1)

$\rho = RA/l = 1.6 \times 10^{-3} \times 7.9 \times 10^{-5}/0.75$ ✓ $R = 1.7 \times 10^{-7}$ ✓ Ω m ✓	**3**

2)

a	(i)	resistivity is defined as $\rho = \frac{RA}{l}$ where R is the resistance of the material of length l✓ and cross-sectional area A✓	2		

a	(ii)	below the critical temperature/maximum temperature which resistivity/resistance ✓ is zero/becomes superconductor✓	2		Any reference to negligible/small/very low resistance loses second mark

b		(use of $\rho = \frac{RA}{l}$) $\rho = 0.70 \times \pi \times 0.0005^2/4.8$ ✓$= 1.1(5) \times 10^{-7}$ (1.1 – 1..2) ✓✓ Ω m✓	4		First mark for substitution R and l Lose 1 mark if diameter used as radius and answer is 4 times too big (4.4 – 4.8) OR if power of ten error

3)

a	Use of $\rho = RA/l$) cross sectional area= $\pi \times (3.7 \times 10^{-3})^2 = 4.3 \times 10^{-5}$ (m^2)✓ $\rho = \frac{3.3 \times 4.3 \times 10^{-5}}{1000}$ ✓$= 1.4(2) \times 10^{-7}$✓Ω m✓	area : lose first mark if use diameter as radius or fail to convert to m^2 (if both errors still only lose 1 mark) CE area for next two marks but if uses diameter in place of area then lose first two marks if leave length in km lose 2nd mark but CE for answer UNIT stand-alone 4th mark	4
b	(current in) steel wire (is less than the current in an) aluminium wire as it has a higher resistivity/resistance OR aluminium is better conductor✓ the six aluminium wires are in parallel OR total cross-sectional area of aluminium is 6 times greater than steel wire✓ each aluminium wire carries three times as much current as the (single) steel wire✓		3
c	resistance of 1 km of 6 Al cables in parallel = $\frac{1.1}{6}$ =0.183 Ω✓ total resistance of the cable = 0.174 Ω✓ power loss per km = 32.3 kW (or 30.7 kW if they ignore the steel)✓ OR power loss in 1 km of steel = 1.70kW✓ power loss in 1 km each of Al cable = 5.11 kW✓ total power loss per km = 32.4 kW (or 30.7 kW if they ignore the steel)✓ OR calculate current in steel wire and aluminium wire (22.7 and 68.2)✓ calculate power loss in aluminium wire and steel wire(1700 and 5115)✓ calculate total power loss (1700 + 6 × 5115 = 32,4 kW)✓	if ignored the steel wire then can score first anf third mark Accept range 32 kW to 33 kW If ignored steel wire range for third mark is 30 kW to 31 kW if wires treated as series resistors then zero	3

4)

(a) (i)	(use of $R = \rho l/A$) $R = 4.0 \times 10^{-3} \times 0.060$ ✓$/(\pi \times 0.012^2)$ ✓ $R = 0.53\ (\Omega)$ ✓ 2 significant figures ✓	**4**
(a) (ii)	halving the diameter **will** increase resistance by factor of 4 or increasing the length by a factor of 4 will increase resistance by factor of 4 ✓ (hence) resistance will be 16 times greater ✓	**2**

(b)	the mark scheme for this part of the question includes an overall assessment for the Quality of Written Communication circuit must include: voltmeter and ammeter connected correctly ✓ power supply with means of varying current ✓	**2**
QWC	**descriptor**	**mark range**
good - excellent	(i) Uses accurately appropriate grammar, spelling, punctuation and legibility. (ii) Uses the most appropriate form and style of writing to give an explanation or to present an argument in a well structured piece of extended writing. [may include bullet points and/or formulae or equations] An excellent candidate will have a working circuit diagram with correct description of measurements (including range of results) and processing. An excellent candidate uses a range of results and finds a mean value or uses a graphical method, eg *I-V* characteristics. They also mention precision eg use of vernier callipers.	**5 - 6**
modest - adequate	(i) Only a few errors. (ii) Some structure to answer, style acceptable, arguments or explanations partially supported by evidence or examples. An adequate candidate will have a working circuit and a description with only a few errors, eg do not consider precision. They have not taken a range of results and fail to realise that the diameter needs to be measured in several places.	**3 - 4**
poor - limited	(i) Several significant errors. (ii) Answer lacking structure, arguments not supported by evidence and contains limited information. Several significant errors, eg important measurement missed, incorrect circuit, no awareness of how to calculate resistivity.	**1 – 2**
incorrect, inappropriate or no response		**0**
	The explanation expected in a good answer should include a coherent account of the procedure and include most of the following points. • length with a ruler • thickness/diameter with vernier callipers/micrometer • measure voltage • measure current • calculate resistance • use of graph, eg *I-V* or resistance against length • use of diameter to calculate cross-sectional area • mention of precision, eg vernier callipers or full scale readings for V and I • flat metal electrodes at each end to improve connection	
	Total	**14**