Materials
For this paper you must have:
• Ruler
• Pencil, Rubber, Protractor and Compass
• Scientific calculator, which you are expected to use when appropriate

Instructions
• Answer all questions
• Answer questions in the space provided
• All working must be shown
• Do all rough work in this book. Cross out any rough work you don’t want to be marked

Information
• The marks for the questions are shown in brackets
This question is about coordination in the human body.

**Figure 1** shows a sensory neurone (nerve cell).

![Figure 1](image)

(a) Which label is the cell nucleus?

Tick one box.

A   B   C   D

(b) Which label is the receptor?

Tick one box.

A   B   C   D

(c) **Figure 2** shows the nerve pathway when a person touches a sharp pin.

![Figure 2](image)

Name structures A and B on **Figure 2**

(2)
(d) When the finger touches the sharp pin, the muscle in the arm contracts to pull the arm away.

What type of action is this?

Tick two boxes

- A conscious action
- A delayed action
- A reflex action

(1)

(e) Doctors tested people of different ages to time how long it took between touching a sharp pin and the arm muscle contracting.

At each age they tested five men and calculated a mean value for the time.

The table below shows the results.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Mean time for muscle to contract in milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>60</td>
<td>23</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
</tr>
</tbody>
</table>

How much longer does it take for the muscle to contract at 80 years of age compared to at 20 years of age?

Give your answer in seconds.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Time = ______________________ s

(2)
(f) **Figure 3** shows the position of some of the glands which release hormones.

![Figure 3](image)

Which label on **Figure 3** shows the position of the pituitary gland?

Tick **one** box.

A [ ]  B [ ]  C [ ]  D [ ]

(g) Luteinising hormone (LH) is a hormone released by the pituitary gland.

What is the function of LH?

Tick **one** box.

- Controls blood glucose concentration [ ]
- Controls the formation of sperm [ ]
- Controls the growth of muscles [ ]
- Controls the release of an egg [ ]
(h) How does LH travel from the pituitary gland to its target organ?

(i) Figure 4 shows the relative levels of sex hormones of three young people over 30 days.

One person is an 8-year-old girl, one is an 18-year-old boy and the other is an 18-year-old girl.

![Figure 4](image)

**Key**
- Oestrogen
- Progesterone
- Testosterone

Which person is the 18-year-old boy?

Give one reason for your answer.

Person ________________________________

Reason ________________________________

(2) (Total 12 marks)

Contraceptives are used to prevent pregnancy.
(a) **Draw one** line from each contraceptive to the method of preventing pregnancy.

<table>
<thead>
<tr>
<th>Contraceptive device</th>
<th>Method of preventing pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contraceptive device</td>
<td>Contains hormones to stop eggs maturing</td>
</tr>
<tr>
<td>Contraceptive device</td>
<td>Prevents the sperm reaching the egg</td>
</tr>
<tr>
<td>Contraceptive device</td>
<td>Kills sperm</td>
</tr>
<tr>
<td>Contraceptive device</td>
<td>Slows down sperm production</td>
</tr>
<tr>
<td>Contraceptive device</td>
<td>Stops an embryo implanting in the uterus</td>
</tr>
</tbody>
</table>

The pie chart shows the percentages of people who used different types of contraception in the UK in 2016.

The people are aged 16–49 years.
(b) Determine the percentage of people who used no contraception.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Percentage of people = ____________________ %

(2)

(c) Suggest two reasons why a person aged 16–49 years might not be using contraception.

1. _________________________________________________________________

___________________________________________________________________

2. _________________________________________________________________

___________________________________________________________________

(2)

The table shows some information about three methods of contraception.

<table>
<thead>
<tr>
<th>Method</th>
<th>Effectiveness</th>
<th>Other information</th>
</tr>
</thead>
</table>
| Combined pill | 99.5%         | • Must be taken every day
               |                | • Free from your GP or sexual health clinic            |
               |                | • May cause headaches                                   |
| Male condom   | 98.0%         | • May split or leak                                     |
               |                | • Only used when you have sexual intercourse            |
               |                | • Inexpensive in supermarkets or free from a sexual health clinic |
| Sterilisation | 100.0%        | • Needs an operation in hospital                       |
               |                | • Usually cannot be reversed                            |
(d) A man and a woman plan to start a family in 5 years' time.

Compare the risks and benefits for this couple of the three methods of contraception.

___________________________________________________________________
___________________________________________________________________
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(4)
(Total 11 marks)

In 2017 more than 420 million people worldwide had diabetes.

The table below shows how the percentage of the population with diabetes has changed.

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of population with diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low-income countries</td>
</tr>
<tr>
<td>1986</td>
<td>3.5</td>
</tr>
<tr>
<td>1992</td>
<td>4.4</td>
</tr>
<tr>
<td>1998</td>
<td>5.2</td>
</tr>
<tr>
<td>2004</td>
<td>6.0</td>
</tr>
<tr>
<td>2010</td>
<td>6.9</td>
</tr>
</tbody>
</table>
(a) Use data from the table above to complete the graph in the graph below.

You should:
• plot the data for the low-income countries
• draw a line of best fit for the low-income countries.

The lines for high-income countries and the world have been drawn for you.

(b) Predict the percentage of the world population with diabetes in 2022 if the current pattern were to continue.

You should extend the line of best fit for the world on the graph above.

Percentage = _______________ %

(c) The trend may not continue in the same pattern after 2010.

Suggest one reason why the trend may change.

___________________________________________________________________
___________________________________________________________________
(d) Give two conclusions from the data shown in the graph above.

1. _________________________________________________________________
   ___________________________________________________________________

2. _________________________________________________________________
   ___________________________________________________________________

(2)

(e) The table above shows that the percentage of people with diabetes in the world has changed.

What are two possible reasons for this change?

Tick two boxes.

People are becoming more obese
People are doing more exercise
People are eating less salt
People are eating more sugar
People are smoking less

(2)

(Total 10 marks)
The diagram shows a reflex arc that moves the arm if the hand touches something hot.

(a) Which part is the receptor?
Tick one box.

A  B  D  F

(b) Which part is the effector of the reflex action?
Tick one box.

A  B  D  F

(c) Which part shows a sensory neurone?
Tick one box.

B  D  E  F

(d) Which part shows a synapse?
Tick one box.

A  B  D  E
(e) Part C contains DNA.

Which part of the nerve cell is C?

Tick one box.

- Cell membrane
- Cytoplasm
- Mitochondrion
- Nucleus

(f) Reflex actions are automatic and do not involve thinking.

Why is this an advantage?

___________________________________________________________________

___________________________________________________________________

(g) Which two factors can make you slower to react to a stimulus?

Tick two boxes.

- Alcohol
- Caffeine
- Daylight
- Practice
- Tiredness

(Total 8 marks)
This question is about the human nervous system.

(a) A ball is thrown towards a boy.

As the ball is thrown, information passes along a pathway to allow the boy to catch the ball.

Draw one line from each action to the correct part of the pathway.

<table>
<thead>
<tr>
<th>Action</th>
<th>Part of the pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retina cells in the eye detect the light from the ball</td>
<td>Coordinator</td>
</tr>
<tr>
<td>The impulse reaches the brain which ‘sees’ the ball and sends an impulse to the arm muscle</td>
<td>Effector</td>
</tr>
<tr>
<td>The muscle in the arm contracts</td>
<td>Response</td>
</tr>
<tr>
<td>The arm stretches to catch the ball</td>
<td>Receptor</td>
</tr>
<tr>
<td></td>
<td>Stimulus</td>
</tr>
</tbody>
</table>

Students in a college made this hypothesis:

‘reaction time will increase as the time you have been awake increases.’

The students set up an investigation to test their hypothesis.

This is the method used.

1. Find 5 volunteers willing to stay awake for 24 hours.
2. Keep the volunteers in a room where they can study, use an exercise bike or watch TV as they wish.
3. Provide food, water, coffee and tea as requested.
4. Measure the volunteers’ reaction time every 4 hours using a computer program.

(b) What was the independent variable in this investigation?
The students used a computer program to test reaction time.

(c) Describe one other method that can be used to measure reaction time.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)

(d) Which method would you choose to use at your school?

Tick one box.

Computer program  
Method described in part (c)  

Give one reason for your choice.
___________________________________________________________________
___________________________________________________________________

(1)
The table shows the students’ results.

<table>
<thead>
<tr>
<th>Time awake in hours</th>
<th>Reaction time in seconds</th>
<th>Volunteer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>0.21</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>0.26</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>0.64</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>0.92</td>
</tr>
</tbody>
</table>

(e) Calculate value X in the table.

Give your answer to 2 significant figures.

___________________________________________________________________
___________________________________________________________________

\[
X = \underline{\quad \quad \quad \quad \quad \quad \quad \quad} \text{seconds}
\]

(2)

(f) Describe the pattern of results for mean reaction time as the time awake increases.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(g) Do these results support the students’ hypothesis: ‘reaction time will increase as the time you have been awake increases’?

Give one reason for your answer.

___________________________________________________________________
___________________________________________________________________

(1)
(g) Give two ways the students could improve their investigation to make it more valid.

1. _________________________________________________________________
___________________________________________________________________

2. _________________________________________________________________
___________________________________________________________________

(Total 15 marks)

This question is about reproduction.

(a) Describe the difference between the way hormonal and non-hormonal methods of contraception work.

Give one example of each method of contraception.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)
The urine of women using hormonal methods of contraception contains high levels of progesterone.

Concentrations of 1–3 ng/dm$^3$ of progesterone are found in the water of rivers near sewage outflow points.

Scientists investigated the effect of different concentrations of progesterone in water on fish reproduction.

This is the method used.

1. Prepare tanks of water containing different concentrations of progesterone.
2. Put a breeding pair of fish into each tank.
3. Record the number of eggs produced per day by the female in each tank for 14 days.

The table shows the results.

<table>
<thead>
<tr>
<th>Concentration of progesterone in water in ng/dm$^3$</th>
<th>Mean number of eggs produced per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>28.6</td>
</tr>
<tr>
<td>0.8</td>
<td>4.5</td>
</tr>
<tr>
<td>1.5</td>
<td>3.2</td>
</tr>
<tr>
<td>3.0</td>
<td>2.8</td>
</tr>
<tr>
<td>10.0</td>
<td>1.1</td>
</tr>
<tr>
<td>20.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>
(b) Plot the data from the table on the grid.

You should:
• label each axis
• use a suitable scale
• draw a line of best fit.
(c) Describe the effect on fish reproduction of the concentrations of progesterone found in rivers near sewage outflows.

Use data from your graph.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
(Total 9 marks)

7

There are several methods of contraception.

(a) 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>

(2)

(b) 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)
Evaluate the use of these contraceptive methods.

<table>
<thead>
<tr>
<th>Percentage (%) effectiveness</th>
<th>Condom</th>
<th>Oral contraceptive</th>
<th>Hormone skin patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>98.0</td>
<td>99.7</td>
<td>99.8</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How contraception is obtained</th>
<th>Condom</th>
<th>Oral contraceptive</th>
<th>Hormone skin patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>From shops or sexual health clinic</td>
<td></td>
<td>From doctor or sexual health clinic</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Possible side effects</th>
<th>Condom</th>
<th>Oral contraceptive</th>
<th>Hormone skin patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>No serious side effects</td>
<td></td>
<td>Headaches, nausea, high blood pressure</td>
<td>Headaches, nausea, blood clots</td>
</tr>
</tbody>
</table>

(6) (Total 9 marks)
The graph below shows how hormone concentrations vary during a normal human menstrual cycle if a woman does not become pregnant.

(a) Calculate the rate of increase in LH concentration between day 9 and day 12

Give your answer in arbitrary units per hour.

Give your answer to 2 significant figures.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Rate = _____________________ arbitrary units per hour

(2)
(b) Describe the sequence of hormone interactions in the menstrual cycle.

Name where each hormone is produced.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(5)

(c) Progesterone is used in some contraceptives.

Suggest one advantage of using a progesterone patch rather than a progesterone oral contraceptive.

___________________________________________________________________
___________________________________________________________________

(1)

(Total 8 marks)

Control of blood glucose concentration is an important aspect of homeostasis.

When the blood glucose concentration is too high the hormone insulin is released.

(a) Name the hormone released when the blood glucose concentration is too low.

___________________________________________________________________

(1)
(b) Explain how the **two** hormones keep the blood glucose concentration at the correct level in a healthy human body.

The two hormones which control blood glucose concentration are proteins.

Proteins are made according to information stored in the DNA structure of genes.

(c) Describe the structure of DNA.

(d) Describe how DNA controls the structure of a protein.
(e) Polydactyly and cystic fibrosis are both inherited disorders caused by faulty DNA.
- Polydactyly is caused by a dominant allele.
- Cystic fibrosis is caused by a recessive allele.

Mother A has polydactyly.

Mother B has cystic fibrosis.

Mother A is more likely to have a child with polydactyly than Mother B having a child with cystic fibrosis.

Explain why.

Assume the fathers of the children have no alleles for polydactyly or cystic fibrosis.

You may use genetic diagrams in your answer.
This question is about the nervous system.

The diagram below shows a reflex arc.

(a) Name parts P and Q shown on the diagram above.

P

Q

(2)

(b) Compare how information is transferred along a neurone with how information is transferred across gap P.

(2)

(c) Why does a conscious action take longer than a reflex action?

(1)
(d) Information travels at 120 metres per second in neurones.

Calculate the time it would take for the information to travel 1.6 m along a neurone.

Give your answer in milliseconds.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Time = ______________________ ms

(3)

(e) Doctors tested people of different ages to time how long it took between touching a sharp pin and the arm muscle contracting.

The table below shows the results.

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Time for muscle to contract in milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>18.9</td>
</tr>
<tr>
<td>40</td>
<td>20.2</td>
</tr>
<tr>
<td>50</td>
<td>23.1</td>
</tr>
<tr>
<td>60</td>
<td>26.7</td>
</tr>
<tr>
<td>70</td>
<td>31.3</td>
</tr>
<tr>
<td>80</td>
<td>37.0</td>
</tr>
</tbody>
</table>

Describe the relationship between age in years and time for the muscle to contract.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(Total 10 marks)