AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level
ENVIRONMENTAL SCIENCE

Paper 2

Time allowed: 3 hours

Materials

For this paper you may use:
- a calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions 1 to 10 and **one** essay from question 11.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- All questions should be answered in continuous prose.
- You will be assessed on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

Answer **all** questions in the spaces provided.

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0 1 **Table 1** gives some information about the criteria used by the International Union for Conservation of Nature (IUCN) to prioritise the conservation of wildlife.

Complete **Table 1**.

[5 marks]

Table 1

Criteria	**Description**
Endemic	
	A species with a high public profile that raises awareness or funding for the conservation of biodiversity.
EDGE	
	A species that has a large effect on its ecosystem relative to its abundance.
	Categorised on the Red List as facing an extremely high risk of extinction in the wild.

5

Turn over ►

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0 2 Owston's civet, *Chrotogale owstoni*, is a cat-like mammal found in the forests of South East Asia.

The number of Owston's civets is decreasing.

0 2 . 1 Suggest **two** ways that Owston's civets may be directly exploited by humans.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 2 Explain **three** ways that habitat destruction may have contributed to the decrease in the number of Owston's civets.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

Do not write outside the box

Owston's civets have been monitored using different types of specialist equipment, such as motion-sensitive cameras.

0 2 . 3 Suggest how the information collected by motion-sensitive cameras may be used in the conservation of Owston's civets.

[4 marks]

0 2 . 4 Other than motion-sensitive cameras, suggest **one** example of modern technology that could be used to collect data on Owston's civets.

[1 mark]

10

Turn over for the next question

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0 3 The monkey puzzle tree, *Araucaria araucana*, is an endangered species found in South America.

0 3 . 1 Suggest **two** reasons why monkey puzzle trees should be conserved.

[2 marks]

1 _____

_____

2 _____

_____

In 2013, the monkey puzzle tree was included in Appendix I of the Convention on International Trade in Endangered Species (CITES).

0 3 . 2 Describe how CITES protects endangered species.

[3 marks]

_____

_____

_____

_____

_____

_____

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As well as CITES, other legislation aims to conserve biodiversity.

0 3 . 3 Describe how legislation aims to conserve biodiversity in the UK.

[4 marks]

0 3 . 4 Describe how 'Debt for Nature Swaps' help to conserve biodiversity.

[1 mark]

10

Turn over for the next question

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0 4 Mangrove trees are adapted to features of a tropical climate.

0 4 . 1 State **two other** abiotic factors that mangrove trees are adapted to.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 2 Explain **two** ways that the conservation of mangroves can benefit coral reef ecosystems.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Do not write outside the box

Only **one** answer per question is allowed.

For each question completely fill in the circle alongside the appropriate answer.

CORRECT METHOD  WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

One method of conserving mangroves is to designate them as legally protected areas.

0 4 . 3 Select the designation suitable for the protection of mangroves.

Shade **one** box only.

[1 mark]

A Local Nature Reserve (LNR) ⬭

B National Nature Reserve (NNR) ⬭

C Ramsar site ⬭

D Special Area of Conservation (SAC) ⬭

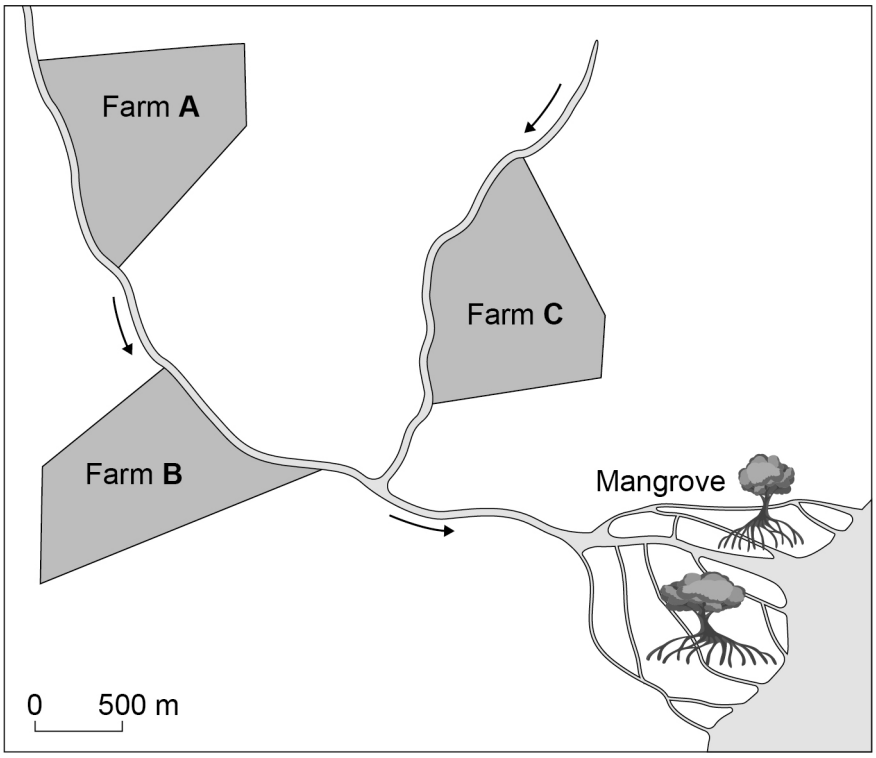
E Sites of Special Scientific Interest (SSSI) ⬭

Question 4 continues on the next page

Figure 1 shows the location of three farms, **A**, **B** and **C**, upstream of an area of mangrove affected by eutrophication.

It was thought that the inorganic nutrients causing the eutrophication were coming from the farms.

Figure 1



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0 4 . 4 Describe a method to find which farm contributes most to the inorganic nutrient content of the river and explain how each stage of your method produces valid results.

[5 marks]

Extra space

10

Turn over for the next question

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The sterile insect technique is used to control the fruit fly pest, medfly, *Ceratitis capitata.*

To be effective, there must be a minimum ratio of 125 sterilised medfly:1 wild medfly.

The sterilised flies are marked with dye so that they can be recognised when checking if the minimum ratio has been reached in the environment.

1 000 000 sterilised medfly were released into the environment.

The population was sampled using traps to check the sterilised medfly:wild medfly ratio.

Table 2 gives the mean number of wild and sterilised medfly recorded.

Table 2

Medfly	**Mean number of medfly per trap**
Wild	7
Sterilised	500

0 5 . 1 Calculate how many **more** sterilised medfly need to be released in order to achieve a ratio of 125 sterilised:1 wild.

Show your working.

[3 marks]

_____ sterilised medfly

Do not write outside the box

0 5 . 2 Describe how the traps would have been used to provide representative data in **Table 2**.

[5 marks]

0 5 . 3 Name **two other** methods of pest control that rely on the use of other organisms.

[2 marks]

1 _____

2 _____

10

Turn over for the next question

Do not write outside the box

0 6 . 1 Explain why systemic pesticides do **not** impact non-target species that land on crops.

[1 mark]

0 6 . 2 Explain how the use of pesticides can reduce the availability of soil nutrients.

[4 marks]

5

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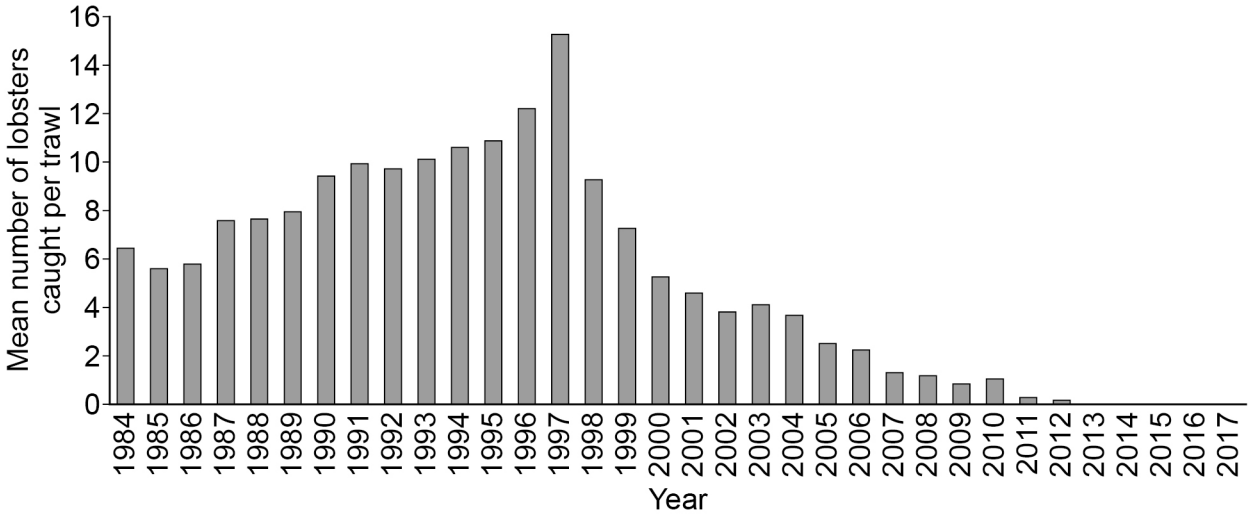
0 7 The American lobster, *Homarus americanus*, is commercially fished from the waters of the north eastern United States of America.

Figure 2 shows the results from a scientific investigation that monitored the population of the American lobster from 1984 to 2017.

Figure 2



0 7 . 1 Suggest reasons for the changes in the catch of lobsters shown in **Figure 2**.

[4 marks]

0 7 . 2 State what **other** information would be needed to calculate the standard deviation for each year shown in **Figure 2**.

[1 mark]

Turn over ►

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0 7 . 3 Describe how the standard deviation can be used to indicate if there is a significant difference in the mean number of lobsters caught in two different years.

[1 mark]

0 7 . 4 Describe how scientists could collect data to estimate the lobster population **without** the use of trawling.

[4 marks]

10

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0 8 The productivity of aquaculture systems can be improved by controlling the abiotic conditions.

An investigation was set up to examine the impact of water temperature on the growth of yellowtail kingfish, *Seriola lalandi.*

The fish were grown in tanks set at five different water temperatures for 32 days. Data on their body mass were recorded.

Table 3 shows the results of the investigation.

Table 3

Temperature / °C	**21.0**	**23.5**	**25.0**	**26.5**	**29.0**
Initial mean body mass / g	4.2	4.1	4.1	4.1	4.1
Final mean body mass / g	32.2	34.0	41.3	49.0	40.2
Specific Growth Rate / % day^{-1}	6.4		7.2	7.8	7.1

The Specific Growth Rates of the fish at different temperatures were calculated. The relationship between the initial body mass and final body mass is non-linear and these data are converted into f and i values to allow the Specific Growth Rate to be calculated using the formula:

$$\text{Specific Growth Rate} = \frac{(f - i) \times 100}{t}$$

Where:
f = converted final mean body mass value
i = converted initial mean body mass value
t = investigation duration (days).

The values of f and i can be found using the mean body masses as shown in **Figures 3** and **4** on the next page.

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Figure 3

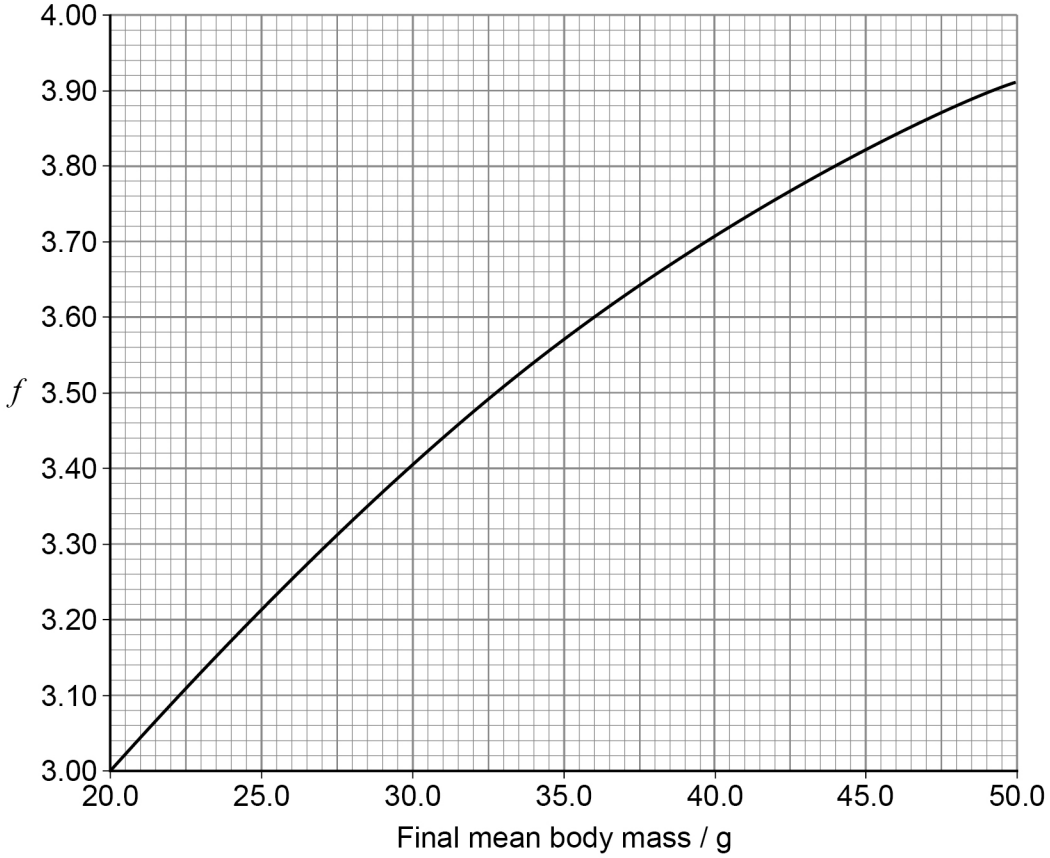
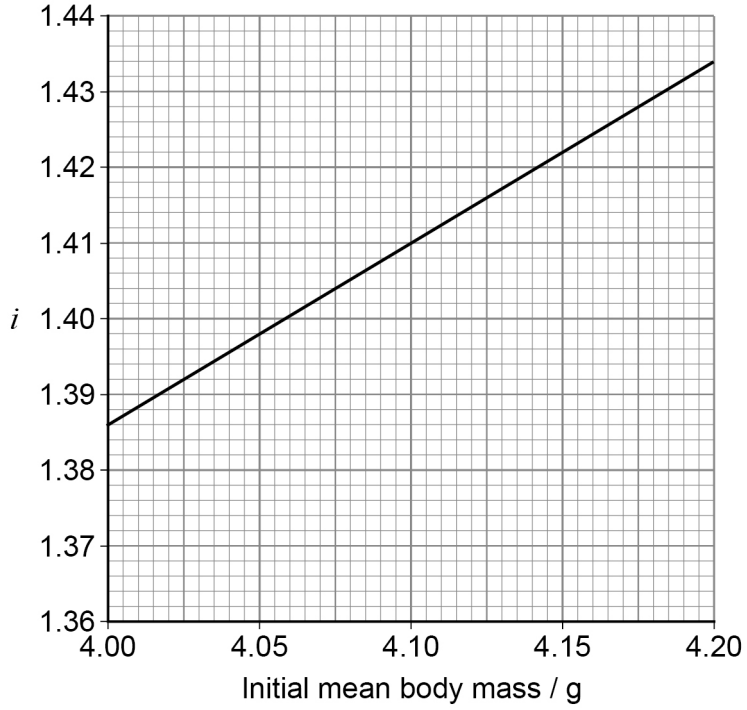


Figure 4



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0 8 . 1 Use the formula on page 18 to calculate the Specific Growth Rate for fish kept at 23.5°C for an investigation for 32 days.

Use the data in **Table 3**, **Figure 3** and **Figure 4** in your calculation.

Give your answer to the appropriate number of significant figures.

Show your working.

[4 marks]

_____ % day $^{-1}$

0 8 . 2 Explain the relationship between temperature and Specific Growth Rates of the yellowtail kingfish using the data in **Table 3**.

[2 marks]

Do not write outside the box

To make the results valid, variables such as the duration of the investigation and species of fish were controlled.

0 8 . 3 In addition to these factors, name **one** abiotic factor and **one** biotic factor that would need to be controlled in this investigation.

Explain why each of these variables would need to be controlled.

[4 marks]

Abiotic _____

_____

_____

_____

Biotic _____

_____

_____

_____

10

Turn over for the next question

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0 9 Satellite imagery shows a loss of 3.23×10^4 hectares (ha) of natural forest in the UK from 2013 to 2018.

It has been estimated that this change equates to an extra 9.42 megatonnes (Mt) of CO_2 in the atmosphere.

0 9 . 1 Calculate how many tonnes of CO_2 the loss of 1 ha of natural forest would contribute to the atmosphere.

Give your answer in standard form.

Show your working.

[3 marks]

_____ t

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It has been suggested that the UK needs to plant an extra 1.5 million ha of new forest to meet climate change targets by 2050. Most of this forest will be new commercial forestry plantations.

Table 4 shows the mean rate of carbon sequestration by two tree species.

Table 4

Tree species	Mean rate of carbon sequestration / t ha^{-1} yr^{-1}
Sitka spruce	3.65
Beech	2.46

0 9 . 2 Calculate how many extra tonnes of carbon will be sequestered in the year 2050 if 1.5 million ha of forest are planted with a mix of 80% Sitka spruce and 20% beech.

Give your answer to an appropriate number of significant figures.

Show your working.

[2 marks]

_____ t

Question 9 continues on the next page

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Figure 5 shows how the rate of carbon sequestration changes with age in Sitka spruce trees.

Figure 5

0 9 . 3 Draw a tangent line on **Figure 5** and calculate the rate of carbon sequestration in 1 ha of trees that are 40 years old.

Show your working.

[1 mark]

_____ t ha^{-1} yr^{-1}

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0 9 . 4 Discuss how commercial forestry may be managed to reduce the impacts on the local environment.

[9 marks]

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15

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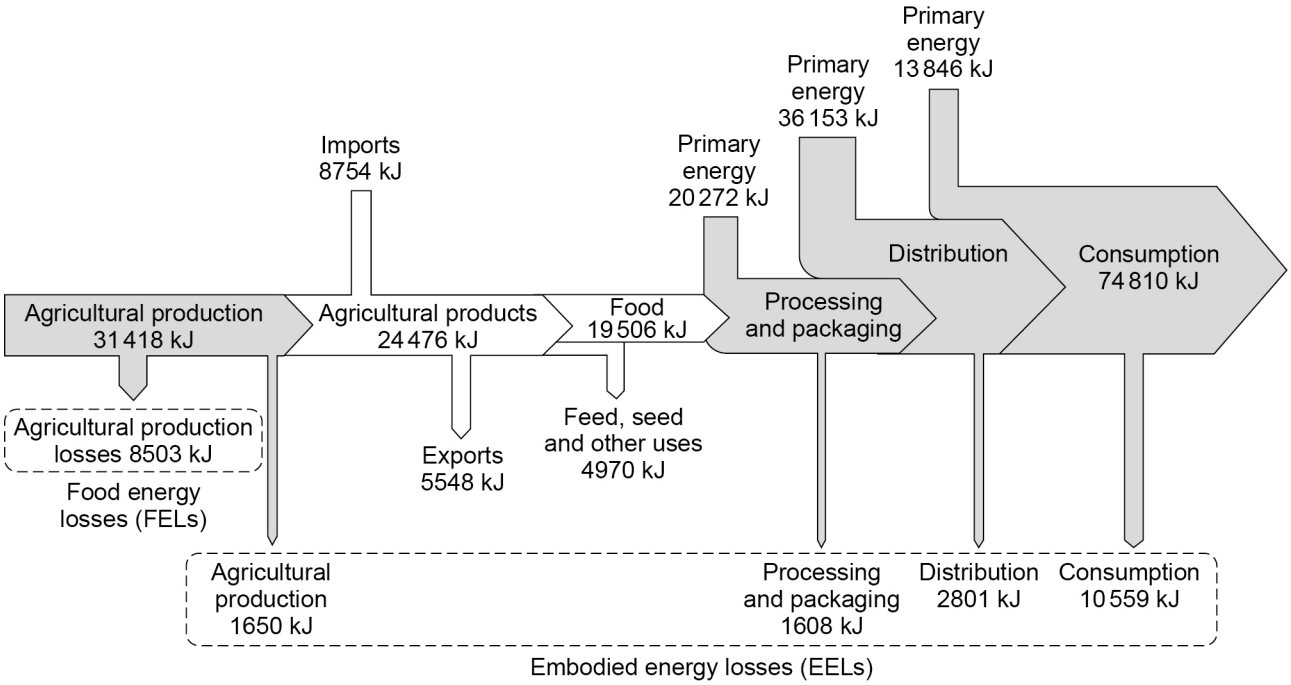
1 0 Embodied energy losses (EELs) occur when activities along the food supply chain require additional energy inputs, such as fuel used in machinery.

Figure 6 shows the energy flow through the different stages of a food supply chain.

Figure 6



1 0 . 1 Calculate the percentage energy efficiency of the agricultural production stage in **Figure 6**.

Give your answer to **two** decimal places.

Show your working.

[1 mark]

_____ %

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Increased public awareness of sustainability is leading to a reduction in the embodied energy losses (EELs) in the food supply chain.

1 0 . 2 Explain **two** ways changes in the behaviour of the public may lead to reductions in the EELs shown in **Figure 6**.

[2 marks]

1 _____

_____

2 _____

_____

Question 10 continues on the next page

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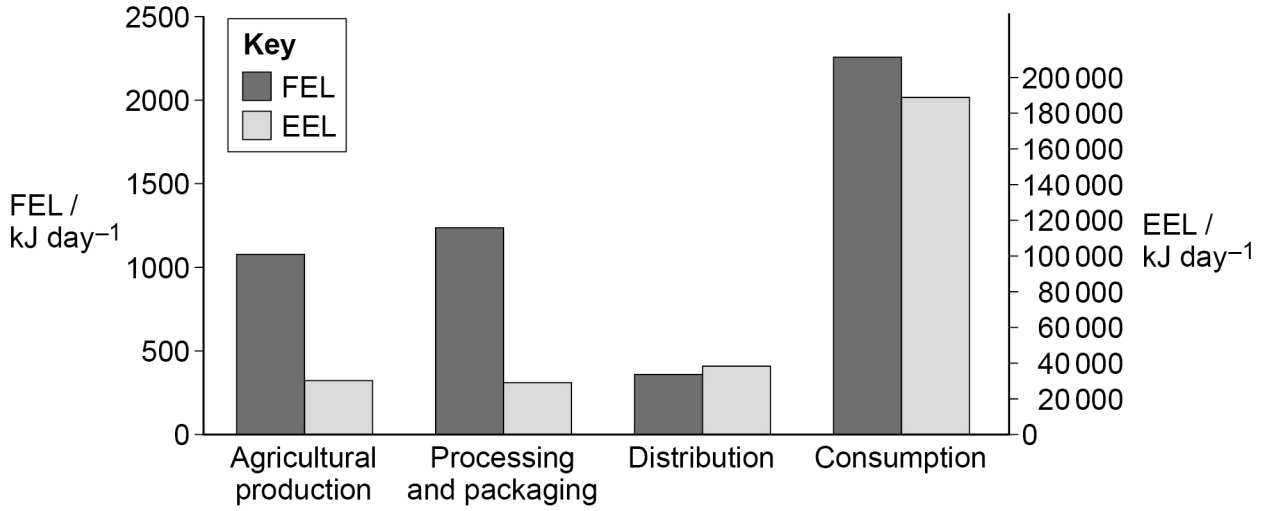
Food energy losses (FELs) occur when plant or animal biomass is lost from the food supply chain and therefore does **not** reach the consumer.

Figure 7 compares the FELs and EELs during different stages of the food supply chain.

Figure 7



1 0 . 3 Describe the difference between the FEL and EEL data throughout the different stages of the food supply chain.

[1 mark]

1 0 . 4 Explain the difference in FEL at the consumption stage with FEL at the distribution stage of the food supply chain shown in **Figure 7**.

[1 mark]

1 0 . 5 Explain the difference in EEL at the consumption stage with EEL at the distribution stage of the food supply chain shown in **Figure 7**.

[1 mark]

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It has been estimated that the FEL in the food supply chain would be enough to feed around 1.9 billion people, and approximately half of those losses could be prevented by adopting concepts from the circular economy.

1 0 . 6 Explain how the reduction of FELs using methods of material cycling may increase the sustainability of food production.

[4 marks]

10

Turn over for the next question

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Write an essay on **one** of the following topics.

1 1 . 1 Discuss how captive breeding and release programmes may be managed to increase their success.

[25 marks]

OR

1 1 . 2 Discuss how genetic manipulation of food species in agriculture may create advantages as well as problems.

[25 marks]

Shade the lozenge below to indicate which optional question you have answered.

Question **1 1 . 1** ⬭ Question **1 1 . 2** ⬭

CORRECT METHOD ⬬ WRONG METHODS ⊗ ⦿ ≋ ✓

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END OF QUESTIONS

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