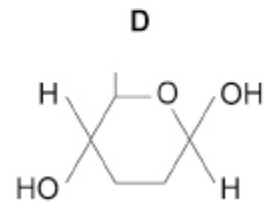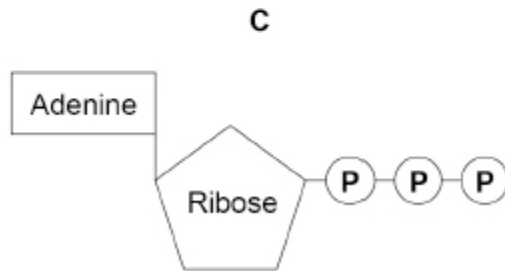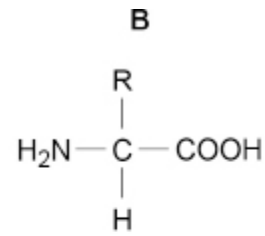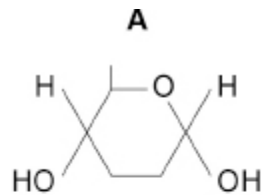# A-Level Biology

Carbohydrates

Question Paper

Time available: 76 minutes
Marks available: 60 marks

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1. The diagram below shows the structure of molecules found in organisms.

A

B

C

D

(a)   Complete the table below by putting the correct letter, **A**, **B**, **C** or **D**, in the box next to each statement. Each letter may be used once, more than once, or not at all.

Letter	Statement
	is a monomer in an enzyme's active site
	is a monomer in cellulose
	is produced during photosynthesis and respiration
	forms a polymer that gives a positive result with a biuret test

(4)

(b)   Raffinose is a trisaccharide of three monosaccharides: galactose, glucose and fructose. The chemical formulae of these monosaccharides are:

- galactose = $C_6H_{12}O_6$
- glucose = $C_6H_{12}O_6$
- fructose = $C_6H_{12}O_6$

Give the number of carbon atoms, hydrogen atoms and oxygen atoms in a molecule of raffinose.

Number of carbon atoms   _____

Number of hydrogen atoms   _____

Number of oxygen atoms   _____

(1)

(c)   A biochemical test for reducing sugar produces a negative result with raffinose solution.

Describe a biochemical test to show that raffinose solution contains a non-reducing sugar.

_____

_____

_____

_____

_____

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_____

(3)

(Total 8 marks)

2.   The diagram shows the structure of two α-glucose molecules.
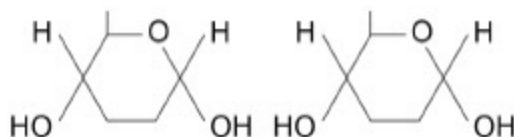
(a)   On the diagram, draw a box around one chemical group in each glucose molecule used to form a glycosidic bond.

(1)

(b) A precipitate is produced in a positive result for reducing sugar in a Benedict's test.
A precipitate is solid matter suspended in solution.

A student carried out the Benedict's test. Suggest a method, other than using a colorimeter, that this student could use to measure the **quantity** of reducing sugar in a solution.

_____

_____

_____

_____

_____

_____

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_____

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_____

_____

_____

(2)

In an investigation, a student wanted to identify the solutions in two beakers, **A** and **B**. She knew one beaker contained maltose solution and the other beaker contained glucose solution. Both solutions had the same concentration.

She did two separate biochemical tests on a sample from each beaker.

Test 1 – used Benedict's solution to test for reducing sugar.

Test 2 – added the enzyme maltase, heated the mixture at 30 °C for 5 minutes, and then used Benedict's solution to test for reducing sugar.

Maltose is hydrolysed by maltase.

The student's results are shown in the table below.

	Colour of solution after testing with Benedict's solution	
Beaker	**Test 1**	**Test 2**
A	red	red
B	red	dark red

(c)   Explain the results for beakers **A** and **B** in the table.

Beaker A _____

_____

_____

_____

Beaker B _____

_____

_____

_____

(2)

(d) Use of a colorimeter in this investigation would improve the repeatability of the student's results.

Give **one** reason why.

_____

_____

_____

_____

(1)

In **Test 1**, the student used a measuring cylinder to measure 15 cm^3 of solution from a beaker. The measuring cylinder gives a volume with an uncertainty of ±1 cm^3. She used a graduated syringe to measure 5.0 cm^3 of Benedict's solution. The graduated syringe gives a volume with an uncertainty of ± 0.5 cm^3. She mixed these volumes of liquid to do the biochemical test.

(e) Calculate the percentage error for the measurements used to obtain a 20 cm^3 mixture of the solution from the beaker and Benedict's solution. Show your working.

(2)

Answer = _____%

(Total 8 marks)

3. (a) What is a monomer?

_____

_____

_____

_____

(1)

(b)   Lactulose is a disaccharide formed from one molecule of galactose and one molecule of fructose.

Other than both being disaccharides, give one similarity and one difference between the structures of lactulose and lactose.

Similarity _____

_____

_____

_____

Difference _____

_____

_____

_____

_____

(2)

(c) Following digestion and absorption of food, the undigested remains are processed to form faeces in the parts of the intestine below the ileum.

The faeces of people with constipation are dry and hard. Constipation can be treated by drinking lactulose. Lactulose is soluble, but is not digested or absorbed in the human intestine.

Use your knowledge of water potential to suggest why lactulose can be used to help people suffering from constipation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(d) Lactulose can also be used to treat people who have too high a concentration of hydrogen ions (H^+) in their blood.

The normal range for blood H^+ concentration is 3.55×10^{-8} to 4.47×10^{-8} mol dm^{-3}

A patient was found to have a blood H^+ concentration of 2.82×10^{-7} mol dm^{-3}

Calculate the minimum percentage decrease required to bring the patient's blood H^+ concentration into the normal range.

Answer = _____

(2)

(Total 7 marks)

4. (a) Glycogen and cellulose are both carbohydrates.
Describe **two** differences between the structure of a cellulose molecule and a glycogen molecule.

1. _____

_____

_____

2. _____

_____

_____

(2)

(b) Starch is a carbohydrate often stored in plant cells.
Describe and explain **two** features of starch that make it a good storage molecule.
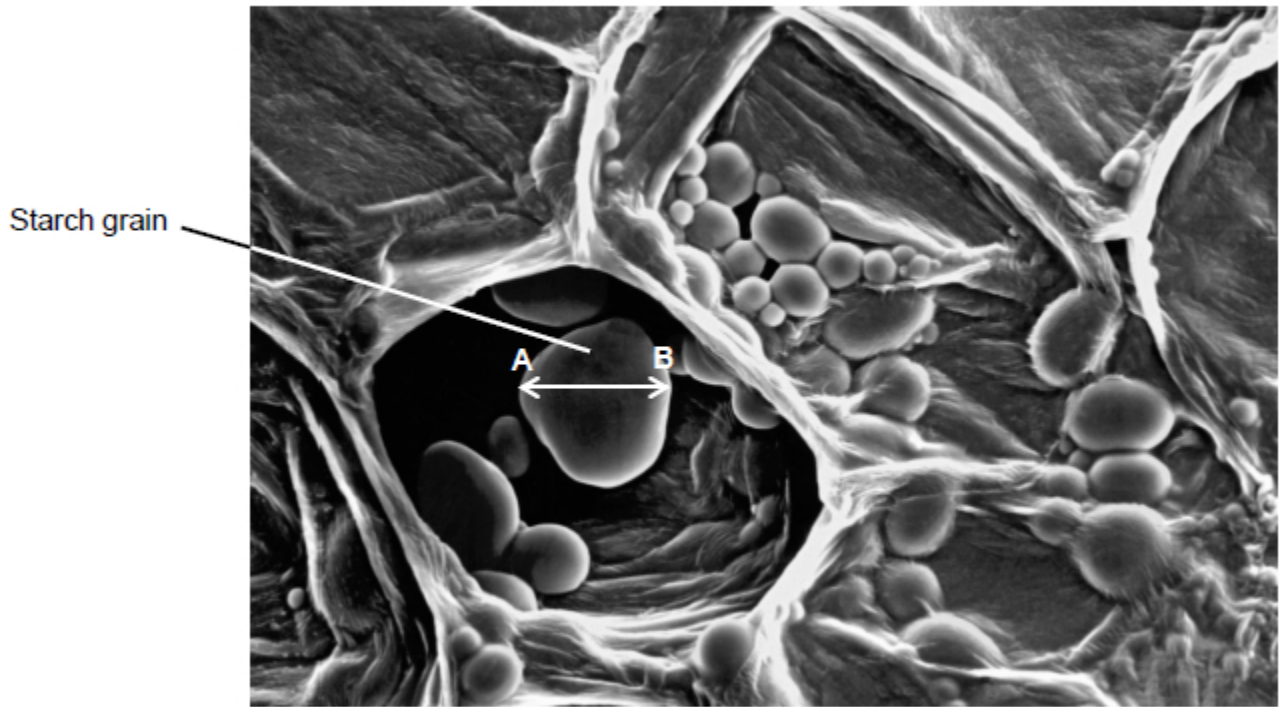
1. _____

_____

_____

2. _____

_____

_____

(2)

(c) Tick (✓) the box that identifies the test which would be used to show the presence of starch.

Acid hydrolysis test ☐

Benedict's test ☐

Emulsion test ☐

Iodine/potassium iodide test ☐

(1)

(d)   The diagram shows a section through a plant tissue at a magnification of ×500.

Starch grain

Calculate the actual diameter of the starch grain between points **A** and **B**.

Answer = _____ µm

(2)

(e)   What type of microscope was used to obtain the image shown in the diagram above?

Give **one** piece of evidence to support your answer.

Type of microscope _____

Evidence _____

(2)
(Total 9 marks)

5. In mammals, in the early stages of pregnancy, a developing embryo exchanges substances with its mother via cells in the lining of the uterus. At this stage, there is a high concentration of glycogen in cells lining the uterus.

(a) Describe the structure of glycogen.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(b) During early pregnancy, the glycogen in the cells lining the uterus is an important energy source for the embryo.

Suggest how glycogen acts as a source of energy.

Do **not** include transport across membranes in your answer.

_____

_____

_____

_____

_____

(2)

(c) Suggest and explain **two** ways the cell-surface membranes of the cells lining the uterus may be adapted to allow rapid transport of nutrients.

1. _____

_____

_____

2. _____

_____

_____

(2)

(d) In humans, after the gametes join at fertilisation, every cell of the developing embryo undergoes mitotic divisions before the embryo attaches to the uterus lining.

- The first cell division takes 24 hours.

- The subsequent divisions each take 8 hours.

After 3 days, the embryo has a total volume of 4.2×10^{-3} mm^3.

What is the mean volume of each cell after 3 days? Express your answer in standard form.

Show your working.

Answer = _____ mm^3
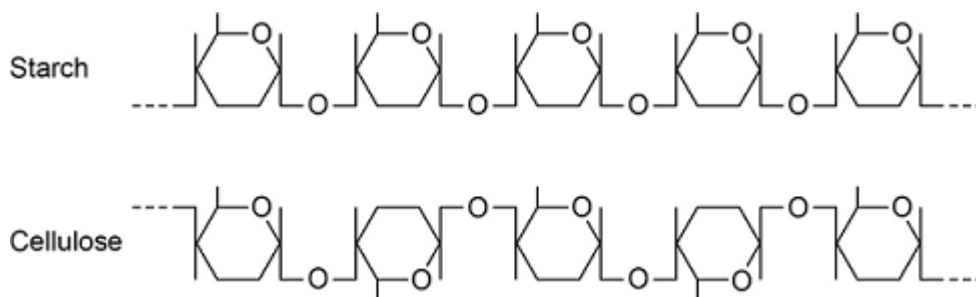
(2)

(Total 8 marks)

6. Starch and cellulose are two important plant polysaccharides.

The following diagram shows part of a starch molecule and part of a cellulose molecule.

(a)   Explain the difference in the structure of the starch molecule and the cellulose molecule shown in the diagram above.

_____

_____

_____

_____

(2)

(b)   Starch molecules and cellulose molecules have different functions in plant cells. Each molecule is adapted for its function.

Explain **one** way in which starch molecules are adapted for their function in plant cells.

_____

_____

_____

_____

(2)

(c)   Explain how cellulose molecules are adapted for their function in plant cells.

_____

_____

_____

_____

_____

_____

(3)
(Total 7 marks)

7.   (a)   What term is used to describe the different structures of α-glucose and β-glucose?

_____

(1)

(b)   A student investigated the difference in the reducing sugar content of two fruit juices. He performed a biochemical test on each fruit juice using Benedict's solution. He then used a colorimeter with each test result.

Describe how the results from the colorimeter can identify the fruit juice containing the higher sugar content.

_____

_____

_____

_____

(1)

(c)   The student controlled variables in the test using Benedict's solution.

Give **two** variables the student controlled.

1 _____

2 _____

(2)

(d)   Apples consist of flesh tissue which surrounds core tissue where the seeds are located.

A student has an apple with a mass of 180 g
The ratio of flesh tissue to core tissue in this apple is 5:1
8% of the whole apple is sugar.

Calculate the mass of sugar in the flesh tissue.

Show your working.

Answer _____ g

(2)

(e) Iodine solution stains fresh apple tissue black. When iodine solution is added to apples stored for a week, the stain is less black.

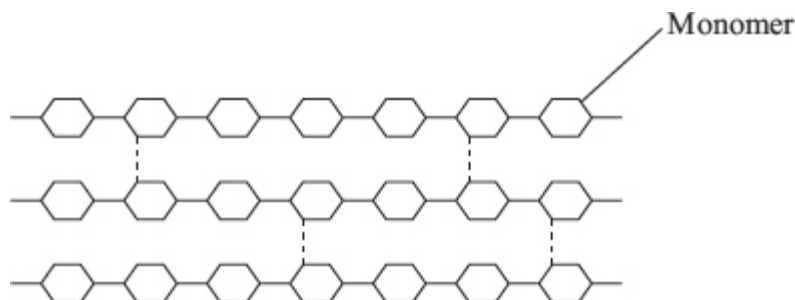The water potential of apple juice decreases when apples are stored.

Suggest why the water potential of apple juice decreases when apples are stored.

_____

_____

_____

_____

_____

_____

(2)
(Total 8 marks)

8. Cellulose is made from one type of monomer. The monomers are held together by bonds. The diagram shows parts of three cellulose molecules in a cell wall.

(a) Name the monomer present in cellulose.

_____

(1)

(b) Name the type of reaction that converts cellulose to its monomers.

_____

(1)

(c)   Cotton is a plant fibre used to make cloth. Explain how cellulose gives cotton its strength.

_____

_____

_____

_____

_____

_____

(3)
(Total 5 marks)