Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2014

Environmental Studies ENVS4

Unit 4 Biological Resources and Sustainability

Friday 6 June 2014 9.00 am to 11.00 am

You will need no other materials.
You may use a calculator.

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- 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 80.
- Two of these marks are for the Quality of Written Communication.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.
- Question 7 should be answered in continuous prose.
  Quality of Written Communication will be assessed in this answer.

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ANSWER IN THE SPACES PROVIDED

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

1 **Table 1** shows definitions connected with aquatic food production systems.

Complete **Table 1**.

[5 marks]

Table 1

Term	Definition
No-Take Zone (NTZ)	An area where fishing is forbidden
By-catch	
	The catching of fish and other organisms by lost or discarded fishing equipment
Maximum Sustainable Yield (MSY)	The maximum harvest which will not reduce the ability of the population to replace losses
Recruitment	
	A marine area where productivity is increased by nutrients carried up from deeper water
Fishing quota	

5

Turn over for the next question

2 (a) With reference to agricultural production systems, define the following terms.

[2 marks]

Efficiency .....

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Productivity .....

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2 (b) **Table 2** gives estimated energy ratios for some agricultural production systems.

Table 2

Production system	Energy ratio	
	Pre-industrial (traditional)	Intensive
Wheat	11.4	5.2
Rice	15.6	4.0
Beef	0.3	0.1
Dairy (cow's milk)	1.2	0.4

2 (b) (i) Explain the difference in energy efficiency between pre-industrial (traditional) and intensive crop-growing systems.

[2 marks]

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2 (b) (ii) Explain why energy ratios are lower for livestock-based production systems than for crop-growing systems.

[2 marks]

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2 (b) (iii) Explain why, despite the greater energy efficiency of crop production, environmental factors may make livestock farming a more productive option in some areas.

[2 marks]

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Question 2 continues on the next page

2 (c) **Table 3** gives some features of an aquaculture system producing prawns.

Table 3

Features of production system	
Total energy input to prawn production	27 200 MJ ha^{-1}
Live weight of harvested prawns	3 264 kg ha^{-1}
Edible portion of prawns (% of harvested weight)	45%
Energy content of edible material	3 MJ kg^{-1}

Calculate the energy ratio for this production system.
Show your working.

[2 marks]

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Turn over for the next question

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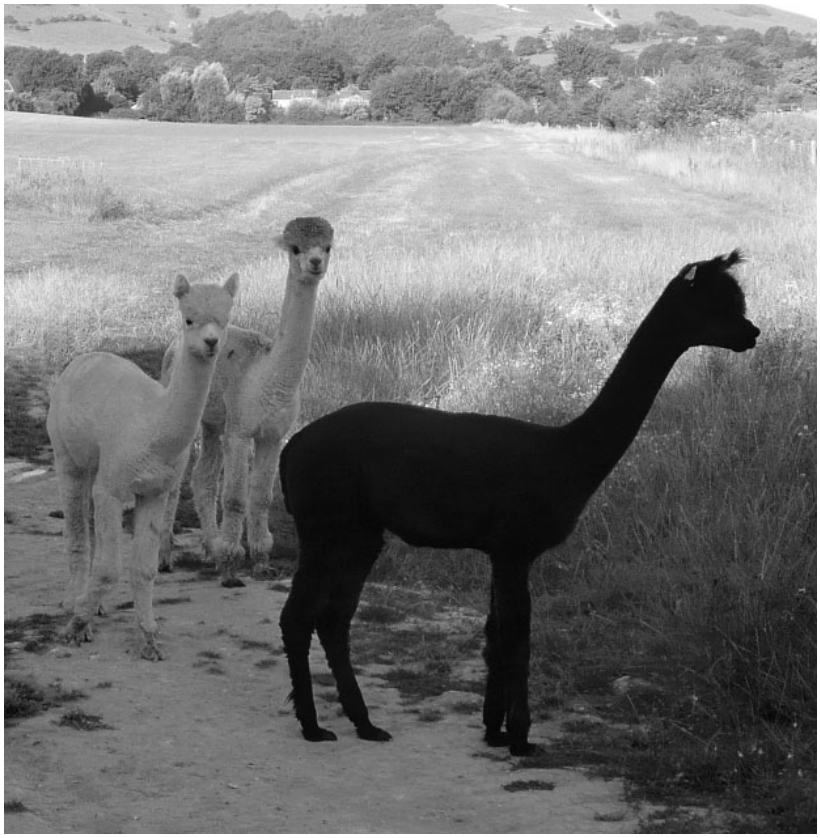
3 (a) **Figure 1** shows alpacas on a farm in the UK.

Figure 1



Keeping unusual types of livestock is one method of farm diversification.
Other methods include growing biofuel crops and developing tourist accommodation and recreational activities on farms.

3 (a) (i) Explain why diversification has become necessary on many farms.

[2 marks]

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3 (a) (ii) Describe ways in which agricultural diversification may contribute to sustainable development.

[3 marks]

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3 (b) Explain how world trade may affect incomes, food production and environmental sustainability in Less Economically Developed Countries (LEDCs).

[5 marks]

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4 Read the passage.

Soil erosion in the Mediterranean region.

The area around the Mediterranean Sea has mild, wet winters and hot, dry summers. Rain often falls during intense storms and local rainfall can vary greatly from year to year. Large parts of the region have steep slopes. All these factors make the soil vulnerable to erosion. The Mediterranean region also has a long history of human land use, and environmental degradation has been recorded for over 2500 years.

Much of the area used to be forest but most has now been lost, often being replaced by plagioclimax plant communities dominated by low-growing shrub species. Some areas are now used for crop growing and grazing, but in other areas desertification has occurred.

Problems have tended to become less severe in countries on the northern shores of the Mediterranean Sea. Intensive agriculture has become concentrated on the best land and people have moved away from more marginal areas. This has often led to a reduction in agriculture and livestock grazing, allowing secondary succession to take place. In one part of southern France, rural depopulation in the mid-twentieth century caused vegetation cover to increase from 7% in 1946 to 49% in 1979. Over the same period, stream flows in the area were estimated to have decreased by 11%.

On the southern and eastern shores of the Mediterranean, problems are more severe and are becoming worse. Rapid population growth in some rural areas of North Africa and the Middle East makes it more and more difficult for people to manage the land sustainably. Many people still burn wood for fuel, as well as using it for building and other purposes. Animal manure is also used for fuel. The increased demand for food leads to cultivation of unsuitable land. Areas which were previously used as pasture for animals may be converted to crop-growing. This pushes livestock grazing further away from settlements and onto vulnerable areas of natural and semi-natural vegetation.

Soil depth is constant when there is a balance between the rate of soil formation and soil removal. Erosion rates need only reach between 12 and 15 t ha^{-1} $year^{-1}$ to be greater than typical rates of soil formation. This is the equivalent of removing a layer less than 1 mm thick from the soil surface. One study in North Africa found that the rate of soil loss from an area that had been cleared of trees and then ploughed was 50 t ha^{-1} $year^{-1}$. On a nearby area, still covered by trees, the rate of loss was only 0.4 t $ha^{-1}year^{-1}$.

Soil erosion reduces the ability of the land to support crops, livestock and natural biodiversity but it also has other effects. Eroded sediment carried by water may contain pollutants, especially if it is largely made up of soil eroded from farmland. The eroded material will eventually be deposited and this may cause problems for shipping, water supply and energy generation, as well as silting up reservoirs and increasing flooding.

Use the information in the passage and your own knowledge to answer the questions.

4 (a) Explain how abiotic factors make the Mediterranean region more vulnerable to soil erosion.

[2 marks]

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4 (b) Suggest how rural depopulation may have caused stream flows to decrease (lines 15–18).

[2 marks]

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4 (c) Outline **one** way in which soil erosion may reduce supplies of renewable energy.

[1 mark]

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Question 4 continues on the next page

4 (d) Explain how rapid population growth in parts of North Africa and the Middle East may make these areas more vulnerable to soil erosion (lines 19 – 34).

[5 marks]

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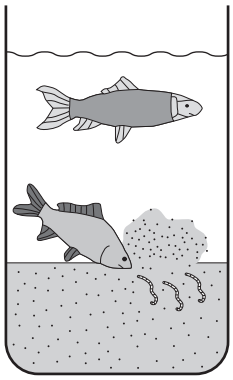
5 (a) Freshwater fish are often farmed in shallow ponds. Two species of fish that are often farmed are Rohu, *Labeo rohita*, and Common Carp, *Cyprinus carpio*.

Figures 2 and 3 show some of the feeding habits of the two species.

Figure 2



- Rohu feed mainly on plankton, which they find in the water.
- Common Carp feed mainly on insect larvae, which they find by disturbing sediment at the bottom of the pond.
- Organic matter decomposes much faster when it is suspended in the water than it does in the sediment.

Figure 3

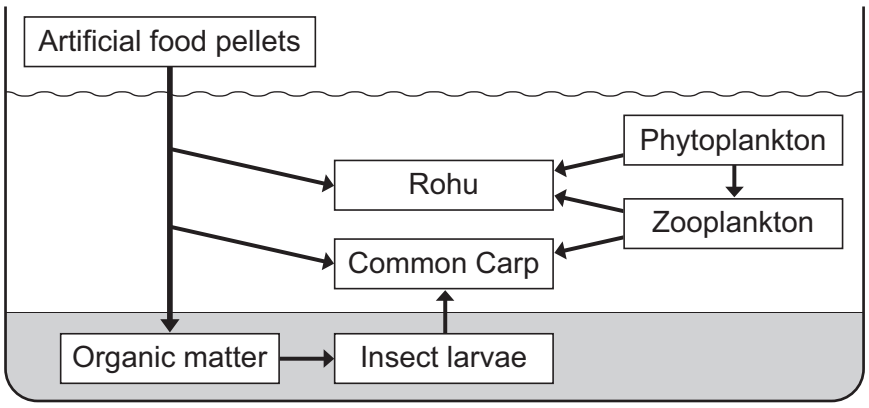


Table 4 gives some details of the abiotic characteristics of the water in ponds containing either a Rohu monoculture or a polyculture of Rohu and Common Carp.

Table 4

	Rohu monoculture	**Polyculture of Rohu and Common Carp**
Phosphate in water / $mg\,l^{-1}$	0.7	1.0
Dissolved oxygen / $mg\,l^{-1}$	7.1	6.4
Depth to which light penetrates / cm	25.5	17.0

5 (a) (i) Using information from **Figure 2**, **Figure 3** and **Table 4**, suggest how farming Rohu and Common Carp in a polyculture creates different abiotic conditions from the farming of Rohu as a monoculture.

[3 marks]

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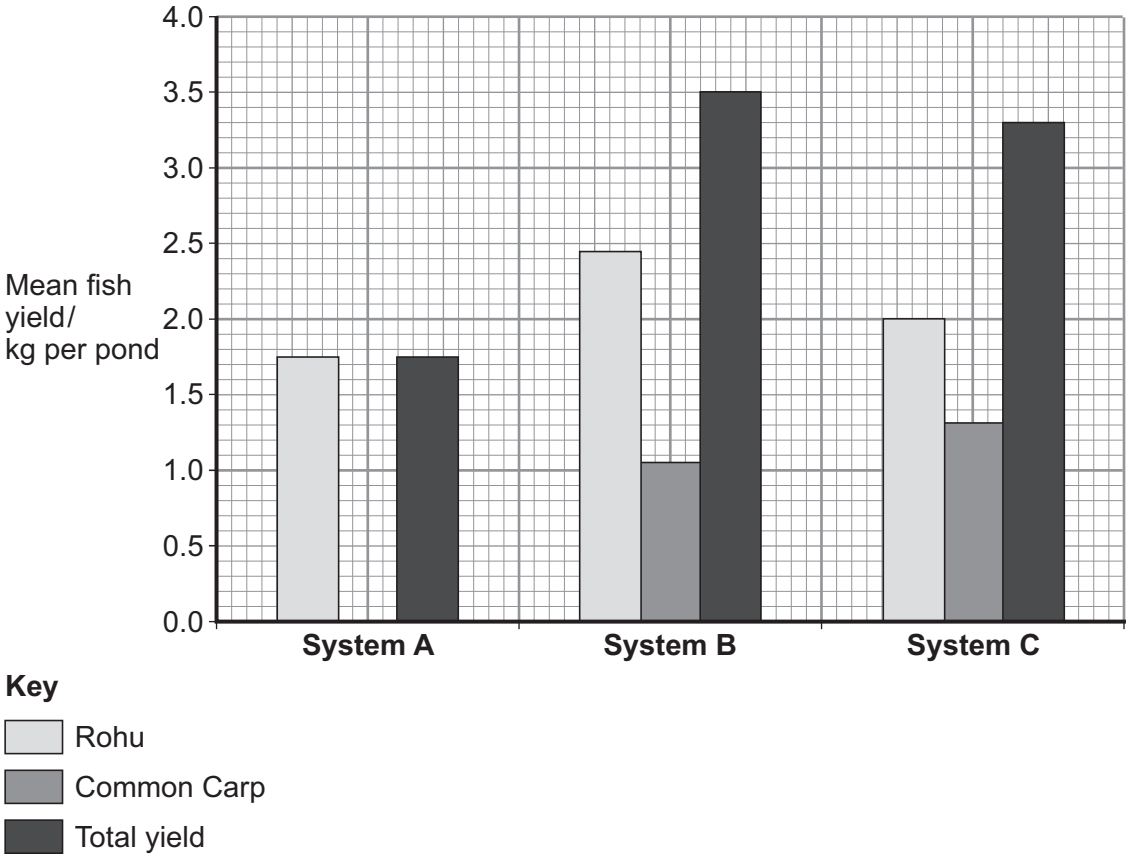
Question 5 continues on the next page

5 (a) (ii) Fifteen ponds, each with a surface area of 100 m^2, were used in an investigation of polyculture. Five ponds were used for each of three different management systems.

- **System A** Monoculture – 150 Rohu in each pond
- **System B** Polyculture – 150 Rohu plus 50 Common Carp in each pond
- **System C** Polyculture – 150 Rohu plus 100 Common Carp in each pond

Figure 4 shows the mean yields of fish from the **three** management systems.

Figure 4



Using information from **Figures 2**, **3** and **4** and **Table 4**, explain why yields of Rohu are different under the three management systems.

[5 marks]

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Question 5 continues on the next page

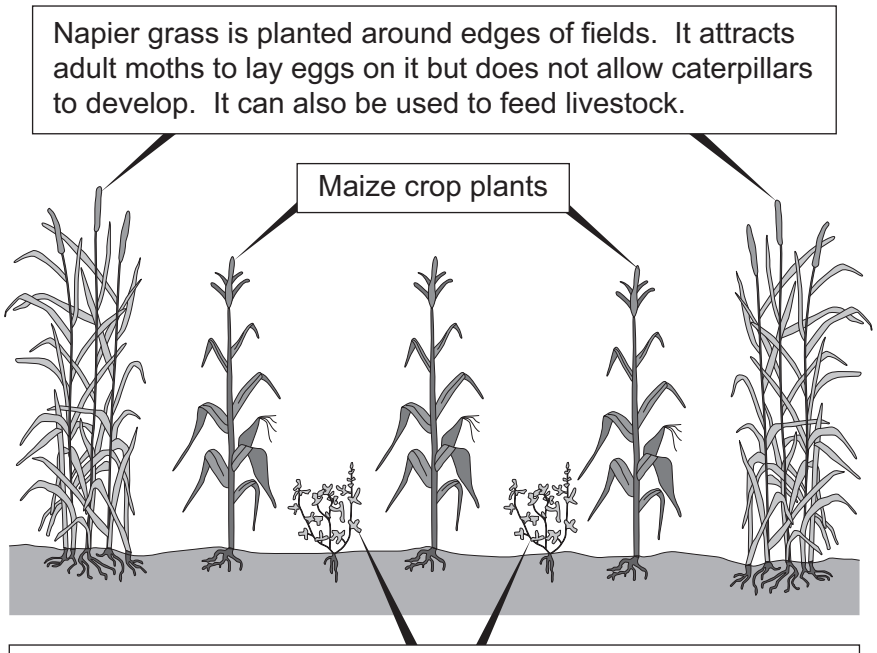
5 (b) Polyculture may be used to control pests and weeds.

The information in **Figure 5** explains how polyculture may be applied to maize crops in Kenya. Witchesweeds, *Striga* spp., and moth caterpillars are especially harmful to maize.

This method includes planting Napier grass, *Pennisetum purpureum*, and tick-trefoil, *Desmodium* spp., with the maize.

Figure 5

Witchesweeds are plants which are parasitic on maize. They produce huge numbers of seeds that stay dormant in the soil until their germination is triggered by chemicals released by the roots of maize and other plants.



5 (b) (i) Explain how this method of pest control may contribute to sustainable development.

[5 marks]

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5 (b) (ii) Suggest how scientists may be able to develop maize plants that produce chemicals to repel insect pests.

[2 marks]

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Turn over for the next question

6 A group of students compared biodiversity in an area of broad-leaved, semi-natural ancient woodland and in a plantation of Norway Spruce trees.

As part of their investigation, the students set ten light traps in each area to capture moths.

They recorded the number of species caught in each trap.

Table 5 shows the students' results.

Table 5

Number of moth species recorded in each trap	
Broad-leaved woodland	**Spruce plantation**
13	7
3	1
7	11
11	3
11	10
10	6
4	1
5	3
9	5
14	8

6 (a) (i) Suggest a suitable hypothesis for the students' investigation of the moth species in these two areas.

[1 mark]

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6 (a) (ii) Explain how the students could have planned the investigation to make sure their results were valid.

[4 marks]

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6 (a) (iii) Give **one** reason why the data collected would **not** allow the students to calculate a Species Diversity Index.

[1 mark]

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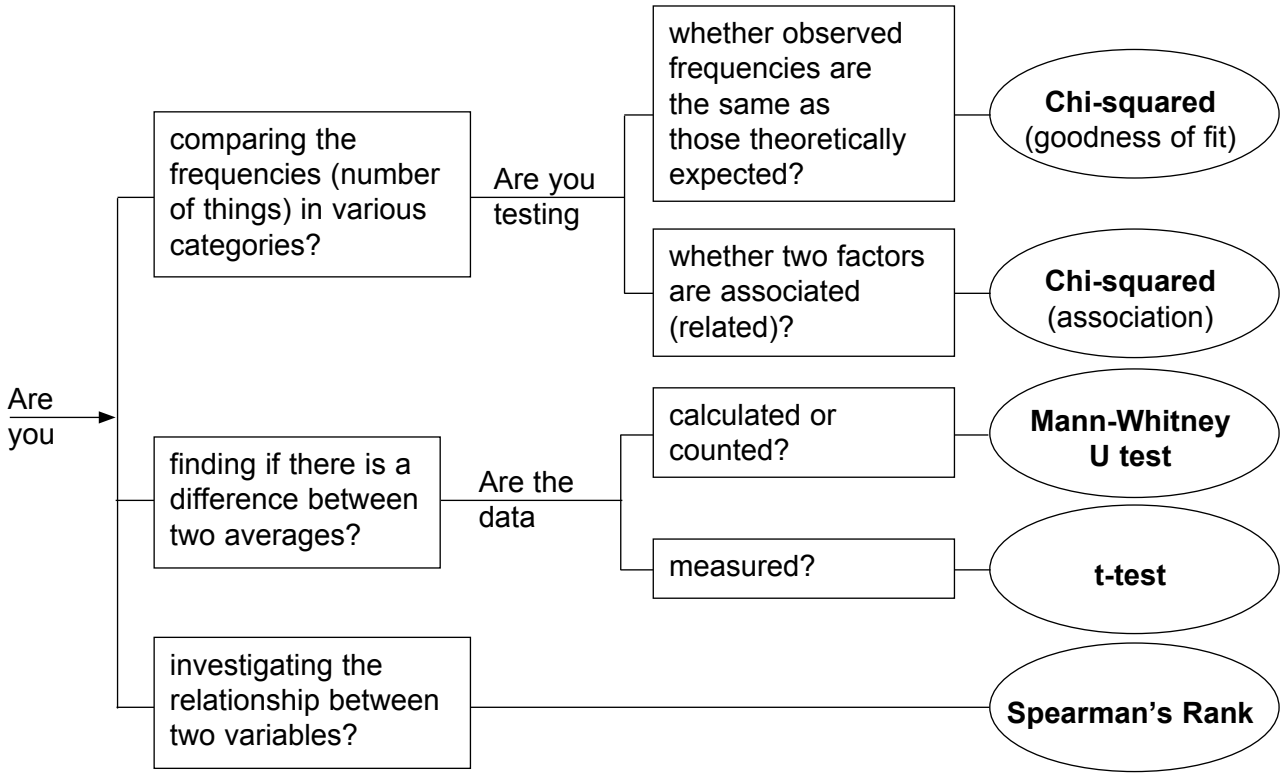
Question 6 continues on the next page

6 (b) **Figure 6** is a flow diagram which is used to help choose the correct statistical test to assess the significance of the results of an investigation.

Figure 6



Why is the Mann-Whitney U test the correct test to use to assess the significance of these results?

[1 mark]

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6 (c) **Figure 7** gives details of how to calculate and interpret values of Mann-Whitney U.

Figure 7

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1$$

$$U' = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2$$

where:

R_1 = sum of the ranks of sample 1
R_2 = sum of the ranks of sample 2
n_1 = size of the smaller sample
n_2 = size of the larger sample

Critical values for the Mann-Whitney U test (at the p = 0.05 level). If the smaller U value is less than or equal to the critical value then there is a significant difference between the two sets of data.

Values of n_1	Values of n_2																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2								0	0	0	0	1	1	1	1	1	2	2	2	2
3					0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8
4				0	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	13
5			0	1	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6			1	2	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
7			1	3	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8		0	2	4	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9		0	2	4	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10		0	3	5	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11		0	3	6	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12		1	4	7	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13		1	4	8	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14		1	5	9	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15		1	5	10	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16		1	6	11	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17		2	6	11	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18		2	7	12	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19		2	7	13	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20		2	8	13	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127

6 (c) (i) Identify the critical value of Mann-Whitney U for this investigation.

[1 mark]

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Turn over ▶

6 (c) (ii) The calculated values of U and U′ for this investigation were 73.5 and 26.5.

State and justify an appropriate conclusion for the investigation.

[2 marks]

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

Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.
You should answer this question in continuous prose.

Either

7 (a) Discuss ways in which personal lifestyles may be made more sustainable.

[20 marks]

or

7 (b) Discuss the ways in which agriculture may cause environmental pollution.

[20 marks]

or

7 (c) Discuss the importance of forests in providing resources and life-support services.

[20 marks]

Which question have you chosen?

Tick (✓) **one** box.

7 (a) ☐

7 (b) ☐

7 (c) ☐

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Extra space for Question 7 .....

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END OF QUESTIONS

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