Wednesday 23 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.
A solar water bag can be used to heat water for an outdoor swimming pool. A student wanted to find out if the colour of the solar water bag affects the temperature increase of the water inside the bag. Figure 1 shows some of the equipment used.

This is the method used.

1. Fill each bag with water.
2. Place the four bags on the ground outside.
3. After three hours, measure the temperature of the water inside each bag.
4. Repeat steps 1–3 on the next two days.

Suggest three changes the student should make to this method to get valid results. [3 marks]

1. 
2. 
3. 

Question 1 continues on the next page
The student repeated the investigation using an improved method.

The results obtained were valid.

**Table 1** shows the results.

<table>
<thead>
<tr>
<th>Colour of bag</th>
<th>Temperature increase in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
</tr>
<tr>
<td>Black</td>
<td>44.0</td>
</tr>
<tr>
<td>Pale blue</td>
<td>38.5</td>
</tr>
<tr>
<td>Pale green</td>
<td>37.9</td>
</tr>
<tr>
<td>White</td>
<td>25.3</td>
</tr>
</tbody>
</table>

The student used a thermometer to measure the temperature of the water inside each bag.

What was the resolution of the thermometer?

**[1 mark]**

Resolution = ____________ °C

Suggest one reason why the temperatures increased less on Day 2 than on Day 1 and Day 3.

**[1 mark]**

_________________________________________________________________________
_________________________________________________________________________
Calculate the mean temperature increase for the white bag.  

mean temperature increase = °C

Which colour of bag would be best to use to heat water?

Give a reason for your answer.

Colour

Reason

 Turn over for the next question
Dravet syndrome is caused by a genetic mutation.

Dravet syndrome causes epileptic seizures. An epileptic seizure is caused by unusual brain activity.

Mutations often happen when cells divide.

Give one other cause of genetic mutations. [1 mark]

Scientists have transferred the mutated gene for Dravet syndrome into zebrafish using genetic engineering.

This means the scientists could test a new drug to treat Dravet syndrome on the zebrafish.

Which two of the following are used during the process of genetic engineering? [2 marks]

Tick two boxes.

- Enzymes
- Placebos
- Vaccines
- Vectors
- White blood cells
Scientists used the genetically engineered zebrafish to test the new drug.

Describe the processes that then need to happen to test the new drug before it can be used to treat all children with Dravet syndrome.

[6 marks]
A man with breathing difficulties goes to hospital.

Figure 2 shows his lung scan and chest X-ray.

Figure 2

Lung scan  Chest X-ray

0 3.1 What is part A? [1 mark]

Tick one box.

Bronchus  
Capillary  
Trachea  
Vein  

0 3.2 Give one advantage of using the lung scan, rather than the chest X-ray, to diagnose problems with the man’s breathing system. [1 mark]
03.3 Give one advantage of using the chest X-ray, rather than the lung scan, to diagnose problems with the man’s breathing system. [1 mark]

03.4 Aerobic respiration and anaerobic respiration are the two types of cell respiration. Give three differences between aerobic and anaerobic respiration. [3 marks]

1

2

3

Question 3 continues on the next page
A health website contains the following advice:

**Stop smoking and you will be healthier and live longer.**

Explain why stopping smoking will improve a person's health. **[6 marks]**
Owls are predators of mice and voles.

Which of the following are biotic factors that would affect owl populations? [2 marks]

Tick two boxes.

1. Availability of food
2. Carbon dioxide levels
3. Moisture levels
4. New diseases
5. Oxygen levels
6. Soil pH

Scientists collected population data for mice, voles and owls from one woodland over two years.

The scientists collected the data using sampling techniques.

Suggest why the population data collected may not be accurate. [2 marks]
**Figure 3** shows how the total number of mice and voles changed over two years.

**Figure 3**

The number of owls also changed over the same time period.

The changes in the numbers followed a typical predator–prey relationship.

Sketch a line on **Figure 3** to show how you would expect the number of owls to change.

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**04.3**

What would happen to the number of voles if the population of mice decreased?

Give reasons for your answer.

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**04.4**
There are no questions printed on this page
Millions of people get salmonella food poisoning each year.

A new vaccine has been developed to protect people against salmonella food poisoning.

Explain how the vaccine prevents people becoming ill with salmonella food poisoning. [5 marks]

Salmonella food poisoning is caused by *Salmonella* bacteria.

*Salmonella* is treated with an antibiotic called nalidixic acid.

Nalidixic acid is no longer effective for some strains of *Salmonella* bacteria.

Explain how these bacteria have evolved by natural selection. [3 marks]
Students investigated the effect of lack of sleep on reaction time.

This is the method used.

1. Each student sleeps for a different amount of time.
2. Each student then completes a reaction time test on the computer five times.

The computer program asks the students to press a key on the keyboard when they hear a sound played at random.

*Table 2* shows the results of the investigation.

**Table 2**

<table>
<thead>
<tr>
<th>Student</th>
<th>Number of hours of sleep</th>
<th>Reaction time in milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>A</td>
<td>8</td>
<td>229.6</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>298.3</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>211.2</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>449.3</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>712.0</td>
</tr>
</tbody>
</table>

Calculate the percentage decrease in mean reaction time when the number of hours of sleep increases from 1 hour to 8 hours.

**[2 marks]**

Percentage decrease in reaction time =
Apart from using a computer program, describe one other method of measuring reaction time. [4 marks]

A computer program measures reaction time accurately. Suggest one other reason why the students used a computer program to measure reaction time. [1 mark]

A student concluded that lack of sleep increases reaction time. Suggest two reasons why the data generated from the students’ method may not allow a valid conclusion to be made. [2 marks]

1 ______________________________________

2 ______________________________________

Question 6 continues on the next page
Scientists investigated the effect of lack of sleep and the effect of alcohol consumption on the human nervous system.

This is the method used.

1. Each person completes an accuracy test using a computer.
2. Their average score is taken as 100%.
3. Half of the group are kept awake for 24 hours.
4. The other half of the group drink alcohol until their blood alcohol level reaches 0.12%.
5. Each person repeats the accuracy test at regular intervals using a computer.

**Figure 4** and **Figure 5** show the results of the investigation.
Mean relative performance is a comparison with the person’s original score. For example, 50% means their accuracy on the test was half of their original score.

If your blood alcohol concentration is above 0.08% it is against the law to drive in the UK.

A newspaper states the following:

**Driving whilst tired is as dangerous as driving after drinking alcohol.**

Evaluate the newspaper’s statement.

Use information from Figure 4 and Figure 5.

[4 marks]
Getting safe drinking water is a problem for millions of people. Cholera is a waterborne disease. 

**Figure 6** shows data about cholera from one area of Africa.

![Graph showing data about cholera from 2002 to 2014: the number of cases and deaths is decreasing over time.](image)
07.1 What percentage of cases of cholera reported in 2004 resulted in deaths in 2004?

Give your answer to 2 significant figures.

[4 marks]

| Percentage deaths = __________________________ |

07.2 A student concluded that a cholera epidemic occurred in 2008.

Give one reason for and one reason against the student’s conclusion.

Use information from Figure 6.

[2 marks]

| Reason for epidemic: __________________________ |
| Reason against epidemic: ______________________ |

07.3 A different student concluded that a cholera epidemic had occurred in 2002.

Why can we not be sure of this from the data given in Figure 6?

[1 mark]

| Reason for not being sure: ______________________ |

Question 7 continues on the next page
Suggest two possible ways in which cholera might spread in one area of Africa. [2 marks]

1

2

There are a number of ways to provide clean and safe water for people. **Figure 7** shows a simple method for collecting clean water. This method is called solar distillation.

**Figure 7**

Explain the processes that occur in the method shown in **Figure 7** to provide clean drinking water. [5 marks]
Another method of making water safe to drink is to use a portable steriliser.

**Figure 8** shows a portable steriliser.

![Portable Steriliser Diagram](image)

The steriliser emits light.

Explain how the steriliser kills the bacteria in the water.

**[3 marks]**

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There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED
Figure 9 shows a rocky shore.

Students were asked to investigate how the abundance and distribution of different organisms change as you move from the edge of the sea to the stony beach.

Describe a method the students could use. [6 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
A kite diagram shows the distribution and number of organisms.

**Figure 10** shows a kite diagram of the results from a similar investigation on the same rocky shore.

Which organism was most abundant?

Give a reason for your answer.

[2 marks]
The shallow rock pool in Figure 10 has a higher biodiversity than the sand or the stony beach.

Suggest three reasons why.

[3 marks]
Neon is an element. Neon is used in advertising signs.

Figure 11 shows a neon sign.

Figure 11

Explain why the atoms of neon give out electromagnetic radiation when the tube is connected to an electricity supply.

[4 marks]

Question 9 continues on the next page
Some elements can have different isotopes.

An isotope of carbon can be shown as $^{13}_6\text{C}$.

Figure 12 shows an incorrect diagram of the structure of an atom of $^{13}_6\text{C}$.

Figure 12

Explain why the diagram of the atomic structure shown in Figure 12 is incorrect.

[4 marks]
Carbon-14 ($^{14}_6\text{C}$) is a radioactive isotope of carbon. Carbon-14 undergoes beta decay.

Figure 13 shows an incomplete nuclear equation for the radioactive decay of carbon-14.

$$^{14}_6\text{C} \rightarrow ^{14}_7\text{N} + \square$$

Which of the following correctly completes the nuclear equation in Figure 13?

[1 mark]

Tick one box.

\[ e \]

[2 marks]

Explain the change in atomic number in the nuclear equation shown in Figure 13.

Question 9 continues on the next page
The half-life of carbon-14 is 5730 years.

Carbon-14 is used for carbon dating. Carbon dating can tell us how old some objects are.

A skeleton was carbon dated. The results showed that there was only 12.5% of the original amount of carbon-14 left in the skeleton.

Calculate the age of the skeleton. [2 marks]

Age of skeleton = ____________ years old