Tuesday 15 May 2018       Afternoon       Time allowed: 1 hour 45 minutes

Materials
For this paper you must have:
• a ruler
• a scientific calculator
• the periodic table (enclosed)
• the Physics Equations Sheet (enclosed).

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions in the spaces provided. Do not write outside the box around each page or on blank pages.
• Do all rough work in this book. Cross through any work you do not want to be marked.
• In all calculations, show clearly how you work out your answer.

Information
• The maximum mark for this paper is 100.
• The marks for questions are shown in brackets.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.
**Figure 1** shows a sweet potato plant.

The sweet potatoes grow underground and can be cooked and eaten.

![Figure 1](image)

**Table 1** shows some of the nutrients in cooked sweet potato.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Mass in grams per 100 grams of cooked sweet potato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>73.83</td>
</tr>
<tr>
<td>Protein</td>
<td>2.01</td>
</tr>
<tr>
<td>Fat</td>
<td>0.15</td>
</tr>
<tr>
<td>Total carbohydrate</td>
<td>20.71</td>
</tr>
<tr>
<td>of which sugars</td>
<td>6.55</td>
</tr>
<tr>
<td>Fibre</td>
<td>3.30</td>
</tr>
</tbody>
</table>
After cooked sweet potato is digested, sugars (including glucose) pass into the blood. Give two other soluble molecules that would pass into the blood after cooked sweet potato is digested. [2 marks]

1

2

Calculate the mass of sugars in 180 g of cooked sweet potato. Use the information from Table 1. [1 mark]

Mass of sugars = _______________ g

The sweet potatoes found underground contain starch. Explain how starch in the sweet potato is produced from carbon dioxide in the air. [6 marks]
A student investigated how the temperature of a metal block changed with time.

An electric heater was used to increase the temperature of the block.

The heater was placed in a hole drilled in the block as shown in Figure 2.

**Figure 2**

[Diagram of a heater setup]

**Question 2 continues on the next page**
The student measured the temperature of the metal block every 60 seconds. Table 2 shows the student’s results.

### Table 2

<table>
<thead>
<tr>
<th>Time in s</th>
<th>Temperature in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20.0</td>
</tr>
<tr>
<td>60</td>
<td>24.5</td>
</tr>
<tr>
<td>120</td>
<td>29.0</td>
</tr>
<tr>
<td>180</td>
<td>31.0</td>
</tr>
<tr>
<td>240</td>
<td>31.5</td>
</tr>
</tbody>
</table>

0.2.1 Complete the graph of the data from Table 2 on Figure 3.

- Choose a suitable scale for the x-axis.
- Label the x-axis.
- Plot the student’s results.
- Draw a line of best fit.

[4 marks]
The rate of change of temperature of the block is given by the gradient of the graph.

Determine the gradient of the graph over the first 60 seconds. [2 marks]

Gradient =

The metal block had a mass of 1.50 kg
The specific heat capacity of the metal was 900 J/kg °C

Calculate the change in thermal energy of the metal during 240 seconds.
Use the Physics Equations Sheet.
Give your answer in kilojoules. [4 marks]

Change in thermal energy = _________________ kJ

Question 2 continues on the next page
Another student repeated the investigation.

Give **two** variables this student would need to control to be able to compare their results with the results in **Table 2**.

[2 marks]

1. 
2. 

---

**02.4**
03 There are several methods of contraception.

03.1 Draw one line from each method of contraception to how the method works.

<table>
<thead>
<tr>
<th>Method of contraception</th>
<th>How the method works</th>
</tr>
</thead>
<tbody>
<tr>
<td>diaphragm</td>
<td>prevents embryo implanting</td>
</tr>
<tr>
<td>intrauterine device</td>
<td>prevents release of the egg</td>
</tr>
<tr>
<td>oral contraceptive</td>
<td>prevents sperm reaching the egg</td>
</tr>
</tbody>
</table>

03.2 When a new oral contraceptive is tested on volunteers, the contraceptive is first given at a low dose. Later, the dose is increased.

Why are new drugs given at low doses at first?

[1 mark]
Table 3 shows information about three methods of contraception.

<table>
<thead>
<tr>
<th></th>
<th>Condom</th>
<th>Oral contraceptive</th>
<th>Hormone skin patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage (%) effectiveness</td>
<td>98.0</td>
<td>99.7</td>
<td>99.8</td>
</tr>
<tr>
<td>How contraception is obtained</td>
<td>From shops or sexual health clinic</td>
<td>From doctor or sexual health clinic</td>
<td></td>
</tr>
<tr>
<td>Possible side effects</td>
<td>No serious side effects</td>
<td>Headaches, nausea, high blood pressure</td>
<td>Headaches, nausea, blood clots</td>
</tr>
</tbody>
</table>

Evaluate the use of these contraceptive methods. [6 marks]

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

Turn over for the next question
There is limited evidence about the Earth’s early atmosphere because of the age of the Earth.

The Earth is 4.6 billion years old.

Which is the correct age of the Earth?

Tick one box.

- $4.6 \times 10^3$ years
- $4.6 \times 10^6$ years
- $4.6 \times 10^9$ years
- $4.6 \times 10^{12}$ years

Scientists think that the Earth’s early atmosphere may have been similar to the atmosphere on Mars today.

Look at Table 4.

### Table 4

<table>
<thead>
<tr>
<th>Gas</th>
<th>Concentration of gas in the atmosphere today in parts per million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Mars 27 000 Earth 780 000</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Mars 1 300 Earth 210 000</td>
</tr>
<tr>
<td>Argon</td>
<td>Mars 16 000 Earth 9 300</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>Mars 950 000 Earth 400</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Mars 800 Earth trace</td>
</tr>
</tbody>
</table>
Calculate the percentage increase in nitrogen from the Earth’s early atmosphere to the atmosphere today.

Assume the Earth’s early atmosphere was the same as the atmosphere today on Mars.

Give your answer to 2 significant figures. \[ \text{Percentage increase in nitrogen} = \underline{\_\_\_\_\_\_\_\_\%} \]

Which process releases carbon monoxide into the Earth’s atmosphere?

Tick one box.

Aerobic respiration

Bacterial decomposition

Incomplete combustion

Photosynthesis

Explain how the oceans were formed in the first billion years of the Earth’s existence. \[ \text{Question 4 continues on the next page} \]
Describe how the increase in greenhouse gases has increased the mass of liquid water in the oceans.

[1 mark]
Alpha, beta and gamma are types of nuclear radiation.

Explain why gamma emission does not change the atomic number of an element.  

[2 marks]

Food can be irradiated to make it safer to eat.

Figure 4 shows a photograph of peaches.

Two of the peaches were irradiated.

The photograph was taken one week after irradiation.
05.2 Explain why irradiating food makes it safer to eat. [3 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

05.3 Food is packaged and then irradiated.

Explained why food is irradiated using gamma radiation rather than alpha or beta radiation. [2 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

05.4 Some people are concerned that irradiated food could be radioactive.

Describe how irradiated food is different from food that is radioactive. [2 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Water travels through plants in xylem tissue.

Describe the structure of xylem tissue. [2 marks]

Figure 5 shows guard cells around open stomata magnified 800 times.
The image size of one of the guard cells is 26 millimetres long.

Calculate the real length of the guard cell in micrometres.

Include the equation you are using to calculate your answer. [3 marks]

\[
\text{Real length of guard cell} = \frac{26 \text{ millimetres}}{1000 \text{ micrometres/millimetre}} \times 1000
\]

Guard cells increase in volume and become curved to open stomata.

Explain how guard cells increase in volume. [2 marks]

Question 6 continues on the next page
The Baobab tree grows in Botswana, Africa.

The tree has no leaves for up to 9 months of the year.

**Figure 6** shows the average temperature and rainfall each month in Botswana.

**Figure 6**

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature in °C</th>
<th>Rainfall in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>40</td>
<td>160</td>
</tr>
<tr>
<td>Feb</td>
<td>35</td>
<td>140</td>
</tr>
<tr>
<td>Mar</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>Apr</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>May</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Jun</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Jul</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Aug</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Sep</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Oct</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Nov</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Dec</td>
<td>25</td>
<td>80</td>
</tr>
</tbody>
</table>

**Key**

- Average maximum temperature in °C
- Average rainfall in mm

Explain how having no leaves from March to November allows the Baobab tree to survive in Botswana.

[3 marks]
Marfan syndrome is a rare genetic disorder that causes problems with many body systems.

Which sentence best describes a gene? [1 mark]

Tick one box.

A long chain of carbohydrate
A short section of DNA
All of the chromosomes in an organism
Several amino acids joined together

What does a gene code for? [1 mark]

Tick one box.

A carbohydrate polymer
A DNA double helix
One glycerol and three fatty acids
A sequence of amino acids

What scientific term is used to describe all the genes of one organism? [1 mark]

Question 7 continues on the next page
What term is used to describe the observed characteristics of an individual? [1 mark]

Tick one box.

- Allele
- Genotype
- Homozygous
- Phenotype

Marfan syndrome is caused by a dominant allele, R. The normal allele is recessive, r.

A man who is heterozygous for Marfan syndrome has a child with a woman who does not have the disorder.

Draw a genetic diagram to show the probability of their child inheriting Marfan syndrome. [4 marks]

Probability = ______________________
Very rarely, a new case of Marfan syndrome can occur because of a mutation during meiosis.

Explain how a mutation during meiosis could affect every cell in one offspring. [4 marks]

Turn over for the next question
There are no questions printed on this page
Some students investigated the compounds in a green lettuce leaf and a red cabbage leaf.

The students placed each leaf in boiling ethanol and then tested each leaf for starch.

The boiling point of ethanol is 78 °C

Ethanol is flammable so should not be directly heated with a Bunsen burner.

Give one way ethanol can be boiled safely.

Do not refer to wearing goggles in your answer.

[1 mark]

Describe how the students could test the leaves for starch.

Give the result if starch is present.

[2 marks]

Test

Result

The students used paper chromatography to investigate the coloured pigments in both types of leaf.

Explain how paper chromatography causes the different pigments to separate.

[3 marks]
Table 5 shows the students’ results. The distance the solvent and each pigment moved was measured from the start line.

Table 5

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Green lettuce</th>
<th>Red cabbage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance moved in mm</td>
<td>R&lt;sub&gt;f&lt;/sub&gt; value</td>
<td>Distance moved in mm</td>
</tr>
<tr>
<td>Solvent front</td>
<td>120</td>
<td>–</td>
</tr>
<tr>
<td>Yellow-green pigment</td>
<td>18</td>
<td>0.15</td>
</tr>
<tr>
<td>Bright green pigment</td>
<td>24</td>
<td>0.20</td>
</tr>
<tr>
<td>Yellow pigment</td>
<td>40</td>
<td>0.33</td>
</tr>
<tr>
<td>Orange pigment</td>
<td>120</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Table 6 shows the known R<sub>f</sub> value ranges of some pigments.

Table 6

<table>
<thead>
<tr>
<th>Pigment</th>
<th>R&lt;sub&gt;f&lt;/sub&gt; value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotene</td>
<td>0.89 – 0.98</td>
</tr>
<tr>
<td>Pheophytin a</td>
<td>0.42 – 0.49</td>
</tr>
<tr>
<td>Pheophytin b</td>
<td>0.33 – 0.40</td>
</tr>
<tr>
<td>Chlorophyll a</td>
<td>0.24 – 0.30</td>
</tr>
<tr>
<td>Chlorophyll b</td>
<td>0.20 – 0.26</td>
</tr>
<tr>
<td>Xanthophyll</td>
<td>0.04 – 0.28</td>
</tr>
</tbody>
</table>
One pigment was found in the green lettuce leaf, but was not found in the red cabbage leaf.

Describe why it is not possible to be certain what this pigment is.

Use the information in Table 5 and Table 6 to help you.

[1 mark]

The experiment was repeated and the solvent front travelled 140 mm from the start line.

Calculate the range of distances where the pigment carotene would be seen.

Use the equation for calculating $R_f$ values and the information in Table 6 to help you.

[5 marks]

From ____________ mm to ____________ mm

Question 8 continues on the next page
Different coloured pigments absorb light at different wavelengths.

Explain how plants could have evolved to contain more than one pigment in their leaves. [6 marks]
An understanding of relative size is essential in science.

**09.1** Draw **one** line from each structure to the approximate radius of that structure.  

<table>
<thead>
<tr>
<th>Structure</th>
<th>Approximate radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>a bacterial cell</td>
<td>$1 \times 10^{-14}$ m</td>
</tr>
<tr>
<td>a large molecule</td>
<td>$5 \times 10^{-10}$ m</td>
</tr>
<tr>
<td>an animal cell</td>
<td>$1 \times 10^{-6}$ m</td>
</tr>
<tr>
<td>an atom</td>
<td>$2 \times 10^{-5}$ m</td>
</tr>
<tr>
<td></td>
<td>$3 \times 10^{-9}$ m</td>
</tr>
</tbody>
</table>

**Figure 7** shows two model cells.  
Both models are cubes.

**Figure 7**

![Diagram of model cells with 0.5 cm and 1 cm scales]
Describe how the surface area to volume ratio changes as the length of the side of the model cell increases.

You should include calculations in your answer.

[3 marks]

Explain why a bacterium can rely on diffusion for gas exchange, but animals need a transport system.

[3 marks]

Question 9 continues on the next page
Some sugar molecules are absorbed from the small intestine into the blood by active transport.

Explain why the rate of absorption of these sugar molecules can depend on the concentration of oxygen in the cells lining the small intestine.

[3 marks]