

Mark Scheme (Results)

Summer 2025

Pearson Edexcel GCE
In Biology (9BI0)
Paper 03: 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)	An answer that includes the following: • conversion of actual size and correct measured size to same units (1) • correct answer to nearest whole number (1)	Sample calculation Accept 64 000 to 66 000 (for measured size in μm) 6×10^{-4} (for actual size in cm) 6×10^{-3} (for actual size in mm) Accept answers in range **10 667 to 11 000** **Do not allow** units Correct answer with no working gains 2 marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(b)	An answer that includes the following: • cell drawn correct shape with clear lines and no {shading / hatching} (1) • {nucleus / vacuole} (1)	Ignore cell wall if drawn **Do not allow** mitochondria **Do not allow** anything smaller eg ribosomes	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(c)(i)	• (presence of) {membrane-bound organelles / named organelle} / nucleus / linear chromosomes / 16 chromosomes / cell wall made of {chitin / mannose} (1)	Accept does not have a nucleoid / Accept does not have a looped {chromosome / DNA} Ignore has a cell wall unqualified	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(c)(ii)	• cell wall not made of cellulose / glycogen granules present / no chloroplasts present / it is single celled / does not have {roots / a stem / leaves} (1)	Accept only what can be seen in the diagram Accept cell wall made of chitin and / or mannose Ignore refs to chlorophyll / photosynthesis Accept not multicellular	**(1)**

(Total for Question 1 = 6 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)(i)	An answer that includes the following: • arrow drawn in correct direction (1)	From right to left (only)	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(a)(ii)	A description that includes three of the following: • (acetylcholine) released from vesicles (into synaptic cleft) (1) • (acetylcholine) diffuses across synaptic cleft (1) • {attaches / binds} to receptors (on post synaptic membrane) (1) • this causes {sodium ions to move into (post synaptic) neurone / an action potential / depolarisation} (in post synaptic neurone) (1)	Accept vesicles (containing ACh) fuse with pre-synaptic membrane / exocytosis (of neurotransmitter) Allow diffuses across gap / synapse Allow opens (voltage-gated) Na^+ channel Ignore sodium channel unqualified	**(3)**

Question Number	Answer	Additional Guidance	Mark
2(a)(iii)	• produce the ATP needed for the synthesis of acetylcholine (1)	Accept for neurotransmitters Accept choline and {acetate / acetyl / ethanoic acid} are combined to make acetylcholine, this requires ATP Allow for exocytosis and endocytosis Allow for loading acetylcholine into vesicles Allow for movement of vesicles to membrane Allow for active transport of calcium / potassium / sodium ions Ignore for active transport of ions if not named	**(1)**

Question Number	Answer	Additional Guidance	Mark
2(b)	An explanation that includes the following: • insulates (the neurone) (1) • so nerve impulse jumps from node to node (1)	 Accept myelin is not conductive / allows {low / no} conduction / blocks sodium ion channels Allow gaps for nodes Accept saltatory {conduction / transmission}	**(2)**

Total for Question 2 = 7 marks

Question Number	Answer	Additional Guidance	Mark
3(a)	An answer that includes the following: • one peak of bacteria drawn around 440 nm (1) • one peak of bacteria drawn around 690 nm (1)	Allow peak on one side only (ie above or below filament) and drawn with dots or a line Allow between 400 and 500 Allow between 650 and 720	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(b)	A description that includes five of the following: • use of different (coloured) filters (placed between lamp and beaker of water) (1) • heat shield in front of beaker (1) • add sodium hydrogencarbonate to beaker (1) • method to exclude ambient (white) light (1) • pondweed allowed to acclimatise at each wavelength (before results collected) (1) • description of method of measuring rate of production of gas produced by pondweed (1) • control of {pondweed / light intensity} (1)	Accept coloured bulbs used (to change wavelength of light) Accept beaker placed in thermostatically controlled water bath Accept use of {measuring cylinder / gas syringe / capillary tubing (with scale)} and reference to time Ignore photosynthometer unqualified Ignore potometer / respirometer Ignore counting bubbles Accept same length or mass / use same pondweed / keeping lamp at a constant distance	**(5)**

Question Number	Answer	Additional Guidance	Mark
3(c)	An explanation that includes two of the following: • to absorb (light of) different wavelengths (1) • (so that) **more** wavelengths can be used (in photosynthesis) (1) • to protect chlorophyll from damage caused by absorbing too much light (1)	Ignore refs to phytochromes Accept a range of wavelengths can be absorbed Allow captured for absorbed Accept more light used (in photosynthesis) Allow faster rate of photosynthesis Allow because photosystems I and II use different wavelengths of light	**(2)**

(Total for Question 3 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)(i)	• $X^B X^B$, $X^B X^b$, $X^b X^b$ (1)	Allow $X^b X^B$	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a)(ii)	• $X^B Y$, $X^b Y$ (1)	Do not allow allele on Y chromosome	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(a)(iii)	An answer that includes the following: • 1 $X^B X^b$ (1) • 2 $X^B Y$ (1) • 3 $X^B X^b$ (1) • 4 $X^B X^b$ and $X^B X^B$ (1)	For 1,2,3 one correct genotype only gets the mark Must have 2 correct genotypes and no other	**(4)**

Question Number	Answer	Additional Guidance	Mark
4(b)(i)	An answer that includes the following • correct genotypes of both parents used **OR** correct genotypes of offspring given in genetic diagram (1) • correct ratio of phenotypes given (1)	Accept parents: X^RX^G and X^GY offspring: X^RX^G, X^GX^G, X^RY, X^GY Do not allow allele on Y chromosome for mp1 Accept 1:1:1:1 of females able to see red and green females able to see green males able to see red males able to see green Accept 25% of each category / ¼ of each category / 0.25 of each category	**(2)**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>4(b)(ii)</td><td>An answer that includes the following:

• correct genotype of mother (1)

• correct genotype of father (1)

• correct genetic diagram to produce offspring as described (female, sees red and green) and Male, sees red only)(1)</td><td>Accept X^RX^R

Accept X^GY

<table><tr><td></td><td>X^R</td><td></td></tr><tr><td>X^G</td><td>X^RX^G</td><td>(Female, sees red and green)</td></tr><tr><td>Y</td><td>X^RY</td><td>(Male, sees red only)</td></tr></table>
Do not allow allele on Y chromosome for mp2 and 3</td><td>(3)</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
4(b)(iii)	• more likely to be able to see {fruits / flowers / insects} (amongst leaves) / more likely to recognise poisonous {insects / fungi / snakes} (1)		**(1)**

Question Number	Answer	Additional Guidance	Mark
4(b)(iv)	A description that includes three of the following: • cut out gene (for required protein from human DNA) (1) • using restriction {enzyme / endonuclease} • introduce this gene to a vector (and transfer to retina of monkey) (1) • test the monkey for colour vision (1)	Ignore DNA ligase Allow {isolate / remove} for cut out Ignore desired characteristic Accept example of vector eg virus Accept appropriate process eg liposome wrapping / microinjection Ignore plasmid / gene gun	**(3)**

(Total for Question 4 = 15 marks)

Question Number	Answer	Additional Guidance	Mark
5(a)	A description that includes the following: • calibrate eyepiece graticule using stage micrometer (1) • measure (pollen tube) using eyepiece graticule (1)	 Accept description eg calculate how many EG units are in one stage micrometer unit / convert EG units into stage micrometer units Allow measure the pollen tube in eyepiece units	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	An answer that includes the following: • calculation of mean growth per hour (1) • calculation of mean growth per minute to 2dp (1)	Example calculation calculate mean per hour from 4 hour data 547 / 4 hours = 136.75 in 1 hour 136.75 divided by 60 = **2.28 (µm per minute)** Correct answer with no working gains full marks 1 mark for correct value to wrong dp	**(2)**

Question Number	Answer	Additional Guidance	Mark
5(b)(ii)	A description that includes three of the following: • if no calcium ions are present, pollen {grains / tubes} will not {germinate / grow} (1) • as concentration of calcium ions increases, (percentage) pollen tube germination increases (1) • above 300 mg dm^{-3}, increasing calcium ion concentration makes no difference to **initial** percentage germination (1) • as concentration of calcium ions increases (above 300 mg dm^{-3}) pollen tube {length increases / grows more} • most germination happens in the first hour / pollen tube growth is fastest in the first hour	Allow calcium nitrate for calcium ions Ignore limiting factors / optimum levels of $Ca(NO_3)_2$ Accept calcium ions are needed for pollen tube germination / growth Allow **rate** of pollen tube germination increases Allow above 300 mg dm^{-3}, increasing calcium ion concentration makes no difference to percentage germination in the first hour Accept as concentration of calcium ions increases (above 300 mg dm^{-3}) **rate** of pollen tube growth increases (1) Accept rate of pollen tube growth slows at higher levels of calcium nitrate	**(3)**

Question Number	Answer	Additional Guidance	Mark
5(c)	An answer that includes four of the following: • collect pollen from {one species of plant / same age anthers} (1) • (add pollen to) additional concentrations of calcium ions / measurements at {shorter / intermediate} intervals to record percentage germination / pollen tube length (1) • add sucrose (solution) of same concentration (1) • control temperature by keeping tubes in a {thermostatically controlled water bath / incubator} (1) • control pH by adding buffer to the tubes (1) • {use / measure} several grains (at each concentration) to calculate {mean / SD} values (for germination / growth rate / length) (1)	Allow named species Allow same plant / same source Accept add to solutions of calcium nitrate at concentrations of 0, 300, 400, 500 (mg dm^{-3}) / carry out at **each** concentration of calcium ions Allow observe each hour for 4 hours to record percentage germination / pollen tube length Ignore measuring growth Accept a maximum of 40°C (if given) Allow multiple grains / minimum 3 Ignore "repeat" unless qualified	**(4)**

(Total for Question 5 = 11 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)(i)	A description that includes two of the following: • set up a grid (5m by 10m) (1) • use random numbers as co-ordinates (1) • placement of quadrat to avoid bias e.g. edge parallel to named axis / bottom LH corner on co-ordinate point (1)	Allow description of 2 tapes at right angles to each other / forming axes **Do not allow** transect Ignore method of getting random numbers Allow random selection of numbered squares (in grid) **Do not allow** throwing quadrat	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(a)(ii)	An answer that includes four of the following: • all three methods tested {same size area / $5m^2$} (1) • {correct values calculated for each size of quadrat / correct mean number of dandelions calculated per $5m^2$ area} (1) • {$0.01m^2$ / smallest quadrat} gives an answer closest to actual value (1) • correct numerical reason given for choice (in context of $0.01m^2$) (1) • because smallest quadrat allows a more representative sample (1)	Accept that all three methods tested 10% of sampling area Accept description as part of calculation **In $50m^2$**: $1m^2$ quadrat gives 10 dandelions, $0.25m^2$ gives 30, $0.01m^2$ gives 60 / **In $1m^2$**: $1m^2$ quadrat gives 0.2, $0.25m^2$ gives 0.6, $0.01m^2$ gives 1.2 / **The mean number of dandelions in $5m^2$** is 5.3 Allow $0.01m^2$ is most accurate / most effective Accept 60 is closest to 53 / 1.2 is closest to 1.06 / 6 is closest to 5.3 Ignore 6 is closest to 53 Accept smallest quadrat tests a wider area	**(4)**

Question Number	Answer	Additional Guidance	Mark
6(b)	A description that includes the following: • number of species present (1) • number of individuals of each species (1)	Penalise amount once Allow species richness Allow population of each species Allow plants / organisms for individuals	**(2)**

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	• a group of {individuals / organisms} (with similar characteristics) that can interbreed to produce fertile offspring (1)	Accept reproduce Ignore mate viable	**(1)**

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	A description that includes two of the following: • gel electrophoresis (1) • detail of method chosen (1) • {look for similarities between the two banding patterns / compare the two banding patterns} (1) **OR** • DNA sequencing • detail of method chosen (1) • compare the two base sequences (using bioinformatics) / look for similarities between the two base sequences	eg use restriction enzymes to cut DNA into fragments / place fragments in wells on agarose gel / pass current through gel Accept if they are related the bands will be similar / the more similarities between the banding patterns, the more closely related they are Accept use of {taq / DNA} polymerase Accept the more similarities between the base sequences, the more closely related they are	**(2)**

(Total for Question 6= 11 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	A description that contains two of the following: • use {same / stated} mass of mung bean seeds (1) • use {same / stated} volume of water (1) • {same / standardised} germination conditions (1)	Allow weight for mass Ignore age / variety of beans Accept control of stated germination conditions eg temperature, light intensity, time If no other mark awarded accept make a single batch / stock solution to give to all students for 1 mark only	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	A description that includes two of the following: • zero the colorimeter with (distilled) water (1) • use an appropriate (green) filter (1) • ensure that cuvettes {are not scratched / have no fingerprints on them} (1)	Accept calibrate / reset for zeroing colorimeter Accept use of phenolphthalein phosphate Ignore reference solution Accept use same filter / fix the wavelength	**(2)**

Question Number	Answer	Additional Guidance	Mark
7(b)(i)	An explanation that includes three of the following: • (between 10 - 60°C / up to 60°C) as temperature increases activity of phosphatase increases (1) • as molecules have more kinetic energy (1) • so collisions between enzyme and substrate {are more likely to occur / occur more frequently} (1) • the optimum temperature is **<u>between 51 - 69°C</u>** (1) • {above optimum temperature / above stated temperature (60 - 80°C)} {<u>enzyme activity / rate of reaction</u>} decreases, as the active site {begins to change / changes} shape (1)	Accept converse in context of temp decreasing for mp1, 2 and 3 Ignore effect of temperature on absorbance of light Accept rate of reaction increases Accept enzymes / substrates /particles have more KE Accept enzyme-substrate complexes are more likely to form Accept more E-S complexes formed per unit time Accept above {optimum temperature / above stated temperature 60 - 80°C)} {<u>the enzyme activity / rate of reaction</u>} decreases, as enzyme {begins to be / is} denatured Ignore high temperature	**(3)**

Question Number	Answer	Additional Guidance	Mark
7(b)(ii)	An answer that includes the four of the following: • (add buffer to each tube of phenolphthalein phosphate) because pH may affect the {rate of reaction / enzyme activity} (1) • (place separate tubes containing phenolphthalein phosphate and enzyme into water baths before mixing together) so they {can come up to temperature / are at the same temperature} (1) • (use smaller temperature intervals than 10°C) so that the optimum temperature can be identified more precisely (1) • (stop the reaction before 20 minutes) so that an initial rate can be calculated (1)	Accept (extremes of) pH can denature enzyme / accept description of denaturation Accept reference to equilibration Accept ref to enzyme reaching required temperature Accept more accurately Ignore identified more easily Accept so that concentration of {reactants / substrates} is not limiting / so end product inhibition does not occur **Do not allow** concentration of enzyme decreases / enzymes used up Ignore refs to enzyme being denatured	**(4)**

Question Number	Answer	Additional Guidance	Mark
7(c)	An answer that includes the following: • one example given (1) • second example given (1)	e.g. synthesis of ATP synthesis of nucleotides / nucleic acids / named nucleic acid synthesis of phospholipids regeneration of ribulose bisphosphate phosphorylation of glucose (in glycolysis) synthesis of NADP Ignore photosynthesis / respiration / translation / protein synthesis / carbon fixation /	**(2)**

Total for Question 7 = 13 marks

Question Number	Answer	Additional Guidance	Mark
8(a)(i)	An answer that includes the following: There is no (significant) difference in the (mean) number of tar spots on leaves (from trees) near roads and trees {in parkland / far from roads} (1)	 Accept there is no difference in the (mean) number of tar spots on leaves from trees near roads and trees {in polluted and non-polluted areas} Ignore relationship / link **Do not allow** correlation	**(1)**

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)	An answer that includes the following: • calculation of x – xbar (1) • substitution of values (1) • calculation of t (1)	Example calculation 4.14 Accept - 4.14 Accept 3.06 / 1.10 / √4.16 / 2.04 **2.03 / 2.029** Accept minus 2.03 Correct answer with no working gains full marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(a)(iii)	An explanation that includes the following: • critical value is 2.05 (at p=0.05) (1) • calculated value (2.03) is less than critical value therefore accept the null hypothesis (1) • there is no **significant** difference between the tar spots {near the road and in parkland / in both places} (1)	Allow ecf for wrong calculated value from part ii for appropriate answers in mp2 and 3 Accept correct value indicated in table Accept 2.05 > 2.03 **Do not accept** - 2.03 < critical value Accept not enough evidence to reject H_0 Accept there is a **more than 5% probability** that the difference tar spots {near roads and in parkland / in each place} is due to chance. Ignore refs to p=0.1 and 0.01	**(3)**

Question Number	Answer	Additional Guidance	Mark
8(b)	An answer that includes two of the following: • select more than one tree in each area so that results are more {representative / repeatable} (1) • select {trees / leaves} using a random sampling method to avoid bias (1) • attempt to control another variable so that {distance from road is the only variable affecting number of tar spots / appropriate reason given / <u>for valid comparison</u>} (1) • {measure actual distance from road to ensure this is constant / select trees at different distance from road to test for a correlation}	Accept repeat in other places so that results are more representative / repeatable Ignore reference to valid / accurate / precise / calculation of mean Ignore increasing sample size / recording more leaves on same tree Accept select leaves of the same size, as bigger leaves could have more tar spots / measure the leaves to calculate number of spots per cm^2 No need to name variable. If variable named credit appropriate reason eg shading as {light / humidity} might affect development of spots height on tree as height may affect exposure to pollution Ignore time of day Accept measure levels of air pollution {as this may depend on how busy the road is / other appropriate reason / to test for a correlation}	**(2)**

(Total for Question 8 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
9(a)	An explanation that includes two of the following: • (vessels) {are empty tubes / do not contain cytoplasm or organelles} (1) • allowing free water movement / for a continuous column of water (1) Or • (walls contain) lignin (1) • so they are {strong / waterproof} (1) Or • lumen of vessel is narrow (1) • so that capillary forces are strong (1) Or • walls contain pits (1) • for lateral movement of water (1)	Accept hollow / no end {walls / plates} Ignore dead Ignore efficient Accept to withstand pressure Accept so water cannot escape Ignore support Accept sideways	**(2)**

Question Number	Answer	Additional Guidance	Mark
9(b)(i)	An answer that includes the following: • correct rate determined from graph to 1dp (1)	Example calculation $\frac{\text{Rate at 13 hours – rate at 5 hours}}{8}$ = **25.3** (g m^{-2} $hour^{-1}$) Accept answers in range 25.0 to 25.6 Correct answer with no working gains full marks	**(1)**

Question Number	Answer	Additional Guidance	Mark
9(b)(ii)	An explanation that includes three of the following: • transpiration is slow between {1-5 / 21-23} hours because {it is dark / no light available} (1) • because (most) stomata are closed (at night / in the dark / between {1-5 / 21-23} hours}) (1) • (rate of) transpiration increases between {3 / 5} and 13 hours as {{temperature / light intensity} increases / as stomata open} (1) • (rate of) transpiration is at a maximum at 13 hours as {light intensity / temperature} is {high / highest} (1) • (rate of) transpiration decreases after 13 hours as {light intensity / temperature} decreases (1)	Allow at night for time Allow up to 5 hours / any 2 values between 1 and 5 / any 2 values between 21 and 23 Allow after {3 / 5} hours transpiration increases as.....	**(3)**

Question Number		Additional Guidance	Mark
9(c)	An answer that includes five of the following: Answers may be expressed in various ways • Potometer B directly measures {water loss / transpiration} / Potometer A measures water uptake (1) • some water is used in photosynthesis (1) • {Potometer A uses cut shoot but Potometer B uses whole plant (with roots) / Potometer B (with roots) is more like the real situation} (1) • Potometer A can only be used for a short time, but B can be used over several days (1) • Potometer A – change in temperature can affect position of air bubble (1) • Potometer A – more likely to have errors in reading of results (1)	Accept water uptake in Potometer A may be affected by {cutting the shoot / air bubbles in xylem} Accept can get repeatable results (more quickly) with a Potometer A / can repeat (easily) Potometer B – loss of leaves / flowers / seeds from plant will affect mass Ignore mass due to {water on leaves / O_2 or CO_2 loss}	**(5)**

Question Number	Answer	Additional Guidance	Mark
9(d)(i)	An answer that includes the following: • **only** phloem shaded (1)	Allow one or more areas of phloem shaded	**(1)**

Question Number	Answer	Additional Guidance	Mark
9(d)(ii)	An answer that includes the following: • sucrose (1)	Ignore radioactive Ignore formula if given	**(1)**

(Total for question 9 = 13 marks)

Question Number	Answer	Additional Guidance	Mark
10(a)	An answer including at least one benefit and at least one difficulty **Benefits** • prevents habitat loss (1) • marine communities may contain species which are dependent on each other (all are protected) (1) • avoids problems of reintroducing species to the habitat (as in ex-situ conservation) (1) • increased education / public awareness (1) **Difficulties** • cannot control movement of animals in and out of protected areas / some marine animals migrate (1) • laws may restrict commercial or leisure activities currently taking place (1) • difficult to {monitor / police} (illegal activity underwater / at sea) (1) • difficult to monitor species (over large area) (1)	Allow prevents named damage to habitat / fishing Allow ref to food chains / webs protected Allow (stay in own habitat) so does not affect behaviour / less trauma /less vulnerable to disease Accept animals are still vulnerable outside the boundaries of protected area Accept named activities eg fishing, sailing, Allow people might not follow regulations Allow still affected by climate change / pollution from outside zone	**(4)**

Level	Marks	
0	0	No awardable content
1	1-3	Limited scientific judgement made with a focus on mainly just one method, with a few strengths / weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding, but with limited evidence to support the judgement being made.
2	4-6	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
3	7-9	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

	Answer
10(b)	**Level 1**: links information given to effect of seagrass **or** pilot study as below (up to 3 points from anywhere) **Level 2**: links information given to effect of seagrass **and** pilot study 4 marks – any combination of 4 points from E **and** B / P 5 marks – any combination of 5 points from E **and** B / P 6 marks – any combination of 6 points from E **and** B / P **Level 3**: links information given to effect of seagrass **and** benefits **and** problems of pilot study 7 marks – 7 points max 5 from E, plus at least one B **and** one P 8 marks – 8 points max 5 from E plus a total of three from B **and** P 9 marks – 9 points max 5 from E plus at least 2 from B **and** 2 from P **No credit for points lifted from information given without qualification eg *seagrass stores a lot of carbon.***

Indicative content

Effects of seagrass meadows - general (E points) Allow converse for loss of seagrass

- *Seagrass stores a lot of carbon*, which will slow or stop climate change / ref greenhouse effect / global warming / named effect
- Seagrass removes CO_2 from seawater reduces ocean acidity
- *Seagrass protects coastal areas from erosion*, preventing flooding
- *Seagrass protects coastal areas from erosion*, prevents damage to coastal habitats or property / link to reduced biodiversity
- *Seagrass acts as a nursery for young fish*, increasing fish stocks – any relevant benefit eg to humans
- *Seagrass acts as a nursery for young fish* – any relevant benefit eg to food chains / niche
- *Seagrass meadow habitat supports a range of species* increasing / maintaining biodiversity
- Seagrass produces oxygen (in seawater) when photosynthesising, benefits other species

Benefits of Wales pilot study (B points) - this is not benefits of seagrass, which are E points above

- small scale study to assess effects
- uses seeds from UK sites, so likely to be compatible with other species in the community
- different planting methods trialled to find the best method
- is restoring a seagrass meadow habitat (not making one in a new place), so does not damage other habitats
- increases local biodiversity by providing food / shelter for animals
- the newly planted area should be protected by law / made an MPA / MCZ
- contributes to knowledge about restoring seagrass meadows / research
- benefit of method eg *bags are biodegradable* so won't pollute ocean (up to 3 points)
- action needed because seagrass is threatened / declining / endangered

Problems with Wales pilot study – could be described as improvements (P points)

- very small area being planted (only *2 hectares*) so may not be representative / will not make a big difference
- removal of seeds from other UK sites may damage viability of these sites
- uses seeds from other UK sites, so may not be compatible with other species in the community
- very low success rate (only *4% successful germination*), allow comment on time **and** success rate eg long time to have effect / only 8 months data
- very labour intensive – *seeds collected by hand by divers* – so hard to replicate on a large scale / time-consuming.
- problems that caused decline of seagrass meadows still exist eg pollution from agricultural run-off / dredging – humans need to change
- problem with method eg ropes / pegs might damage marine life (up to 3)
- should protect the existing seagrass meadows

Total for Question 10 = 13 marks

Question Number	Answer	Additional Guidance	Mark
11(a)(i)	An answer that includes the following: • correct conversion of dilution factor (1) • correct number of bacteria calculated, given in standard form (1)	Sample calculation (126 x 10^3 gives) **126 000 / 1.26 x 10^5 / 1.3 x 10^5** **Accept** (13 x 10^4 =) 130 000 / 1.3 x 10^5 (1 x 10^5 =) 100 000 / 1 x 10^5 **Accept mean value** ie 128 000 / 1.28 x 10^5 / 1.3 x 10^5 118 667 / 1.19 x 10^5 / 1.2 x 10^5 (126 000 x 2 =) **2.52 x 10^5 / 2.5 x 10^5 (per cm^3)** Accept (130 000 x 2 =) 2.6 x 10^5 (100 000 x 2 =) 2 x 10^5 (128 000 x 2 =) 2.56 x 10^5 / 2.6 x 10^5 (118 667 x 2 =) 2.37 x 10^5 / 2.4 x 10^5 Correct answer with no working gains full marks Correct answer not in standard form gets 1 mark 252 000 / 260 000 / 200 000 / 256 000 / 237 334	**(2)**

Question Number	Answer	Additional Guidance	Mark
11(a)(ii)	An explanation that includes four of the following: • {lag phase / 0 to 1.3 hours} **increase is slow** as {bacteria are adjusting to conditions / enzymes are being synthesised / cells increase in size} (1) • {log phase / 1.3 to 4.7 hours} **increase is** {**exponential / very rapid**} as conditions are ideal for bacteria (1) • {stationary phase / 4.7 to 9.7 hours} number of bacteria remains **constant** because {{nutrients / named nutrient} begin to run out / toxins start building up / pH decreases} (1) • {death phase / 9.7 hours to 11 hours} number of bacteria **decreases** (as they die) due to build up of {toxins / waste products}	Accept very little change in numbers Allow acclimatise Accept nothing slowing down division competition is not too high named example of ideal conditions (eg nutrients) Accept {number of new cells formed / reproduction rate} is equal to {number of cells dying / death rate} for constant Allow competition for resources Ignore birth rate = death rate Accept death rate greater than reproduction rate for decreases Accept {build-up of carbon dioxide / decreased pH / lack of nutrients} (causes cell death)	**(4)**

Question Number	Answer	Additional Guidance	Mark
11(a)(iii)	An answer that includes the following: • correct substitution of values into equation (1) • correct calculation of *k* **to 2dp** (1)	Example of calculation $\frac{5.01 - 2.6}{3.4 \times 0.301}$ **2.35** Correct answer to wrong number of dp gets 1 mark Ignore units Correct answer with no working gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
11(a)(iv)	An answer that includes the following: • correct calculation of *g* (1)	Example of calculation Allow ecf from 11(a)(iii) $g = \frac{60}{2.35}$ = 25.53 / 25.532 / 25.5 Accept maximum of 3dp	**(1)**

Question Number	Answer	Additional Guidance	Mark
11(b)	An answer that includes four of the following: **Serial dilution and plating** • allows calculation of {viable / living} bacteria (1) • gives a direct {cell count / number of bacteria} (1) • allows different types of bacteria to be identified (1) • does not need expensive equipment **Measurement of turbidity using colorimeter** • {is relatively easy to carry out / does not require a lot of resources} (1) • results are available immediately (1) • is less likely to be affected by {random / measurement} error (1) • is less likely to be contaminated during process (1)	**Credit maximum of 3 from each** Accept allows death phase to be counted more accurately / allow the identification of the stationary and death phases Accept does not depend on calibration using another method eg using a haemocyometer eg colorimeter Accept faster Accept human error	**(4)**

(**Total for Question 11 = 13marks)**

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