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

__________________________________________________________

___________________________________________________________________

___________________________________________________________________

(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

__________________________________________________________

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

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(Total 9 marks)
Discs of carrot were placed in a solution containing potassium ions ($K^+$). The concentration of oxygen in air bubbled through the solution was changed and the rates of respiration and uptake of potassium ions were measured. The results are shown in the table.

<table>
<thead>
<tr>
<th>Concentration of oxygen / %</th>
<th>Rate of respiration / arbitrary units</th>
<th>Rate of uptake of potassium ions / arbitrary units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>12.2</td>
<td>69</td>
<td>72</td>
</tr>
<tr>
<td>20.8</td>
<td>90</td>
<td>80</td>
</tr>
</tbody>
</table>

Describe and explain the link between oxygen concentration, rate of respiration and rate of uptake of potassium ions.

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___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
Cylinders of potato were cut using a cork borer. Their initial lengths were measured. Each cylinder was then put in a different concentration of sucrose solution for 12 hours. The graph shows the changes in length of the potato cylinders in the different sugar solutions.

(i) In what concentration of sucrose did the length of the potato cylinder remain the same?

________________________________________________________________________

(1)

(ii) The initial length of the potato cylinder in the solution of concentration 0.1 mol dm$^{-3}$ was 90 mm. Calculate its final length. Show your working.

Final length = ____________________ mm

(2)

(iii) Explain the change in length which occurs in a sucrose solution of concentration 0.5 mol dm$^{-3}$.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

(2)

(Total 9 marks)
Inorganic ions include those of sodium, phosphorus and hydrogen. Write an essay to describe how these and other inorganic ions are used in living organisms.

(Total 25 marks)
Mark schemes

1. (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)

(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.

(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

[9]

(a) greater rate of oxygen consumption / leads to greater rate of respiration and greater rate of uptake;

(allow this mark even if spread through account but cause and effect must be within the correct context)

oxygen required for respiration;
respiration produces ATP / releases energy;
(ignore ref to producing or making energy)
potassium ions taken up by active transport / against concentration gradient;
(b)  (i)  0.25 (mol dm$^{-3}$);

(ii)  1 mark  Incorrect answer but derived from ratio of 1.2 and initial length of 90 mm

2 marks  Correct answer of 108 mm;

(iii)  water potential inside potato higher / less negative than in solution; water moves out by osmosis;
<table>
<thead>
<tr>
<th>Score Range</th>
<th>Description</th>
<th>Quality Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 – 25</td>
<td>Extended abstract Generalised beyond specific context</td>
<td>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.</td>
</tr>
<tr>
<td>16 – 20</td>
<td>Relational Integrated into a whole</td>
<td>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</td>
</tr>
<tr>
<td>11 – 15</td>
<td>Multistructural Several aspects covered but they are unrelated</td>
<td>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.</td>
</tr>
<tr>
<td>6 – 10</td>
<td>Unistructural Only one or few aspects covered</td>
<td>Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.</td>
</tr>
<tr>
<td>1 – 5</td>
<td>Unfocused</td>
<td>Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.</td>
</tr>
</tbody>
</table>
Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.
<table>
<thead>
<tr>
<th>Levels mark scheme word/statement</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holistic</td>
<td>Synoptic, drawing from different topics (usually sections of the specification)</td>
</tr>
<tr>
<td>A fully integrated answer which makes clear links between several different topics and the theme of the question</td>
<td>All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. ‘Several’ here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.</td>
</tr>
<tr>
<td>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</td>
<td>Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.</td>
</tr>
<tr>
<td>No significant errors or irrelevant material.</td>
<td>A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.</td>
</tr>
<tr>
<td>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</td>
<td>An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.</td>
</tr>
<tr>
<td>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</td>
<td>Not addressing the biological theme of the essay (e.g. importance) at A-level standard.</td>
</tr>
</tbody>
</table>

Inorganic ions include those of sodium, phosphorus and hydrogen.
Please note that to obtain full credit, students must use information to describe how these and other inorganic ions are used in living organisms.

Topics

| 3.1.3 | Lipids |
| 3.1.5 | Nucleic acids are important information-carrying molecules |
| 3.1.6 | ATP |
| 3.2.3 | Transport across cell membranes |
| 3.5.1 | Photosynthesis |
| 3.5.2 | Respiration |
| 3.5.4 | Nutrient cycles |
| 3.6.2 | Nervous coordination |

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.