Pearson Edexcel

# Mark Scheme (Results)

## Summer 2024

Pearson Edexcel Advanced Level GCE
In Biology B (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 V3 | Additional Guidance | Mark |
|---|---|---|---|
| **1(a)** | An answer that includes the following<br><br>• meristem (1) | | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)(i)** | An answer that includes the following:<br><br>• to {break down middle lamella / break down pectins / separate layers of cells} (1) | Accept calcium pectate<br>separate cells | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)(ii)** | An answer that includes the following:<br><br>• to make the {chromosomes / DNA} visible (1) | Accept to dye / colour the chromosomes / DNA | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(b)(iii)** | An answer that includes the following:<br><br>• to form a single layer of cells (1) | Accept to separate layers of cells / form a thin layer of cells | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **1(c)** | An answer that includes the following:<br><br>• number of actively dividing cells counted (1)<br><br>• mitotic index calculated to 1dp (1) | <br><br>4<br><br>10.3<br><br>Correct answer with no working gains full marks | **(2)** |

**(Total for Question 1 = 6 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)(i)** | An explanation that includes the following:<br><br>• (urea moves) from {blood vessel / capillaries / glomerulus / blood} into capsule (1)<br><br>• by ultrafiltration (1) | <br><br>Accept description of high blood pressure forcing {urea / small molecules} into capsule for mp1 and 2<br><br>Accept due to high blood pressure / hydrostatic pressure | **(2)** |

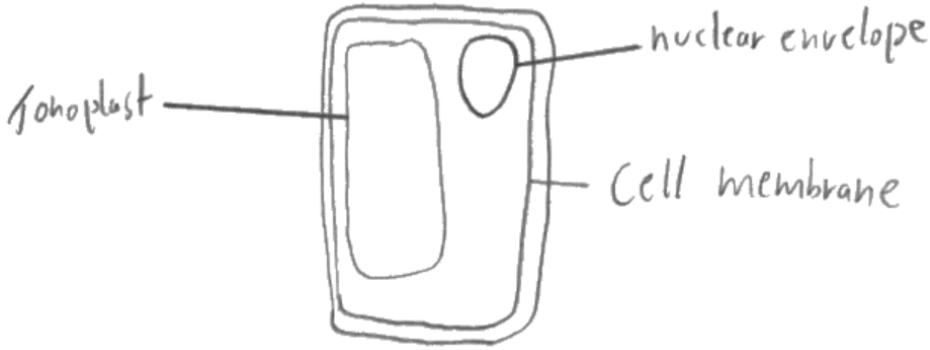
| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(a)(ii)** | An explanation that includes three of the following:<br><br>• concentration of ions is higher {outside nephron / in medulla} (than inside nephron) (1)<br><br>• water moves out of {descending limb / collecting duct} (1)<br><br>• by osmosis (1)<br><br>• (loop of Henle acts as a) countercurrent multiplier (1) | Accept causes lower water potential outside / higher water potential in nephron<br>Accept lowers the water potential in the medulla<br>Accept correct ref to hypertonic / hypotonic<br>Accept interstitial fluid for fluid in medulla<br>Accept concentration of sodium ions is highest at the bottom of the loop<br><br>Accept down a water potential gradient / from high to low water potential<br><br>Accept concentration (of urine) increases <u>along length of loop of Henle</u> | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(i)** | • correct ratio determined (1) | 3.9 : 2 : 1<br><br>Accept 4 : 2 : 1<br>3.93 : 2 : 1<br><br>Accept numbers in any order if qualified | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(ii)** | An explanation that includes two of the following:<br><br>• nephron has (relatively) long loop of Henle (1)<br><br>• so {long(er) distance for gradient to build up / (fluid in) medulla can become (more) concentrated / large(er) gradient can build up} / greater countercurrent multiplier effect (1)<br>OR<br>• thick medulla compared to cortex (1)<br>• as loops of Henle are longer (1)<br>OR<br>• highly folded cell membrane around (epithelial) cells lining nephron (1)<br>• so large(er) surface area for absorption (1)<br>OR<br>• high numbers of mitochondria in (epithelial) cells lining nephron (1)<br>• so (more) ATP for active transport (1) | Accept large numbers of juxtamedullary nephrons / thin descending loop of Henle is relatively long<br><br>Accept many ions can be pumped out (due to long length)<br><br>Accept mitochondria (in epithelial cells) have many cristae | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **2(b)(iii)** | {hide in burrows during the day / nocturnal / feed at night / leave burrows for a short time only} (1) | | **(1)** |

**Total for Question 2 = 9 marks**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(i)** | An answer that includes the following<br><br>• drawing of cell containing cell wall, vacuole and nucleus (1)<br><br>• three membranes correctly labelled (1) |  <br>Shape of cell does not matter – can include other structures<br>Do not accept chloroplasts<br><br>eg tonoplast, cell (surface) membrane, nuclear membrane / envelope, ignore mitochondrial / Golgi / chloroplast membrane | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(a)(ii)** | An answer that includes the following<br><br>• phospholipid bilayer (1)<br><br>• proteins embedded / protein channels (1) | <br><br><br>Accept integral / intrinsic / carrier proteins<br>Accept correct detail of named organelle membrane | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(i)** | A description that contains two of the following:<br><br>• as temperature increases <u>absorbance</u> increases (until 50C) (1)<br><br>• increase is greatest between 40°C and 50°C (1)<br><br>• (absorbance) {levels off / plateaus} {at / above} 50°C (1) | Ignore permeability<br><br>Accept converse<br>Accept positive correlation between absorbance and temperature increase<br><br>Accept increase is sigmoid / not linear<br><br>Ignore mean is lower at 60°C | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(b)(ii)** | An explanation that contains **one of the following**:<br><br>• increasing temperature causes increased permeability (1)<br><br>• betalain (molecules) can pass through the {tonoplast / cell membrane} if it is {disrupted / gaps form} (1)<br><br>**and one from:**<br><br>• as temperature increases membrane becomes more fluid (1)<br><br>• above 40°C proteins in the membrane are denatured (1) | Accept pigment for betalain<br><br>Accept betalain (molecules) cannot pass through the {tonoplast / cell membrane} unless it is disrupted<br><br>Accept as temperature increases membrane is disrupted<br><br>Accept at <u>higher</u> temperatures proteins in the membrane are denatured<br><br>Ignore references to enzymes | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **3(c)** | An answer that includes four of the following:<br><br>• less than 20cm$^3$ water in boiling tube (1)<br><br>• different beetroot used (1)<br><br>• beetroot pieces may be longer than 1cm (1)<br><br>• beetroot pieces may not have been rinsed (1)<br><br>• beetroot pieces may have been left in tubes longer than 20 minutes (1)<br><br>• tubes may have been shaken (1)<br><br>• example of incorrect use of colorimeter (1) | **Answers must be consistent with higher absorbance ie directional**<br><br>Accept ref to slanted ends / larger surface area<br><br>Ignore blotted dry<br><br>Accept left for in tubes for too long<br><br>Accept cylinder may have been damaged / squeezed as it was removed from tube<br><br>Accept cuvettes scratched / have fingerprints<br>incorrect filter used<br>colorimeter not zeroed | **(4)** |

(**Total for Question 3 = 12 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)(i)** | A description that includes five of the following: | | |
| | • find mass of woodlice (1) | Allow same / stated mass | |
| | • {description / diagram} of respirometer (1) | Accept description of basic respirometer<br>or detail of method eg way of keeping woodlice away from soda lime | |
| | • with {sodium hydroxide / potassium hydroxide / soda lime} (to absorb carbon dioxide) (1) | | |
| | • measure distance moved by liquid in stated time (1) | Allow time to move fixed distance | |
| | • method of control of temperature (1) | Accept thermostatically controlled waterbath<br>Accept control tube described (to compensate for changes in temperature / air pressure) | |
| | • method of finding volume of oxygen used (1) | Accept volume of air needed to reset liquid to original position if syringe used / use of $\pi r^2 d$ | |
| | • method of calculation of rate (1) | Accept volume of oxygen used divided by time divided by mass<br>Accept units ie $mm^3\ min^{-1}\ g^{-1}$<br>Accept finding the gradient on a graph | **(5)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(a)(ii)** | An answer that includes the following:<br>**One from**<br>Safety<br>• soda lime is corrosive, so wear gloves / goggles (1)<br>• {allergy to woodlice / they may have bacteria on them} so wear gloves (1)<br>• glassware may break, so wear gloves (1)<br><br>**And one from**<br>Ethics<br>• avoid harm to woodlice by {handling carefully / handling with a paintbrush / handling with a teaspoon / returning to garden} (1)<br>• woodlice may be harmed by soda lime, so make sure they are separated from it eg {gauze / small bag} (1)<br>• woodlice might use all the oxygen in the respirometer so refresh the air (1) | Accept harmful / toxic / irritant<br><br>Accept avoid reducing population by returning woodlice to garden (once investigation is over) (1) | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)(i)** | A explanation that includes the following:<br><br>Test<br>• chi squared (1)<br><br>Reason<br>• {used to compare observed and expected frequencies / we are investigating the distribution of a single categoric variable} (1) | Accept to compare observed and expected data / values | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)(ii)** | An explanation that includes the following:<br><br>• (woodlice prefer dark conditions as) more likely to be {humid / damp} so woodlice less likely to lose water (1)<br><br>• (woodlice prefer) damp so can absorb oxygen (more) effectively (when gills are damp) (1) | Accept less likely to be eaten by predators<br><br>Accept gas exchange for absorbing oxygen | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **4(b)(iii)** | A description that includes three of the following:<br><br>• set up choice chamber in advance (1)<br><br>• leave woodlice for longer than 5 minutes (1)<br><br>• ensure all woodlice are the same species (1)<br><br>• use more woodlice (than 5 / 20) (1)<br><br>• {take a photograph and analyse that to count numbers / statement of how to deal with woodlice on boundary} (1) | Accept clean chamber between trials to remove scent trails | **(3)** |

(**Total for Question 4 = 14 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(i)** | A description that includes the following:<br><br>• correct ratio (3:1) (1)<br><br>• {correct volume of stock solution and water / make up other volumes in correct ratio and use 10cm$^3$} (1) | Accept any correct eg 15 cm$^3$ and 5 cm$^3$<br><br>7.5 cm$^3$ stock and 2.5 cm$^3$ water<br><br>Accept 7.5 cm$^3$ stock and make up to 10 cm$^3$ (using measuring cylinder / volumetric flask) | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(ii)** | An answer that includes the following:<br><br>• axes correctly orientated and labelled with units (1)<br><br>• all values accurately plotted on linear scale (1)<br><br>• scattergraph with straight line joining points (1) | Must be <u>Mean</u> % of plasmolysed cells<br><br>Allow tolerance of half a small square | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(iii)** | An answer that includes the following:<br><br>• correct value for 50% plasmolysis (1) | 0.37 (mol $dm^{-3}$)<br>Accept range of 0.36 – 0.38 | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(iv)** | An answer that includes the following:<br><br>• correct value for 0.37 mol $dm^{-3}$ (1) | **Allow ecf from 5aiii**<br><br>- 980 (kPa)<br>(+ or – 20 of any value which matches their answer to 5aiii)<br>Do not accept + values | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(v)** | An answer that includes:<br><br>water potential = turgor pressure + osmotic potential (1) | Accept $\Psi = P + \pi$ $\Psi = \Psi_P + \Psi_S$<br><br>Accept solute potential for osmotic potential | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(a)(vi)** | An answer that includes the following:<br><br>• correct value for water potential (1) | **Allow ecf from 5aiv**<br><br>- 980 (kPa) | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **5(b)** | An explanation that includes the following:<br><br>• (tissue collected from same onion) as different onions may have (cell sap with a) different {osmotic / solute} potential (1)<br><br>• (all tubes kept in waterbath) as temperature affects rate of osmosis (1)<br><br>• (count more than one field of view) as it may not be representative (1) | Accept different onions may have (cells with) different water potential<br><br>Accept correct directional answer eg as temperature increases, rate of osmosis increases<br><br>Accept to increase sample size<br>to calculate standard deviation<br>to identify outliers / anomalous results | **(3)** |

**Total for Question 5 = 12 marks**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(i)** | A explanation that includes two of the following:<br><br>• <u>rate</u> of photosynthesis is {high / higher / highest} in {white light / with no filter} / (1)<br><br>• because the {chlorophyll / plant} is able to absorb more (wavelengths of) light when no filter is present (1)<br>,<br><br>• so more {GP / GALP / glucose / amino acids / cellulose / ATP} is made<br>OR<br>more glucose allows faster respiration<br>OR<br>so mitosis occurs more rapidly producing daughter plants (1) | Accept converse for red and blue filters<br><br>Accept <u>rate</u> of photosynthesis is slower in red or blue light / with red or blue filters<br><br>Accept pigments / other named pigments<br>Accept {red filter does not transmit {blue / green} light / blue filter does not transmit {red / green} light so less light for chlorophyll / plant to absorb<br><br>Accept “products of light independent stage” | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(ii)** | An answer that includes two of the following<br><br>• higher light intensity (1)<br><br>• higher temperature (1)<br><br>• higher concentration of carbon dioxide (1)<br><br>• add {fertiliser / more mineral ions} (1) | Accept move lamp closer<br><br>Accept place heater in tank<br><br>Accept add sodium hydrogen carbonate / bubble carbon dioxide through water | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(iii)** | An answer including one of the following<br><br>• plants may overlap (so difficult to count) (1)<br><br>• {frond / plant} size may vary (so not comparable) (1)<br><br>• (when budding is occurring it is) hard to tell when one plant becomes two (1) | Ignore difficult to count unqualilfied | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(a)(iv)** | A description including two of the following<br><br>• measure mass of plants (1)<br>• detail of technique eg blotting dry / use of replicates and dry mass (1)<br><br>OR<br>• measure surface area covered (1)<br>• detail of technique eg use of squared paper, or photograph (1)<br>OR<br>• measure root length (1)<br>• detail of technique eg use of calipers / straighten root (1) | <br><br><br><br><br><br>Accept estimate % cover<br>Accept use of quadrat / grid<br><br><br>Accept plant length | **(2)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(b)** | An explanation that includes three of the following<br><br>• as fertiliser concentration increases, {mitosis / cell division / growth} increases (1)<br><br>• because nitrate is needed to make {amino acids / proteins / enzymes / DNA / RNA / chlorophyll} (1)<br><br>• because phosphate is needed to make {nucleic acids / DNA / RNA / ATP / ADP / NADP / phospholipid} (1)<br><br>• because magnesium is needed to make chlorophyll (1) | Accept positive correlation<br>Accept more fertiliser / higher mass of fertiliser | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **6(c)** | An answer that includes **a maximum of three of the following**:<br>Positives<br>• removes excess minerals from the water (1)<br>• rapid growth rate so large amounts of animal feed produced (1)<br>• cheap (as it uses waste products) (1)<br>• floats so not shaded by manure in water (1)<br>• error bars do not overlap, so concentration affects growth (1)<br>**and a maximum of three of the following:**<br>Negatives<br>• need a large surface area to grow it (as it floats in a single layer) (1)<br>• needs a warm temperature for rapid growth (1)<br>• very high levels of minerals may inhibit growth of duckweed (1)<br>• duckweed may be killed by pollutant chemicals in water (1)<br>• duckweed may have negative effects on other aquatic life (1)<br>• error bars are large so good growth not certain (1)<br>• animal feed may be contaminated with bacteria (1) | Accept duckweed removes pollutants<br>Accept large amounts of animal feed produced in a short time<br>Accept idea of renewable / recycling / sustainable<br>Accept would have to be grown indoors in the winter<br>Accept not all required minerals may be present / not right ratio<br>Ignore pH<br>Accept relevant example of effect<br>Accept causing disease | **(4)** |

(**Total for Question 6 = 14 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(a)** | An answer that includes six of the following: | | |
| | • suitable method of making root extract (1) | eg grind / liquidise with sterile water and filter | |
| | • method of controlling concentration (1) | eg known mass in known volume of water | |
| | • suitable method of growing bacteria (1) | eg on agar plates or in broth / liquid growth medium | |
| | • suitable method of applying extract (1) | eg on filter paper discs / in wells in agar or as liquid to nutrient broth / accept turmeric in agar | |
| | • carried out with and without turmeric (1) | accept compared with water / solvent used<br>Ignore different concentrations as long as one is 0 | |
| | • suitable {time / temp} for incubation (1) | Accept 24-72 hours / temperature at or below 30°C | |
| | • method of collecting results (1) | eg diameter / area of clear area on agar<br>eg liquid method eg haemocytometer / turbidity in colorimeter<br>Accept counting colonies if turmeric in agar | |
| | • use of suitable stats test to test hypothesis (1) | eg t-test<br>Accept use of replicates to calculate SD | |
| | • description of aseptic technique (1) | | **(6)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **7(b)** | An answer that includes **a maximum of four** of the following:<br><br>• small number of patients in trial (1)<br><br>• short duration of trial (1)<br><br>• limited range of ages involved in trial (1)<br><br>• not a double-blind study (1)<br><br>• measurement of pain is subjective (1)<br><br>**and up to four** of the following:<br>• relevant comment on pain reduction (1)<br><br>• relevant comment on side effects (1)<br><br>• relevant comment on overall outcome (rated by doctors) (1)<br><br>• relevant comment on weight loss (1) | Accept people with complex conditions excluded<br><br>Accept patients knew which treatment they were getting / patients may have been biased<br><br>eg very little difference between treatments<br><br>eg curcumin had fewer side effects<br><br>eg very little difference between treatments<br><br>eg curcumin causes weight loss<br>eg weight loss will improve symptoms / not good if person already underweight | **(6)** |

(**Total for Question 7 = 12 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(a)** | There is no correlation between the (mean) abundance of {celandine plants / *Ficaria verna*} and the distance from the path. (1) | Accept these plants | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(b)(i)** | • calculation of $\sum d^2$ (1)<br>• calculation of intermediate step (1)<br>• calculation of $r_s$ to **3 sf** (1) | example of calculation<br>$\sum d^2 = 236$<br>$\frac{6 \sum d^2}{n(n^2 - 1)} = 1.967$<br>$r_s$ = (-) 0.967<br>correct answer with no working gains full marks | **( 3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(b)(ii)** | An answer that includes the following:<br><br>• critical value is 0.700 (1)<br><br>• calculated value (0.967) is greater than the critical value, therefore reject the null hypothesis (1)<br><br>• there is a **significant** (negative) correlation between distance from the path and abundance of celandine plants. (1) | Accept correct value indicated in table<br>Accept 0.833<br><br>Allow ecf from 8bi for wrong calculated value<br>Do not allow minus 0.967< critical value<br><br>Accept observed correlation between abundance of celandine plants and distance from path is not due to chance | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(c)(i)** | • suitable abiotic factor chosen (1) | eg<br>light intensity / humidity / temperature / soil pH / soil humus content / soil mineral content / soil water content | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(c)(ii)** | A description that includes the following points<br><br>• use of correct {equipment / method} (1)<br><br>• standardisation (1)<br><br>• location of samples (1) | eg use of probe / meter if appropriate.<br>eg collection of soil sample, weighing, heating and reweighing<br><br>eg sample at known depth / meter at known / same height above soil surface<br>Ignore time of day / year<br><br>eg sample at every position on the transect / at 1m intervals / smaller intervals | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **8(c)(iii)** | An explanation that includes the following:<br><br>• comment on how factor will vary <u>as distance from path increases</u> (1)<br><br>• correct explanation for why this factor will vary (1)<br><br>• comment on how this affects plant physiology (1)<br><br>• explanation of how this affects growth (1) | <br><br>{light intensity / temperature / pH} will decrease<br>{humidity / soil humus content} will increase<br>Accept {soil water / mineral content} will increase or decrease<br><br>eg {light / temperature / humidity} affected by shading from trees<br>soil humus increased due to decomposing leaf litter<br>soil minerals increase due to decomposing leaf litter or decrease as trees / (mycorrhizal) fungi take up more<br>soil pH decreased by decomposing leaf litter<br>soil water increased as less evaporation due to shading / more humus or decreased as trees take up more water.<br><br>eg light – reference to light dependent reactions of photosynthesis<br>temperature / pH – reference to enzyme-controlled reactions<br>humidity – reference to transpiration<br>water - reference to photolysis / mineral uptake / turgor pressure<br>minerals / humus – reference to uptake of nitrates etc<br><br>eg less photosynthesis, so less glucose / amino acids for growth<br>slower <u>named</u> enzyme-controlled reaction for growth<br>more minerals, so more amino acids / chlorophyll etc for growth | **(3)** |

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

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **9(a)** | An explanation that includes four of the following:<br><br>• dark moths were a result of (random) mutation (1)<br><br>• (in industrial areas) {dark moths are less likely to be {seen / eaten} (by predators) / light moths are more likely to be {seen / eaten} (by predators) (1)<br><br>• {dark moths have a selective advantage / light moths have a selective disadvantage} in industrial areas (1)<br><br>• dark moths are more likely to (survive and) breed, passing on (new) allele (1)<br><br>• allele frequency (for dark wing) increases (1) | Accept (random) mutation causes variation<br><br>Accept ref to camouflage / blending in for less likely to be seen<br>Ignore dark moths being eaten in rural areas<br><br>Allele for dark wing is advantageous in industrial areas<br><br>Accept allele frequency (for light wing) decreases | **(4)** |

*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.<br><br>Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures.<br><br>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.<br><br>Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures.<br><br>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.<br><br>Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.<br><br>The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. |

| | | |
|---|---|---|
| ***9(b)** | **L 1: up to three comments from any area**<br>**L 2: up to 6 comments from at least two areas**<br>**L 3: minimum of 6 comments, must be from 3 areas**<br><br>**Indicative content**<br>**Investigation 1: predation by birds**<br>• data supports natural selection because very visible moths were eaten<br>• better camouflaged moths not eaten<br><br>**Investigation 2: recapture of light and dark moths**<br>• data supports natural selection because in the industrial area, twice as many dark moths survived.<br>• this matches the data from the bird predation investigation<br>• in the rural area, almost three times as many light moths survived compared to dark moths<br><br>**Investigation 3: map data**<br>• data supports natural selection because non-industrial areas have mostly / all light-coloured moths<br>• example of non-industrial area fitting this pattern eg northern Scotland, Cornwall<br>• data supports natural selection because industrial areas have mainly / all dark-coloured moths<br>• example of industrial area fitting this pattern eg named suitable city / region<br>• data supports NS as prevailing winds blow air pollution to rural areas and affect numbers of moths + example<br>• relevant comment on change between 1950s and 1970s<br><br>**Confounding data:**<br>• Investigation 2 – light form survival % are the same in industrial and rural areas, so does not support<br>• if moths do not rest on tree trunks, camouflage against lichens is not relevant, so does not support<br>• bats are main predators + camouflage does not matter as bats hunt at night, so likely to eat equal numbers of both forms<br>• 1970s – changes in proportions of moths without changes in lichen cover, so does not support<br>• suggests it may be the pollution itself causing the change, not the camouflage<br>• No idea of sample size / SD<br>• Comment on mark recapture technique<br>• Assumes those not recaptured are eaten, but % recapture may not equal % survival<br>• other factors may be involved eg not just due to pollution affecting natural selection | Level 3 (comments from 3 areas)<br>7 marks 6 comments<br>8 marks 7 comments, including 1 confounding<br>9 marks 8 comments, including 2 confounding |

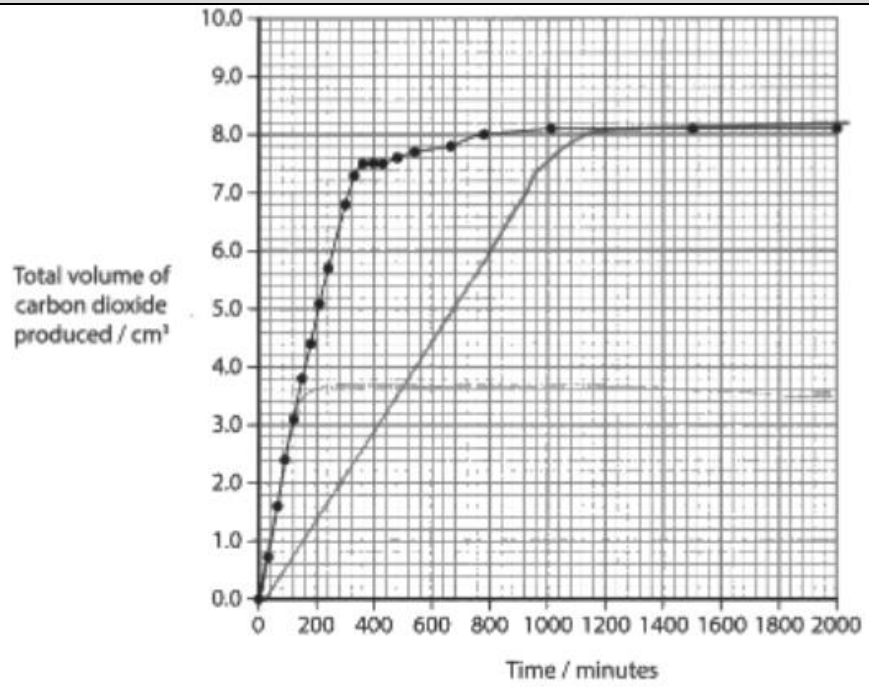
**(Total for Question 9 = 13 marks)**

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(a)(i)** | An answer that includes the following<br><br>• correct rate of respiration (1) | 0.03 ($cm^3$ $min^{-1}$) accept 0.028 – 0.032 | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(a)(ii)** | An explanation that includes the following:<br><br>• (yeast) can use sucrose to produce carbon dioxide (1)<br><br>• (yeast) cannot use lactose, so no respiration (1)<br><br>• because lactose cannot be broken down (1)<br><br>• {respiration stops / volume of carbon dioxide remains constant} because all {sucrose / substrate} has been used up (1) | Accept (yeast) can use sucrose to respire<br><br>Accept line levels off because all {sucrose / substrate} {has been used up / is a limiting factor} | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(a)(iii)** | An explanation that includes the following:<br><br>• lactase breaks down lactose to give glucose and galactose (1)<br><br>• yeast can use one of these (sugars) as a respiratory substrate (1)<br><br>• because volume of $CO_2$ is approx. half of that {expected / produced by sucrose} (1)<br><br>• rate of respiration at 400 minutes is close to zero as all {glucose / substrate} has been used up (1) | Accept yeast can respire using glucose /one of these sugars<br>Accept yeast cannot use one of them / galactose to respire<br><br>Accept because the volume of $CO_2$ has levelled out as all the {glucose / substrate} has been used up | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(b)** | An explanation that includes three of the following:<br><br>• at lower temperature, there will be less kinetic energy, so respiration **rate** is lower (1)<br><br>• because fewer enzyme-substrate collisions <u>per unit time</u> (1)<br><br>• respiration will continue until all of the {sucrose / substrate} is used up (1)<br><br>• so that {the same volume (of $CO_2$) is produced / (eventually) rate of respiration will reach zero} (1) | Accept at lower temperature, there will be less kinetic energy, so less $CO_2$ produced per unit time<br><br>Accept less ES complexes per unit time<br>Accept less frequent / likely collisions<br>Do not accept no ES collisions<br>Do not accept in context of enzyme denatured<br><br>(at a lower temperature) it will take longer for the {rate of respiration to reach zero / same volume of $CO_2$ to be produced} | **(3)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(c)(i)** | An answer that includes the following:<br><br>• line drawn to the right of existing line ie slower initial rate and reaching same final value (1) |  | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **10(c)(ii)** | An explanation that includes three of the following:<br><br>• (7g yeast / high concentration) more yeast cells present, so {carbon dioxide is produced faster / more carbon dioxide produced (at start) (1)<br><br>• (more yeast cells present), so more enzymes to {hydrolyse sucrose / carry out respiration} (1)<br><br>• final volume of $CO_2$ produced is the same for 7g and 3.5g yeast (1)<br><br>• because {mass / concentration} of {sucrose / substrate} is the same for both (1)<br><br>• line levels off sooner for 7.0g because sucrose is used up more quickly} (1)<br><br>• 3.5g yeast will produce half the rate of reaction compared to 7.0g yeast (1) | **All marking points must be comparative**<br>Accept converse for 3.5g yeast for all points<br><br>Accept more enzymes (for more yeast)<br>Accept more yeast cells so higher respiration rate<br><br>Accept line levels off sooner for 7.0g because rate of respiration is faster<br><br>Accept it takes twice as long for the line to plateau (with 3.5g yeast) | **(3)** |

**(Total for Question 10 = 14 marks**

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