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ENVIRONMENTAL MANAGEMENT **0680/22**

Paper 2 Management in Context **October/November 2023**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

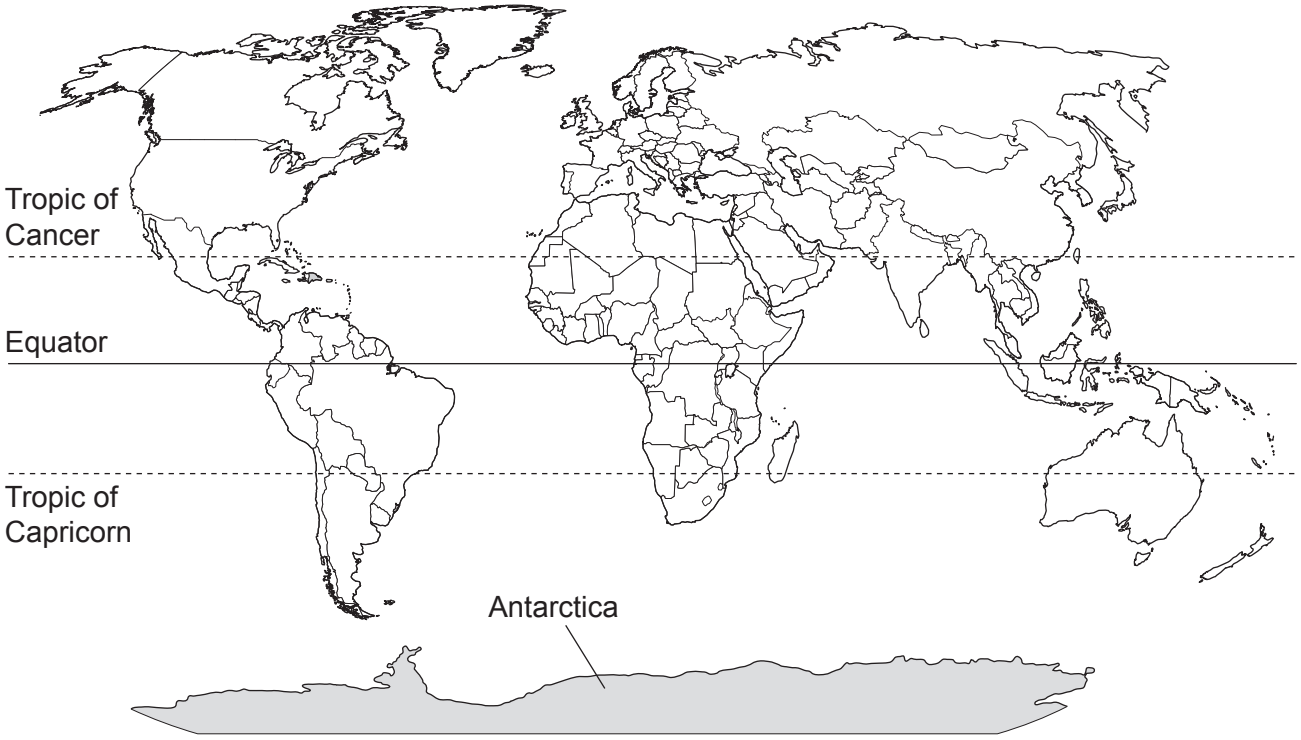
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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world map showing the location of Antarctica



Area of Antarctica: 14.2 million km^2

Population of Antarctica: no permanent population, only scientific research station workers and tourists

Climate of Antarctica: there are 105 days of 24-hour darkness each year; the coldest, windiest and driest continent on Earth; extremely low temperatures in the centre, with average temperatures of –57 °C, more moderate climate in the north-west

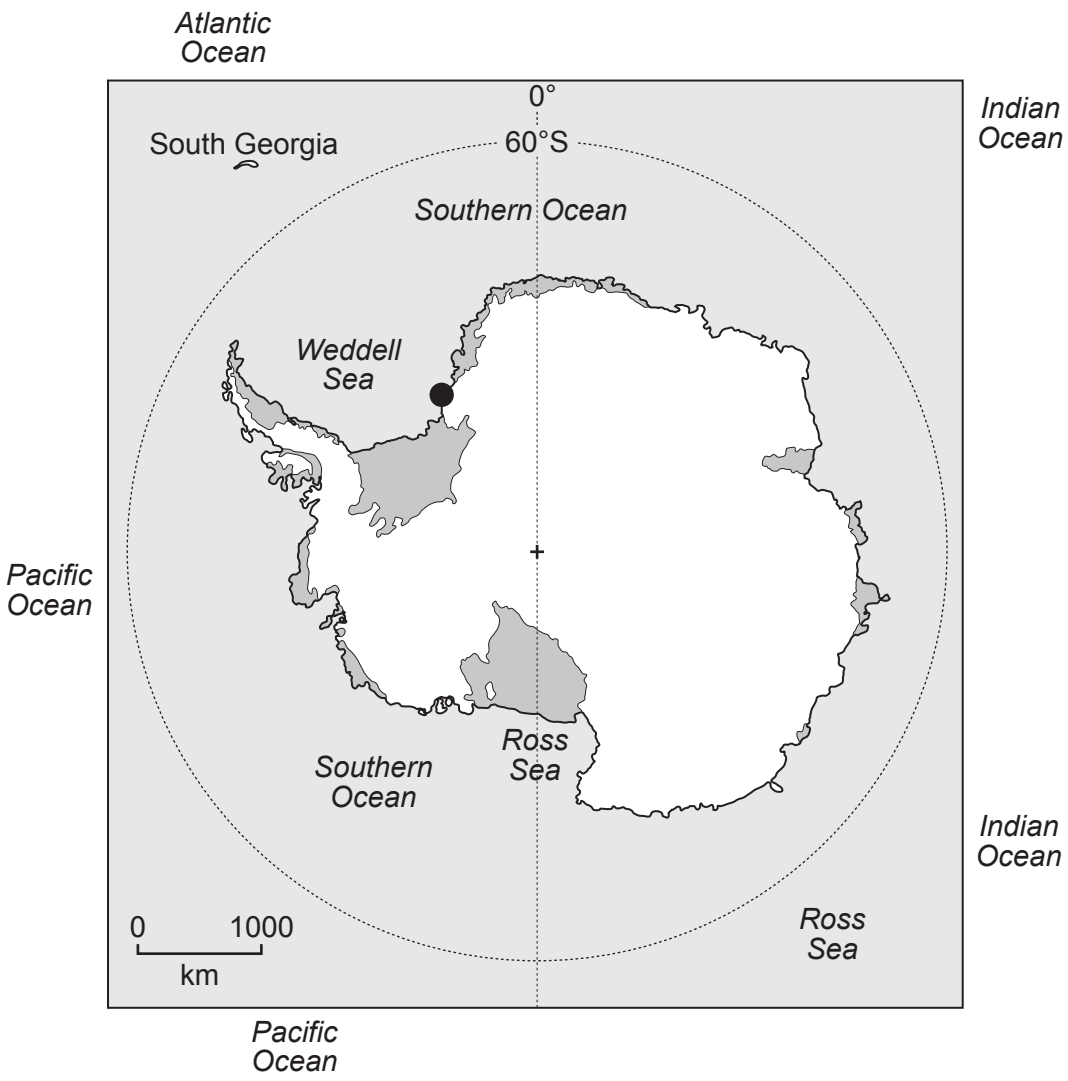
Terrain of Antarctica: thick ice sheet, barren rock, mountain ranges and areas of flat ice-covered land; 11% of the land is glaciers and floating ice shelves attached to the land

Main activities in Antarctica: scientific research and tourism

Antarctica is the fifth-largest continent. There are up to 5400 scientists and support staff at research stations and ships in Antarctica. There are deposits of many minerals, but exploration and mining are banned. Tourism is popular and increasing.

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map of Antarctica



1 Halley is a British scientific research station in Antarctica.

Halley is built on a floating ice shelf in the Weddell Sea. The ice shelf is 150 m thick.

(a) 11% of the area of Antarctica is floating ice shelves.

Calculate the area of Antarctica that is floating ice shelves.

Give your answer to **one** decimal place.

..... million km^2 [2]

(b) The table shows temperature data for Halley.

month	minimum temperature / °C	maximum temperature / °C	average temperature / °C
Jan	–6.6	–2.5	–4.6
Feb	–15.2	–6.5	–10.0
Mar	–21.5	–10.3	–16.5
Apr	–29.2	–14.5	–21.7
May	–32.3	–16.4	–24.9
Jun	–32.5	–19.6	–26.9
Jul	–35.4	–22.7	–28.8
Aug	–36.7	–19.9	–28.4
Sep	–33.3	–16.7	–26.4
Oct	–24.9	–14.1	–19.7
Nov	–16.0	–8.5	–11.6
Dec	–8.2	–3.5	–5.3

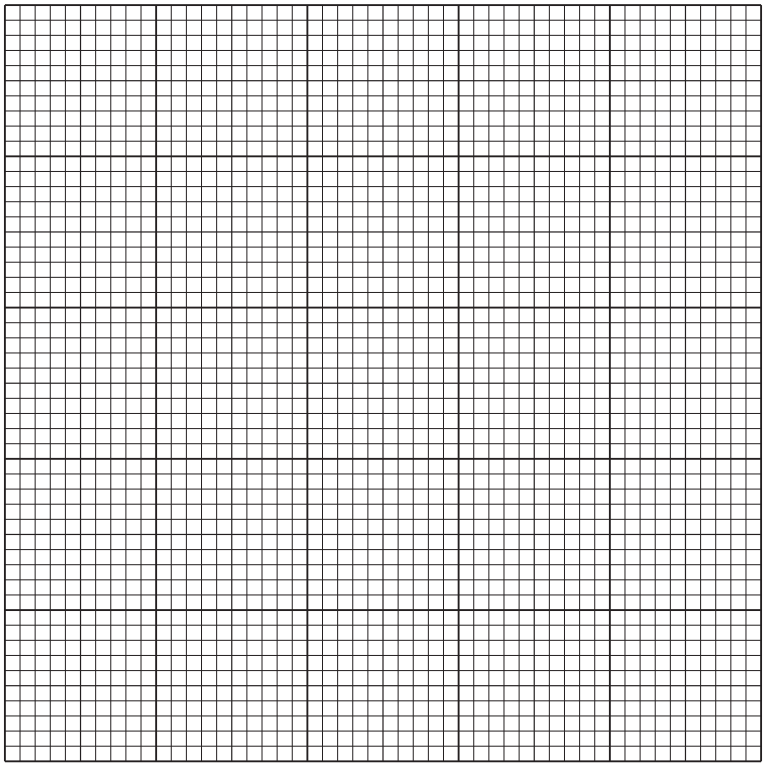
(i) Calculate the annual range in **minimum** temperature for Halley.

..... °C [2]

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(ii) October to February are summer months in Antarctica.

Plot a line graph of the **average** temperature for these summer months.



[4]

(iii) Explain why it is **not** possible to grow crops at Halley.

.....

.....

.....

.....

.....

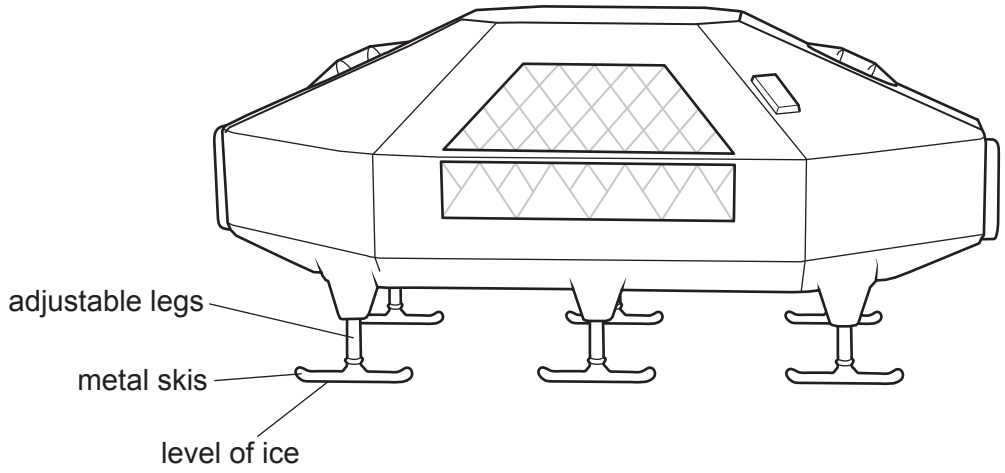
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..... [4]

(c) Halley is built on an ice shelf that moves 400 m further into the Weddell Sea every year. The depth of the ice at Halley increases by 1 m every year.

The diagram shows part of the living accommodation at Halley.



The accommodation is built on giant metal skis, with adjustable legs. Previous research stations were built on fixed legs that were buried in the ice sheet.

(i) Suggest reasons why Halley is built on giant metal skis, with legs that can be adjusted.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) The accommodation is built using insulating material that is very good at reducing heat loss.

Suggest **two** reasons why this is important at Halley.

1 .....

.....

2 .....

.....

[2]

(d) The waste management policy at Halley is to:

- minimise the quantity of waste produced
- reuse and recycle
- remove all waste from Antarctica, apart from sewage and food waste.

(i) Suggest reasons why it is important to minimise the quantity of waste produced at Halley.

.....

.....

.....

..... [2]

(ii) Suggest why sewage and food waste are **not** removed from Antarctica.

.....

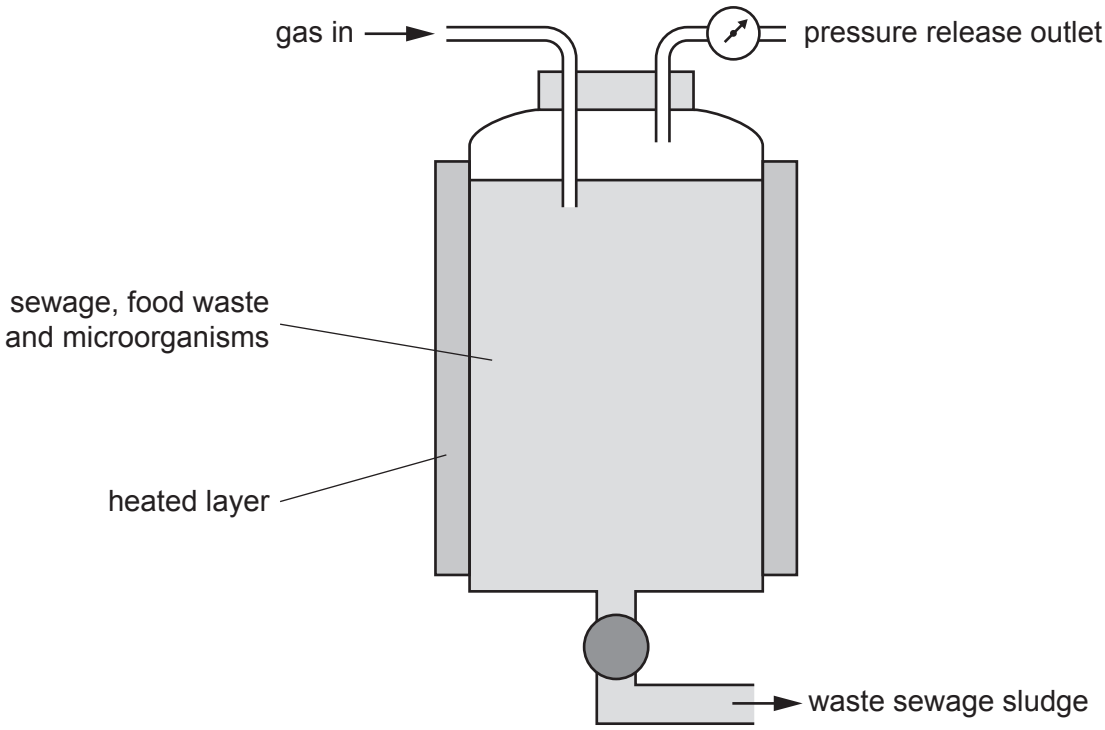
..... [1]

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[Turn over

(e) Sewage and food waste at Halley can be treated using a bioreactor. A bioreactor contains microorganisms.

The diagram shows a bioreactor.



(i) The microorganisms in the bioreactor respire.

State the name of the gas needed for the microorganisms to respire.

..... [1]

(ii) Suggest **one** reason why pressure builds up in the bioreactor.

.....

..... [1]

(iii) The microorganisms need an optimum temperature to work correctly.

Temperature is an abiotic component in an ecosystem.

State **three** other abiotic components in an ecosystem.

1 .....

2 .....

3 .....

[3]

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(iv) Waste sewage sludge can be dried and burnt. The ash produced can be collected.

Suggest **one** environmental impact of burning waste sewage sludge.

.....

..... [1]

(v) In many countries, waste sewage sludge is spread onto fields.

Suggest **one** benefit of this practice to farmers.

.....

..... [1]

(vi) Bioreactors are used to produce biofuels. Biofuels are a renewable energy resource.

State **two** other renewable energy resources.

1 .....

2 .....
[2]

[Total: 30]

2 A fact sheet about South Georgia is shown.

> South Georgia is an island in the Southern Ocean near Antarctica. 88% of the species in the Southern Ocean are found nowhere else on Earth.
>
> The island has an area of 3903 km^2 and a population of 30 scientists and support staff. Tourists also visit the island.
>
> There are no trees or bushes. Birds nest on the ground. The land is often covered with snow and some areas have permanent glaciers.
>
> Rats were accidentally introduced to the island by whale hunters 200 years ago. The rats ate the eggs and chicks of seabirds. They threatened the pipit bird and the brown duck with extinction.

(a) A rat-removal programme began in 2010.

(i) Suggest reasons why rats needed to be removed from South Georgia.

.....

.....

.....

..... [2]

(ii) A total of 300 tonnes of poisoned rat food were dropped on the island from the air over five years as part of the removal programme.

Suggest why some scientists were concerned about this method of rat removal.

.....

..... [1]

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(b) In 2018, South Georgia Island was declared rat free.

(i) Strategies are used to keep South Georgia Island rat free. They include:

- keeping large tourist boats offshore
- moving people to the island in smaller boats.

Suggest how these strategies help to keep the island rat free.

.....

..... [1]

(ii) After the poisoned rat food was dropped, two methods were used to find out if all the rats were removed.

method 1: Three dogs were walked 2500 km around the island. The dogs were trained to identify rats by their smell.

method 2: Thousands of chew sticks were installed around the island to detect signs of rat teeth-marks.

Suggest limitations for each method.

method 1 .....

.....

.....

method 2 .....

.....

.....

[3]

(c) New Zealand consists of about 600 islands. It has a total area of 268 021 km^2 and a population of approximately five million people.

New Zealand plans to remove all their rats by 2050.

Suggest reasons why the removal programme will be more difficult in New Zealand than on South Georgia.

.....

.....

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..... [3]

(d) Rats can spread bacterial diseases if their urine gets into drinking water.

State **two** strategies to treat water that contains bacteria to make it safe to drink.

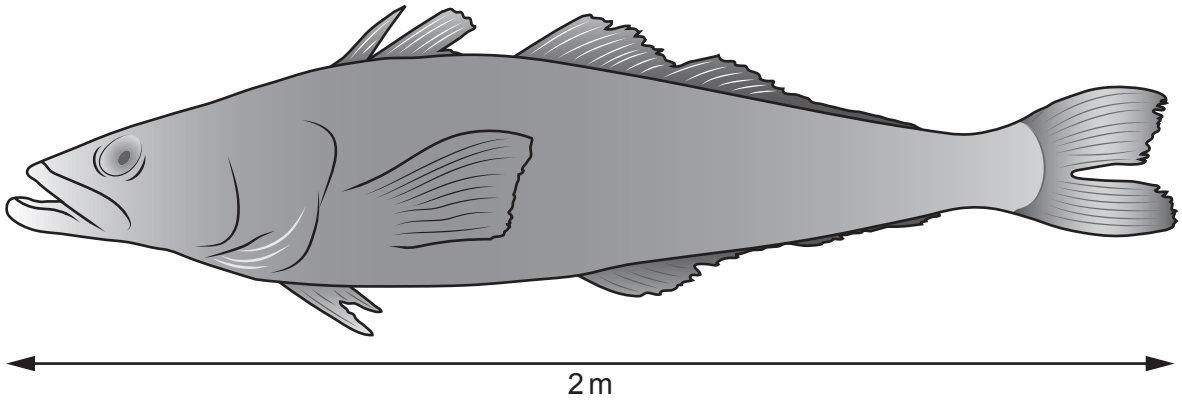
1 .....

2 .....
[2]

[Total: 12]

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3 Patagonian toothfish are found in the Southern Ocean. The fish grow slowly. It is 10 years before they become adult fish. They can live for up to 50 years. The fish can sell for $140 for 1 kg of fish.



(a) Illegal fishing of the Patagonian toothfish occurs. This fishing is unsustainable.

Explain what is meant by unsustainable fishing.

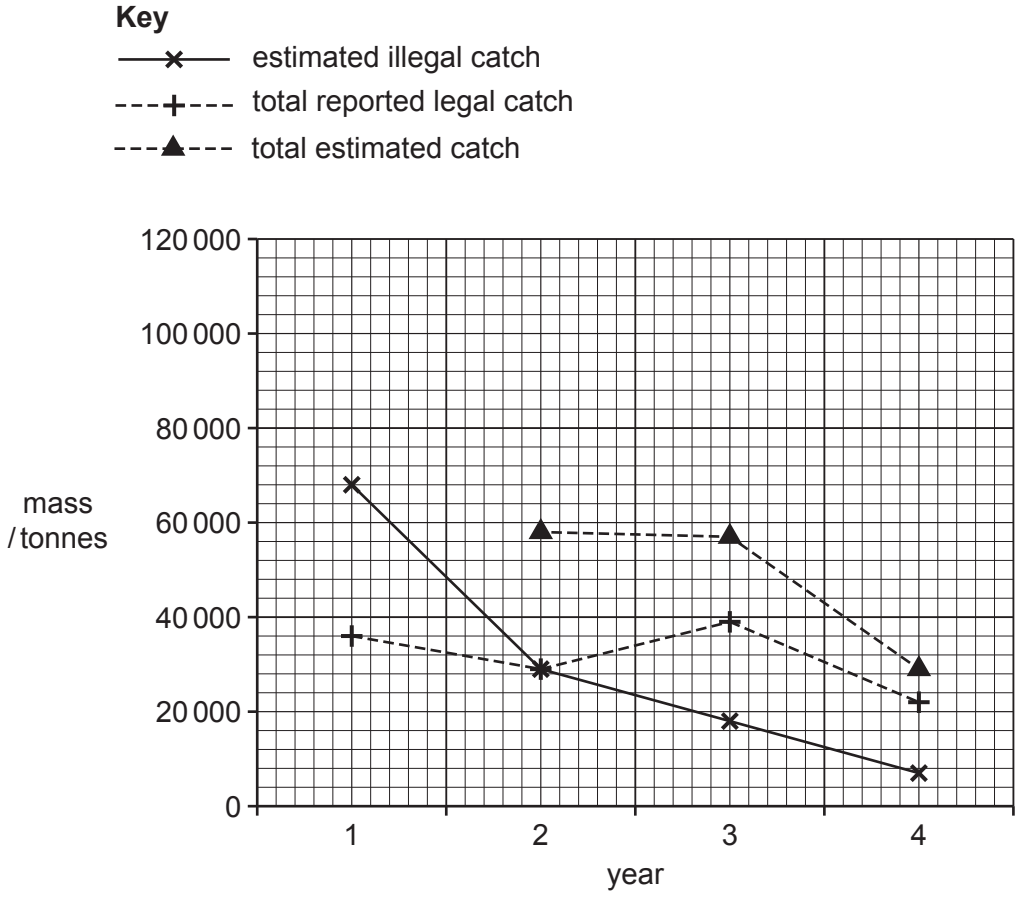
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..... [2]

(b) The graph shows the mass of total reported legal catch, estimated illegal catch and total estimated catch for Patagonian toothfish for a four-year period.



(i) Calculate the mass of the total estimated catch for year 1.

..... tonnes [1]

(ii) Suggest reasons why there is a large trade in illegal fishing of the Patagonian toothfish.

.....

.....

.....

.....

.....

..... [3]

(iii) State **three** ways the harvesting of marine species in the Southern Ocean can be managed.

1 .....

2 .....

3 .....
[3]

(c) A food chain for the Patagonian toothfish is shown.

phytoplankton → krill → squid → Patagonian toothfish

There are about 450 million tonnes of krill in the Southern Ocean.

A report states that climate change could reduce the size of the krill population by up to 40%.

(i) Suggest **one** impact on the population of Patagonian toothfish if the krill population is reduced. Give a reason for your answer.

impact .....

reason .....
[1]

(ii) Suggest reasons why climate change could reduce the size of the krill population.

.....

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..... [2]

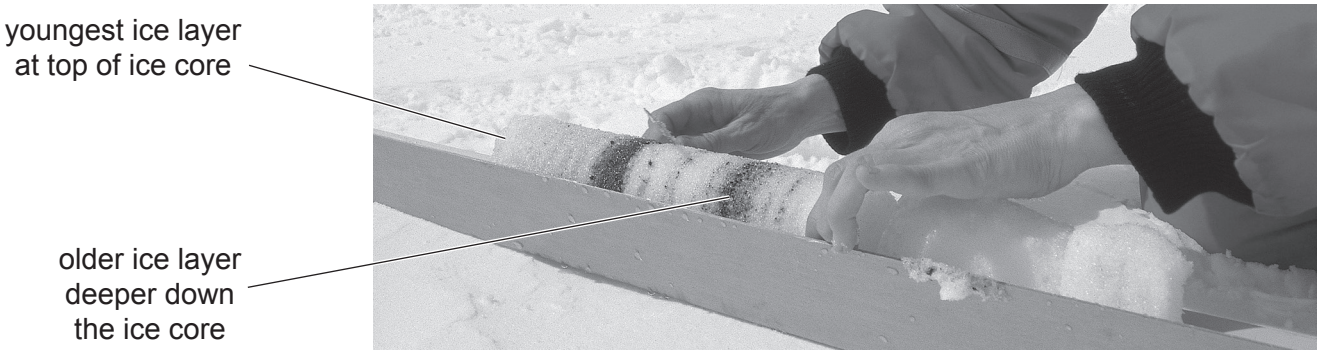
[Total: 12]

4 Snow builds up in layers in Antarctica every year. Over time, the buried snow is compressed by the weight of the snow above it. This forms layers of ice.

Chemicals in the atmosphere are captured by falling snow and become part of the ice. Bubbles of air are also trapped in the ice layers.

Samples of ice are taken by drilling down into the ice layers to remove ice cores.

The photograph shows layers of ice in part of an ice core.



(a) Ice cores are cut into thin slices and each slice is analysed to investigate the climate in the past.

(i) Suggest why thin slices of an ice core are individually analysed rather than the whole length of the ice core.

.....

..... [1]

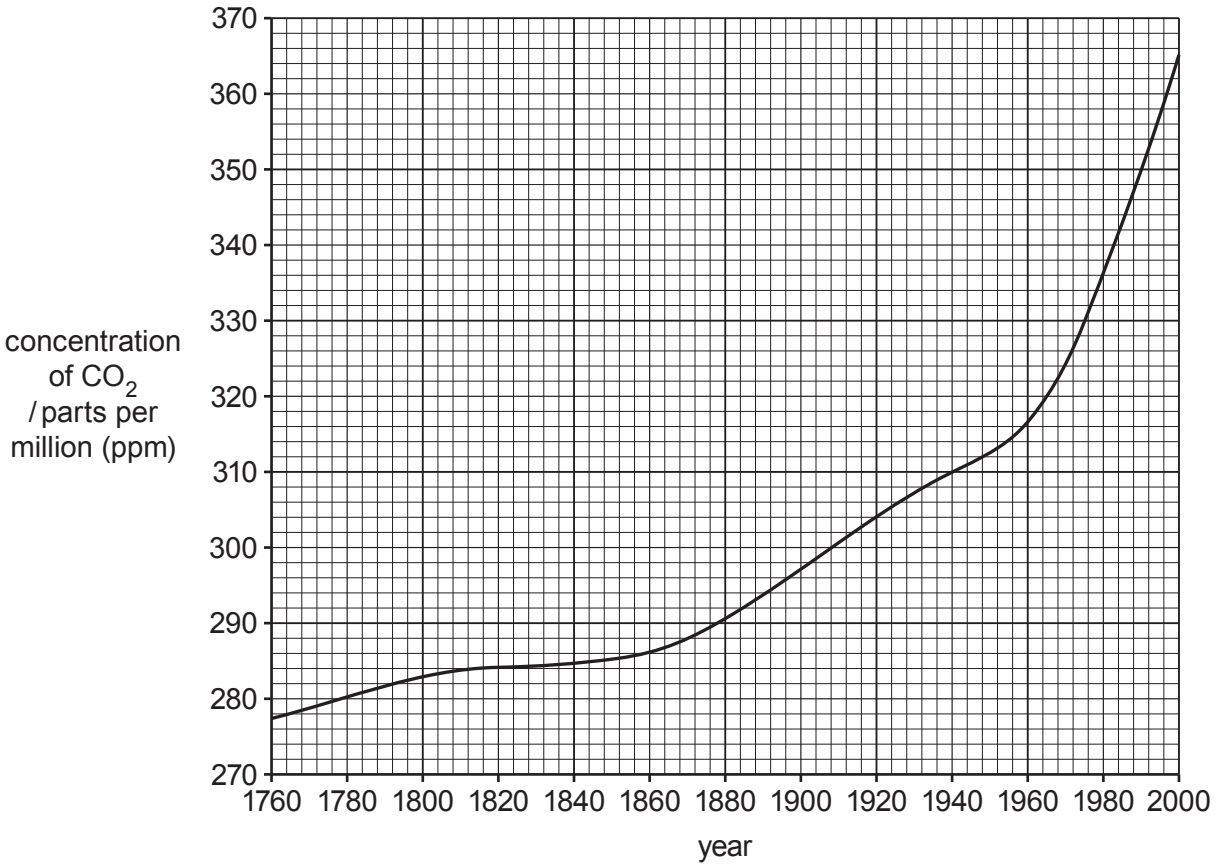
(ii) Suggest how major volcanic eruptions are used to determine the age of a slice of an ice core.

.....

..... [1]

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(b) The graph shows data obtained from an ice core for the concentration of carbon dioxide in the atmosphere from 1760 to 2000.



(i) Describe the trend shown by the graph.

.....

.....

.....

..... [2]

(ii) Suggest reasons for the trend shown by the data.

.....

.....

.....

..... [2]

(iii) Carbon dioxide is a greenhouse gas that is used to give information on climate change.

State the names of **two** other greenhouse gases.

1 .....

2 .....
[2]

(iv) Explain why climate change is causing sea levels to rise.

.....

.....

.....

.....

.....

..... [3]

(c) The ozone hole is an area of depleted ozone in the atmosphere over Antarctica. It was discovered by Antarctic scientists in 1985.

(i) Name the chemicals responsible for ozone depletion.

..... [1]

(ii) Name the layer of the atmosphere where ozone depletion occurs.

..... [1]

(iii) Explain why ozone depletion is a concern.

.....

.....

.....

.....

.....

..... [3]

[Total: 16]

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5 **(a)** Tourism to Antarctica is increasing.

(i) In 2016, there were 43 915 Antarctic tourists.

In 2017, this increased to 51 707.

Calculate the percentage increase in tourist numbers.

.....% [2]

(ii) Tourists travel to Antarctica by ship. They visit for one to three hours each day in groups of less than 100. They must be supervised by experts on Antarctic wildlife.

Suggest how this strategy limits the impact of tourism on Antarctic wildlife.

.....

.....

.....

..... [2]

(b) In 2009, large ships carrying tourists were banned from Antarctic waters. This was to reduce the risk of an oil spill from the ships.

(i) Explain how a double-hulled ship can reduce the risk of an oil spill.

.....

.....

.....

..... [2]

(ii) State **one** strategy for dealing with an oil spill.

..... [1]

(c) Describe the impacts of an oil spill on marine mammals.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

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