A-level
BIOLOGY
7402/2

Paper 2

Mark scheme

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Mark scheme instructions to examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information in the 'Comments' column is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for the same mark are indicated by the use of **OR**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the 'Comments' column of the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.4 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the mark scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the mark scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.5 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.6 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.7 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

Question	Marking Guidance	Mark	Comments
01.1	1. Organic 2. Respiration 3. Carbon 4. Calorimetry;;	2 (2 x AO1)	4 correct = **2 marks** 2–3 correct = **1 mark** 0–1correct = **0 marks** 2. Ignore aerobic/anaerobic. 3. Accept cells/tissue(s)/plant(s)/animal(s)/organism(s)/ NPP/ living material/biological molecules. 3. Ignore biomass/biological materials/organic matter and reference to 'dry'. 4. Accept calorimeter but reject colorimeter. 4. Accept phonetic spellings.

Question	Marking Guidance	Mark	Comments
01.2	1. Carbon dioxide combines/reacts with ribulose bisphosphate/RuBP; 2. Produces two glycerate (3-)phosphate/GP using (enzyme) Rubisco; 3. GP reduced to triose phosphate; 4. Using reduced NADP; 5. Using energy from ATP; 6. Triose phosphate converted to glucose/hexose/RuBP/ribulose bisphosphate/named organic substance;	6 (6 x AO1)	1 to 6. Accept marks in suitable diagram. 1. Accept idea of fixation for 'reacts'. 2. Accept: any answer which indicates that 2 × as much GP produced from one RuBP catalysed by Rubisco. 2 and 3. Reject GP once if incorrectly named e.g., glucose 3- phosphate. 3. Must have idea of reduction. This may be conveyed by stating mp4. 3 and 6. Only accept TP if triose phosphate is also in the answer. However only penalise once. 4. Accept NADPH or $NADPH_2$ or NADPH + H for reduced NADP. 4. Reject: Any reference to reduced NAD for mp4 but allow reference to reduction for mp3. 4. and 5. must be in context of GP to triose phosphate.

Question	Marking Guidance	Mark	Comments
02.1	Automarked question – ☑ *N = I – (F + R)*; (Box 2)	1 (AO1)	

Question	Marking Guidance	Mark	Comments
02.2	21.6 **OR** 22;	1 (AO2)	

Question	Marking Guidance	Mark	Comments
02.3	Correct answer of 88500/89000 = **2 marks**;; Incorrect but shows 1.8975/1.898/1.9/1.90 (million) /1897500 = **1 mark** **OR** Incorrect but shows 1.809/1.81/1.8/1.80 (million) / 1809000 = **1 mark** **OR** Incorrect but shows 885/89/90 with incorrect position of decimal point = **1 mark**;	2 (2 x AO2)	Accept 90000 for **2 marks.** Accept any of the answers in any correct mathematical form e.g., shows 1.8 (million) as 1800000.

Question	Marking Guidance	Mark	Comments
02.4	1. Energy lost between/at trophic/feeding levels; 2. Energy lost via respiration/excretion/faeces;	2 (2 x AO2)	1. Accept description of trophic levels e.g., food chain. 2. Accept energy lost via heat/metabolism/food not eaten/digested /muscle contraction/movement /maintaining temperature. 2. Reject energy used in respiration. 2. Reject energy produced/generated.

Question	Marking Guidance	Mark	Comments
03.1	1. Volume of (stock) bacteria (culture); 2. Concentration of (stock) bacteria (culture); 3. Concentration of glucose **OR** Concentration of (respiratory) substrate; 4. Volume of ammonium chloride; 5. Time (bacteria/culture left to divide); 6. Concentration/volume of oxygen; 7. Concentration/volume of nitrogen;	2 max (2 x AO2)	Accept vol. for volume and conc. for concentration. 1 and 2. If neither credited accept number/mass of bacteria for 1 mark. 1 and 2. Ignore volume/concentration of liquid culture. 3. Accept concentration of ion/named ion but ignore ammonium chloride. Ignore 'same bacteria/species/type'. 1, 2, 3, 4, 6. and 7. Ignore amount. 3. Ignore 'sugar'. 3 and 4. Ignore nutrients. 6 and 7. Ignore availability/access/exposure.

Question	Marking Guidance	Mark	Comments
03.2	(For) 1. Nitrogenase activity decreases with increase in ammonium chloride (concentration); 2. Nitrogenase activity zero with high (concentration of) ammonium chloride **OR** Ammonium chloride remains (in medium) when nitrogenase activity zero; (Against) 3. Only used one species; 4. (Inhibition/results) may be due to chloride (ions)	3 max (3 x AO3)	1 and 2. Accept ammonia for ammonium chloride. 1. Accept negative correlation between nitrogenase activity and ammonium chloride (concentration). 2. Accept nitrogenase activity zero at 80/100/120/above 60 (µg cm^3 of ammonium chloride). 2. Accept 'stops' for zero. 3. Accept only *Azotobacte*r/*A. chroococcum* / chroococcum / one nitrogen-fixing bacterium / one type/strain used.

	OR (Investigation) uses ammonium chloride not ammonia;		4. Reject 'chlorine'. Ignore reference to statistical tests.

Question	Marking Guidance	Mark	Comments
03.3	1. Less/no ATP/energy required/used **OR** More ATP/energy available; 2. ATP/energy can be used for growth/synthesis/replication **OR** Lower (rate of) respiration required **OR** ATP for phosphorylation;	2 (2 x AO2)	2. Accept ATP can be used for 'other reactions', 'movement', 'active transport' or correctly named reaction. 2. Ignore 'aerobic', 'anaerobic' in context of respiration. 2. Reject ATP/energy used for/in respiration. 2.Reject mitosis.

Question	Marking Guidance	Mark	Comments
04.1	Automarked question – ☑ Reduction of pyruvate (Box 3)	1 (AO1)	

Question	Marking Guidance	Mark	Comments
04.2	1. <u>Oxygen/O_2</u> taken up/used (by seeds); 2. Carbon dioxide/CO_2 (given out) is absorbed by solution/potassium hydroxide/KOH; 3. Decrease in pressure/volume (of air inside);	3 (3 x AO2)	3. Ignore 'negative pressure' but reject reference to vacuum. 3. Accept 'air pressure higher than inside'.

Question	Marking Guidance	Mark	Comments
04.3	1. Distance (drop/liquid moves); 2. Diameter/radius/bore of tubing/lumen;	2 (2 x AO2)	Ignore time. 1.Accept description of distance, e.g. 'start and end position'. 2. Accept (cross-sectional) area of tubing/lumen.

Question	Marking Guidance	Mark	Comments
04.4	1. Remove potassium hydroxide/KOH **OR** Remove solution which removes carbon dioxide. **OR** Replace potassium hydroxide/KOH with water; 2. Record distance liquid moves (without potassium hydroxide); 3. Use difference in distance liquid moves (with potassium hydroxide and without potassium hydroxide) **OR** Use difference in (calculated) volumes (with potassium hydroxide and without potassium hydroxide);	3 (3 x AO3)	Answers which add/use a syringe, reject mp2 **and** mp3. 1. Reject if seeds removed or another organism used. 2. Reject moves to the right. 2. Accept 'liquid would not move'. 3. Accept 'if liquid does not move (volume of) carbon dioxide produced is the same as (volume of) oxygen used'.

Question	Marking Guidance	Mark	Comments
04.5	Answer in the range 3×10^{-7} to 3.33×10^{-7};	1 (AO2)	Accept equivalent answers in this range which are not in standard form. Accept 3.0×10^{-7} Ignore any numbers after 3.33.

Question	Marking Guidance	Mark	Comments
05.1	1. *E. rufus* in north (west) **OR** *E. rufus* in the west **OR** *E. rufus* above river; 2. *E. rufifrons* in south **OR** *E. rufifrons* in west **and** east **OR** *E. rufifrons* below river; 3. (Actual) distribution similar to expected (distribution) **OR** (Actual) distribution similar to environmental needs **OR** (Actual) distribution (slightly) less than expected distribution;	3 (3 x AO3)	1 and 2. Accept equivalent valid statements e.g., for 1, no *E. rufus* in south. 1 and 2. If neither mark is awarded, accept, for one mark, 'they are separated by the river' **OR** 'there is no overlap in their distribution/ranges'. 1 and 2. Accept converse. 1 and 2. Do not penalise 'prefer'. 3. Accept for one or both species.

Question	Marking Guidance	Mark	Comments
05.2	1. Geographical isolation **OR** Allopatric speciation; 2. Reproductive separation/isolation **OR** No gene flow **OR** Gene pools separate; 3. Different selection pressures **OR**	5 max (3 x AO1, 2 x AO2)	1.Ignore descriptions of geographical isolation. 1. Reject sympatric. Ignore reference to two species at start. 2. Reproductive isolation must be at beginning of process. 2. Accept no interbreeding but must be a separate idea from mp 6 which relates to definition of a species.

	Different environmental/abiotic conditions/factors; 4. (Variation due to) mutation(s) (in different populations); 5. (Different/advantageous) allele/s passed on/selected **OR** Change in frequency of allele/s; 6. (Eventually different species) cannot (inter)breed to produce fertile offspring;		2. Reject no inbreeding.

Question	Marking Guidance	Mark	Comments
05.3	(Marking) does not affect survival/predation/recapture;	1 (AO3)	Accept. Mark does not rub/wash off/is non- toxic. Ignore 'does not harm' on its own unless it relates to survival/predation/recapture. .

Question	Marking Guidance	Mark	Comments
05.4	3;	1 (AO2)	Ignore any wording provided e.g. lemurs.

Question	Marking Guidance	Mark	Comments
06.1	(1) I^AI^O **and** (2) I^AI^B;	1 (AO2)	Accept I^OI^A for (1) **and** I^BI^A for (2). Accept AO or OA for (1) **and** AB or BA for (2). Accept lower case for A, B and O.

Question	Marking Guidance	Mark	Comments
06.2	1. Rhesus positive parents produce 7/Rhesus negative child **OR** 3 and 4 produce 7/Rhesus negative child **OR** Two Rhesus positive produce 7/Rhesus negative child; 2. Both Rhesus positive/3 and 4 have recessive allele **OR** Both Rhesus positive/3 and 4 are heterozygous/carriers **OR** If Rhesus positive was recessive, all children (of 3 and 4) would be Rhesus positive / have recessive (phenotype);	2 (2 x AO2)	1. Reject if incorrect evidence and correct evidence provided. 1.Accept Rhesus positive parents produce Rhesus positive and Rhesus negative child. 2. Reject if incorrect explanation and correct explanation provided. 1 and 2. Accept 'affected' for Rhesus positive and 'unaffected' for Rhesus negative.

Question	Marking Guidance	Mark	Comments
06.3	Correct answer of 0.125 / $^{1}/_{8}$ / 12.5% = **2 marks**;; Incorrect answer of 0.25 / $^{1}/_{4}$ / 25% = **1 mark**;	2 (2 x AO2)	Accept 1 in 8 for 2 marks or accept 1 in 4 for 1 mark. Accept equivalent raw fractions e.g., $^{2}/_{16}$ for 2 marks or $^{4}/_{16}$ for 1 mark. Accept 12.5 for 1 mark.

Question	Marking Guidance	Mark	Comments
06.4	0.2 **OR** 0.20;	1 (AO2)	

Question	Marking Guidance	Mark	Comments
06.5	1. Chi-squared; 2. 3;	2 (2 x AO2)	1. Accept χ^2 or Chi^2

Question	Marking Guidance	Mark	Comments
06.6	1. Selection (against/for a blood group/phenotype/allele); 2. (High rate of) mutation; 3. Immigration/emigration; 4. No random mating.	2 max (2 x AO2)	1 to 4. Reject converse statements as context would be incorrect' Ignore births/deaths. 3. Accept 'migration' or population is not isolated. 4. Ignore no 'random fertilisation'.

Question	Marking Guidance	Mark	Comments
07.1	1. (Only) the presynaptic neurone/knob/membrane releases/has neurotransmitter/acetylcholine; 2.(Only) the postsynaptic neurone/membrane has receptors **OR** No receptors in the presynaptic neurone/membrane;	2 (2 x AO1)	1. Accept abbreviations for acetylcholine e.g., ACh, Ach, AChol. 1. Ignore has/releases 'transmitter'.

Question	Marking Guidance	Mark	Comments
07.2	1. Temporal; 2. (Several/repeated impulses in short time) provide (enough) neurotransmitter/acetylcholine to reach threshold **OR** (Several/repeated impulses in short time) so (enough) sodium ions enter to reach threshold **OR** (Several/repeated impulses in short time) increases membrane potential to reach threshold;	2 (2 x AO2)	2. Accept abbreviations for acetylcholine e.g., ACh, Ach, AChol. 2. Accept 'to cause depolarisation' or 'to produce 'action/generator potential' for 'to reach threshold'. 2. Accept Na^+ for sodium ions.

Question	Marking Guidance	Mark	Comments
07.3	1. Less/no acetylcholine/neurotransmitter binds to receptor/s; 2. Less/no depolarisation **OR** Fewer/no action potential(s) **OR** Fewer/no sodium ions enter to reach threshold;	2 (2 x AO2)	1. Accept abbreviations for acetylcholine e.g., ACh, Ach, AChol 1. Ignore competitive inhibition but reject ''active site'. 2. Accept 'takes longer for depolarisation or action/generator potential to be produced'. 2. Ignore 'weaker action potential/depolarisation'. 2. Accept Na^+ for sodium ions.

Question	Marking Guidance	Mark	Comments
07.4	1. Less/no acetylcholine/neurotransmitter broken down; 2. (More) acetylcholine attaches to <u>receptors</u>; 3. Depolarisation (of sarcolemma) occurs **OR** Action potential(s) produced **OR** (Enough) sodium <u>ions</u> enter to reach threshold **OR** Fewer/no antibodies attach;	3 (1 x AO1, 2 x AO2)	1. Accept (more) acetylcholine/neurotransmitter present/remains. 1 and 2. Accept acetylcholine/neurotransmitter remains attached to receptors (for longer) = 2 marks. 1 and 2. Accept ACh or other abbreviations e.g. AChol for acetylcholine. 3. Accept Na^+ for sodium ions.

Question	Marking Guidance	Mark	Comments
08.1	Correct answer of 8.1 / 8.07/ 8.066 / 8.0658 / 8.06575 <u>$\times 10^{-3}$</u> = **2 marks**;; Incorrect answer but shows 8 / 8.1 / 8.07 / 8.066 / 8.0658 / 8.06575 = **1 mark** Correct answer but not in standard form = **1 mark** Incorrect rounding of correct answer in correct standard form e.g., 8.06 x10^{-3} = **1 mark;**	2 (2 x AO2)	**Note**. To award 2 marks <u>$\times 10^{-3}$</u> is required. Accept 8 x 10^{-3} for 2 marks but 8.0 x 10^{-3} = 1 mark due to incorrect rounding.

Question	Marking Guidance	Mark	Comments
08.2	For (valid) comparison as rats vary in mass **OR** (So) each rat receives a quantity relative to their mass **OR** (So) <u>concentration</u> in the blood/body is the same;	1 (AO2)	Accept 'standardisation' for 'comparison'. Accept 'weight' for mass but ignore size.

Question	Marking Guidance	Mark	Comments
08.3	1. SDs do not overlap (for blood glucose concentration) **OR** SDs do not overlap (for mass); 2. So significant difference/increase (in blood glucose concentration) **OR** So significant difference/increase (in mass); 3.(Type II diabetes) causes high blood glucose (concentration); 4. Obesity/high body mass is a (risk) factor (in type II diabetes) **OR** High fat (diet) is a (risk) factor (in type II diabetes); 5. (Investigation) done on rats (not humans); 6. (Only shows) results after short-time period **OR** Long-term effects not known;	5 max (5 x AO3)	2. Accept 'difference/increase is not due to chance' for significant difference/increase. Ignore reference to stats test. 3. Accept 'associated/linked/have' for causes. 6. Accept 1, 2 or 3 weeks.

Question	Marking Guidance	Mark	Comments
08.4	1. (Type II) still produce/release insulin; 2. (Type II) cells/receptors less/not responsive/sensitive to insulin; 3. Pancreatic cells not destroyed (in type II diabetes); 4. Damage to pancreatic cells may affect processes/reactions (in the body);	2 max (2 x AO3)	1. Accept 'type 1 would not produce/release insulin' **or** this would cause type I diabetes. 2. Accept involves 'faulty receptors' or 'fewer receptors'. 3. Ignore pancreas is not destroyed.

Question	Marking Guidance	Mark	Comments
09.1	Posterior pituitary;	1 (AO1)	Accept phonetic spelling. Ignore any other additional wording.

Question	Marking Guidance	Mark	Comments
09.2	1. Dehydration/thirst; 2. Frequent urination **OR** Increase in volume of urine; 3. Less concentrated urine OR Dilute urine **OR** Urine paler/lighter in colour;	2 max (2 x AO2)	2. Ignore amount. 2. Accept increased urination.

Question	Marking Guidance	Mark	Comments
09.3	1. (Stimulates) addition of channel proteins into membrane; 2. Increases permeability to water **OR** (More) water (re)absorbed; 3. By osmosis;	3 (3 x AO1)	1. Accept aquaporins for channel proteins. 1. Accept movement for addition. 1. Accept (stimulates) opening of channel proteins in membrane. 2. Accept for reabsorbed 'enters blood' or 'leaves collecting duct'.

Question	Marking Guidance	Mark	Comments
10.1	1. Change in DNA base sequence/triplet; 2. Change in (sequence of) amino acids **OR** Change in primary/tertiary/3^0 structure; 3. (Results in) rapid/uncontrollable cell division;	3 (3 x AO2)	2. Ignore reference to protein not being formed. 2. Reject (different) amino acids formed. 2. Ignore 3D structure. 3. Accept cell division cannot be regulated. 3. Ignore growth. 3. Accept cell replication but ignore cell reproduction.

Question	Marking Guidance	Mark	Comments
10.2	1. Use of PCR to amplify (DNA/sample); 2. Cut (DNA) using restriction endonuclease/enzymes; 3. Separate (DNA fragments) using electrophoresis; 4. Addition of (labelled) DNA probes **and** binding (by DNA hybridisation); 5. (Mutations) identified by fluorescence/radioactivity **OR** Compare positions/bands (to known) DNA sample with (all harmful) mutations;	4 max (3 x AO1, 1 x AO2)	1. Accept description of amplification. 3. Accept use of microarray for electrophoresis. 4. Ignore primers. 4. Reference to probe being complementary is insufficient. 5. Accept identification using X-ray/photographic/film/autoradiography or UV light. **Note if only DNA sequencing** is used award **max 3 marks** for the following. 1 Use of PCR to amplify (DNA/sample); 2. Sequence the DNA sample; 3. Compare DNA sequence with known DNA sequence of mutation;

Question	Marking Guidance	Mark	Comments
10.3	1. (Drug) binds to (oestrogen/ER) receptor; 2. Prevents binding of oestrogen/hormone; 3. No/fewer transcription factor(s) bind to <u>promoter</u> **OR** RNA polymerase not stimulated/activated;	3 (3 x AO2)	1. Accept (inactive) transcription factor for receptor. 1 and 2. Reject active site/enzyme - substrate complex once only.

Question	Marking Guidance	Mark	Comments
10.4	1. High/increased (concentration of) PSA not always linked to (prostate) cancer **OR** High/increased (concentration of) PSA could be a false positive; 2.(Could be) due to urinary infection **OR** (Could be) due to enlarged prostate;	2 (2 x AO2)	2. Accept 'urine infection'.

Question	Marking Guidance	Mark	Comments
10.5	1. (Drugs could) increase methylation of oncogene(s); 2. (Drugs could) decrease methylation of tumour suppressor gene(s); 3. (Increased) methylation of DNA/gene(s) inhibits transcription/expression (of genes) **OR** Decreased methylation of DNA/gene(s) stimulates transcription/expression (of genes); 4. Decreased acetylation of histones inhibits transcription/expression (of genes) **OR** (Increased) acetylation of histones stimulates transcription/expression (of genes);	3 max (1 x AO1, 2 x AO2)	Ignore methylation of histones and acetylation of DNA/genes. Ignore proto-oncogenes. 3. Accept promoter (region) for DNA/gene 3 and 4. Ignore 'switching on' and 'switching off' genes once but accept as alternative(s) for 1 mark if used correctly in context of transcription/ expression for **both** points 3 and 4.