Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2015

Science in Society SCIS3

Unit 3 Exploring Key Scientific Issues

Tuesday 16 June 2015 1.30 pm to 3.30 pm

For this paper you must have:
- a calculator
- a ruler.

Time allowed
- 2 hours

Instructions
A
- 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 90.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

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

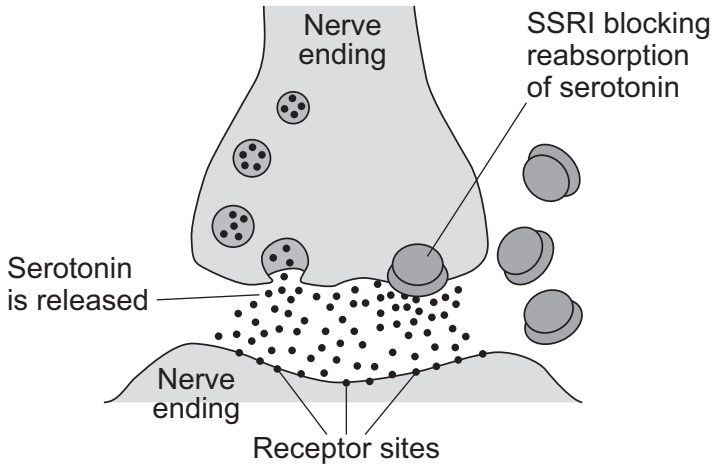
1 About 1 person in 5 in Britain will suffer from depression at some point in their life. The symptoms of depression include unhappiness, anxiety, loss of interest in life, inability to enjoy things and tiredness.

In the 1950s, doctors were treating tuberculosis (TB) with a drug called iproniazid. The drug had little effect on TB. However, the doctors observed that those TB patients with depression became less depressed.

Iproniazid was studied and found to inhibit the breakdown of the neurotransmitter serotonin. Scientists developed a hypothesis that low levels of serotonin cause depression.

New drugs called SSRIs were developed to increase serotonin levels. SSRIs do this in a different way from iproniazid, by blocking reabsorption of serotonin as shown in **Figure 1**.

Figure 1



1 (a) (i) Label the synapse on **Figure 1**.

[1 mark]

1 (a) (ii) Draw an arrow on **Figure 1** showing the direction of the nerve impulse.

[1 mark]

1 (a) (iii) Explain, with reference to **Figure 1**, why a decrease in serotonin level can change brain function.

[1 mark]

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1 (b) Prescriptions of SSRIs have continued to increase each year since their introduction in the 1980s. However, not all evidence supports the hypothesis that depression is caused by low levels of serotonin. Some of the evidence is given below in statements **A** to **D**.

A About 60% of people taking SSRIs show improvement in their depression.

B Average improvement for the 60% who do respond to SSRIs is about 30% better than their improvement when taking a placebo.

C SSRIs increase the level of serotonin in the brain within a few hours but patients only improve after a month or more on the drug.

D Some studies show that depressed patients have low levels of serotonin before treatment. Other studies do not show this.

1 (b) (i) Choose the item of evidence **A**, **B**, **C** or **D** above which most strongly contradicts the low-serotonin hypothesis.

Write the letter in the box below.

[1 mark]

1 (b) (ii) Explain your choice.

[2 marks]

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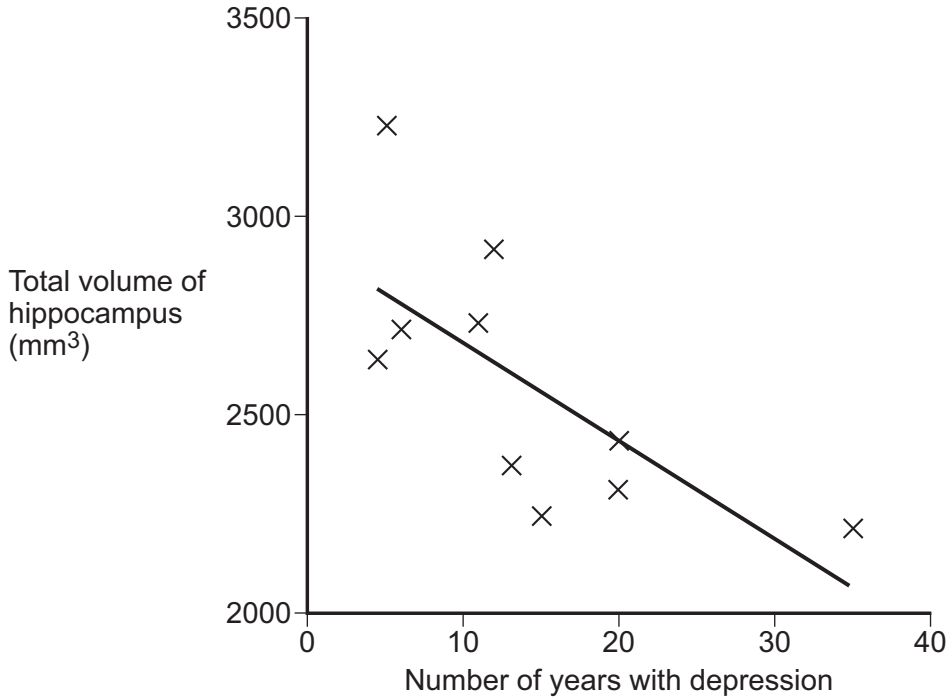
Question 1 continues on the next page

1 (c) In the 1990s, MRI brain scans became widely used in research into depression. These scans showed that the brains of severely depressed patients have a smaller hippocampus than the brains of people without depression.

New explanations for depression that included the role of the hippocampus were suggested.

One recent study measured the volume of the hippocampus in depressed patients after they had died. Researchers plotted the hippocampus volume against the number of years the patient had suffered from depression. The results are shown in **Figure 2**.

Figure 2



There is more than one possible explanation for the relationship shown in **Figure 2**.

Suggest **two** possible explanations.

[4 marks]

Explanation 1 .....

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Explanation 2 .....

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1 (d) (i) In the 2000s, scientists proposed the hypothesis that SSRIs treat depression, not because they increase serotonin levels, but because they stimulate the growth of neurons in the hippocampus.

Explain how this hypothesis would be consistent both with the evidence you chose in part (b)(i) and with the evidence on the size of the hippocampus in **Figure 2**.

[2 marks]

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Question 1 continues on the next page

1 (d) (ii) Use examples from this question to describe ways in which new scientific explanations are developed and then tested.

[6 marks]

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2 IQ tests are widely used as a measure of a human characteristic we call intelligence. Both genetic and environmental factors are known to influence IQ test scores. The relative importance of each factor is much debated.

2 (a) In most countries IQ test scores have increased over the last 100 years by about 10 IQ points per generation. The median IQ is defined as 100, and tests have to be re-standardised from time to time in order to bring the median back to 100.

2 (a) (i) Experts assume that this increase in IQ test scores is due to environmental changes and not to genetic changes in the population.

Explain why.

[2 marks]

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2 (a) (ii) Suggest **two** environmental changes that may have contributed to the increase in IQ test scores.

[2 marks]

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Question 2 continues on the next page

2 (b) It is widely accepted that, at any one time, more than 50% of the range of IQ test scores within a population is due to genetic differences.

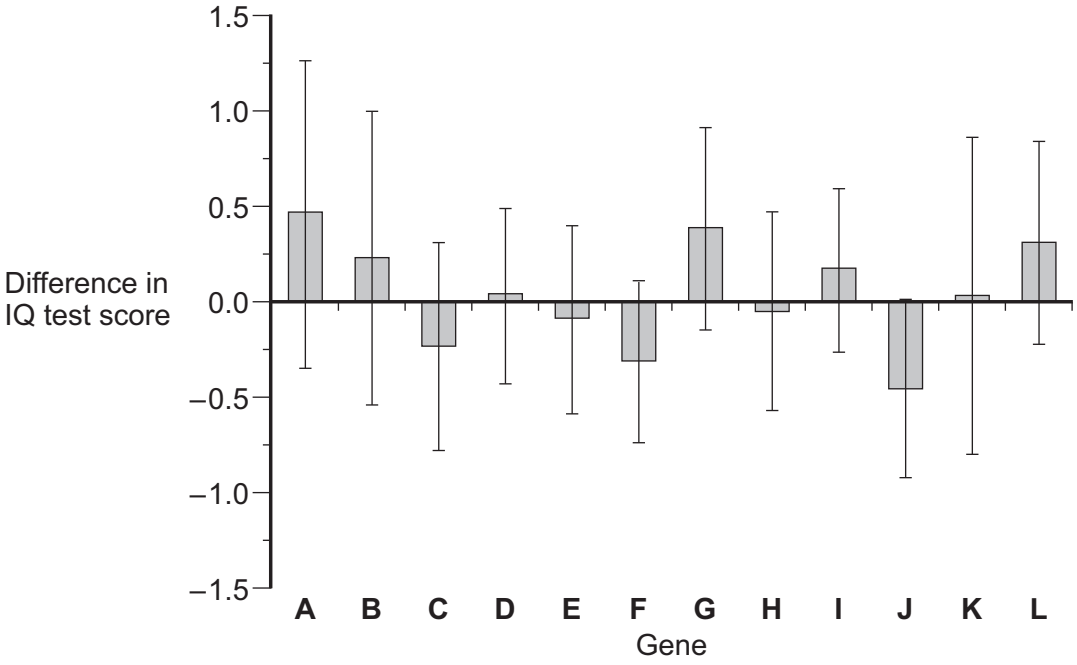
A number of research studies have identified genes whose alleles appear to influence IQ.

Some of these studies were repeated by a different team of researchers. This team studied the relationship between allele and IQ for 12 genes, **A** to **L**, that had been identified in the earlier studies. 10 000 people were included in this repeat study.

For each of the 12 genes, the team compared the IQ test scores of people with the less common allele with the scores of people with the more common allele.

Figure 3 shows the mean increase or decrease in IQ test score associated with the less common allele for genes **A** to **L**.

Figure 3



Note: the error bars show 95% confidence intervals.

2 (b) (i) The data in **Figure 3** indicate that **none** of these 12 genes has a statistically significant effect on IQ test scores.

Explain how the data show this.

[2 marks]

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2 (b) (ii) The title of the paper in which the results in **Figure 3** were published is:

Most Reported Genetic Associations With General Intelligence Are Probably False Positives.

A false positive means that, although data appear to show an association between a factor and an outcome, in fact there is no relationship between them.

The authors suggest that the false positives were due to small sample sizes.

Explain why small sample sizes are more likely to lead to false positives.

[2 marks]

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Question 2 continues on the next page

2 (c) Research on genes for intelligence is frequently reported in the popular media.

2 (c) (i) Suggest **two** reasons why some scientists might choose to promote their research in the popular media.

[2 marks]

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2 (c) (ii) The team who did the research described in part (b) expressed concern about the way news stories in the media often report unconfirmed associations between genes and intelligence. They believe that this both exaggerates the effect of any single gene and gives a false impression of the state of knowledge in the field.

The following are examples of headlines from such stories:

First intelligence gene discovered

Gene for intelligence identified.

Suggest **three** questions that an informed member of the public should ask when evaluating a media report that a 'gene for intelligence' has been identified.

[3 marks]

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2 (d) Some scientists who research the association between genes and intelligence have publicly justified their research in the following way:

"It may be possible to predict someone's intelligence from an early age, and to offer help to children who are at risk of learning disabilities."

Discuss whether or not you think very early genetic testing to predict intelligence would be a desirable application of the research, if it were to become possible.

[4 marks]

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Turn over for the next question

3 (a) Scientists agree that rising carbon dioxide concentrations cause a rise in mean global temperature due to the greenhouse effect.

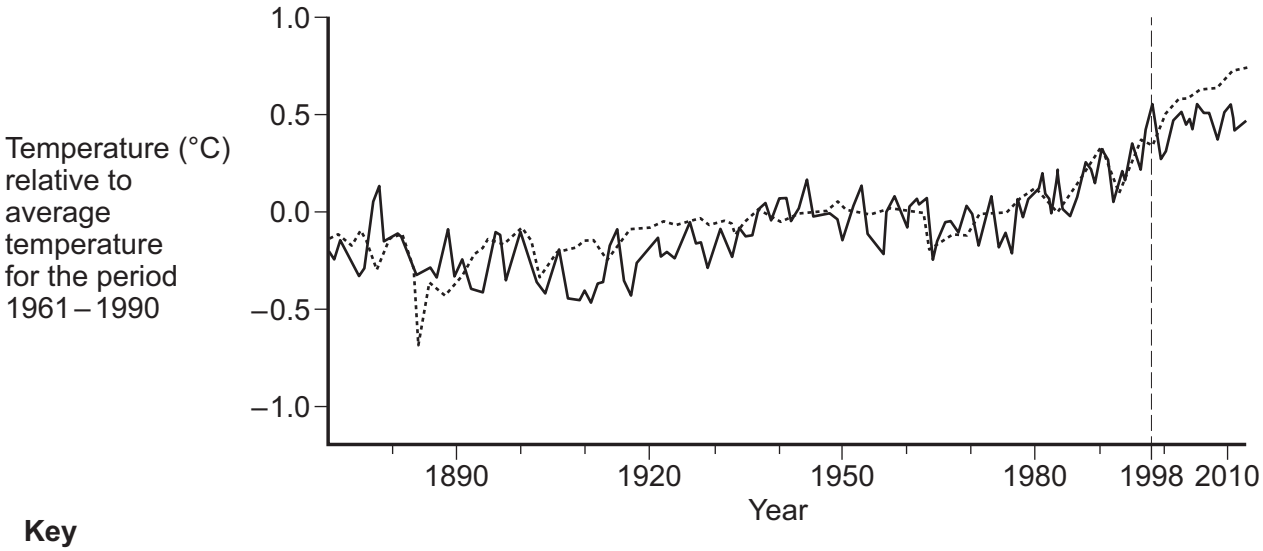
Draw and label a diagram to explain the greenhouse effect.

[3 marks]

3 (b) The solid line in **Figure 4** shows how the observed mean global surface air temperature has changed since 1870, relative to its average value for the period 1961–1990. This solid line indicates that the rate of increase in mean temperature since 1998 has been slower than over the previous 30 years.

The dotted line in **Figure 4** shows the change in mean global surface air temperature predicted by climate models.

Figure 4



Describe how the observed temperatures compare with the temperatures predicted by climate models, over the period 1870–1998, as shown in **Figure 4**.

[2 marks]

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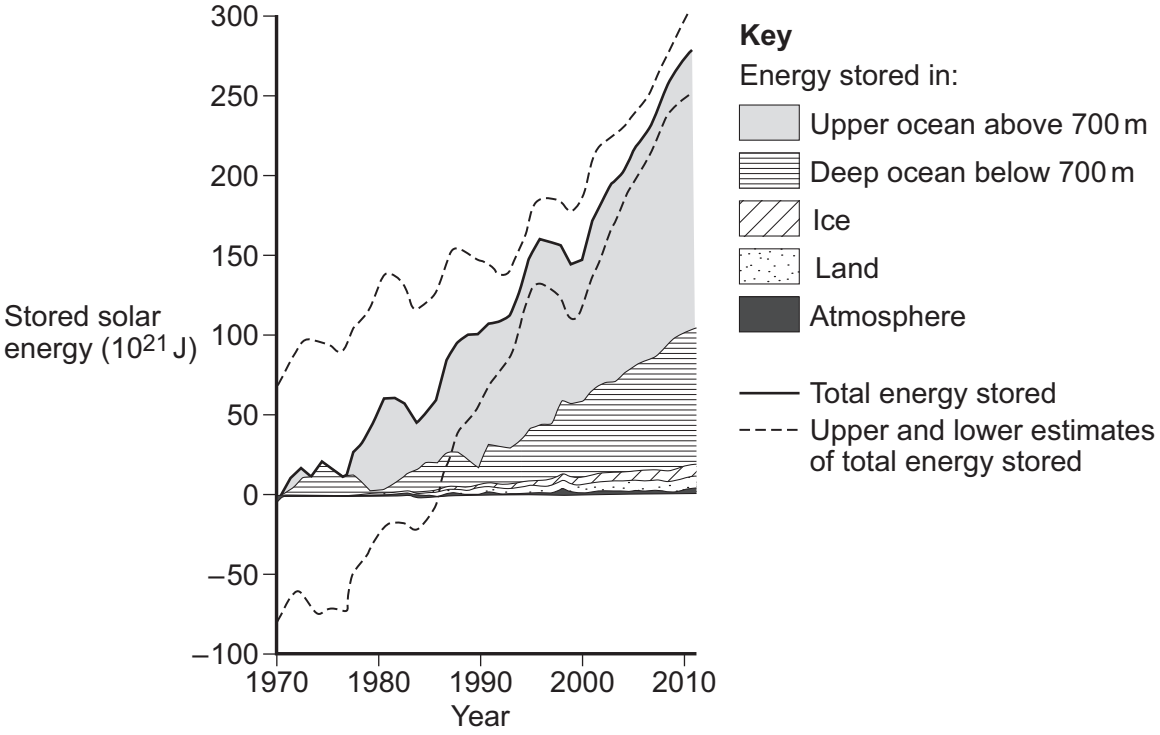
Question 3 continues on the next page

3 (c) Climate modellers still do not fully understand the climate system. In particular, the role of the oceans in influencing climate change is still poorly understood.

It is known that less energy is leaving Earth as radiation than is arriving as solar radiation. Measurements indicate that the oceans store about 94% of all this energy gain, as shown in **Figure 5**.

Figure 5 Solar energy stored in different components of the Earth's climate system (relative to 1971) as estimated from observations



3 (c) (i) Suggest how the changes in the solar energy stored in the oceans, as shown in **Figure 5**, might explain the observed lack of warming of the surface air temperature since 1998, as shown in **Figure 4**.

[1 mark]

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3 (c) (ii) Suggest **two** reasons why, as shown in **Figure 5**, the difference between upper and lower estimates of total energy stored has decreased so much over the period.

[2 marks]

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3 (d) The observed temperature data since 1998, shown in **Figure 4**, was reported in some news media under headlines such as:

Global warming 'proof' is disappearing

Human induced global warming may no longer be happening.

The data, when considered together with our understanding of the climate, do not justify these comments.

Explain why.

[4 marks]

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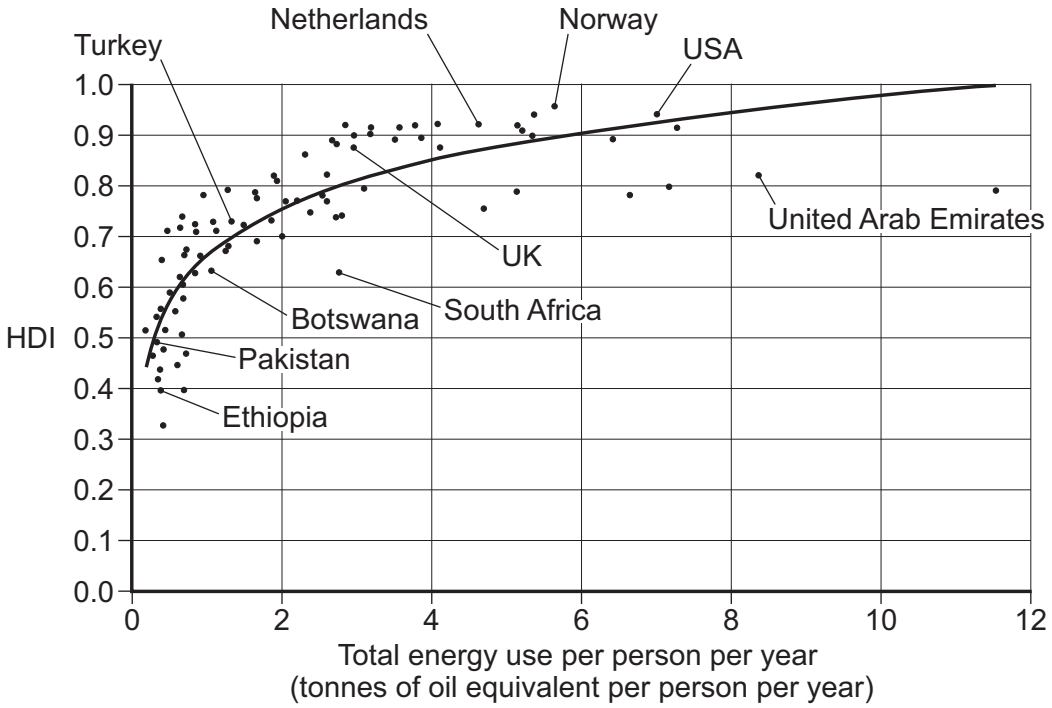
Turn over for the next question

4 The Human Development Index (HDI) provides an indicator of general well-being in a society. Its value ranges from 0 to 1. It is calculated by the United Nations using three factors: life expectancy, education and income.

Figure 6 shows a plot of HDI against total energy use per person per year for a range of countries. Each country is represented by a dot. Total energy includes all fuels used but is expressed as tonnes of oil equivalent.

Figure 6



4 (a) Describe how HDI varies with total energy use per person per year as shown in **Figure 6**.

[3 marks]

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4 (b) (i) Three different factors are used to calculate HDI.

For each factor, give **one** example of a use of energy that might raise HDI.

[3 marks]

Life expectancy

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Education

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Income

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4 (b) (ii) An HDI of 0.75 or above is defined as a high level of development.

What range of energy use per person per year is found in countries at or close to this threshold (0.7–0.8 HDI)?

[1 mark]

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4 (b) (iii) Some countries with similar HDI of between 0.7 and 0.8 have very different energy use per person per year.

Suggest **two** reasons why.

[2 marks]

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Question 4 continues on the next page

4 (c) In December 2015 there will be a major conference aimed at reaching international agreement on reducing global carbon dioxide emissions. These emissions are mainly produced by burning fuels. In the past similar conferences have struggled to reach agreement because of conflicts of interest between the richer and poorer countries.

Suggest and explain **two** reasons for such conflicts of interests. Use the data in **Figure 6** to support your answer.

[4 marks]

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Turn over for the next question

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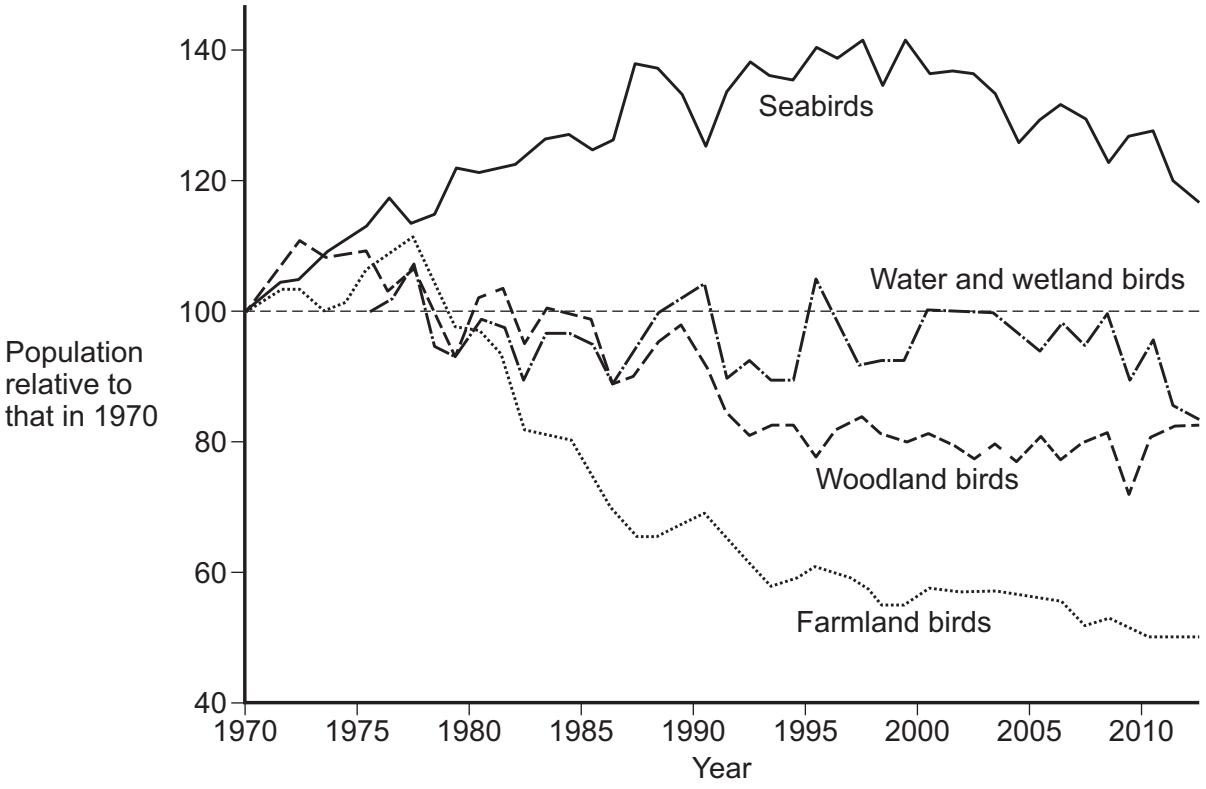
5 **Figure 7** shows how the population of birds in different habitats in the UK changed between 1970 and 2012, relative to the population in 1970.

Figure 7



5 (a) Many birds are high up in the food chain. This means they are good indicators of the general state of biodiversity.

5 (a) (i) Explain the meaning of the phrase **high up in the food chain**.

[2 marks]

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5 (a) (ii) Explain the meaning of the term **biodiversity**.

[2 marks]

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5 (b) From 1973 to 1987, grants to farmers were aimed at increasing food production from farmland in the UK. The more intensive farming practices encouraged by these grants are thought to be the main cause of the fall in the population of farmland birds.

5 (b) (i) Name **one** feature of more intensive farming and explain why it might cause some bird species to decline.

[2 marks]

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5 (b) (ii) Since 1987 the government has developed Agri-Environment Schemes (AES) to try to halt the decline in farmland birds.

AES grants pay farmers to manage land in ways that should increase biodiversity in the environment. These grants compensate farmers for any loss of productivity.
Farmers can choose from a variety of different farm management options that all qualify for AES grants.

Describe what the data in **Figure 7** suggest about the effectiveness of AES grants so far.

[2 marks]

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Question 5 continues on the next page

5 (c) The skylark is an endangered species in the UK. It was once a common farmland bird but its total population has declined by about 60% over the last 30 years.

Three of the AES options are expected to benefit skylarks. **Table 1** shows the rate of population change for skylarks in areas with and without these AES options over the period 2001–2011. A rate of more than 1 means that the population is increasing.

Data are taken from 2000 randomly selected 1 km squares over all types of lowland farmland. Similar areas with and without AES were compared.

Table 1 Rate of population change for skylarks in areas with and without AES options over the period 2001–2011

	AES option		
	Stubble management	**Wild bird seed in winter**	**Grassland management**
% of all AES grant payments	22%	6.2%	9.5%
Rate of population change at end of period with AES	0.88	0.89	0.80
Rate of population change at end of period without AES	0.85	0.86	0.78

Note: all differences in rate between farms with and without AES are statistically significant ($p < 0.05$).

5 (c) (i) Suggest **two** difficulties in the collection of accurate data for such a study.

[2 marks]

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5 (c) (ii) Give **two** conclusions about the impact of AES on skylark populations that can be drawn from the results in **Table 1**.

[2 marks]

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5 (d) The government pays farmers about £500 million a year in AES grants.

Outline arguments for and against the government spending money on biodiversity conservation in this way.

[6 marks]

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6 The public often perceive risk very differently from the risk as estimated by experts. GM crops, air pollution and nuclear waste are all examples of issues where decision making has been influenced by public perception of risk.

Discuss the ways in which the perception of risk by the public has influenced decision making, even where this differs from the estimates of risk by experts.

- Include examples where the public underestimate risk and cases where the public overestimate risk.
- Describe the factors which may have affected public perception of risk in these cases.

[12 marks]

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END OF QUESTIONS

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Figure 2: Cobb et al, Hippocampal volume and total cell numbers in major depressive disorder. Journal of Psychiatric Research (March 2013) volume 47 number 3, pages 299-306.

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Figure 7: Contains public sector information licensed under the Open Government Licence v2.0. 'Wild bird populations in the UK. 1970 to 2012', Defra, copyright 2013.