

Name: \_\_\_\_\_

Resistivity (old)

Mark Scheme

**Date:**

**Time:**

**Total marks available:**

**Total marks achieved:** \_\_\_\_\_

## **Mark Scheme**

Q1.

Question Number	Answer	Mark
	A	(1)

Q2.

Question Number	Answer	Mark
	<u>Effect of stretching wire</u> Refers to $R = \rho l/A$ (1) Increasing length leads to increase in resistance (1) Thinner wire has smaller CSA which leads to increase in resistance (1)  [last two points may be combined to give single statement, can score both marks]	3

Q3.

Question Number	Answer	Mark
	Use of $R = \rho l/A$ (1) $\times 8$ (1) $R = 0.28 \text{ } (\Omega)$ (1)  [Omitting $\times 8$ gives $R = 0.035 \text{ } \Omega$ scores 1]  <u>Example of calculation</u> $R = (9.9 \times 10^{-8} \text{ } \Omega \text{ m}) \times (8 \times 0.03 \text{ m}) \div 8.5 \times 10^{-8} \text{ m}^2$ $R = 0.2795 \text{ } \Omega$	3

Q4.





Question Number	Answer	Mark
(a)	Substitution into $R = \rho l/A$ (ignore powers of 10) (1) Conversion cm to m (1) $R = 540 (\Omega)$ (1)  <u>Example of calculation</u> $R = (5.4 \times 10^{-3} \Omega \text{ m} \times 0.15 \text{ m}) / 1.5 \times 10^{-6} \text{ m}^2$ $R = 540 \Omega$	3
(b)(i)	Resistance/resistivity changes with temperature (allow wire gets hotter etc)(1) As <u>temperature</u> increases, resistance/resistivity decreases (this statement implies 1st mark so scores 2)	2
(b)(ii)	Current flow causes a heating effect (1) Resistance of lead decreases/ number of charge carriers increases (1) Relates to $V = IR$ e.g. $R \propto 1/I$ or 'because $V$ is constant, as $R \downarrow$ , $I \uparrow$ ' (1)	3
	<b>Total for question</b>	<b>8</b>

Q8.

Question Number	Answer	Mark
(a)	best fit line (1) use of gradient Or use of $R/l$ from graph or table (1) use of $\rho = RA/l$ (1) resistivity = $4.7 \times 10^{-7} \Omega \text{ m}$ (range $4.5$ to $4.8 \times 10^{-7} \Omega \text{ m}$ ) (1)  <u>Example of calculation</u> gradient = $4.4 \Omega \div 1.0 \text{ m} = 4.4 \Omega \text{ m}^{-1}$ $\rho = A \times \text{gradient} = 1.06 \times 10^{-7} \text{ m}^2 \times 4.4 \Omega \text{ m}^{-1}$ resistivity = $4.66 \times 10^{-7} \Omega \text{ m}$	4
(b)	temperature increases (with increasing current) (1) resistance/resistivity would have increased (with temperature) (1)	2
(c)	Precaution (1) Explanation (1)  E.g. ensure good contact (e.g. tight croc clips); so pd across contact resistance doesn't make V results inaccurate E.g. Avoid pressing too hard on wire; as a deformation would affect cross-sectional area and therefore resistance e.g. ensure wire is straight so length measurement is accurate e.g. ensure eyes perpendicular to scale to avoid parallax errors  <b>Do not credit:</b> diameter of wire since area is not in the table repeat and average high resistance voltmeter keep temperature constant	2
	<b>Total for question</b>	<b>8</b>

Q9.

Question Number	Answer	Mark
(a)	Conversion of kW to W (1) Use of $P = V^2/R$ OR $P = VI$ and $V = IR$ (1) $R = 53 \text{ } (\Omega)$ (to at least 2 s.f.) [no ue] (1)  <u>Example of calculation</u> $R = (230 \text{ V} \times 230 \text{ V}) / 1000 \text{ A}$ $R = 52.9 \text{ } \Omega$	3
(b)	Use of $R = \rho l/A$ (1) $l = 6.3 \text{ m}$ ('Show that' value gives 5.9 m) (1)  <u>Example of calculation</u> $l = RA/\rho$ $l = 53 \text{ } \Omega \times 1.3 \times 10^{-7} \text{ m}^2 / 1.1 \times 10^{-6} \text{ } \Omega \text{ m}$ $l = 6.3 \text{ m}$	2
(c)	If length halved, area must half (for same resistance) / state $A \propto l$ (1) Use of area = $\pi r^2$ (1) Diameter = 0.28 mm or 0.29 mm (1) <b>OR</b> Use of the resistivity formula (1) Use of area = $\pi r^2$ (1) To give correct diameter for their values of length and resistance (1)  (0.14 mm scores 2 marks)	3
	<b>Total for question</b>	<b>8</b>

Q10.

Question Number	Answer	Mark
(a)	The (maximum) length is (directly) proportional to the area	(1) 1
(b)(i)	Use of $\rho l/A = R$ $R = 1.34 \text{ } (\Omega)$  <u>Example of calculation</u> $R = 1.68 \times 10^{-8} \text{ } \Omega \text{ m} \times 80 \text{ m} \div 1.0 \times 10^{-6} \text{ m}^2$ $R = 1.34 \text{ } \Omega$	(1) (1) 2
(b)(ii)	Use of $P = I^2 R$ $P = 160 \text{ W}$ allow ecf from (i)  <u>Example of calculation</u> $P = (11 \text{ A})^2 \times 1.34 \text{ } \Omega$ $P = 162 \text{ W}$ (157 W if they use 1.3 $\Omega$ )	(1) (1) 2
(b)(iii)	Use of $V = IR$ Or use of $P = VI$ Or use of $P = V^2/R$ $V = 15 \text{ V}$ allow ecf from (i) and/or (ii)  <u>Example of calculation</u> $V = 11 \text{ A} \times 1.34 \text{ } \Omega = 14.7 \text{ V}$ (14.3 V if 1.3 $\Omega$ is used)	(1) (1) 2
(c)	To prevent (use of a cable with) resistance that is too large (Accept answers that refer to maintaining or not exceeding a resistance of about 1.3 $\Omega$ )  Meaning more energy / power / p.d. available for the shredder	(1)  (1) 2
<b>Total for Question</b>		<b>9</b>

Q11.

Question Number	Answer	Mark	
(a)(i)	Determines width of at least 9 coils Use of half of their diameter in $\pi r^2$ Area = $(1.96 \text{ to } 2.42) \times 10^{-7} (\text{m}^2)$  <u>Example of calculation</u> 18 coils = 1.00 cm Diameter = $0.0100 \text{ m} \div 18 = 5.56 \times 10^{-4} \text{ m}$ Area = $\pi \times (5.56 \times 10^{-4} \div 2)^2$ Area = $2.42 \times 10^{-7} \text{ m}^2$	(1) (1) (1)	3
(a)(ii)	Use of $R = \rho l / A$ Resistivity magnitude = $4.4 \times 10^{-7}$ (show that value gives $3.7 \times 10^{-7}$ ) Unit $\Omega \text{m}$  <u>Example of calculation</u> $\rho = RA / l$ $= 22 \Omega \times 2.4 \times 10^{-7} \text{ m}^2 / 12 \text{ m}$ $= 4.4 \times 10^{-7} \Omega \text{m}$	(1) (1) (1)	3
(a)(iii)	A sensible response with some detail, e.g. <ul style="list-style-type: none"> <li>• Avoid difficulty in reading a small scale while holding it and counting turns</li> <li>• it can be enlarged and done more accurately</li> <li>• compare with unravelling and using a micrometer</li> <li>• remains stationary, so easier to measure accurately</li> <li>• you can mark the coils as you go so you don't lose count</li> </ul> (treat parallax as neutral and )	(1)	1
(b)	Use of ratio of lengths $\times$ pd $V = 8.2 \text{ V}$  <u>Example of calculation</u> $V = (7.0 \text{ cm} / 10.2 \text{ cm}) \times 12 \text{ V}$ $= 8.2 \text{ V}$	(1) (1)	2
<b>Total for question</b>			<b>9</b>

Q12.

Question Number	Answer	Mark
(a)	<p><u>Effect of stretching wire</u></p> <p>Refers to <math>R = \rho l / A</math></p> <p>Increasing length leads to increase in resistance</p> <p>Decreasing area leads to increase in resistance [must relate thinner to area]</p> <p>[last two points may be combined to give single statement, can score both marks]</p>	<p>1</p> <p>1</p> <p>1</p>
(b)	<p><u>Resistance calculation</u></p> <p>Use of <math>R = \rho l / A</math></p> <p><math>\times 8</math></p> <p><math>R = 0.22 \text{ } (\Omega)</math></p> <p>[Omitting <math>\times 8</math> gives <math>R = 0.028 \text{ } \Omega</math> scores 1]</p> <p><b>Example of answer</b></p> <p><math>R = (9.9 \times 10^{-8} \text{ } \Omega \text{ m}) \times (8 \times 0.025 \text{ m}) \div 0.9 \times 10^{-7} \text{ m}^2</math></p> <p><math>R = 0.22 \text{ } \Omega</math></p>	<p>1</p> <p>1</p> <p>1</p>
(c)	<p><u>Relationship and increase in R</u></p>	
(i)	<p>Attempts to substitute for <math>A = V/l</math> in <math>R = \rho l / A</math></p> <p><math>R = \rho l^2 / V</math></p>	<p>1</p> <p>1</p>
(ii)	<p>Any attempt to relate original resistance of gauge to <math>2.5^2</math> (possibly <math>\times 8</math>, cm or m)</p> <p>Relates this to resistance associated with increase in length</p> <p>Change in resistance = <math>1.76 \times 10^{-3} \text{ } \Omega</math></p> <p>OR</p> <p>Uses <math>V=lA</math> to find new area</p> <p>Uses this <math>A</math> with new length to find new <math>R</math></p> <p>Change in resistance = <math>1.76 \times 10^{-3} \text{ } \Omega</math></p> <p>[if candidate assumes <math>A</math> constant and finds new <math>R</math> and <math>\Delta R = 0.001 \text{ } \Omega</math>, score 1 mark]</p> <p><b>Example of answer</b></p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

	$\text{New } R = \left( \frac{2.51^2}{2.5^2} \times 0.22 \right) - 0.22$ $\Delta R = 1.76 \times 10^{-3} \Omega$	
(d)	<u>Zigzag pattern</u> Each section of wire increases in length/gives a longer total length/long wire in small space Small change in length of gauge leads to larger change in resistance	1 1
	<b>Total for question</b>	<b>13</b>