QUESTION 1		
Code	**Points to score**	**Marks**
A_1	**b** measured at at least 3 places	½
A_2	Average value of b: 2.20 ≤ b ≤ 2.50 cm, recorded to 2 pd in cm ½ + ½	1
A_3	**d** measured at at least 3 places	½
A_4	Average value of d: 0.40 ≤ b ≤ 0.60 cm, recorded to 2 pd in cm ½ + ½	1
A_5	C is at 49.5 – 50.5 cm mark, recorded to 1dp in cm ½ + ½	1
A_6	P_o recorded to 1 dp in cm	½
A_7	New position of pointer recorded to 1 dp in cm ½ + ½	1
A_8	*x* correctly calculated to 3 decimal places in metres ½ + ½	1
A_9	Correct substitution into the expression – everything in SI units	½
A_{10}	E correctly calculated (1.00 ≤ E ≤ 2.50) x 10^{10} N m^{-2} to 2 or 3 sig. figures 1 + ½	1½
		8½
B_1	Columnar table of: *l*, P_o, P, y, log*l* and log y @¼	1½
B_2	Correct units: (m), (cm), (cm), (m), -, - @¼	1½
B_3	Initial positions of pointer, P_o, recorded to 1 dp in cm (or to 3 dp in m) @½	3½
B_4	Final positions of pointer, P, recorded to 1 dp in cm (or to 3 dp in m) @½	3½
B_5	Values of y correctly calculated to 3 dp in m, decreasing @¼	2
B_6	Values of log*l* read to 3 dp: -0.046, -0.097, -0.155, -0.222, -0.301, -0.398, -0.523	2
B_7	@¼	2
	Values of logy read to 3 dp @¼	
		16
C_1	Title of the graph: *A graph of* ***log*** *y against* ***log*** *l*	½
C_2	Axes: Each drawn with an arrow in the increasing direction, each labeled with quantity and unit …….. ½ + ½	1
C_3	Scales: Uniform, each spanning at least ½ pg, demarcations marked, starting values	1
C_4	indicated …….. ½ + ½	3½
C_5	Points correctly plotted: no shading, no use of star …….@½	½

C_6	Best fit : awarded if at least 4 points were correctly plotted Intercept, C, correctly read and $-1.280 \leq C \leq -0.870$ to 2 or 3 dp …… ½ + ½	1
		7½
D_1	Substitution into $C = \log\left(\frac{0.4g}{Ebd^3}\right)$ …. All in SI units	½
D_2	E correctly calculated and $(1.00 \leq E \leq 2.50) \times 10^{10}$ N m^{-2} to 3 sig. figures ... 1 + ½	1½
D_3	Calculation of the average value of E from the two methods to 3sig. figures … ½ + ½	1
		3
	Total = 34	

QUESTION 2		
Code	**Points to score**	**Marks**
A_1	u recorded to 1 decimal place in cm and $9.0 \leq h \leq 12.0$ cm 2 + ½	2½
A_2	v recorded to 1 decimal place in cm and $9.0 \leq a \leq 12.0$ cm 2 + ½	2½
A_3	f correctly calculated to 1 decimal place in cm and $9.0 \leq f_1 \leq 12.0$ cm 1 + ½	1½
		6½
B_1	Columnar table of y, X_1, X_2, d, y^2, d^2 and $(y^2 - d^2)$ ……..@¼	2
B_2	Correct units: (cm), (cm), (cm), (cm), (cm^2),(cm^2), (cm^2) ……. @¼	2
B_3	Values of X_1 increasing between 10.0 – 14.0 cm, recorded to 1 dp in cm ….@½	3
B_4	Values of X_2 decreasing between 10.0 – 14.0 cm, recorded to 1 dp in cm ….@½	3
B_5	d correctly calculated to 1 dp in cm ……@¼	1½
B_6	y^2 correctly calculated to 1 dp in cm^2 ……@¼	1½
B_7	d^2 correctly calculated to 3 or 4 significant figures cm^2 (0 dp) ……@¼	1½
B_8	$(y^2 - d^2)$ correctly calculated to 3 or 4 significant figures cm^2 (0 dp) ……@¼	1½
		16
C_1	Title of the graph: *A graph of $(y^2 - d^2)$ against y*	½
C_2		

C_3	Axes: Each drawn with an arrow in the increasing direction, each labeled with quantity and unit …….. ½ + ½	1
C_4	Scales: Uniform, each spanning at least ½ page, demarcations marked, starting values	1 3
C_5	indicated …….. ½ + ½	½
C_6	Points correctly plotted: no shading, no use of stars …….@½	
C_7	Best fit : awarded if at least 4 points were correctly plotted s correctly calculated, if the coordinates were correctly read and 36.0 ≤ s ≤ 48.0 recorded to 1 or 2 decimal places …….. 1 + ½	1½
		7½
D_1	Substitution into s = 4f	½
D_2	f correctly calculated and 9.0 ≤ f ≤ 12.0 to 1dp …... 1 + ½	1½
D_3	Calculation of the average value of f from the two methods to 1dp …… ½ + ½	1
		3
Total = 33		

QUESTION 3		
Code	**Points to score**	**Marks**
A_1	Values of I_1 = 0.26 – 0.32 A, recorded to 2 decimal places 1 + ½	1½
A_2	Values of V_1 = 1.29 – 1.34 V, recorded to 2 decimal places 1 + ½	1½
A_3	Values of I_2 = 0.17 – 0.22 A, recorded to 2 decimal places 1 + ½	1½
A_4	Values of V_2 = 1.35 – 1.41 V, recorded to 2 decimal places 1 + ½	1½
A_5	Correct substitution into $\sigma = \frac{1}{2}\left[\frac{2V_1}{I_1} + \frac{4V_2}{3I_2}\right]$	1
A_6	σcorrectly calculated and $8.0 \leq \sigma \leq 10.0\ \Omega\ m^{-1}$. 1 + ½	1½
		8½
B_1	Columnar table of: x, y, $\frac{1}{x}$, $\frac{1}{y}$ …… @¼	1
B_2	Correct units: (m), (m), (m^{-1}), (m^{-1}) …… @¼	1
B_3		

B_4	Values of y increasing between 0.380 and 0.600 m, recorded to 3 dp in m (or 1 dp in cm) @1	6 1½
B_5	Values of $\frac{1}{x}$ calculated to 2 decimal places …… @¼ Values of $\frac{1}{y}$ correctly calculated to 2 decimal places …… @¼	1½
		11
C_1	Title of the graph: *A graph of* $\frac{1}{y}$ *against* $\frac{1}{x}$	½
C_2	Axes: Each drawn with an arrow in the increasing direction, each labeled with quantity and unit …….. ½ + ½	1
C_3	Scales: Uniform, each spanning at least ½ page, demarcations marked, starting values indicated …….. ½ + ½	1
C_4	Points correctly plotted: no shading …….@½	3
C_5	Best fit : awarded if at least 4 points were correctly plotted	½
C_6	Indication of triangle or equivalent for calculating s, covering all points	½
C_7	s correctly calculated, if the coordinates were correctly read and $0.180 \le s \le 0.212$ recorded to 2 or 3 decimal places …….. 1 + ½	1½
C_8	The intercept, C, correctly read and $1.50 \le s \le 2.00$ m^{-1} 1 + ½	1½
		9½
D_1	Substitution into $\mathbf{r = \frac{s\sigma}{C}}$	½
D_2	r correctly calculated and $0.40 \le r \le 0.80$ to 2dp …... 1 + ½	1½
D_3	Mention of any 2 genuine sources of error …… @½ e.g - resistances at connection points - the cells used may slightly run down during the experiment	1
D_4	Mention of any 2 scientific precautions taken relevant to the experiment …….. @½ e.g - ensuring firm connections - open the switches until when taking readings - no parts of W within length x should touch any conductor	1
		4
	Total = 33	