Question		Marking details	Marks Available
(d)	(i)	Large triangles used (should be close to the extremities of the lines) or 2 equivalent suitable points clearly indicated on each line. (1) Both gradients calculated correctly (ignore unit and significant figures) (1 + 1) Allow **ecf** for incorrect max/min lines. Exemplar values – values must be in agreement with candidate's graph. Max gradient = $\frac{6.33 - 4.69}{80.0 - 0.0}$ = 0.0205 [$\Omega\,°C^{-1}$] Min gradient = $\frac{6.17 - 4.86}{80.0 - 0.0}$ = 0.0164 [$\Omega\,°C^{-1}$] Marking tips: First check: The value of m_{max} should be ~ 0.021 [$\Omega\,°C^{-1}$] and the value of m_{min} should be about 0.016 [$\Omega\,°C^{-1}$]. Candidates who have drawn lines which do not take full advantage of the error bars may get <0.020 and >0.017 respectively. This is penalised in (c), so apply **ecf**. Candidates who have drawn 'tram lines' will have two nearly identical values of ~ 0.018. Again **ecf** should be applied.	3
	(ii)	Mean gradient correct (1) [Exemplar value ~ 0.0184[5] [$\Omega\,°C^{-1}$] but apply **ecf** from *(b)* and *(d)*(i)]. No unit penalty. Percentage uncertainty correct (1) [Exemplar value ~ 11%. Allow 1 or 2 sig figs. Apply **ecf** from *(b)* and (*d)*(i)].	2
(e)	(i)	Mean value correct [Exemplar value 4.78 [Ω]]. (1) Percentage uncertainty correct [Exemplar value ~2% - allow 1 or 2 sig figs]. (1) Allow **ecf**. Intercept = Resistance (of copper) at 0 °C. (1)	3
	(ii)	$\alpha = \frac{\text{gradient}}{R_0}$ or $\alpha = \frac{\text{gradient}}{\text{intercept}}$ stated or implied by calc. (1) Correct calculation, i.e. $\alpha = \frac{\text{answer to } (d)(\text{ii})}{\text{answer to } (e)(\text{i})}$ (1) $\alpha = 3.9 \times 10^{-3}$ [Accept answer in range 3.8 to 4.0 $\times 10^{-3}$]. (1) Note: This mark is for accuracy. Do not apply **ecf**. No sig figs penalty. Unit given as $°C^{-1}$ (or K^{-1}). (1) N.B. If data points selected from the graph or table (1), calculation of α (1), correct unit (1) i.e. maximum of 3 marks awarded.	4
	(iii)	Total % uncertainty = % in *(d)*(ii) + % in *(e)*(i). (1) [Exemplar value ~ 13%. Apply **ecf**] Absolute uncertainty correct and given to 1 or 2 sig figs. (1) [Exemplar value ~ 0.5 $\times 10^{-3}$] Temperature coefficient of resistance written correctly with its uncertainty, ignore unit, the value given to number of sig figs consistent with uncertainty [e.g. 0.0039 ± 0.0005 $°C^{-1}$; (3.9 ± 0.5) $\times 10^{-3}\,°C^{-1}$. (1) Award the mark if α and absolute uncertainty calculated correctly but written separately.	3
		Question total	**25**