HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.2 Carbohydrates

Mark scheme

TOTAL MARKS	QUESTIONS
60	9

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

Monosaccharides, disaccharides and glycosidic bonds 3.1.2

Question	Marking guidance	Mark	Comments
01.1	Disaccharide: Sucrose Monosaccharides produced: Glucose and fructose;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
01.2	$C_{12}H_{22}O_{11}$;	**1** (1 × AO2)	**Accept** atoms in any order **Reject** $C_{12}H_{24}O_{12}$ (water not removed)

Question	Marking guidance	Mark	Comments
01.3	1. Condensation; 2. Glycosidic (bond);	**2** (2 × AO1)	2. **Accept** 1-4 glycosidic (bond); this detail is not required **Reject** hydrolysis 2. **Reject** peptide, ester, phosphodiester or hydrogen bond

Question	Marking guidance	Mark	Comments
01.4	1. (Digestive) enzymes are specific OR no (digestive) enzyme has an active site complementary to lactulose, so lactulose is not hydrolysed (to monosaccharides); 2. Disaccharides/lactulose cannot cross the epithelium OR there are no carrier/transport proteins for lactulose (so only monosaccharides are absorbed); 3. Lactulose remains (as a solute) in the large intestine/colon, where water is normally absorbed; 4. Lowers the water potential of the contents of the intestine; 5. Water moves into the intestine (from cells/blood) by osmosis OR less water is absorbed from the intestine by osmosis;	**4 max** (1 × AO1) (3 × AO2)	1. **Accept** lactase has an active site complementary to lactose only/cannot bind lactulose because of its different shape 2. **Ignore** 'it is not absorbed' (restates the stem) unless a reason is given 3. **Ignore** 'stays in the intestine' (restates the stem) unless the large intestine/colon is named 1. **Ignore** 'not digested/broken down' without reference to hydrolysis or enzymes 4. **Reject** water concentration for water potential 5. **Accept** down a water potential gradient for by osmosis **Accept** bacteria in the large intestine hydrolyse lactulose, producing more solutes, as an alternative to marking point 3

Question	Marking guidance	Mark	Comments
02.1	Correct answer for 2 marks: 72 (%);; Accept for 1 mark: increase of 3.6 (mmol dm^{-3}) **OR** (8.6 − 5.0) ÷ 5.0	**2** (2 × AO2)	Plotted values: 5.0 at 0 minutes and 8.6 at 30 minutes **Accept** readings to within 0.1 mmol dm^{-3} of the plotted values, giving answers in the range 66 to 78 (%), for 2 marks **Reject** percentage of the final value, eg 3.6 ÷ 8.6

Question	Marking guidance	Mark	Comments
02.2	1. After sucrose, blood glucose rises faster and to a higher peak (8.6 compared with 6.8) OR after isomaltulose, blood glucose peaks later (45–60 minutes compared with 30 minutes) OR stays raised for longer; 2. Isomaltulose is hydrolysed more slowly (to glucose and fructose); 3. (Because the glycosidic bond is in a different position) isomaltulose fits the active site (of the enzyme) less well OR fewer enzyme–substrate complexes form; 4. So glucose is absorbed (into the blood) more slowly but over a longer time;	**3 max** (2 × AO2) (1 × AO3)	1. **Accept** isomaltulose is higher than sucrose from 60 minutes onwards 3. **Accept** isomaltulose is less complementary to the active site **Reject** isomaltulose is not hydrolysed/digested at all **Ignore** 'broken down' for hydrolysed

Question	Marking guidance	Mark	Comments
02.3	1. (Supports) after isomaltulose, blood glucose rises more slowly/has a lower peak (6.8 compared with 8.6 mmol dm^{-3}); 2. (Supports) after isomaltulose, blood glucose stays above the starting value for longer/is higher from 60 minutes (eg 6.2 compared with 5.2 at 90 minutes); 3. Blood glucose concentration is not a measure of energy release/respiration OR energy release was not measured; 4. Only 10 volunteers OR no spread of data/standard deviations shown, so we cannot tell if the difference is significant/real; 5. Only measured for 120 minutes OR blood glucose had not returned to the starting value after isomaltulose (5.6 mmol dm^{-3});	**3 max** (3 × AO3)	**Max 2** if only supporting points or only limitations are given **Accept** fructose is also produced but was not measured as a limitation **Ignore** 'fair test' unqualified

Polysaccharides: structure and function 3.1.2

Question	Marking guidance	Mark	Comments
03.1	Correct answer for 2 marks: 67 (%);; Accept for 1 mark: difference of 3.2 **OR** (4.8 − 1.6) ÷ 4.8	**2** (2 × AO2)	**Accept** 66.7 or 66.6 (%) for 2 marks **Reject** 33 (%) (GSD IV rate as a percentage of the healthy rate) **Reject** 300 or 200 (%)

Question	Marking guidance	Mark	Comments
03.2	1. (GSD IV) glycogen is less branched/has longer chains between branches (38 compared with 12 monomers); 2. So it has fewer (chain) ends; 3. The enzyme acts at the ends, so glycogen is hydrolysed more slowly OR fewer glucose monomers are released per minute; 4. Less glucose is released (from liver cells) into the blood (between meals);	**3 max** (3 × AO2)	2. **Accept** fewer sites for the enzyme to act on **Ignore** 'smaller surface area' **Reject** glycogen is not hydrolysed at all **Ignore** references to glucagon/insulin

Question	Marking guidance	Mark	Comments
03.3	A larger mass (of glycogen) would have more (chain) ends/substrate, so the rate would not depend only on the structure/branching (of the glycogen);	**1** (1 × AO3)	**Accept** so the only difference is the structure/branching of the glycogen **Accept** rate may not be proportional to mass, eg enzyme concentration may become limiting, so rates are only comparable for the same mass **Ignore** 'fair test' unqualified

Question	Marking guidance	Mark	Comments
04.1	β-glucose;	**1** (1 × AO1)	**Accept** beta glucose **Reject** glucose unqualified **Reject** α-glucose

Question	Marking guidance	Mark	Comments
04.2	Glycosidic bonds between monomers;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
04.3	Correct answer for 2 marks: 41 (%);; Accept for 1 mark: decrease of 570 **OR** (1400 − 830) ÷ 1400	**2** (2 × AO2)	**Accept** 40.7 or 40.71 (%) for 2 marks **Reject** 59 (%)

Question	Marking guidance	Mark	Comments
04.4	1. Cellulose molecules are long, straight/unbranched chains; 2. (Parallel) chains are held together by (many) hydrogen bonds; 3. Longer molecules form more hydrogen bonds each OR overlap with more other molecules; 4. Chains are grouped into (micro)fibrils; 5. So more force/energy is needed to separate the molecules/fibres OR greater strength/rigidity;	**3 max** (1 × AO1) (2 × AO2)	**Max 2** unless point 3 is given, ie the answer links greater length to more hydrogen bonds/overlap. Points 1, 2, 4 and 5 are interchangeable; no single one of them is required 2. **Reject** hydrogen bonds within one chain only, eg 'coiled and held by hydrogen bonds' 4. **Reject** myofibrils **Accept** alternate monomers rotated/inverted (180°) so chains are straight, for point 1

Question	Marking guidance	Mark	Comments
04.5	1. Supported: force needed decreases as the number of monomers (per molecule) decreases OR there is a positive correlation; 2. Correlation does not show cause OR other changes during recycling could reduce strength, eg fibres made shorter/damaged/fewer hydrogen bonds between fibres; 3. Only one batch of paper OR no repeats/spread of data OR no statistical test;	**2 max** (2 × AO3)	**Accept** a named other factor for point 2 **Ignore** 'more data needed' unqualified

Question	Marking guidance	Mark	Comments
05.1	1. Add iodine/potassium iodide (solution); 2. (Turns) blue-black/black/dark blue;	**2** (2 × AO1)	1. **Accept** iodine solution 1. **Reject** Benedict's solution 2. **Do not accept** 'blue' on its own 2. **Ignore** heating

Question	Marking guidance	Mark	Comments
05.2	1. Starch is a polymer of α-glucose, which is hydrolysed to glucose for respiration (when the seed germinates); 2. Starch is coiled/helical, so it is compact OR stores a lot of glucose in a small space; 3. Starch is branched, so it has many ends for (enzymes to) hydrolyse, releasing glucose quickly; 4. Starch is insoluble, so it does not affect the water potential of the cell/cause osmosis; 5. Starch is a large molecule, so it cannot leave/diffuse out of the cell; 6. Cellulose is made of β-glucose OR alternate monomers are rotated/inverted (180°) OR cellulose forms long, straight/unbranched chains; 7. (Parallel) cellulose chains are held together by (many) hydrogen bonds; 8. Cellulose chains form (micro)fibrils; 9. Cellulose gives the cell wall strength/rigidity, so it resists (turgor) pressure OR stops the cell bursting;	**6 max** (5 × AO1) (1 × AO2)	**Max 4** if only starch or only cellulose is described Each point must link the structure to the correct molecule 2. 'Compact' must be linked to coiling/helix 3. **Ignore** 'large surface area' for branching 6–9. **Credit** any of these; no single cellulose point is required **Credit** amylose and amylopectin, and 1-4 and 1-6 glycosidic bonds, when used correctly as part of a point. These terms are never required **Reject** cellulose is branched or coiled; reject starch contains β-glucose

Biochemical tests for carbohydrates 3.1.2

Question	Marking guidance	Mark	Comments
06.1	Sucrose;	**1** (1 × AO2)	Negative reducing sugar test, positive after acid hydrolysis, and no starch present

Question	Marking guidance	Mark	Comments
06.2	1. Heat with Benedict's (solution); 2. Red (precipitate/colour);	**2** (2 × AO1)	1. Heating must be stated. Accept boil OR heated/boiling water bath 1. **Ignore** 'water bath' unqualified; ignore 'warm' 1. **Reject** heating with acid 2. **Accept** green/yellow/orange/brown 2. A colour must be given; ignore 'precipitate' without a colour

Question	Marking guidance	Mark	Comments
06.3	1. Lactose is a reducing sugar; 2. Glucose and galactose (produced by hydrolysis) are also reducing sugars; 3. So a positive result would be obtained whether or not lactose is still present OR the test cannot tell lactose from its products;	**2 max** (2 × AO3)	**Reject** lactose is a non-reducing sugar (cancels point 1) **Ignore** references to sucrose

Question	Marking guidance	Mark	Comments
07	1. Heat a sample (of the drink) with Benedict's (solution) to test for reducing sugar; 2. Heat a second sample with (dilute) acid/HCl; 3. Neutralise (with an alkali), eg sodium hydrogencarbonate; 4. Then heat with Benedict's; 5. Use the same volume of drink and of Benedict's (solution) and the same heating time for both tests; 6. Dilute the drink OR use excess Benedict's (solution), so the Benedict's is not all used up/reduced by the glucose alone (and the two results can differ); 7. More (red) precipitate/colour further towards red/higher absorbance (with a colorimeter) after acid hydrolysis shows a non-reducing sugar is present; 8. (Because) the acid hydrolyses (glycosidic bonds in) the non-reducing sugar to (reducing) monosaccharides;	**5 max** (3 × AO1) (2 × AO3)	**Max 3** unless point 5, 6 or 7 is given Heating must be stated for points 1 and 4. Accept boil or heated/boiling water bath; ignore 'water bath' unqualified 2. **Reject** heating with acid in the reducing sugar test (point 1) 3. **Accept** named alkali, eg $NaHCO_3$/NaOH 7. **Reject** 'positive result after acid hydrolysis' on its own, because glucose is already present 8. **Accept** named product, eg glucose and fructose from sucrose **Accept** removing all reducing sugar first (repeat the Benedict's test and filter until no further precipitate forms), then hydrolysing the filtrate; a positive result is then valid for point 7

Separating and measuring sugars 3.1.2 (AT c, AT g)

Question	Marking guidance	Mark	Comments
08.1	1. X: lactose; 2. Y: maltose; 3. Z: sucrose/isomaltulose;	**3** (3 × AO2)	R_f values: X 0.24 and 0.32 (galactose and glucose); Y 0.32 (glucose only); Z 0.32 and 0.39 (glucose and fructose) **Max 2** if no working/R_f values or monosaccharides are shown If no disaccharide is correct, award 1 mark for all five R_f values correctly calculated **Accept** 0.387 for 0.39

Question	Marking guidance	Mark	Comments
08.2	Run the chromatogram (of Y) again in a different solvent (and see if the spot separates into two);	**1** (1 × AO3)	**Accept** two-way chromatography **Accept** use a longer plate/let the solvent run further so the spots separate more **Ignore** 'repeat the experiment' unqualified

Question	Marking guidance	Mark	Comments
09.1	4.0 (cm^3) glucose solution **and** 6.0 (cm^3) distilled water;	**1** (1 × AO2)	**Accept** 4 and 6

Question	Marking guidance	Mark	Comments
09.2	Correct answer for 2 marks: 500 (mmol dm^{-3});; Accept for 1 mark: reading of 5.0 (mmol dm^{-3}) from the curve **OR** correct reading × 100	**2** (2 × AO2)	On the plotted curve, absorbance 0.42 is at 5.0 mmol dm^{-3} **Accept** readings of 4.8 to 5.2, giving 480 to 520 (mmol dm^{-3}), for 2 marks **Reject** 5.0 for 2 marks (dilution not taken into account)

Question	Marking guidance	Mark	Comments
09.3	(Undiluted) nectar would give an absorbance/concentration above the range of the calibration curve OR above the highest standard (10 mmol dm^{-3});	**1** (1 × AO3)	**Accept** so that its concentration falls within the range of the glucose solutions **Accept** undiluted nectar would reduce all the Benedict's/Cu^{2+}, so Benedict's would not be in excess and the colour/absorbance would reach its maximum **Ignore** 'too concentrated' unqualified

Question	Marking guidance	Mark	Comments
09.4	1. The curve is less steep/levels off at high(er) concentrations OR above about 8 mmol dm^{-3}; 2. So a small change/error in absorbance gives a large change/range in the concentration read;	**2** (2 × AO3)	**Accept** use of figures, eg absorbance rises by 0.16 from 2 to 4 but only 0.10 from 8 to 10 mmol dm^{-3} **Accept** 'greater uncertainty' for 'less precise' **Ignore** 'reading is off the graph' **Ignore** suggestions to dilute the sample further (an improvement, not an explanation)

Question	Marking guidance	Mark	Comments
09.5	Benedict's solution reacts with all reducing sugars, so other reducing sugars in the nectar, eg fructose/maltose, would also increase the absorbance;	**1** (1 × AO3)	**Accept** the test is not specific to glucose **Accept** nectar contains coloured/cloudy substances that absorb light, and no nectar blank (without Benedict's) was used **Reject** sucrose as the other reducing sugar