Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

18 May 2023

Zone A morning | **Zone B** morning | **Zone C** morning

Candidate session number

1 hour 15 minutes

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

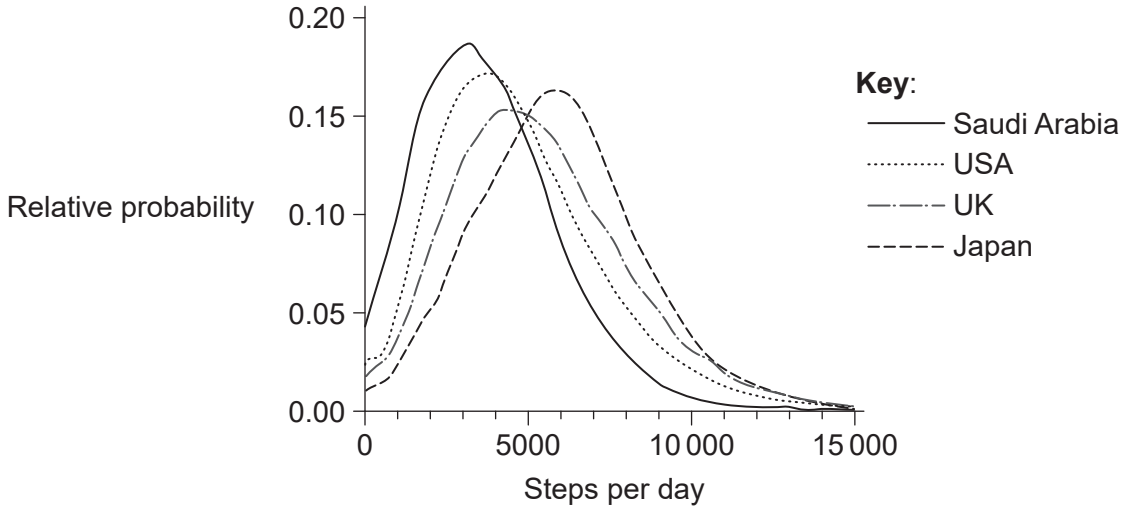
2223 – 6011

17 pages

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Smartphone data from more than 700 000 individuals in 111 countries was used to estimate their activity levels. Data from more than 68 million days of activity was analysed, including the numbers of steps taken per day. The graph shows the distribution of numbers of steps per day for four countries.



[Source: Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.]

(a) State the **mode** for the number of steps per day in Japan and USA, rounding your answers up or down to the nearest 1000 steps. [1]

Japan: . . . . . .

USA: . . . . . .

(b) Distinguish between the distribution of activity in Saudi Arabia and the UK. [2]

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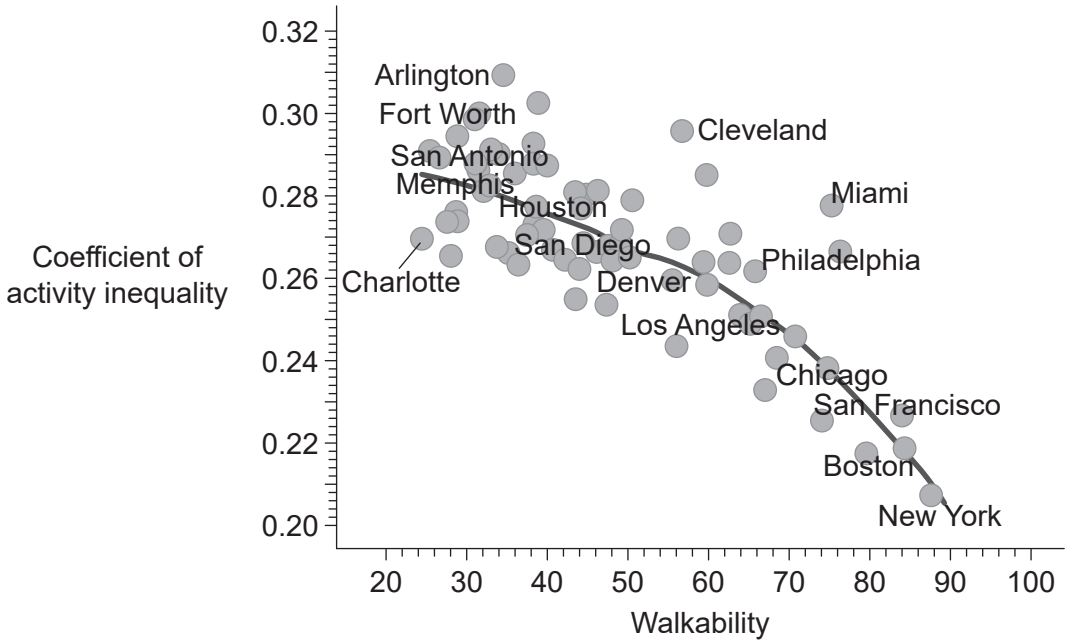
(Question 1 continued)

Walkability is a measure of how friendly an urban area is for walking. The researchers determined a walkability score for cities in the USA, based on such measures as block length, availability of sidewalks and distances between homes and destinations such as shops, workplaces or parks. They also calculated a coefficient of activity inequality for each city from the variation among individuals in number of steps per day. A coefficient of zero would indicate that all individuals took the same number of steps. The scattergraph shows the relationship between walkability and activity inequality for the 69 cities where smartphone data was available for at least 200 individuals.



[Source: Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.]

(c) Identify the city with the highest and the city with the lowest walkability. [1]

Highest: . . . . . .

Lowest: . . . . . .

(d) Suggest reasons for the relationship shown in the graph. [2]

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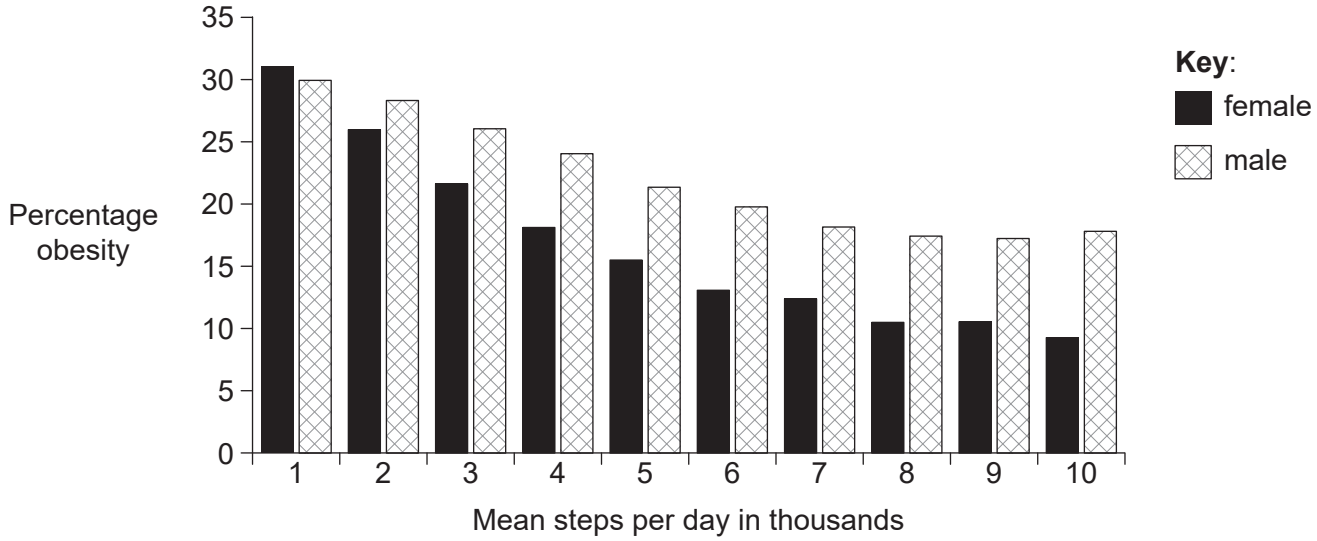
(Question 1 continued)

Combining the data for all countries, including the body mass index (BMI) of each individual, the researchers grouped males and females according to their mean number of steps per day. Using the BMI of each individual, they calculated the percentage of males and females who were obese (BMI over 30) for each of these groups. The chart shows the data.



[Source: Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.]

(e) Compare and contrast the data in the chart for males and females. [2]

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(f) Suggest **two** hypotheses to account for the relationship between the mean number of steps per day and the proportion of people who are obese. [2]

Hypothesis 1: . . . . . .

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Hypothesis 2: . . . . . .

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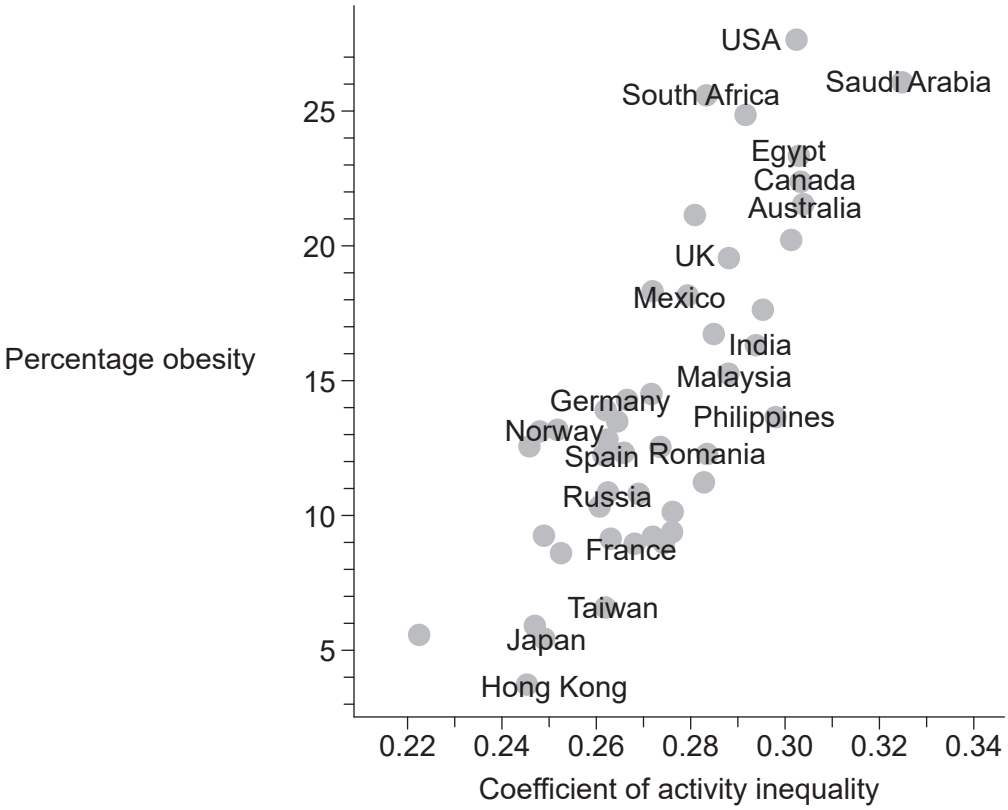
(Question 1 continued)

The scattergraph shows the coefficient of activity inequality and the percentage of the population that is obese in the 46 countries or regions for which data was available.



[Source: Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.]

(g) State the relationship between activity inequality and obesity shown in the scattergraph. [1]

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(h) Using only evidence from the data in Question 1, suggest **two** strategies for reducing obesity in countries where this health problem is most prevalent. [2]

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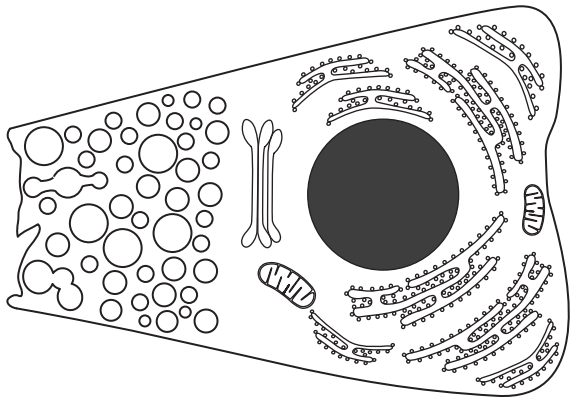
2. The diagram shows the structure of a cell in the pancreas that secretes digestive enzymes.



(a) Explain how the pancreas cell carries out its function, with reference to **three** organelles visible in the diagram. [3]

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(b) The pancreas secretes lipase into the small intestine.

(i) Outline the function of lipase. [1]

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(ii) State **one** other enzyme secreted by the pancreas. [1]

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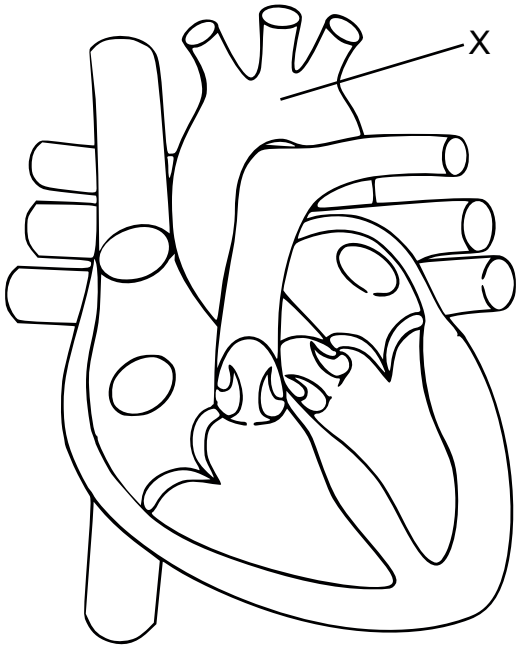
3. The diagram shows the structure of the human heart.



(a) Annotate the diagram by adding arrows to show how deoxygenated blood enters the heart. [1]

(b) Identify the blood vessel labelled X. [1]

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(c) Explain the function of the left ventricle. [2]

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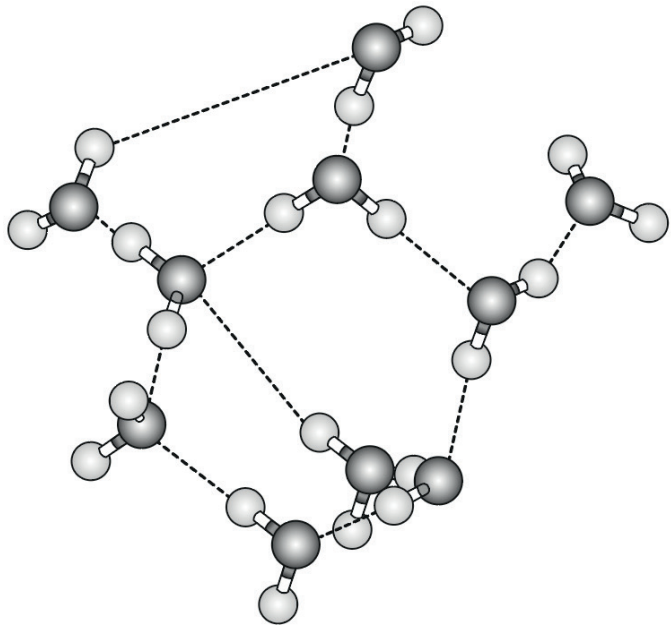
4. The diagram shows water molecules as they might be arranged in liquid water and the interactions between them.



(a) (i) State how many water molecules are shown in the diagram. [1]

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(ii) Identify the interactions that are shown between the water molecules. [1]

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(Question 4 continued)

(b) (i) With reference to the diagram, explain how water in sweat evaporates. [2]

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(ii) Outline the reasons for secretion of sweat in humans. [2]

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5. The spider *Dolomedes plantarius* usually has white bands down the left and right sides of its body, but some individuals lack these bands. The photograph shows the banded form of *D. plantarius* with a ball of spiderlings.

Crosses were performed to investigate the inheritance of this trait, by allowing specific males and females to mate. Numbers of banded and unbanded spiderlings that hatched out from all the eggs laid by the female were recorded. Results are shown in the table.

		Progeny phenotypes		
Cross number	**Parental phenotypes ♀ × ♂**	**Banded**	**Unbanded**	**Proportion banded**
1	Banded × Banded	46	16	0.742
2	Unbanded × Banded	37	38	0.493
3	Unbanded × Banded	63	0	1.000
4	Unbanded × Unbanded			

(a) Explain the conclusion that can be drawn from Cross 1. [2]

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(Question 5 continued)

(b) Deduce reasons for the difference between the results of Cross 2 and Cross 3. [2]

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(c) There were 79 progeny in Cross 4. Predict the expected results by completing the table. [1]

(d) The proportion of banded and unbanded individuals in a population of *D. plantarius* can change. Suggest how such a change could occur. [1]

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Section B

Answer **one** question. Up to one additional mark is available for the construction of your answer. Answers must be written within the answer boxes provided.

6. In eukaryotes, the chromosomes are located in the nucleus, and the nucleus can divide by mitosis or meiosis.

(a) Outline the sequence of events that occurs during mitosis. [5]

(b) Describe the processes that occur in the nucleus of a cell during interphase. [7]

(c) Explain how the presence of a Y chromosome in the cells of a human embryo causes it to develop as a male. [3]

7. Plant species discovered in wild habitats are named and classified by taxonomists. Some plants have been genetically modified to make them more suitable for use by humans.

(a) Describe how plants are named and classified, including recognition features of plant phyla. [7]

(b) Outline the stages of the carbon cycle that involve plants or materials made by plants. [5]

(c) Discuss briefly the potential risks and benefits of the genetic modification of crop plants. [3]

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References:

1.(a) Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.

1.(c). Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.

1.(e) Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.

1.(g) Material from: Althoff, T., Sosič, R., Hicks, J., et al., Large-scale physical activity data reveal worldwide activity inequality, published 2017, *Nature*, reproduced with permission of SNCSC.

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5. photo: Vėlavičienė, N., 2004. [Dolomedes.] [image online] Available at: https://commons.wikimedia.org/wiki/File:Dolomedes_fimbriatus.jpg. [Accessed 14 March 2022]. Licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license (https://creativecommons.org/licenses/by-sa/3.0/deed.en).

table: Baillie, A.L., Baillie, S.R. and Smith, H., 2019. The heritability of lateral banding in *Dolomedes plantarius*. *Arachnology*, [e-journal] 18(3), pp. 237–244. https://doi.org/10.13156/arac.2019.18.3.237.