistance = _____ Ω

(3)

(Total 9 marks)

Q11.

A student is investigating some electrical components.

- (a) Describe how the student could set up a circuit to find the resistance of a lamp.

You should include a circuit diagram in your answer.

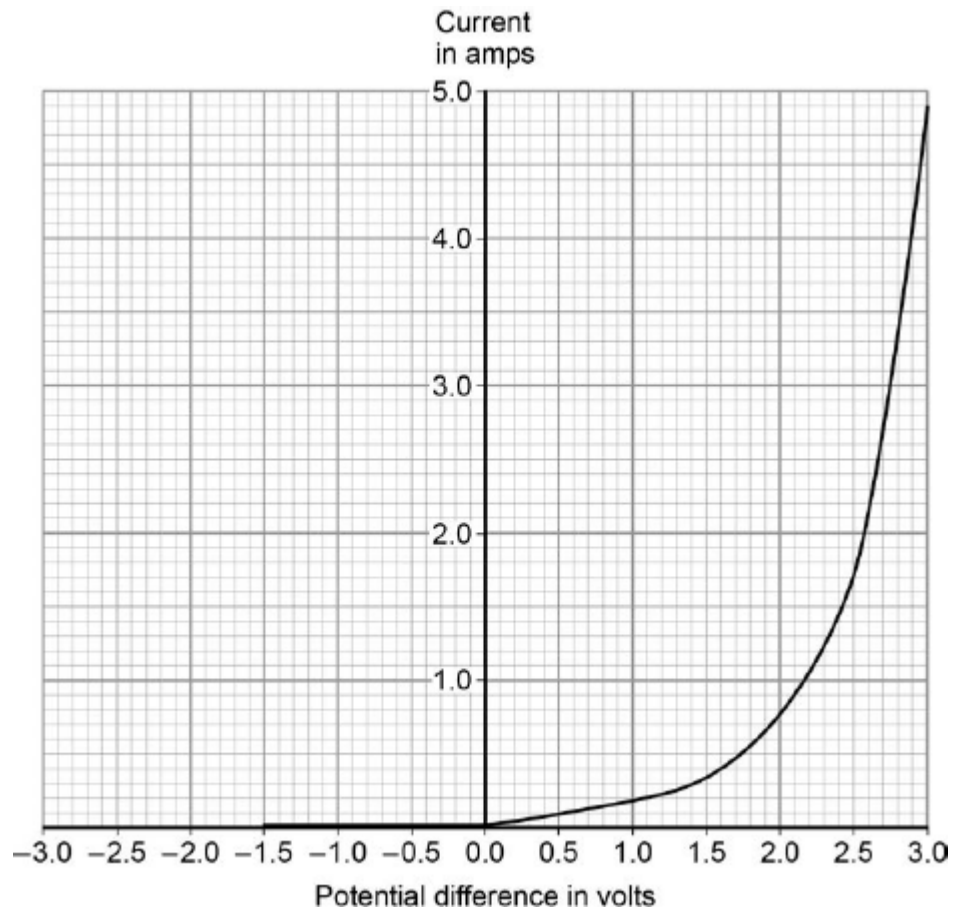
(4)

- (b) The student is given an electrical component in a sealed box.

She has to find out what the electrical component is by experiment.

The student records the current and the potential difference for the component.

Her results are shown in the figure below.



Explain how the student could know that the electrical component in the sealed box is **not** an ohmic conductor.

(2)

(c) What is the electrical component in the sealed box?

Explain your answer.

Component _____

—

Explanation _____

—

(3)

(d) Use the graph to determine the resistance of the component at 2.3 V.

Resistance = _____ Ω

(4)

(Total 13 marks)

Mark schemes

Q1.

- (a) a curve in the first and third quadrants only, passing through origin

1

decreasing gradient

1

- (b) any **two** from:

- $I_1 = I_2 + I_3$
- $I_2 = I_3$
- $I_1 = 2I_2$
- $I_1 = 2I_3$

allow 1 mark for each correct description given in words

2

- (c) $3 = I^2 \times 12$

1

$$I = \sqrt{\left(\frac{3}{12}\right)}$$

1

$$I = 0.5 \text{ (A)}$$

1

$$Q = 0.5 \times 60 = 30$$

*allow Q =
their calculated I × 60*

1

$$Q_{\text{total}} = 60$$

*allow an answer that is consistent with their
calculated value of I*

1

or

$$3 = I^2 \times 12 \text{ (1)}$$

$$I = \sqrt{\left(\frac{3}{12}\right)}$$

$$I = 0.5 \text{ (A) (1)}$$

$$I_{\text{total}} = 1.0 \text{ (A) (1)}$$

allow I_{total} = their I × 2

$$Q = 1.0 \times 60 = 60 \text{ (1)}$$

*allow an answer that is consistent with their
calculated value of I*

coulombs or C

1

an answer of 60 scores 5 calculation marks

- (d) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- resistance of LDR changes when light intensity changes
- when light intensity increase resistance of LDR decreases
- overall resistance of circuit decreases
- potential difference across total resistance remains unchanged
- current in ammeter increases
- potential difference across fixed resistor increases
- potential difference across LDR decreases
- reading on the voltmeter decreases
- potential difference is shared between the components in series
- the lower the resistance of the LDR the smaller the share of the potential difference
- reading on the voltmeter decreases

[16]

Q2.

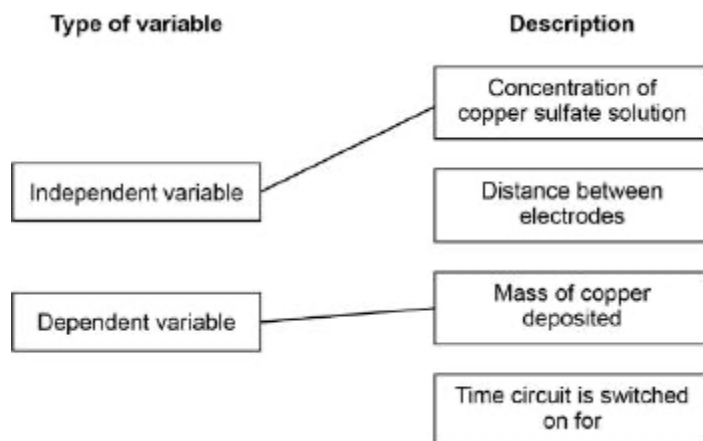
- (a) switch

1

- (b) electrolysis

1

- (c)



1 mark for each correct line

2

(d) some copper fell off the electrode

1

(e) 0.16 (g)

1

(f) a positive charge

answer line takes precedence

1

(g) the ions cannot move

1

(h) (charge flow =) 0.6×300

1

(charge flow =) 180 (coulombs)

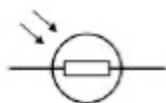
1

an answer of 180 (coulombs) scores 2 marks

[10]

Q3.

(a)



1

(b) in series with LDR in parallel with LDR

1

(c) (graph shows) direct proportion

1

(because) it is a straight line through the origin

allow inverse proportion would show a curve with a negative gradient

1

(d) straight line through the origin with a positive gradient

1

current is always of smaller magnitude than line already plotted for a given potential difference

this mark only scores if first mark is awarded

1

allow for 2 marks a straight horizontal line along the x-axis

- (e) potential difference = current $\times$ resistance

allow $V = IR$

1

- (f) 12.5 mA = 0.0125 A

1

$$5.50 = 0.0125 \times R$$

this mark may be awarded if current is incorrectly / not converted

1

$$(R =) \frac{5.50}{0.0125}$$

this mark may be awarded if current is incorrectly / not converted

1

$$(R =) 440 (\Omega)$$

allow an answer consistent with incorrectly / not converted current

1

an answer of 440 (Ω) scores 4 marks

an answer of 0.44 (Ω) scores 3 marks

[11]

Q4.

- (a) **A**

1

- (b) **C**

1

- (c) **C**

1

- (d) **B**

1

- (e) a series circuit has only one path/loop/branch

1

a parallel circuit has a branch(es) to provide more than one path / loop

allow answers that describe the difference in terms of potential difference, current or resistance

1

(f)	R	1
(g)	P	1
(h)	$Q = 0.97 \times 60$	1
	$Q = 58.2 \text{ (C)}$	1
	$Q = 58 \text{ (C)}$ <i>an answer of 58 (C) scores 3 marks</i>	1
		[11]

Q5.

(a)	ammeter	1
	voltmeter <i>must be in the correct order</i>	1
(b)	0.300 (m)	1
	there is the smallest spread about the mean	1
(c)	to reduce the effect of random errors	1
(d)	potential difference = current $\times$ resistance <i>allow $V = I \times R$</i>	1
(e)	$R = V / I$	1
	$R = 2.1 / 0.30$	1
	$R = 7.0 \Omega$ <i>an answer of 7.0 Ω scores 3 marks</i>	1
(f)	length in m	1
	resistance in Ω <i>must be in the correct order</i> <i>allow other correct labelling eg</i> <i>length / m</i> <i>length (m)</i> <i>allow 1 mark if units are omitted</i>	

(g) resistance is directly proportional to length

1

1

[12]

Q6.

(a) mains electricity is an alternating current (ac) which is constantly changing direction

1

a battery supplies a direct current (dc) which flows in one direction only

1

(b) one watt = one volt $\times$ one amp

1

(c) green and yellow - brown - blue

1

(d) the potential of the live wire is 230 V

1

a person's potential is 0 V

1

(so) there is a large potential difference between live wire and a person

1

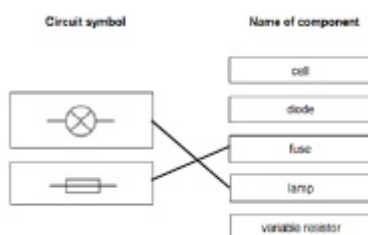
and so the charge / current passes through the person's body
allow would result in an electric shock

1

[8]

Q7.

(a)



extra lines from circuit symbols negate the mark

1

1

(b) charge

1

(c) 0.13 (A)

1

(d) 0.56×300

1

168 (C)

	<i>an answer of 168 (C) scores 2 marks</i>	1
(e)	168×4.5	1
	756 (J)	
	<i>an answer of 756 (J) scores 2 marks</i> <i>allow ecf from part (d)</i>	1
(f)	decreases to zero <i>allow reads zero</i>	1
(g)	(A1) decreases to zero <i>allow reads zero</i>	1
	(A2) decreases <i>do not accept 'to zero' for A2</i>	1
(h)	thermistor	1
(i)	answer in range 160–165 (Ω)	1
		[13]
Q8.		
(a)	17.8 <i>accept 17.7 or 17.9</i>	1
(b)	potential difference = current $\times$ resistance <i>accept $V = I R$</i>	1
(c)	$3.22 = 2.18 \times R$	1
	$R = 3.22/2.18$	1
	$R = 1.477(064\dots) \Omega$	1
	$R = 1.48 (\Omega)$ <i>an answer of 1.48 (Ω) scores 4 marks</i> <i>an answer that rounds to 1.48 (Ω) scores 3 marks</i>	1
(d)	temperature of wire will increase during experiment <i>allow description of this in terms of energy being dissipated,</i> $P = I^2 R$	1

- if constantan is used, this will not have a significant effect on results 1
- (e) 50.0 cm 1
- allow other ways of indicating the anomalous result in the table (eg ringing 5.26)* 1
- (f) the ammeter gave a reading that was too low 1
- [10]

Q9.

- (a) $1\,950 / 2\,500 \times 100$ 1
- 78 (%) 1
- (b) expected mass of aluminium
- $1950 \times 54 / 102$ 1
- $= 1032.35$ 1
- mass not collected
- $1032.35 - 1\,000$
- $= 32.4$
- allow 32.4 with no working shown for 3 marks* 1
- incorrect number of sig. figs max 2 marks*
- (c) because oxygen is formed at the anode 1
- which reacts with the carbon anode to produce carbon dioxide 1
- and wears it away 1
- (d) power = $1.5 \times 10^5 \times 4$ 1
- $= 6.0 \times 10^5 \text{ W}$ 1
- 24 hours = $24 \times 60 \times 60 = 8.64 \times 10^4$ seconds 1
- energy transferred = $6.0 \times 10^5 \times 8.64 \times 10^4$
- allow ecf from power calculation* 1

$$= 5.184 \times 10^{10}$$

allow 5.184×10^{10} with no working for 5 marks

1

- (e) 3 moles of electrons are needed to produce 27 g or 0.027 kg aluminium

1

so moles of electrons to produce 1 000 kg = $1\,000 / 0.027 \times 3$

1

$$= 111\,000$$

allow 111 000 with no working shown for 3 marks

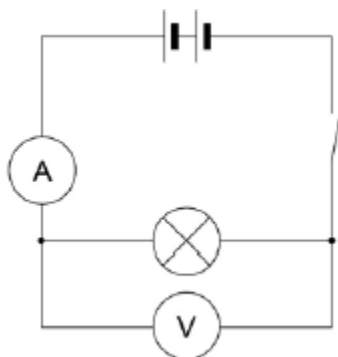
1

incorrect no. of sig. figs max 2 marks

[16]

Q10.

(a)



battery connected correct way round

1

ammeter and voltmeter correct way round

1

- (b) 6.4 V

1

- (c) (the lamp will) get dimmer

1

because increasing the resistance decreases the current

1

- (d) potential difference = current $\times$ resistance

allow $V = IR$

1

- (e) $3.3 = 0.15 \times R$

1

$$R = 3.3 \div 0.15$$

1

$$= 22(\Omega)$$

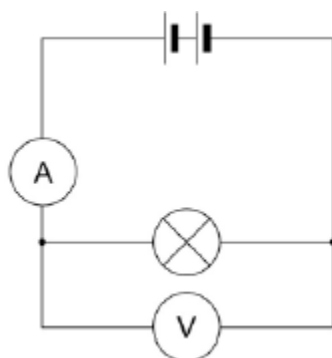
1

allow 22 with no working shown for 3 marks

[9]

Q11.

(a)



ammeter connected in series

1

voltmeter connected in parallel

1

measure the potential difference across the lamp at known current

1

calculate resistance from measured values using $V = IR$

1

(b) for ohmic conductors the current is directly proportional to the potential difference applied across it

1

this graph is curved so it is not an ohmic conductor

1

(c) diode

1

because it has a high resistance with negative potential differences

1

and a low resistance for positive potential differences.

1

allow answers in terms of current

(d) tangent to the curve drawn at 2.3 V

1

correct reading of Δy and Δx from graph

1

either

substitution of values into $V = IR$ (1)

1

value of R calculated (1)

accept values in the range 0.50 to 0.65

1

or

calculation of gradient (1)

allow ecf from incorrect readings of Δy and Δx

calculation of $R = 1 / \text{gradient (1)}$

accept values in the range 0.50 to 0.65

[13]

Examiner reports

Q1.

- (a) 33% of students drew a curve in the correct quadrants which passed through the origin with decreasing gradient to score two marks. 25% of students then curved their lines back towards the **x**-axis at the ends and so did not score the gradient mark. The most common mistake was to draw a straight line in the correct quadrants through the origin as for a fixed resistor. A few drew the graph for a diode. Some students drew a curve or straight line through the second and fourth quadrants, and some drew a line or curve which was in one quadrant only, or intersected more than two quadrants.
- (b) Responses to this question were very mixed. 24% of students scored two marks and 24% of students scored one mark. Many students talked about the current being strongest close to the battery, and weaker further away. Voltage was also discussed in some responses.

Many students just stated that the current split which was not sufficient. However, there were some excellent concise answers that demonstrated a very good understanding of current in parallel circuits.

- (c) Half of the students found this multistep calculation question very challenging and scored no marks. 13 % of students scored five marks for correctly calculating a charge flow of 30 C but did not double this to determine the total.

Those who were unable to calculate the correct current could still have scored three marks for multiplying their incorrectly calculated current by 60, then doubling this number and finally naming the correct unit. Very few of these scored anything other than the unit mark. Those that did multiply a number by 60 often did not gain credit because it was unclear what their number represented.

- (d) Very few students achieved a level 3 response in this question. 38% of students gained at least one mark. A large number of students listed what they could recall about circuits despite this not being relevant to the question – information such as which meter is connected in series, which in parallel and what other components are in the circuit.

The majority of students were unable to recognise the symbol for the LDR with many stating it was a thermistor. Those that did recognise the symbol for the LDR often did not recall the correct link between light intensity and resistance or even the function of the LDR. Many students thought that the LDR was the actual light that was switched on and off by the light intensity. Many students who started the question well, correctly identifying the LDR and linking that correctly to how the resistance of the LDR would change, failed to explain how this change in resistance would affect the readings on the ammeter and voltmeter. Very few students demonstrated an understanding of how resistance affects current.

Q2.

- (a) More than three quarters of students identified the given circuit symbol as a switch. Of the remaining responses, more chose the fuse than the other two options.
- (b) More than three quarters of students chose the correct response of 'electrolysis', with 'distillation' being the next most popular choice.

- (c) Around 17% of students gained both marks for this question. Students who scored one mark usually did so for correctly identifying the independent variable of 'concentration of copper sulfate solution'.

Although both 'concentration of copper sulfate solution' and 'mass of copper deposited' were chosen by a good number of students, these were often paired to the incorrect variable.

Other incorrect answers included various combinations of the type of variable and the description. Despite the instruction to draw one line from each type of variable, several students showed two lines from each.

- (d) Slightly more than one third of students chose the correct response that some copper fell off the electrode. The other two options were as popular as each other.
- (e) Around half of students were able to identify the pattern in the results and state the correct value of 0.16 g.

A common incorrect answer was 16 g, indicating that students had recognised the pattern, but had forgotten to include the decimal point.

Another common incorrect response was 0.07 g, which was the result given in the table; perhaps students had not taken on board the previous question which referred to this result as being anomalous.

- (f) Around 70% of students correctly identified that copper ions have a positive charge. Of the incorrect responses, 'a negative charge' was more popular.
- (g) Just over half of students realised that solid copper sulfate does not conduct electricity because the ions cannot move. The other three choices had a similar number of responses, with 'the ions are too big' being the least popular choice.
- (h) Around 8% of students did not attempt this question. Most of those who attempted it were able to substitute the given values into the equation and work out the correct answer, thus scoring two marks.

Some students substituted other values for current, such as 0.06 A or 6 A, rather than the given 0.6 A. It was not clear whether they had deliberately converted the value, or just made an error in writing it down. A few students divided the two values rather than multiplying them. It should be noted that in a low demand question where the equation is provided, it is always in the form needed, so no re-arrangement is necessary.

Q3.

Foundation

- (a) Around one third of students left this blank. Of those who attempted an answer, many did not draw anything resembling any recognised circuit symbol.

Some students realised that a resistor symbol would be part of the diagram, and some remembered that the symbol included arrows. Less than 2% gave a completely correct symbol.

- (b) Just over two thirds of students knew that one component would be in series and the other in parallel. The choices were fairly evenly matched, with the correct answer of ammeter in series and voltmeter in parallel gaining slightly more responses. Of the other two options, the two components in parallel was a more popular choice than

them being in series.

- (c) More than one third of students did not attempt this question.

Many students realised that the given graph showed a directly proportional relationship; this gave them one mark. However, not many were able to correctly identify the features of the graph which showed this, or which would show an inverse proportional relationship.

Some students attempted to explain an experimental error which led to incorrect results.

- (d) More students left this question blank than attempted it. The vast majority of those who attempted the question drew a straight line through the origin with a negative gradient.

Fewer than 3% of students drew a correct line.

- (e) More than 20% of students left this blank. Of those who wrote something, some wrote an equation which was totally unconnected to the quantities listed. Some wrote expressions which were not equations, i.e. did not have an equals sign. Quite a number looked on to the following question and performed a calculation using the values given.

Of those who wrote a mathematical equation connecting the given quantities, just over 20% gave a correct form of the equation to gain the mark.

- (f) Linking to the previous question, as many students did not give the correct equation, they were unable to perform the calculation correctly, the most common error being to multiply the two given numbers.

Of those who divided the potential difference by the current, the majority did not attempt to convert the current value from mA to A; nevertheless, they were able to gain some credit. Of the few students who tried to do this conversion, most multiplied by a power of ten rather than dividing by 1000. Very few students scored all four marks.

Higher

- (a) Fewer than 5 % of students drew the correct circuit symbol for the LDR. Some made some mistake such as arrows pointing away or an arrow through the resistor itself. A variety of different circuit symbols was seen, including many made-up ones. A common incorrect symbol was that for an LED, or an approximation of this.
- (b) Around half of students knew the correct arrangement of the ammeter and voltmeter in a circuit. A further quarter knew that one was in series and one was in parallel but chose the wrong way round. The remaining responses were fairly evenly spread between both in series and both in parallel.
- (c) Just under half of students gained at least one mark for stating that the given graph showed direct proportionality. Many attempted to describe why the graph showed this, but answers tended to be incomplete, either just saying that it was a straight line, or that it went through the origin, but rarely saying both. Some students attempted to describe what a graph showing inverse proportion would look like, but again, answers tended to be incomplete. Around 7% of students did not attempt this question.
- (d) The vast majority of students incorrectly drew a line from top left to bottom right

through the origin. A few students drew a straight line through the origin with a positive gradient. Some of these were steeper than the given graph line. The number who correctly drew the line with a shallower gradient was small.

- (e) A few students gave equations which did not connect all the quantities shown, for instance the equation for electrical power or for a transformer were seen several times.

About half of the students were able to write the equation in one of its correct forms. Credit was given for answers in terms of symbols, for instance $V = IR$, but incorrect symbols such as C for current were not credited. Students would be advised to write the equation in words if they are unsure of the correct symbols. The triangle notation which helps students with re-arranging was not acceptable as an equation.

- (f) Around 5% of students achieved the correct answer of 440Ω . A further 40 % scored three of the four marks for doing a correct calculation with a value of the current which had not been converted from milliamps into amps. In many cases, the conversion had not been attempted at all, leading to an answer of 0.44Ω . In other cases, students had attempted to convert by multiplying or dividing by a power of 10. Multiplying by 1000, rather than dividing, was a common mistake.

Students who gained no marks tended to multiply the values for the potential difference and current.