

AQA A-LEVEL • 7402

BIOLOGY



EXAM QUESTION PACK

3.1.7 WATER

SCORE

/45

PERCENTAGE

%

STEMUP

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Q1.

- (a) State **and** explain the property of water that can help to buffer changes in temperature.

(2)

- (b) Water is used to hydrolyse ATP.

Name the **two** products of ATP hydrolysis.

1. _____

2. _____

(1)

Hydrolysis of ATP is catalysed by the enzyme ATP hydrolase.

A student investigated the effect of ATP concentration on the activity of ATP hydrolase. She used shortening of strips of muscle tissue caused by contraction as evidence that ATP was being hydrolysed.

- She took four slides **A**, **B**, **C** and **D**, and added strips of muscle tissue of the same length to each slide.
- She then added the same volume of ATP solutions of different concentrations to the four slides and left each slide for five minutes.
- She then recorded the final length of each strip of muscle tissue.

Her results can be seen in the table.

Slide	Concentration of ATP solution added to slide / $\times 10^{-6} \text{ mol dm}^{-3}$	Final length of muscle tissue after 5 minutes / mm
A	2	36

B	4	31
C	6	29
D	8	26

- (c) Other than those given, name two variables the student should have controlled.

1. _____

 2. _____

(2)

- (d) Describe and explain the pattern shown by the data in the table.

Description

Explanation _____

(2)

- (e) The hydrolysis of 1 dm³ of a 1 mol dm⁻³ solution of ATP releases 30 500 J of energy.

60% of the energy released during the hydrolysis of 1 mol dm⁻³ of ATP is released as heat; the rest is used for muscle contraction.

The student added 0.05 cm³ of ATP solution to slide **D**.

Calculate the energy available from ATP for contraction of the muscle on this slide.

Answer = _____ J

(3)

(Total 10 marks)

Q2.

Water and inorganic ions have important biological functions within cells.

- (a) Give **two** properties of water that are important in the cytoplasm of cells.
For each property of water, explain its importance in the cytoplasm.

Property 1 _____

Biological importance within cells _____

Property 2 _____

Biological importance within cells _____

(4)

- (b) Other than sodium, name **one** inorganic ion and give **one** example of its biological importance in a cell.

Name of inorganic ion _____

Biological importance _____

(2)

- (c) Compare and contrast the processes by which water and inorganic ions enter cells.

(3)

(Total 9 marks)

Q3.

The UK government pays farmers to leave grassy strips around the edges of fields of crops. These grassy strips contain a variety of plant species. Leaving the strips is an attempt to encourage biodiversity of animals.

(a) Give **two** reasons why the grassy strips increase the biodiversity of animals.

1. _____
2. _____

(2)

A group of scientists investigated the effect of grassy strips on the biodiversity of soil animals.

- They divided a field into plots measuring 25 m × 5 m, with a 5-metre-wide grassy strip of land between each plot.
- Each year, they planted wheat in each of the plots.
- In the fifth year, they removed samples of soil from each plot where wheat was growing and from the grassy strips around them.
- They sorted each soil sample by hand for 40 minutes to collect the soil animals within the sample.

(b) The scientists decided to collect animals from the soil samples for 40 minutes.

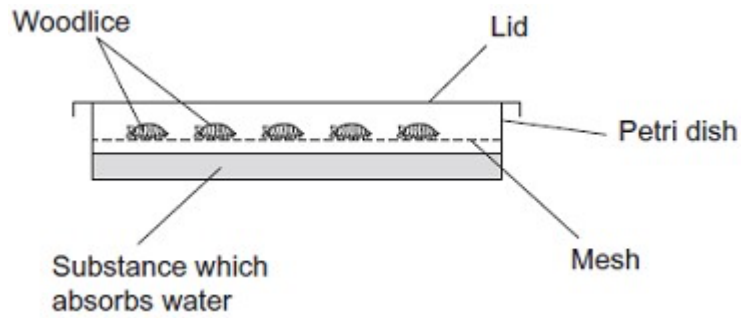
Suggest how the scientists decided that 40 minutes was an appropriate time.

(2)

(c) The table below shows how the scientists published their results. They calculated mean values and two times the standard deviation (SD) of the mean.

Two standard deviations above and below the mean includes 95.4% of the data.

Group of animals	Mean number of animals per m ² (± 2 × SD)		Mean number of species per m ² (± 2 × SD)	
	Soil under wheat crop	Soil under grassy strips	Soil under wheat crop	Soil under grassy strips
Beetles	41.2 (± 6.4)	80.1 (± 10.1)	10.0 (± 1.6)	17.3 (± 1.0)
Centipedes	18.4 (± 3.6)	13.5 (± 1.0)	1.8 (± 0.3)	2.1 (± 0.2)
Earthworms	244.5 (± 27.1)	281.2 (± 39.4)	3.8 (± 0.3)	5.1 (± 0.2)
Millipedes	38.4 (± 12.2)	36.2 (± 2.9)	3.5 (± 0.3)	3.2 (± 0.2)

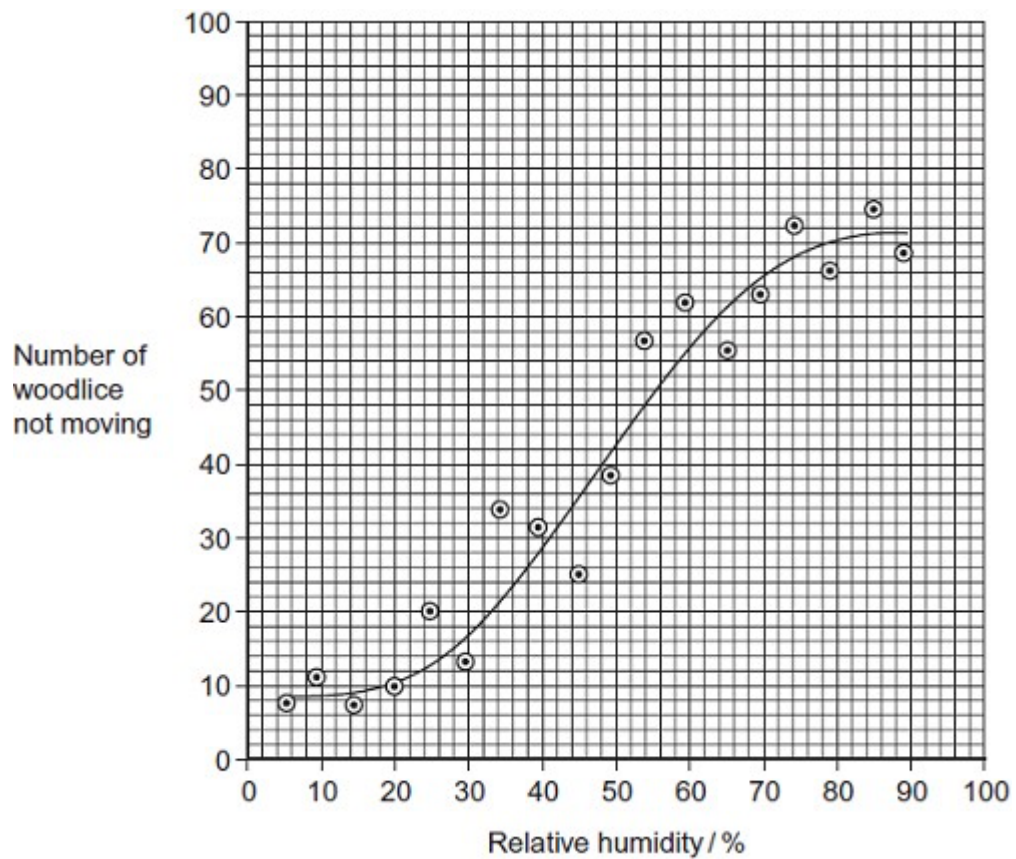


The scientists

- placed 10 woodlice in the top half of the dish
- replaced the lid and left the apparatus for 15 minutes in the laboratory
- recorded the number of woodlice **not** moving during the next 30 seconds
- repeated the experiment to obtain data for 100 woodlice
- repeated the experiment at different humidities.

The results are shown in **Figure 2**.

Figure 2



The movement of the woodlice in low relative humidity is an advantage to their survival. Explain how.

Q5.

Read the following passage.

Straw consists of three main organic substances – cellulose, hemicellulose and lignin. Cellulose molecules form chains which pack together into fibres. Hemicellulose is a small molecule formed mainly from five-carbon (pentose) sugar monomers. It acts as a cement holding cellulose fibres together. Like hemicellulose, lignin is a polymer, but it is not a carbohydrate. It covers the cellulose in the cell wall and supplies additional strength. In addition to these three substances, there are small amounts of other biologically important polymers present.

The other main component of straw is water. Water content is variable but may be determined by heating a known mass of straw at between 80 and 90°C until it reaches a constant mass. The loss in mass is the water content.

Since straw is plentiful, it is possible that it could be used for the production of a range of organic substances. The first step is the conversion of cellulose to glucose. It has been suggested that an enzyme could be used for this process. There is a difficulty here, however. The lignin which covers the cellulose protects the cellulose from enzyme attack.

Use information from the passage and your own knowledge to answer the following questions.

- (a) (i) Give **one** way in which the structure of a hemicellulose molecule is similar to the structure of a cellulose molecule.

(1)

- (ii) Complete the table to show **two** ways in which the structure of a hemicellulose molecule differs from the structure of a cellulose molecule.

Hemicellulose	Cellulose

(2)

- (b) Name **one** biologically important polymer, other than those mentioned in the passage, which would be found in straw.

(1)

- (c) Explain why the following steps were necessary in finding the water content of straw:

- (i) heating the straw *until it reaches constant mass* (line 9);

(1)

- (ii) not heating the straw above 90°C (line 9).

(2)

- (d) A covering of lignin protects cellulose from enzyme attack (line 14). Use your knowledge of the way in which enzymes work to explain why cellulose-digesting enzymes do not digest lignin.

(2)

- (e) Describe the structure of a cellulose molecule and explain how cellulose is adapted for its function in cells.

(6)

(Total 15 marks)

Mark schemes

Q1.

- (a) 1. (water has a relatively) high (specific) heat capacity;
Ignore numbers relating to heat capacity
2. Can gain / lose a lot of heat / energy without changing temperature;
OR
Takes a lot of heat / energy to change temperature;
Accept due to H bonding between water molecules

2

- (b) Adenosine diphosphate and (inorganic) phosphate;
Accept ADP for adenosine diphosphate
Accept P_i / PO_4^{3-} / P in a circle for inorganic phosphate
Reject adenine diphosphate
Reject phosphorus / P for phosphate

1

- (c) 1. Species / organism the muscle tissue came from;
OR
Thickness / type / source of the muscle tissue;
Ignore surface area of muscle tissue
2. Temperature of the muscle tissue / ATP solution / slides;
Need to be qualified
3. pH of the ATP solution;
Need to be qualified
Reject concentration / volume of ATP hydrolase

2 max

- (d) Description
1. As concentration of ATP increases, length of muscle decreases;
Accept negative correlation

Explanation

2. More ATP (hydrolysed by ATP hydrolase), **so** more energy released, **so** more muscle contraction / shortening of muscle;
Accept more ATP available for correct/named aspect of muscle contraction
Idea of more is required once.
Reject energy produced

2

- (e) 4.88×10^{-6} ;;;

If answer incorrect

EITHER

Allow 1 mark for 0.244

Allow 1 mark for 1.22×10^{-5}

OR

Allow 1 mark for 12200 / 1.525

Allow 1 mark for 0.61

Accept 5×10^{-6}

Accept correct answer however expressed

Max 2 for incorrect final answer

3

[10]

Q2.

- (a)
1. Polar molecule;
 2. Acts as a (universal) solvent;

OR

3. (Universal) solvent;
4. (Metabolic) reactions occur faster in solution;

OR

5. Reactive;
6. Takes place in hydrolysis / condensation / named reaction;
Polar molecule so acts as (universal) solvent so (metabolic reactions are faster = 3 marks

4

- (b) Name of ion;

Correct function within cell;

Ions other than sodium in specification are H^+ , Fe^{2+} and PO_4^{3-} but accept any correct ion (other than sodium) plus relevant function = 2.

Allow ion to be named in words but not as element, e.g, iron ion but not iron.

2

- (c)
1. Comparison: both move down concentration gradient;
 2. Comparison: both move through (protein) channels in membrane;
Accept aquaporins (for water) and ion channels
 3. Contrast: ions can move against a concentration gradient by active transport

3

[9]

Q3.

- (a) Any **two** valid reasons;

e.g.

1. Increase in plant diversity leads to more types of food for animals;
2. Increase in variety of animals leads to increase in predator species;
3. Increase in niche / habitat

2 max

- (b)
1. Repeat soil sorting for different times and record number of species collected;
 2. Find optimum time / time beyond which further sorting does not lead to increase in animal species found

2

- (c)
1. No data on number of individuals in each

$$\text{species / diversity index} = \frac{N(N-1)}{\sum n(n-1)}$$

1

- (d) Principle:

1. Overlap of $2 \times \text{SD}$ shows probability of differences (in means) being due to chance is greater than 0.95;

Allow converse of MP1

Credit MP1 wherever it appears

Agree:

2. No difference in number of earthworms and millipedes (per m²)
3. No difference in number of species of centipedes or millipedes.

Disagree:

4. More beetles and woodlice in grassy strips;
5. More species of beetles, earthworms, woodlice in grassy strips.

4 max

[9]

Q4.

Low humidity results in more woodlice moving;

So increased movement increased chance of leaving dry / unfavourable environment so reduce water loss / reduce evaporation;

[2]

Q5.

- (a) (i) both are polymers / polysaccharides / built up from many sugar units / both contain glycosidic bonds / contain (C)arbon, (H)ydrogen and (O)xygen;

1

- (ii) hemicellulose shorter / smaller than cellulose / fewer carbons;

hemicellulose from pentose / five-carbon sugars and cellulose from hexose / glucose / six-carbon sugars;

(only credit answers which compare like with like.)

2

- (b) protein / nucleic acid / enzyme / RNA / DNA / starch / amylose / amylopectin polypeptide;

1

- (c) (i) to make sure that all the water has been lost;

1

- (ii) only water given off below 90 °C;
(above 90°C) other substances straw burnt / oxidised / broken down;
and lost as gas / produce loss in mass;

2

- (d) enzymes are specific;
shape of lignin molecules will not fit active site (of enzyme);
OR
shape of active site (of enzyme);
will not fit molecule;

2 max

- (e) 1. made from β -glucose;
2. joined by condensation / removing molecule of water / glycosidic bond;
3. 1 : 4 link specified or described;
4. "flipping over" of alternate molecules;
5. hydrogen bonds linking chains / long straight chains;
6. cellulose makes cell walls strong / cellulose fibres are strong;
7. can resist turgor pressure / osmotic pressure / pulling forces;
8. bond difficult to break;
9. resists digestion / action of microorganisms / enzymes;

(allow maximum of 4 marks for structural features)

6 max

[15]

Examiner reports

Q1.

Answers to (a) showed good knowledge, but there was some confusion between heat capacity and the latent heat of vaporisation. Many students hedged their bets by referring to latent heat capacity. There were several students who stated that a high heat capacity was caused by strong hydrogen bonds, or that hydrogen bonds were between H^+ and O^{2-} in water, not between water molecules.

Question (b) was well answered; the most common mistake was stating *adenine* diphosphate instead of adenosine diphosphate.

In (c) many students did not consider the question and either gave variables whose control had already been given in the question, or gave unqualified answers of temperature and pH. Only 7% of students scored two marks. Many also stated the concentration of ATP hydrolase, again showing a failure to consider the question and realising that this cannot be controlled as it was produced by the muscle tissue.

In question (d), the description was well answered by the majority, however many students thought the muscle became shortened as the muscle tissue was being hydrolysed. Several also stated that ATP released more energy for respiration. References to energy being 'produced' negated otherwise good responses.

Students found (e) very difficult, with only 3.7% of them scoring all three marks. Many failed to use the table correctly and realise that the concentration of ATP added to the slide was $\times 10^{-6} \text{ mol dm}^{-3}$. Two marks were regularly awarded for incorrect responses, however, for including 12200 and 0.61 in the workings. 7.5% of students made no attempt whatsoever to answer this question.

Q4.

Many candidates were confused about low relative humidity environments and whether they were dry or moist. Also, many did not use the data from **Resource B** to state that more woodlice move in a low humidity environment. Several candidates linked low humidity to water on the gills and so decreased gas exchange.

Q5.

- (a) (i) Answers to parts of this question were not infrequently marred by lack of knowledge of the basic structure of cellulose as a polymer of β -glucose. Thus, although all that was required here was to note that both molecules were polymers, many disqualified their answers by referring to cellulose as also being a pentose.
- (ii) Limited question technique frequently restricted the credit available. Many candidates concentrated on functional rather than structural differences. As a consequence, the answer boxes were often so full that they rarely compared like with like and offered a valid comparison. Among the better, more focused, answers were some which unfortunately were a little too concise, referring to hemicellulose as a pentose and cellulose as a hexose. Questions requiring structural similarities are likely to remain a feature of BYA1. Candidates clearly need an effective strategy for answering them.
- (b) Starch and protein were correctly identified by many, but a range of incorrect responses included glycogen, phospholipid and various monosaccharides.

- (c) (i) Answers suggested that, although candidates were clearly familiar with the term “constant mass”, they were by no means all conversant with the idea that it represented the point at which all water had been lost.
- (ii) There were many correct answers. Answers to this second part, such as “Going over 90 °C would start to boil the water so that we would be unable to calculate the water content” were frequent and suggested that candidates had failed to focus on the information provided in the second paragraph of the passage. The better candidates at whom this question was directed were generally able to point out, however, that high temperatures might lead to other substances being broken down and a consequent loss in mass.
- (d) Although most candidates were aware of the specific nature of enzyme action, they experienced varying degrees of difficulty in relating the general concepts involved to the context of this question. Those candidates who gained least credit were inclined to reword the question and offer an explanation in terms of the lignin covering. Others offered responses centred around lignin acting as an enzyme inhibitor. Better candidates clearly understood the concepts of molecular shape and fit and were able to apply them to this situation.
- (e) Answers to this part of the question ranged from those of the more able candidates who wrote clearly and logically about cellulose structure and function, often with a pleasing level of accuracy and detail, to those which did not gain credit. Among the latter were many who failed to attempt this part of the question and others who confused cellulose with other molecular components of plant cells such as starch and plasma membranes. There was much confusion between hydrogen bonds and glycosidic bonds, and between α -glucose and β -pleated sheets.

Other incorrect assertions which frequently arose were that cellulose is formed from alternating α - and β -glucose residues, and that it contains both 1-4 and 1-6 linkages. Many candidates correctly identified strength as one of the molecule’s properties and went further in discussing the importance of this in withstanding pressures resulting from osmosis. A frequent error, however, was to assign the function of energy storage to cellulose.