GCE A LEVEL MARKING SCHEME

SUMMER 2025

A LEVEL
CHEMISTRY – COMPONENT 2
A410U20-1

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.

GCE A LEVEL CHEMISTRY

COMPONENT 2: ORGANIC CHEMISTRY AND ANALYSIS

SUMMER 2025 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks
Examiners must mark in red ink.
One tick must equate to one mark, apart from extended response questions where a level of response mark scheme is applied.
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.

Extended response questions
A level of response mark scheme is applied. The complete response should be read in order to establish the most appropriate band. Award the higher mark if there is a good match with content and communication criteria. Award the lower mark if either content or communication barely meets the criteria.

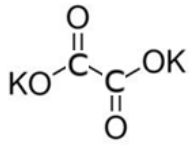
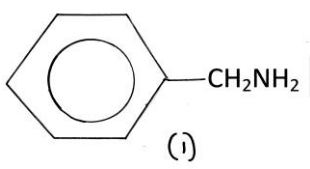
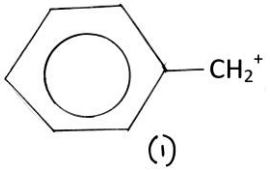
Marking rules
All work should be seen to have been marked.
Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.
Crossed out responses not replaced should be marked.

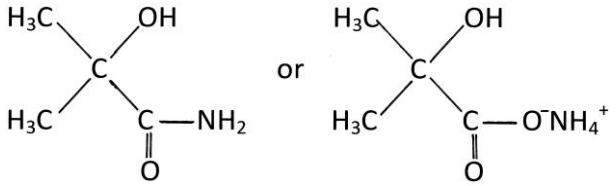
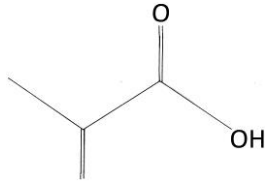
Marking abbreviations
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

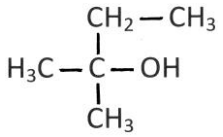
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

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

Section A

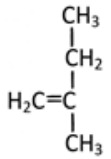
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
1				8.91	1			1		
2	(a)			the delocalised benzene ring structure is very stable and needs too much energy to disrupt its structure	1			1		
	(b)			another radical is produced to continue the reaction	1			1		
3	(a)			166		1		1		
	(b)					1		1		
4				 (i)  (i) must be an aliphatic amine because no diazonium compound is formed / because nitrogen is formed (1)		3		3		

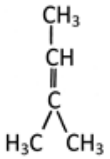
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			benzoic acid has <u>hydrogen bonding</u> between molecules (1) this is stronger than other intermolecular forces therefore <u>more energy</u> is needed to overcome these forces than those in the other compounds (1)	2			2		
	(b)			both compounds have permanent dipoles but the van der Waals forces are greater for the larger molecule (ethyl benzoate) resulting in a higher boiling temperature	1			1		
6	(a)			nucleophilic addition	1			1		
	(b)						1	1		
	(c)			no small molecule is lost / there is only one product	1			1		
	(d)				1			1		
				Section A total	**9**	**5**	**1**	**15**	**0**	**0**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		171 cm^3 of hydrogen from 1.23 g of compound **W** 24500 cm^3 of hydrogen from $\frac{1.23 \times 24\,500}{171}$ = 176 g (1) this is the mass of 2 mol of compound **W** mass of 1 mol = $\frac{176}{2}$ = 88 g ⇨ M_r of compound **W** = 88 (1)		2		2	2	
		(ii)		M_r of the alkyl group is 88 – 17 = 71 molecular formula ⇨ $C_5H_{12}O$		1		1		
		(iii)					1	1		
		(iv)	I	award (1) for any of following • sulfuric acid / H_2SO_4 • phosphoric acid / H_3PO_4 • aluminium oxide / Al_2O_3	1			1		1

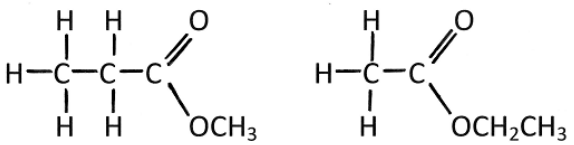
<table>
<tr><th colspan="4" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td></td><td></td><td></td><td>II</td><td>award (1) for either of following structures

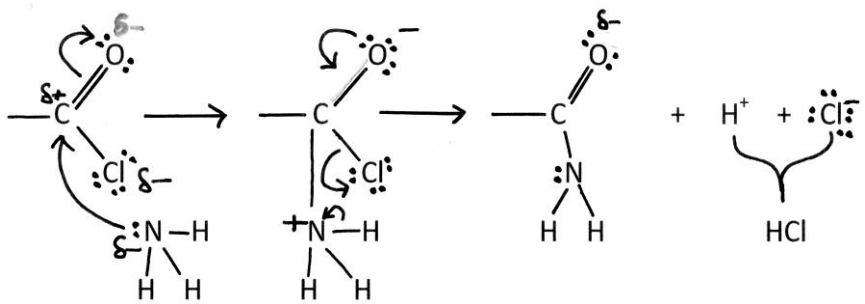
award (1) for name of compound drawn

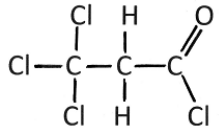
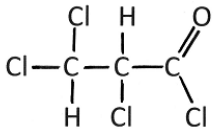
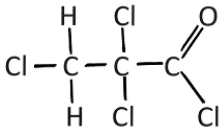
 
2-methylbut-1-ene

 
2-methylbut-2-ene

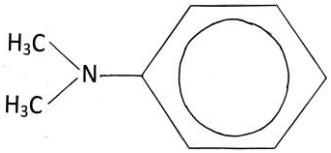
credit any answer following on from incorrect structure in part (iii)</td><td></td><td>1</td><td>1</td><td>2</td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td></td><td><table><tr><th>Reagent</th><th>4-hydroxybutan-2-one</th><th>butanoic acid</th></tr><tr><td>sodium hydrogencarbonate</td><td>no observable change</td><td>effervescence</td></tr><tr><td>acidified potassium dichromate</td><td>orange to green solution</td><td>no change / remains orange</td></tr><tr><td>universal indicator solution</td><td>no change / remains green</td><td>turns orange / red</td></tr><tr><td>aqueous alkaline iodine</td><td>yellow precipitate</td><td>no observable change</td></tr></table>
award (1) for each correct row
accept box left blank as no observable change</td><td></td><td>4</td><td></td><td>4</td><td></td><td>4</td></tr>
</table>

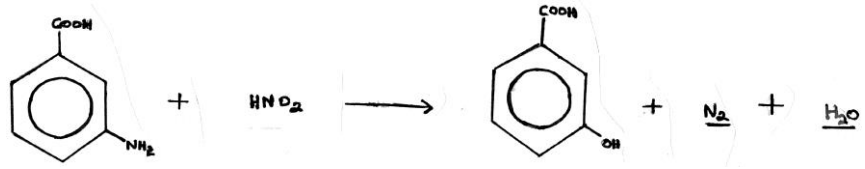
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)		award (1) for any correct structure e.g. 			1	1		
	(c)	(i)		$2CH_3CH_2CH_2COOH + CaCl_2 \rightarrow (CH_3CH_2CH_2COO)_2Ca + 2HCl$	1			1		
		(ii)		warm the solution (to near boiling) (1) filter <u>hot</u> (and dry / wash with hot water) (1)			2	2		2
		(iii)		$(CH_3CH_2CH_2COO)_2Ca \rightarrow CaCO_3 + CH_3CH_2CH_2C(O)CH_2CH_2CH_3$ (1) heptan-4-one (1)	1	1		2		
				Question 7 total	**3**	**9**	**5**	**17**	**2**	**7**

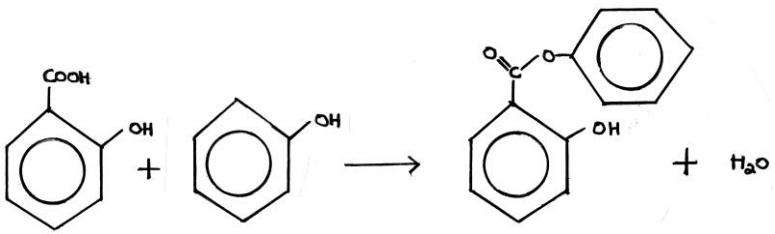
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		water / moisture / unreacted diammonium butanedioate do not accept butanedioic acid / succinic acid / ammonia			1	1		1
		(ii)		award (1) for identification of both signals at 2.8 ppm ⇨ —CH_2–C=O protons at 8.9 ppm ⇨ —N–H proton ratio CH_2CO: NH ⇨ 4 : 1 (1)	2			2		
	(b)	(i)		 award (2) for all four full charges shown award (1) for any two or three full charges shown		2		2		
		(ii)		both missing words must be correct ..... substitution …… nucleophile ….. addition-elimination ≡ substitution	1			1		

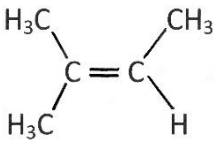
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		M_r(AgCl) = 143.5 n(AgCl) = $\frac{8.61}{143.5}$ = 0.060 mol (1) 1 mol acid chloride → 1 mol AgCl M_r(compound **T**) = $\frac{11.76}{0.060}$ = 196 (1) 'M_r' of R = 196 – (12 + 16 + 35.5) = 132.5 (1)		3		3	2	
		(ii)		^{13}C NMR has three signals ⇨ one carbon is part of the —COCl group therefore R contains two carbon environments (1) ^{1}H NMR has one signal ⇨ all protons are in the same environment (1) R has M_r 132.5 ⇨ likely to be $C_2H_2Cl_3$ award (1) for any of following structures   	2		1	3		

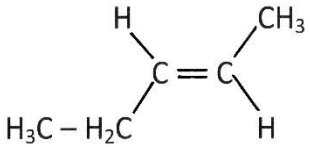
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(d)	(i)		hexane-1,6-dioic acid		1		1		
		(ii)	I	award (1) each for any two of following • 1 atm pressure / increased pressure unnecessary • relatively low temperature • use of a catalyst accept any sensible answer			2	2		
			II	0.5 mol of PA66 gives $\frac{68 \times 0.5}{100}$ = 0.34 mol of the diamine mass produced = 0.34 × 116 = 39.4 g		1		1		1
				Question 8 total	**5**	**7**	**4**	**16**	**2**	**2**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		the intermediate product contains the benzoate anion / $C_6H_5COO^-$ / potassium benzoate	1			1		1
		(ii)	I	concentrated nitric acid **and** concentrated sulfuric acid	1			1		1
			II	NO_2^+	1			1		1
		(iii)		lower / melts over a range	1			1		1
		(iv)		tin **and** concentrated hydrochloric acid accept iron	1			1		1
	(b)	(i)		5-10^{o}C	1			1		1
		(ii)	I	—N=N— accept —N=N—C_6H_5COOH	1			1		
			II			1		1		
		(iii)	I	light at the blue end of the visible spectrum is absorbed		1		1		

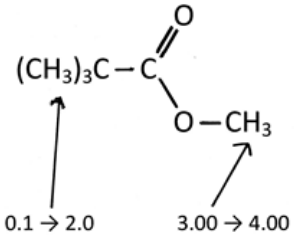
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	award (1) for correct equations $E = hf$ **and** $f = \frac{c}{\lambda}$ **OR** $E = \frac{hc}{\lambda}$ $E = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^{8}}{420 \times 10^{-9}} = 4.74 \times 10^{-19}$ J energy per mole = $\frac{4.74 \times 10^{-19} \times 6.02 \times 10^{23}}{1000} = 285$ kJ mol^{-1} (1)		2		2	2	
		(iv)				1		1		
		(v)	I	aqueous sulfuric acid / hydrochloric acid		1		1		1
			II	the absorption at 2100-2250 cm^{-1} (due to C≡N) will be <u>absent</u>		1		1		
	(c)	(i)		award (1) for two correct M_r values 2-hydroxybenzoic acid = 138 phenol = 94 mass of phenol = $\frac{6.90 \times 94 \times 60}{138 \times 100} = 2.82$ g (1)		2		2	2	

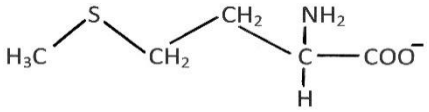
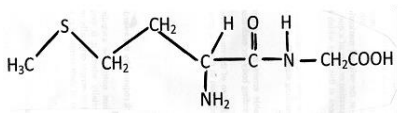
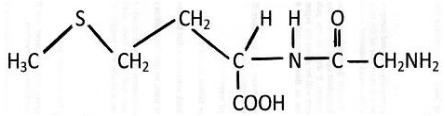
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)					1	1		
				Question 9 total	**7**	**9**	**1**	**17**	**4**	**7**

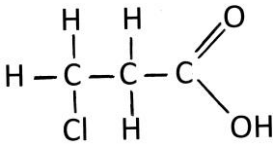
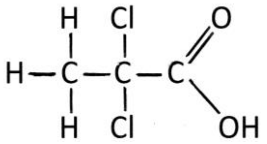
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
10	(a)	(i)		electrophilic addition	1			1		
		(ii)		the reaction proceeds via the formation of a secondary carbocation which is more stable / formed more easily than a primary carbocation		1		1		
		(iii)		(fractional) distillation	1			1		1
		(iv)		2.85 g of bromine in $\frac{2.85 \times 165}{79.9}$ = 5.89 g of the bromohexanes (1) mass of hex-1-ene in the mixture = 6.11 – 5.89 = 0.22g percentage of hex-1-ene in the mixture = $\frac{0.22 \times 100}{6.11}$ = 3.60 (1)		2		2	1	
	(b)	(i)		the intermediates are both secondary carbocations, therefore one product is not particularly favoured over the other			1	1		
		(ii)	I	$CH_3—CH_2—CH_2—\overset{*}{C}HBr—CH_2—CH_3$	1			1		
			II	it is a racemic mixture / equimolar proportions of both enantiomers	1			1		
	(c)	(i)		 (1) the carbon-carbon double bond in the alkene shown / 2-methylbut-2-ene is cleaved to give a three carbon ketone (propanone) and a two carbon aldehyde (ethanal) (1)			2	2		

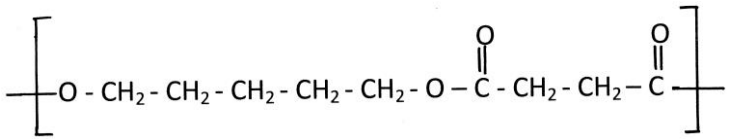
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)					1	1		
	(d)			**Indicative content** • place reaction products in a separating funnel • add (the same volume of) ethoxyethane • replace stopper and shake • allow to separate • remove stopper and run off lower aqueous layer • repeat the ethoxyethane extraction with the (removed) aqueous layer • add anhydrous magnesium sulfate to the ethoxyethane extract and shake • filter mixture to remove solid magnesium sulfate • distill to remove ethoxyethane • using an electric heater – no flames	2	2	2	6		6

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
				5-6 marks Method includes the essential stages and reference to all the information given *The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions.* *The candidate uses scientific conventions and vocabulary appropriately and accurately*. **3-4 marks** Method refers to most of the essential stages and some of the information given *The candidate constructs an account correctly linking some relevant points showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately*. **1-2 marks** Sensible attempt to describe some of the stages *The candidate makes some relevant points showing limited reasoning. The answer addresses the question with significant omissions. The candidate makes limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
				Question 10 total	**6**	**5**	**6**	**17**	**1**	**7**

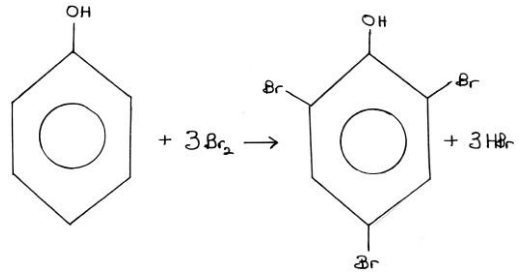
Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)		2,2-dimethylpropanoic acid		1		1		
		(ii)	I	concentrated sulfuric acid / concentrated hydrochloric acid	1			1		1
			II	 chemical shifts for both environments (1) both singlets / no splitting (because no adjacent carbon atom has any protons) (1) peak areas are 9:3 / 3:1 (1)			3	3		
		(iii)		two of the products have the same boiling temperature so separation would be difficult (1) toxic HCl gas is produced so would need containment / to use a fume cupboard (1)			2	2		2
		(iv)		some of the pivaloyl chloride will be hydrolysed by the water present in the aqueous ammonia			1	1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
		(v)		award (2) for answer to 2 sig figs ⇨ 6.0 g if incorrect award (1) for either of following 5.986 $\frac{0.10 \times 82 \times 73}{100}$		1	1	2	1	
	(b)			$(CH_3)_3C—NH_2 + H_2O \rightarrow (CH_3)_3C—NH_3^+ + OH^-$ (1) the nitrogen atom has a lone pair of electrons and can act as a base / an electron pair donor (1)	1		1	2		
	(c)	(i)				1		1		
		(ii)		award (1) for either of following  			1	1		
	(d)			it exists as a zwitterion / $H_3C—CH(NH_3^+)—COO^-$ (1) therefore has strong ionic forces between 'molecules' (1)	1	1		2		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)	(i)					1	1		
		(ii)		 (1) M_r of 2,2-dichloropropanoic acid = 143 percentage Cl = $\frac{71\times100}{143}$ = 49.7 (1)		2		2	1	
				Question 11 total	**3**	**6**	**10**	**19**	**2**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
12	(a)	(i)		deep blue solution gives a brown red precipitate (of copper(I) oxide)	1			1		1
		(ii)	I	award (1) for either of following acidified potassium dichromate ⇨ orange solution turns green acidified potassium manganate(VII) ⇨ purple solution turns colourless		1		1		1
			II	award (1) for either of following lithium tetrahydridoaluminate(III) / $LiAlH_4$ sodium tetrahydridoborate(III) / $NaBH_4$		1		1		1
		(iii)	I	4		1		1		
			II			1		1		
		(iv)		atom economy = $\frac{118}{164}$ × 100 = 72%		1		1		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(b)			**Indicative content** • weigh a sample of the impure sodium benzoate • add cold water and stir to dissolve • add hydrochloric acid until no more benzoic acid is precipitated • filter off benzoic acid • wash with a little cold water • dry • weigh the dry benzoic acid crystals • use the mass of benzoic acid crystals to find the mass of sodium benzoate in the original sample • calculate the percentage purity of the sodium benzoate sample	2	2	2	6		6
				5-6 marks Essential stages of method described, reference to the required weighings and purity calculation *The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions.* *The candidate uses scientific conventions and vocabulary appropriately and accurately*. **3-4 marks** Description of most stages of the method and some reference to weighing pure or impure material *The candidate constructs an account correctly linking some relevant points showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately*. **1-2 marks** Sensible attempt to describe some stages of the method *The candidate makes some relevant points showing limited reasoning. The answer addresses the question with significant omissions. The candidate makes limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)			2,4,6-tribromophenol (1) 		2		2		
	(d)			M_r(4-nitrophenol) = 139 (1) 235μg dm^{-3} = 235 × 10^{-6} g dm^{-3} concentration in mol dm^{-3} = $\frac{235 \times 10^{-6}}{139}$ = 1.69 × 10^{-6} (1)		2		2	1	
	(e)	(i)		solubility is due to the polar —OH hydrogen bonding with water molecules but this is only a small part of the molecule so its effect is limited			1	1		
		(ii)		n(NaOH) = $\frac{24.50 \times 0.100}{1000}$ = 2.45 × 10^{-3} (1) stoichiometric ratio is 1:1 so 2.45 × 10^{-3} mol of phenylethanoic acid in 25.0 cm^3 of solution M_r(phenylethanoic acid) = 136 solubility = $\frac{2.45 \times 10^{-3} \times 1000 \times 136}{25.0}$ = 13.3 g dm^{-3} (1)		2		2	1	
				Question 12 total	**3**	**13**	**3**	**19**	**2**	**9**

COMPONENT 2: ORGANIC CHEMISTRY AND ANALYSIS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

QUESTION	AO1	AO2	AO3	TOTAL	MATHS	PRACTICAL
Section A	9	5	1	15	0	0
7	3	9	5	17	2	7
8	5	7	4	16	2	2
9	7	9	1	17	4	7
10	6	5	6	17	1	7
11	3	6	10	19	2	3
12	3	13	3	19	2	9
TOTALS	36	54	30	120	13	35