Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCE
In Biology (9BIO)
Paper 3: General and Practical Principles in Biology

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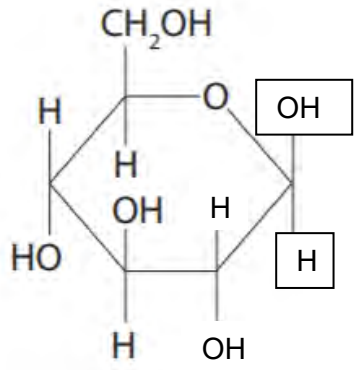
General Marking Guidance

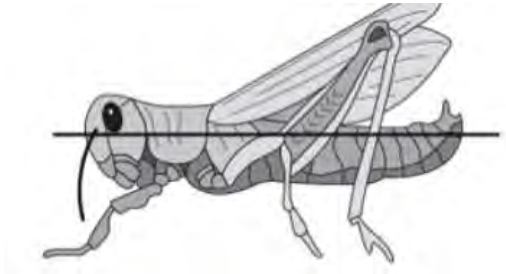
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Additional Guidance	Mark
1(a)		Accept HO for OH	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(b)	An answer that includes three of the following: • cellulose is made up of beta glucose (monomers) but starch is made up of alpha glucose (monomers) (1) • cellulose contains {unbranched / straight / linear} chains (of glucose) but starch contains branched chains (1) • cellulose contains 1,4 glycosidic bonds but starch contains 1,4 and 1,6 glycosidic bonds (1) • {inverted / flipped} glucose molecules in cellulose but glucose molecules in same orientation in starch (1)	**Piece 2 adjacent sentences only** Accept b / β and a / α Accept cellulose contains one type of molecule but starch contains {two types / amylose and amylopectin} Accept amylose is coiled but cellulose is {not coiled / a straight chain molecule} Accept starch contains 1,6 glycosidic bonds but cellulose does not Accept a diagram	**(3)**

Question Number	Answer	Additional Guidance	Mark
1(c)	An explanation that includes the following: • insoluble (1) • so does not {have an osmotic effect / affect water potential} (1) **or** • {compact / dense / coiled / tightly packed} (1) • so a lot can be stored in a {small / given} space (1) **or** • (amylopectin / starch is) branched (1) • so can be {broken down / hydrolysed} more quickly (1)	**Do not piece** Accept so cannot cross membrane and leave cell Ignore takes up less space unqualified Accept contains many {end branches / terminal glucose molecules} Ignore easy / easier release	**(2)**

(Total for Question 1 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	An answer that includes the following: • appropriate line drawn (1)	 • through thorax and abdomen • roughly horizontal • curved or straight • in lighter grey area	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	• (so that the) {gas exchange system / respiratory system / trachea / air sacs / it} is clearly visible (1)	Accept {gas exchange system / respiratory system / trachea / air sacs / it} is easier to see Ignore refs to seeing tracheoles / spiracles Accept to stop it drying out Do not accept any incorrect reason	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that includes the following: • A trachea (1) • B spiracle (1)	 A accept tracheae B accept spiracles Accept phonetic spelling	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	• tracheole(s) (1)	Accept tracheole fluid Accept phonetic spelling	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)(iii)	An answer that includes the following: • correct measurement of A or X (1) • correct diameter of X calculated to 2dp (1)	Sample calculation A = 5 (mm) accept 4.5 to 5.5mm X = 1 (mm) accept 0.5 to 1.5mm **0.18 mm** **Accept answer in range 0.08 to 0.30** Correct answer gains full marks	**(2)**

(**Total for Question 2 = 7 marks)**

Question Number	Answer	Additional Guidance	Mark
3(a)(i)	• (DNA) ligase (1)		**(1)**

Question Number	Answer	Additional Guidance	Mark
3(a)(ii)	• *A. tumefaciens* (1)	Accept plasmid / bacterium Ignore any names of plasmids if given	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(b)	An explanation including two of the following • plant cells are totipotent (1) • plant cells contain gene for herbicide resistance (1) • cells divide by mitosis (to produce genetically identical daughter cells) (1) • so (herbicide resistant) plants can be grown from {one / a few} plant cells (1)	Ignore references to sexual / asexual reproduction Accept cells from {crown gall / callus / tumour} are totipotent Accept plant cells contain {modified gene / recombinant DNA} Accept cells from {crown gall / callus / tumour} divide by mitosis	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)	An explanation that includes three of the following: • (in GM plants) herbicide {kills / removes} weeds but not crop plant (1) • so there is less competition (from weeds) (1) • for one named resource (1) • for second named resource (1) • so {more {light / water} for photosynthesis / more nitrates for {proteins / amino acids} / named mineral for appropriate function} (1)	 Accept (for non-GM plants) herbicide would kill soya bean plants, so cannot be used to kill weeds Accept (in non-GM plants) weeds compete with soya bean plants Accept water / light / minerals / named mineral Ignore space / nutrients / CO_2 Accept so {less {light / water} for photosynthesis / less nitrates for {proteins / amino acids} / less named mineral for appropriate function in non-GM plants	**(3)**

(**Total for Question 3 = 7 marks)**

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	A description that includes the following • dilution by {1 in 1000 / 1 : 999} (1) • dilution in ratio of {3 in 10 / 3 : 7} (1)	Answer must be volumes not mass Accept other suitable dilutions. eg 1 cm^3 of stock plus 999 cm^3 water eg 300 cm^3 stock plus 700 cm^3 water correct volumes given in one step gain 2 marks eg 0.3 cm^3 stock + 999.7 cm^3 water 3 cm^3 stock + 9997 cm^3 water etc Correct answer with no working gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	An answer that includes one from step 2 and one from step 3: Step 2 • embryo {produces / releases / contains} gibberellin (1) • endosperm {half / part} produces the amylase (1) Step 3 • {kill {bacteria / fungi / microbes} / sterilise the grain} (1) • {bacteria / fungi / microbes} may produce amylase (1)	Accept if embryo discarded, there is no gibberellin to affect results Ignore {bacteria / fungi / microbes} stop growing	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	A description that includes one abiotic and one biotic factor: **Abiotic** • control pH by adding buffer (to agar) (1) **Biotic** • control {mass / length / surface area} of grains, with suitable method of measurement described (1)	Accept control temperature by using an incubator Accept control {age / species / variety / type} with suitable method described eg collect from same {parent / packet / named species} Accept use of aseptic technique to prevent {contamination / growth of microbes}	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(b)(ii)	A description that includes three of the following: • rinse grains in water after soaking in hypochlorite (1) • use more than one grain for each concentration (1) • example of aseptic technique (1) • measure diameter of clear zone several times (1) • use a control with 0% gibberellin (1)	Accept repeat {the experiment / at each concentration} Accept measure area as clear zone may not be circular	**(3)**

(**Total for Question 4 = 9 marks)**

Question Number	Answer	Additional Guidance	Mark
5(a)(i)	A description that includes two of the following: • prokaryotes have a loop of DNA but eukaryotes have linear chromosomes (1) • prokaryote cell wall contains {peptidoglycan / teichoic acid / murein}, but eukaryote cell wall does not (1) • prokaryotes do not have a nucleus but eukaryotes do (1) • prokaryotes do not contain membrane-bound organelles, but eukaryotes do (1) • prokaryotic cells (only) have 70S ribosomes, but eukaryotic cells have {80S ribosomes / have both 70S and 80S} (1)	Accept prokaryotes have one {piece of DNA / chromosome}, but eukaryotes have several chromosomes Accept in eukaryotes DNA is associated with histone proteins but not in prokaryotes Ignore references to plasmids Accept eukaryote cell wall (if present) contains {cellulose / chitin}, but prokaryote cell wall does not Accept all prokaryotic cells have a cell wall but some eukaryotic cells do not have a cell wall Accept eukaryotes have a nucleus but prokaryotes have {a nucleoid / DNA in cytoplasm} Accept named organelle eg mitochondria / chloroplasts / Golgi body Accept prokaryotic ribosomes are smaller than those in eukaryotic cells / prokaryotic ribosomes have subunits 30S and 50S, but eukaryotic ribosomes have subunits 40S and 60S	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(a)(ii)	An explanation including **two** of the following • bacteria are Gram negative • (the cell wall has) {a thin peptidoglycan layer / an outer membrane / lipopolysaccharide layer} (1) • so it does not retain violet / blue stain (but picks up red stain) (1) **and** • so helps to determine which **antibiotics** {are used / will be most effective} (to treat infection (1)	Accept - ve Accept {less / little} peptidoglycan Accept {primary stain / crystal violet} for blue stain Accept {outer membrane / lipopolysaccharide} is a barrier to some antibiotics Ignore ref to {bactericidal / bacteriostatic / exotoxins / endotoxins} and focus on choosing antibiotic Ignore determining dose of antibiotics	**(3)**

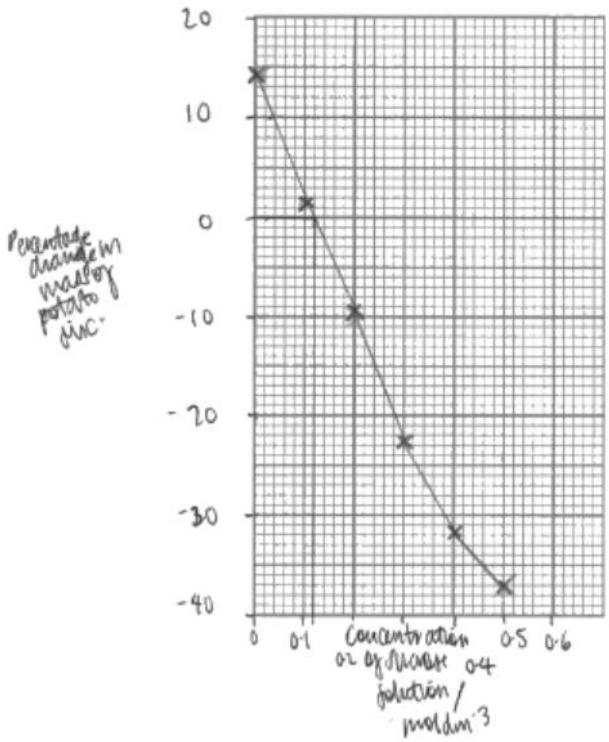
Question Number	Answer	Additional Guidance	Mark
5(b)(i)	A description including four of the following • use of inoculating loop to transfer bacteria (to nutrient agar) (1) • {description / diagram} of streak plating (1) • incubation for suitable period (1) • incubation at suitable temperature (1) • identification of {bacteria / colonies} by {colour / shape} (1) • transfer to separate agar plates (1)	Accept description of loop eg wire Accept use of loop to transfer from {culture / broth} Accept {24-48 hours / stated time in range} Accept {20-37 °C / stated temperature in range / below 37°C / below 30°C / stated temperature below this value} Accept identification of {colonies / bacteria} by microscopy Accept use of selective media to identify {colonies / bacteria} Accept description of transfer	**(4)**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	An explanation including three of the following • use of **aseptic technique** to prevent {contamination / growth of pathogens} (1) • **example of** aseptic technique with appropriate explanation (1) • incubation below 30 °C, as {this is below optimum for pathogens / pathogens are more likely to grow at 37 °C} (1) • use of cross tape between lid and base, to {allow air to enter / prevent growth of anaerobes} (1)	Accept example of aseptic technique eg • autoclaving {to kill bacteria / so no pathogens present} • use of sterile equipment to prevent contamination • flaming {inoculation loops / neck of bottle} to kill bacteria • working near lit Bunsen to {create an updraft / carry bacteria away from plate} • partially opening lids of plates to prevent entry of bacteria • disinfection of surfaces to {kill / remove} bacteria Accept stated temperature below 30 °C Accept not sealing lid to base of plate to {allow air to enter / prevent growth of anaerobes}	**(3)**

(Total for Question 5 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	A calculation which includes the following: • correct answer (1)	(Ψ = 400 + (-500)) = - 100	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	An explanation that includes two of the following: • (water moves) out (of cell) by **osmosis** (1) • (because water moves) from an area of {high / higher} water potential to an area of {low / lower} water potential (1)	**Allow ecf from 6ai** Accept water moves from -100 kPa to -400 kPa by osmosis Accept water moves down a water potential gradient Accept correct answers expressed in terms of {concentration of water / osmotic potential / solute concentration / hypotonic / hypertonic}	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	An answer that includes the following: • axes correctly orientated and labelled with units (1) • all values accurately plotted on linear scale (1) • points joined with straight lines (1)	Example graph  	**(3)**

Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	An answer that includes the following: • correct intercept obtained (1)	(Molarity =) 0.11 - 13	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(b)(iii)	An answer that includes five of the following: **Strengths:** • use of cork borer to give {standard / equal} size pieces (1) • cut into discs to increase surface area (1) • 12 hours was enough time for osmosis to occur (1) • all discs taken from the same tuber (1) • range of concentrations used {was appropriate / gave positive and negative values} (1) **Weaknesses:** • discs must be submerged in sucrose solution (1) • discs should be the same {width / thickness / size} (1) • only one disc in each solution (so mean could be calculated) (1) • discs should be blotted dry (before being reweighed) (1) • test more molarities near intercept point (1) • temperature should be controlled (1) • need to use a conversion table to get the {osmotic / water} potential (1)	**At least one strength and one weakness for maximum marks** Accept same surface area for equal size Accept no further movement of water occurs Accept only one potato was used Accept use an equal volume of sucrose solution (for each concentration) Accept repeats Accept smaller intervals of molarities should be tested Accept need to convert concentrations to {osmotic / water} potential	**(5)**

(Total for Question 6 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	there is no **difference** in the (mean) area of leaves growing in sun and shade (1)	Accept there is no **difference** in the (mean) area of leaves growing {in the two areas / at the **two** light intensities}	**(1)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	An answer that includes four of the following: • random selection of plants to be studied (1) • measure leaf **area** of {hedge woundwort / *Stachys sylvatica*} (1) • method of measurement described eg using squared paper (1) • suggested method of control of which leaf to measure (1) • (select leaves in) light and shade (1) • {control / monitor} other relevant named factor (1)	Accept other suitable method eg {photocopy or trace and weigh / use of computer programme / measure length and width and multiply by a factor} eg lowest leaf on each plant Accept measurement of light intensity eg soil type, water {content / availability}, pH, mineral content, slope, aspect, same day	**(4)**

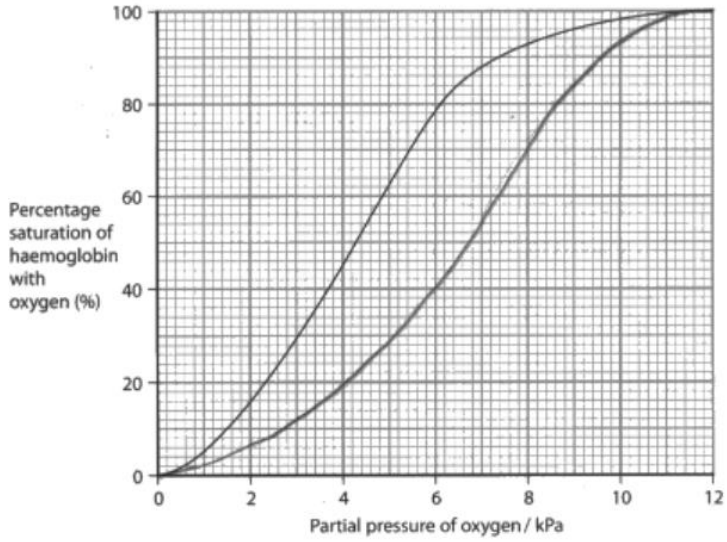
Question Number	Answer	Additional Guidance	Mark
7(b)(i)	• calculation of 2SD (1) • calculation of range (1)	2 x 9.62 = 19.24 (cm^2) **8.31 to 46.79** (cm^2) Accept 38.48 Correct answer with no working gains full marks Correct calculation of value for shade (28.7 to 82.3/ range of 53.6) gives 1 mark	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)(ii)	• calculation of difference between 2 means (1) • substitution of values into denominator (1) • correct value of *t* (1)	27.95 (ignore minus) Accept intermediate values 4.63 / 8.98 / √13.61 / 3.69 7.57 / 7.58 / 7.6 (ignore minus) Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(b)(iii)	An answer that includes three of the following: • calculated value is more than the critical value of **2.02 / 2.71** (1) • therefore reject the null hypothesis / H_0 (1) • there is a **significant** difference between the leaf area in sun and shade plants (1)	**Allow ecf from part ii** Accept 7.6 > 2.02 **Do not accept** minus 7.6 < 2.02 / 2.71 Accept value circled in table Accept leaves of shade plants have a significantly bigger area Accept there is a less than {0.05 / 5%} probability that the difference in leaf area is due to chance	**(3)**

(Total for Question 7 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	An explanation that includes three of the following • four {polypeptide chains / subunits / haem groups / Fe^{2+}} (1) • haem groups {combine / bind} (reversibly) with oxygen (molecules) (1) • so can pick up four molecules of oxygen (1) • co-operative binding occurs (1) • because after first molecule of oxygen binds, the (3D) shape of the molecule changes (1)	Accept 2 alpha and 2 beta chains / subunits Accept iron {combines / binds} with oxygen Accept description eg after first molecule of oxygen binds {other oxygen molecules can be picked up more easily / there is a higher affinity for oxygen}	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	• curve drawn lower and to the right of existing curve with same start and end point (1)	Sample graph 	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(a)(iii)	An explanation including two of the following: • oxygen more likely to be released (from Hb) at {respiring tissues / muscle} (1) • because {partial pressure / concentration} of carbon dioxide is {high / higher} in {respiring / muscle} tissues (1) • {Bohr shift occurs / the affinity of haemoglobin for oxygen is reduced} when {partial pressure / concentration} of carbon dioxide is {high / higher} (1)	Accept haemoglobin gives up oxygen more easily when {partial pressure / concentration} of carbon dioxide is {high / higher} Accept when carbon dioxide concentration is high, carbonic acid (releases H^+ which) causes quaternary structure of Hb to change	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(b) (i)	0.25	Accept 25% / ¼ / one in four / 1:3 Do not accept 1:4 / 3:1	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(b) (ii)	An explanation that includes the following • (heterozygotes have) one {dominant / non-mutated} copy of the allele (1) • so {beta globin / the protein} can still be made (1)	Accept in heterozygotes the dominant allele is always expressed Accept both alleles must be recessive for the symptoms to be shown Ignore reference to carrier	**(2)**

Question Number	Answer	Additional Guidance	Mark
8(c)(i)	An answer including the following: • value for q^2 identified (1) • value for q or p calculated (1) • value for 2pq calculated to 2sf (1)	Example calculation 0.28 q = 0.53 / 0.529 or p = 0.47 / 0.471 (this gains mp1 & 2 if 0.28 not seen) 0.50 / 50% Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(c)(ii)	An answer including two of the following: • migration may occur (1) • mating may not be random (1) • population (on island) may be small (1) • {selection may occur / beta thalassaemia may affect fertility} (1) • mutation may occur (1)	 Accept population {is / may not be} isolated Accept may not be an equal chance of reproduction Accept population size {is not infinite / should be large} Accept genetic drift occurs Accept description of heterozygous advantage leading to higher number of heterozygotes	**(2)**

(**Total for Question 8 = 14 marks)**

Question Number	Answer	Additional Guidance	Mark
9(a)	An explanation including four of the following: • {plaque / clot / atheroma} forms in (coronary) artery (1) • causing {narrowing / blockage} of the **coronary** artery (1) • therefore reducing the blood supply to {cardiac / heart} {muscle / tissue / cells} (1) • so {cardiac / heart} muscle dies (1) • heart (muscle) stops contracting (if enough cardiac muscle cells die) (1) • so oxygen not supplied to brain cells (causing death) (1)	Accept cholesterol build up in artery Accept less {oxygen / glucose} reaches {cardiac / heart} {muscle / tissue / cells} Accept {heart attack / myocardial infarction / MI / cardiac arrest / heart failure} Accept heart stops pumping (blood around body)	**(4)**

Question 9b

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Answer	Additional Guidance	Mark
9(b)	**Indicative content** **Lifestyle choices (L points) – likely to reduce risk of death** • increased exercise (intensity or duration) reduces risk • diet detail eg more {fruit / vegetables / antioxidants} decrease risk • some lifestyle choices increase risk • diet high in {saturated fat / cholesterol} / high salt • {poor diet / lack of exercise} increases risk of {obesity / high BMI} • smoking increases risk of atherosclerosis • alcohol consumption • lifestyle changes may not have been the only reason for decrease in deaths * • credit other factors likely to reduce death **Confounding factors (C points)** • different age groups have different risk / older people more at risk as more likely to have atherosclerosis • different sexes have different risk / males more at risk • ethnicity – different ethnic backgrounds have different risk • genetic predisposition to factors increasing risk • eg high blood pressure / high cholesterol / type 1 & 2 diabetes as more likely to have atherosclerosis • detail of damage eg. high blood sugar leads to damage to lining of blood vessels • credit other factors which will prevent deaths reaching zero • credit idea that any of these could stop deaths (in UK) reaching zero* **Data points (D points)** • death rate declines over the period (in all countries except Montenegro) • relevant comparison of data between UK and other European countries		

	• manipulation of data • graph appears to be plateauing • suggestion of why number of deaths in other countries may not have fallen • comment on percentage change compared to absolute change • comment on table refers to male and female, graph refers to males only – same pattern • comment on gradual decline, not a single event causing decline • incomplete data eg only 1990 and 2019 / no ages of people • no data on incidence of CHD, only death from CHD • no evidence that lifestyle choices have changed* • correct suggestion of why aspects of data collection not valid*
	L1 : 1 mark one point, 2 marks any 2 points, 3 marks any 3 points **L2 points from at least 2 areas, including data** 4 marks 4 points 5 marks 5 points 6 marks 6 points **L3 points from 3 areas, with comment on validity*** 7 marks 7 points 8 marks 8 points 9 marks 9 points, includes a reasoned argument assessing validity

(Total for Question 9 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
10(a)	An answer that includes the following • mass of maggots (1) • {radius / diameter / area} of capillary tubing Ignore volume of capillary tubing	 Accept weight Accept volume of air (read from syringe) needed to reset liquid to original position (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
10(b)	An answer that includes two of the following: • use thermostatically controlled waterbath so temperature does not {change / affect the rate of respiration} (1) • control age of maggots as respiratory rate may change with age (1) • control species of maggot as some may have a {higher / lower} respiratory rate (1) • use of a control tube without maggots to account for changes in {temperature / pressure} (1) • maggots left to equilibrate in apparatus before results are recorded (1)	Accept putting apparatus in an incubator to control temperature Accept affects rate Accept affects rate Accept to determine changes in liquid movement without maggots	**(2)**

Question Number	Answer	Additional Guidance	Mark
10(c)(i)	0.07 (1)	Accept 0.069	**(1)**

Question Number	Answer	Additional Guidance	Mark
10(c)(ii)	An explanation that includes the following: • {enzymes / substrates} will have less **kinetic** energy (1) • (so) collisions (between enzymes and substrates) are less {likely / frequent} (1)	Accept so fewer {collisions / enzyme-substrate complexes form} per unit time Accept E-S complexes {are less likely to form / form less frequently}	**(2)**

Question Number	Answer	Additional Guidance	Mark
10(d)	A description that includes the following: • oxygen is the {final / terminal} {hydrogen acceptor / electron acceptor} (1) • allows electrons to pass down electron transport chain (1) • allows {FAD / NAD} to be replaced (1) • movement of {hydrogen ions / protons} through {pores / stalked particles} in membrane drives synthesis of ATP (1)	Accept allows electrons to be passed through electron carriers Accept {hydrogen ions / protons} move through {ATP synthase / ATPase} forming ATP	**(3)**

(Total for Question 10 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
11 (a)(i)	An answer including one of the following: {rainfall / availability of water / soil water} (1) OR frequency of {mowing lawn / grazing} / use of herbicide / trampling (1) OR time of year data was collected (1) OR {geographical location / altitude} of data collection sites (1) OR disease in plants (1)	Accept hours of {sunlight / cloud cover} Accept different number of participants involved Accept daylength Different gardens may have been surveyed in both years	**(1)**

Question Number	Answer	Additional Guidance	Mark
11(a)(ii)	An answer including five of the following: **Strengths** • large amount of data collected (1) • method is simple so easy to follow (1) • random sampling, so lack of bias (1) **Weaknesses** • area surveyed may not be exactly one m^2 (1) • area surveyed may not be chosen randomly (1) • {plants / flowers} may be identified incorrectly (1) • flowers may be counted incorrectly (1) • we are not told the area surveyed in 2019 (1) • time of year may vary (1)	**At least one strength and one weakness for full marks** Accept easy to count flowers / easier to count flowers than plants Accept one m^2 is {a very small / too small an} area Accept not all parts of UK might be covered Accept area surveyed may be different in the two years Accept not all data collected on the same day	**(5)**

Question Number	Answer	Additional Guidance	Mark
11(b)(i)	A calculation including the following steps • calculation of N(N-1) (1) • calculation of {correct values for n(n-1) / denominator} (1) • calculation of final value (1)	 1190 Accept 110, 56, 182, 2 / 350 3.4 Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
11(b)(ii)	A description including the following • {record / count} all species of plants (including grasses) (1) • {record / count} number of plants not number of flowers (1)	 Accept {larger range of / more} plant species recorded	**(2)**

Question Number	Answer	Additional Guidance	Mark
11(c)(i)	• calculation of intermediate step (1) • calculation of final value (1)	Example calculation eg $\frac{41\ 912}{38\ 885}$ = 1.0778 / 1.078 (ratio of nectar sugar 2019 to 2020) OR $\frac{38\ 885}{41\ 912}$ = 0.9278 / 0.928 OR $\frac{41\ 912}{3.8}$ = 11 029.47 (nectar sugar needed to support one bee) 3.5 3.53 gets 1 mark Correct answer with no working gains 2 marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
11(c)(ii)	An explanation including four of the following: • S - (there will be a) decrease in population of bees due to lack of {food / nectar} (1) • S - (data suggests) bee population decreases by 7.9% (1) • S - (fewer bees so) reduced pollination of (wildflower) plants results in less {seed / offspring} produced (1) • L - (reduced pollination of wildflower plants) so population of (wildflower) plants declines in future years (1) • L - population of (wildflower) plants decline in future years could lead to further decline of bee populations (1) • S / L - (fewer bees so) reduced pollination of {crop plants / named crop plant} results in decreased yield (1) • L - description of effect on predators if fewer {bees / other pollinators} (1)	**At least one short term and one long term effect for full marks** Accept other pollinators for bees Accept ecf for correctly calculated % decrease from wrong value for 11ci Accept {reduced genetic diversity / smaller gene pool} as an alternative to bp 4 or 5	**(4)**

(**Total for Question 11 = 17 marks)**

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