Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

29 October 2025

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

Candidate session number

2 hours 30 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 two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

8825 – 6009

23 pages

Section A

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

1. Common bottlenose dolphins, *Tursiops truncatus*, are marine mammals of temperate and tropical oceans throughout the world, where they feed on fish, squid and crustaceans.

Research has been carried out on a population of these dolphins in Sarasota Bay, Florida. The table shows the mean sea surface temperature in Sarasota Bay and catch per unit effort (CPUE) in winter and summer. A large CPUE indicates it would take little effort for the dolphin to catch a lot of prey.

	Winter	**Summer**
Mean sea surface temperature / °C	22.6	28.7
Catch per unit effort (CPUE)	110.5	663.2

(a) (i) Calculate the difference between summer and winter sea surface temperatures. [1]

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(ii) Calculate summer CPUE as a percentage of winter CPUE. [1]

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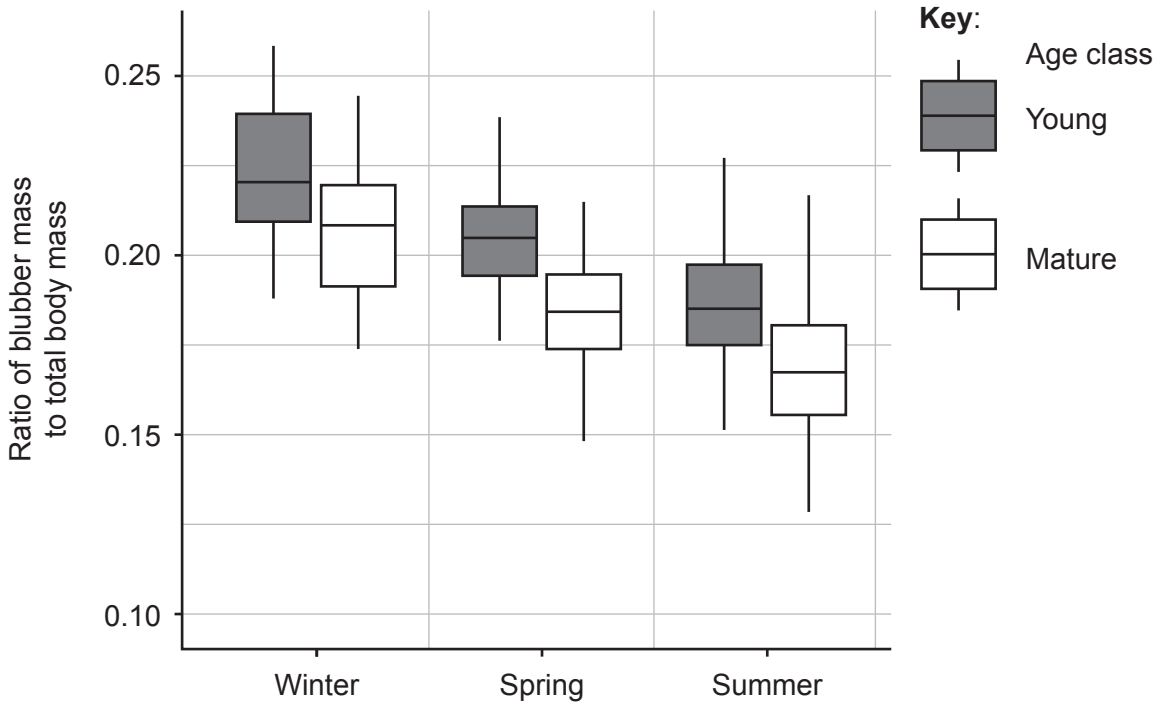
(This question continues on the following page)

(Question 1 continued)

Blubber is a type of tissue located under the skin of marine mammals. It consists of adipocytes (fat storage cells) and collagen fibres. Blubber helps form the streamlined shape of marine mammals and provides heat insulation. The amount of this tissue varies and can be assessed by calculating the ratio of blubber mass to total body mass of an individual. The box-and-whisker plot shows the ratio of blubber to total body mass for dolphins of different ages at different times of the year.



(b) (i) Distinguish between young and mature dolphins in their ratios of blubber mass to total body mass. [1]

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(ii) Suggest reasons for the differences between young and mature dolphins in the ratio of blubber mass to total body mass. [2]

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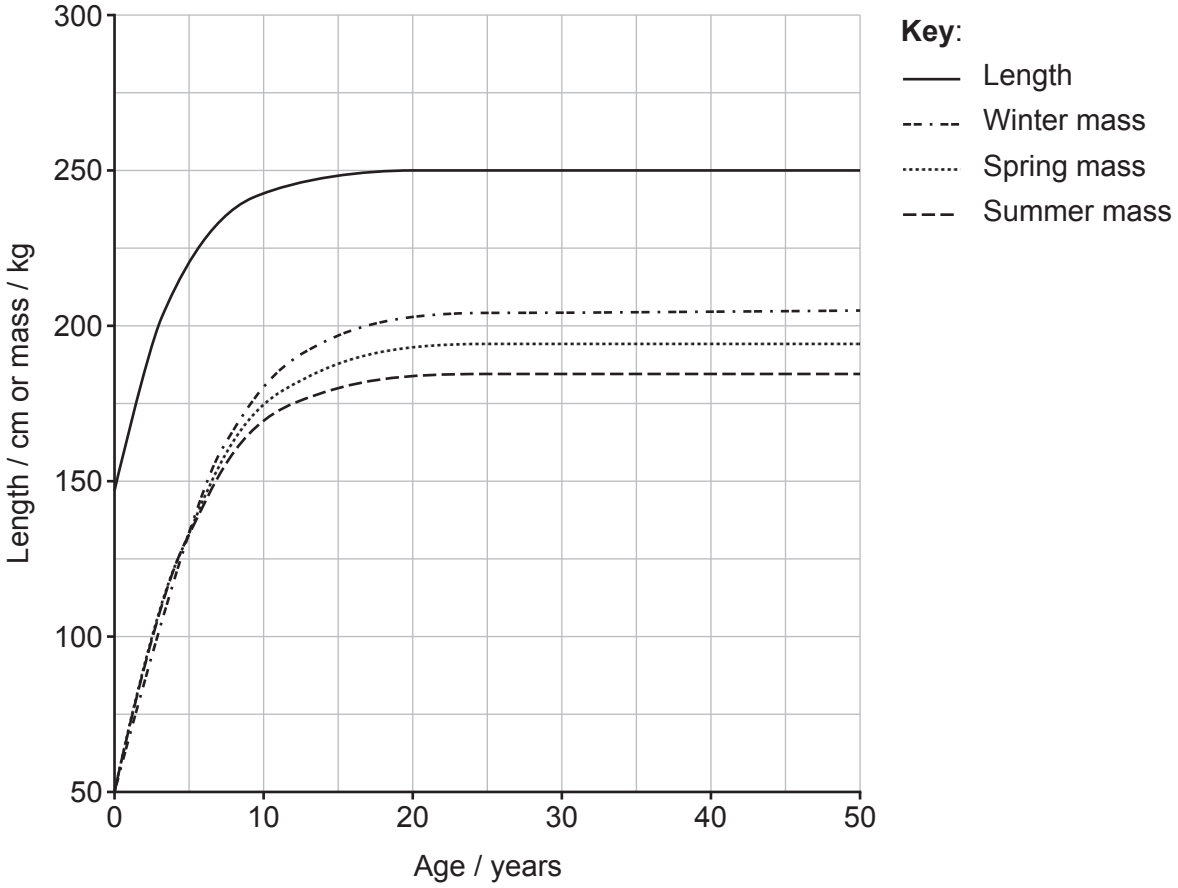
Answers written on this page
will not be marked.

(Question 1 continued)

The graph shows the length of common bottlenose dolphins and their body mass in winter, spring and summer at different ages.



(c) Compare and contrast the trend for length with the trend for total body mass in summer. [2]

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(d) Explain the reasons for differences in total body mass between seasons. [2]

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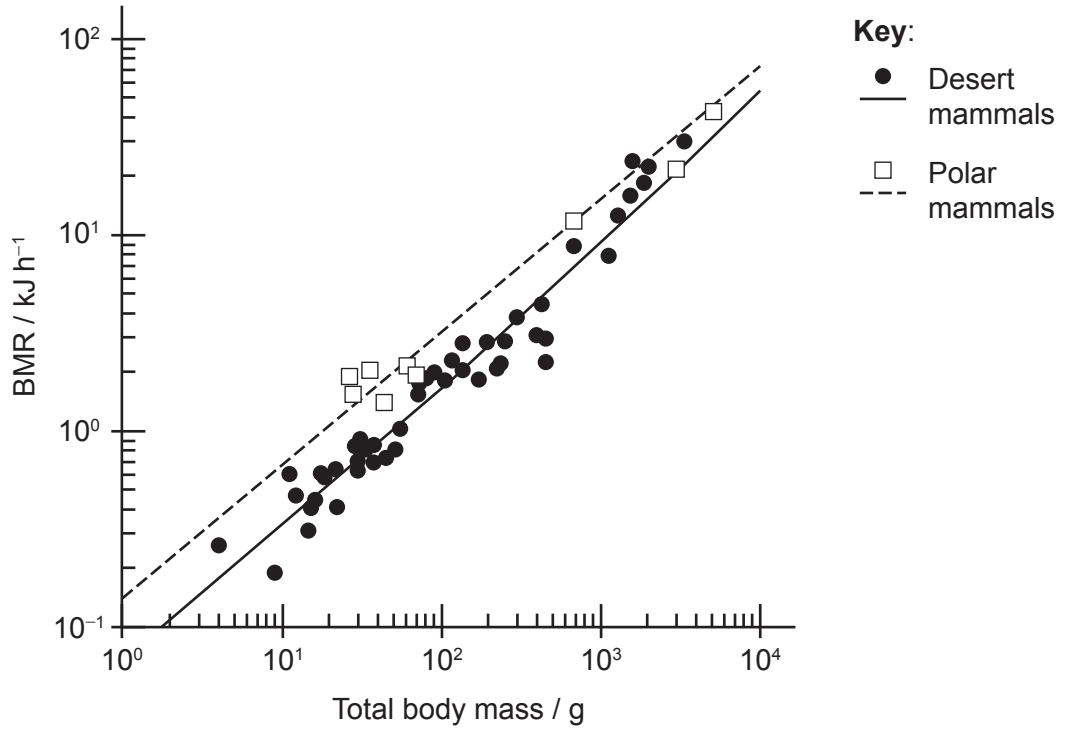
(Question 1 continued)

Basal metabolic rate (BMR) is the total amount of energy used per hour in an animal at rest but not asleep in a "comfortable" ambient temperature. It can be determined by measuring the rate of oxygen absorption, carbon dioxide excretion or heat production of the animal.

The scatter graph shows the BMR of mammals with desert or polar habitats, up to a total body mass of 10 kg (10^4 g).



(e) (i) State the relationship between total body mass and BMR for desert mammals. [1]

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(ii) Outline the reason for this relationship. [1]

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(Question 1 continued)

(f) Explain the differences in BMR between desert and polar mammals up to a mass of 10^3 g. [2]

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(g) Above a body mass of 10 kg, there is little difference in BMR between desert and polar mammals. Suggest reasons for this. [2]

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2. (a) Some of the twenty amino acids that are linked together to make polypeptides in human cells are essential in the diet and others are not. Distinguish between essential and non-essential amino acids. [2]

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(b) The molecules of all amino acids include an amine group, a carboxyl group and an R-group. Draw a diagram to show the structure of an amino acid molecule. [3]

(c) The R-groups of amino acids are very diverse chemically. Interaction between R-groups in different parts of a polypeptide helps to determine the tertiary structure of a protein. List **two** types of interaction between R-groups. [2]

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3. (a) Outline the function of mitochondria in muscle fibres. [2]

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(b) Explain the function of actin and myosin in the sarcomeres of muscle fibres. [3]

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(c) Explain the role of the protein titin in muscle relaxation. [2]

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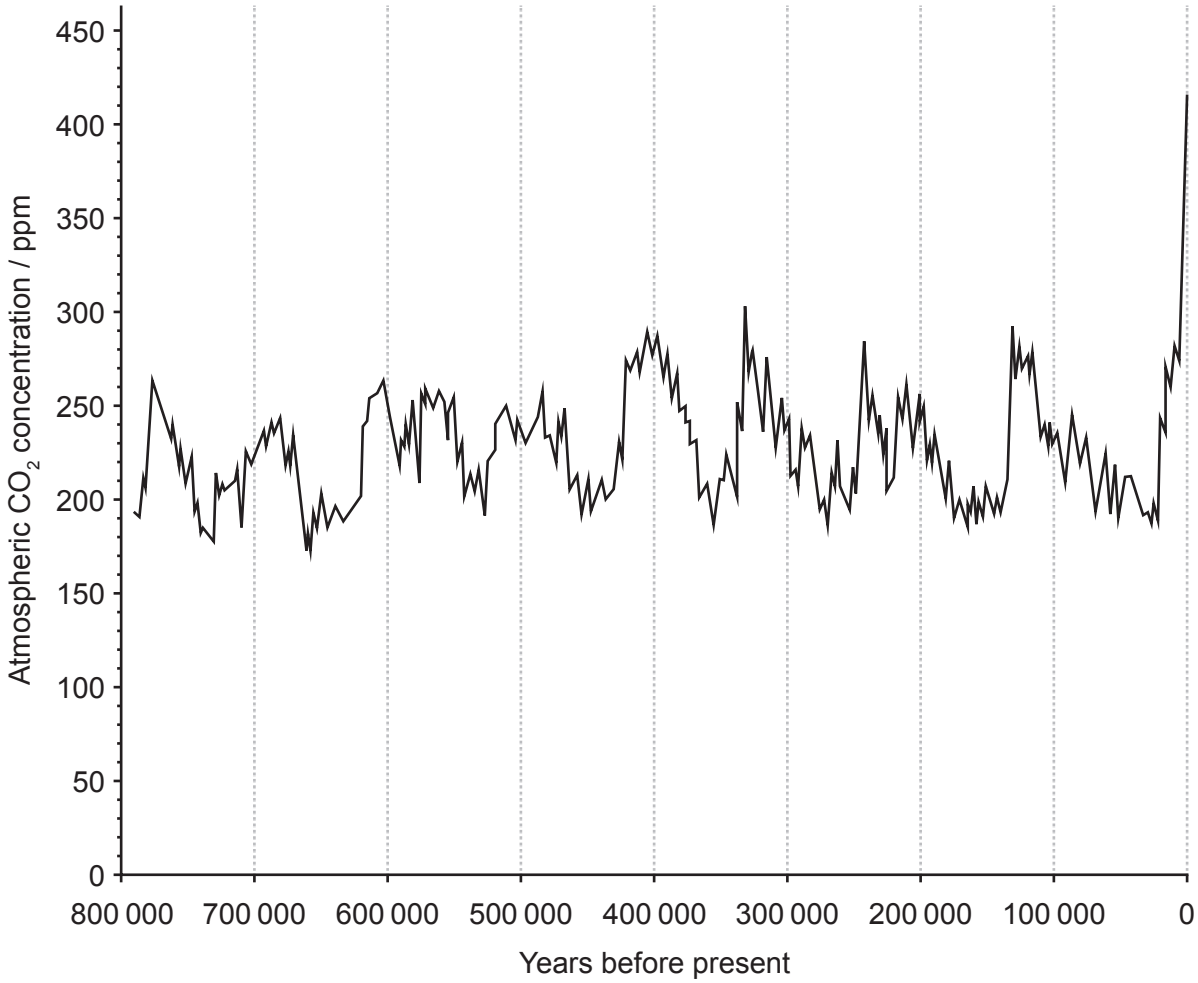
4. The graph shows carbon dioxide (CO_2) concentration in the atmosphere during the past 800 000 years. The data was produced by measuring the CO_2 concentration of air bubbles trapped in cores of Antarctic ice.



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(Question 4 continued)

(a) State **one** metabolic process that removes CO_2 from the atmosphere. [1]

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(b) The graph shows long-term fluctuations in atmospheric CO_2 concentration of about 80 ppm. The decreases in CO_2 concentration are probably due to oceans acting as a sink by holding large quantities of dissolved CO_2.

Identify **two** other examples of natural sinks that can remove carbon from the carbon cycle and reduce atmospheric CO_2 concentration. [2]

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(c) The graph shows a recent extremely rapid increase in atmospheric CO_2 concentration. Explain **two** anthropogenic causes of this increase. [2]

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5. Fish are harvested from many estuaries where a river flows into the sea.

(a) Describe how scientists can assess whether the rate of harvesting of fish is sustainable. [2]

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Concentrations of the heavy metal arsenic have been measured in fish and crustaceans living in the water of Hangzhou Bay, an estuary on the east coast of China. The mean arsenic concentration of the water is $1.47\,\mu g\,L^{-1}$, but in some tissues of the organisms the concentration was over a thousand times higher.

(b) Outline the processes that can cause high concentrations of arsenic to develop in the tissues of marine organisms. [2]

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In five of the eleven fish and crustacean species tested, arsenic concentrations were high enough to cause an unacceptable risk of cancer in children.

(c) Explain how chemical substances can cause cancer. [2]

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(Question 5 continued)

(d) The organism with the highest arsenic concentration was *Portunus trituberculatus,* a species of crustacean. The table shows the classification of *Portunus trituberculatus.* Identify the domain of this species and the missing taxon in the hierarchy of taxa, writing your answers in the table. [2]

Domain:	. . . . .
Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Malacostraca
Order:	Decapoda
. . . . .	Portunidae
Genus:	*Portunus*
Species:	*trituberculatus*

6. The photo shows vegetation in the Sonoran Desert, which is part of the hot desert biome.

(a) State what a biome is. [2]

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(b) Explain **three** adaptations of plants that can help them survive in the dry conditions of hot deserts. [3]

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(c) State **one** adaptation of plants in hot deserts that can help them to resist herbivory. [1]

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Section B

Answer **two** questions. One additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

7. At all levels of biological organization there is diversity.

(a) Explain the diversity of possible base sequences in nucleic acids. [4]

(b) Describe, with examples, the diversity of structure in viruses. [7]

(c) Suggest how the diversity of chromosome number in animals and plants has evolved. [4]

8. Interactions in biological systems may have harmful or beneficial effects.

(a) Explain, using an example, how competitive inhibitors interfere with enzyme activity. [4]

(b) Describe the role of neurotransmitters in synaptic transmission and how transmission can be disrupted by exogenous chemicals. [7]

(c) Discuss the consequences of infection with HIV. [4]

9. Living organisms have mechanisms for preventing or reducing change.

(a) Explain how mutation is avoided during DNA replication. [4]

(b) Describe the mechanisms used to keep blood glucose levels within narrow limits in humans. [7]

(c) Explain the need for isotonic conditions in human blood plasma and tissue fluid. [4]

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References:

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1.c Adamczak, S.K., McHuron, E.A., Christiansen, F., Dunkin, R., McMahon, C.R., Noren, S., Pirotta, E., Rosen, D., Sumich, J. and Costa, D.P., 2023. *Conserv. Physiol*. 11(1): coad035. https://doi.org/10.1093/conphys/coad035. Reference redacted. Source adapted.

1.e Ballesteros, F.J., Martinez, V.J., Luque, B., Lacasa, L., Valor, E. and Moya, A., 2018. On the thermodynamic origin of metabolic scaling. *Scientific Reports* 8(1): 1448. Source adapted.

4. Keramidas, K., Diaz Vazquez, A., Weitzel, M., Vandyck, T., Tamba, M., Tchung-Ming, S., Soria-Ramirez, A., Krause, J., Van Dingenen, R., Chai, Q., Fu, S. and Wen, X. Global Energy and Climate Outlook 2019: Electrification for the low carbon transition, Luxembourg: Publications Office of the European Union, 2020, ISBN 978-92-76-15065-7, doi:10.2760/350805, JRC119619.

6. Mischke, E., 2023. *Sunset on Bell Pass in The Majestic McDowell Mountains*. [image online] Available at: https://www.gettyimages.co.uk/detail/photo/sunset-on-bell-pass-in-the-majestic-mcdowell-royalty-free-image/1469510156?phrase=Sonoran+Desert&adppopup=true [Accessed 11 October 2024]. Source adapted.