



GCE A LEVEL MARKING SCHEME

SUMMER 2024

**A LEVEL
ELECTRONICS – COMPONENT 1
A490U10-1**

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

EDUQAS A LEVEL ELECTRONICS – COMPONENT 1

PRINCIPLES OF ELECTRONICS

SUMMER 2024 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response question).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

Marking abbreviations

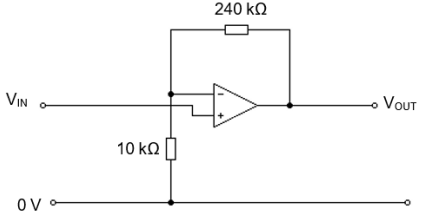
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only

ecf = error carried forward

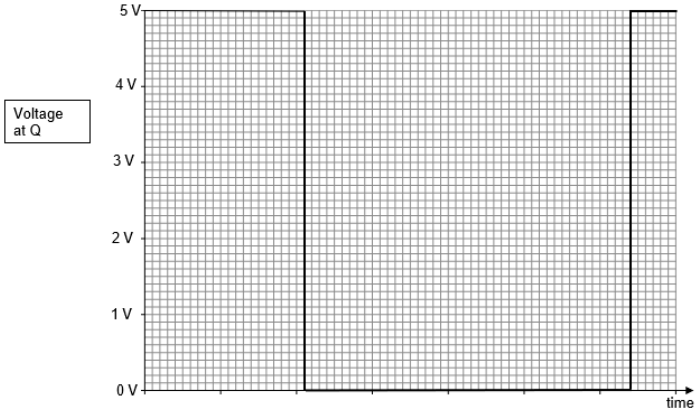
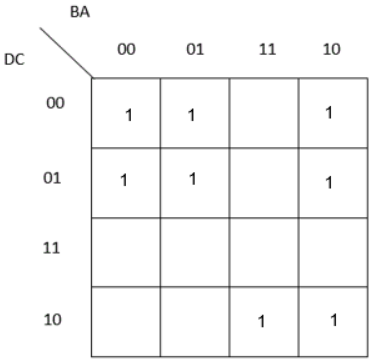
Question		Marking details	Marks available																																																																				
			AO1	AO2	AO3	Total	Maths																																																																
1	a	<table border="1" style="margin-left: 20px;"> <thead> <tr> <th>C</th> <th>B</th> <th>A</th> <th>L</th> <th>M</th> <th>N</th> <th>Q</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr> </tbody> </table> <p style="margin-left: 20px;"> Column L (1) Column M (1) Column N (1) ecf from L Column Q (1) ecf from N and M </p>	C	B	A	L	M	N	Q	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	1	0	0	0	0	1	1	1	0	1	0	0	1	1	1	1	0	0	0	0	0	1	1	1	0	1	0	1				4	4	
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	b	(i) <div style="margin-left: 20px;"> </div> <p style="margin-left: 20px;"> NOT (1) AND (1) NOR (1) OR (1) </p>				4	4																																																																

Question			Marking details	Marks available																																								
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2	a	(i)	0 (1)	1			1																																					
		(ii)	1 (1)	1			1																																					
		(iii)	$C + \bar{B}$ (1)	1			1	1																																				
	b		$\bar{C}.\bar{B}.\bar{A} + \bar{C}.\bar{B}.\bar{A}$ deMorgan's applied correctly once (1) $\bar{C}.B.A + C.B.A$ (1) $B.A.(\bar{C} + C)$ (1) $B.A$ (1)	1		3	4	4																																				
	c		<table border="1" style="margin-left: 20px;"> <thead> <tr> <th>C</th> <th>B</th> <th>A</th> <th>Q</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>1</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>0</td></tr> </tbody> </table> <p>Q correct for each term (2) -1 for each error</p>	C	B	A	Q	0	0	0	0	0	0	1	1	0	1	0	0	0	1	1	1	1	0	0	0	1	0	1	0	1	1	0	1	1	1	1	0				2	
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	d		$\bar{C}.\bar{B}.A + \bar{C}.B.A + C.B.\bar{A} + C.B.A$ All correct (2) Two correct (1)			2	2																																					
Question 2 total				4	7		11	5																																				

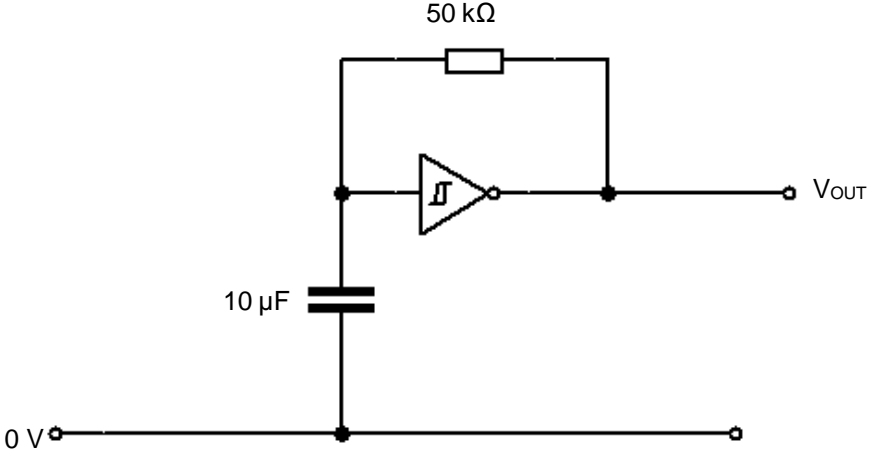
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
3	a	(i)	<p>Identification that $0.7 \times \text{gain} = 17.5$ (1) (accept $0.707 \times 25 = 17.7$ or 17.677 but NOT 17.6) From graph, Bandwidth = 18.75 kHz (18.5 – 19.0) (1) GBP = gain x bandwidth = 25×18.75 ecf (1) = 468.75 (462.5 – 475) (1)</p>	2	2		4	2
		(ii)	 <p>Correct connections for V_{IN}, R_F (1) Correct connections R_1 (1) Gain = $R_F/R_{IN} + 1$ $24 = R_F/R_{IN}$ (1) All $R > 1 \text{ k}\Omega$ (1)</p> <p>(Inverting amplifier achieves connections R_F (1), $25 = R_F/R_{IN}$ (1) and all $R > 1 \text{ k}\Omega$ (1) as ecf)</p>	2	2		4	1
	b	(i)	<p>$G = V_{OUT}/V_{IN}$ $35 = 14/V_{IN}$ $V_{IN} = 14/35$ (1) = 0.40 V (1)</p>	1	1		2	2
		(ii)	<p>$\Delta t = \Delta V/\text{slew rate} = 14/5$ (1) = 2.8 μs (1)</p>	1	1		2	2
		(iii)	<p>$f = \text{slew rate}/2\pi V_P$ (1) = $5 \times 10^6/2\pi \times 8$ (1) = 99.5 kHz (1)</p>	2	1		3	2
Question 3 total				8	7		15	9

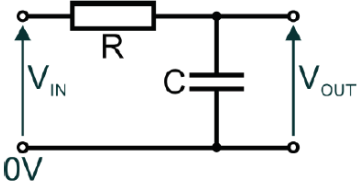
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
4	a		<p>$T = 1.1RC$ $1 = 1.1 \times 100 \times 10^{-6} \times R$ $R = 1 / 1.1 \times 100 \times 10^{-6}$ rearrangement and substitution (1) $R = 9090 \Omega$ (accept 9.1 kΩ) (1) RC circuit correct (1) Connections to pins 6 and 7 correct. (1)</p>	2	2		4	2
	b		<p>\bar{Q} connected to D for all flip-flops (1) Clock connections (\bar{Q} to CK on next flip-flop) (1) Pulses IN and Output connections (1)</p>	3			3	
			Question 4 total	5	2		7	2

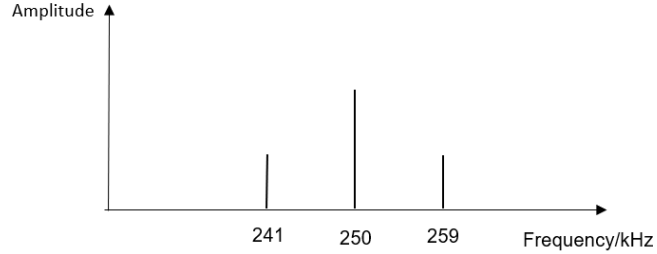
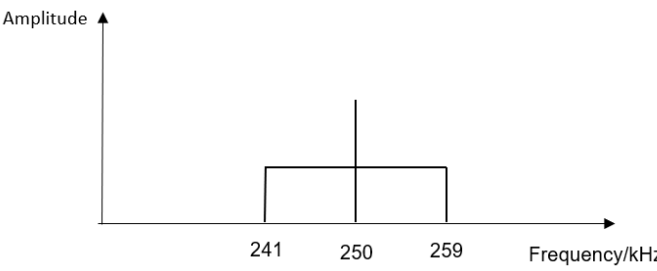
Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
5	a	$I_C = P/V = 180\text{m}/6 = 30 \text{ mA}$ (1) $I_b = I_C/h_{FE} = 30 \text{ ecf} \times 10^{-3}/60$ (1) $= 0.5 \text{ mA}$ (1) $V_{8.2k} = I_b R_b = 0.5\text{m ecf} \times 8.2\text{k} = 4.1 \text{ V}$ (1) $V_{IN} = 4.1 \text{ ecf} + 0.7 = 4.8 \text{ V}$ (1)	2	3		5	5
	b	LDR and resistor in series (1) LDR between 6 V supply rail and V_{IN} (1)	2			2	
	c	Transistor not saturated (so buzzer not operating at rated value) (1) Occurs when V_{IN} between 0.7 and 4.8 V (1) Solution: Put a Schmitt inverter between the light sensor and the base resistor to condition the signal (1) Reverse the LDR and resistor in the light sensor (1) Alternate solution: Comparator with reference voltage (1) Connections to inputs configured correctly described (1)			2 2	4	
Question 5 total			4	3	4	11	5

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
6	a	(i)	A = 0 (1)		1		1	
		(ii)	 <p>Starts at 5 V (1) Transitions correct. Tolerance $\pm\frac{1}{2}$ square (2)</p>	1	2		3	
	b	(i)	 <p>All correct (1)</p>	1			1	

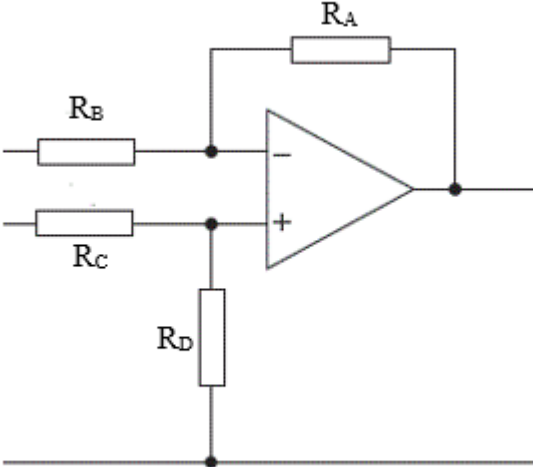
Question	Marking details	Marks available				
		AO1	AO2	AO3	Total	Maths
(ii)	<p> $Q = D.\bar{B} + \bar{D}.B.A + D.C.\bar{A}$ 3 x each group (1) Combining as equation with min 2 terms correct (1) </p>		4		4	
(iii)	<p> AND gate (1) Connections (1) </p>			2	2	

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
	(iv)	 <p>Circuit (1)</p> <p>$f = 1/RC$ $R = 1/2 \times 10 \times 10^{-6}$ (1) $R = 50 \text{ k}\Omega$ (1)</p>	1				
			1	1		3	2
Question 6 total			4	8	2	14	2

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
7	a	(i)	$T = 1/f = 1/4 \times 10^3$ (1) $T = 2.5 \times 10^{-4}$ (1) 1 square = 0.5×10^{-4} s or 50 μ s (1)	1	2		3	3
		(ii)	Amplitude = 3.3 – 3.4 squares (1) Voltage = $2 \times 3.3 = 6.6$ (1) (Accept answers in the range 6.6 – 6.8 V)	1	1		2	2
	b	(i)	All three plotted correctly within ± 0.5 of a division (2) ecf on (a)ii Or Two plotted correctly within 0.5 of a division (1) Good best fit curve (1)		3		3	3
		(ii)	Low pass	1			1	
		(iii)	Use of $0.7 \times$ peak voltage = $0.7 \times 10 = 7$ V (1) Lines on graph (1) $F_b = 3000$ Hz (accept between 2700 – 3300) (1)	2	1		3	3
		(iv)	 <p>RC in series (1) V_{OUT} across C (1) ecf from (b) (ii)</p>	2			2	
Question 7 total				7	7		14	11

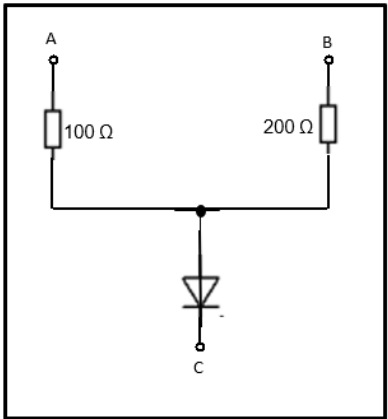
Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
8	a	(i)	<i>Frequency</i>	1			1	
		(ii)	<i>More/very</i>	1			1	
		(iii)	<i>Less</i>	1			1	
		(iv)	<i>Higher/greater</i>	1			1	
	b	(i)	 <p>Line at 250 kHz (must be higher) (1) Lines at 241 and 259 kHz (1)</p>	1 1			2	
(ii)		 <p>Line at 250 kHz (1) Band between 241 and 259 kHz (1) Bandwidth = 259 – 241 = 18 kHz (1)</p>	1 1 1			3		

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
	c	(i)	$B = \Delta f_c / f_i = 80 / 18 = 4.4$ Equation and substitution (1) Answer (1)		2		2	2
		(ii)	$\text{Bandwidth} = 2(1 + \beta)f_i = 2(1 + 4.44 \text{ ecf from i}) \times 18\text{k} = 196 \text{ kHz}$ Or $\text{Bandwidth} = 2(\Delta f_c + f_i) = 2(80 + 18) = 196 \text{ kHz}$ Equation and substitution (1) Answer (1) (Note: use of $\beta = 4.4$ gives 194.4 kHz)		2		2	2
		(iii)	$\text{No. channels} = \text{available bandwidth} / \text{channel bandwidth}$ $= (99.8 - 97.6) \times 10^6 / 196 \times 10^3 \text{ (1)}$ $= 11.2 \text{ so 11 channels (1)}$ ecf from part (ii)		2		2	2
Question 8 total				9	6		15	6

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
9	a	$V_{TOP} = 12 \times 9.7 / (9.7 + 10.3) = 5.82 \text{ V}$ (1) $V_{BOTTOM} = 6 \text{ V}$ (by inspection is ok) (1) $V_{OUT} = V_T - V_B = 5.82 - 6.00 = -0.18 \text{ V}$ (1)		3		3	3
	b	 <p>Inverting input circuit correct (1) Non-inverting input circuit correct (1) $R_A/R_B = 50$ (1) $R_A = R_D$ and $R_B = R_C$ AND all resistors $\geq 1 \text{ k}\Omega$ (1)</p>	1	1	2	4	
Question 9 total			1	4	2	7	3

Question		Marking details		Marks available				
				AO1	AO2	AO3	Total	Maths
10	a		First op amp: Ratios of input resistors: $R_4/R_1 = 3$, $R_4/R_2 = 1$, $R_4/R_3 = 0.5$ Any one correct (1) or/ All three correct (2) Second inverting amplifier with a gain of -1 ($R_5 = R_6$) (1) All $R \geq 1\text{k}\Omega$ and min 1 ratio correct (1)	1	1	2	4	2
	b	(i)	$V_{\text{OUT}} = 3 \times 1 + 1 \times 3 + 0.5 \times 8$ (1) $= 10 \text{ V}$ (1) <p style="text-align: right;">Accept method using R values ecf from a</p>		2		2	2
		(ii)	$V_{\text{OUT}} = 3 \times 3 + 1 \times 5 + 0.5 \times 9$ $= 18.5 \text{ V}$ (1) <p style="text-align: right;">Accept method using R values ecf from a</p> <p>But output saturates at +14 V (1)</p>	1	1		2	2
	c	(i)	Change gain for the inputs: $111 = 14 \text{ V}$ so $001 = 2 \text{ V}$ (1) Gain for $V_1 = V_{\text{OUT}}/V_{\text{IN}} = 2/5 = 0.4$ (1) So $R_1 = 2.5R_4$ (1) $R_2 = 0.5R_1$ $R_3 = 0.5R_2$ for both (1) Alternative method using resistor values. $14 = R_f (5/R_1 + 5/R_2 + 5/R_3)$ (1) Intermediate working (1) Last two marks for R values the same			4	4	2
		(ii)	Increasing staircase (1) 2 V increments (1) Resets to 0 V on 8 th pulse (1)	1	2		3	
Question 10 total				3	6	6	15	8

Question			Marking details	Marks available				
				AO1	AO2	AO3	Total	Maths
11	a	(i)	External signals added to the information signal (1) Example such as from lightning or electrical machinery or crosstalk picked up from nearby transmissions. (1)	2			2	
		(ii)	SNR = $10\log_{10} (P_S/P_N)$ $20 = 10\log_{10} (200/P_N)$ (1) $10^2 = 200/P_N$ (1) $P_N = 200/100 = 2 \times 10^{-3}$ W or 2 mW (1)	2	1		3	2
	b	(i)	$I_D = g_m(V_{GS} - 3)$ $V_{GS} = (2.5/0.8) + 3$ Formula and Substitutions (1) $= 6.125$ V (1)	1	1		2	2
		(ii)	$R = V/I = (12 - 4) / 2.5$ (1) $= 3.2 \Omega$ (1) Select 3.3 Ω ecf (1)	1	2		3	2
		(iii)	$P = I_D^2 r_{DSon} = 2.5^2 \times 0.04$ (1) $= 0.25$ W (1)	1	1		2	2
Question 11 total				7	5		12	8

Question		Marking details	Marks available				
			AO1	AO2	AO3	Total	Maths
12		<p>Indicative Content:</p> <ul style="list-style-type: none"> • Diode direction from current measurements of CA and CB • No diode between A or B because the current is the same in both directions AB and BA. • $R_{AB} = V/I = 9/0.03 = 300 \Omega$ • R_A found from I_{AC} • Calculation of R_A using $R = V/I = (V_{AC} - 0.7) / 0.083$ giving $R = 100 \Omega$ • R_B found by similar method using I_{BC} or by identifying that I_{BC} is half of I_{AC}. • Checking answer using current I_{AB} or I_{BA} or total resistance R_{AB} 		2	4	6	2

Question	Marking details	Marks available				
		AO1	AO2	AO3	Total	Maths
	<p>5-6 marks Circuit completely correct. Explanation of reasoning including the direction of the diode and that there is no diode between A and B. Calculations correct and explained clearly.</p> <p>There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant to the argument.</p> <p>3-4 marks Elements of the circuit diagram correct. Some calculations correct. Some correct explanation of the reasoning behind the calculations.</p> <p>There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included in the response but there may be some minor errors or the inclusion of some information not relevant to the argument.</p> <p>1-2 marks One or two elements of the indicative content correct. A calculation shown.</p> <p>There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of information not relevant to the argument.</p> <p>0 marks No attempt made or no response worthy of credit.</p>					
	Question 12 total			6	6	2

COMPONENT 1

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

QUESTION	AO1	AO2	AO3	TOTAL MARK	MATHS
1	0	13	0	13	0
2	4	7	0	11	5
3	8	7	0	15	9
4	5	2	0	7	2
5	4	3	4	11	5
6	4	8	2	14	2
7	7	7	0	14	11
8	9	6	0	15	6
9	1	4	2	7	3
10	3	6	6	15	8
11	7	5	0	12	8
12	0	2	4	6	2
TOTAL	52	70	18	140	61