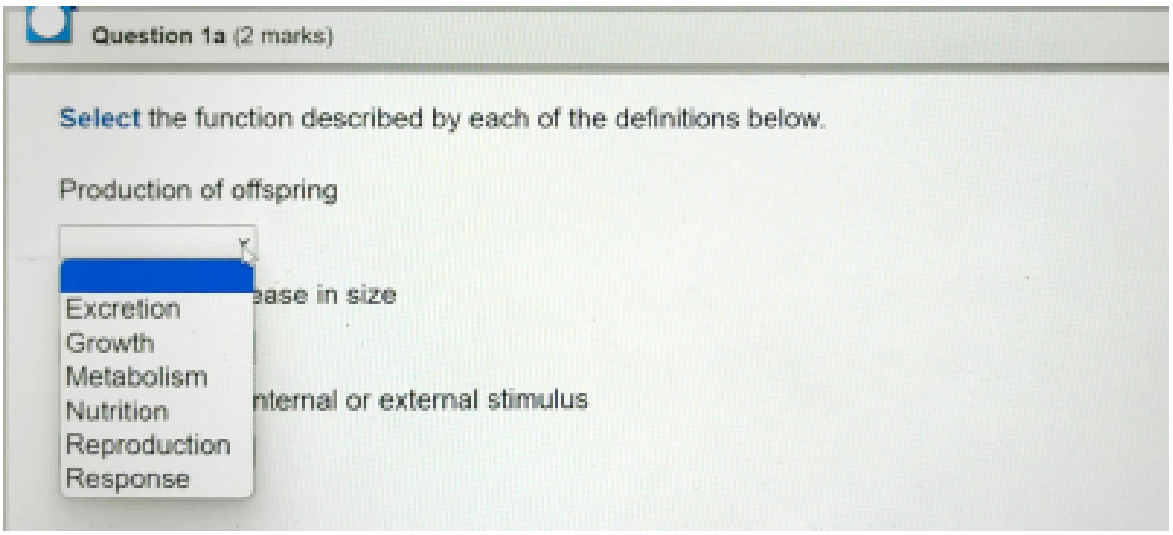
**Question 1a** (2 marks)

**Select** the function described by each of the definitions below.

Production of offspring

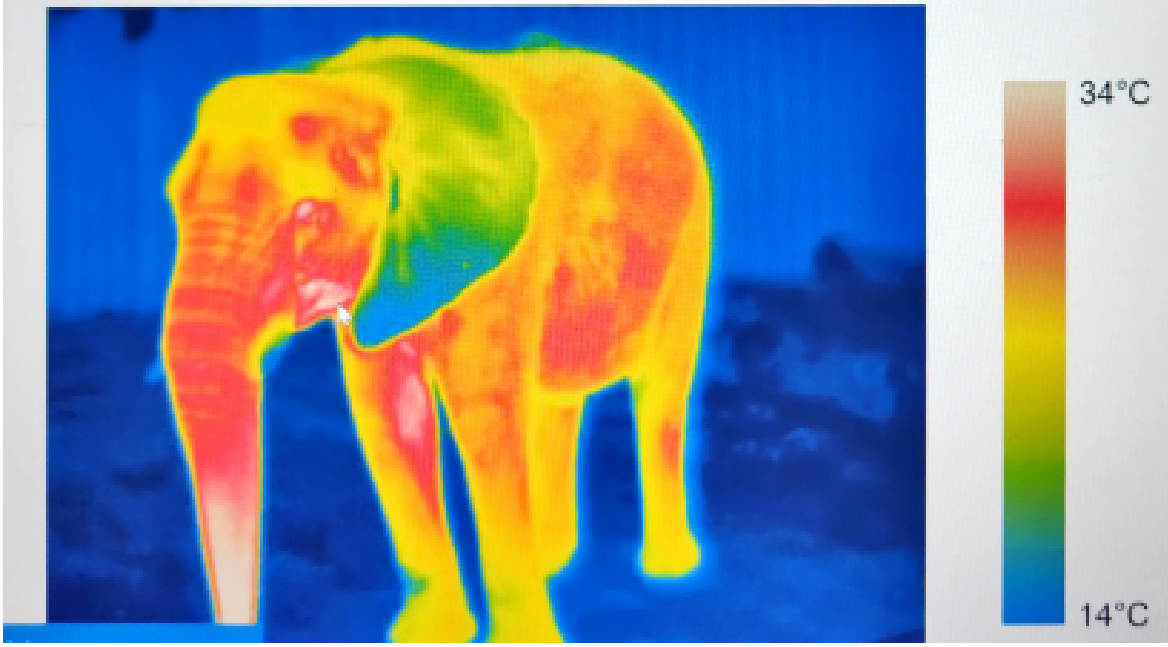
Permanent increase in size

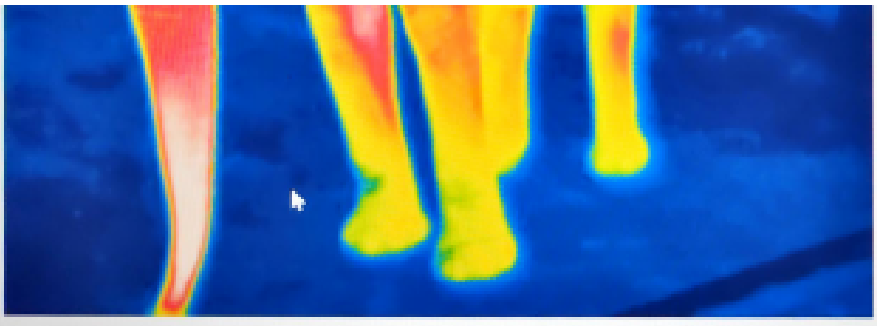
Reaction to an internal or external stimulus



**Question 1b** (2 marks)

Homeostasis is the maintenance of a stable internal environment. The image below shows the temperature of an elephant.



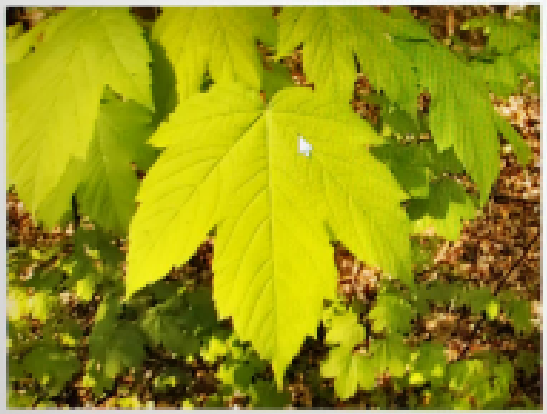




©

**Outline** how an elephant's ears help to maintain its body temperature.

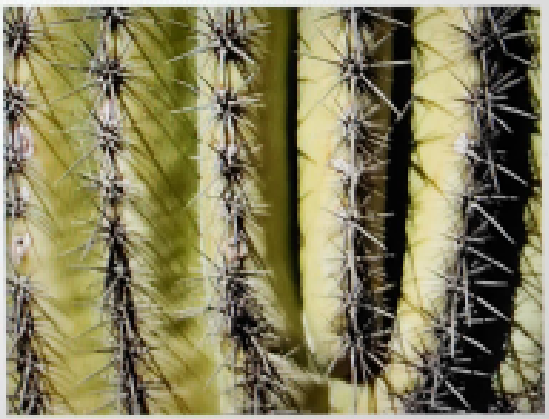
**Question 1c** (2 marks)

Plants have adapted to their environments by evolving a variety of leaf shapes and sizes. Broad-leaf plants, like the maple tree found in temperate forests, have large leaves which grow quickly.



**Question 1d** (2 marks)

Other plants, like the saguaro cactus found in the desert, have spines, which are modified leaves.



**Outline** one possible advantage of maple leaves having a large surface area.

**Outline** one possible advantage of cactus leaves having a small surface area.

**Question 1e** (3 marks)

All cells need to obtain nutrients and eliminate waste efficiently. Because of this, cells are limited in size by the relationship between their surface area and their volume.

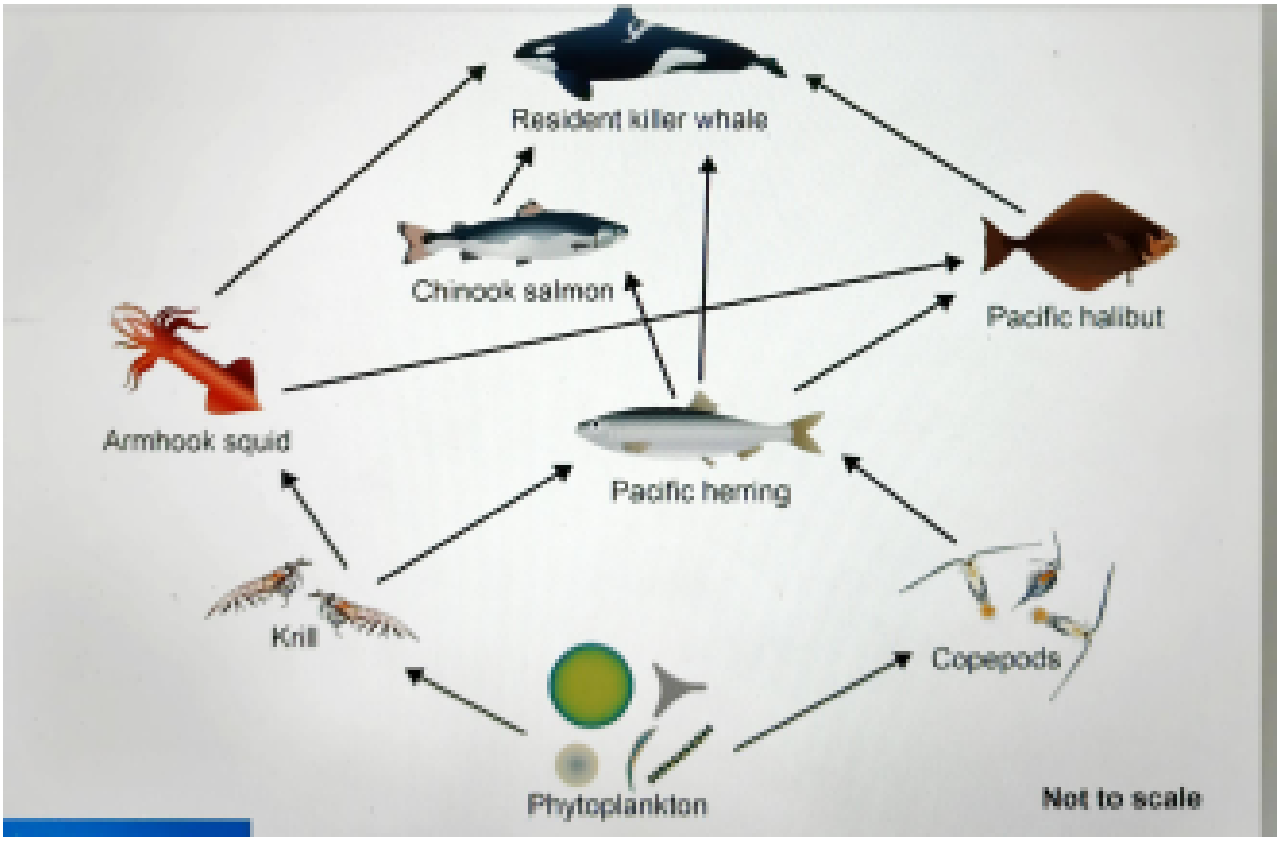

| | | | |
|---|---|---|---|
| **Total surface area** (height x width x number of sides) | **6** | **54** | **150** |
| **Total volume** (height x width x length) | **1** | **27** | **125** |
| **Surface area to volume ratio** (surface area ÷ volume) | **6** | **2** | **1.2** |

**Explain** why having a high surface area to volume ratio is beneficial to a cell.


Question 2 (12 marks)

Question 2a (1 mark)

Below is a food web from the North Pacific Ocean.




Using the food web above, **construct** a food chain that consists of five species including the pacific halibut at the fourth trophic level.

Draggable items:

- Armhook squid
- Chinook salmon
- Copepods
- Krill
- Pacific herring
- Phytoplankton
- Resident killer whale

→ → → Pacific halibut →

**Question 2b** (2 marks)

Using examples from the food web above, **justify** how a resident killer whale can belong to more than one trophic level.

**Question 2c** (1 mark)

The North Pacific Ocean ecosystem is home to three different kinds of killer whale. Resident, transient, and offshore killer whales all have slightly different appearances and hunting behaviours.

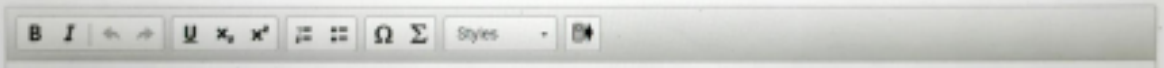
| Resident killer whale | Transient killer whale | Offshore killer whale |
|---|---|---|
|  |  |  |
| **Size** | **Size** | **Size** |
| Largest | Mid-sized | Smallest |
| **Prey** | **Prey** | **Prey** |
| Fish, especially salmon | Large marine mammals | Halibut and sleeper sharks |
| **Hunting behaviours** | **Hunting behaviours** | **Hunting behaviours** |
| Stay in the same areas all year and hunt in groups of 5 to 30 | Migrate and hunt in smaller groups of 2 to 5 | Hunt in the open ocean in large groups of around 50 |

**Suggest** why the three different killer whales have different hunting preferences.

**Question 2d** (4 marks)

A species is a group of organisms that can interbreed and produce fertile offspring. Speciation occurs when one species becomes two separate species over time. There are many reasons why this can happen, for example when populations become geographically separated. The three types of killer whale share an ecosystem, but are not observed to interact.

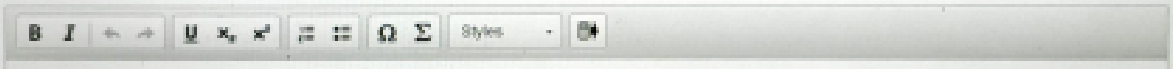
**Discuss** the possibility that the three different types of killer whale are in the process of speciation.



**Question 2e** (3 marks)

Genome mapping is a technique that can be used to distinguish between different species.

**Outline** how genome mapping could be used to confirm whether the three different types of killer whale are different species. You should use scientific terminology in your answer.



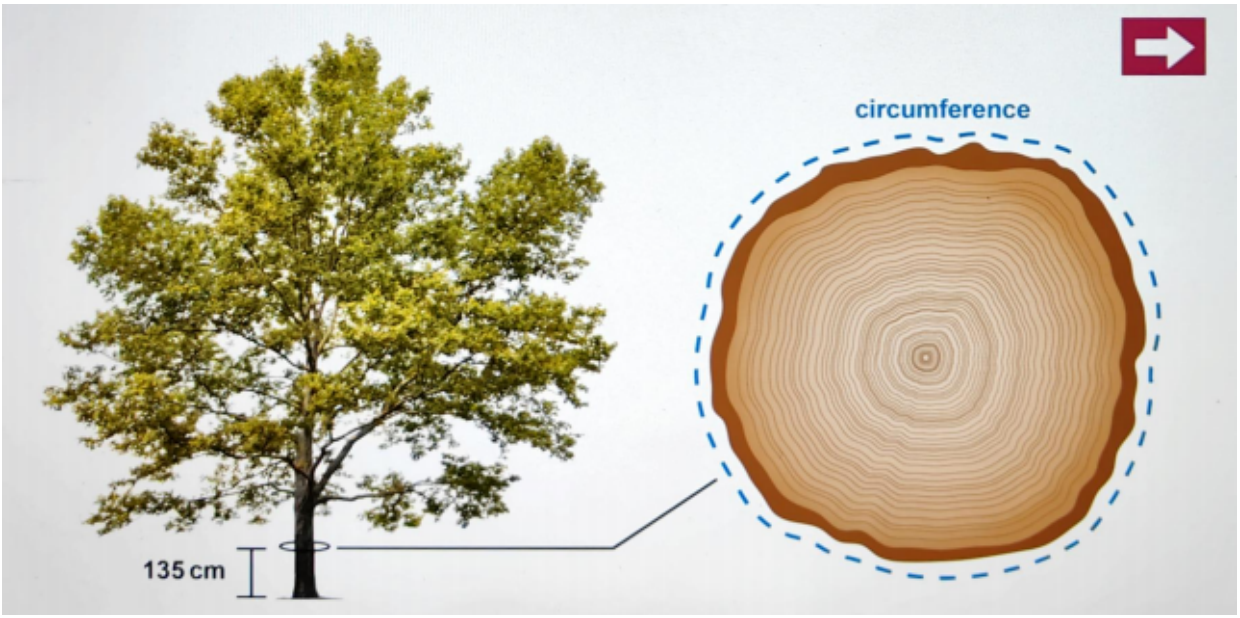
**Question 2f** (1 mark)

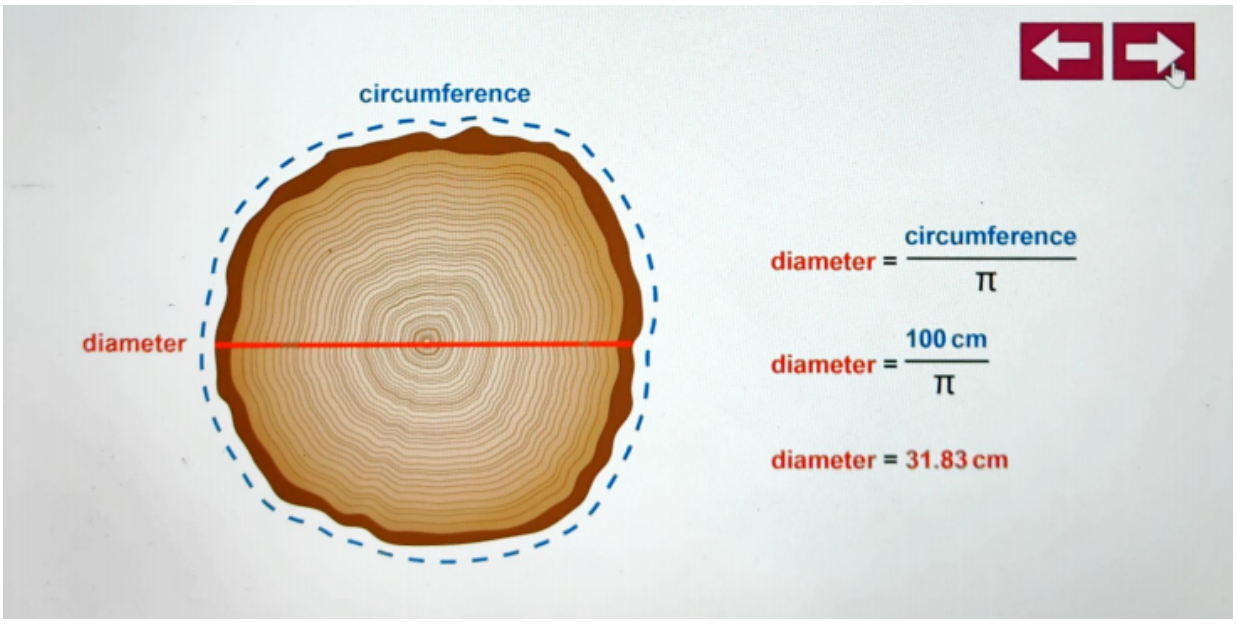
**Comment** on whether the three different types of killer whale should be classified as three different species.

**Question 3** (12 marks)

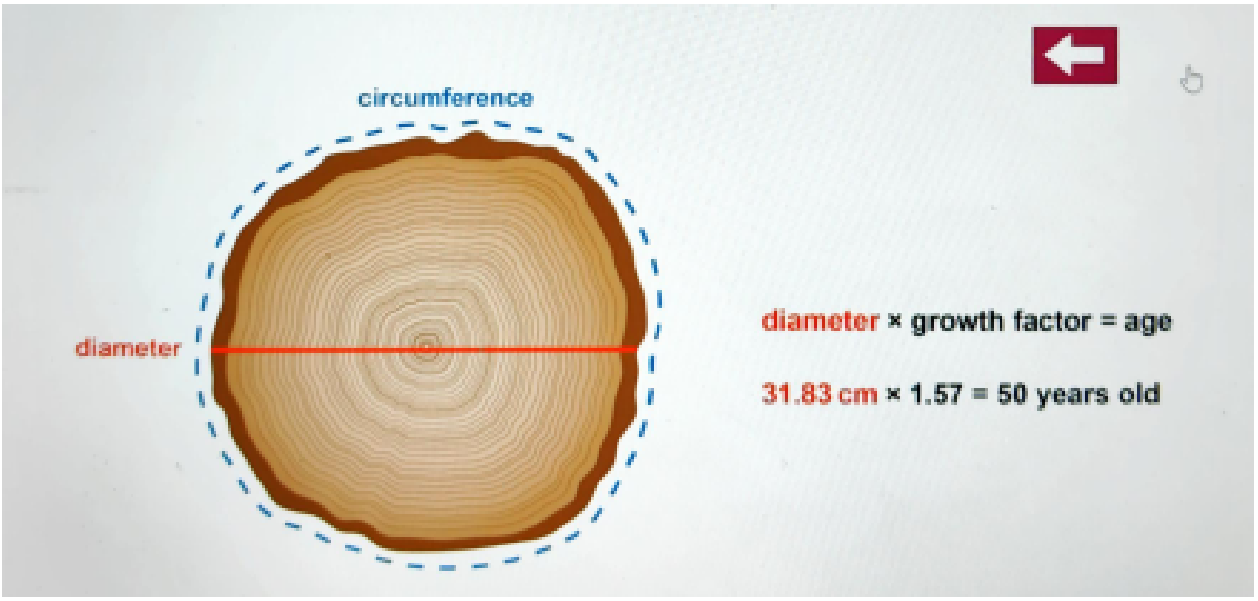
The oldest living tree is thought to be over 5000 years old.

The age of a tree can be estimated using growth factor values. Trees that grow faster have a higher growth factor. Different tree species have different growth factors. The method of estimation is shown below.




circumference
diameter
diameter = circumference / π
diameter = 100 cm / π
diameter = 31.83 cm


Species:
Sycamore
Growth factor:
1.57



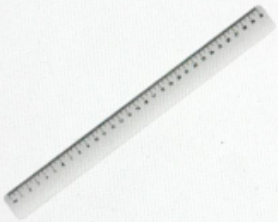

**4** Multiply the diameter by the growth factor to estimate the age.

| Circumference / cm | Diameter / cm | Growth factor / y cm$^{-1}$ | Age / y |
|---|---|---|---|
| 100 | 31.83 | 1.57 | 50 |

**Question 3a** (1 mark)

**Select** the most appropriate piece of equipment for measuring the circumference of the tree.

○ Protractor



○ Ruler

○ Tape measure


○ Stopwatch

**Question 3b** (1 mark)

The table below shows data collected for two different species of tree. The age has been estimated for the sycamore tree.

| Species | Growth factor / y $cm^{-1}$ | Circumference / cm | Estimated age / y |
|---|---|---|---|
| Sycamore | 1.57 | 100 | 50 |
| Beech | 1.91 | 89 | |

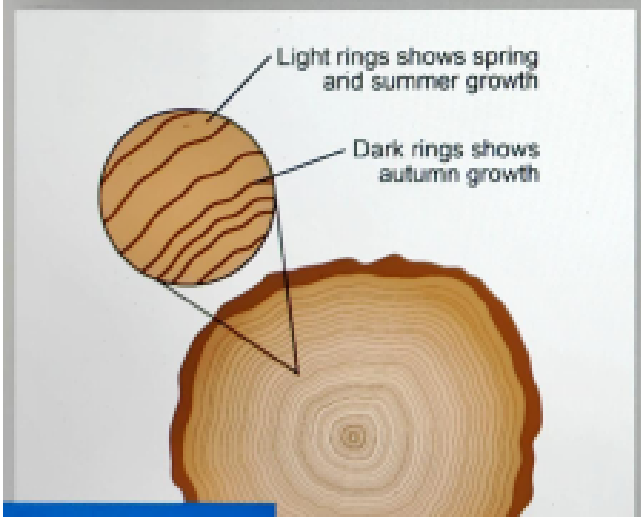
**Calculate** the estimated age of the beech tree and add your value to the table. You should give your value to the nearest year.

**Question 3c** (1 mark)

**Suggest** why the unit of measurement for the circumference is important when estimating tree age.

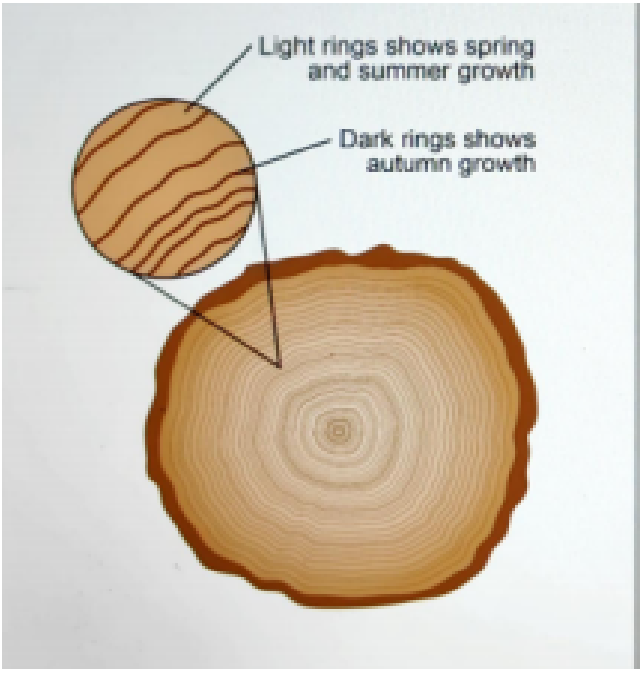
**Question 3d** (2 marks)

An alternative method for estimating tree age is counting growth rings in the cross section of a trunk. Growth rings occur because trees grow faster in the spring and summer and slower in the autumn.




Method:

1. Cut a cross section through the tree trunk 30 cm from the base.
2. Count the number of dark rings to determine the age of the tree.


Method:

1. Cut a cross section through the tree trunk 30 cm from the base.
2. Count the number of dark rings to determine the age of the tree.

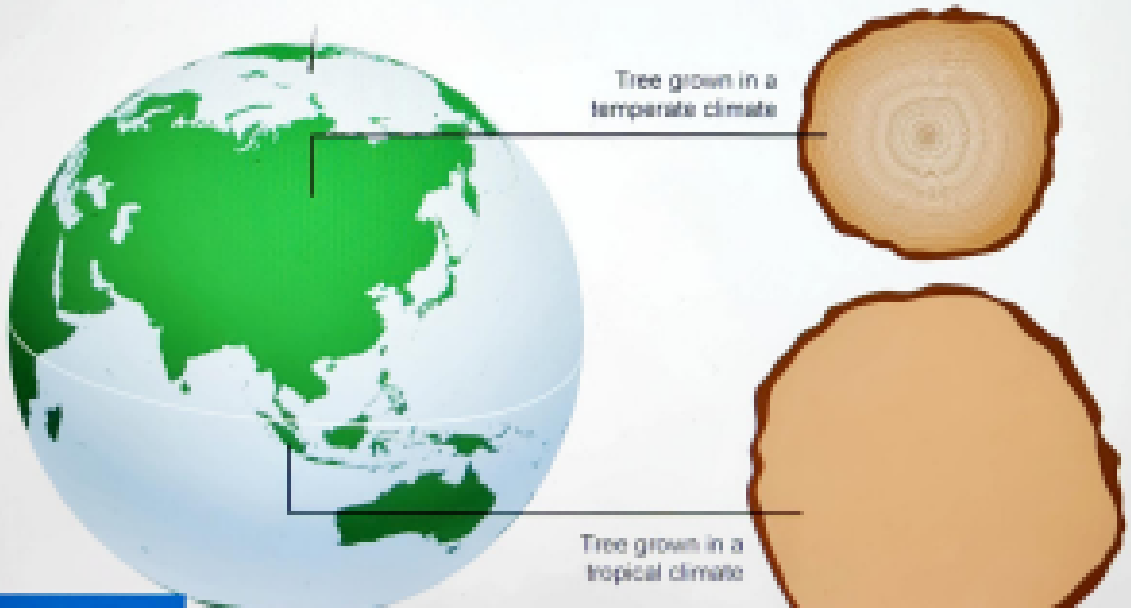
**Outline** why counting both the light and dark rings would not accurately estimate the age of the tree.

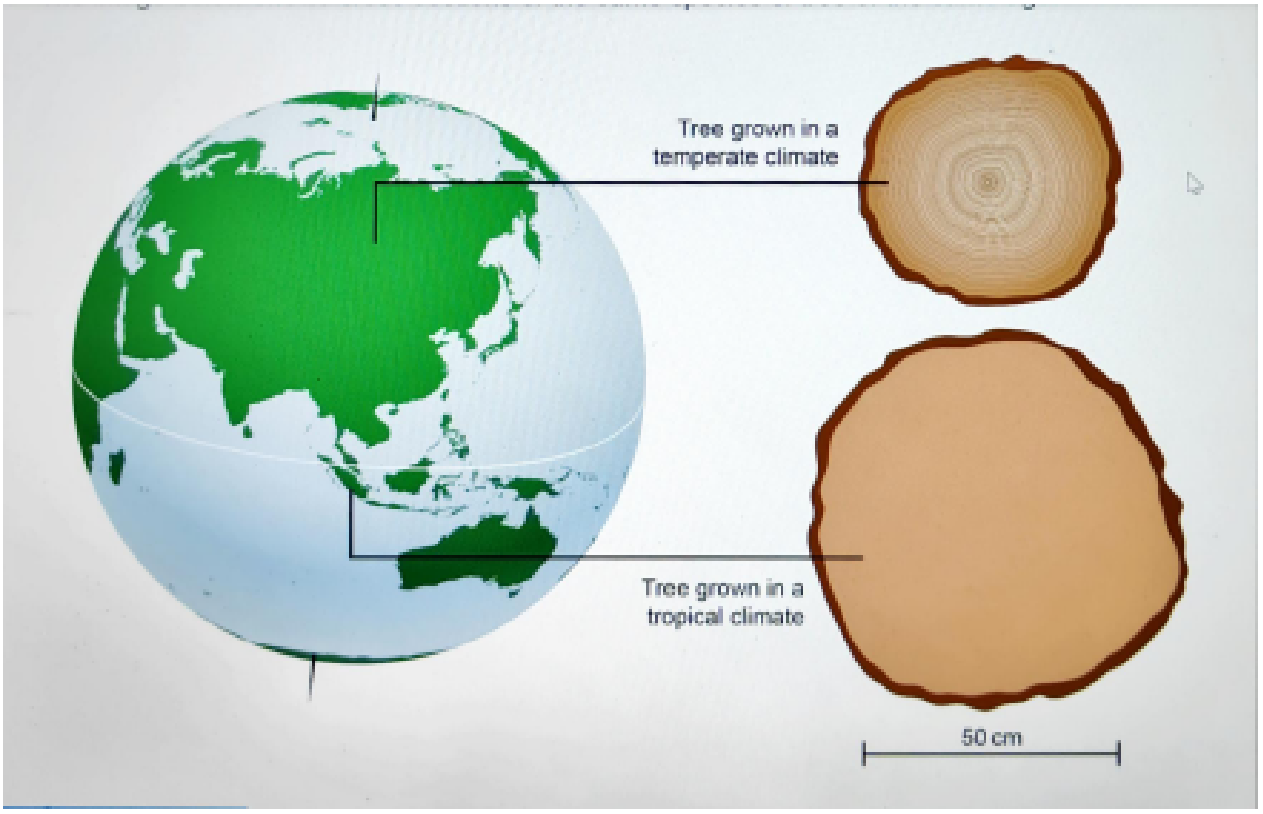
**Question 3e** (1 mark)

**Justify** why cutting near the base of the tree gives a more valid estimate of the tree's age.

**Question 3f** (4 marks)

The image below shows cross sections of the same species of tree of the same age.






Using the image, **explain** two differences between the cross sections.

**Question 3g** (2 marks)

**Identify** a limitation of each method used to estimate the age of trees.

Growth factor values

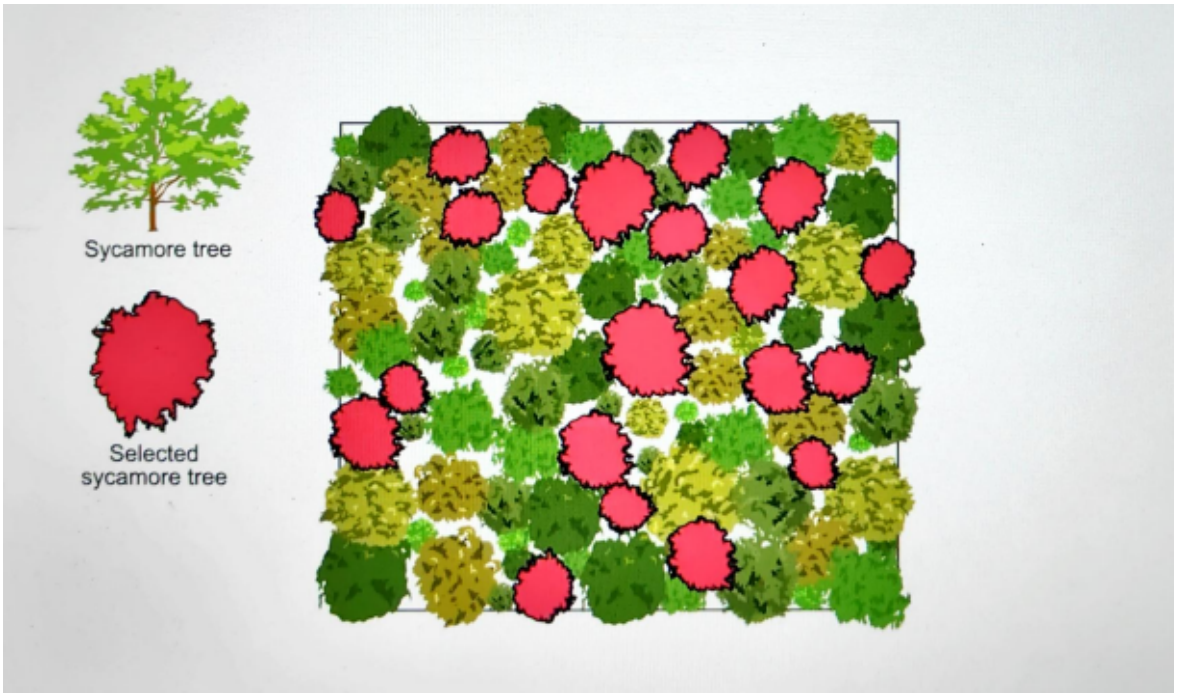
Counting rings

**Question 4** (13 marks)

Some MYP students wanted to investigate the relationship between the age and height of sycamore trees growing in their local forest. The forest had over 500 sycamore trees. After discussing with their teacher how height could be estimated, they collected data on a sample of 20 randomly selected sycamore trees.

**This media contains no audio.**

Sycamore tree




**Question 4a** (2 marks)

**Suggest** why the sample of 20 sycamore trees was randomly selected.

**Question 4b** (1 mark)

**Outline** how the sample could be randomly selected.

**Question 4c** (1 mark)

The students all agreed that the height of the tree was the dependent variable in their investigation. The students could not agree on a prediction.

Student A: If the tree has a greater circumference, then it will be older.

Student B: If the tree is older, then it will be taller.

Student C: If the tree is taller, then it will have a greater growth factor.

Student D: If the tree has a larger growth factor, then it will have a larger circumference.

**Justify** which is the best prediction for **this investigation**.

**Question 4d** (1 mark)

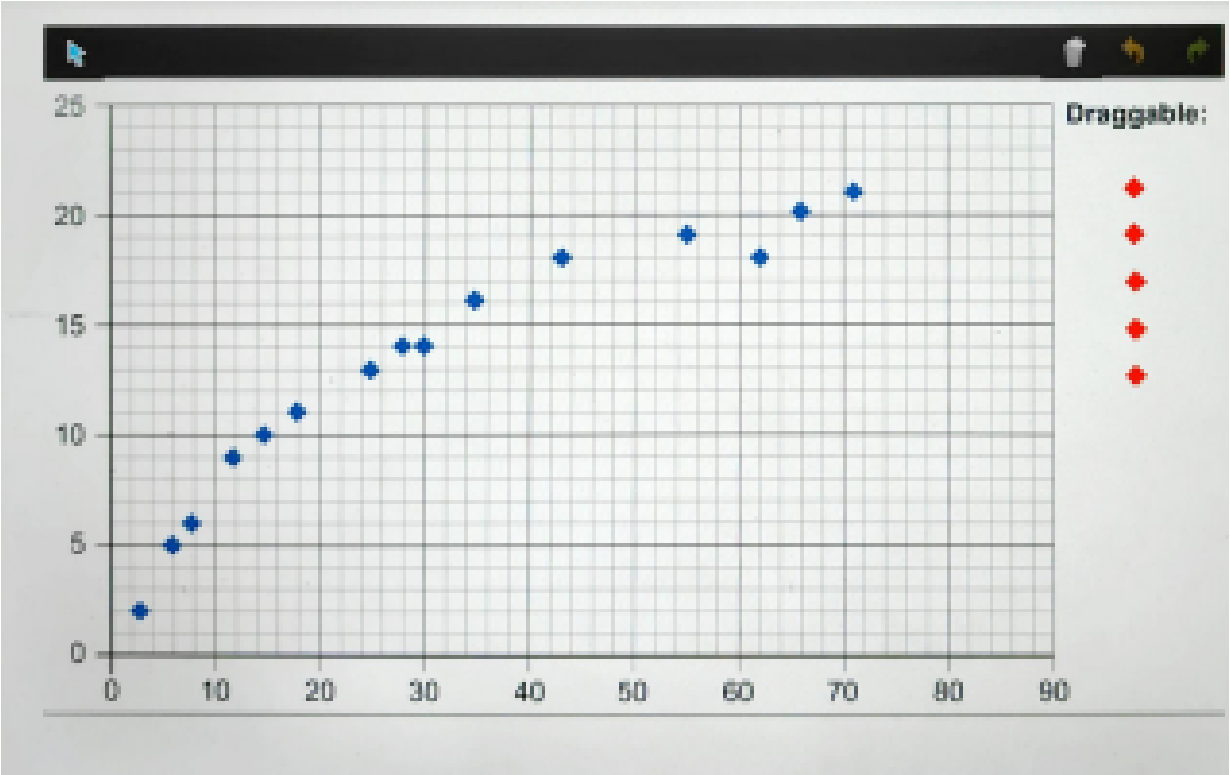
The students recorded their results in the lab book shown below:

| Age / y | Height / m | Comments |
|---|---|---|
| 80 | 22 | Dense forest, not much light available |
| 40 | 17 | |
| 20 | 12 | |
| 10 | 7 | Many flowers surrounding trees |
| 5 | 3 | |

**State** how the students could have recorded more accurate measurements.

**Question 4e** (6 marks)

The graph below shows data for 15 trees from the sample. **Plot** the data in part (d) to complete the graph below.



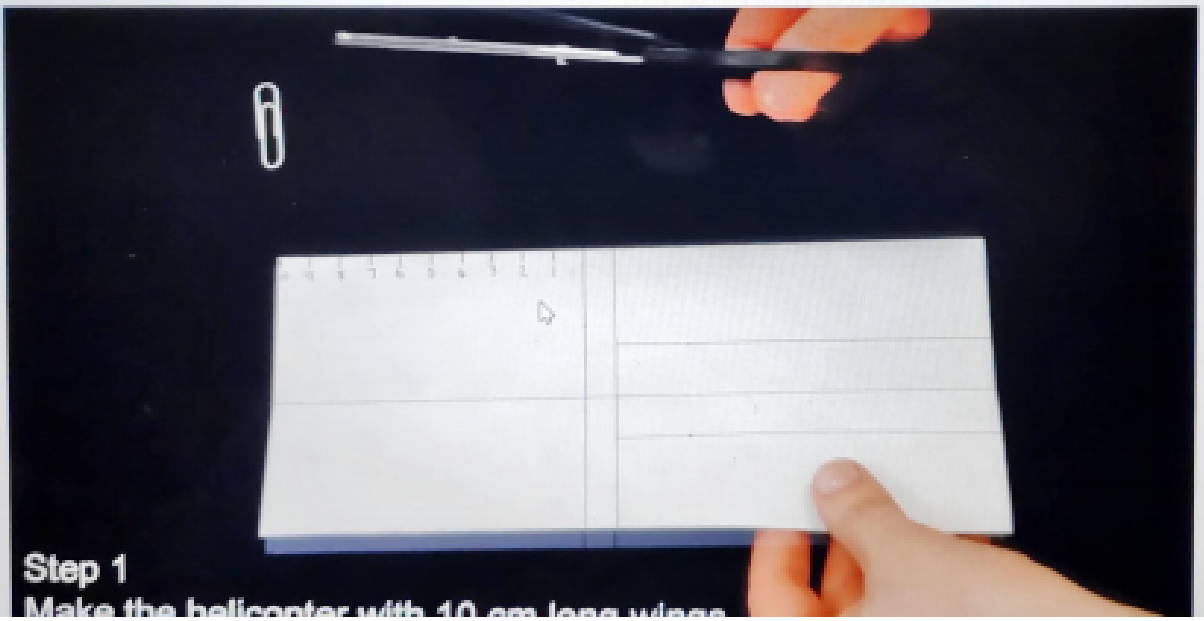

**Question 4f** (2 marks)

Use the graph in part (e) to **deduce** how the rate of growth of sycamore trees changes over time.

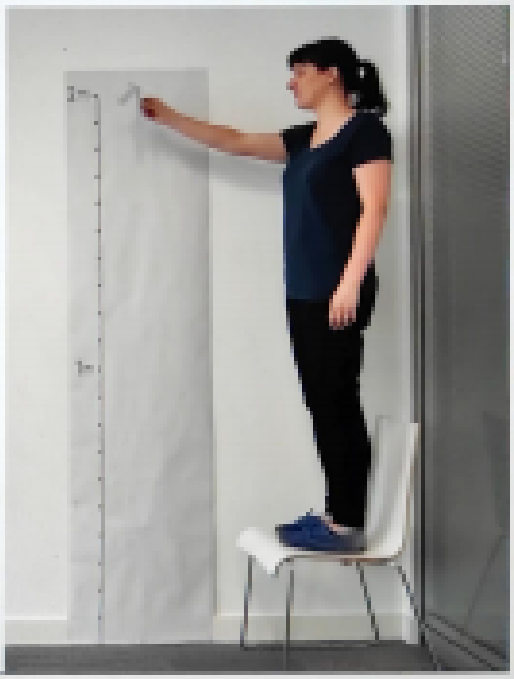
**Question 5** (10 marks)

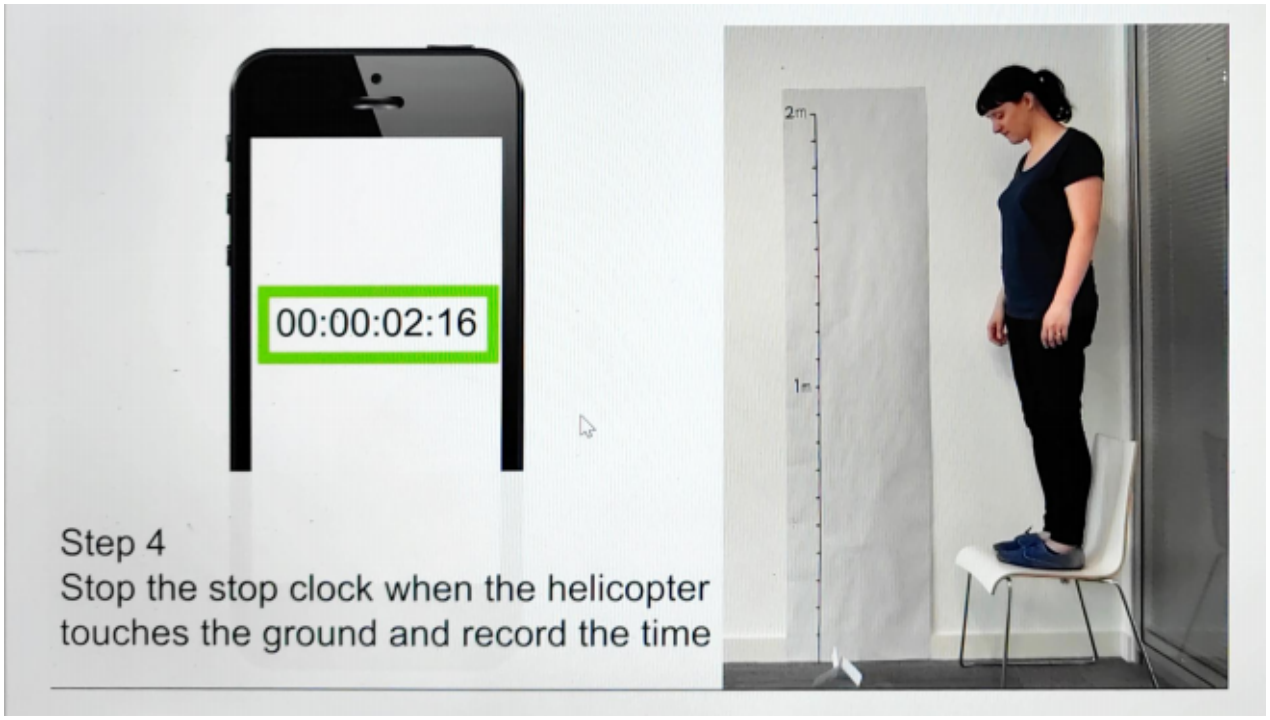
Sycamore seeds are contained in winged structures called samaras. When sycamore seeds fall, they spin in circles. This helps them to stay in the air longer.

A group of MYP students investigated the relationship between the height from which a sycamore seed falls and the time it spends in the air.




Step 3
Line up the top of the helicopter with the scale then drop the helicopter and simultaneously start the stop clock.






| Height from which seed is dropped / m | Time spent in the air / s | |
|---|---|---|
| | Trial 1 | Trial 2 |
| 0.50 | 0.56 | 0.67 |
| 0.75 | 1.15 | 1.07 |
| 2.00 | 2.16 | 2.38 |

**Question 5a** (4 marks)

**Identify** the variables in this investigation.

Independent variable

Control variable 1

**Question 5b** (2 marks)

**Outline** why the group's data is insufficient to draw a valid conclusion.

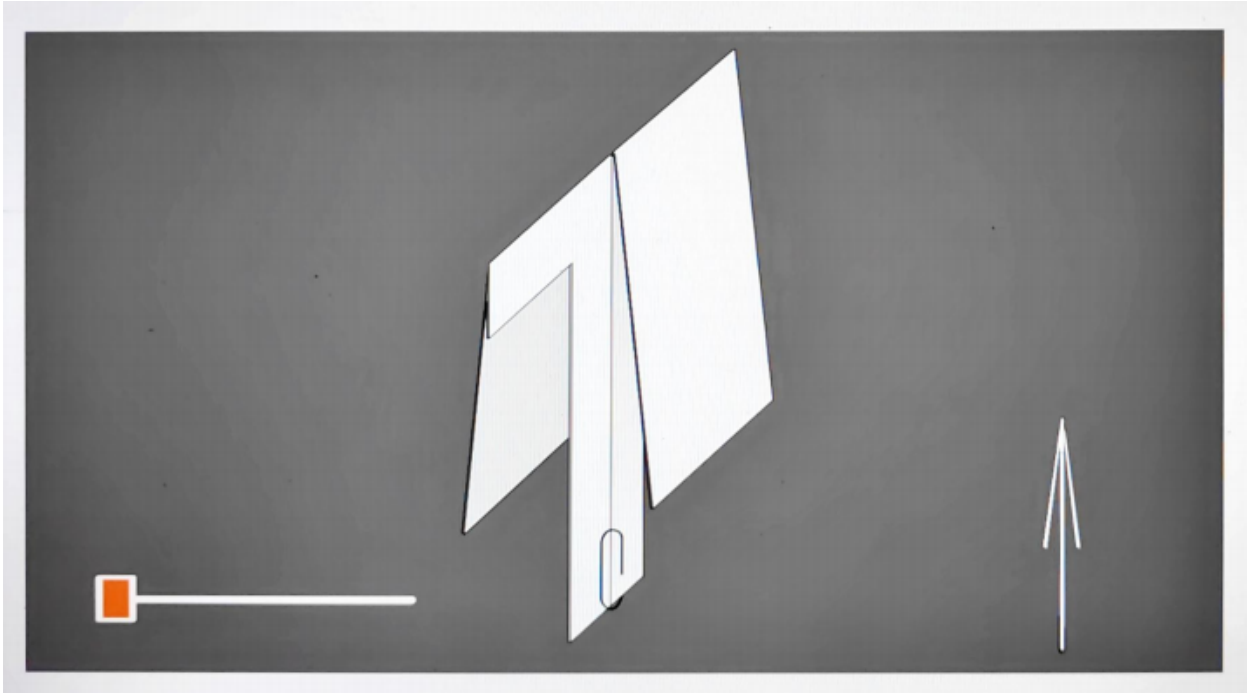
**Suggest** and **justify** two improvements that would make the model closer to what happens in nature.

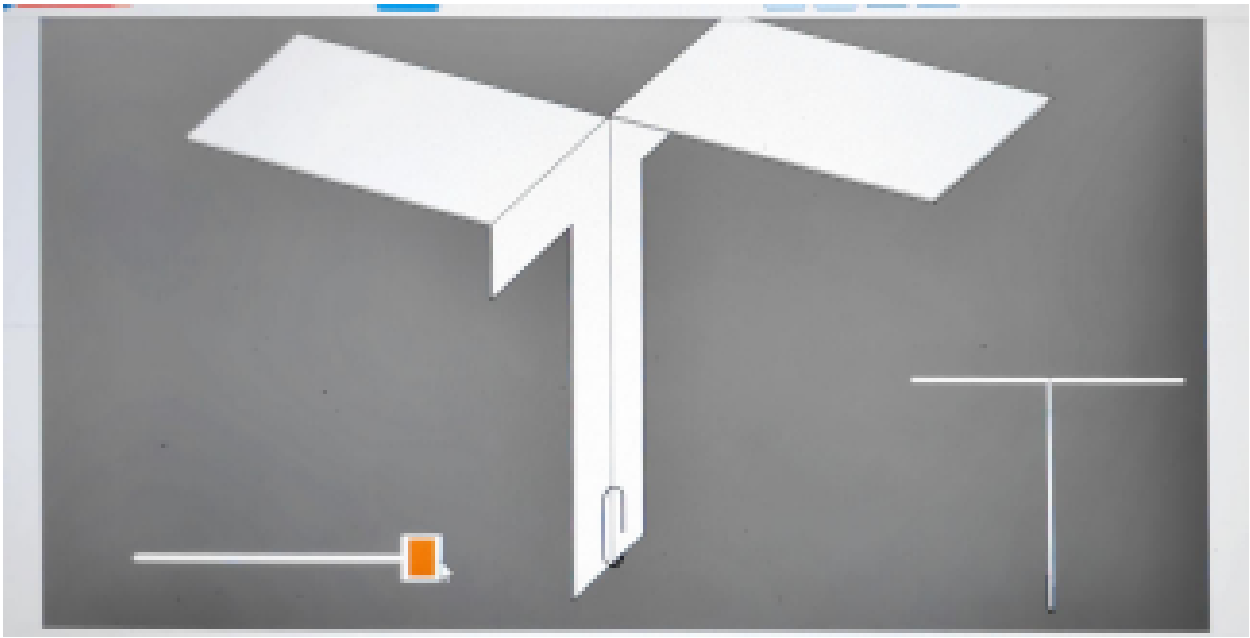
Suggestion 1 and justification

Suggestion 2 and justification

**Question 6** (16 marks)

Some MYP students looked at a range of seed pods from closely related trees. They noticed that the angle between the two wings differed considerably. They decided to investigate how changing the angle between the wings affects the time it takes for the seed pods to fall to the ground.





**Design** an investigation to model the effect of wing angle on the time it takes for a seed pod to fall to the ground. In your answer, you should include:

- the independent variable, the dependent variable and two control variables
- a hypothesis
- equipment you will use
- details of how to manipulate, measure or monitor the variables
- details of the method to collect sufficient data
- how you will make your method safe.

Question 7 (11 marks)

Question 7a (4 marks)

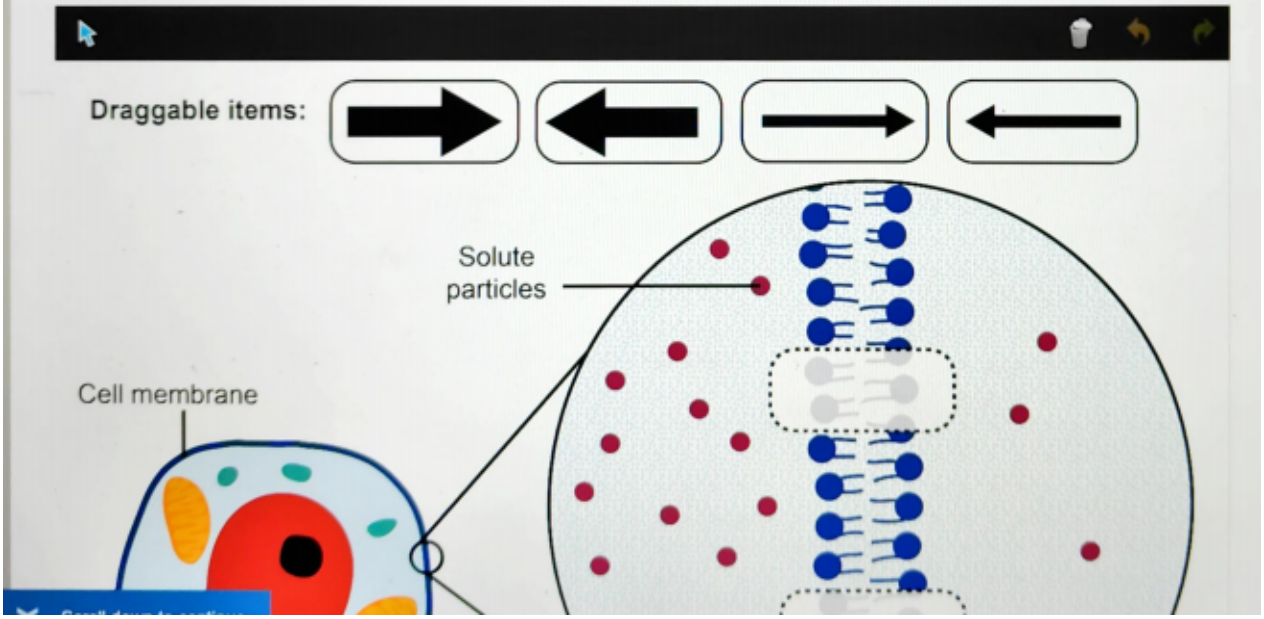
The human body is 65 % water. Different body systems use water to carry out their specific functions. If a person does not drink enough water, they become dehydrated and their body systems do not work effectively. For each of the functions below, **outline** the effect of dehydration.

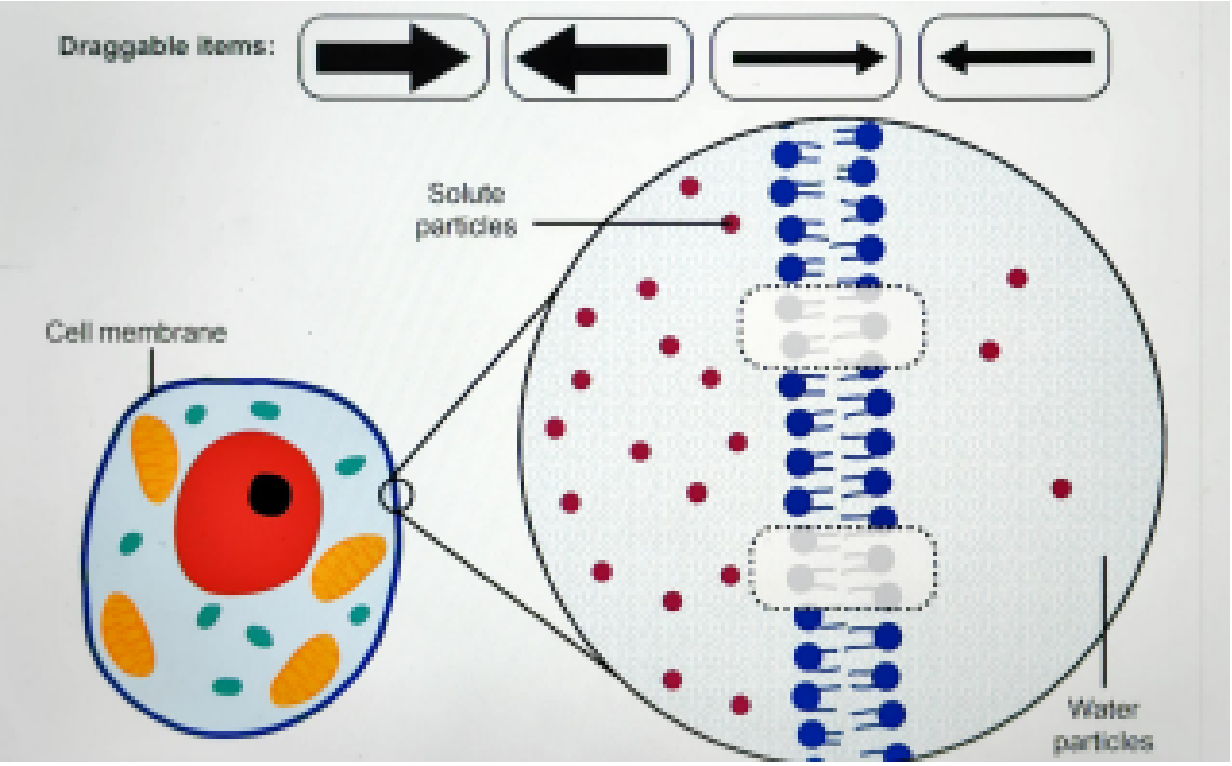
Excretion of waste

Temperature control

Question 7b (2 marks)

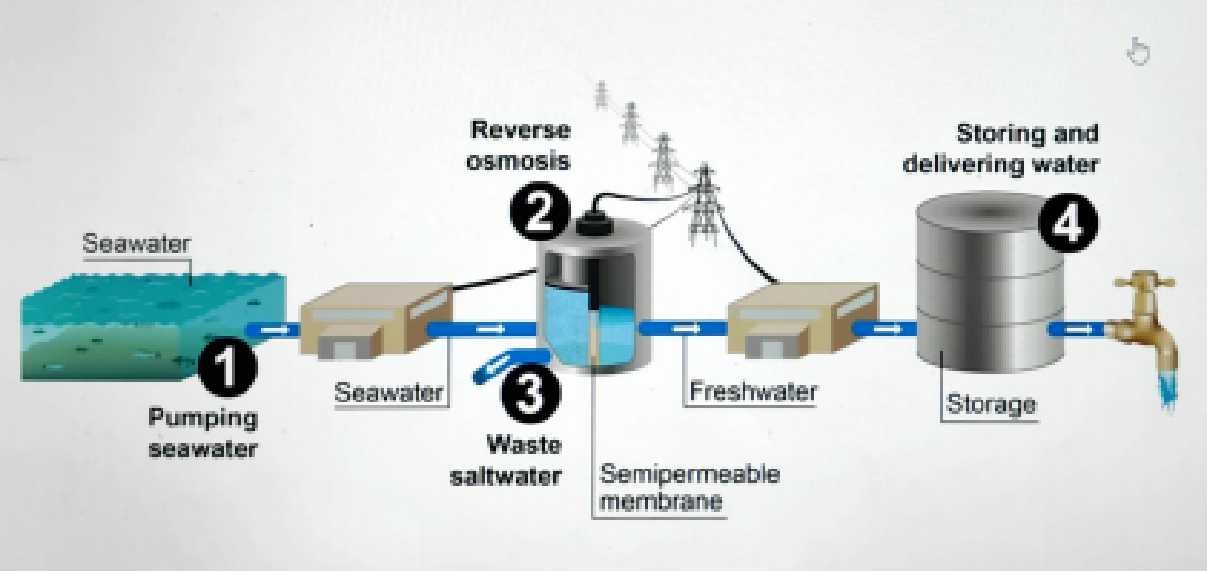
Water can enter and exit cells by osmosis. **Select** arrows to show the net movement of water across the cell membrane in the diagram below.

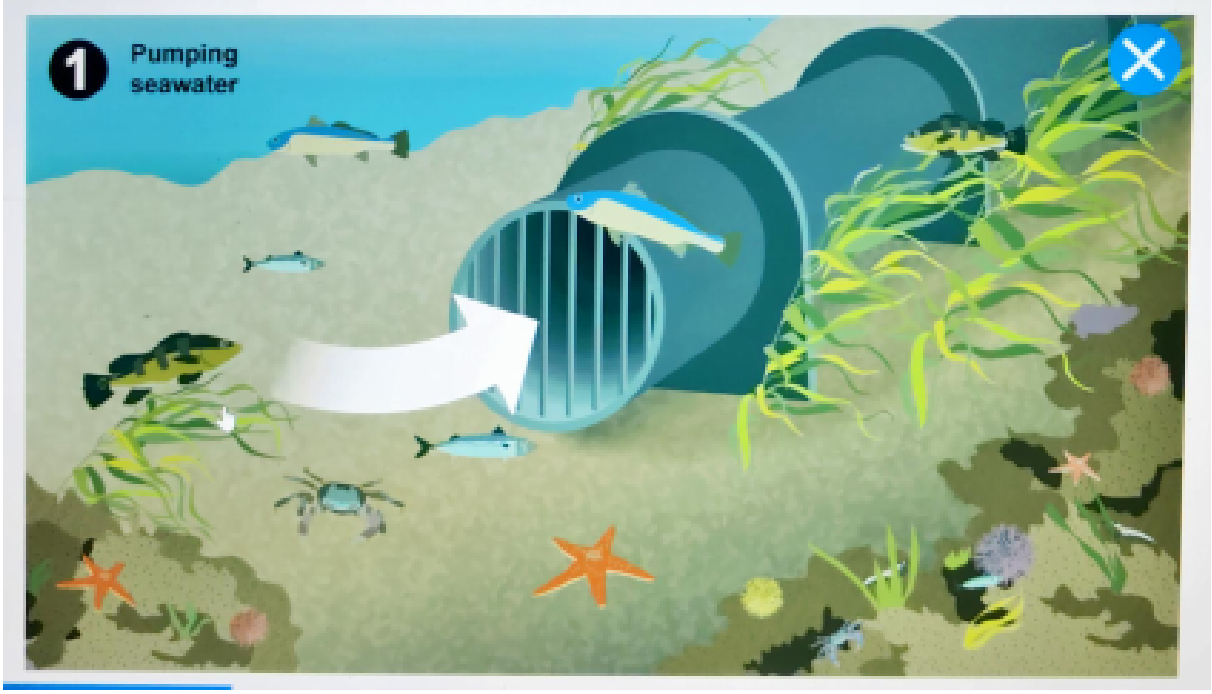


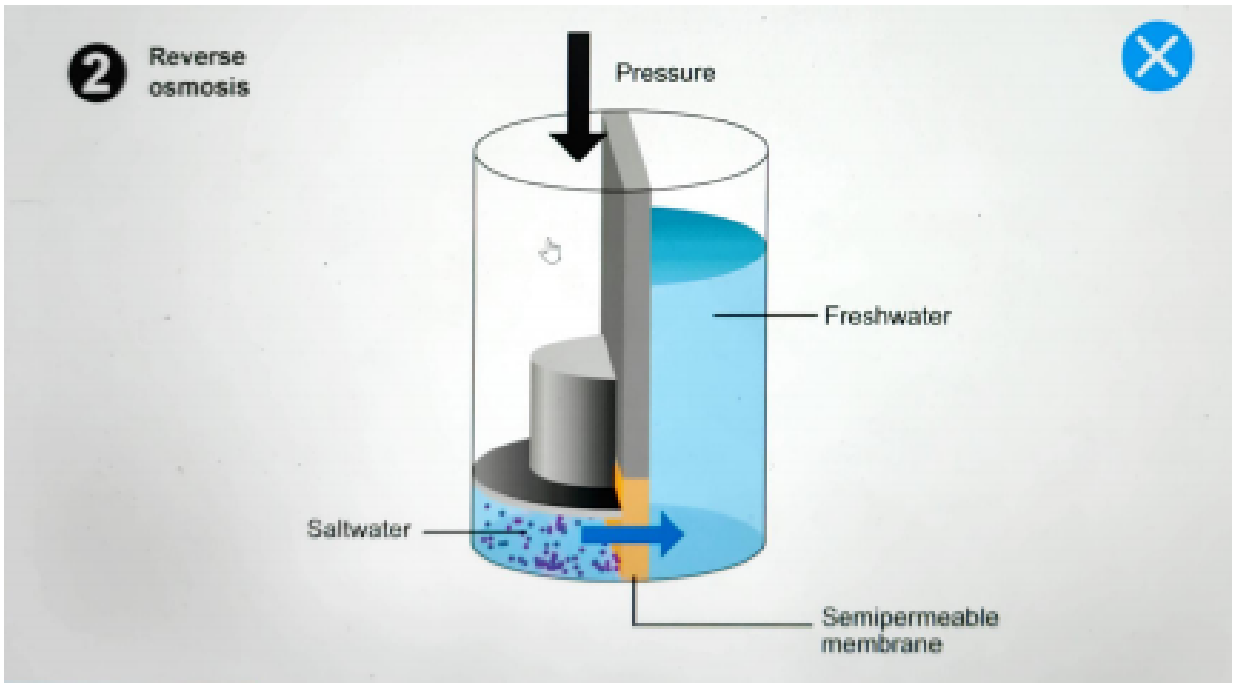



**Question 7c** (5 marks)

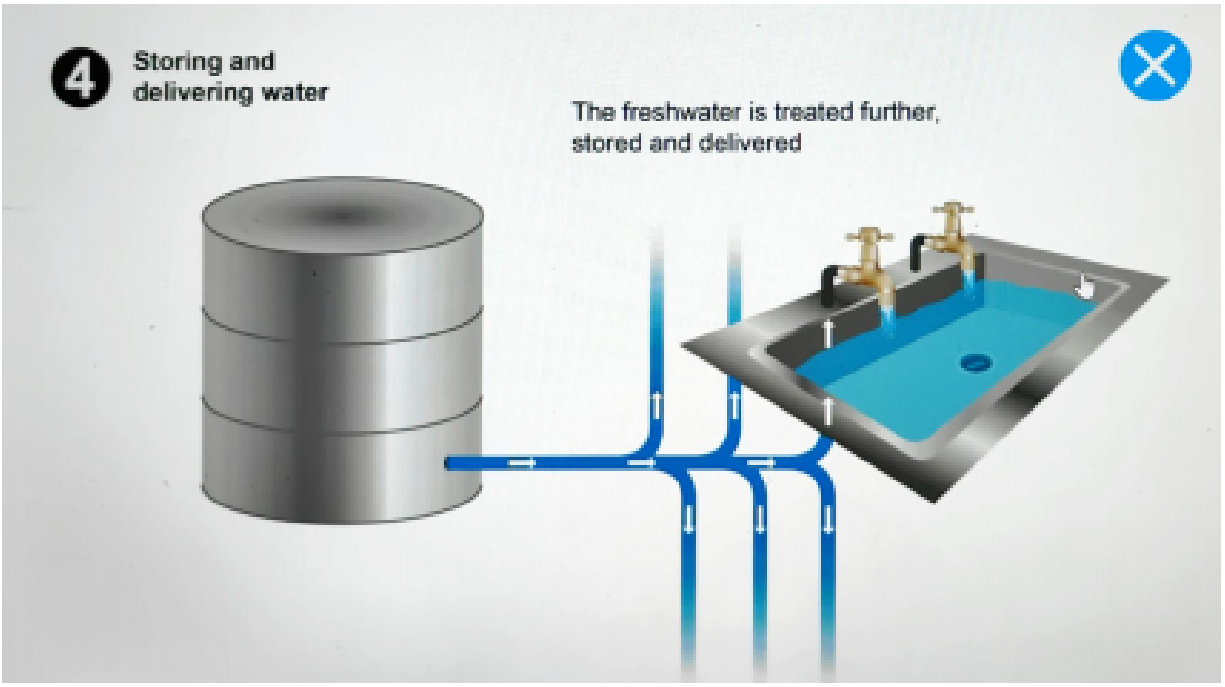
Nations that have limited natural freshwater may need to supplement their water supply with water from the sea. Humans should not drink seawater due to the high concentration of dissolved salts. Reverse osmosis is a process that can make seawater safe for drinking. The process of reverse osmosis is shown in the diagram below.


Reverse osmosis
Storing and delivering water
Seawater
2
4
1
Seawater
3
Freshwater
Storage
Pumping seawater
Waste saltwater
Semipermeable membrane


1
Pumping seawater


2
Reverse osmosis
Pressure
Freshwater
Saltwater
Semipermeable membrane


3
Waste saltwater



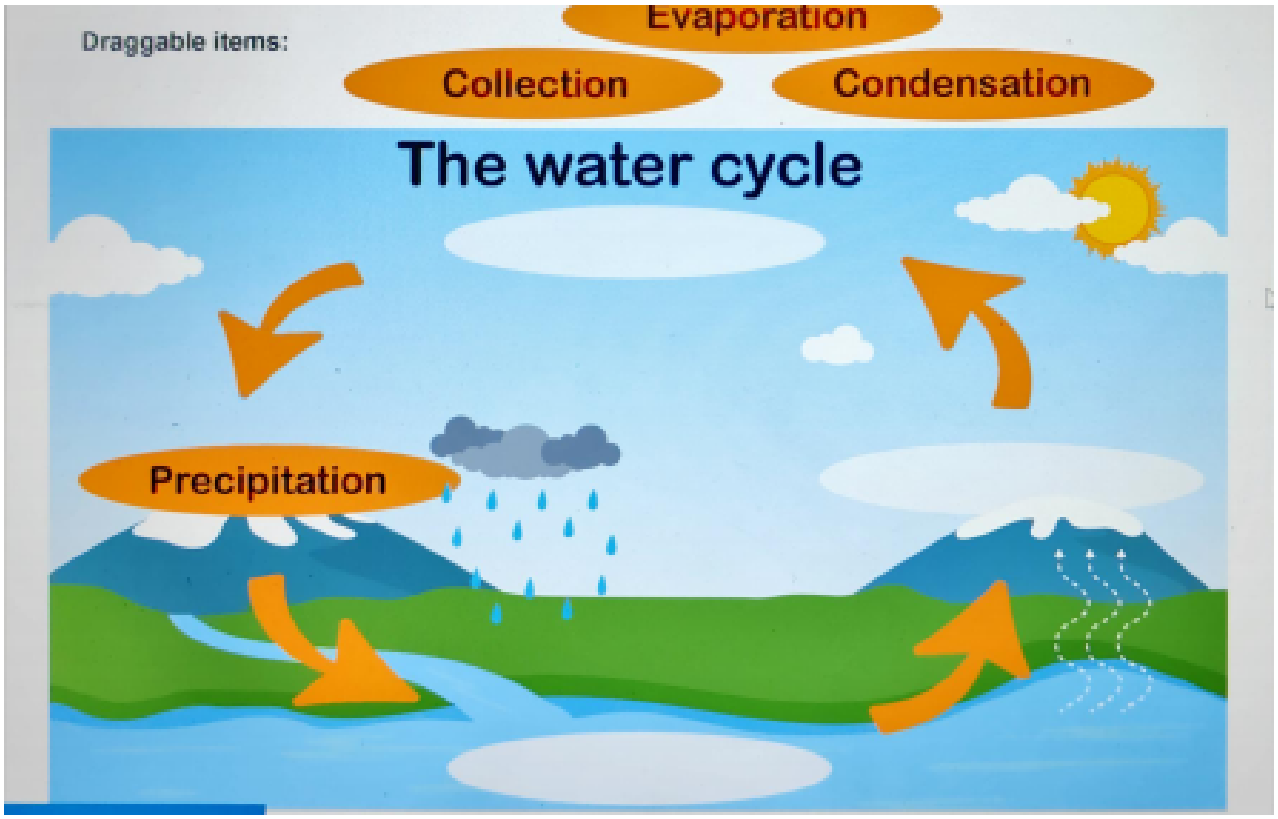

**Discuss** the implications of using reverse osmosis to provide freshwater. In your answer, you should include:

- the impacts on different ecosystems
- the consequences of high energy use
- a concluding appraisal.

Question 8 (15 marks)

**Question 8a** (1 mark)

Precipitation is one step in the water cycle. **Select** the location for the other three processes shown in the water cycle.



**Question 8b** (2 marks)

Some of the processes in the water cycle are changing due to climate change. Precipitation is one of these processes.

**Outline** the consequences to a region if precipitation changes due to climate change.

Increased precipitation

Decreased precipitation

**Question 8c** (12 marks)

Water is a finite resource. It is essential for life. It is necessary for hydration, hygiene, agriculture and food production. Human actions have changed the water cycle.

Water is a finite resource and is essential for life. Humans have designed ways to easily access water, using wells to obtain water from underground, pumps and pipes to extract water from lakes and rivers, and reverse osmosis plants to make seawater drinkable. These innovations have enabled us to transport water to where we want it.

Human uses of water include: personal hygiene, household cleaning, washing clothes and washing dishes.

Humans also use water for commercial and industrial needs such as power generation, mining, and aquaculture.

One of the largest consumer uses of water is for food production.

Farmed foods like vegetables and fruit only use water for growth. However, often this water comes from freshwater sources such as lakes and rivers. Water is also used for the transportation of fruits and vegetables, but this can be reduced if consumers buy them locally and in season.

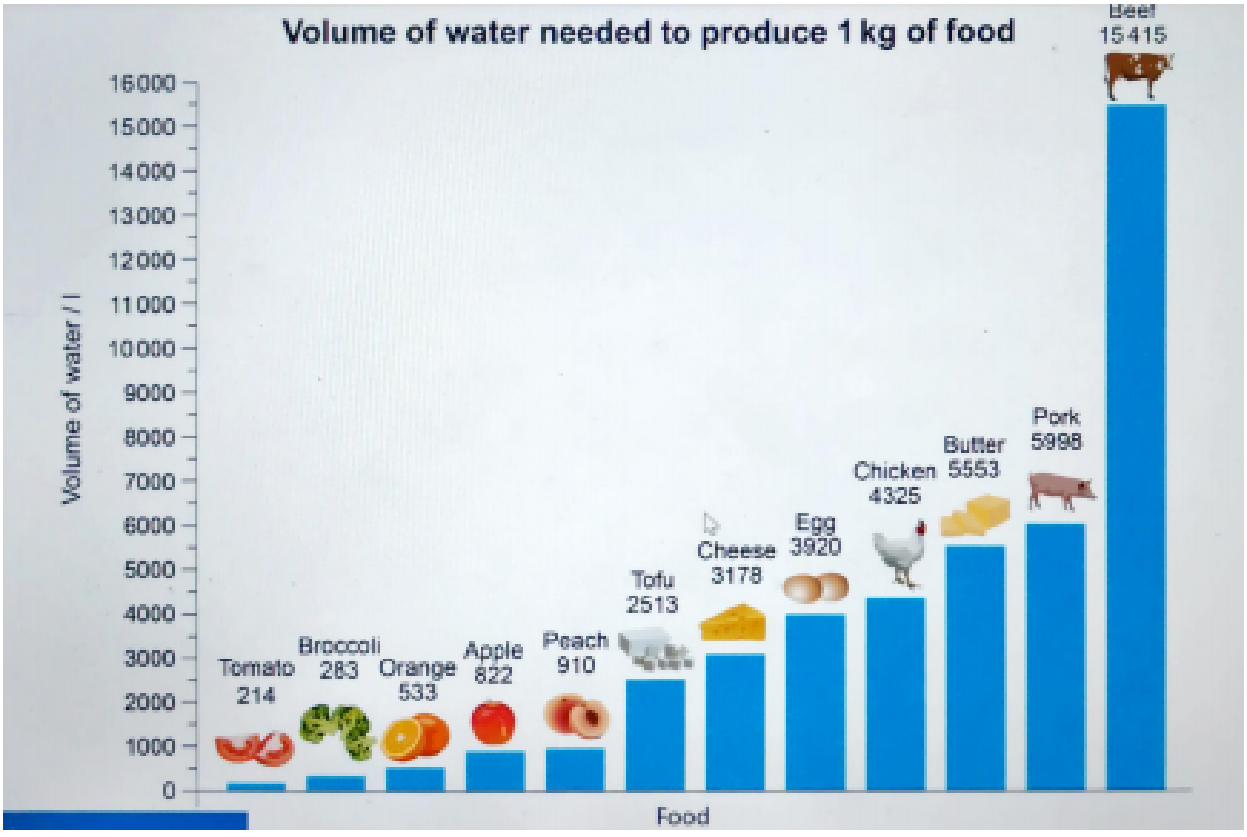
Farmed animals, such as cows and chickens, need a large volume of water daily to grow and maintain bodily functions. Water is used to prepare, transport and package the meat, and to clean the processing facility. Water is also necessary to grow the food that farmed animals eat, such as corn.

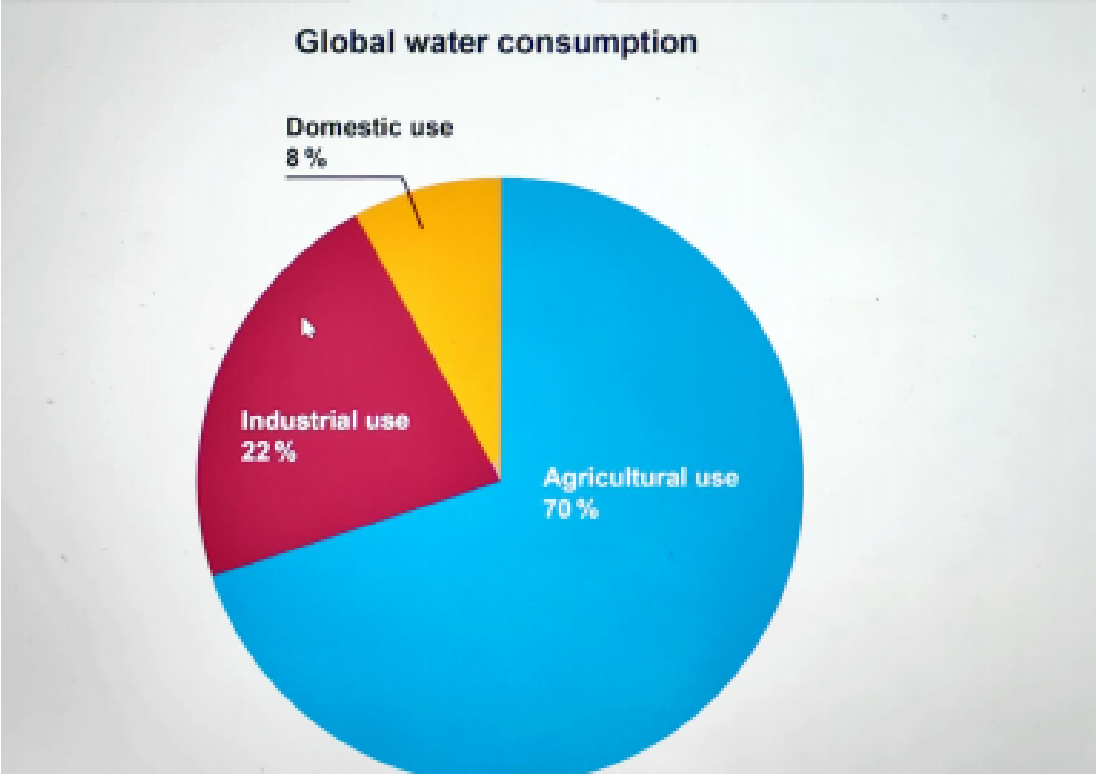
Even more water is used to produce foods like processed snacks, cookies and soft drinks.

Water is also used for transportation, packaging and cleaning the machines used to produce the food.

As water becomes more scarce, we will need to take steps to reduce our water use. Governments can take measures such as educating citizens on sustainable use and even bringing in laws to restrict water use.

The total volume of freshwater used to meet our needs is called a water footprint. This includes using water directly as well as using it to produce other items. Below, you can see examples of how water is used globally and how much water is used for different purposes.






Using information from this task and your wider MYP studies, **discuss** and **evaluate** how the decisions made by individuals and governments can make water use more sustainable. In your answer, you should include:

- steps that could be taken to reduce water usage in the home
- a description of how an individual's dietary choices can affect their water footprint
- a suggestion of how government policies can influence water use
- a concluding appraisal.