Teacher Resource Bank

GCE Physics

Sample A2 EMPA:

- Mark Scheme

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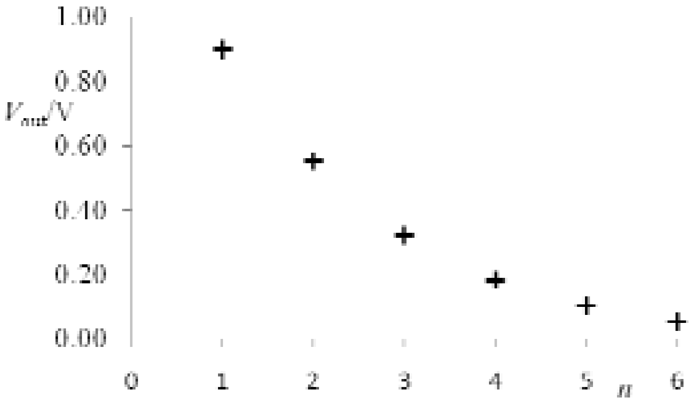
Section A Task 1

Question 1			
(a)	accuracy:	I_1 and I_2 to 1 mA, I_2 about 1.75 × I_1 ✓	**1**
(b)	accuracy:	I_3 and I_4 to 1 mA, $I_4 \approx I_3 \pm$ 1 mA ✓ $I_3 = I_1$ ✓	**2**
(c)	explanation:	$R_2 > R_1$ or 0/2 ✓ when R_1 and R_2 are in parallel with R_2, I increases significantly [I_2 much greater than I_1] ✓ [when R_1 and R_2 are in parallel with R_1, I increases by only a small amount (I_4 not much greater than I_3) ✓]	**2**
(d)	explanation:	**method 1** 'background' = 3.65 V ✓ computes 'corrected' values of V, all correct ✓ evaluates (at least) 2 ratios of 'corrected' V ✓ to show that the students suggestion is false ✓ **variation on method 1** 'background' = 3.65 V ✓ computes 'corrected' values of V, all correct ✓ sketches 'corrected' V against n and makes (at least) 2 'half life' measurements ✓ to show that the student's suggestion is false ✓ **method 2** evaluates ln (V/V), using 'uncorrected' or 'corrected' V ✓ all ln (V/V) correct ✓ evaluates (at least) 2 differences between adjacent values of ln (V/V) ✓ to show that the student's suggestion is false ✓ **variation on method 2** evaluates ln (V/V), using 'uncorrected' or 'corrected' V ✓ all ln (V/V) correct ✓ sketches ln (V/V) against n and produces best-fit line of negative, **decreasing** gradient ✓ to show that the student's suggestion is false ✓ [allow 'suggestion is correct' if straight best-fit line drawn]	**4**
		Total	**9**

Data for use in Question 1 (d) Section A Task 1

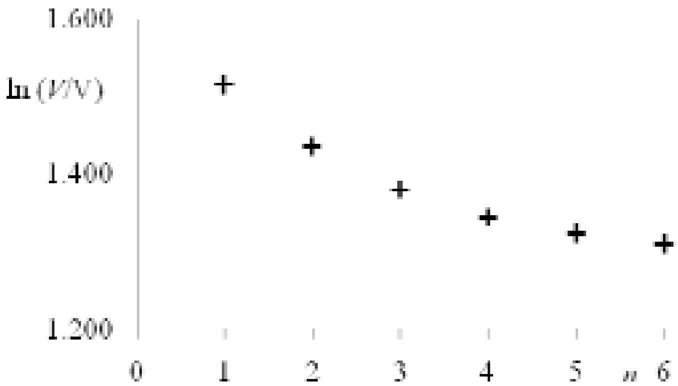
see method 1

n	V_{out}/V		ratios
	uncorrected	corrected	
1	4.55	0.90	
2	4.20	0.55	0.611
3	3.97	0.32	0.582
4	3.83	0.18	0.563
5	3.75	0.10	0.556
6	3.70	0.05	0.500



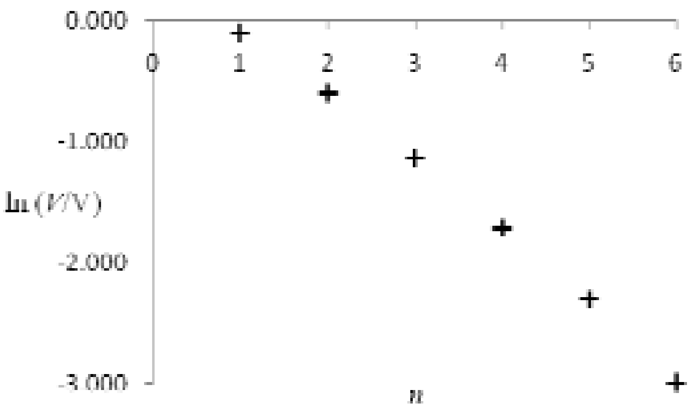
see method 2

n	V_{out}/V	ln (*V*)	difference
	uncorrected		
1	4.55	1.515	
2	4.20	1.435	0.0800
3	3.97	1.379	0.0563
4	3.83	1.343	0.0359
5	3.75	1.322	0.0211
6	3.70	1.308	0.0134



or

n	V_{out}/V	ln (*V*)	difference
	corrected		
1	0.90	-0.105	
2	0.55	-0.598	0.4925
3	0.32	-1.139	0.5416
4	0.18	-1.715	0.5754
5	0.10	-2.303	0.5878
6	0.05	-2.996	0.6931



Question 2			
(a) (i)	accuracy:	sensible time base setting recorded, with units ✓	**1**
(ii)	accuracy:	evidence of working; cycle (or $n \times$ cycle) converted to s by multiplying by time base setting ✓ period, T, recorded to 0.1 ms ✓ f from $\frac{1}{T}$, in range 800 Hz to 900 Hz ✓	**max 2**
(b)	method:	evidence of working; 3 measurements in mm or divisions, converted to V by multiplying by Y-gain sensitivity ✓ $V_1 > V_2 > V_3$, $V_1 \approx 1.6$ V ✓	**2**
(c)	explanation:	$\frac{V_3(V_1 + V_2)}{V_1 V_2}$, no unit, 0.97 to 1.07 ✓✓ [0.92 to 1.13 ✓]	**2**
		Total	**7**
		Section A Task 1 Total	**16**

Section A Task 2

Question 1			
(a)	accuracy:	T_0 in range 40(.0) to 60(.0) (s) ✓	**1**
(b)	tabulation:	T /s R /Ω ✓ deduct ½ for each missing label or separator, rounding down	**5**
	results:	6 sets of T and R ✓✓ deduct (up to 2 marks) for each missing deduct 1 mark if no T (including T_0) is calculated from nT where n or $\Sigma n \geq 2$	
	significant figures:	all T (including T_0) to 0.1(0) s ✓	
	quality:	at least 5 points to + 2 mm of straight line of positive gradient (judge from graph, providing this is suitably-scaled) ✓	

(c)	tabulation: $\frac{1}{T}$ $\frac{1}{R}$ significant figures: all of each set to either 3 sf or 4 sf axes: marked $\frac{1}{T}/\mathrm{s}^{-1}, \frac{1}{R}/\mathrm{k\Omega}^{-1}$, [$\Omega^{-1}$] ✓✓ deduct ½ for each missing label or separator, rounding down; no credit if axes reversed scales: points should cover at least half the grid horizontally ✓ **and** half the grid vertically ✓ (if necessary, a false origin should be used to meet these criteria; either or both marks may be lost for use of a difficult or non-linear scale or if the interval between the numerical values are marked on an axis with a frequency of > 5 cm) points: 6 points plotted correctly (check at least two) ✓✓✓ marks are deducted for points > 1 mm from correct position and if poorly marked line: (ruled) best fit line of positive gradient ✓	**10**
	Total	**16**

Section B

Question 1		
(a)	y-step at least 8 cm and x-step at least 8 cm ✓ (if a poorly-scaled graph is drawn the hypotenuse of the gradient triangle should be extended to meet the 8 × 8 criteria) correct transfer of y-step and x-step data between graph and calculation ✓ (mark is withheld if points used to determine either step > 1 mm from correct position on grid; if tabulated points are used these must lie on the line)	**2**
(b)	GT_0 in range 14.0 to 16.0 or 15 kΩ ✓✓ [13.0 to 17.0 kΩ , 14 kΩ or 16 kΩ ✓]	**2**
	Total	**4**

Question 2		
(a)	R is in parallel with concealed resistor ✓ thus combined resistance is less (than concealed resistor) ✓ since time measured is (directly) proportional to (circuit) resistance, $T < T_0$ ✓	**max 2**
(b)	same number as R ✓	**1**
	Total	**3**

Question 3		
(a)	G is doubled ✓ because T values are all halved (hence $\frac{1}{T}$ values doubled) ✓	**2**
(b)	GT_0 is unchanged ✓ because G doubled (allow ecf from (a)) and T_0 is halved ✓	**2**
	Total	**4**

Question 4		

		ΔV	%
V_1/V	2.15	0.05	2.33%
V_2/V	1.15	0.05	4.35%
V_3/V	0.80	0.05	6.25%
$(V_1 + V_2)$	3.30	0.10	3.03%
$\frac{V_3(V_1+V_2)}{V_1V_2}$	1.068		15.95%

(a)	percentage error in V_1, V_2 and V_3 correctly calculated, accept 2 sf ✓	**1**
(b) (i) (ii) (iii)	absolute error in $(V_1 + V_2)$ = 0.1(0) V percentage error in $(V_1 + V_2)$ correctly calculated, accept 2 sf ✓ percentage error in $\frac{V_3(V_1+V_2)}{V_1V_2}$ calculated from sum of percentage errors in V_1, V_2, V_3 and $(V_1 + V_2)$ ✓ 15.95%, 15.9% or 16.0% ✓	**4**
(c)	smooth best-fit line; two horizontal sections with smooth transition to non-linear central section with point of inflexion near mid-point ✓ when $\frac{V_3(V_1+V_2)}{V_1V_2}$ = 1.50, f = 600 ± 50 Hz ✓	**2**
(d) (i) (ii) (iii)	Y-shift ✓ by aligning the bottom of the trace with a gridline the student only has to estimate the position of the top of the trace ✓ X-shift ✓ Y-gain sensitivity ✓ **no advantage** gained because height of trace to be measured is the same in Figure 11 as in Figure 10 ✓ **disadvantage** because it is not certain that zero volts is aligned with the lowest horizontal grid line on the screen✓	**max 5**
	Total	**12**
	Section B Total	**23**