Materials
For this paper you must have:
- a ruler
- a calculator
- the periodic table (enclosed)
- the Physics equation sheet (enclosed).

Instructions
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- There are 100 marks available on this paper.
- 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.
- When answering questions 08.6, 10.2 and 11.1 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

Advice
- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.
Feeding relationships can be shown using food chains.

**Figure 1** shows a food chain for organisms in a habitat.

**Figure 1**

What is the **producer** in the food chain?

Tick one box.

- Beetle
- Leaf
- Mouse
- Owl

Name the **primary consumer** in the food chain.

[1 mark]
What is the group of leaves, beetles, mice and owls in a habitat called?  
Tick one box.  
[1 mark]

Community  
Ecosystem  
Population  
Species  

What are two abiotic factors that can affect the food chain?  
Tick two boxes.  
[2 marks]

Availability of food  
Light intensity  
New diseases  
New predators  
Wind direction  

Turn over for the next question
Figure 2 shows the carbon cycle.

Use information from Figure 2 to answer the questions.

In process A, carbon dioxide in the atmosphere is taken into plants.

What is process A?

Tick one box.

Evaporation
Fossilisation
Photosynthesis
Respiration

[1 mark]
02.2 In process B, carbon dioxide is released from plants and animals into the atmosphere.

What is process B? [1 mark]

Tick one box.

- Burning
- Feeding
- Photosynthesis
- Respiration

02.3 In which process is carbon passed from one organism to another? [1 mark]

Tick one box.

- A
- B
- C
- D

02.4 What will happen to the concentration of carbon dioxide in the atmosphere if lots of trees are cut down? [1 mark]

Question 2 continues on the next page
Greenhouse gases cause global warming.

Carbon dioxide is a greenhouse gas.

Name **two** other greenhouse gases.  

[2 marks]

1

2

When living organisms die the dead material decays and is broken down.

The process of decay returns carbon dioxide to the atmosphere.

What type of organism causes decay?  

[1 mark]
Turn over for the next question
Figure 3 shows an atom of boron.

**Figure 3**

- **03.1** When the mass of the boron atom is calculated, the mass of the electrons is ignored. Why is the mass of the electrons ignored? [1 mark]

- **03.2** How many electrons are there in the boron atom? [1 mark]

- **03.3** What is the electrical charge on the nucleus of the boron atom? [1 mark]
  
  Tick **one** box.

  +1  
  +5  
  +6  
  +11
03.4 The mass number of boron is 11.

Use **Figure 3** to calculate the number of neutrons in the nucleus of the boron atom.

Explain how you worked out the answer.  

[3 marks]

Number of neutrons = 

Explanation 

03.5 Phosphorus has a mass number of 31 and has 16 neutrons.

What percentage of the mass number of phosphorus is the number of neutrons?

Give your answer to two significant figures.  

[2 marks]

Percentage = 

Turn over for the next question
Density can be explained using the particle model.

What is the unit of density ($\rho$)?

Tick one box.

- joules, J
- joules per kilogram, J/kg
- kilograms, kg
- kilograms per metre cubed, kg/m$^3$

Figure 4 shows particles of the same substance in three states of matter.

Use Figure 4 to explain why the solid has the highest density.
Complete the sentences. Use answers from the box. [2 marks]

| downwards | kinetic | nuclear | potential | randomly | slowly |

The particles in a gas are constantly moving.
The particles move ____________________________.

When the temperature of the particles in a gas is increased
the particles have more ____________________________ energy.

A gas is put into a closed container.
The container and the gas inside it are heated.

What will happen to the pressure inside the container? [1 mark]

Turn over for the next question
Sexual reproduction in humans involves the joining together of an egg cell and a sperm cell.

The sex of an embryo is decided by the chromosomes they inherit from their mother and father.

Where in the cell are the chromosomes?

Tick one box.

Cell membrane
Cytoplasm
Nucleus
Ribosomes

Draw one line from each type of cell to the number of chromosomes in the cell.

<table>
<thead>
<tr>
<th>Type of cell</th>
<th>Number of chromosomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sperm cell</td>
<td>23</td>
</tr>
<tr>
<td>Embryo cell</td>
<td>52</td>
</tr>
</tbody>
</table>

[2 marks]
A man and a woman decide to have a child. Complete the genetic diagram in Figure 5.

**Figure 5**

<table>
<thead>
<tr>
<th>Parent</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>XX</td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On **Figure 5**, circle a male child. [1 mark]

What is the chance of the man and woman having a boy? [1 mark]

Tick one box.

- 1 in 2
- 1 in 3
- 1 in 4
- 1 in 8

Turn over for the next question
There are no questions printed on this page
Pathogens are microorganisms that cause infectious disease.

Draw one line from each disease to the way the disease is spread. [3 marks]

<table>
<thead>
<tr>
<th>Disease</th>
<th>Way the disease is spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholera</td>
<td>Drinking contaminated water</td>
</tr>
<tr>
<td>Cold</td>
<td>Droplets in the air when people cough or sneeze</td>
</tr>
<tr>
<td>Malaria</td>
<td>Eating food that is contaminated</td>
</tr>
<tr>
<td></td>
<td>Breathing air polluted with carbon dioxide</td>
</tr>
</tbody>
</table>

One way the human body protects itself against the entry of pathogens is by producing antimicrobial chemicals.

Antimicrobial chemicals kill pathogens.

Give two other ways the human body protects itself against the entry of pathogens. [2 marks]

1

2
Measles is a childhood disease caused by a microorganism.

Measles is not treated by antibiotics.

Give the reason why.

[1 mark]

Vaccinations help people become immune to infections.

In 2013, 92% of children in the UK had two vaccination injections against measles.

**Figure 6** shows how the concentration of antibodies in the blood changes after each measles vaccination.
06.4 Suggest what day the second vaccination was given. [1 mark]

06.5 What is the highest concentration of antibodies produced by the first vaccination? [1 mark]

06.6 How will the number of children getting measles change as more children are vaccinated against measles?

Give a reason for your answer. [2 marks]

Change

Reason

Turn over for the next question
This question is about radioactive decay.

Figure 7 shows a nuclear equation for the decay of an atom of uranium.

\[
\text{\(^{235}_{92}U \rightarrow ^{231}_{90}Th + ^{4}_{2}He}\]
\]

Use information from Figure 7 to complete Table 1. [3 marks]

<table>
<thead>
<tr>
<th></th>
<th>(U)</th>
<th>(Th)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass number</td>
<td>235</td>
<td></td>
</tr>
<tr>
<td>Number of protons</td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>Number of neutrons</td>
<td>143</td>
<td></td>
</tr>
</tbody>
</table>
Figure 8 shows how the count rate from a radioactive isotope changes with time.

**Figure 8**

What is the half-life of the radioactive isotope?  

Explain why you chose that value.  

Half-life = ________ hours  

Explanation ____________________________________________________________

[2 marks]

Question 7 continues on the next page
When a radioactive isotope decays it can produce beta particles.

What is a beta particle? [1 mark]

Tick one box.

A high-speed electron
A neutron and an electron
A neutron and a proton
A helium nucleus

Beta particles can cause cancer.

Complete the sentences.

Use words from the box. [2 marks]

Tumours form when cell division is _______________________.

Tumours that do not invade other tissues are called _______________________.

benign controlled differentiated malignant slow uncontrolled
Figure 9 shows a diagram of the human heart.

**Figure 9**

Name parts A and B. [2 marks]

A

B

What is the function of blood vessel C? [1 mark]

Tick one box.

- To take blood from the heart around the body
- To take blood from the body to the heart
- To take blood from the heart to the lungs
- To take blood from the lungs to the heart
Coronary heart disease (CHD) develops when layers of fatty material build up in the coronary artery.

One treatment for CHD is to insert a stent into the coronary artery.

**Figure 10** shows a stent in a coronary artery.

![Coronary artery with stent](image)

**Question 8**

Explain why the stent helps to prevent a heart attack. [4 marks]

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**Question 8 continues on the next page**
Look at Table 2.

Table 2

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of deaths from CHD per 100 000 population per year</th>
<th>Amount of fruit and vegetables eaten in kg per person per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>285</td>
<td>180</td>
</tr>
<tr>
<td>B</td>
<td>250</td>
<td>320</td>
</tr>
<tr>
<td>C</td>
<td>198</td>
<td>250</td>
</tr>
<tr>
<td>D</td>
<td>151</td>
<td>220</td>
</tr>
<tr>
<td>E</td>
<td>125</td>
<td>244</td>
</tr>
</tbody>
</table>
Plot the missing bars for countries D and E on Figure 11.

Use data from Table 2.

Figure 11

Key:  
- CHD deaths per 100,000 population
- Amount of fruit and vegetables in kg per person per year

People in country B are more likely to die from CHD than people in country E.

How many more times as likely are people to die from CHD in country B than in country E?

[1 mark]
A student concluded:

‘The factor that causes CHD is not eating enough fruit and vegetables.’

Evaluate the student’s conclusion.

Use data from Figure 11, and your own knowledge, in your answer. [6 marks]
Figure 12 shows a cell viewed through a light microscope.

Figure 12

The size of the real cell is 0.03 mm.

Calculate the magnification of the microscope.

Use Figure 12 to help you answer.

[2 marks]

Magnification =

Question 9 continues on the next page
A light microscope uses light waves to observe objects.

Light waves can be modelled using water waves.

Figure 13 shows a water wave.

![Figure 13](image)

**09.2** Give one similarity between a light wave and a water wave.

**09.3** Write down the equation that links frequency, wave speed and wavelength.
The wave in Figure 13 has a wavelength of 75 cm.

The wave moves at a speed of 1.6 m/s.

Calculate the frequency of the wave. [4 marks]

Frequency = ________________ Hz
A student investigates the rate of respiration in maggots.

**Figure 14** shows the equipment he uses.

**Figure 14**

Why does the student put the maggots on gauze?

[1 mark]
When maggots respire they take in a gas from the air and release a different gas.

Solution A absorbs the gas released.

At the start of the investigation the student records the distance of the water droplet from the bend in the capillary tube.

Explain what happens to the water droplet as the maggots respire. [4 marks]

Question 10 continues on the next page
Table 3 shows the results the student calculated.

Table 3

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Rate of respiration in units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td>20</td>
<td>7.5</td>
</tr>
<tr>
<td>30</td>
<td>8.4</td>
</tr>
<tr>
<td>40</td>
<td>14.0</td>
</tr>
</tbody>
</table>

The student uses his results to plot the graph in Figure 15.

Label the x and y axis. [1 mark]
How could the student find out if the result at 30 °C is anomalous? [1 mark]

Suggest what the value at 30 °C should be to fit the pattern of the graph. [1 mark]

Turn over for the next question
All life on Earth depends on water.

**Figure 16** shows an iceberg floating on the sea.

*Figure 16*

1. Explain how the water molecules in the iceberg could end up as water in a lake. [4 marks]
Rainwater collects in rivers and lakes. Water in rivers and lakes contains materials that make the water unsafe to drink. Describe how the water from rivers and lakes is treated to make it safe to drink. [4 marks]
There are no questions printed on this page
Statins are drugs used to treat coronary heart disease (CHD).

New drugs must be trialled before they can be licensed for use.

Some scientists trialled two different types of statin.

The scientists:
- conducted the trial on 325 patients with a history of CHD in their family
- used a double-blind trial method
- measured the change in blood cholesterol levels over two years
- measured the change in thickness of an artery wall over two years.

During the trials the statins are tested for side effects.

Give **two** other reasons why the statins are trialled before use. **[2 marks]**

1

2

Describe how the double-blind method is used in this trial. **[2 marks]**
The results of drug trials are **peer reviewed** before they are published.

Why are peer reviews important in drug trials? 

Tick one box.

- To calculate the best dose
- To check the drug works
- To make sure the scientist gets credit
- To prevent false claims

**Table 4** shows the results of the trial.

<table>
<thead>
<tr>
<th></th>
<th>Drug A</th>
<th>Drug B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients who died during the trial</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Number of patients who reported aching muscles</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Number of patients who reported mild abdominal cramps</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Change in blood cholesterol level in percentage</td>
<td>−50.5</td>
<td>−41.2</td>
</tr>
<tr>
<td>Change in thickness of artery wall in mm</td>
<td>−0.0033</td>
<td>+0.032</td>
</tr>
</tbody>
</table>
Drug A is more effective than Drug B.

Give **two** reasons that support this conclusion.

Use information from **Table 4.**

[2 marks]

1

2

A scientist concludes that Drug A is a safer drug than Drug B.

Give **two** reasons why this is **not** a valid conclusion.

[2 marks]