

FOR OFFICIAL USE

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**X009/301**

Total for  
Sections B & C

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NATIONAL  
QUALIFICATIONS  
2009

THURSDAY, 28 MAY  
1.00 PM – 3.30 PM

HUMAN BIOLOGY  
HIGHER

Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Date of birth

Day Month Year

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Scottish candidate number

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Number of seat

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**SECTION A—Questions 1–30**

Instructions for completion of Section A are given on page two.

For this section of the examination you must use an **HB pencil**.

**SECTIONS B AND C**

- (a) All questions should be attempted.

(b) It should be noted that in **Section C** questions 1 and 2 each contain a choice.
- The questions may be answered in any order but all answers are to be written in the spaces provided in this answer book, **and must be written clearly and legibly in ink.**
- Additional space for answers will be found at the end of the book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the **front** cover of this book.
- The numbers of questions must be clearly inserted with any answers written in the additional space.
- Rough work, if any should be necessary, should be written in this book and then scored through when the fair copy has been written. If further space is required a supplementary sheet for rough work may be obtained from the invigilator.
- Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.



### Read carefully

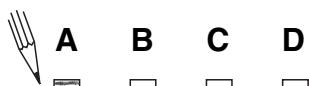
- 1 Check that the answer sheet provided is for **Human Biology Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil**, and where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate Number) and **Centre Name** printed on it.  
Do not change any of these details.
- 4 If any of this information is wrong, tell the Invigilator immediately.
- 5 If this information is correct, **print** your name and seat number in the boxes provided.
- 6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).
- 7 There is **only one correct** answer to each question.
- 8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.
- 9 At the end of the exam, put the **answer sheet for Section A inside the front cover of this answer book**.

### Sample Question

The digestive enzyme pepsin is most active in the

- A stomach
- B mouth
- C duodenum
- D pancreas.

The correct answer is **A**—stomach. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



### Changing an answer

If you decide to change your answer, carefully erase your first answer and, using your pencil, fill in the answer you want. The answer below has been changed to **D**.



SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. Which of the following often act as a co-enzyme?

- A Lipids
- B Polysaccharides
- C Hormones
- D Vitamins

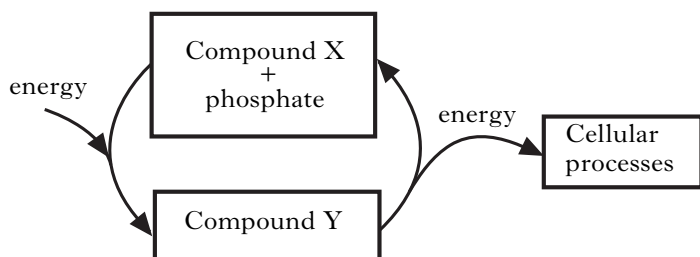
2. The table below refers to the mass of DNA in certain human body cells.

Cell type	Mass of DNA in cell ( $\times 10^{-12}$ g)
liver	6.6
lung	6.6
P	3.3
Q	0.0

Which of the following is most likely to identify correctly cell types P and Q?

	P	Q
A	kidney cell	sperm cell
B	sperm cell	mature red blood cell
C	mature red blood cell	sperm cell
D	nerve cell	mature red blood cell

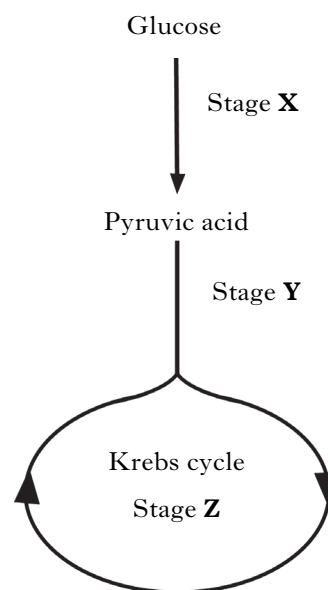
3. The diagram below shows energy transfer within a cell.



Which line in the table below identifies correctly compounds X and Y?

	X	Y
A	glucose	ATP
B	glucose	ADP
C	ADP	ATP
D	ATP	glucose

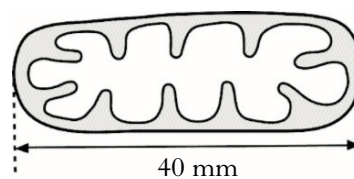
4. The following chart shows stages in the complete breakdown of glucose in aerobic respiration.



At which stage or stages is hydrogen released to be picked up by hydrogen acceptors?

- A Stages X, Y and Z
- B Stages X and Y only
- C Stages Y and Z only
- D Stage Z only

5. The cell organelle shown below is magnified ten thousand times.



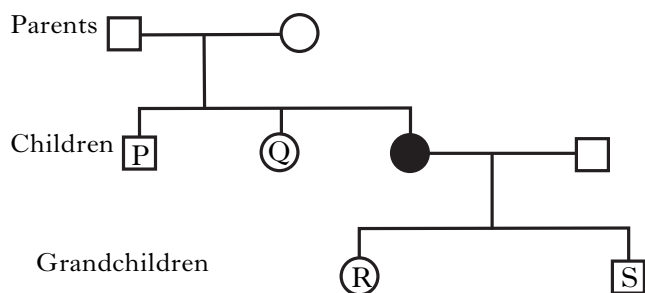
What is the actual size of the organelle?

- A 0.04  $\mu$ m
- B 0.4  $\mu$ m
- C 4  $\mu$ m
- D 40  $\mu$ m

6. Lysosomes are abundant in

- A enzyme secreting cells
- B muscle cells
- C cells involved in protein synthesis
- D phagocytic cells.

7. The family tree below shows the transmission of the Rhesus D-antigen through three generations of a family. The allele coding for the presence of the Rhesus D-antigen is dominant and autosomal.



- Rhesus positive male
- Rhesus negative male
- Rhesus positive female
- Rhesus negative female

Which of the children and grandchildren in the family tree must be heterozygous?

- A P, Q, R and S
  - B P and Q only
  - C R and S only
  - D Q and R only
8. The table below shows some genotypes and phenotypes associated with a form of anaemia.

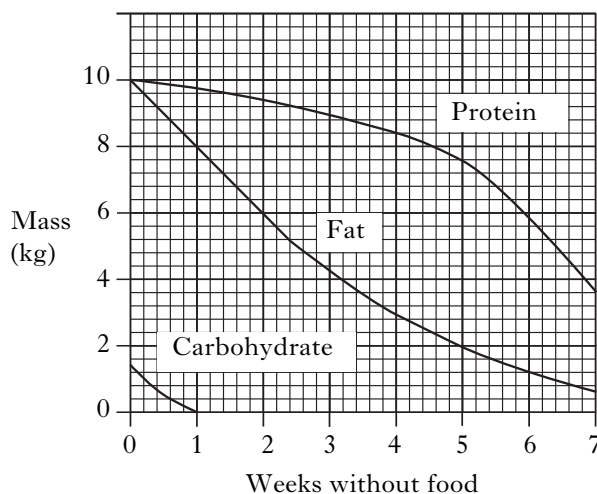
<i>Genotype</i>	<i>Phenotype</i>
AA	Unaffected
AS	Sickle cell trait
SS	Acute sickle cell anaemia

An unaffected person and someone with sickle cell trait have a child together.

What are the chances of the child having acute sickle cell anaemia?

- A none
- B 1 in 4
- C 1 in 2
- D 1 in 1

9. The graph below shows changes which occur in the masses of protein, fat and carbohydrate in a person's body during seven weeks without food.

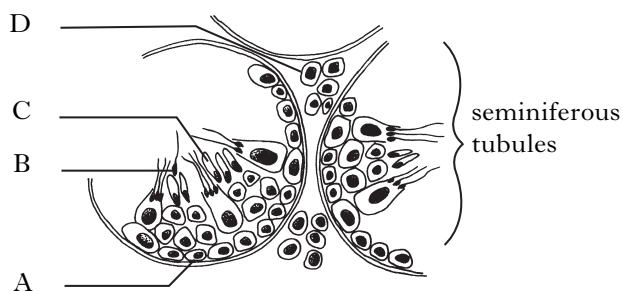


The person's starting weight was 60 kg. Predict their weight after two weeks without food.

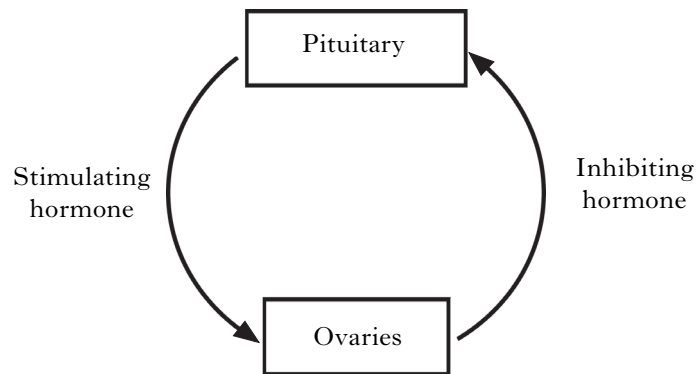
- A 57 kg
- B 54 kg
- C 50 kg
- D 43 kg

10. The diagram below shows a section through seminiferous tubules in a testis.

Which cell produces testosterone?



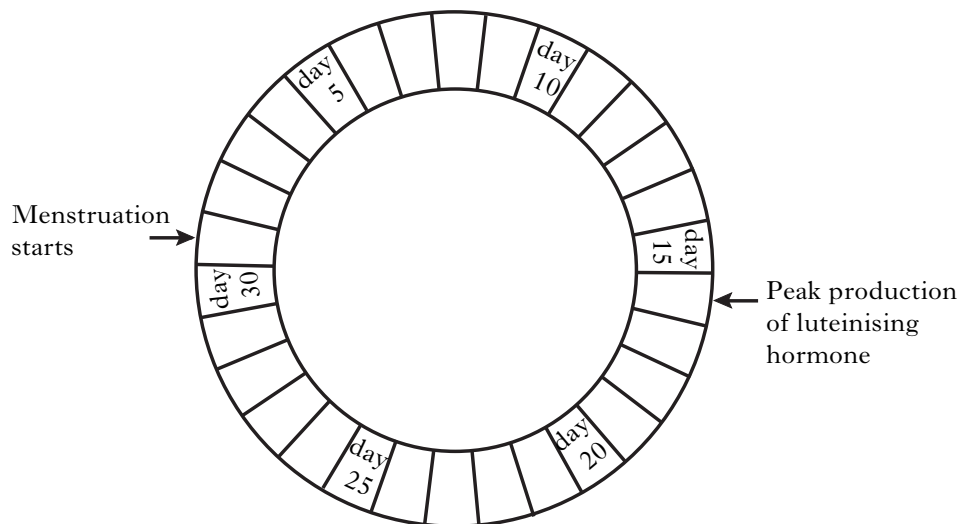
11. The diagram below represents part of the mechanism which controls ovulation.



The hormones indicated above are

	<i>Stimulating hormone</i>	<i>Inhibiting hormone</i>
A	FSH	oestrogen
B	progesterone	FSH
C	oestrogen	LH
D	LH	testosterone

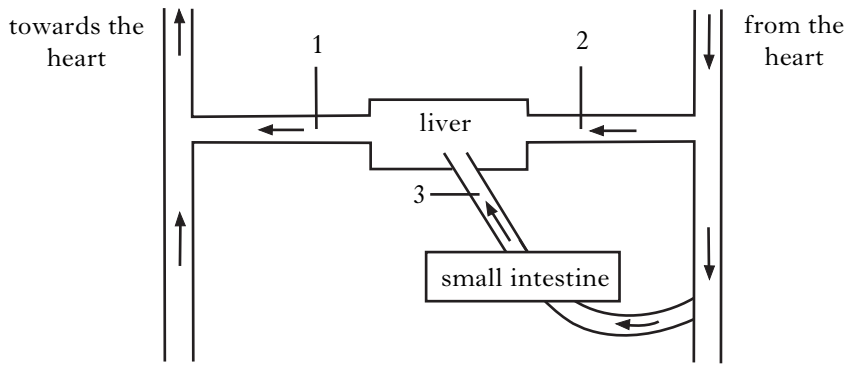
12. On which day in the following menstrual cycle could fertilisation occur?



- A Day 30
- B Day 17
- C Day 14
- D Day 2

[Turn over

13. The diagram below shows blood vessels associated with the liver. The arrows show the direction of blood flow.



Which of the following correctly identifies the blood vessels.

	1	2	3
A	hepatic artery	hepatic vein	hepatic portal vein
B	hepatic vein	hepatic portal vein	hepatic artery
C	hepatic vein	hepatic artery	hepatic portal vein
D	hepatic artery	hepatic portal vein	hepatic vein

14. The relatively high urea concentration in the hepatic vein is a result of

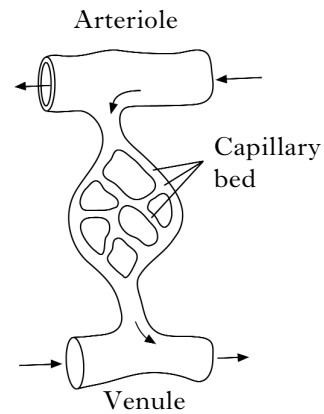
- A reabsorption of amino acids in the kidney
- B conversion of glycogen to glucose in the liver
- C deamination of amino acids in the liver
- D excretion of amino acids in the kidney.

15. A person produces 0.75 litres of urine in 24 hours. The urine contains 18 g of urea.

What is the concentration of urea in the urine?

- A 1.0 g/100 cm<sup>3</sup>
- B 1.8 g/100 cm<sup>3</sup>
- C 2.4 g/litre
- D 2.4 g/100 cm<sup>3</sup>

16. The diagram below represents a part of the circulatory system of the skin.

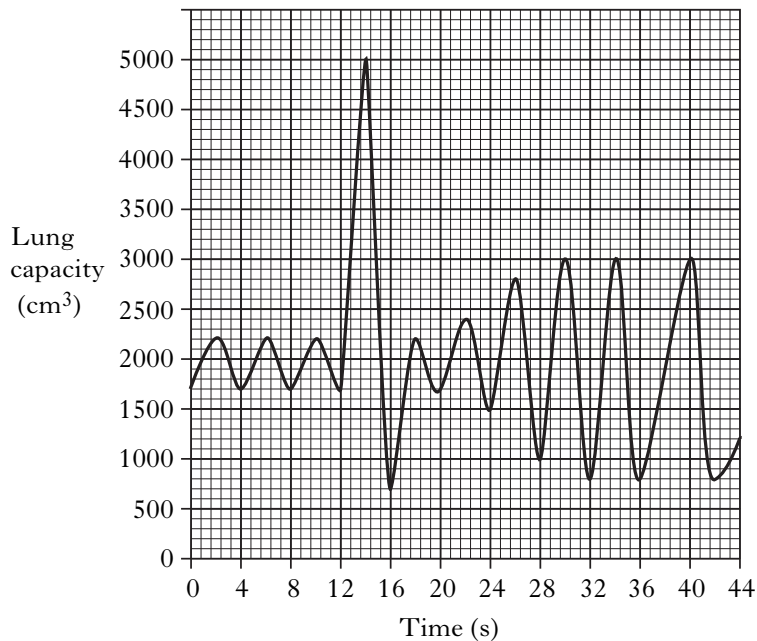


Which line in the table below correctly identifies changes which would take place in the blood as it flows from arteriole to venule?

	Concentration of	
	glucose	CO <sub>2</sub>
A	increase	decrease
B	decrease	decrease
C	increase	increase
D	decrease	increase

17. A man was asked to breathe steadily at rest, then to breathe in and out as deeply as possible and finally to breathe steadily when exercising.

A trace of his lung capacity during this activity is shown.



His volume of one breath at rest is

- A 500 cm<sup>3</sup>
- B 2200 cm<sup>3</sup>
- C 4300 cm<sup>3</sup>
- D 5000 cm<sup>3</sup>.

18. Which of the following is **not** a function of the lymphatic system?
- A It returns excess tissue fluid to the blood.
  - B It causes the clotting of blood at wounds.
  - C It destroys bacteria.
  - D It transports fat from the small intestine.

19. When there is a decrease in the water concentration of the blood, which of the following series of events occur during the negative feedback response of the body?

	<i>Concentration of ADH</i>	<i>Permeability of kidney tubules</i>	<i>Volume of urine</i>
A	increases	increases	increases
B	decreases	decreases	increases
C	increases	increases	decreases
D	decreases	increases	decreases

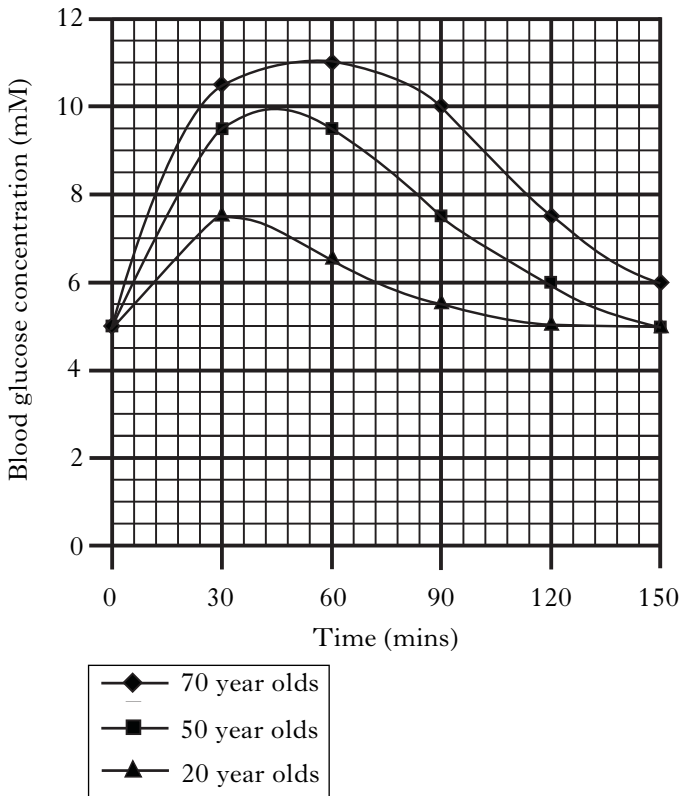
20. Which of the following shows the correct responses to changes in blood sugar concentration?

	<i>Sugar concentration in blood</i>	<i>Glucagon secretion</i>	<i>Insulin secretion</i>	<i>Glycogen stored in liver</i>
A	increases	decreases	increases	increases
B	increases	decreases	increases	decreases
C	decreases	increases	decreases	increases
D	decreases	decreases	increases	decreases

[Turn over

21. High levels of blood glucose can cause clouding of the lens in the human eye. Concentrations above 5.5 mM are believed to put the individual at a high risk of lens damage.

In an investigation, subjects of different ages each drank a glucose solution. The concentration of glucose in their blood was then monitored over a number of hours. The results are shown in the graph below.



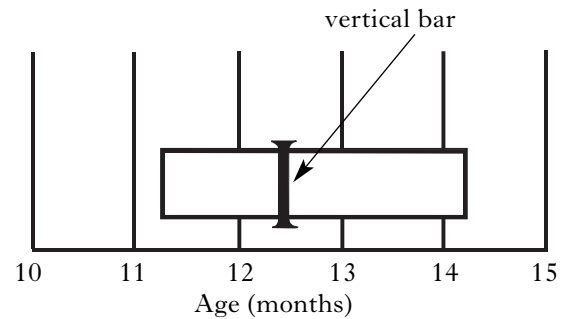
For how long during the investigation did 20 year olds remain above the high risk blood glucose concentration?

- A 84 mins  
 B 90 mins  
 C 120 mins  
 D 148 mins
22. Which of the following parts of the brain is important in transferring information between the two cerebral hemispheres?
- A Hypothalamus  
 B Corpus callosum  
 C Cerebellum  
 D Medulla oblongata

23. Which parts of the body are controlled by the largest motor area of the cerebrum?

- A Hands and lips  
 B Feet and hands  
 C Arms and hands  
 D Legs and arms

24. The diagram below shows the ages in months at which children are able to walk unaided. The left end of the bar shows the age at which 25% of infants can walk unaided. The right end of the bar shows the age at which 90% of infants can walk unaided. The vertical bar shows the age at which 50% of infants can walk unaided.



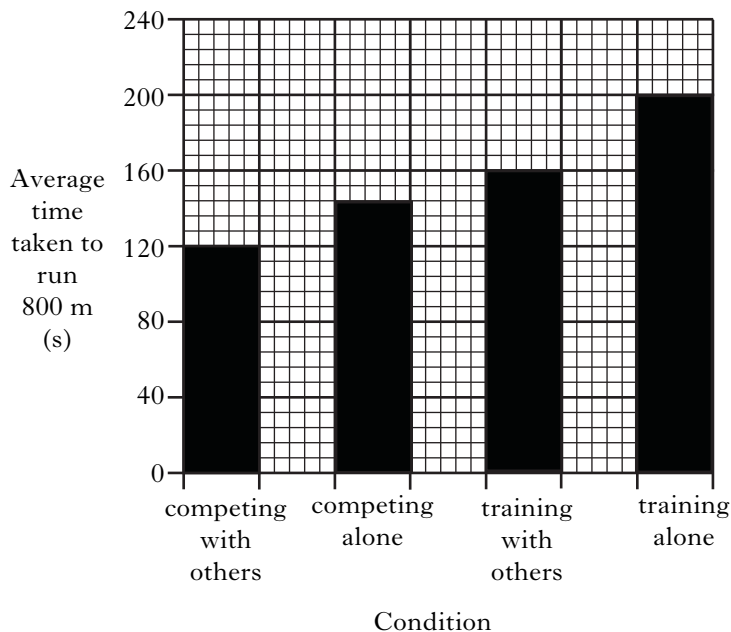
If sixteen infants, aged twelve months, were tested, how many would be expected to walk unaided?

- A 4  
 B 7  
 C 9  
 D 12

25. Which of the following best describes memory span?

- A The total memory capacity of the brain  
 B The time taken to learn a piece of information  
 C The storage capacity of the short-term memory  
 D The capacity to store information in long-term memory

26. The graph below shows the results of a survey carried out on members of an athletic club who ran an 800m course under different conditions.

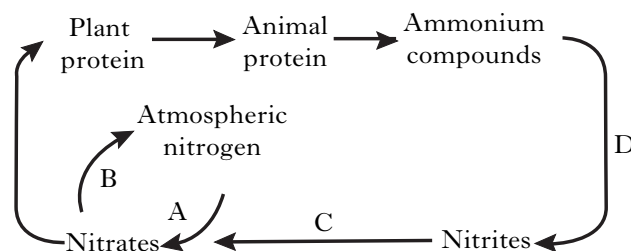


What is the percentage improvement in the time taken to run 800 m between those athletes training on their own and those training with others?

- A 40%  
 B 25%  
 C 24%  
 D 20%
27. Which of the following processes reduces atmospheric carbon dioxide concentrations?
- A Decomposition  
 B Nitrogen fixation  
 C Respiration  
 D Photosynthesis
28. Which of the following is a major source of methane?
- A Motor vehicles  
 B Aerosols  
 C Cattle  
 D Nitrate fertilisers

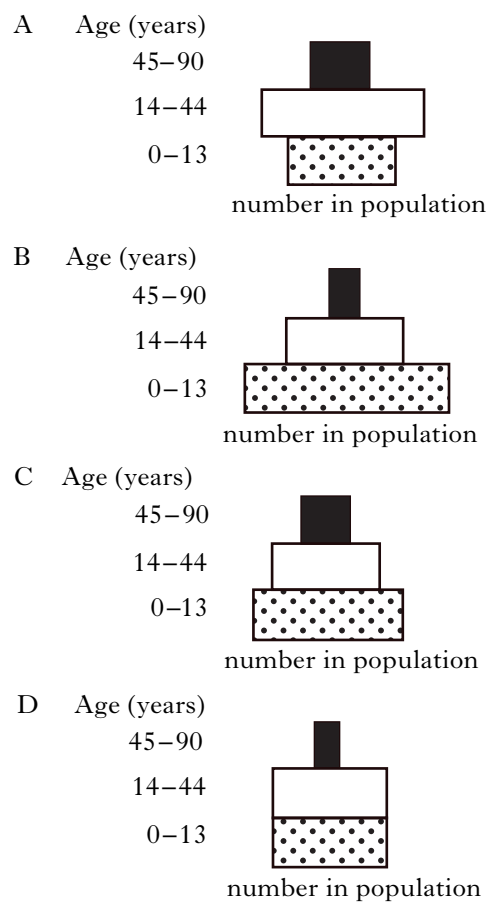
29. The diagram below shows a nitrogen cycle associated with soil.

Which arrow indicates the activity of denitrifying bacteria?



30. The age structure for four different human populations is represented in the diagrams below. The bars indicate the relative numbers in each age group.

Which diagram shows the population with the greatest potential for growth in the next forty years?



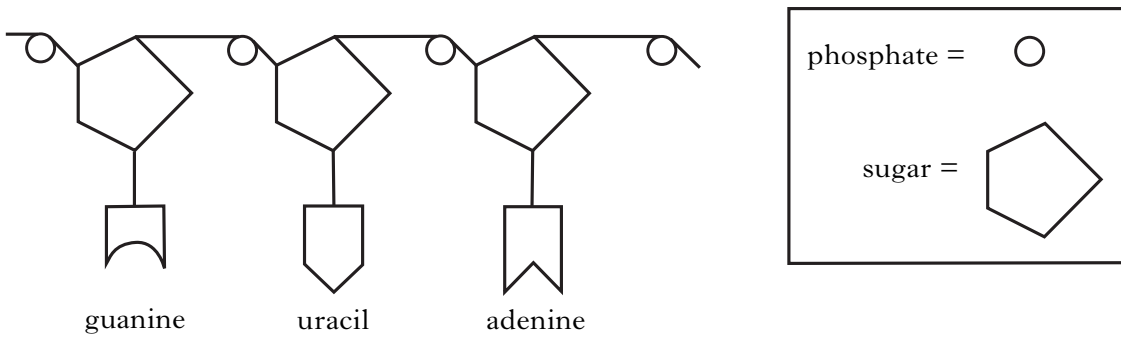
Candidates are reminded that the answer sheet **MUST** be returned **INSIDE** the front cover of this answer booklet.

Marks

**SECTION B**

**All questions in this section should be attempted.  
All answers must be written clearly and legibly in ink.**

1. (a) The diagram below shows a section of a messenger RNA (mRNA) molecule.



(i) Name the sugar that is present in mRNA.

\_\_\_\_\_

1

(ii) Which base found in mRNA is **not** shown in the diagram?

\_\_\_\_\_

1

(iii) Name **two** parts of a cell where mRNA is found.

1 \_\_\_\_\_

2 \_\_\_\_\_

1

(b) DNA templates are used to produce mRNA molecules.

(i) Insert the names of the DNA bases which pair with the RNA bases shown in the table below.

<i>DNA base</i>	<i>RNA base</i>
	adenine
	uracil
	guanine

1

**1. (b) (continued)**

*Marks*

- (ii) Apart from free RNA nucleotides and a DNA template, name **one** other molecule that is essential for mRNA synthesis.

\_\_\_\_\_

**1**

- (iii) Describe the part played by an mRNA molecule in the manufacture of a cell protein.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**3**

**[Turn over**

2. Many inherited disorders are caused by inborn errors of metabolism.

Marks

(a) (i) What causes disorders that lead to inborn errors of metabolism?

\_\_\_\_\_

1

(ii) How do these inherited disorders affect metabolic pathways?

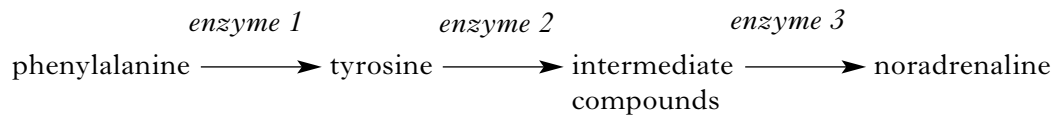
\_\_\_\_\_

\_\_\_\_\_

1

(b) Phenylketonuria (PKU) is an example of an inherited disorder.

One metabolic pathway affected by PKU is shown below.



(i) Describe how PKU affects the metabolic pathway shown above.

\_\_\_\_\_

\_\_\_\_\_

1

(ii) With reference to the metabolic pathway shown, explain why PKU affects the nervous system.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2

(c) What term describes the testing of newborn babies for inherited disorders such as PKU?

\_\_\_\_\_

1

3. (a) The MN blood group system is determined by two alleles, M and N. Each of these alleles controls the production of a different antigen on the cell membrane of red blood cells.

Marks

M and N are co-dominant.

- (i) Two parents, who are heterozygous for this blood group, have a son. Complete the Punnett square below to show the parental gametes and the possible genotypes of their son.

Parents Genotype	Mother MN	×	Father MN
		<i>mother's gametes</i>	
<i>father's gametes</i>			MN

1

- (ii) The son has a different genotype to either of his parents. What are the chances of this happening?

*Space for calculation*

\_\_\_\_\_ %

1

- (iii) Describe how the son's phenotype differs from his parents.

\_\_\_\_\_

\_\_\_\_\_

1

- (b) The immune system recognises antigens on the cell membrane as self or non-self.

What term describes

- (i) an immune reaction to self antigens?

\_\_\_\_\_

1

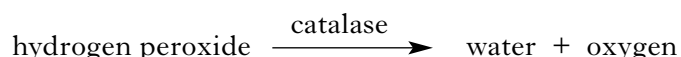
- (ii) an over-reaction to a normally harmless non-self antigen?

\_\_\_\_\_

1

[Turn over

4. Hydrogen peroxide is a toxic chemical which is produced during metabolism. Catalase is an enzyme which breaks down hydrogen peroxide as shown below.



Experiments were carried out to investigate how changing the concentration of catalase affects the rate of hydrogen peroxide breakdown.

Filter paper discs were soaked in catalase solutions of different concentration. Each disc was then added to a beaker of hydrogen peroxide solution as shown in **Figure 1**.

The disc sank to the bottom of the beaker before rising back up to the surface. The time taken for each disc to rise to the surface was used to measure the reaction rates.

The results of the investigation are shown in **Table 1**.

Figure 1

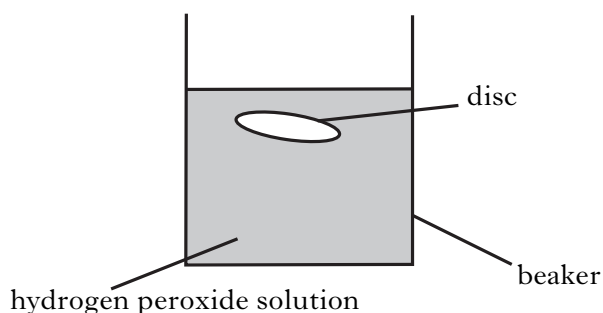


Table 1

<i>catalase concentration (%)</i>	<i>average time for ten discs to rise (s)</i>
0.125	9.8
0.25	6.9
0.5	5.0
1.0	3.8
2.0	3.8

- (a) Explain why the filter paper discs rose to the surface of the hydrogen peroxide solution.

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1

- (b) Name **three** variables which should be controlled during this investigation.

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

2

- (c) What feature of **this** investigation makes the results more reliable?

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1

Marks

4. (continued)

Marks

(d) It was suggested that the filter paper was reacting with the hydrogen peroxide. How could this be tested using the same procedure?

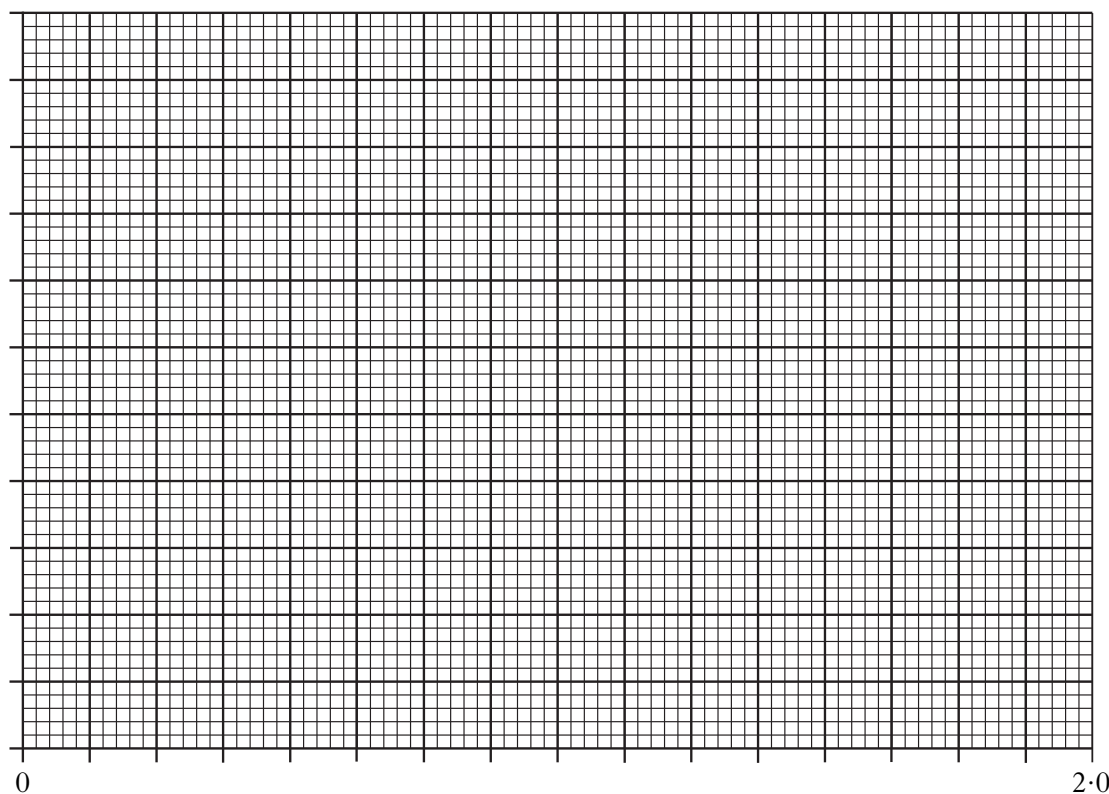
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1

(e) (i) Plot a line graph to illustrate the results of the investigation. (Additional graph paper, if required, can be found on *Page thirty-two*.)



2

(ii) State **two** conclusions which can be drawn from these results.

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

2

(f) Explain why the addition of an inhibitor would slow down the rate of this reaction.

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1

5. The diagram shows part of the reproductive system of a woman in early pregnancy.

Marks



(a) Place an **X** on the diagram to show where fertilisation occurred.

1

(b) Structure P produces progesterone at this stage in pregnancy.

(i) Name structure P.

\_\_\_\_\_

1

(ii) State **one** function of progesterone during early pregnancy.

\_\_\_\_\_

\_\_\_\_\_

1

(c) Structure Q will develop into the placenta.

Name the processes involved in the transfer of oxygen, glucose and antibodies across the placenta.

Oxygen \_\_\_\_\_

Glucose \_\_\_\_\_

Antibodies \_\_\_\_\_

2

(d) In the early stages of pregnancy the cells of the embryo are starting to differentiate.

Describe what happens during differentiation.

\_\_\_\_\_

\_\_\_\_\_

1

**5. (continued)**

*Marks*

- (e) Name a stage of embryo development that comes between fertilisation and differentiation.

\_\_\_\_\_

**1**

- (f) A woman gives birth to monozygotic twins.

State whether monozygotic twins are identical or non-identical and give a reason for your answer.

Monozygotic twins \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

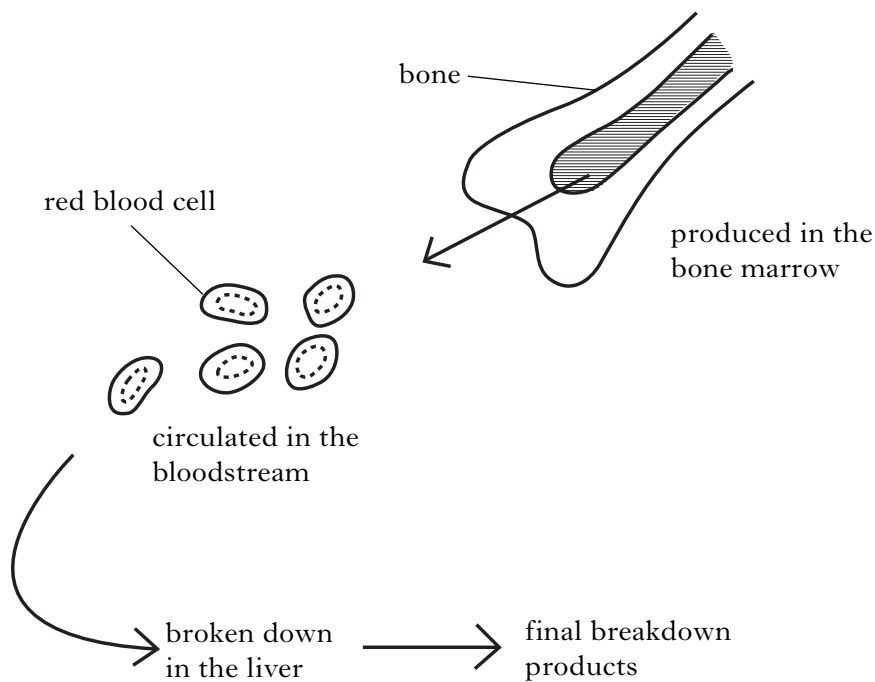
\_\_\_\_\_

**1**

**[Turn over**

6. The diagram below shows stages in the life history of a red blood cell.

Marks



(a) Vitamin B<sub>12</sub> and iron are both used in the production of red blood cells.

(i) What substance is needed for the absorption of Vitamin B<sub>12</sub> from the gut?

\_\_\_\_\_

1

(ii) Which molecule requires iron for its production?

\_\_\_\_\_

1

(b) On average, how long do red blood cells remain in circulation?

\_\_\_\_\_

1

(c) At any given time there are 5.5 million red blood cells in 1 millilitre of human blood.

Calculate how many red blood cells will be in the circulation of an individual who has a total blood volume of 5 litres.

*Space for calculation*

\_\_\_\_\_ million

1

Marks

**6. (continued)**

(d) Explain how the structure of a red blood cell

(i) makes it very efficient at absorbing oxygen.

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1

(ii) allows it to pass through capillaries.

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1

(e) Apart from the liver, name a body site where red blood cells are broken down.

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1

(f) One of the final products of the breakdown of red blood cells is bile.

(i) Where is bile stored in the body?

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1

(ii) Explain the importance of bile salts in the digestion of lipids.

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2

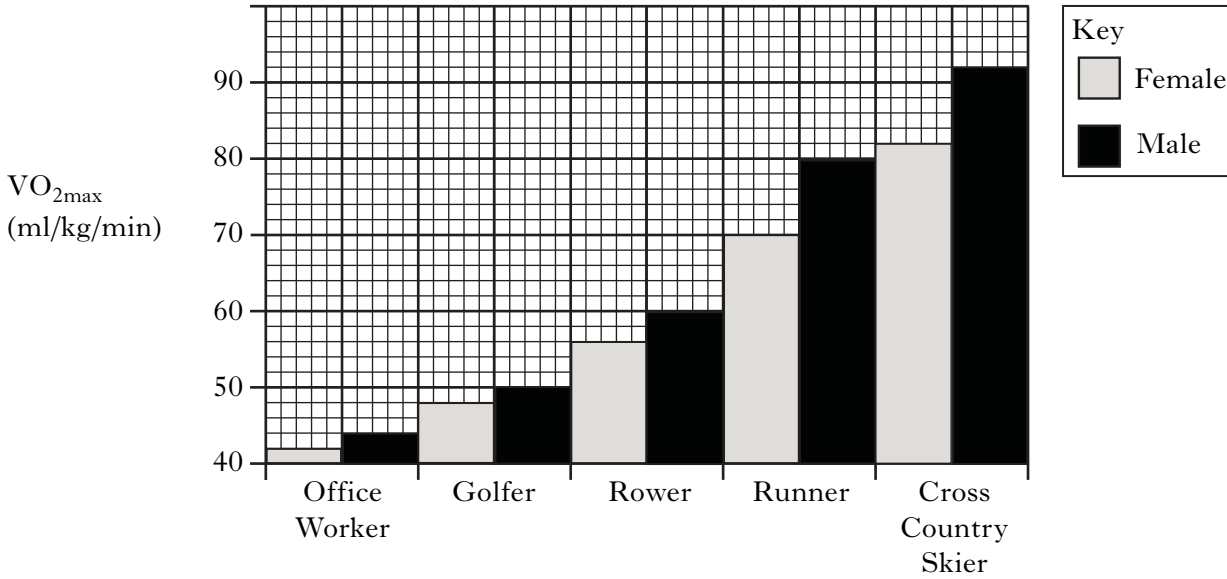
**[Turn over**

7. Oxygen consumption is often used to measure the intensity of exercise.

$VO_{2max}$  is the maximum rate at which someone can take up and use oxygen.

Marks

**Graph 1** shows the  $VO_{2max}$  of office workers, and various professional sportsmen and sportswomen.



(a) (i) What is the difference between the  $VO_{2max}$  of a male cross-country skier and a male office worker?

*Space for calculation*

\_\_\_\_\_ 1

(ii) Cross-country skiing is a very energy demanding sport.

What is the advantage to a cross-country skier of having a high  $VO_{2max}$ ?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ 1

(b) Calculate the oxygen uptake, during a three minute race, of a female rower who weighs 85 kg. Assume that she has maximum oxygen uptake throughout the race.

*Space for calculation*

\_\_\_\_\_ litres 1

(c) The graph shows that, on average, men have higher maximum oxygen uptakes than women.

Suggest a reason for this difference.

\_\_\_\_\_  
\_\_\_\_\_ 1

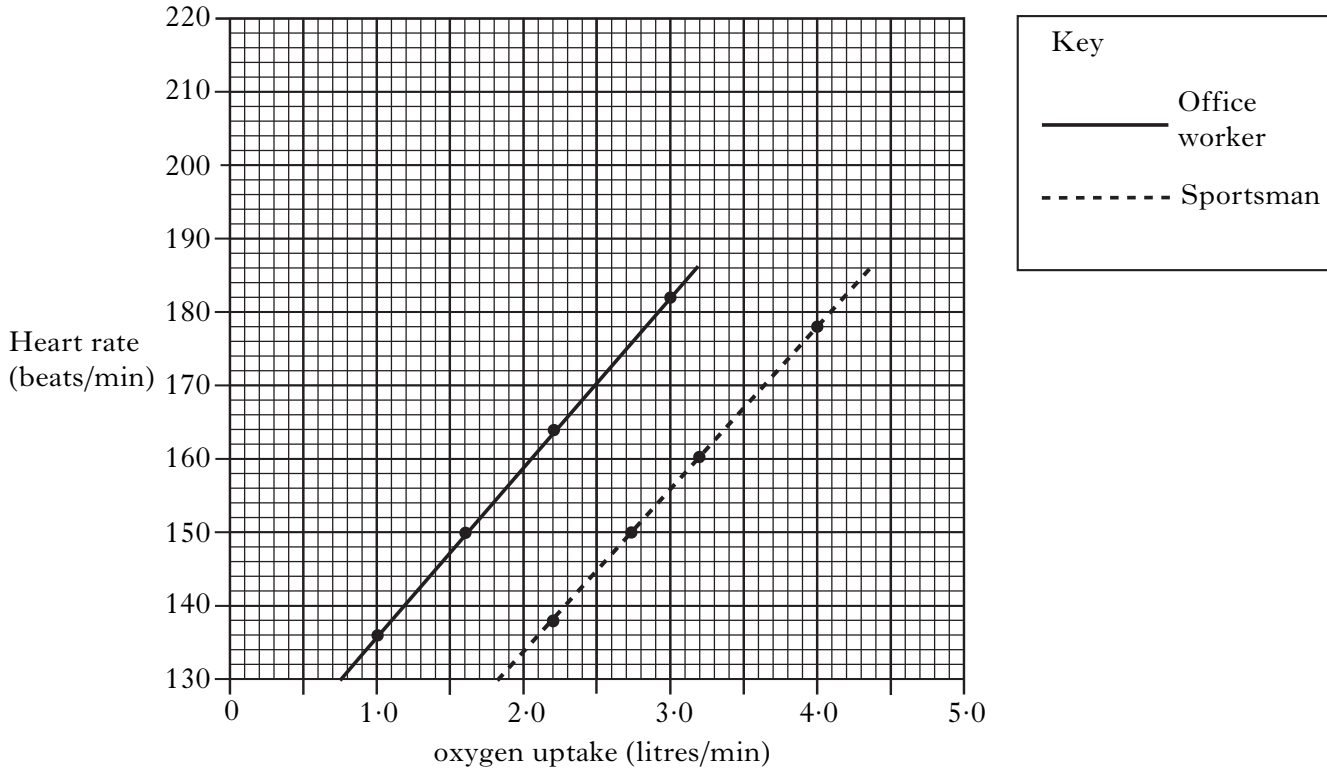
Marks

7. (continued)

Tests which determine the  $VO_{2max}$  of individuals use the relationship between heart rate and oxygen uptake.

The maximum oxygen uptake occurs when an individual's heart is beating at its maximum rate.

**Graph 2** shows measurements of heart rate and oxygen uptake for a professional sportsman and an office worker, who are both 24 years old. The measurements were taken as speed was gradually increased on a treadmill.



(d) (i) An individual's maximum heart rate can be calculated by subtracting their age from 220.

Calculate the maximum heart rate of the office worker.

*Space for calculation*

\_\_\_\_\_ beats/min **1**

(ii) **Use the graph** to predict the maximum oxygen uptake of the office worker.

\_\_\_\_\_ litres/min **1**

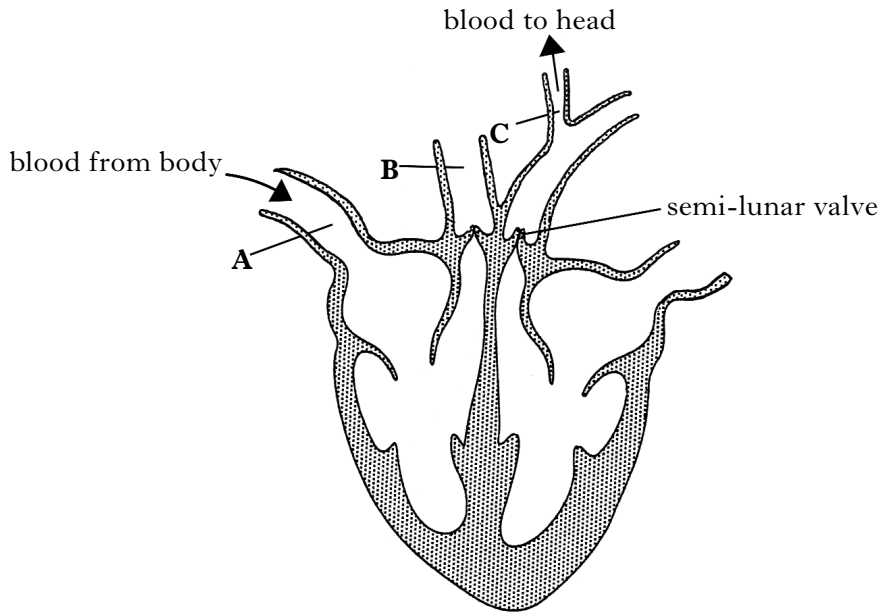
(iii) The sportsman weighed 60 kg.

Use the information in **graphs 1 and 2** to determine his sport.

\_\_\_\_\_ **1**

8. The diagram below shows the human heart and some associated blood vessels. The arrows on the diagram show the direction of blood flow.

Marks



- (a) Name blood vessels **A**, **B** and **C**.

**A** \_\_\_\_\_

**B** \_\_\_\_\_

**C** \_\_\_\_\_

2

- (b) Place arrows on the diagram to show the path of oxygenated blood as it flows through the heart.

1

- (c) Describe the function of the semi-lunar valve **labelled on the diagram**.

\_\_\_\_\_

\_\_\_\_\_

1

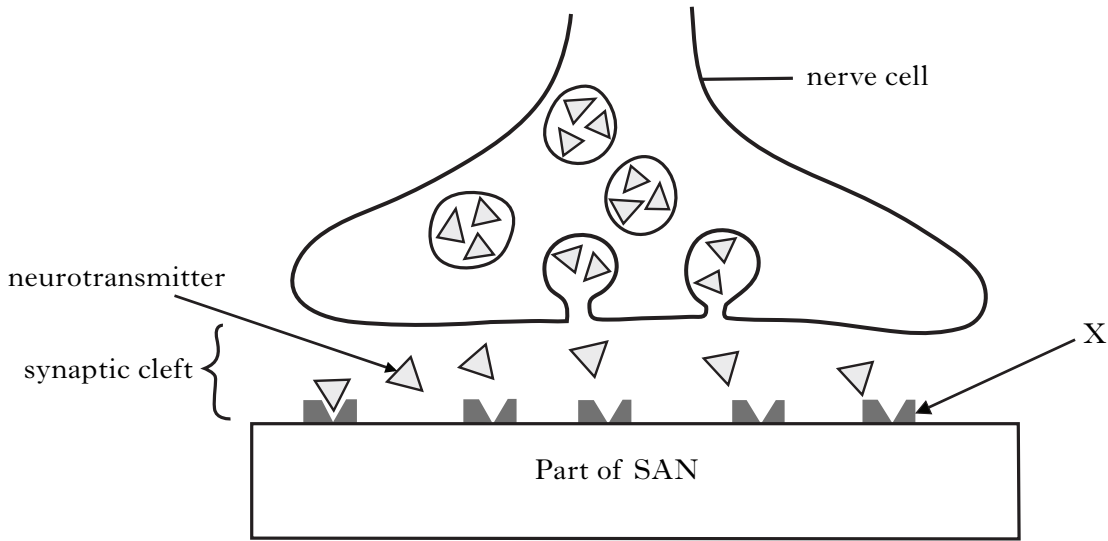
- (d) During which stage of the cardiac cycle do the semi-lunar valves open?

\_\_\_\_\_

1

Marks

9. (a) The diagram below shows a synapse which links a nerve cell with the sinoatrial node (SAN) in the heart.



- (i) Where in the heart is the SAN located?

\_\_\_\_\_

1

- (ii) Describe the function of molecule X.

\_\_\_\_\_

1

- (b) One example of a neurotransmitter is acetylcholine.

How is acetylcholine removed from the synapse?

\_\_\_\_\_

\_\_\_\_\_

1

- (c) (i) In which area of the brain does the sympathetic nervous system originate?

\_\_\_\_\_

1

- (ii) Describe a situation which would lead to stimulation of the sympathetic nervous system.

\_\_\_\_\_

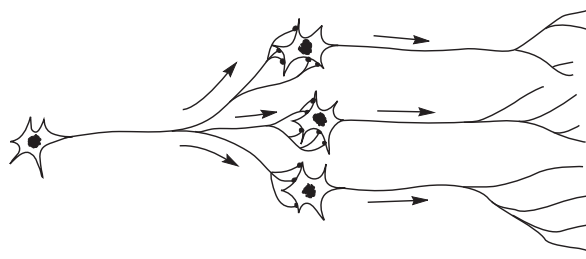
\_\_\_\_\_

1

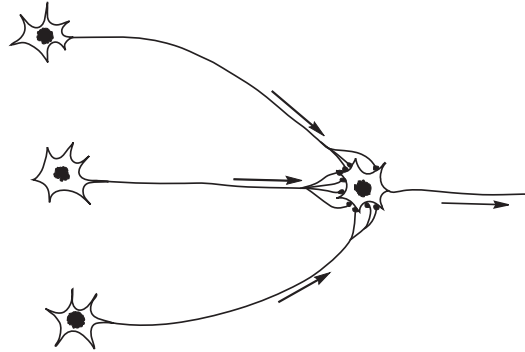
10. The diagram below shows two different neural pathways.  
Nerve impulses are travelling from left to right in both pathways.

Marks

**Pathway A**



**Pathway B**



- (a) (i) Name the types of pathway represented by **A** and **B**.

**A** \_\_\_\_\_

**B** \_\_\_\_\_

1

- (ii) Pathway **A** helps the hand to function.

Explain how it does this.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2

- (b) Blinking is a reflex action.

- (i) What is a reflex action?

\_\_\_\_\_

\_\_\_\_\_

1

- (ii) The blinking reflex can sometimes be suppressed.

What term refers to the ability of the nervous system to suppress reflexes?

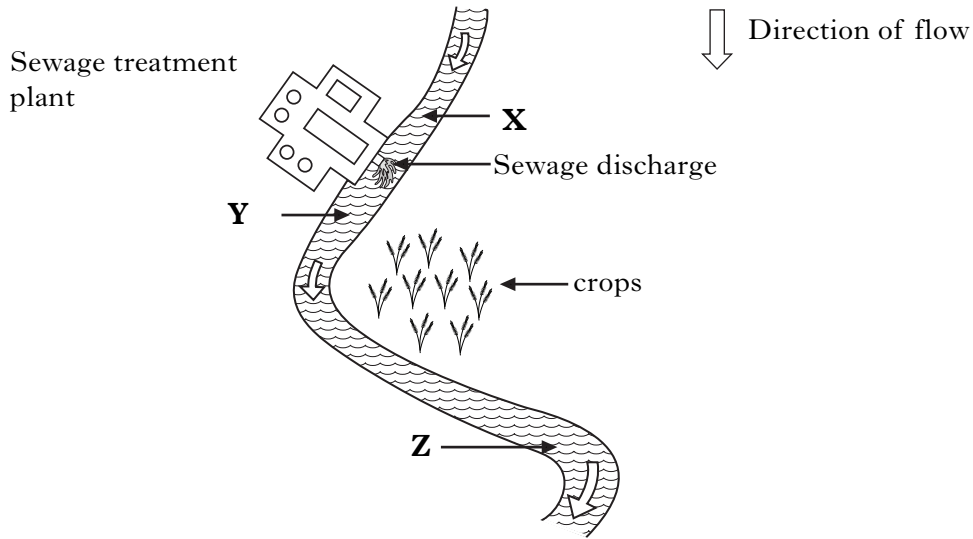
\_\_\_\_\_

1



12. The map below represents a short length of a Scottish river.

Marks



(a) The sewage treatment works sometimes gets overloaded and untreated sewage is discharged into the river.

(i) Following the discharge of sewage, state how bacteria would change in number between the following points.

Give a reason for your answer.

A Between points **X** and **Y**.

Change \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

1

B Between points **Y** and **Z**.

Change \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

1

(ii) State how algae would change in number between points **Y** and **Z**.

Give a reason for your answer.

Change \_\_\_\_\_

Reason \_\_\_\_\_

\_\_\_\_\_

1

**12. (continued)**

*Marks*

(b) Herbicides are frequently applied to land where crops are growing.

(i) What is a herbicide?

\_\_\_\_\_

**1**

(ii) Explain how the use of herbicides leads to an increased crop yield.

\_\_\_\_\_

\_\_\_\_\_

**1**

(c) Crop yield can be increased by the insertion of a gene from another organism into a chromosome of the crop plant.

Name this process.

\_\_\_\_\_

**1**

**[Turn over for Section C**

## SECTION C

**Both questions in this section should be attempted.**

Note that each question contains a choice.

**Questions 1 and 2 should be attempted on the blank pages which follow.**

**Supplementary sheets, if required, may be obtained from the invigilator.**

**Labelled diagrams may be used where appropriate.**

1. Answer **either A or B**.

**A.** Discuss how other people can affect an individual's behaviour under the following headings:

(i) the influence of groups;

6

(ii) influences that change beliefs.

4

(10)

**OR**

**B.** Discuss global warming under the following headings:

(i) possible causes of global warming;

6

(ii) potential effects of rising sea levels.

4

(10)

**In question 2, ONE mark is available for coherence and ONE mark is available for relevance.**

2. Answer **either A or B**.

**A.** Describe how immunity is naturally acquired.

(10)

**OR**

**B.** Describe the nature and reproduction of viruses.

(10)

[END OF QUESTION PAPER]

SPACE FOR ANSWERS

SPACE FOR ANSWERS

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SPACE FOR ANSWERS

ADDITIONAL GRAPH FOR QUESTION 4(e)

