OCR
Oxford Cambridge and RSA

GCE

Biology A

Unit **H420A/03:** Unified biology

Advanced GCE

Mark Scheme for June 2017

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations

Annotation	Meaning
DO NOT ACCEPT	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ACCEPT	Answers that can be allowed
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

INTRODUCTION

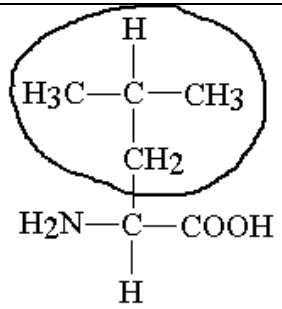
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question			Answer	Marks	Guidance
1	a	i	 ✓	1	**ACCEPT** any shape or mark that indicates the R group unambiguously
		ii	solubility / adsorption / interactions with the stationary phase, similar / same / AW ✓ R/ functional / residual, groups, similar / AW ✓	1 max	**ACCEPT** leucine *slightly* more soluble / interacts *slightly* less with stationary phase **ACCEPT** both more soluble than Y **IGNORE** size/ charge
		iii	a mark shown on the diagram at 1.5 cm from the origin ✓✓✓	3	***Correct answer = 3 marks (indicated by 3 ticks on diagram) even if no working shown*** **ACCEPT** a mark in the range 1.4 -1.6 cm **ACCEPT** centre of dot on or within guidelines ***Max 2 for calculation if mark not drawn on the diagram within this range, OR if two dots drawn and second dot incorrect*** Marks for seeing in calculation: *(R_f* of Y =) 2.5 / 5 = 0.5 / *(R_f* of Y =) 25 / 50 = 0.5 ✓ *(R_f* of Z =) 0.5 - 0.2 = 0.3 ✓ **ALLOW ECF** for *R_f value* of Y (Distance moved by Z) = 0.3 x 5 = 1.5 / (Distance moved by Z) = 0.3 x 50 = 15 ✓ **ALLOW ECF** for *R_f value* of Z

Question			Answer	Marks	Guidance
	b	i	silica (gel) ✓	1	**ACCEPT** aluminium oxide/ alumina/ cellulose/ zirconium oxide / silicon dioxide **DO NOT ACCEPT** paper/ silicon / aluminate **IGNORE** plastic / perspex
		ii	photosystems ✓ (in) thylakoid (membranes) ✓	2	**ACCEPT** antenna complex/ reaction centre / light harvesting , clusters / systems **IGNORE** grana **ACCEPT** lamellae (membranes)
	c		1. separates by (relative) , adsorption / solubility / interaction with the stationary phase in TLC **and** (separates) by size in electrophoresis ✓ 2. TLC separates non - charged particles **and** electrophoresis (only) separates charged particles ✓ 3.electricity, used for electrophoresis / not used for TLC ✓ 4.buffer solution, used for electrophoresis / not used for TLC ✓ 5.dyes used in TLC **OR** radioactive / fluorescent , tags / nucleotides, used in electrophoresis ✓ *6.Idea of* electrophoresis is , automated / computerised / uses laser scanning (to analyse sequence) / TLC is not automated ✓	3 max	**Read as prose and look for any three correct mp's** **for mp1 and 2** **IGNORE** separates by size of charge on molecule **ACCEPT** mass/ length for size **ACCEPT** electrophoresis uses, current / voltage / charge / (named) electrode(s)

Question			Answer	Marks	Guidance
2	a	i	secondary quaternary primary tertiary	2	All 4 correct ✓✓ 2 or 3 correct ✓
		ii	other foods have , same / similar , <u>antigen</u> ✓ *idea that* the antigen is a short sequence of amino acids (so may be common to more than one polypeptide) ✓ variable region / binding site, (of antibody) is not specific (to gliadin antigens) ✓ antibody binds to ,T lymphocyte / mast cell ✓ mast cell releases histamine (causes inflammation) ✓	2 max	**DO NOT ACCEPT** active site **ACCEPT** binding site is complementary to, more than one molecule/ substances other than gliadins **IGNORE** Antibody can bind to, range of structures / foods **ACCEPT** attaches to
	b	i	1.(at start) respiration is <u>anaerobic</u> / glucose converted into ethanol✓ 2.respiration, decreases rapidly /stops , once glucose used up ✓ 3.ethanol used (as a carbon source) once glucose has been consumed ✓ 4.aerobic respiration (of ethanol) ✓ 5.(because) acetyl Co A used in Krebs cycle ✓ 6.respiration stops when, ethanol / respiratory substrate, has been used up ✓	3 max	**ACCEPT** oxygen is needed for the metabolism of ethanol

Question			Answer	Marks	Guidance
		ii		2 max	**Mark first two suggestions given**
			(use) aseptic techniques / avoid contamination ✓		**ACCEPT** a description of an aseptic technique **ACCEPT** sterile techniques
			provide (sources of) nutrients / respiratory substrates ✓		**ACCEPT** a specific example of a nutrient
			(incubate at) suitable temperature ✓		**ACCEPT** optimum temperature / right temperature /a specific, appropriate temperature (15- 35°C) **IGNORE** keep temperature constant / low temperature/ monitor temperature / control temperature
			use (pH) buffer ✓		**ACCEPT** maintain optimum pH / right pH /a specific, appropriate pH (4-7) **IGNORE** keep pH constant / monitor pH / control pH
			agitation / stirring / shaking ✓		**ACCEPT** mixing **IGNORE** ref to aeration / oxygen supply / sparging
		iii	3.75 ✓ x 10^5 ✓	2	**One mark** awarded for a correct calculation with the wrong number of significant figures or not in standard form (e.g. 375000 , 375 x 10^3 ,3.8 x10^5)

Question			Answer	Marks	Guidance
		iv	*Yes because*… a suitable, range / intervals, of temperatures have been chosen ✓ volume controlled ✓ temperature , controlled / maintained ✓ repeats, to identify anomalies / outliers ✓ same yeast suspension used ✓ *No because*… availability of, oxygen/ nutrients / yeast concentration, not controlled ✓ pH is not be controlled at start of experiment ✓ *idea of* pH change would not be an accurate measure of respiration rate ✓ no time reference (to calculate rate) ✓ no control (sample) ✓	3 max	**Max 2 for statements supporting only one view** **IGNORE** large / wide, range of temperatures **IGNORE** repeats exclude anomalies **ACCEPT** 'better to collect (volume of) carbon dioxide produced' / 'It is better to use a respirometer' (implies pH change not accurate) 'because some CO_2 would diffuse into the air'
		v	difference (between the means), is not significant / can be explained by chance (at $p = 0.05$) ✓	1	**ACCEPT** null hypothesis / H_o, can be accepted **DO NOT ACCEPT** null hypothesis / H_o can be rejected **ACCEPT** the results are not significantly different ($p = 0.05$)

Question			Answer	Marks		Guidance
3	a	i	anatomical ✓	1		***Mark the first answer only. If additional incorrect answer given, then 0 marks*** **ACCEPT** anatomy
		ii	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* o *award the higher mark where the Communication Statement has been met.* o *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** ***•The Communication Statement determines the mark within a level.*** ***A level annotation should be used where all marks for a level have been achieved eg for 6 marks*** **L3** ***If a candidate has achieved 5 marks then they have reached level 3 but with one mark omitted*** **e.g L3** ^ ***The same principal should be applied to level 2 and level1*** ***No marks (0) should have a cross***			

			Level 3 (5-6 marks) Provides a full and accurate description of natural selection **and** describes the role of regulatory gene(s) and mentions a correct role of a structural gene. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** Provides a description of natural selection with few errors or omissions **and** mentions a correct role of a structural gene (e.g. for fur colour / pigmentation) *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.* **Level 1 (1-2 marks)** Provides an outline of natural selection *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**		**Indicative scientific points may include** *Natural selection* • mutations (e.g. of pigment gene, and of regulatory genes) • selection pressure of prey availability • the adaptation helped tigers hide from prey / ref to camouflage • striped tigers had a greater survival probability and were more likely to reproduce • beneficial alleles were passed on to the next generation • the allele frequency for the relevant genes would have increased with each generation • after many generations, all tigers within a population were striped *Roles of regulatory genes* • (regulatory) genes control, the pattern/ where pigments produced / expression of other genes • genes switched on or off during development (i.e. epigenetic changes / transcription factors)

						• correct roles for epistasis – e.g. recessive epistasis preventing expression of pigment gene • ignore role of hox genes as not relevant • ignore 'genes for striped fur' or 'striped pattern' alone as this is neither a structural or regulatory gene role
	b		2 ✓✓✓	**3**		**Max 2 marks for calculation if answer not to one significant figure** (q^2 = 1 in 10,000 = 0.0001) q = 0.01 ✓ (p = 1 – 0.01 = 0.99) 2pq = 0.0198 ✓ 0.02 = **2 marks** 1.98 = **2 marks**

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>a</td><td></td><td>
<table>
<tr><th>Type of bacteria</th><th>Location</th><th>Reactant</th><th>Product</th><th>Oxidation or reduction of nitrogen?</th></tr>
<tr><td>Rhizobium</td><td>root <u>nodules</u> / <u>legum</u>inous roots</td><td>N_2 and H^+ ions</td><td>NH_3</td><td>reduction</td></tr>
<tr><td>Nitrosomonas</td><td>soil</td><td>NH_4^+ / ammonium , ions / compounds</td><td>NO_2^- / nitrites</td><td>oxidation</td></tr>
<tr><td>Nitrobacter</td><td>soil</td><td>NO_2^- / nitrites</td><td>NO_3^-</td><td>oxidation</td></tr>
<tr><td>Denitrifiying bacteria</td><td>soil</td><td>NO_3^-</td><td>N_2 / nitrogen gas</td><td>reduction</td></tr>
</table>
✓ ✓ ✓ ✓
</td><td>4</td><td>AWARD one mark per correct column

IGNORE references to oxygen in the reactant and product columns.

DO NOT ACCEPT incorrect formulae or charge

ACCEPT NH_3 /ammonia for Nitrosomonas reactant</td></tr>
<tr><td></td><td>b</td><td>i</td><td>1.cluster / iron / molybdenum / sulfur , are , cofactors / prosthetic groups ✓
2.H_2 is a, competitive inhibitor / end product inhibitor ✓
3.CO is a <u>non-competitive</u> inhibitor ✓
4.(CO binds to allosteric site and) causes change in shape of active site ✓
5.energy required (from ATP) ✓
6.acidic conditions, are tolerated / increase reaction rate ✓</td><td>4 max</td><td>DO NOT ACCEPT coenzyme

2. ACCEPT H_2 , competes /AW, with N_2 for the active site OR 'increase in H_2 will reduce the activity of the enzyme'
3. ACCEPT CO acts as a cofactor (as candidates may be unfamiliar with CO)

5. ACCEPT ATP required as process is active</td></tr>
</table>

Question			Answer	Marks	Guidance
		ii	transport of oxygen, for respiration / to generate ATP (in *Rhizobium*)✓ removes(excess) oxygen so less inhibition (of enzyme / reaction)✓ removes CO to prevent inhibition (of nitrogenase) ✓	2	 **ACCEPT** removes oxygen **/** creates anaerobic conditions, for nitrogen fixation **IGNORE** removes H_2 so more N_2 can bind (to active site)
	c	i	8550 (kJ m^{-2} yr^{-1}) ✓✓	2	**AWARD** one mark for 8 550 000 (J m^{-2} yr^{-1}) **OR** **AWARD** one mark for 9 x 950 000 **OR** **AWARD** one mark for 7600 (kJ m^{-2} yr^{-1})
		ii	11 (%) ✓	1	**ACCEPT ECF from c (i)** (look for 950(000) divided by answer to c(i)and a correct calculation to 2 sig figs) e.g. if calculated 7600 (kJ m^{-2} yr^{-1}) then answer would be 13(%)

Question			Answer	Marks	Guidance
5	a	i	1. antigens on , neurones / nerve cell / Schwann cells / myelin sheath (activate immune system) ✓ 2.antibodies against , neurones / nerve cells / Schwann cells/ myelin sheath (are produced)✓ 3.phagocytes / neutrophils / macrophages / T(killer) cells, attack / break down, neurones / nerve cells / Schwann cells / myelin sheath ✓	2	**For mp 1**,**2**,**and 3**, **IGNORE** nerves **ACCEPT** oligodendrocytes / glial cells / cells in nervous system **ACCEPT** 'immune system fails to recognise antigens on , neurones / nerve cells/ Schwann cells / myelin sheath , as self ' **ACCEPT** ' immune system recognises antigens on , neurones / nerve cells/ Schwann cells / myelin sheath , as, foreign/non self ' **IGNORE** T helper cells / T memory cells **IGNORE** 'kill' cells
		ii	fewer / damaged , Schwann cells ✓ no / less / incomplete / damaged, myelin (sheath) ✓ no saltatory conduction ✓	2 max	**IGNORE** no / dead, Schwann cells **ACCEPT** oligodendrocytes / glial cells **ACCEPT** less insulation (on neurone) **ACCEPT** description of lack of saltatory conduction e.g. action potential travels along whole axon membrane **IGNORE** ref to axon size

	b	i	(greater loss of) memory / thinking / cognition / speech / smell / sight / hearing **AND** (due to damage to) cerebrum / cerebral cortex ✓ (greater loss of) balance / coordination **AND** (due to damage to) cerebellum ✓ (greater loss of) feeding / sleeping patterns / temperature control / water balance **AND** (due to damage to) hypothalamus ✓ (greater loss of)swallowing / bladder control / bowel movement / control of, heart rate / breathing rate **AND** (due to damage to) medulla oblongata / brain stem ✓	**2**	**Mark as prose. Mark first two symptoms given only** **ACCEPT** visual /olfactory / auditory (cortex) if linked to correct loss of speech /smell /sight **ACCEPT** corpus callosum if linked to loss of cognition / balance / memory / thinking **ACCEPT** (due to damage to) motor cortex
		ii	fewer / lower frequency / lower rate of, action potentials / impulses, reach NMJ ✓ no/less, acetylcholine / ACh / neurotransmitter, released ✓ no/less, (neurotransmitter) binding to (sarcolemma) receptors ✓ no/ less, depolarisation of, post-synaptic membrane / sarcolemma / T tubules ✓	**2 max**	**DO NOT ACCEPT** 'signals' / 'messages' / weaker action potentials **IGNORE** slower action potentials alone (as stated in previous question) **ACCEPT** takes longer for neurotransmitter to build up **IGNORE** less neurotransmitter produced **ACCEPT** fewer action potentials generated

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<tr><td>6</td><td></td><td></td><td colspan="4">Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

In summary:
Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)
Using a ‘best-fit’ approach based on the science content of the answer, first decide which of the level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.
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○ award the higher mark where the Communication Statement has been met.
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• The science content determines the level.
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A level annotation should be used where all marks for a level have been achieved eg for 6 marks L3

If a candidate has achieved 5 marks then they have reached level 3 but with one mark omitted e.g L3
The same principal should be applied to level 2 and level1
No marks (0) should have a cross</td></tr>
<tr><td></td><td></td><td></td><td>Level 3 (5-6 marks)
Describes and explains some improvements to the method and the presentation.

There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. The information presented is relevant and substantiated.
Level 2 (3-4 marks)
Describes some improvements to the method and the presentation, and explains improvements to either method or presentation
There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented in the most part relevant and supported by some evidence.

Level 1 (1-2 marks)</td><td>6</td><td></td><td>Indicative scientific points may include
Method:
• sample sizes should be increased to improve the accuracy and repeatability of the results
• same number of subjects for, smokers/non-smokers/gender, to make comparisons more valid
• gender should be controlled/tested separately because heart rate may show an overall difference between genders
• other subject factors (e.g. diet, exercise history, other health issues) should be controlled/taken into account because these can influence heart rate</td></tr>
</table>

			Describes some improvements to either method **and / or** presentation. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*			• the level of smoking (e.g. casual vs 20 per day) should be controlled because this is likely to be a continuous variable rather than the discrete variable the student has implied • time of day should have been standardised because this may influence heart rate • subjects should have been given an exercise that required a particular intensity (e.g. treadmill running) because effort will have varied • more repeats before calculating mean to identify anomalies *Presentation:* • smokers and non-smokers should have been presented as separate columns to make comparisons easier • units should be include for the final two columns to show that the three heart rate measurements were made using the same method • the number of significant figures/decimal places should be the same for each measurement to standardise the level of precision • present data graphically to spot trends more easily • label heart rates as mean heart rates for clarity

Question			Answer	Marks	Guidance
7	a	i	*Insects* many / branched, tracheae / tracheoles / tubes ✓ *Fish* many / AW , filaments / lamellae / plates✓	2	**IGNORE** many spiracles **ACCEPT** many / branched,vessels **ACCEPT** feathery filaments **IGNORE** folding with no reference to an increase in number e.g. primary lamellae folded **but ACCEPT** if primary lamellae, folded into / covered with, secondary lamellae / plates
		ii	oxygen is in short supply (in lugworm habitat) ✓ rate of diffusion is, insufficient / too slow (to meet needs) ✓ lugworms have a smaller surface area to volume ratio (than some worms) ✓ lugworms have a high(er) <u>metabol</u>ic rate ✓	1 max	**IGNORE** Live in habitat where gas exchange difficult **DO NOT ACCEPT** no oxygen **ACCEPT** harder to get oxygen
	b		goblet ✓ noradrenaline ✓ diaphragm ✓ forced / conscious / active / voluntary ✓	4	**ACCEPT** phonetic spelling throughout **ACCEPT** norepinephrine
			Total	70	

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