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.
There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED
Sperm cells and egg cells carry genetic information.

What is the name of the chemical that carries genetic information? [1 mark]

What are sperm cells and egg cells? [1 mark]
Tick one box.

- Gametes
- Genes
- Homozygous
- Phenotype

Which process produces sperm cells? [1 mark]
Tick one box.

- Fertilisation
- Homeostasis
- Meiosis
- Respiration

Question 1 continues on the next page
Mice have 40 chromosomes in each body cell. How many chromosomes will be in each sperm cell? [1 mark]

Tick one box.

10  
20  
40  
80  

A mouse will always have black fur if one or two black fur alleles are inherited.

What word describes the black fur allele? [1 mark]

Tick one box.

- Dominant
- Recessive
- Heterozygous
- Homozygous
Two black mice both have one black fur allele (B) and one brown fur allele (b).

01.6 Complete the genetic diagram in Figure 1 to show the possible offspring of these mice.

![Figure 1]

01.7 On Figure 1 draw a ring around one offspring with brown fur.

01.8 What is the chance of the offspring from the two black mice being brown?

Turn over for the next question
Table 1 shows the relative mass and charge of the particles in an atom.

<table>
<thead>
<tr>
<th>Name of particle</th>
<th>Relative mass</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>neutron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td>very small</td>
<td></td>
</tr>
</tbody>
</table>

Complete Table 1.

[3 marks]

Figure 2 represents a lithium atom.

Give the number of protons, neutrons and electrons in the lithium atom shown in Figure 2.

[3 marks]

Number of protons ____________
Number of neutrons ____________
Number of electrons ____________
Scientific models of the atom have changed over time.

Draw **one** line from each description of the atomic model to the stage in the development of the atomic model.

[2 marks]

<table>
<thead>
<tr>
<th>Description of atomic model</th>
<th>Stage in the development of the atomic model</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ball of positive charge with electrons embedded in it</td>
<td>Dalton atoms</td>
</tr>
<tr>
<td>Spherical atoms</td>
<td>Neutrons discovered</td>
</tr>
<tr>
<td></td>
<td>Nucleus of atoms discovered</td>
</tr>
<tr>
<td></td>
<td>Plum pudding model</td>
</tr>
</tbody>
</table>

Turn over for the next question
This question is about gases in the air.

Figure 3 represents a molecule found in air.

Figure 3

\[ \text{O} &= \text{C} &= \text{O} \]

What is the formula of the molecule shown in Figure 3? [1 mark]

Tick one box.

- Co2
- 2CO
- CO₂
- CO²

What is the name of the molecule shown in Figure 3? [1 mark]

You may use the periodic table to help you.
03.3 The percentage of oxygen in air is 21%.

The mass of air in a classroom was 220 kg

Calculate the mass of oxygen in the classroom. [1 mark]

Mass of oxygen = ___________ kg

Carbon monoxide is an air pollutant.

03.4 Describe how carbon monoxide is produced from fuels. [2 marks]

Carbon monoxide can decrease the concentration of oxygen in the blood.

Which part of the blood would be most affected by carbon monoxide? [1 mark]

Tick one box.

- Red blood cells
- Plasma
- Platelets
- White blood cells
What **two** effects could a decreased concentration of oxygen in the blood have on body cells?

Tick **two** boxes.

- Cell death
- Decreased respiration rate
- Faster cell division
- Faster cell growth
- More energy released

Some air pollutants cause acid rain.

Give **one** problem caused by acid rain.

[1 mark]
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED
**Figure 4** shows the lower surface of a leaf magnified 800 times.

**Figure 4**

![Leaf image]

**04.1** Name hole A in the leaf surface.  
[1 mark]

**04.2** Name cell B.  
[1 mark]
Cell B can lose or gain water.

Complete the sentences.

Choose answers from the box. [2 marks]

active transport  condensation
osmosis  photosynthesis  transpiration

Cell B can gain water by ________________________________ .

Water vapour can escape from the leaf through hole A by ________________________________ .

Which factors increase the rate of water loss from hole A? [2 marks]

Tick two boxes.

- Increasing acidity  
- Increasing nitrogen concentration  
- Increasing oxygen concentration  
- Increasing temperature  
- Increasing wind speed  

Give one reason why the movement of water in a plant is important. [1 mark]

__________________________________________________________________________

Question 4 continues on the next page
04.6 The African Baobab tree has no leaves for up to 9 months of the year. Suggest how this helps the tree to survive in an area where there is not much rain. [1 mark]

04.7 Figure 4 on page 12 is a photograph taken through a microscope. The image is magnified 800 times. One of the cells in the image has a width of 12 mm

Calculate the real width of this cell in micrometres.

Complete the following steps. [3 marks]

Use the equation to work out the real width of the cell in millimetres.

\[
\text{real width of object} = \frac{\text{width of image}}{\text{magnification}}
\]

Real width of cell = ______________________ millimetres

Convert the real width of the cell from millimetres to micrometres.
1 millimetre = 1000 micrometres.

Real width of cell = ______________________ micrometres
The concentration of glucose in the blood is controlled by homeostasis.

Give **one** other example of an internal condition controlled by homeostasis. [1 mark]

Question 5 continues on the next page
Figure 5 shows the change in glucose concentration in the blood of a person with Type 1 diabetes.

**Figure 5**

![Graph showing glucose concentration over time]

Concentration of blood glucose in mmol/dm$^3$

Time of day

12 noon, 2 pm, 4 pm, 6 pm

0 2 4 6 8 10 12

0 2 4 6 8 10 12

0

0 5.2 Calculate the increase in blood glucose concentration between 1 pm and 2 pm.

[1 mark]

Increase in blood glucose = mmol/dm$^3$

0 5.3 Suggest at what time the person ate lunch.

Use Figure 5.

[1 mark]

0 5.4 Name the hormone the person injected that caused the blood glucose concentration to decrease.

[1 mark]
Explain the decrease in blood glucose concentration after the hormone was injected. Use all the words in the box in your explanation. [2 marks]

blood  cells  glucose  glycogen

Normal blood glucose concentration is approximately 4 mmol/dm$^3$.

What could be the reason for the blood glucose concentration falling below normal at 4 pm? [1 mark]

Tick one box.

- The food contained too much glucose
- The person ate another meal
- The person injected too much hormone
- The person fell asleep

Explain what would happen to the blood glucose concentration if the person went for a run at 6 pm. [2 marks]

Turn over
0 5.8

Look at Figure 5 on page 16.

Suggest one way that the graph would be different for a person who does not have diabetes.

[1 mark]
Figure 6 shows a food web.
What name is given to all the organisms together in an ecosystem? [1 mark]

Tick one box.

Community
Environment
Habitat
Population

Give the name of one secondary consumer shown in Figure 6. [1 mark]

Algae can photosynthesise.

Which word describes the algae in this food web? [1 mark]

Tick one box.

Consumer
Predator
Prey
Producer

Question 6 continues on the next page
Explain why most algae are found near the surface of the sea, and not at greater depths.

[2 marks]

Toothed whales will compete with each other for food. Suggest what else toothed whales might compete for.

[1 mark]

Look at Figure 6 on page 20. The population of leopard seals decreases if there are fewer elephant seals. Explain why.

[2 marks]
Gamma radiation is emitted from the nuclei of some atoms.

What is a gamma ray?  
Tick one box.  

A helium nucleus  
A high speed electron  
A neutron  
A type of electromagnetic radiation

Which would be the best absorber of gamma radiation?  
Tick one box.  

A few mm of air  
A thick sheet of cardboard  
A thick sheet of lead  
A thin sheet of paper

Question 7 continues on the next page
Food can be irradiated with gamma rays to kill bacteria.

**Figure 7** shows a photograph of peaches.

Two of the peaches were irradiated.

The photograph was taken one week after irradiation.

![Figure 7]

Why do food producers need to kill bacteria on food? [2 marks]

Tick two boxes.

- To change the colour of the food
- To decrease the rate of decay of the food
- To decrease the shelf life of the food
- To prevent food poisoning
- To remove dirt from food
How do gamma rays kill bacteria? [1 mark]

Tick one box.

- Gamma rays cause meiosis to occur
- Gamma rays cause mutations
- Gamma rays decrease the size of bacterial cells
- Gamma rays destroy the food source for bacteria

Food producers can irradiate food by passing it close to a radioactive source. [2 marks]

How can food producers increase the level of radiation that the food is exposed to?

Tick two boxes.

- Boil the food before passing it close to the radioactive source
- Decrease the distance between the food and the radioactive source
- Increase the time for which the food is close to the radioactive source
- Put the radioactive source in a box
- Reduce the temperature of the radioactive source

A student said: ‘The irradiated food would become radioactive.’

Give one reason why the student is not correct. [1 mark]
Some students tested a red cabbage leaf for starch.
This is the method used.
1. Boil the leaf in ethanol.
2. Rinse the leaf in water.
3. Add the reagent to test the leaf for starch.

Give one safety precaution the students should take in this test. [1 mark]

Which reagent is used to test the boiled leaf for starch?
Tick one box.

- Benedict’s solution
- Biuret solution
- Iodine solution
- Sodium chloride solution
What colour will be seen if the test for starch is positive? [1 mark]

Tick one box.

Blue-black
Pale pink
Orange
Red

The students then used paper chromatography to investigate the coloured pigments in a red cabbage leaf.

Complete the sentences. Choose answers from the box. [2 marks]

Chromatography can be used to ________________________ mixtures.

In paper chromatography, the paper is part of the stationary phase.

The solvent is called the ________________________ phase.

Question 8 continues on the next page
Table 2 shows the students’ results.

The distance each pigment moved was measured from the start line.

<table>
<thead>
<tr>
<th>Pigment Description</th>
<th>Distance moved in mm</th>
<th>R_f value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow-green pigment</td>
<td>17</td>
<td>X</td>
</tr>
<tr>
<td>Yellow pigment</td>
<td>46</td>
<td>0.42</td>
</tr>
<tr>
<td>Orange pigment</td>
<td>100</td>
<td>0.91</td>
</tr>
</tbody>
</table>

The R_f value is calculated using the equation:

\[
R_f \text{ value} = \frac{\text{distance moved by pigment}}{\text{distance moved by solvent}}
\]

The solvent moved 110 mm from the start line.

Calculate R_f value X in Table 2.

Give your answer to 2 significant figures.

\[
R_f \text{ value } X = \text{__________________________________________}
\]

[2 marks]
The known ranges of $R_f$ values of some pigments are shown in **Table 3**.

<table>
<thead>
<tr>
<th>Pigment</th>
<th>$R_f$ value range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotene</td>
<td>0.89 to 0.98</td>
</tr>
<tr>
<td>Chlorophyll a</td>
<td>0.24 to 0.30</td>
</tr>
<tr>
<td>Chlorophyll b</td>
<td>0.20 to 0.26</td>
</tr>
<tr>
<td>Xanthophyll</td>
<td>0.04 to 0.28</td>
</tr>
</tbody>
</table>

The $R_f$ value for the orange pigment in red cabbage leaves is 0.91. What is this orange pigment most likely to be? [1 mark]

Tick **one** box.

- Carotene
- Chlorophyll a
- Chlorophyll b
- Xanthophyll

Turn over for the next question
Figure 8 shows a sweet potato plant.

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

Table 4 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 of which sugars</td>
<td>20.71</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 4.  

[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 9.

Figure 9

Question 10 continues on the next page
The student measured the temperature of the metal block every 60 seconds. Table 5 shows the student’s results.

Table 5

<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>

Complete the graph of the data from Table 5 on Figure 10.

- 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]
10.2 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 = ________________

10.3 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 10 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 5.

[2 marks]

1. 
2. 

10.4
There are several methods of contraception.

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

[2 marks]

<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>

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 6 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 (%)</td>
<td>98.0</td>
<td>99.7</td>
<td>99.8</td>
</tr>
<tr>
<td>effectiveness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How contraception is</td>
<td>From shops or sexual health clinic</td>
<td>From doctor or sexual health clinic</td>
<td></td>
</tr>
<tr>
<td>obtained</td>
<td></td>
<td></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]

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

END OF QUESTIONS