GCE A LEVEL MARKING SCHEME

SUMMER 2025

A LEVEL
BIOLOGY – UNIT 4
1400U40-1

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.

WJEC GCE A LEVEL BIOLOGY

UNIT 4 – VARIATION, INHERITANCE AND OPTIONS

SUMMER 2025 MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks
Examiners must mark in red ink.
One tick must equate to one mark (apart from the 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.

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. Award the middle mark in the level if most of the content statements are given and the communication statement is partially met. Award the lower mark if only the content statements are matched.

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

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)		**Any one (x1) from** Nectaries / (production of) nectar (1) Scent (production) / (sweet) smell (1) Accept {UV/ Bee} lines/guides	1			1		
		(ii)		• {Stamens and carpels / male and female reproductive organs} mature at different times (in a single flower) / or description of / protandry (1) • {transfers pollen / pollinate} to a {<u>different / another</u>} {plant / flower} / cannot {deposit pollen onto/ pollinate} the <u>same</u> {plant / flower}. (1)		2		2		
		(iii)		• Cross-pollination increases genetic {variation / diversity} (in offspring) / more genetic {variation / diversity} than self-pollination / {wider range / more mixing} of alleles / more different alleles (1) • (Some individuals) {can adapt to / with advantageous alleles survive / increases the chance of survival in / selective advantage} {different / changing / new} {environments / conditions / habitats} (1)	2			2		
	(b)	(i)		Ovary		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>(ii)</td><td></td><td><table><tr><td>Structure within the ovule</td><td>Structure of the seed</td></tr><tr><td>Zygote</td><td>Embryo (1)</td></tr><tr><td>Outer integument</td><td>Testa / seed coat (1)</td></tr></table></td><td>2</td><td></td><td></td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td></td><td>(Endosperm becomes)
a {food / energy / nutrient/ starch/ proteins/ lipids} {store/ reserve}. (1)</td><td>1</td><td></td><td></td><td>1</td><td></td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td></td><td>Any two (x1) from
(Transported) by {water / river/ canal} (currents). (1)
{attached to / moved by / owtte} {people / animals} (1)
(eaten by animals then) {deposited in {faeces / waste} / egested}. (1)</td><td></td><td></td><td>2</td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td></td><td>• Seeds dispersed {further / over larger area} (from parent plant than explosive mechanism) / owtte / ORA (1)
• Less (intraspecific)competition / larger area can be colonised. (1)</td><td></td><td></td><td>2</td><td>2</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Question 1 total</td><td>6</td><td>3</td><td>4</td><td>13</td><td>0</td><td>0</td></tr>
</table>

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		**Autosomal** (found on a) non sex chromosome / not (on) X or Y chromosome. (1) Accept not sex linked **Recessive** an allele that is {expressed/ shown (in the phenotype)} only {in the absence of a dominant allele / when homozygous/ when two copies are present} / owtte. (1) Accept only {expressed/ shown (in the phenotype)} when another recessive allele is present/ Is not {expressed/ shown (in the phenotype)} in the heterozygote	2			2		
		(ii)	I	0.48 / 48% (4 marks) Award 3 marks for (2pq =) 2(0.6x0.4) Award 2 marks for q = 0.4 **and** p = 0.6 Award 1 mark for q^2 = 0.16 / 16%		4		4	4	
			II	**Any one (x1) from** Population is large (1) Equal probability of mating / random mating / owtte (1) Sexually reproducing (1) Diploid (1) Isolated (1) Accept no selective advantage (1)		1		1		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)	I	(Competition for) {breeding / nesting} sites / ledges (on cliffs) / space to lay eggs / owtte		1		1		
			II	**Any one (x1) from** • {eggs / chicks / offspring / young guillemots} {more likely to survive / owtte} when temperature is warm(er) / eggs more likely to hatch when temperature is warm(er) / ORA (1) • more {food / fish} available (1) • parents better able to hunt (1)			1	1		
	(b)	(i)		Continuous (variation) (1) Wingspan – polygenic / controlled by {genes at more than one gene locus / many genes} (1) Reject ref to alleles		2		2		
		(ii)		**Any one (x1) from** • (Data / graph) {shows a skew / shifted} {towards larger wingspan / to the right} (1) • Wingspan of {modal class / mode / most common size} increases (1) • positively skewed/ owtte (1)		1		1		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		**Any three (x1) from** A. Birds with a larger wingspan fly {further / faster} (1) B. {Obtain {more/ other} food/ catch more sand eels} (for chicks) / {more likely / easier} to feed offspring (1) C. (Birds with a larger wingspan) have a <u>selective advantage</u> (1) D. (More likely to) {breed / survive} and pass on {advantageous / beneficial} {alleles / mutation} / owtte} (1) E. Frequency of allele for larger wingspan increases (in the population) (1) Accept reverse argument			3	3		
				Question 2 total	**2**	**9**	**4**	**15**	**4**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)			**Any three (x1) from** A. Allopatric speciation / geographical isolation / reference to physical barrier (1) B. Mutations occur (in each group). (1) C. Different selection pressures (1) D. Allele frequencies differ (between the groups)/ {genomes / gene pools} become different (from each other)/ genetic drift/ no gene flow between two populations (1) E. (separated) {groups / populations/ demes/ they} are no longer able to {interbreed / breed together} and produce fertile offspring. (1)		3		3		
	(b)	(i)		**Any one (x1) from** • (double stranded) DNA separated into {two / single} strands (1) • Breaking (hydrogen) bonds between {pairs of bases/ complementary base pairs/ (two) DNA strands} (1) Reject breaking bonds between nucleotides/	1			1		1
		(ii)	I.	Primer is a {short / 6-25 base} {single strand of DNA / {chain / strand} of nucleotides} (1)	1			1		1
			II.	**Any one (x1) from** {Anneals / joins to / forms hydrogen bonds with/ binds with} (complementary strand of) DNA at start of a {sequence / strand} (1) Enable {DNA/ Taq} polymerase to {attach / owtte / add complementary nucleotides} (prior to replication) (1)	1			1		1

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		Thermostable / can {withstand/ tolerate / resist} {{high / extreme} temperatures / 95°C} (without denaturing) Accept does not denature at high temperatures		1		1		1
		(iv)		1.073741824 x 10^9 = 2 marks (or any correct rounding) **If incorrect award 1 mark for** 1073741824 (1) Answer given in standard form but incorrect rounding e.g. 1.073…. x 10^9 (1) Correct answer given but in incorrect standard form e.g.10.73741824 x 10^8 (1)		2		2	2	2
		(v)		**Any one (x1) from** • {Number of primer molecules / number of (free) nucleotides} {becomes limiting/ used up/ runs out} (1) • *{Taq /*DNA} polymerase becomes denatured (after repeated heating) (1) • Single stranded DNA molecules pair with each other rather than primers. (1)			1	1		1
	(c)	(i)		**Any one (x1) from** Possible to develop (new / specific) {insecticides / drugs / medicines} (1) Possible {genetic modification / gene editing} of parasite. (1)			1	1		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(ii)	I	**Any one (x1) from** • Clothing needed during migration to colder climate / humans likely to have clothing {before / during} ice age / Ice age increased selection pressure for use of clothing / owtte. (1) • Evidence humans {could use skins of animals / may have worn skins of animals} before body lice evolved/ (Subspecies of) lice diverged after humans started to use clothing (1)			1	1		
			II	**Any one (x1) from;** • No evidence that clothing was used for {a long time / figures from timeline} after reduction of body hair / OWTTE (1) • Takes time for mutations {to occur / become established in a population} (1)			1	1		
				Question 3 total	**3**	**6**	**4**	**13**	**2**	**7**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	I	Orange **and** female (1)		1		1		
			II	Correct gamete genotypes X^B, Y , X^O, (X^O.) (1) Correct offspring genotypes – X^BX^O, X^OY (1) Ecf from genotypes given		2		2		
			III	0.5/ 50% / ½/ ecf Must match II unless II left blank		1		1	1	
		(ii)		Only one X chromosome **and** therefore only one allele for fur colour / owtte (1)		1		1		
	(b)	(i)		Different X chromosome inactivated in different cells. (1) So allele for each pigment {expressed / not expressed/ or description of} in different areas (of the skin). (1)			2	2		
		(ii)		**Any one (x1) from** • Transcription cannot take place/ mRNA cannot be synthesised. (1) • DNA cannot unwind RNA polymerase cannot attach (to DNA bases). (1)		1		1		
		(iii)		Gene expression is {controlled / altered/ affected} without changing the DNA {nucleotide / base} sequence / owtte (1)	1			1		
				Question 4 total	**1**	**6**	**2**	**9**	**1**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		Point / gene / substitution (mutation). (1)	1			1		
		(ii)		Red blood cells contain no {nucleus / DNA/ chromosomes/ genetic material} (1) so cannot undergo {mitosis / cell division}. (1)	2			2		
	(b)	(i)	I	**Any two (x1) from;** • RBC live for (up to) four months/ this is the life span of a rbc / no more rbcs left (1) • so effect unlikely to last longer (than four months) / {benefit/ owtte} would only last up to four months • so that donated and laboratory produced RBCs are not present at the same time/ owtte (1)		1	1	2		2
			II	**Any one (x1) from;** • RBCs from stem cells are all {new / young} (1) • RBCs from donor blood {different ages / not all new cells / some donor red blood cells are old} (1) • fewer donor RBC last for 4 months (1) • more RBC from stem cells live {longer / 4 months} (1)			1	1		1
		(ii)		any difference is due to the {origin / type} of red blood cell (only) / the only variable is the type of red blood cell/ reduce the effect of other variables (1)		1		1		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		Ethical issues of using embryonic stem cells / destruction of potential life / ORA for using white blood cells / religious objections (1)		1		1		1
	(c)	(i)		{(SD) bars / owtte} show an overlap (between 6 and 12 months.) (1)		1		1	1	1
		(ii)		**Any one (x1) from** • Increase in (mean Hb) concentration lasts longer (than transfusion) (1) (comparison must be clear). • Gene therapy {requires {fewer / only one} treatment/ does not need to be repeated}/ cell transfer requires {several/ more} treatments} (1) • Less chance of rejection (as cells from same individual) (1)		1		1		1
		(iii)		**Any one (x1) from** • Not all (introduced) cells will express the transferred / normal {gene / allele} (1) • {Introducing / extracting} bone marrow is a surgical procedure / risks associated with surgery e.g. infection (1) • Altered genome {may cause immune response/ trigger oncogenes} (1) Accept Surgery is an invasive procedure			1	1		
				Question 5 total	**3**	**5**	**3**	**11**	**1**	**6**

Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
6	**Indicative content;** **Transfer of gases** **A1** Diffusion {distance/ pathway} is {short/ reduced} **A2** Maternal blood {within {sinuses/ spaces/ lacunae/description} /not in blood vessels} **A3** Foetal blood vessels {contact / close to} {chorion / chorionic cells} **A4** (Wall of) {foetal {blood vessels/ capillaries}/ chorionic villus} {only one cell thick/ are squamous cells} **A5** Large surface area due to {chorionic villi / presence of microvilli/ many {blood vessels/ capillaries}} **A6** Countercurrent flow / description of **No direct contact** **B1** {Foetus/Foetal capillaries} {protected/separated} from {high(er) / variation in} maternal blood pressure/ owtte **B2** Prevent maternal immune system {rejecting/ harming/ recognising} (genetically different) foetus / cells of maternal immune system cannot reach foetal blood / B2 accept 'attacking. Reject killing **B3** Reduce {blood clotting / agglutination} if maternal and foetal blood {groups/types} differ **B4** Prevents (some) {pathogens / bacteria/ antigens} passing {from mother/ to foetus} **B5** {Reduce / prevent} {maternal hormones / drugs/ harmful substances/ toxins/ harmful chemicals/ medicines/ owtte} passing {from mother/ to foetus} **Hormones** **C1** Oestrogen stimulates growth of the {uterus / mammary glands} **C2** Progesterone maintains the {endometrium/ placenta} **C3** Progesterone inhibits {production of oxytocin / contraction of the uterus / production of {milk / prolactin}} / decrease in progesterone (removes inhibition so) allows the {{production of oxytocin / contraction of the uterus / production of {milk / prolactin}} **C4** {Oestrogen/ progesterone} inhibit {FSH / LH} (so no follicles mature) **C5** HCG {maintains the corpus luteum (in early pregnancy)/ causes growth of the {uterus/ chorion}} **C6** Correct use of figures from graph.		3		9		

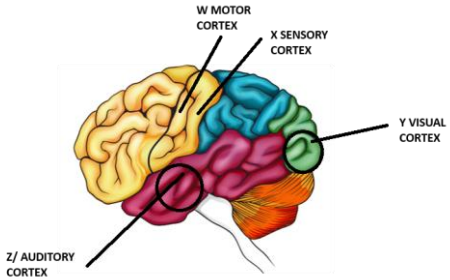
Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
	7-9 marks Indicative content of this level is detailed content from all three sections *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, 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.* **4-6 marks** Indicative content of this level is detailed content from two sections *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.* **1-3 marks** Indicative content of this level is content from one section *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has 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 6 total	**6**	**3**		**9**		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		Vector	1			1		
		(ii)		RNA is {replicated/ copied/ duplicated} (1) {Protein synthesis/ transcription **and** translation/ or description of} to produce capsid proteins (1) (New) virus particles are assembled / RNA enclosed within capsid (1)		3		3		
	(b)	(i)		Artificial – {synthesised/ not naturally produced/ ready made/ owtte} antibodies (injected) (1) Passive - individual receives antibodies/ not made by individuals immune system/ owtte (1)	2			2		
		(ii)		**Any four (x1) from** • Provides immediate protection / No natural antibodies (1) • Takes time for {plasma cells to be synthesised/ clonal expansion} (1) • RIG {causes a decrease in rabies virus concentration/ prevents virus spreading (to CNS)} (1) • Latent period (of 7 days) before natural immunity starts (1) • Ref to antibodies are short lived/ the vaccine will give long lasting immunity/ Vaccine eventually produces {more/higher concentration of} antibodies (1) • through the creation of memory cells. (1)		2	2	4		
		(iii)	I	Memory cells {were produced / already present} (1) Following re-exposure to rabies there is a shorter latent period / antibodies are made more quickly / more antibodies produced (1)	1		1	2		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
			II	(Booster shot to stimulate production of) more memory cells (1)		1		1		
	(c)	(i)		Higher the concentration the further the antibiotic <u>diffuses</u> (1) (Higher the concentration) the more bacteria killed/ fewer bacteria survive at higher concentrations/ owtte (1)	2			2		2
		(ii)		1.5 (μg cm^{-3})		1		1		1
		(iii)		12.5 cm^3 = 2 marks If incorrect award 1 mark for <u>10x50</u> 40 500/40		2		2	2	
		(iv)		**Advantage** Shigella is present in the {intestines/ digestive system} (so can be treated with oral administration) / can be administered {at home/ themselves} (1) **Disadvantage** {lack of time in gut/ passes through too quickly} due to diarrhoea / (antibiotic) could be {digested/ destroyed} before the small intestine/ affect {gut/ useful/ owtte} bacteria (1)			2	2		
				Question 7 total	**6**	**9**	**5**	**20**	**2**	**3**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		**Both correct for 1 mark** X – canaliculi Y – Haversian canal	1			1		
		(ii)		**Any 2 for 1 mark from** arteriole, venule, lymph (vessel) nerve (fibres) **Accept blood vessels for arteriole / venule**	1			1		
	(b)	(i)		Osteomalacia is a result of {deficiency/ lack of/ owtte} of calcium **and** Vitamin D (1) (Dairy =) calcium + {strength/ density} of bones (1) (Oily fish =) Vitamin D + increases {absorption/ owtte} of calcium (1)	3			3		
		(ii)		{Abnormal/ rapid/ owtte} loss of bone {density/ mass} (1)	1			1		
		(iii)		As you get older bones become less dense / more likely to fracture (1) exercise increases bone {density/ strength} (1) Accept reference to production of osteoblasts Reduces the risk of fracture (if you fall) (1)		3		3		
		(iv)		25.26/25.3/ 25% = 2 marks If incorrect award 1 mark for $\frac{0.95-0.71}{0.95} \times 100$		2		2	2	

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(c)	(i)		Displaced (fracture) (1)		1		1		
		(ii)		Treated (with surgery) {inserting/ using} metal {rods/ pins/ plate / screws} (1)		1		1		
		(iii)		**Any two (x1) from:** Speeds up recovery/ enables mobility sooner (1) lack of mobility leads to {other health issues/ or example of} (1) DVT / pulmonary embolism (1) bone is high weight bearing/ owtte} (1)		2		2		
	(d)	(i)		**Any two (x1) from** (risk of hip fracture) increases with increasing age (1) Increases with smoking (1) is higher in females (1) At 50 is the same for all (1)			2	2		
		(ii)	I.	European study is more reliable because **Any two (x1) from** larger sample (1) across {larger area/ more countries} (1) included diet/ family history/ ethnicity (1) ORA for Welsh study Must have evaluative statement to gain two marks			2	2		3
			II	**Any one (x1) from** Diet + {vitamin D / Calcium} Ethnicity – {different genetic disposition/ owtte} Family history – {genetic disposition/ owtte}			1	1		
				Question 8 total	**6**	**9**	**5**	**20**	**2**	**3**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
9	(a)	(i)		W / motor cortex X / sensory cortex Y / visual cortex Z / auditory cortex All correct = 2 marks 2/3 = 1 mark 0/1 = 0 marks  	2			2		
		(ii)		Motor cortex (due to paralysis) (1) Broca's (area) (motor area for speech) (1)			2	2		
		(iii)		Left (hemisphere) (1) **Any two (x1) from:** Right side of body affected/ right arm {paralysis/paralysed} (1) right side of body controlled by left side of brain = 2 marks Nerve fibres cross over (through corpus collosum) (1) Broca's area in left hemisphere (1)		2	1	3		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iv)		Advantages MRI does not use (ionising) radiation (1) MRI provides more detailed scans/ shows brain activity (1) CT preferred for people with claustrophobia/ sensitive to loud noises/ people with pacemakers/ cochlea implants/ faster {results/ procedure} (1)	2		1	3		
		(v)	I	Neuroplasticity is changes in neural pathways which enable brain to compensate for injury/ owtte (1) Undamaged axons will grow new nerve endings to {reconnect damaged neurones / form new neural pathways/ form new synapses} (1)		2		2		
			II	most (developmental) plasticity occurs in the young brain / fewer synapses present in older brain/ ref to synaptic pruning (1) Accept converse for younger brain (Repetition is important because) connections {are reinforced/ will become stronger/ owtte} (1)		2		2		
	(b)	(i)		Operant conditioning – {Association/ link} between a behaviour and {reward / punishment} (1) Learned behaviour – change in behaviour due to {past experience/ or example} (1)	2			2		
		(ii)		long cycle training resulted in a longer (mean) time spent on the unheated side/ ORA/ Long training cycles were more effective for {learning / conditioning} (than short training cycles)			1	1		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
		(iii)		48(%) = 2 marks Award 1 mark for (200-104)/200 x 100 96/ 200 x 100		2		2	2	2
		(iv)		Increase sample size / repeat experiment		1		1		1
				Question 9 total	**6**	**9**	**5**	**20**	**2**	**3**

UNIT 4: VARIATION AND INHERITANCE

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

QUESTION	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	6	3	4	13	0	0
2	2	9	4	15	4	0
3	3	6	4	13	2	7
4	1	6	2	9	1	0
5	3	5	3	11	1	6
6	6	3	0	9	0	0
Option	6	9	5	20	2	3
TOTAL	**27**	**41**	**22**	**90**	**10**	**16**